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Technical Reference

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Technical Reference

Revised Edition (March 1986)

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CAUTION

This product described herein is equipped with a grounded plug for the user's safety. It is to be used in conjunction with a properly grounded receptacle to avoid electrical shock.

Notes:

Preface

This publication describes the various components of the IBM Personal Computer XT and IBM Portable Personal Computer; and the interaction of each.

The information in this publication is for reference, and is intended for hardware and program designers, programmers, engineers, and anyone else with a knowledge of electronics and/or programming who needs to understand the design and operation of the IBM Personal Computer XT or IBM Portable Personal Computer.

This publication consists of two parts: a system manual and an options and adapters manual.

The system manual is divided into the following sections:

Section 1, "System Board", discusses the component layout, circuitry, and function of the system board.

Section 2, "Coprocessor", describes the Intel 8087 coprocessor and provides programming and hardware interface information.

Section 3, "Power Supply", provides electrical input/output specifications as well as theory of operation for both the IBM Personal Computer XT power supply and the IBM Portable Personal Computer power supply.

Section 4, "Keyboard", discusses the hardware makeup, function, and layouts of the IBM Personal Computer XT 83-key and 101/102-key keyboards and the IBM Portable Personal Computer keyboard. In addition, keyboard encoding and usage is discussed.

Section 5, "System Bios", describes the basic input/output system and its use. This section also contains the software

interrupt listing, a BIOS memory map, descriptions of vectors with special meanings, and a set of low memory maps.

Section 6, "Instruction Set", provides a quick reference for the 8088 and 8087 assembly instruction set.

Section 7, "Characters, Keystrokes, and Colors", supplies the decimal and hexadecimal values for characters and text attributes.

A glossary, bibliography, and index are also provided.

The *Technical Reference* Options and Adapters manual provides information, logic diagrams, and specifications pertaining to the options and adapters available for the IBM Personal Computer family of products. The manual is modular in format, with each module providing information about a specific option or adapter. Modules having a large amount of text contain individual indexes. The modules are grouped by type of device into the following categories:

- Expansion Unit
- Displays
- Printers
- Storage Devices
- Memory Expansion
- Adapters
- Miscellaneous
- Cables and Connectors.

Full-length hard-tab pages with the above category descriptions, separate the groups of modules.

The term "*Technical Reference* manual" in the Options and Adapters manual, refers to the:

- IBM Personal Computer XT/IBM Portable Personal Computer *Technical Reference* manual
- IBM Personal Computer *Technical Reference* manual
- IBM Personal Computer AT *Technical Reference* manual.

The term "*Guide to Operations* manual" in the Options and Adapters manual, refers to the:

- IBM Personal Computer *Guide to Operations* manual
- IBM Personal Computer XT *Guide to Operations* manual
- IBM Portable Personal Computer *Guide to Operations* manual
- IBM Personal Computer AT *Guide to Operations* manual.

Prerequisite Publications

- IBM Personal Computer XT *Guide to Operations*
- IBM Portable Personal Computer *Guide to Operations.*

Suggested Reading

- *BASIC for the IBM Personal Computer*
- *Disk Operating System (DOS)*
- *Hardware Maintenance Service* manual
- *Hardware Maintenance Reference* manual
- *Macro Assembler for the IBM Personal Computer.*

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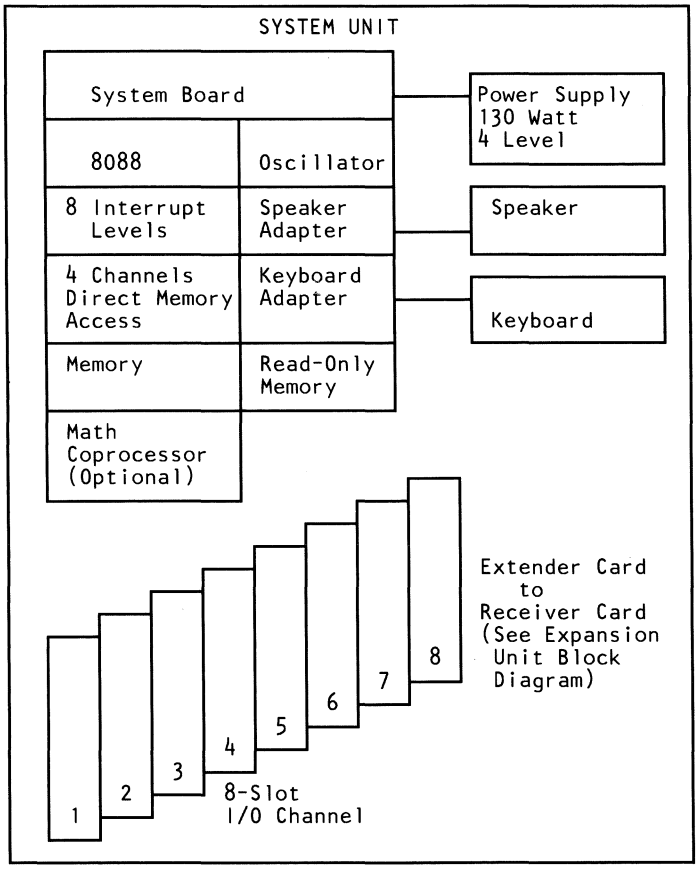
System Block Diagram (XT)

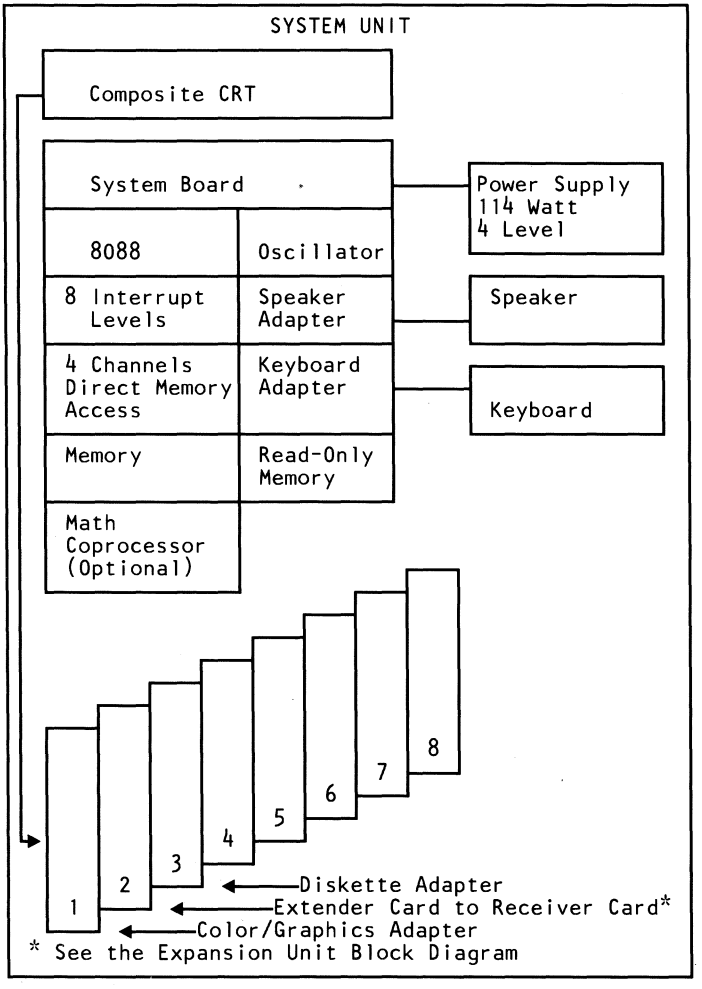
The following is a system block diagram of the IBM Personal Computer XT.



Note: A "System to Adapter Compatibility Chart," to identify the adapters supported by each system, and an "Option to Adapter Compatibility Chart," to identify the options supported by each adapter, can be found in the front matter of the *Technical Reference* Options and Adapters manual, Volume 1.

System Block Diagram (Portable)

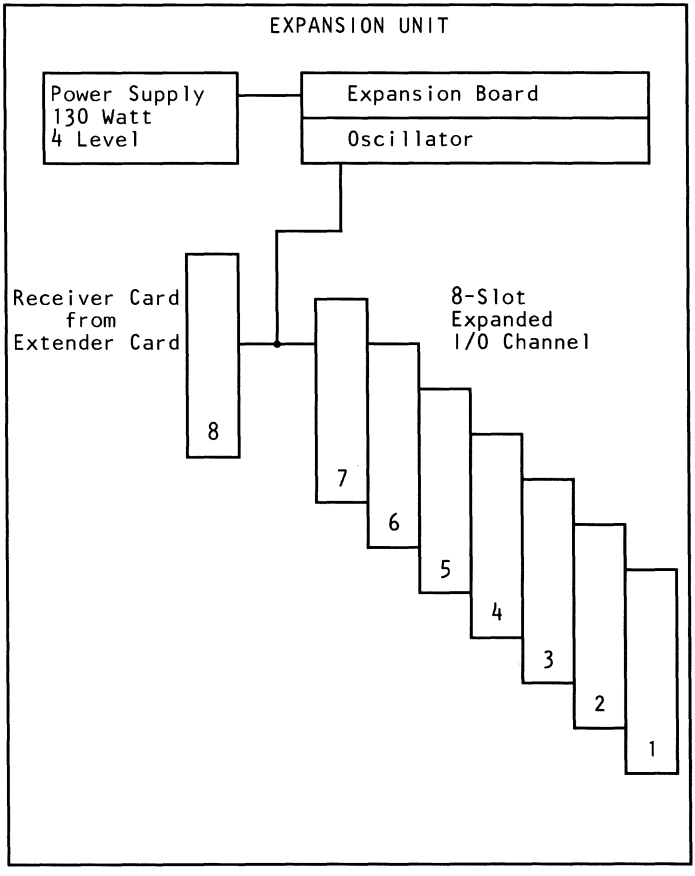
The following is a system block diagram of the IBM Portable Personal Computer.



Note: A "System to Adapter Compatibility Chart," to identify the adapters supported by each system, and an "Option to Adapter Compatibility Chart," to identify the options supported by each adapter, can be found in the front matter of the *Technical Reference* Options and Adapters manual, Volume 1.

Expansion Unit Block Diagram

The following is an expansion unit block diagram for the IBM Portable Personal Computer and IBM Personal Computer XT with the 64/256K system board.



Note: A "System to Adapter Compatibility Chart," to identify the adapters supported by each system, and an "Option to Adapter Compatibility Chart," to identify the options supported by each adapter, can be found in the front matter of the *Technical Reference* Options and Adapters manual, Volume 1.

Notes:

SECTION 1. SYSTEM BOARD

Notes:

Description

The system board fits horizontally in the base of the system unit of the Personal Computer XT and Portable Personal Computer and is approximately 215 mm by 304 mm (8-1/2 x 12 in.). It is a multilayer, single-land-per-channel design with ground and internal planes provided. DC power and a signal from the power supply enter the board through two 6-pin connectors. Other connectors on the board are for attaching the keyboard and speaker. Eight 62-pin card-edge sockets are also mounted on the board. The I/O channel is bussed across these eight I/O slots. Slot J8 is slightly different from the others in that any card placed in it is expected to respond with a 'card selected' signal whenever the card is selected.

A dual in-line package (DIP) switch (one 8-switch pack) is mounted on the board and can be read under program control. The DIP switch provides the system programs with information about the installed options, how much storage the system board has, what type of display adapter is installed, whether or not the coprocessor is installed, what operational modes are desired when power is switched on (color or black-and-white, 80- or 40-character lines), and the number of diskette drives attached.

The system board contains the adapter circuits for attaching the serial interface from the keyboard. These circuits generate an interrupt to the microprocessor when a complete scan code is received. The interface can request execution of a diagnostic test in the keyboard.

The system board consists of five functional areas: the processor subsystem and its support elements, the ROM subsystem, the read/write (R/W) memory subsystem, integrated I/O adapters, and the I/O channel. All are described in this section.

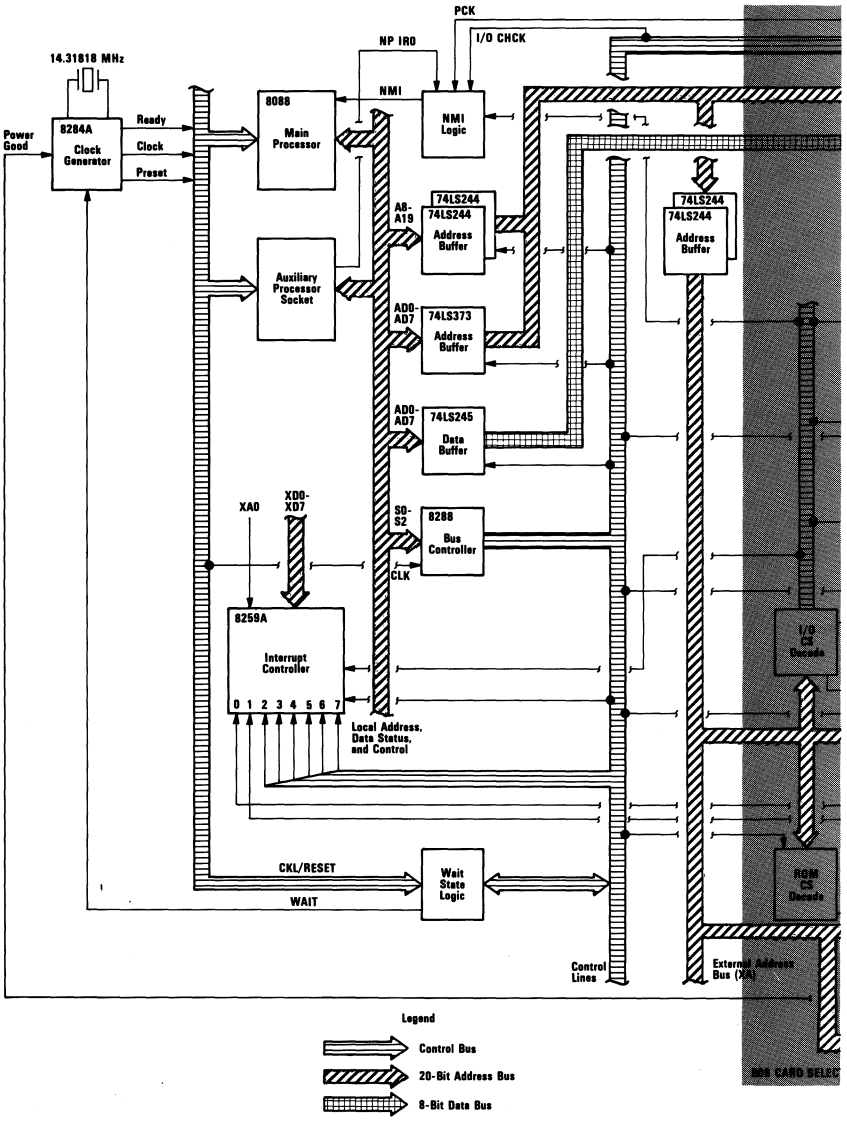
Microprocessor

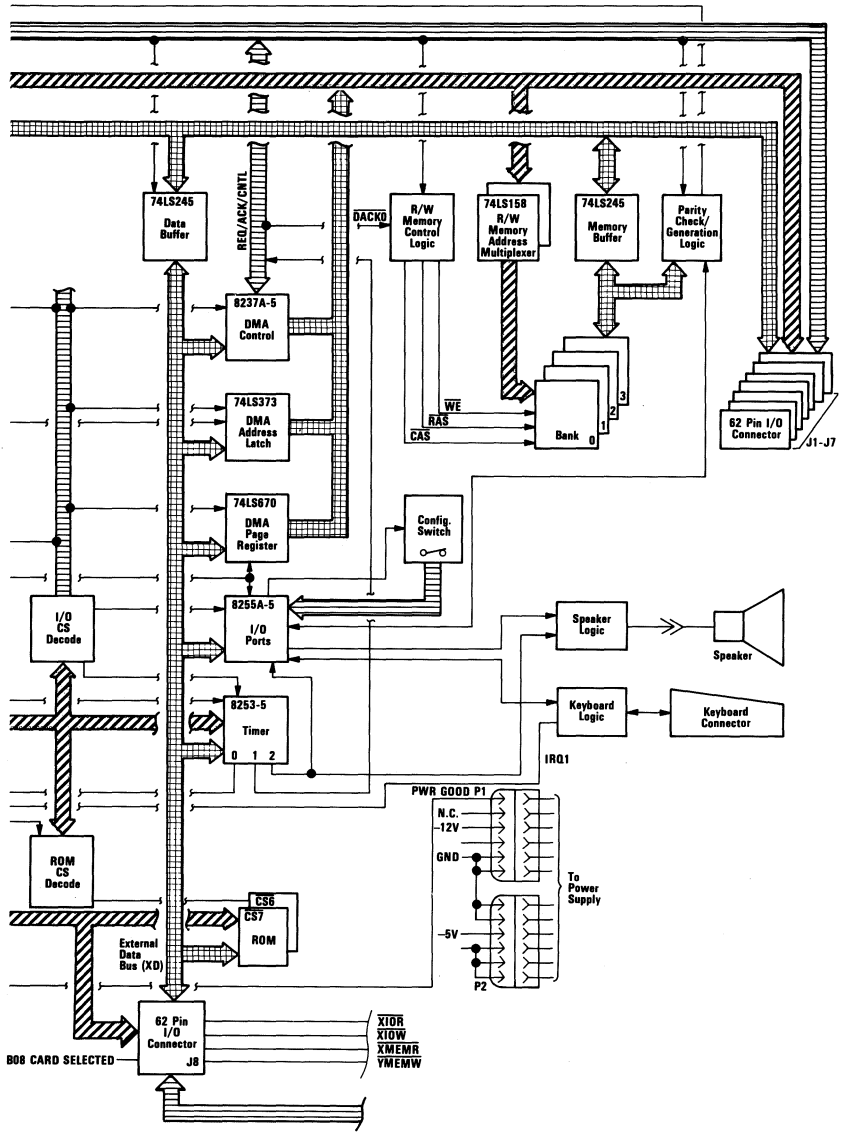
The heart of the system board is the Intel 8088 Microprocessor. This is an 8-bit external-bus version of Intel's 16-bit 8086 Microprocessor, and is software-compatible with the 8086. Thus, the 8088 supports 16-bit operations, including multiply and divide, and 20 bits of addressing (1M byte of storage). It also operates in maximum mode, so a coprocessor can be added as a feature. The microprocessor operates at 4.77MHz. This frequency is derived from a 14.31818MHz crystal, the frequency of which is divided by 3 for the microprocessor clock, and divided by 4 to obtain the 3.58MHz color-burst signal required for color televisions.

At the 4.77MHz clock rate, the 8088 bus cycles are four clocks of 210 nanoseconds (ns) each, or 840ns total. Some I/O cycles take five 210ns clocks or 1.05 microseconds (μs).

Data Flow Diagrams

The system board data flow diagram starts on the next page.


PCK
NP IRQ
I/O CHCK
14.31818 MHz
NMI
8088
Main Processor
NMI Logic
Power Good
8284A
Clock Generator
Ready
Clock
Reset
74LS244
74LS244
Address Buffer
A8-A19
Auxiliary Processor Socket
AD0-AD7
74LS373
Address Buffer
74LS245
Data Buffer
XA0
XD0-XD7
S0-S2
8288
Bus Controller
CLK
8259A
Interrupt Controller
0 1 2 3 4 5 6 7
Local Address, Data Status, and Control
I/O CS Decode
ROM CS Decode
CKL/RESET
WAIT
Wait State Logic
Control Lines
External Address Bus (XA)
Legend
Control Bus
20-Bit Address Bus
8-Bit Data Bus


74LS245
Data
Buffer
REQ/ACK/CNTL
DACK0
R/W
Memory
Control
Logic
74LS158
R/W
Memory
Address
Multiplexer
74LS245
Memory
Buffer
Parity
Check/
Generation
Logic
8237A-5
DMA
Control
74LS373
DMA
Address
Latch
74LS670
DMA
Page
Register
WE
RAS
CAS
Bank 0 1 2 3
62 Pin I/O
Connector
J1-J7
Config.
Switch
I/O
CS
Decode
8255A-5
I/O
Ports
Speaker
Logic
Speaker
8253-5
Timer
0 1 2
Keyboard
Logic
Keyboard
Connector
IRQ1
PWR GOOD P1
N.C.
-12V
GND
-5V
P2
To
Power
Supply
ROM
CS
Decode
CS6
CS7
ROM
External
Data
Bus (XD)
62 Pin
I/O
Connector
J8
B08 CARD SELECTED
XIOR
XIOW
XMEMR
YMEMW

System Memory Map

Start Address		Function	
Decimal	Hex	64/256K	256/640K
0K	00000	128-256K Read/Write Memory on the System Board	256-640K Read/Write Memory on the System Board
16K	04000		
32K	08000		
48K	0C000		
64K	10000		
80K	14000		
86K	18000		
112K	1C000		
128K	20000		
144K	24000		
160K	28000		
176K	2C000		
192K	30000		
208K	34000		
224K	38000		
240K	3C000		
256K	40000	384K R/W Memory Expansion in the I/O Channel	
272K	44000		
288K	48000		
304K	4C000		
320K	50000		
336K	54000		
352K	58000		
368K	5C000		
384K	60000		
400K	64000		
416K	68000		
432K	6C000		
448K	70000		
464K	74000		
480K	78000		
496K	7C000		
512K	80000		
528K	84000		
544K	88000		
560K	8C000		
576K	90000		
592K	94000		
608K	98000		
624K	9C000		

System Memory Map (Part 1 of 2)

Start Address		Function
Decimal	Hex	64/256K & 256/640K
640K	A0000	128K Reserved
656K	A4000	
672K	A8000	
688K	AC000	
704K	B0000	Monochrome
736K	B8000	Color/Graphics
752K	BC000	
768K	C0000	Enhanced Graphics
784K	C6000	Professional Graphics
800K	C8000	Fixed Disk Control
816K	CC000	PC Network
832K	D0000	Cluster
848K	D4000	192K Read Only Memory Expansion and Control
864K	D8000	
880K	DC000	
896K	E0000	
912K	E4000	
928K	E8000	
944K	EC000	
960K	F0000	64K Base system BIOS and BASIC ROM
976K	F4000	
992K	F8000	
1008K	FC000	

System Memory Map (Part 2 of 2)

System Timers

Three programmable timer/counters are used by the system as follows: Channel 0 is used as a general-purpose timer providing a constant time base for implementing a time-of-day clock.

Channel 0	**System Timer**
GATE 0	Tied on
CLK IN 0	1.193182 MHz OSC
CLK OUT 0	8259A IRQ 0

Channel 1 is used to time and request refresh cycles from the DMA channel.

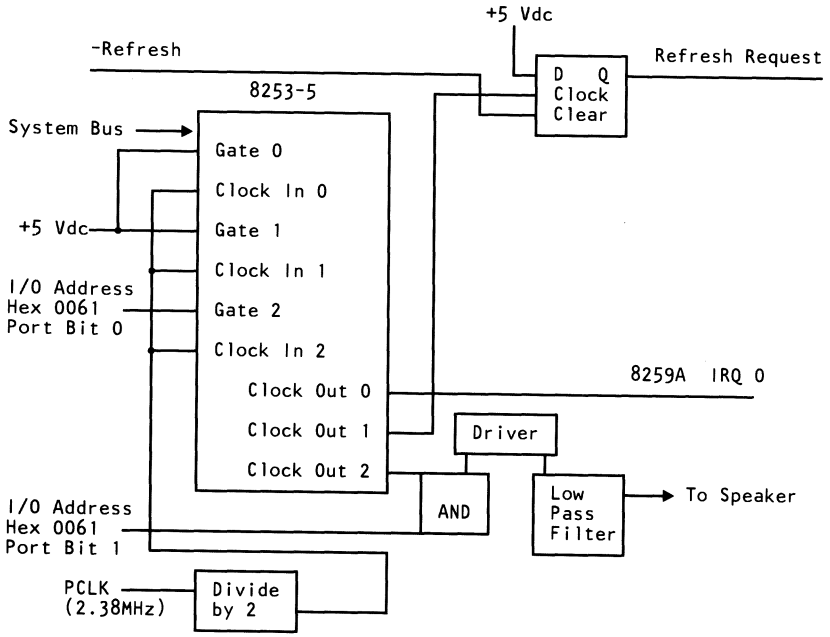
Channel 1	**Refresh Request Generator**
GATE 1	Tied on
CLK IN 1	1.193182 MHz OSC
CLK OUT 1	Request refresh cycle

> **Note:** Channel 1 is programmed as a rate generator to produce a 15-microsecond period signal.

Channel 2 is used to support the tone generation for the audio speaker. Each channel has a minimum timing resolution of 1.05μs.

Channel 2	**Tone Generation for Speaker**
GATE 2	Controlled by bit 0 of port hex 61, PPI bit
CLK IN 2	1.193182 MHz OSC
CLK OUT 2	Used to drive the speaker

The 8254-2 Timer/Counter is a programmable interval timer/counter that system programs treat as an arrangement of four external I/O ports. Three ports are treated as counters; the fourth is a control register for mode programming. The following is a system-timer block diagram.



System-Timer Block Diagram

System Interrupts

Of the eight prioritized levels of interrupt, six are bussed to the system expansion slots for use by feature cards. Two levels are used on the system board. Level 0, the higher priority, is attached to Channel 0 of the timer/counter and provides a periodic interrupt for the time-of-day clock. Level 1 is attached to the keyboard adapter circuits and receives an interrupt for each scan code sent by the keyboard.

The non-maskable interrupt (NMI) of the 8088 is used to report memory parity errors.

The following diagram contains the System Interrupt Listing.

Number	Usage
NMI	Parity 8087
0	Timer
1	Keyboard
2	EGA Display, PC Net, 3278/79
3	Asynchronous Communications (Alternate) PC Net(Alternate) 3278/79(Alternate) SDLC Communications BSC Communications Cluster (Primary)
4	Asynchronous Communications (Primary) SDLC Communications BSC Communications Voice Communications Adapter *
5	Fixed Disk
6	Diskette
7	Printer Cluster (Alternate)
* Jumper selectable to 2, 3, 4, 7.	

8088 Hardware Interrupt Listing

System Boards

There are two types of system boards, 64/256K and 256/640K.

RAM

64/256K System Board

The 64/256K system board has either 128K or 256K of R/W memory. Memory greater than the system board's maximum of 256K is obtained by adding memory cards in the expansion slots. The memory consists of dynamic 64K by 1 bit chips with an access time of 200ns and a cycle time of 345ns. All R/W memory is parity-checked.

256/640K System Board

The 256/640K system board has either 256K, 512K or 640K of R/W memory. The memory consists of dynamic 64K by 1 bit chips in Banks 2 and 3 and dynamic 256K by 1 bit chips in Banks 0 and 1 with an access time of 200ns and a cycle time of 345ns. All R/W memory is parity-checked.

System Board	Minimum Storage	Maximum Storage	Memory Modules	Pluggable (Banks 0-1)	Pluggable (Banks 2-3)
64/256K	64K	256K	64K by 1 bit	2 Banks of 9	2 Banks of 9
256/640K	256K	640K	256K by 1 bit and 64K by 1 bit	2 Banks of 9	2 Banks of 9

ROM

The system board supports both read only memory (ROM) and R/W memory. It has space for 64K by 8 of ROM or erasable programmable read-only memory (EPROM). Two module sockets are provided, each of which can accept a 32K or 8K device. On the 64/256K system board, one socket has 32K by 8 bits of ROM, the other 8K by 8 bits. On the 256/640K system board, both sockets have 32K by 8 bits of ROM installed. This ROM contains the power-on self test, I/O drivers, dot patterns for 128 characters in graphics mode, and a diskette bootstrap loader. The ROM is packaged in 28-pin modules and has an access time and a cycle time of 250ns each.

DMA

The microprocessor is supported by a set of high-function support devices providing four channels of 20-bit direct-memory access (DMA), three 16-bit timer/counter channels, and eight prioritized interrupt levels.

Three of the four DMA channels are available on the I/O bus and support high-speed data transfers between I/O devices and memory without microprocessor intervention. The fourth DMA channel is programmed to refresh the system's dynamic memory. This is done by programming a channel of the timer/counter device to periodically request a dummy DMA transfer. This action creates a memory-read cycle, which is available to refresh dynamic memory both on the system board and in the system expansion slots. DMA data transfers take five clock cycles of 210ns, or 1.05μs. (See I/O CH RDY on page 1-22.) Refresh cycles occur once every 72 clocks (approximately 15μs) and require four clocks or approximately 5.6% of the bus bandwidth.

The following formula determines the percentage of bandwidth used for refresh.

64K X 1

$$\%\ \text{Bandwidth used for Refresh} = \frac{4\ \text{cycles} \times 128}{1.93\text{ms}/210\text{ns}} = \frac{512}{9190} = 5.6\%$$

256K X 1

$$\%\ \text{Bandwidth used for Refresh} = \frac{4\ \text{cycles} \times 256}{3.86\text{ms}/210\text{ns}} = \frac{1024}{19048} = 5.6\%$$

I/O Channel

The I/O channel is an extension of the 8088 microprocessor bus. It is, however, demultiplexed, repowered, and enhanced by the addition of interrupts and direct memory access (DMA) functions.

The I/O channel contains an 8-bit, bidirectional data bus, 20 address lines, 6 levels of interrupt, control lines for memory and I/O read or write, clock and timing lines, 3 channels of DMA control lines, memory refresh-timing control lines, a 'channel check' line, and power and ground for the adapters. Four voltage levels are provided for I/O cards: +5 Vdc ± 5%, -5 Vdc ± 10%, +12 Vdc ± 5%, and -12 Vdc ± 10%. These functions are provided in a 62-pin connector with 100-mil card tab spacing.

An 'I/O channel ready' line (I/O CH RDY) is available on the I/O channel to allow operation with slow I/O or memory devices. These devices can pull I/O CH RDY low to add wait states to the following operations:

- Normal memory read and write cycles take four 210ns clocks for a cycle time of 840ns/byte.
- Microprocessor-generated I/O read and write cycles require five clocks for a cycle time of 1.05μs/byte.
- DMA transfers require five clocks for a cycle time of 1.05μs/byte.

I/O devices are addressed using I/O mapped address space. The channel is designed so that 768 I/O device addresses are available to the I/O channel cards.

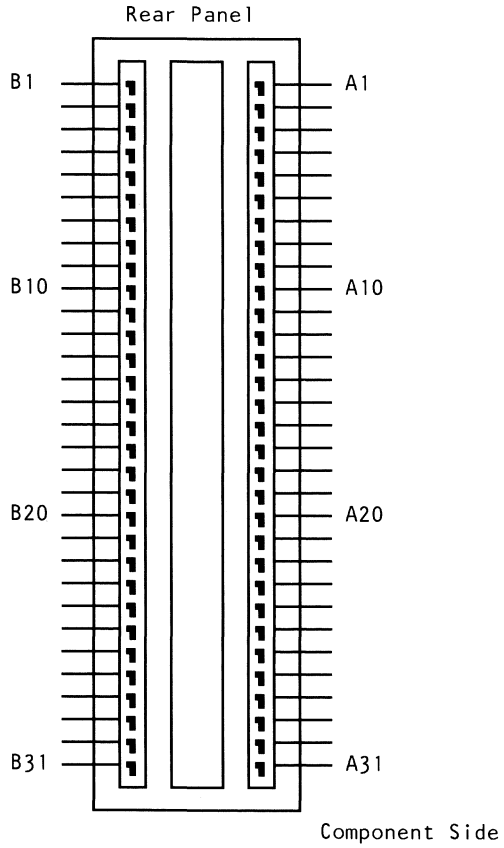
A 'channel check' line exists for reporting error conditions to the microprocessor. Activating this line results in a non-maskable interrupt (NMI) to the 8088 microprocessor. Memory expansion options use this line to report parity errors.

The I/O channel is repowered to provide sufficient drive to power all eight (J1 through J8) expansion slots, assuming two low-power

Schottky (LS) loads per slot. The IBM I/O adapters typically use only one load.

Timing requirements on slot J8 are much stricter than those on slots J1 through J7. Slot J8 also requires the card to provide a signal designating when the card is selected.

The following figure shows the pin numbering for I/O channel connectors J1 through J8.



I/O Channel Pin Numbering (J1-J8)

The following figures show signals and voltages for the I/O channel connectors.

I/O Pin	Signal Name	I/O
A1	-I/O CH CK	I
A2	SD7	I/O
A3	SD6	I/O
A4	SD5	I/O
A5	SD4	I/O
A6	SD3	I/O
A7	SD2	I/O
A8	SD1	I/O
A9	SD0	I/O
A10	I/O CH RDY	I
A11	AEN	O
A12	SA19	I/O
A13	SA18	I/O
A14	SA17	I/O
A15	SA16	I/O
A16	SA15	I/O
A17	SA14	I/O
A18	SA13	I/O
A19	SA12	I/O
A20	SA11	I/O
A21	SA10	I/O
A22	SA9	I/O
A23	SA8	I/O
A24	SA7	I/O
A25	SA6	I/O
A26	SA5	I/O
A27	SA4	I/O
A28	SA3	I/O
A29	SA2	I/O
A30	SA1	I/O
A31	SA0	I/O

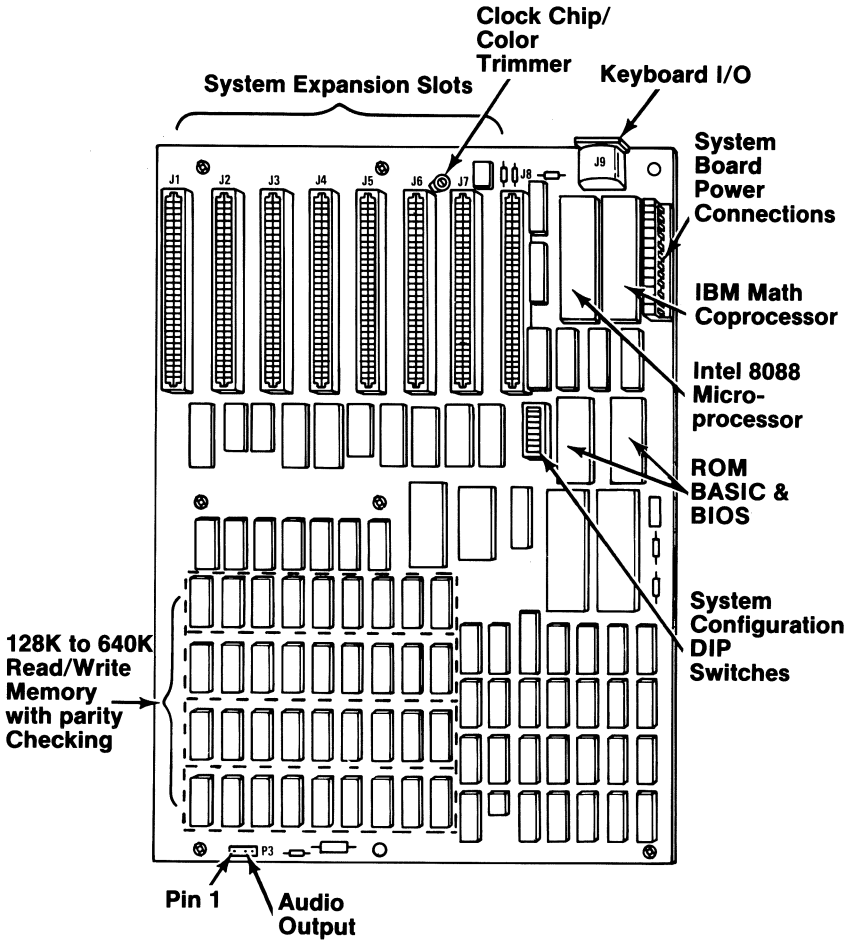
I/O Channel (A-Side, J1 through J8)

I/O Pin	Signal Name	I/O
B1	GND	Ground
B2	RESET DRV	O
B3	+5 Vdc	Power
B4	IRQ 2	I
B5	-5 Vdc	Power
B6	DRQ2	I
B7	-12 Vdc	Power
B8	-CARD SLCTD	I
B9	+12 Vdc	Power
B10	GND	Ground
B11	-MEMW	O
B12	-MEMR	O
B13	-IOW	I/O
B14	-IOR	I/O
B15	-DACK3	O
B16	DRQ3	I
B17	-DACK1	O
B18	DRQ1	I
B19	-DACK0	I/O
B20	CLK	O
B21	IRQ7	I
B22	IRQ6	I
B23	IRQ5	I
B24	IRQ4	I
B25	IRQ3	I
B26	-DACK2	O
B27	T/C	O
B28	ALE	O
B29	+5Vdc	Power
B30	OSC	O
B31	GND	Ground

I/O Channel (B-Side, J1 through J8)

System Board Diagram

The following diagram shows the component layout for the system board. All system board switch settings for total system memory, number of diskette drives, and types of display adapters are shown on page 1-27.



System Board Component Diagram

I/O Channel Description

The following is a description of the I/O Channel. All lines are TTL-compatible.

A0–A19 (O)

Address bits 0 to 19: These lines are used to address memory and I/O devices within the system. The 20 address lines allow access of up to 1M byte of memory. A0 is the least significant bit (LSB) and A19 is the most significant bit (MSB). These lines are generated by either the microprocessor or DMA controller. They are active high.

AEN (O)

Address Enable: This line is used to de-gate the microprocessor and other devices from the I/O channel to allow DMA transfers to take place. When this line is active (high), the DMA controller has control of the address bus, data bus, Read command lines (memory and I/O), and the Write command lines (memory and I/O).

ALE (O)

Address Latch Enable: This line is provided by the 8288 Bus Controller and is used on the system board to latch valid addresses from the microprocessor. It is available to the I/O channel as an indicator of a valid microprocessor address (when used with AEN). Microprocessor addresses are latched with the falling edge of ALE.

-CARD SLCTD (I)

-Card Selected: This line is activated by cards in expansion slot J8. It signals the system board that the card has been selected and that appropriate drivers on the system board should be directed to either read from, or write to, expansion slot J8. Connectors J1 through J8 are tied together at this pin, but the system board does not use their signal. This line should be driven by an open collector device.

CLK (O)

System clock: It is a divide-by-3 of the oscillator and has a period of 210ns (4.77MHz). The clock has a 33% duty cycle.

D0—D7 I/O

Data Bits 0 to 7: These lines provide data bus bits 0 to 7 for the microprocessor, memory, and I/O devices. D0 is the LSB and D7 is the MSB. These lines are active high.

-DACK0 to -DACK3 (O)

-DMA Acknowledge 0 to 3: These lines are used to acknowledge DMA requests (DRQ1—DRQ3) and refresh system dynamic memory (-DACK0). They are active low.

DRQ1–DRQ3 (I)

DMA Request 1 to 3: These lines are asynchronous channel requests used by peripheral devices to gain DMA service. They are prioritized with DRQ3 being the lowest and DRQ1 being the highest. A request is generated by bringing a DRQ line to an active level (high). A DRQ line must be held high until the corresponding DACK line goes active.

-I/O CH CK (I)

-I/O Channel Check: This line provides the microprocessor with parity (error) information on memory or devices in the I/O channel. When this signal is active low, a parity error is indicated.

I/O CH RDY (I)

I/O Channel Ready: This line, normally high (ready), is pulled low (not ready) by a memory or I/O device to lengthen I/O or memory cycles. It allows slower devices to attach to the I/O channel with a minimum of difficulty. Any slow device using this line should drive it low immediately upon detecting a valid address and a Read or Write command. This line should never be held low longer than 10 clock cycles. Machine cycles (I/O or memory) are extended by an integral number of clock cycles (210ns).

-IOR (O)

-I/O Read Command: This command line instructs an I/O device to drive its data onto the data bus. It may be driven by the microprocessor or the DMA controller. This signal is active low.

-IOW (O)

-I/O Write Command: This command line instructs an I/O device to read the data on the data bus. It may be driven by the microprocessor or the DMA controller. This signal is active low.

IRQ2—IRQ7 (I)

Interrupt Request 2 to 7: These lines are used to signal the microprocessor that an I/O device requires attention. They are prioritized with IRQ2 as the highest priority and IRQ7 as the lowest. An interrupt request is generated by raising an IRQ line (low to high) and holding it high until it is acknowledged by the microprocessor (interrupt service routine).

-MEMR (O)

-Memory Read: This command line instructs the memory to drive its data onto the data bus. It may be driven by the microprocessor or the DMA controller. This signal is active low.

-MEMW (O)

-Memory Write: This command line instructs the memory to store the data present on the data bus. It may be driven by the microprocessor or the DMA controller. This signal is active low.

OSC (O)

Oscillator: High-speed clock with a 70ns period (14.31818MHz). It has a 50% duty cycle.

RESET DRV (O)

Reset Drive: This line is used to reset or initialize system logic upon power-up or during a low line-voltage outage. This signal is synchronized to the falling edge of CLK and is active high.

T/C (O)

Terminal Count: This line provides a pulse when the terminal count for any DMA channel is reached. This signal is active high.

I/O Address Map

The following pages contain the planar and channel I/O Address Maps.

Hex Range*	Device
000-01F	DMA controller, 8237A-5
020-03F	Interrupt controller, 8259A
040-05F	Timer, 8253-5
060-06F	PPI 8255A-5
080-09F	DMA page registers
0AX**	NMI Mask Registers

Note: I/O Addresses, hex 000 to 0FF, are reserved for the system board I/O. Hex 100 to 3FF are available on the I/O channel.

* These are the addresses decoded by the current set of adapter cards. IBM may use any of the unlisted addresses for future use.

** At power-on-time, the Non Mask Interrupt into the 8088 is masked off. This mask bit can be set and reset through system software as follows:

Set mask: Write hex 80 to I/O Address hex A0(enable NMI)

Clear mask: Write hex 00 to I/O Address hex A0(disable NMI)

Planar I/O Address Map

Hex Range*	Device
200-20F	Game Control
201	Game I/O
20C-20D	Reserved
210-217	Expansion Unit
21F	Reserved
278-27F	Parallel printer port 2
2B0-2DF	Alternate Enhanced Graphics Adapter
2E1	GPIB (Adapter 0)
2E2 & 2E3	Data Acquisition (Adapter 0)
2F8-2FF	Serial port 2
300-31F	Prototype card
320-32F	Fixed Disk
348-357	DCA 3278
360-367	PC Network (low address)
368-36F	PC Network (high address)
378-37F	Parallel printer port 1
380-38F***	SDLC, bisynchronous 2
390-393	Cluster
3A0-3AF	Bisynchronous 1
3B0-3BF	Monochrome Display and Printer Adapter
3C0-3CF	Enhanced Graphics Adapter
3D0-3DF	Color/Graphics Monitor Adapter
3F0-3F7	Diskette controller
3F8-3FF	Serial port 1
6E2 & 6E3	Data Acquisition (Adapter 1)
790-793	Cluster (Adapter 1)
AE2 & AE3	Data Acquisition (Adapter 2)
B90-B93	Cluster (Adapter 2)
EE2 & EE3	Data Acquisition (Adapter 3)
1390-1393	Cluster (Adapter 3)
22E1	GPIB (Adapter 1)
2390-2393	Cluster (Adapter 4)
42E1	GPIB (Adapter 2)
62E1	GPIB (Adapter 3)
82E1	GPIB (Adapter 4)
A2E1	GPIB (Adapter 5)
C2E1	GPIB (Adapter 6)
E2E1	GPIB (Adapter 7)

Note: I/O Addresses, hex 000 to 0FF, are reserved for the system board I/O. Hex 100 to 3FF are available on the I/O channel.

* These are the addresses decoded by the current set of adapter cards. IBM may use any of the unlisted addresses for future use.

*** SDLC Communication and Secondary Binary Synchronous Communications cannot be used together because their hex addresses overlap.

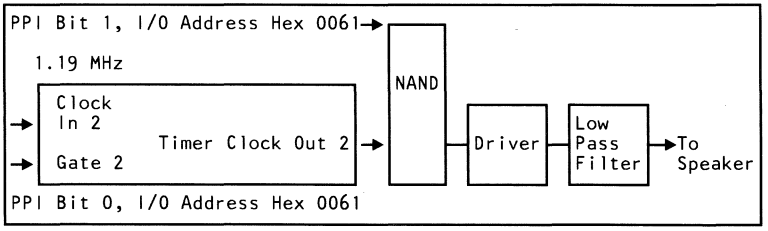
Channel I/O Address Map

Other Circuits

Speaker Circuit

The system unit has a 57.15 mm (2-1/4 in.) audio speaker. The speaker's control circuits and driver are on the system board. The speaker connects through a 2-wire interface that attaches to a 3-pin connector on the system board.

The speaker drive circuit is capable of approximately 1/2 watt of power. The control circuits allow the speaker to be driven three different ways: 1.) a direct program control register bit may be toggled to generate a pulse train; 2.) the output from Channel 2 of the timer/counter may be programmed to generate a waveform to the speaker; 3.) the clock input to the timer/counter can be modulated with a program-controlled I/O register bit. All three methods may be performed simultaneously.



Speaker Drive System Block Diagram

```
Channel 2 (Tone generation for speaker)
     Gate 2      -- Controlled by 8255A-5 PPI Bit (See 8255 Map)
     Clock In 2  -- 1.19318 MHz OSC
     Clock Out 2 -- Used to drive speaker
```

Speaker Tone Generation

The speaker connection is a 4-pin Berg connector.

	Pin	Function
P3	1	Data out
	2	Key
	3	Ground
	4	+5 Vdc

Speaker Connector (P3)

8255A I/O Bit Map

The 8255A I/O Bit Map shows the inputs and outputs for the Command/Mode register on the system board. Also shown are the switch settings for the memory, display, and number of diskette drives. The following page contains the I/O bit map.

Hex Port Number				
0060	INPUT	PA0	+ Keyboard Scan Code 0	Or Diagnostic Outputs 0
		1	1	1
		2	2	2
		3	3	3
		4	4	4
		5	5	5
		6	6	6
		7	7	7
0061	OUTPUT	PB0	+ Timer 2 Gate Speaker	
		1	+ Speaker Data	
		2	Spare	
		3	Read High Switches or Read Low Switches	
		4	- Enable RAM Parity Check	
		5	- Enable I/O Channel Check	
		6	- Hold Keyboard Clock Low	
		7	- (Enable Keyboard or + (Clear Keyboard)	
0062	INPUT	PC0	Loop on POST Sw-1	Display 0 **Sw-5
		1	+ CoProcessor Installed Sw-2	Display 1 **Sw-6
		2	+ Planar RAM Size 0 * Sw-3	Or # Drives ***Sw-7
		3	+ Planar RAM Size 1 * Sw-4	# Drives 1 ***Sw-8
		4	Spare	
		5	+ Timer Channel 2 Out	
		6	+ I/O Channel Check	
		7	+ RAM Parity Check	

0063 Command/Mode Register Hex 99

Mode Register Value

7	6	5	4	3	2	1	0
1	0	0	1	1	0	0	1

* Sw-4 Sw-3 0 0 0 1 1 0 1 1	Amount of Memory on System Board - 64/256K 64K 128K 192K 256K
* Sw-4 Sw-3 0 0 0 1 1 0 1 1	Amount of Memory on System Board - 256/640K 256K 512K 576K 640K
** Sw-6 Sw-5 0 0 0 1 1 0 1 1	Display at Power-Up Mode Reserved Color 40 X 25 (BW Mode) Color 80 X 25 (BW Mode) IBM Monochrome 80 X 25
*** Sw-8 Sw-7 0 0 0 1 1 0 1 1	Number of Diskette Drives in System 1 2 3 4

Notes:
PA Bit = 0 implies switch "ON". PA Bit = 1 implies switch "OFF".
A plus (+) indicates a bit value of 1 performs the specified function.
A minus (-) indicates a bit value of 0 performs the specified function.

8255A I/O Bit Map

Specifications

System Unit

Size

- Length: 498 millimeters (19.6 inches)
- Depth: 411 millimeters (16.2 inches)
- Height: 147 millimeters (5.8 inches)

Weight

- 14.2 kilograms (31.6 pounds)

Power Cable

- Length: 1.8 meters (6 feet)

Environment

- Air Temperature
  - System On: 15.6 to 32.2 degrees C (60 to 90 degrees F)
  - System Off: 10 to 43 degrees C (50 to 110 degrees F)
- Wet Bulb Temperature
  - System On: 22.8 degrees C (73 degrees F)
  - System Off: 26.7 degrees C (80 degrees F)

- Humidity
  - System On: 8% to 80%
  - System Off: 20% to 80%
- Altitude
  - Maximum altitude: 2133.6 meters (7000 feet)

Heat Output

- 1229 British Thermal Units (BTU) per hour

Noise Level

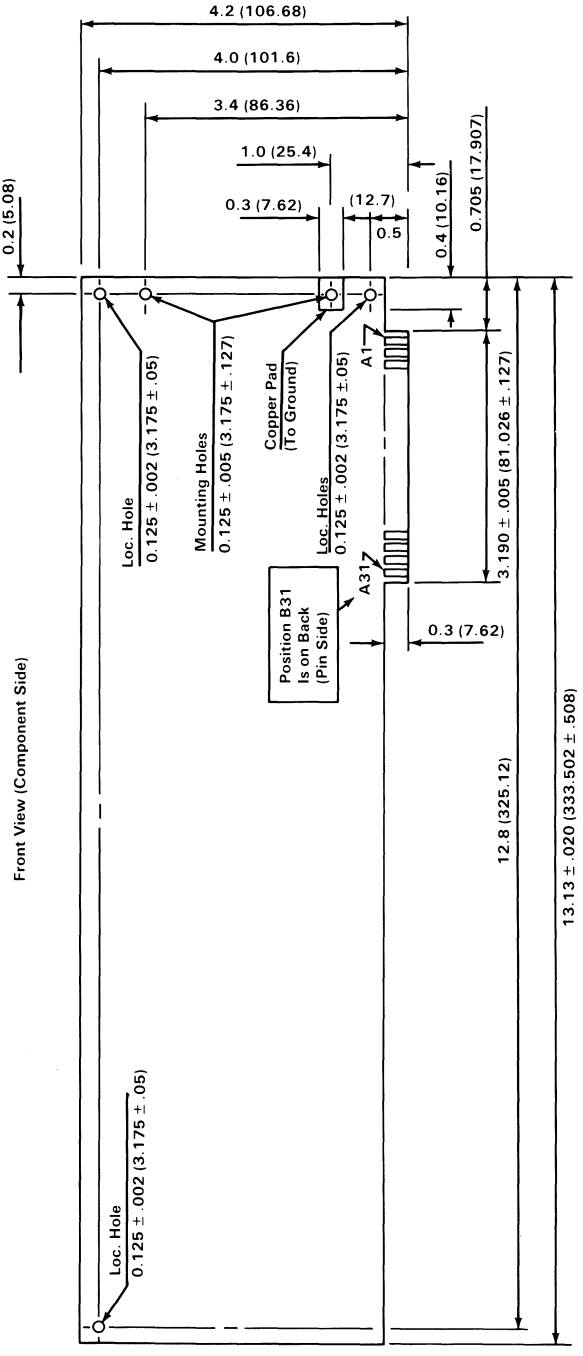
- 43 decibels average-noise rating (without printer)

Electrical

- Power: 450 VA
- Input
  - Nominal: 115 Vac
  - Minimum: 100 Vac
  - Maximum: 125 Vac

Card Specifications

The specifications for option cards follow.



Notes:

1. All Card Dimensions are ± .010 (.254) Tolerance (With Exceptions Indicated on Drawing or in Notes).
2. Max. Card Length is 13.15 (334.01) Smaller Length is Permissible.
3. Loc. and Mounting Holes are Non-Plated Thru. (Loc. 3X, Mtg. 2X).
4. 31 Gold Tabs Each Side, 0.100 ± .0005 (2.54 ± .0127) Center to Center, 0.06 ± .0005 (1.524 ± .0127) Width.
5. Numbers in Parentheses are in Millimeters. All Others are in Inches.

Connectors

The system board has the following additional connectors:

- Two power-supply connectors (P1 and P2)
- Speaker connector (J19)
- Keyboard connector (J22)

The pin assignments for the power-supply connectors, P1 and P2, are as follows. The pins are numbered 1 through 6 from the rear of the system.

Connector	Pin	Assignments
P1	1	Power Good
	2	Key
	3	+12 Vdc
	4	-12 Vdc
	5	Ground
	6	Ground
P2	1	Ground
	2	Ground
	3	-5 Vdc
	4	+5 Vdc
	5	+5 Vdc
	6	+5 Vdc

Power Supply Connectors (P1, P2)

The speaker connector, J19, is a 4-pin, keyed, Berg strip. The pins are numbered 1 through 4 from the front of the system. The pin assignments are as follows:

Connector	Pin	Function
J19	1	Data out
	2	Key
	3	Ground
	4	+5 Vdc

Speaker Connector (J19)

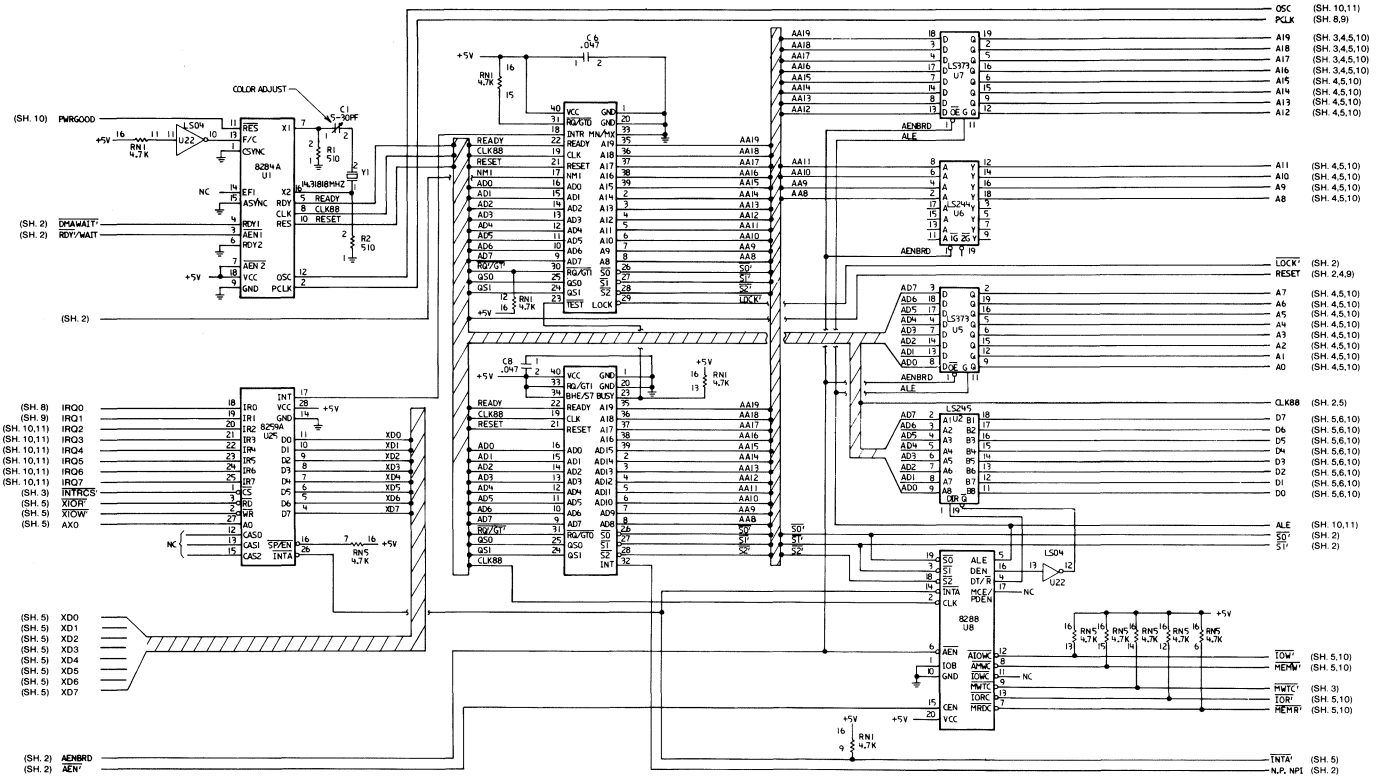
The keyboard connector, J22, is a 5-pin, 90-degree printed circuit board (PCB) mounting, DIN connector. For pin numbering, see the "Keyboard" section. The pin assignments are as follows:

Connector	Pin	Assignments
J22	1	Keyboard Clock
	2	Keyboard Data
	3	Reserved
	4	Ground
	5	+5 Vdc

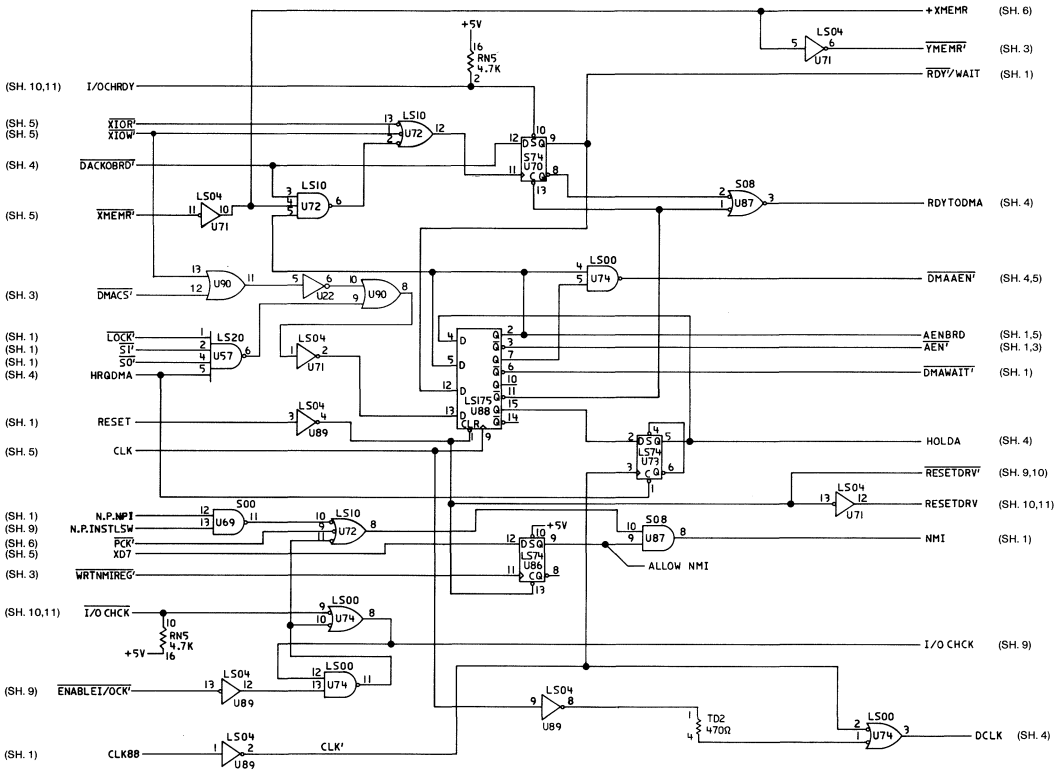
Keyboard Connector (J22)

Logic Diagrams - 64/256K

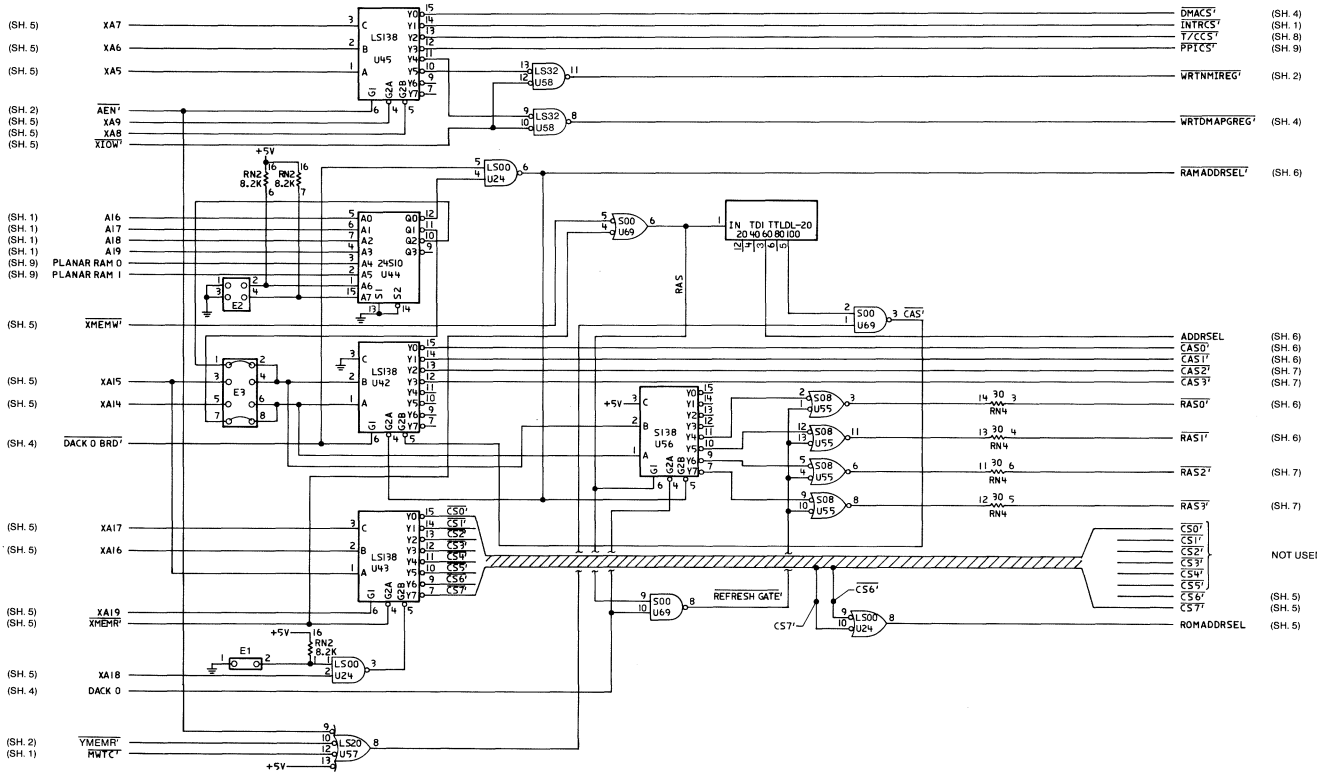
The following pages contain the logic diagrams for the 64/256K system board.



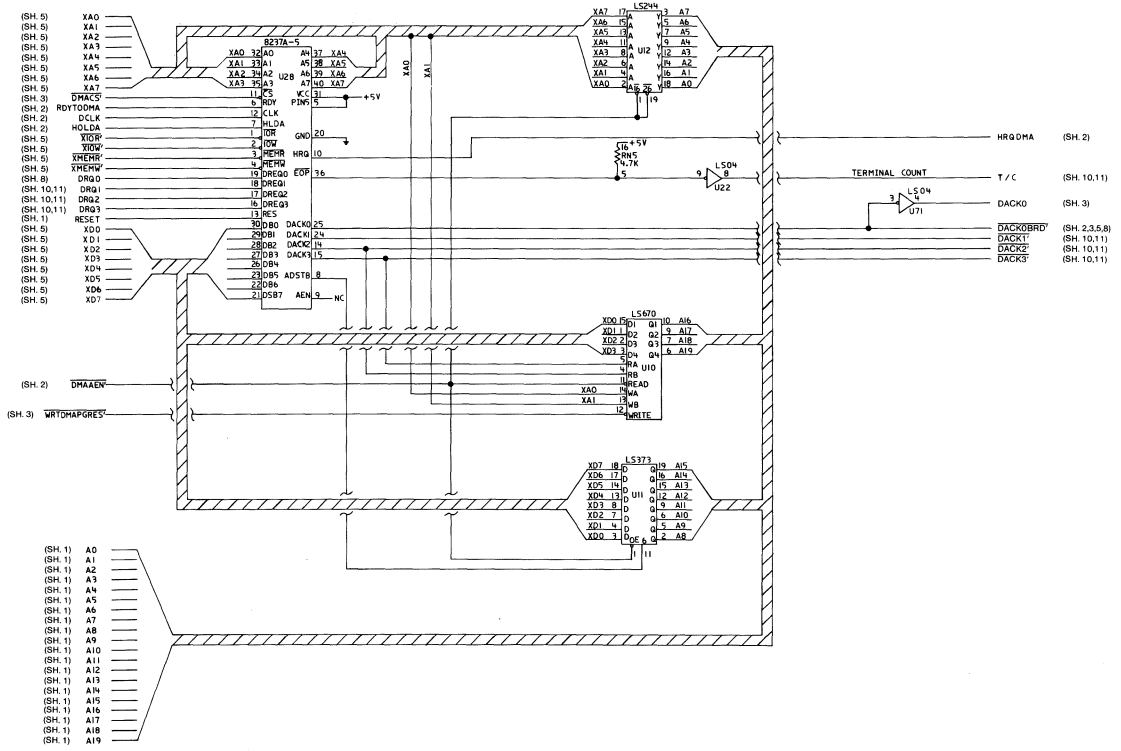
64/256K System Board (Sheet 1 of 11)



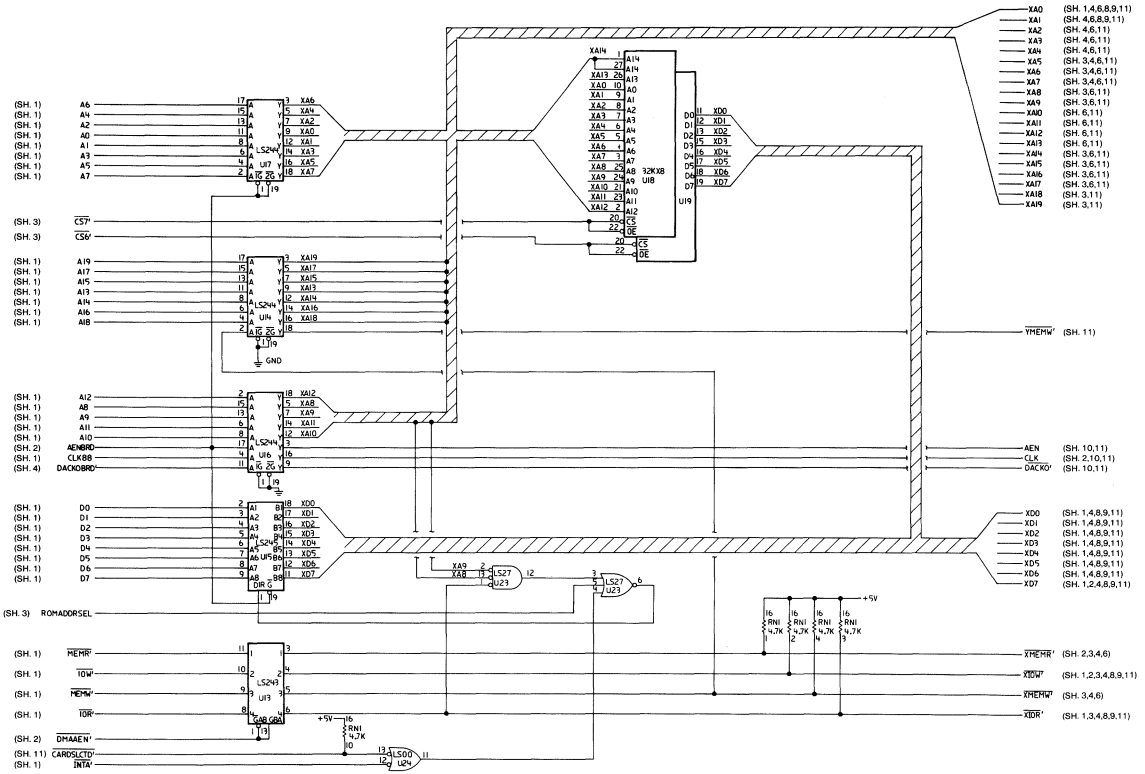
64/256K System Board (Sheet 2 of 11)



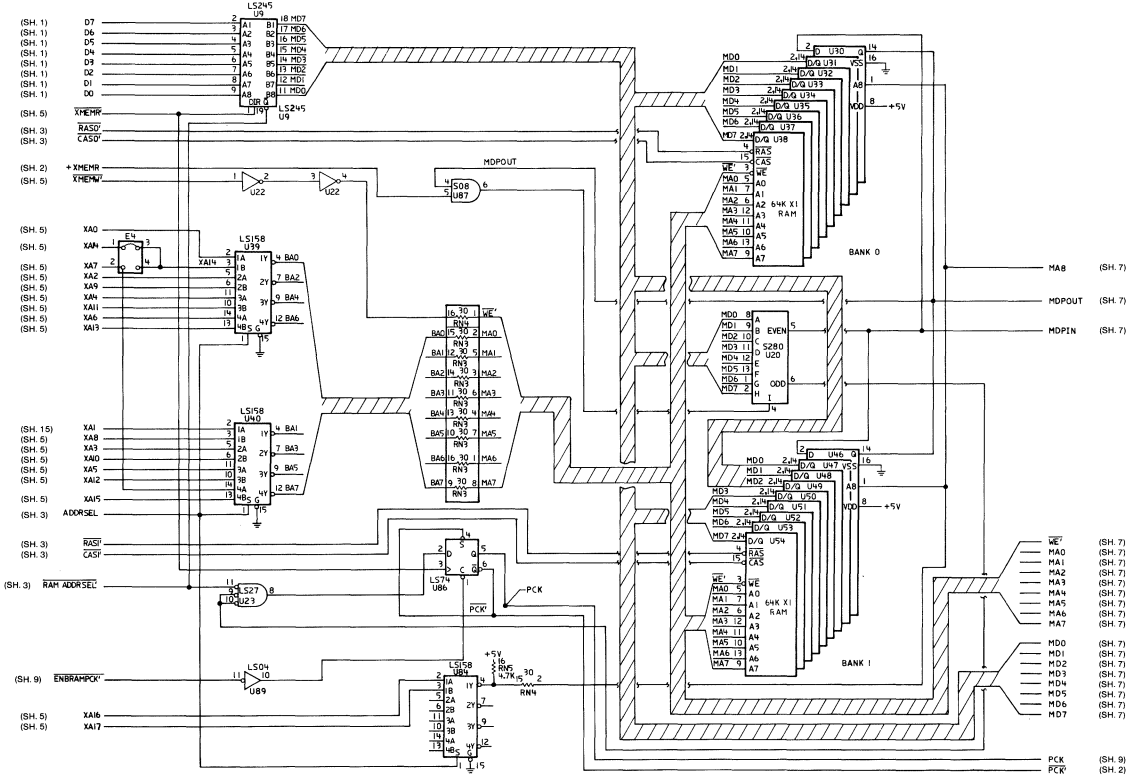
64/256K System Board (Sheet 3 of 11)



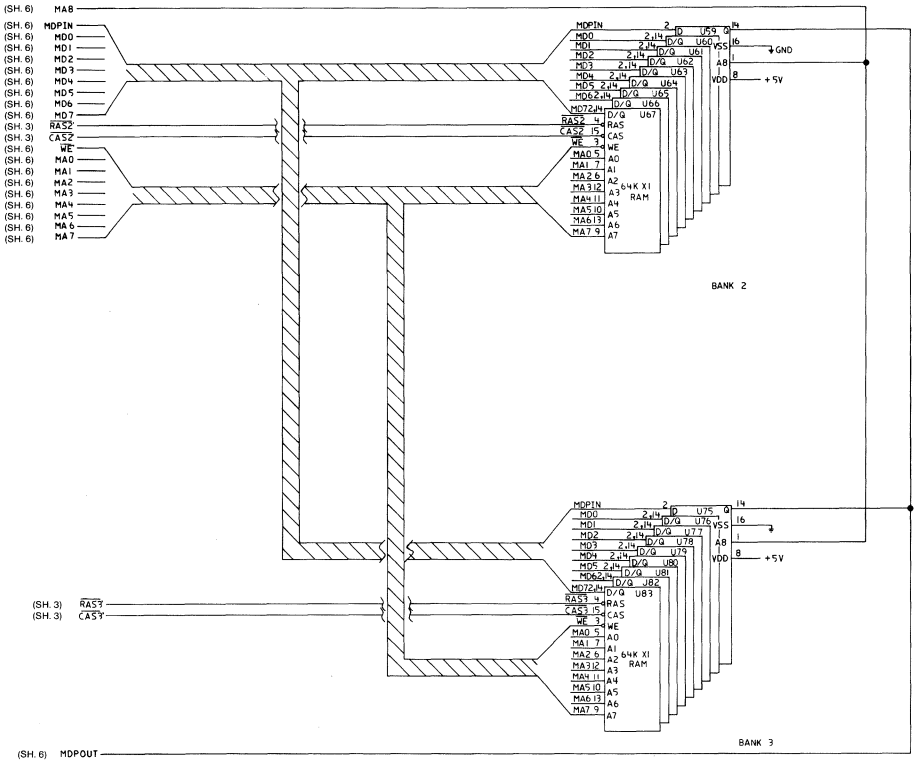
64/256K System Board (Sheet 4 of 11)



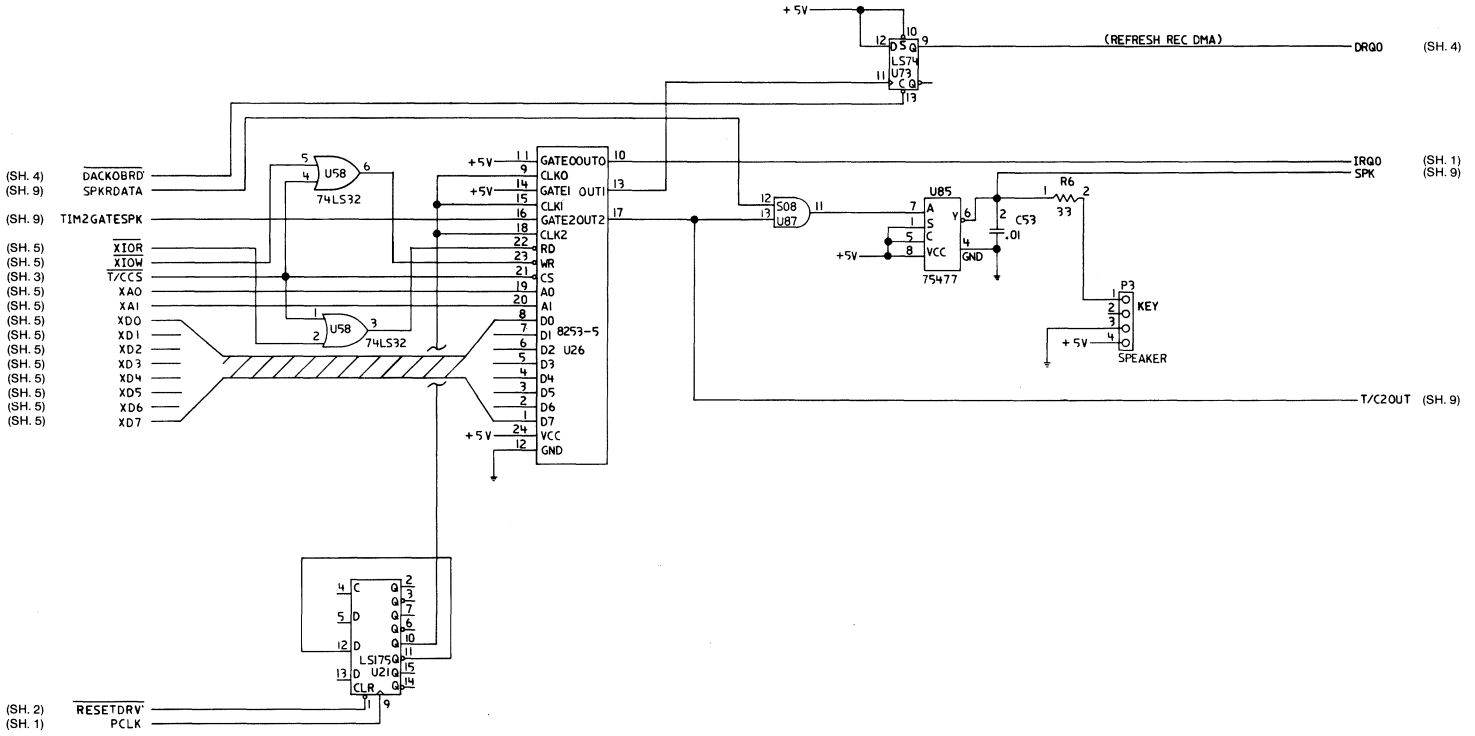
64/256K System Board (Sheet 5 of 11)



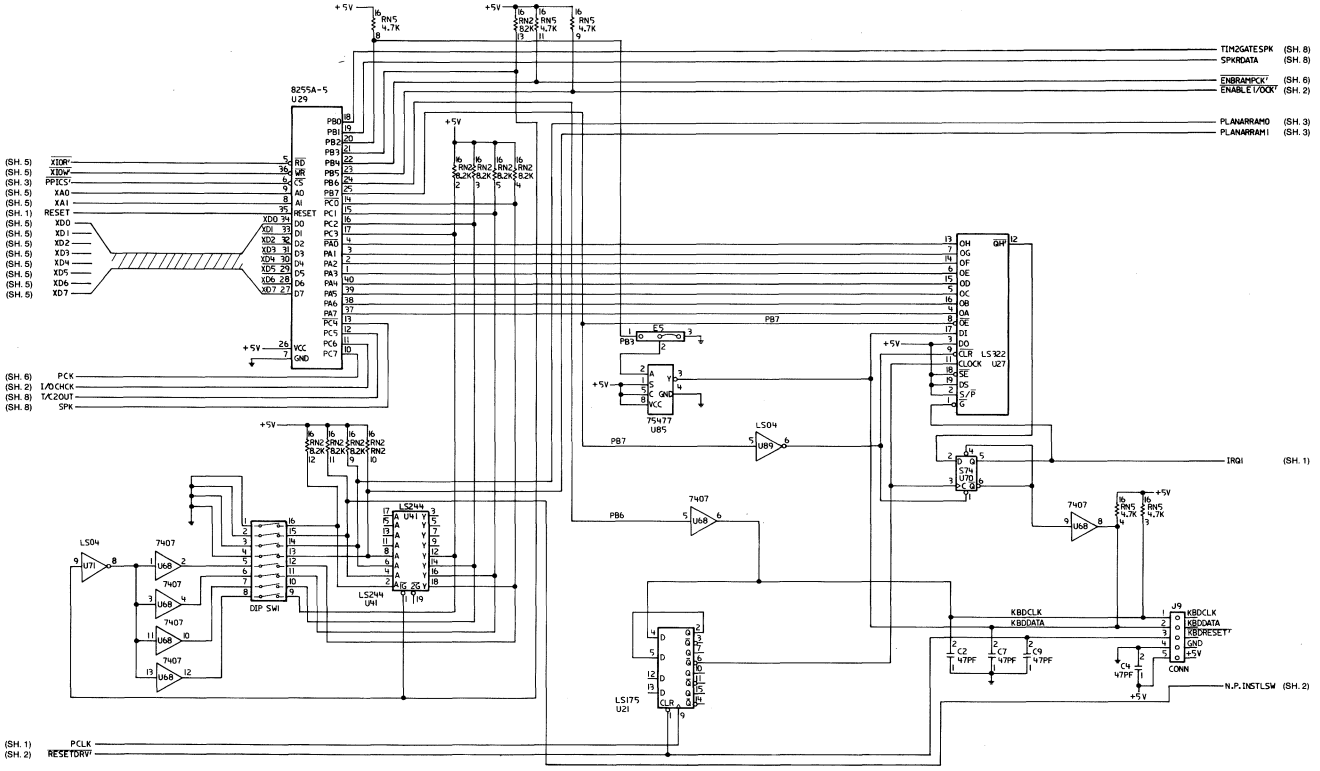
64/256K System Board (Sheet 6 of 11)



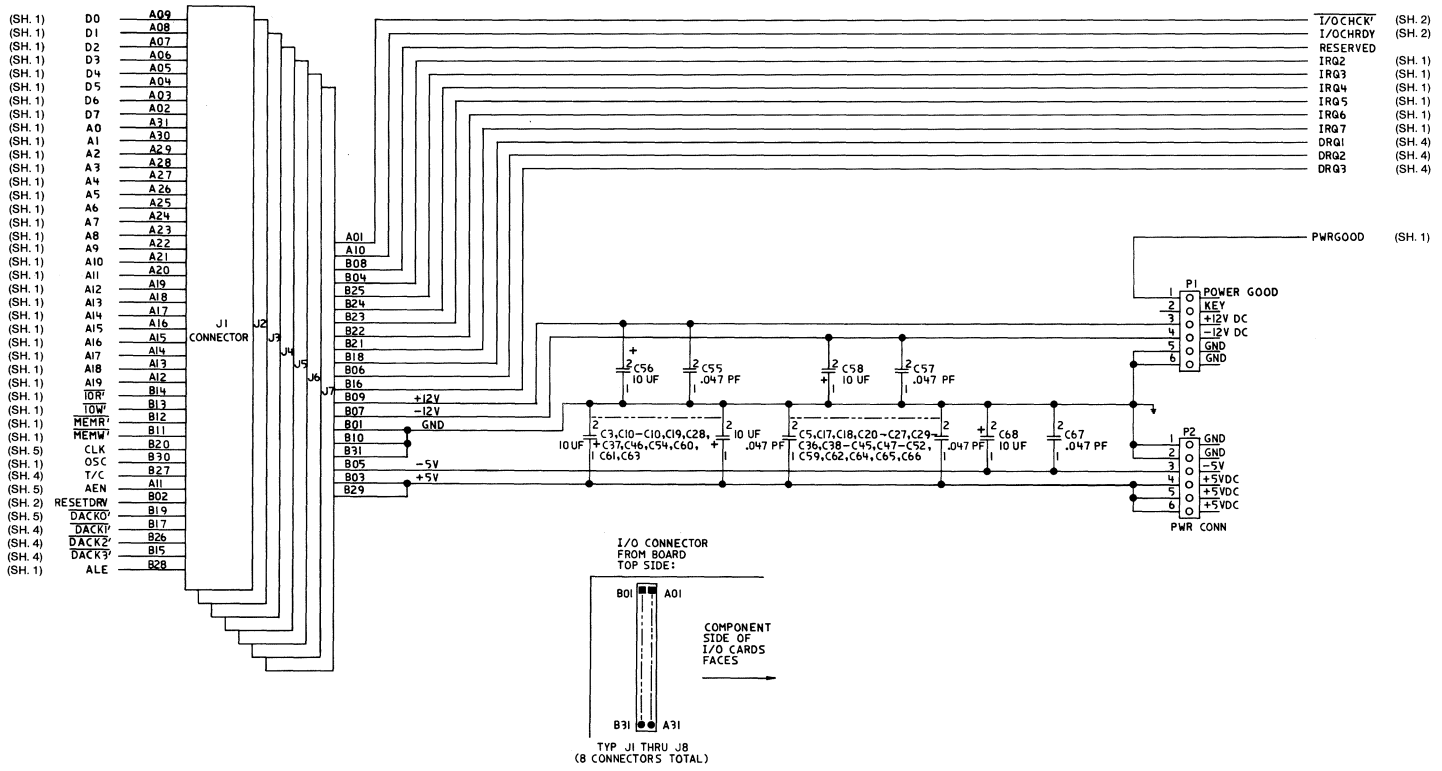
64/256K System Board (Sheet 7 of 11)



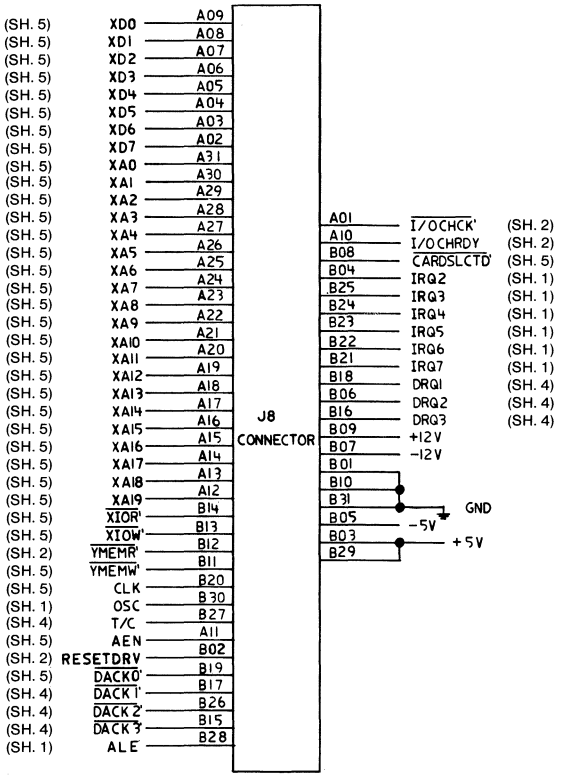
64/256K System Board (Sheet 8 of 11)



64/256K System Board (Sheet 9 of 11)



64/256K System Board (Sheet 10 of 11)



64/256K System Board (Sheet 11 of 11)

Logic Diagrams - 256/640K

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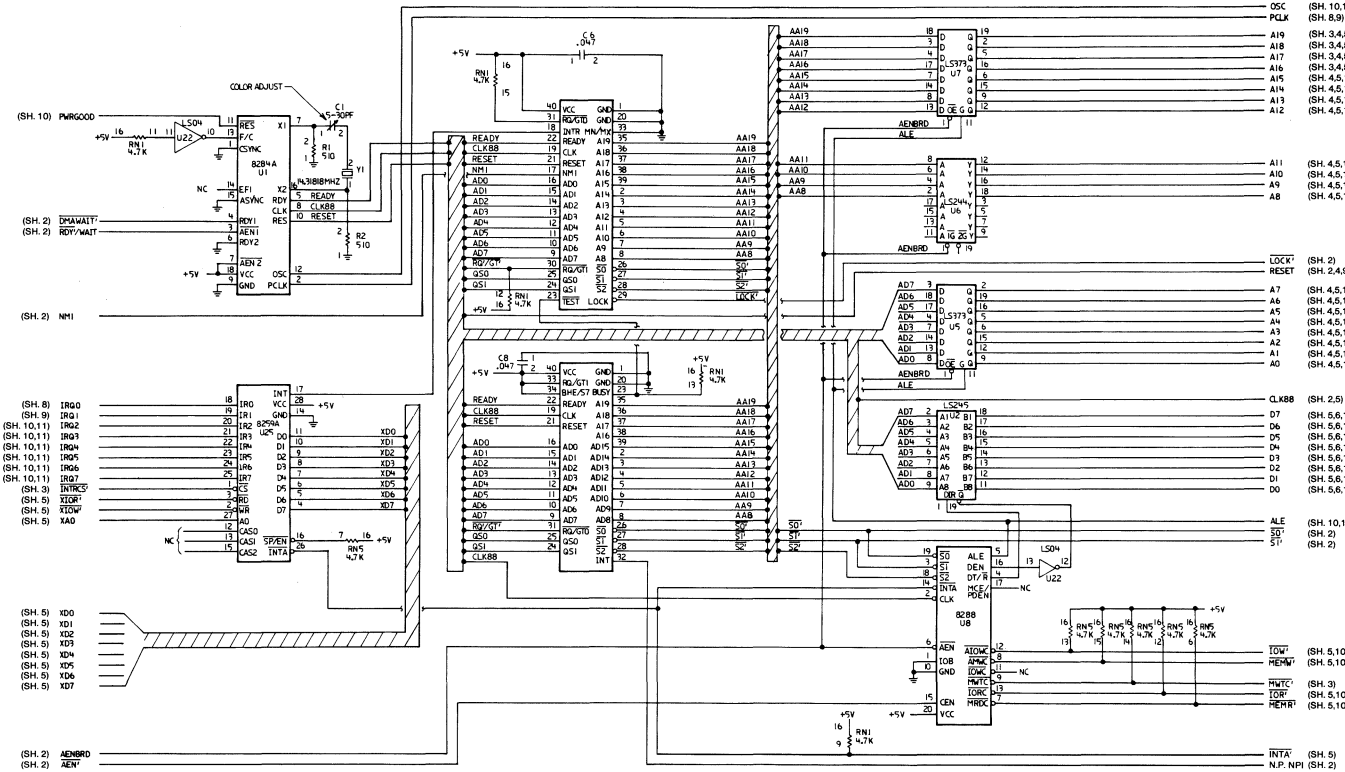
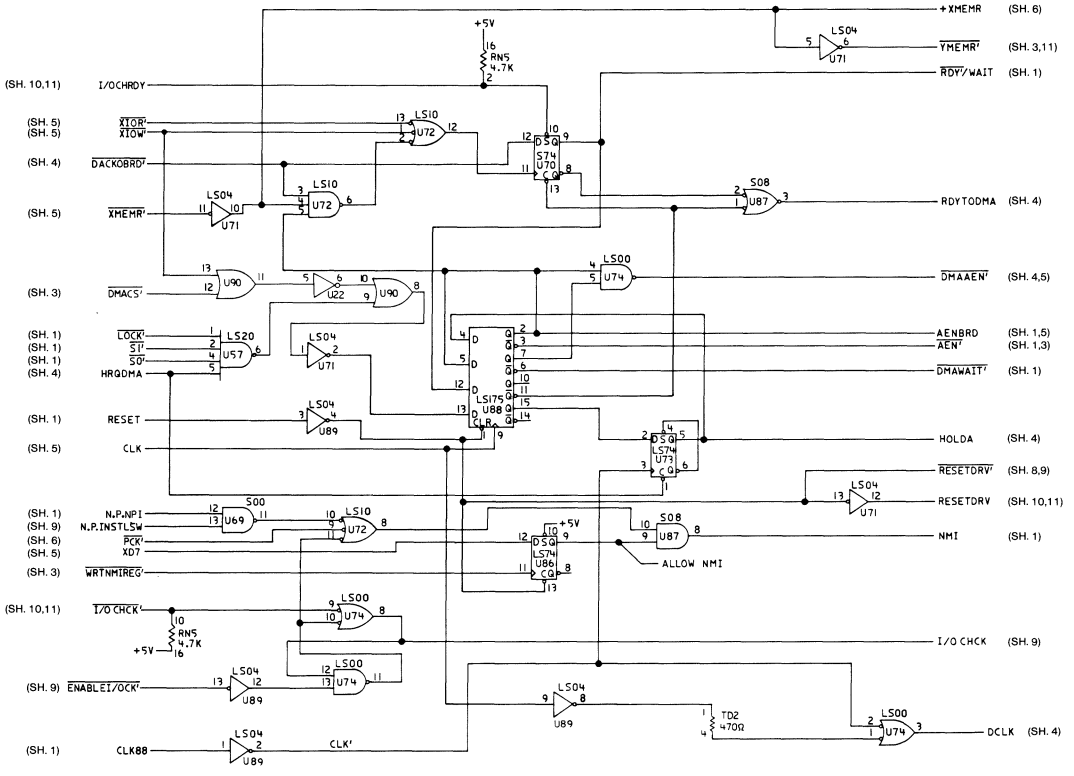
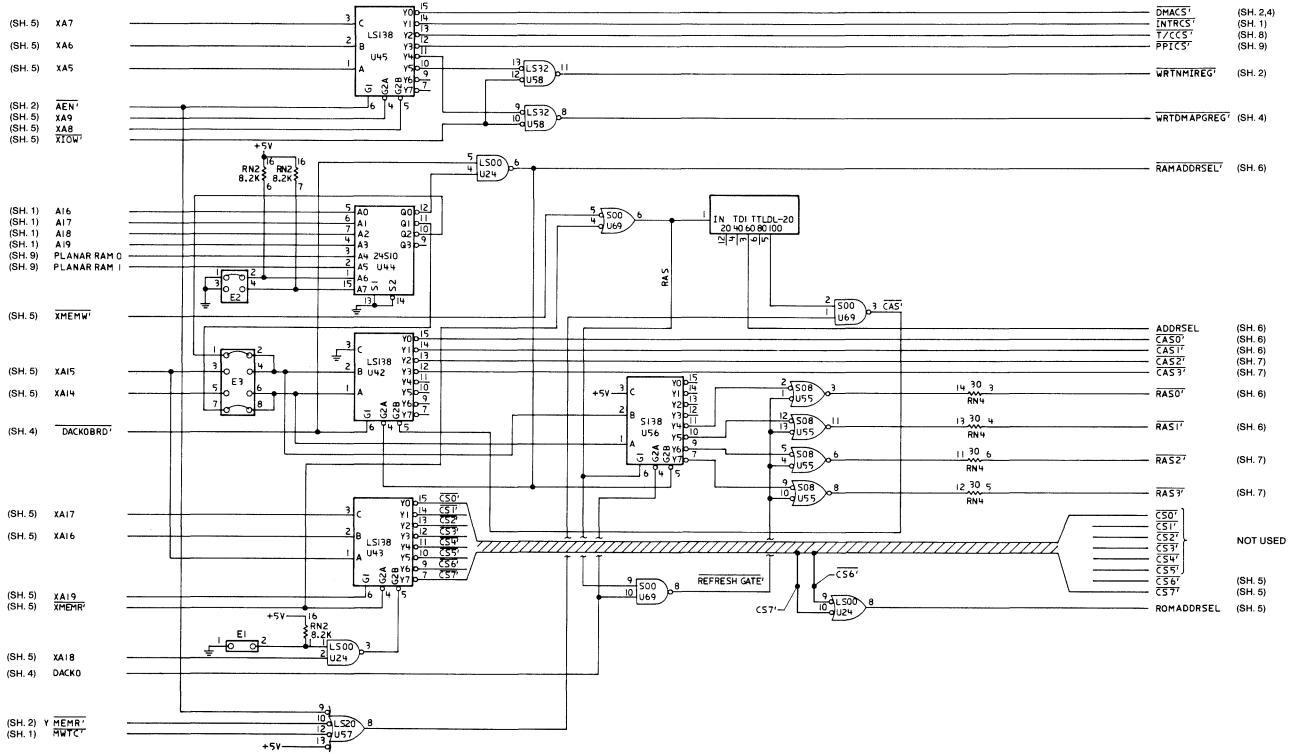


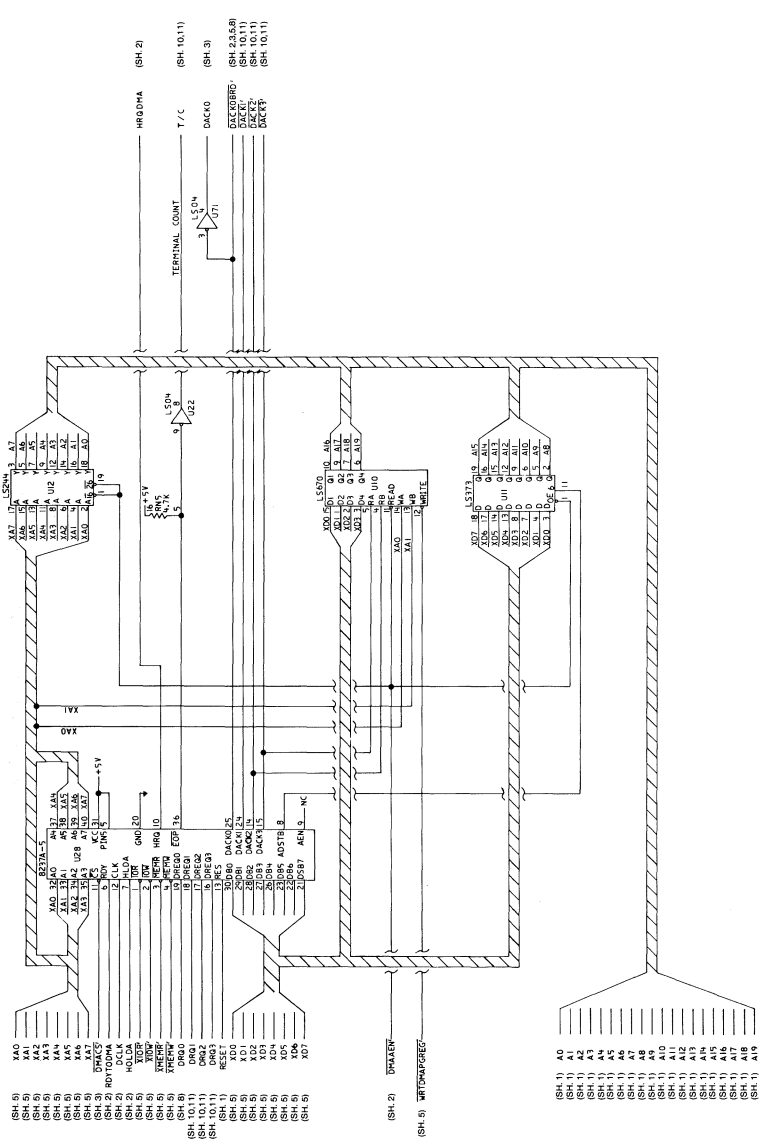
256/640K System Board (Sheet 1 of 11)



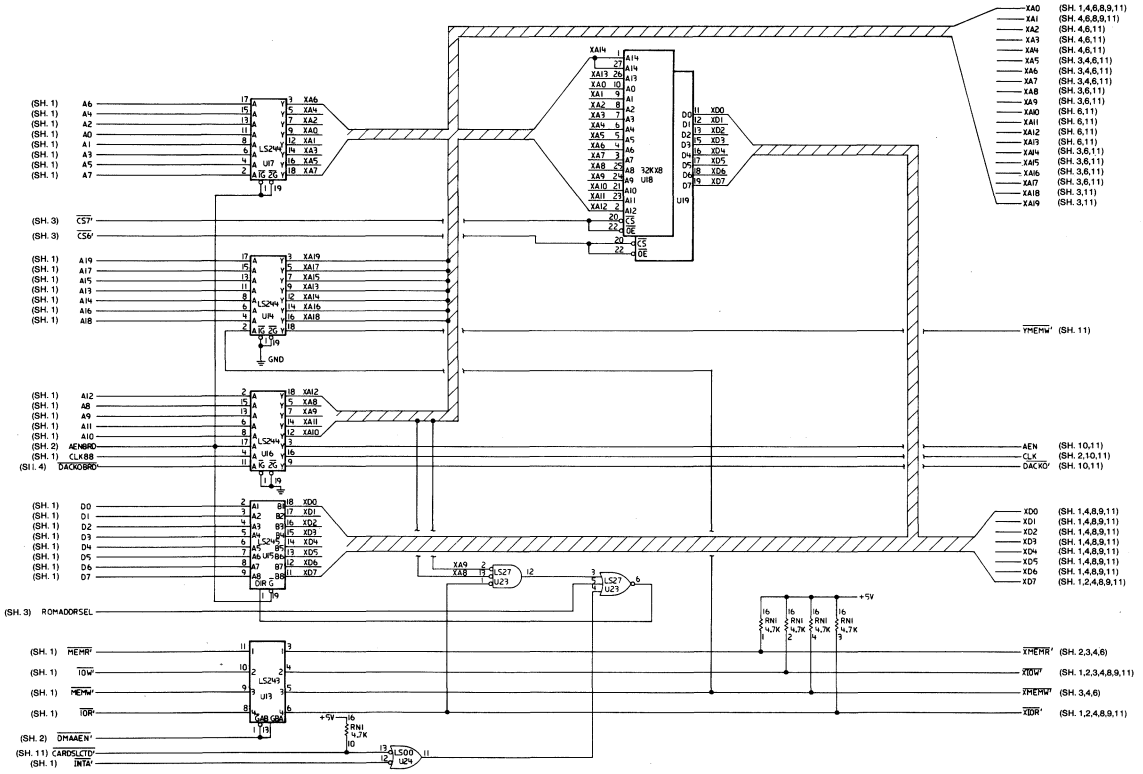
256/640K System Board (Sheet 2 of 11)



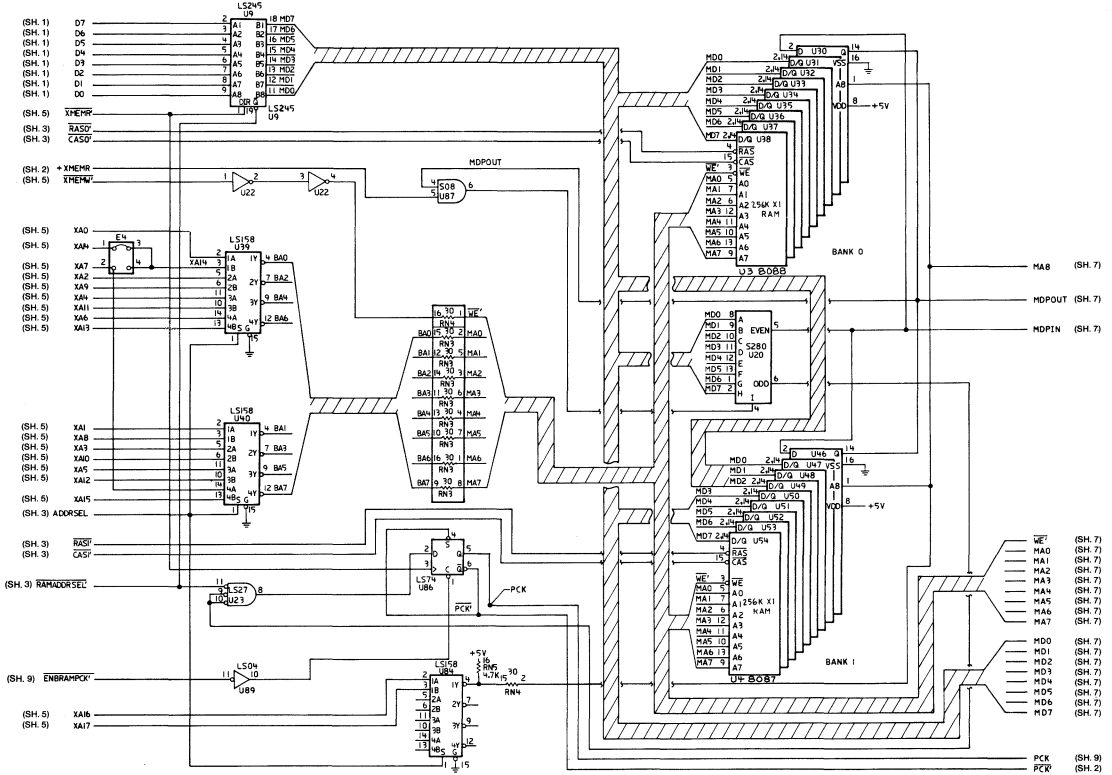
256/640K System Board (Sheet 3 of 11)



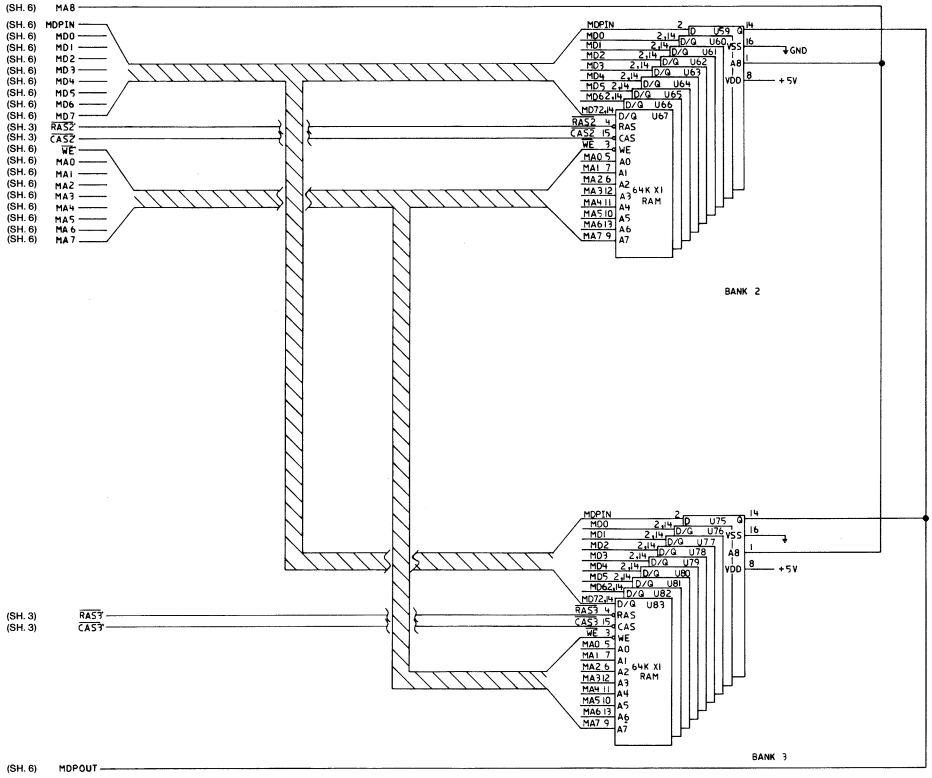
256/640K System Board (Sheet 4 of 11)



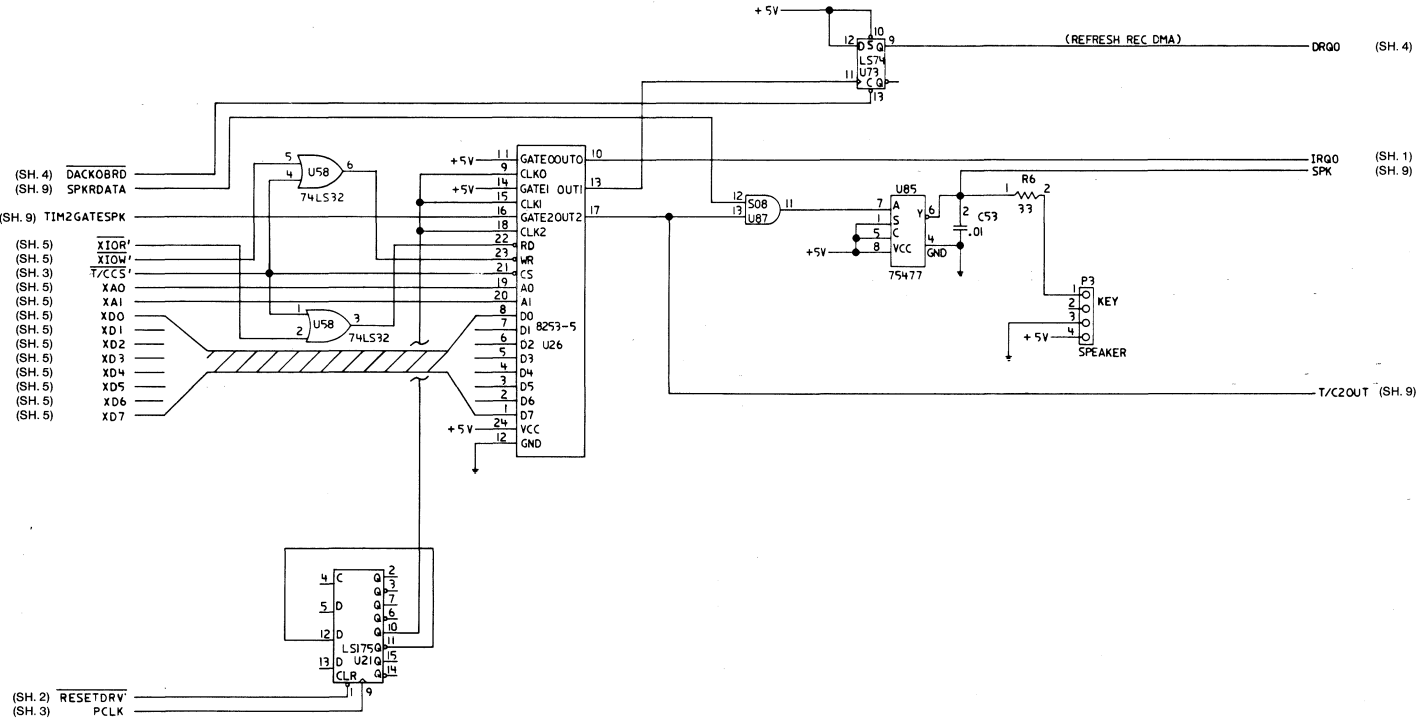
256/640K System Board (Sheet 5 of 11)



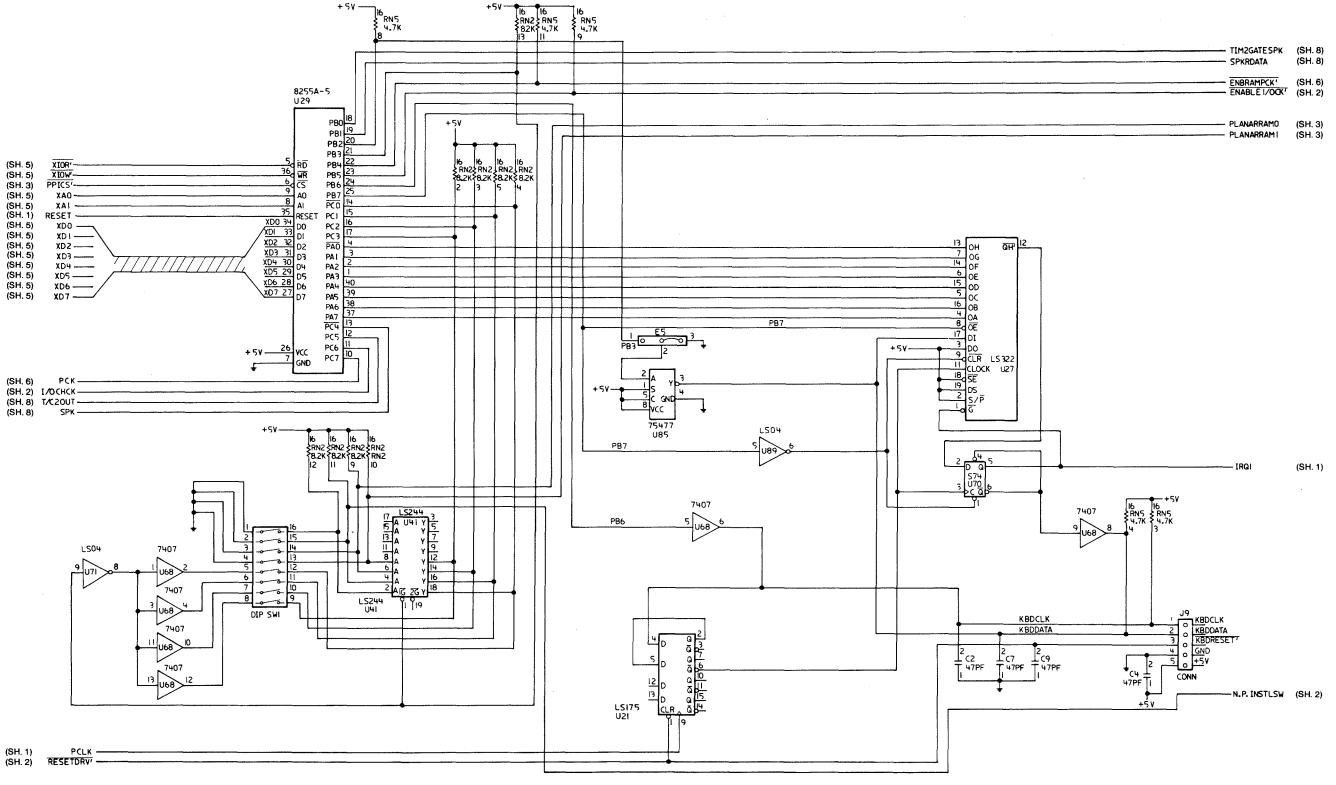
256/640K System Board (Sheet 6 of 11)



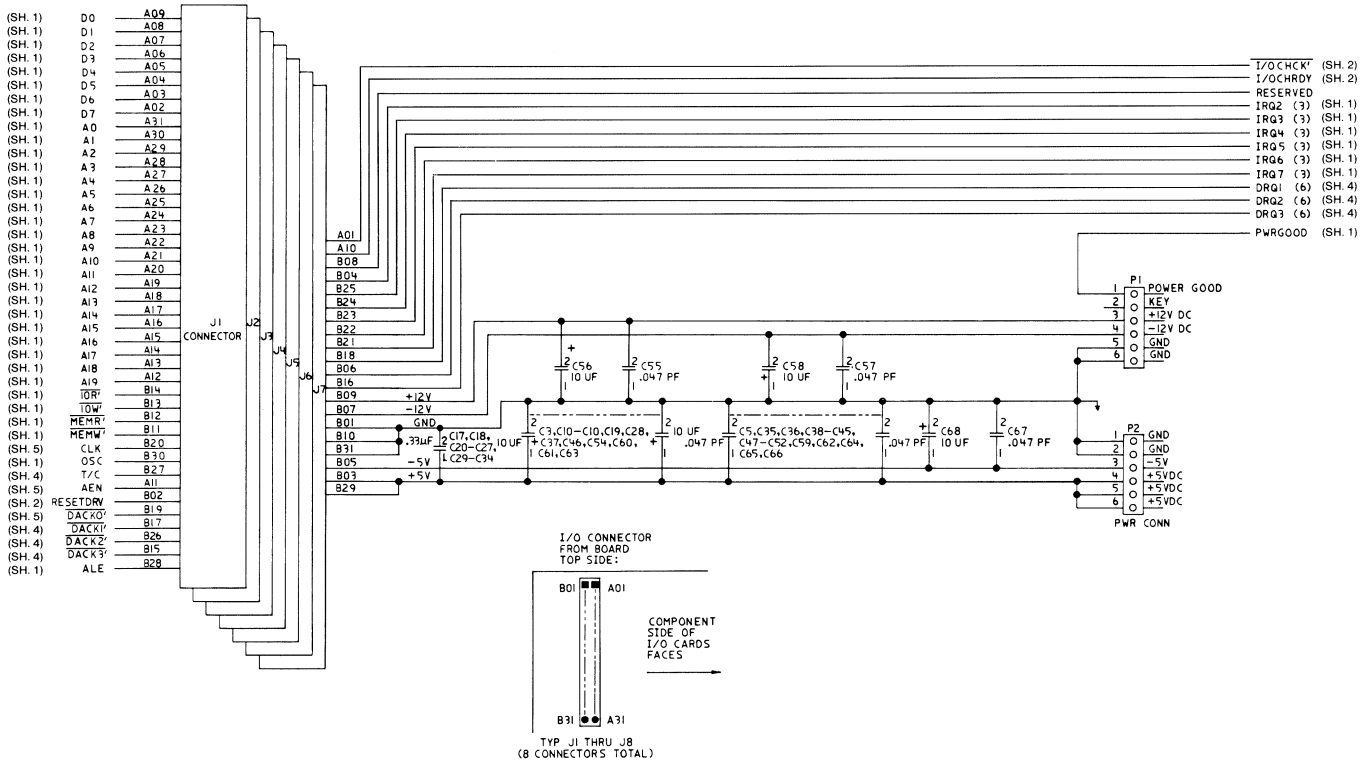
256/640K System Board (Sheet 7 of 11)



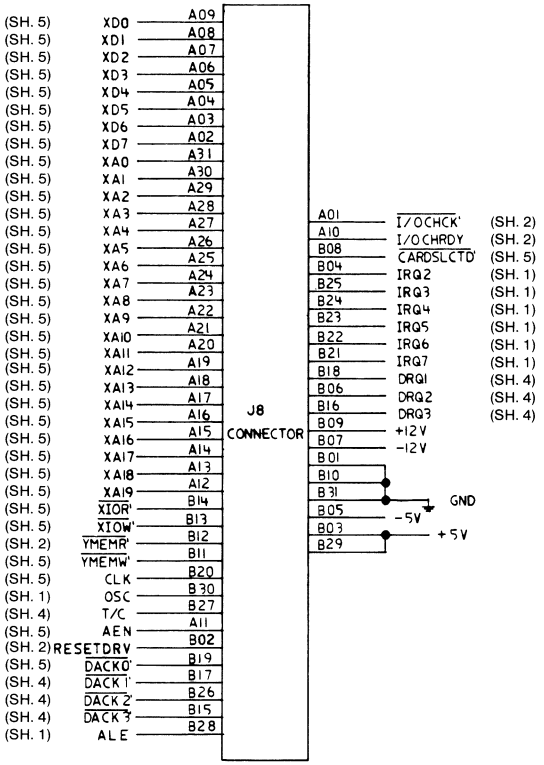
256/640K System Board (Sheet 8 of 11)



256/640K System Board (Sheet 9 of 11)



256/640K System Board (Sheet 10 of 11)



256/640K System Board (Sheet 11 of 11)

Notes:

SECTION 2. COPROCESSOR

Notes:

Description

The Math Coprocessor (8087) enables the IBM Personal Computer to perform high-speed arithmetic, logarithmic functions, and trigonometric operations with extreme accuracy.

The 8087 coprocessor works in parallel with the microprocessor. The parallel operation decreases operating time by allowing the coprocessor to do mathematical calculations while the microprocessor continues to do other functions.

The first five bits of every instruction's operation code for the coprocessor are identical (binary 11011). When the microprocessor and the coprocessor see this operation code, the microprocessor calculates the address of any variables in memory, while the coprocessor checks the instruction. The coprocessor takes the memory address from the microprocessor if necessary. To gain access to locations in memory, the coprocessor takes the local bus from the microprocessor when the microprocessor finishes its current instruction. When the coprocessor is finished with the memory transfer, it returns the local bus to the microprocessor.

The IBM Math Coprocessor works with seven numeric data types divided into the three classes listed below.

- Binary integers (3 types)
- Decimal integers (1 type)
- Real numbers (3 types).

Programming Interface

The coprocessor extends the data types, registers, and instructions to the microprocessor.

The coprocessor has eight 80-bit registers, which provide the equivalent capacity of the 40 16-bit registers found in the microprocessor. This register space allows constants and temporary results to be held in registers during calculations, thus reducing memory access and improving speed as well as bus availability. The register space can be used as a stack or as a fixed register set. When used as a stack, only the top two stack elements are operated on. The figure below shows representations of large and small numbers in each data type.

Data Type	Bits	Significant Digits (Decimal)	Approximate Range (Decimal)
Word Integer	16	4	$-32{,}768 \leq X \leq +32{,}767$
Short Integer	32	9	$-2\times10^{9} \leq X \leq +2\times10^{9}$
Long Integer	64	18	$-9\times10^{18} \leq X \leq +9\times10^{18}$
Packed Decimal	80	18	$-9..99 \leq X \leq +9..99$ (18 digits)
Short Real *	32	6-7	$8.43\times10^{-37} \leq \lvert X\rvert \leq 3.37\times10^{38}$
Long Real *	64	15-16	$4.19\times10^{-307} \leq \lvert X\rvert \leq 1.67\times10^{308}$
Temporary Real	80	19	$3.4\times10^{-4932} \leq \lvert X\rvert \leq 1.2\times10^{4932}$

* The Short Real and Long Real data types correspond to the single and double precision data types.

Data Types

Hardware Interface

The coprocessor uses the same clock generator and system bus interface components as the microprocessor. The microprocessor's queue status lines (QS0 and QS1) enable the coprocessor to obtain and decode instructions simultaneously with the microprocessor. The coprocessor's 'busy' signal informs the microprocessor that it is executing; the microprocessor's WAIT

instruction forces the microprocessor to wait until the coprocessor is finished executing (WAIT FOR NOT BUSY).

When an incorrect instruction is sent to the coprocessor (for example, divide by 0 or load a full register), the coprocessor can signal the microprocessor with an interrupt. There are three conditions that will disable the coprocessor interrupt to the microprocessor:

1. Exception and interrupt-enable bits of the control word are set to 1's

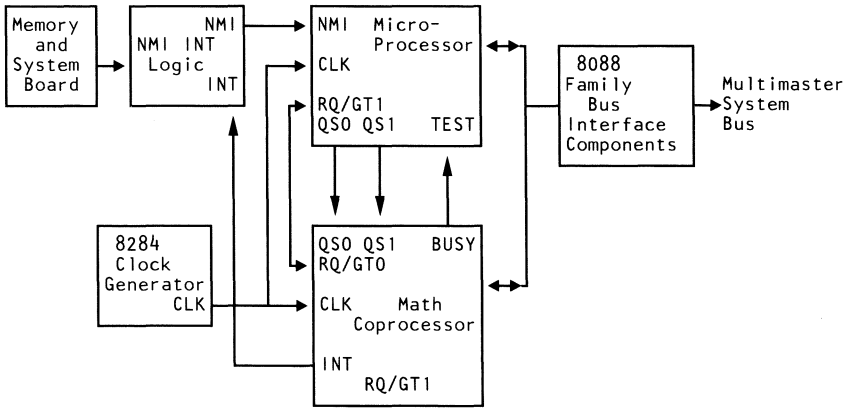
2. System-board switch-block 1, switch 2, set in the On position

3. Non-maskable interrupt register (NMI REG) is set to zero.

At power-on time, the NMI REG is cleared to disable the NMI. Any program using the coprocessor's interrupt capability must ensure that conditions 2 and 3 are never met during the operation of the software or an "Endless WAIT" will occur. An "Endless WAIT" will have the microprocessor waiting for the 'not busy' signal from the coprocessor while the coprocessor is waiting for the microprocessor to interrupt.

Because a memory parity error may also cause an interrupt to the microprocessor NMI line, the program should check the coprocessor status for an exception condition. If a coprocessor exception condition is not found, control should be passed to the normal NMI handler. If an 8087 exception condition is found, the program may clear the exception by executing the FNSAVE or the FNCLEX instruction, and the exception can be identified and acted upon.

The NMI REG and the coprocessor's interrupt are tied to the NMI line through the NMI interrupt logic. Minor modifications to programs designed for use with a coprocessor must be made before the programs will be compatible with the IBM Personal Computer Math Coprocessor.



Coprocessor Interconnection

Detailed information for the internal functions of the Intel 8087 Coprocessor can be found in the books listed in the Bibliography.

SECTION 3. POWER SUPPLIES

Notes:

IBM Personal Computer XT Power Supply

Description

The system dc power supply is a 130-watt, 4 voltage-level switching regulator. It is integrated into the system unit and supplies power for the system unit, its options, and the keyboard. The supply provides 15 A of +5 Vdc, plus or minus 5%, 4.2 A of +12 Vdc, plus or minus 5%, 300 mA of -5 Vdc, plus or minus 10%, and 250 mA of -12 Vdc, plus or minus 10%. All power levels are regulated with overvoltage and overcurrent protection. There are two power supplies, 120 Vac and 220/240 Vac. Both are fused. If dc overcurrent or overvoltage conditions exist, the supply automatically shuts down until the condition is corrected. The supply is designed for continuous operation at 130 watts.

The system board takes approximately 2 to 4 A of +5 Vdc, thus allowing approximately 11 A of +5 Vdc for the adapters in the system expansion slots. The +12 Vdc power level is designed to power the internal diskette drives and the 10M or 20M fixed disk drive. The -5 Vdc level is used for analog circuits in the diskette adapter's phase-lock loop. The +12 Vdc and -12 Vdc are used for powering the Electronic Industries Association (EIA) drivers for the communications adapters. All four power levels are bussed across the eight system expansion slots.

The IBM Monochrome Display has its own power supply, receiving its ac power from the system unit's power system. The ac output for the display is switched on and off with the Power switch and is a nonstandard connector.

Input Requirements

The nominal power requirements and output voltages are listed in the following tables.

Voltage @ 50/60 Hz ± 3 Hz		
Nominal Vac	Minimum Vac	Maximum Vac
110 220/240	90 180	137 259
Current: 4.1 A max at 90 Vac		

Input Requirements

Outputs

Nominal Output(Vdc)	Load Current (A) Min	Max	Regulation Tolerance
+5 Vdc	2.3	15.0	+5% to -4%
-5 Vdc	0.0	0.3	+10% to -8%
+12 Vdc	0.4	4.2	+5% to -4%
-12 Vdc	0.0	0.25	+10% to -9%

Vdc Output

Nominal Output(Vac)	Load Current (A) Min	Max	Voltage Limits Min	Max
120	0.0	1.0	90	137
220/240	0.0	0.5	180	259

Vac Output

The sense levels of the dc outputs are:

Output(Vdc)	Minimum (Vdc)	Sense Voltage Nominal (Vdc)	Maximum (Vdc)
+5 Vdc	+4.5	+5.0	+5.5
-5 Vdc	-4.3	-5.0	-5.5
+12 Vdc	+10.8	+12.0	+13.2
-12 Vdc	-10.2	-12.0	-13.2

Vdc Sense Levels

Overvoltage/Overcurrent Protection

Voltage Nominal(Vac)	Type Protection	Rating Amps
110	Fuse	5.0
220/240	Fuse	3.5

Voltage and Current Protection

Power Good Signal

When the supply is switched off for a minimum of 1.0 second, and then switched on, the 'power good' signal will be regenerated.

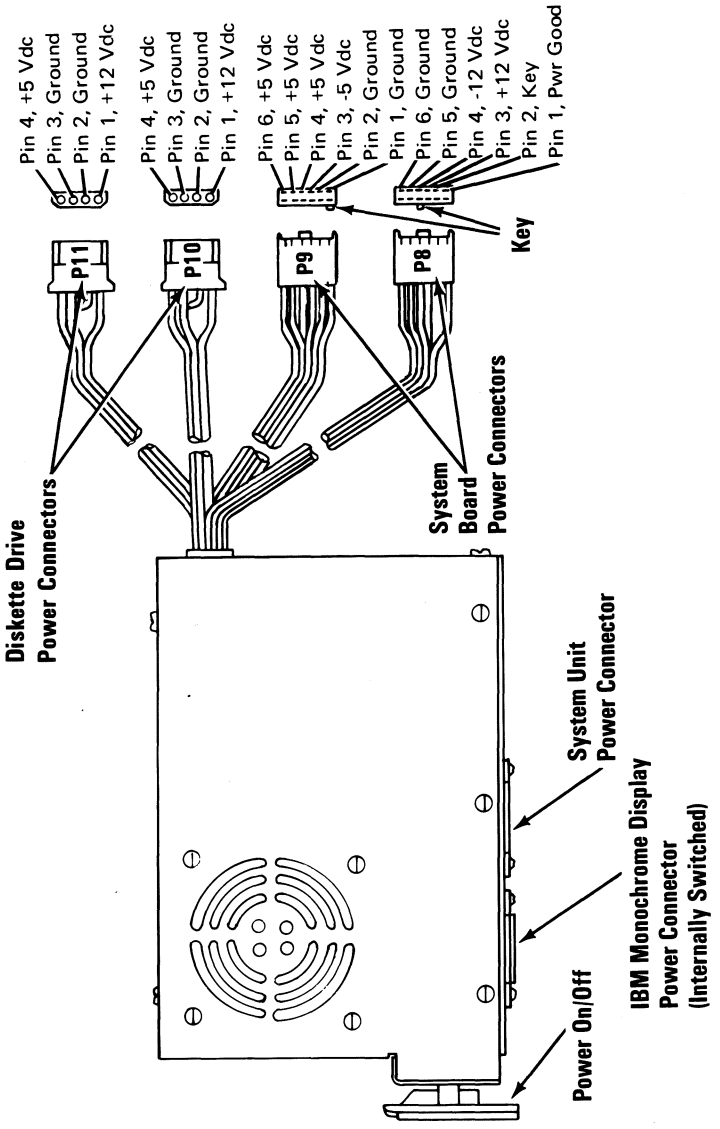
The 'power good' signal indicates that there is adequate power to continue processing. If the power goes below the specified levels, the 'power good' signal triggers a system shutdown.

This signal is the logical AND of the dc output-voltage 'sense' signal and the ac input-voltage 'fail' signal. This signal is TTL-compatible up-level for normal operation or down-level for fault conditions. The ac 'fail' signal causes 'power good' to go to a down level when any output voltage falls below the regulation limits.

The dc output-voltage 'sense' signal holds the 'power good' signal at a down level (during power-on) until all output voltages have reached their respective minimum sense levels. The 'power good' signal has a turn-on delay of at least 100 ms but no greater than 500 ms.

Connector Specifications and Pin Assignments

The power connector on the system board is a 12-pin male connector that plugs into the power-supply connectors. The pin assignments and locations are shown below.



Power Supply and Connectors

IBM Portable Personal Computer Power Supply

Description

The system unit's power supply is a 114-watt, switching regulator that provides five outputs. It supplies power for the system unit and its options, the power supply fan, the diskette drive, the composite display, and the keyboard. All power levels are protected against overvoltage and overcurrent conditions. The input voltage selector switch has 115 Vac and 230 Vac positions. If a dc overload or overvoltage condition exists, the power supply automatically shuts down until the condition is corrected, and the power supply is switched off and then on.

The internal 5-1/4 inch diskette drive uses the +5 Vdc and the +12 Vdc power levels. Both the +12 Vdc and -12 Vdc power levels are used in the drivers and receivers of the optional communications adapters. The display uses a separate +12 Vdc power level. The +5 Vdc, -5 Vdc, +12 Vdc, and -12 Vdc power levels are bussed across the system expansion slots.

Voltage and Current Requirements

Voltage @ 50/60 Hz ± 3 Hz		
Nominal Vac	Minimum Vac	Maximum Vac
110 220/240	90 180	137 259
Current: 3.5 A max at 90 Vac		

Note: Input voltage to be 50 or 60 hertz, ± 3 hertz.

Nominal Output(Vdc)	Load Current (A) Min	Max	Regulation Tolerance
+5 Vdc	2.3	11.2	+5% to -4%
-5 Vdc	0.0	0.3	+10% to -8%
+12 Vdc	0.04	2.9	+5% to -4%
-12 Vdc	0.0	0.25	+10% to -9%
+12 Vdc (display)	0.5	1.5	+10% to -9%

Vdc Output

Output(Vdc)	Minimum (Vdc)	Sense Voltage Nominal (Vdc)	Maximum (Vdc)
+5 Vdc	+4.5	+5.0	+6.5
-5 Vdc	-4.3	-5.0	-6.5
+12 Vdc	+10.8	+12.0	+15.6
-12 Vdc	-10.2	-12.0	-15.6
+12 Vdc (display)	+10.8	+12.0	+15.6

Vdc Sense Levels

Voltage Nominal(Vac)	Type Protection	Rating Amps
110	Fuse	5.0
220/240	Fuse	2.5

Voltage and Current Protection

Power Good Signal

When the power supply is switched off for a minimum of 1 second and then switched on, the 'power good' signal is regenerated.

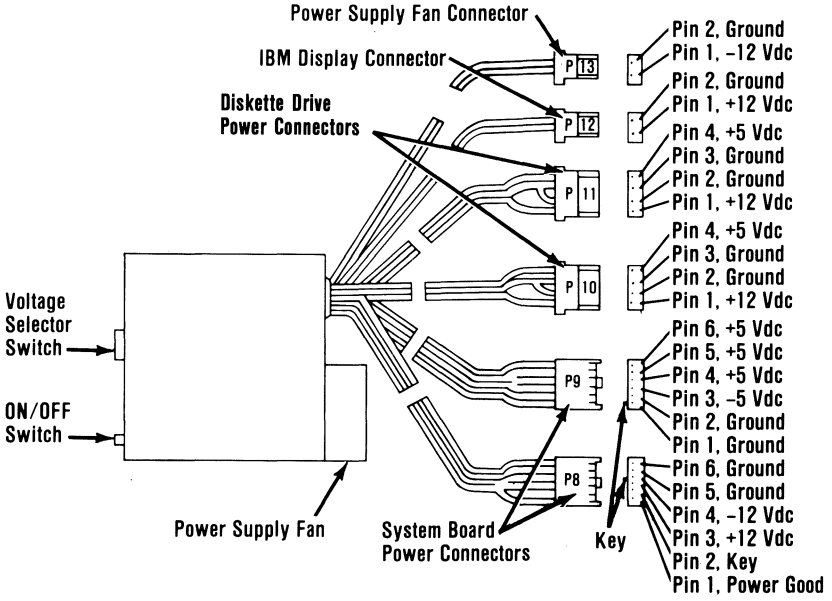
This signal is the logical **AND** of the dc output-voltage sense signal and the ac input-voltage fail signal. This signal is **TTL**-compatible up-level for normal operation or down-level for fault conditions. The ac 'fail' signal causes 'power good' to go to a down-level when any output voltage falls below the sense voltage limits.

When power is switched on, the dc output-voltage sense signal holds the 'power good' signal at a down level until all output

voltages reach their minimum sense levels. The 'power good' signal has a turn-on delay of 100 to 500 milliseconds.

Connector Specifications and Pin Assignments

The power connector on the system board is a 12-pin connector that plugs into the power supply connectors, P8 and P9. The Input Voltage Selector switch and the pin assignment locations follow.



Power Supply and Connectors

Notes:

SECTION 4. KEYBOARDS

Introduction

Three keyboards are discussed in this section. The 83-key keyboard information for the Personal Computer XT and Portable Personal Computer begins below. Information about the IBM Enhanced Personal Computer Keyboard, hereafter referred to as the 101/102-Key Keyboard, begins on page 4-22.

83-Key Keyboard Description

The Personal Computer XT keyboard has a permanently attached cable that connects to a DIN connector at the rear of the system unit. This shielded 5-wire cable has power (+5 Vdc), ground, and two bidirectional signal lines. The cable is approximately 183 cm (6 ft) long and is coiled, like that of a telephone handset.

The IBM Portable Personal Computer keyboard cable is a detachable, 4-wire, shielded cable that connects to a modular connector in the front panel of the system unit. The cable has power (+5 Vdc), ground, and two bidirectional signal lines in it. It is 762 mm (30 in.) long and is coiled.

Both keyboards use a capacitive technology with a microprocessor (Intel 8048) performing the keyboard scan function. The keyboard has two tilt positions for operator comfort (5- or 15-degree tilt orientations for the Personal Computer XT and 5- or 12-degree tilt orientations for the IBM Portable Personal Computer).

Note: The following descriptions are common to both the Personal Computer XT and IBM Portable Personal Computer.

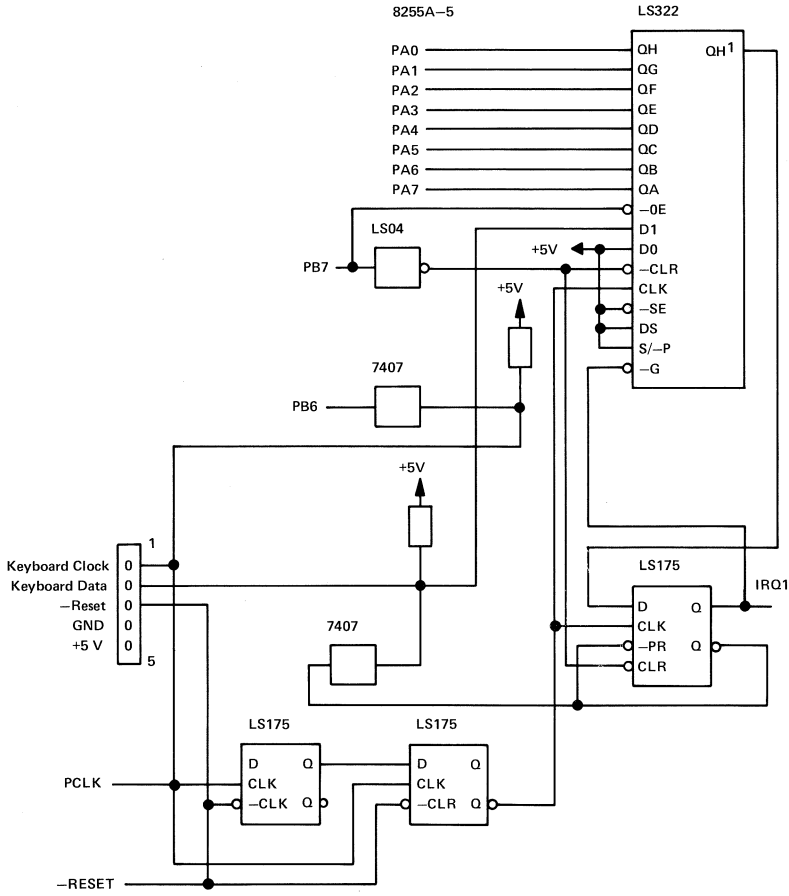
The keyboard has 83 keys arranged in three major groupings. The central portion of the keyboard is a standard typewriter keyboard layout. On the left side are 10 function keys. These keys are user-defined by the software. On the right is a 15-key keypad. These keys are also defined by the software, but have legends for the functions of numeric entry, cursor control, calculator pad, and screen edit.

The keyboard interface is defined so that system software has maximum flexibility in defining certain keyboard operations. This is accomplished by having the keyboard return scan codes rather than American Standard Code for Information Interchange (ASCII) codes. In addition, all keys are typematic (if held down, they will repeat) and generate both a make and a break scan code. For example, key 1 produces scan code hex 01 on make and code hex 81 on break. Break codes are formed by adding hex 80 to make codes. The keyboard I/O driver can define keyboard keys as shift keys or typematic, as required by the application.

The keyboard microprocessor (Intel 8048) performs several functions, including a power-on self test when requested by the system unit. This test checks the keyboard's ROM, tests memory, and checks for stuck keys. Additional functions are keyboard scanning, buffering of up to 16 key scan codes, maintaining bidirectional serial communications with the system unit, and executing the handshake protocol required by each scan-code transfer.

Several different keyboard arrangements are available. These are illustrated on the following pages. For information about the keyboard routines required to implement non-US keyboards, refer to the *Guide to Operations* and *DOS* manuals.

Block Diagram



Keyboard Interface Block Diagram

Keyboard Encoding and Usage

Encoding

The keyboard routine provided by IBM in the ROM BIOS is responsible for converting the keyboard scan codes into what will be termed "Extended ASCII."

Extended ASCII encompasses 1-byte character codes with possible values of 0 to 255, an extended code for certain extended keyboard functions, and functions handled within the keyboard routine or through interrupts.

Character Codes

The following character codes are passed through the BIOS keyboard routine to the system or application program. A '-1' means the combination is suppressed in the keyboard routine. The codes are returned in AL.

Key	Base Case	Uppercase	Ctrl	Alt
1	Esc	Esc	-1	-1
2	1	!	-1	(*)
3	2	@	Nul(000) (*)	(*)
4	3	#	-1	(*)
5	4	$	-1	(*)
6	5	%	-1	(*)
7	6	^	RS(030)	(*)
8	7	&	-1	(*)
9	8	*	-1	(*)
10	9	(	-1	(*)
11	0	)	-1	(*)
12	-	_	US(031)	(*)
13	=	+	-1	(*)
14	Backspace (008)	Backspace (008)	Del(127)	-1
15	→| (009)	|← (*)	-1	-1
16	q	Q	DC1(017)	(*)
17	w	W	ETB(023)	(*)
18	e	E	ENQ(005)	(*)
19	r	R	DC2(018)	(*)
20	t	T	DC4(020)	(*)
21	y	Y	EM(025)	(*)
22	u	U	NAK(021)	(*)
23	i	I	HT(009)	(*)
24	o	O	SI(015)	(*)
25	p	P	DLE(016)	(*)
26	[	{	Esc(027)	(*)
27	]	}	GS(029)	-1
28	CR	CR	LF(010)	-1
29 Ctrl	-1	-1	-1	-1
30	a	A	SOH(001)	(*)
31	s	S	DC3(019)	(*)
32	d	D	EOT(004)	(*)
33	f	F	ACK(006)	(*)
34	g	G	BEL(007)	(*)
35	h	H	BS(008)	(*)
36	j	J	LF(010)	(*)
37	k	K	VT(011)	(*)
38	l	L	FF(012)	(*)
39	; ,	: "	-1	-1
40	'	~	-1	-1
41	`	|	FS(028)	-1
42 Shift (Left)	-1	-1	-1	-1
43	\	Z	FS(028)	-1
44	z	X	SUB(026)	(*)
45	x	C	CAN(024)	(*)
46	c	V	ETX(003)	(*)

Notes:
(*) Refer to "Extended Functions" in this section.

Character Codes (Part 1 of 2)

Key	Base Case	Uppercase	Ctrl	Alt
47	v	V	SYN(022)	(*)
48	b	B	STX(002)	(*)
49	n	N	SO(014)	(*)
50	m	M	CR(013)	(*)
51	,	<	-1	-1
52	.	>	-1	-1
53	/	?	-1	-1
54 Shift (Right)	-1	-1	-1	-1
55	*	PrtSc	?	?
56 Alt	-1	-1	-1	-1
57	Space	Space	Space	Space
58 Caps Lock	-1	-1	-1	-1
69 Num Lock	-1	-1 (*)	Pause (**)	-1
70 Scroll Lock	-1	-1	Break (**)	-1
107	-	-	(*)	(*)
108	Enter	Enter	-1	-1
112	Null (*)	Null (*)	Null (*)	Null(*)
113	Null (*)	Null (*)	Null (*)	Null(*)
114	Null (*)	Null (*)	Null (*)	Null(*)
115	Null (*)	Null (*)	Null (*)	Null(*)
116	Null (*)	Null (*)	Null (*)	Null(*)
117	Null (*)	Null (*)	Null (*)	Null(*)
118	Null (*)	Null (*)	Null (*)	Null(*)

Notes:
(*) Refer to "Extended Functions" in this section.
(**) Refer to "Special Handling" in this section.

Character Codes (Part 2 of 2)

Keys 71 through 83 have meaning only in base case, in Num Lock (or shifted) states, or in Ctrl state. Note that the Shift key temporarily reverses the current Num Lock state.

Extended Codes

Extended Functions

For certain functions that cannot be represented in the standard ASCII code, an extended code is used. A character code of 000 (Null) is returned in AL. This indicates that the system or application program should examine a second code that will indicate the actual function. Usually, but not always, this second code is the scan code of the primary key that was pressed. This code is returned in AH.

Shift States

Most shift states are handled within the keyboard routine and are not apparent to the system or application program. In any case, the current set of active shift states is available by calling an entry point in the ROM keyboard routine. The key numbers are shown on the keyboard diagrams beginning on page 4-12. The following keys result in altered shift states:

Shift

This key temporarily shifts keys 2–13, 15–27, 30–41, 43–53, 55, 59–68 to uppercase (base case if in Caps Lock state). Also, the Shift key temporarily reverses the Num Lock or non-Num-Lock state of keys 71–73, 75, 77, and 79–83.

Ctrl

This key temporarily shifts keys 3, 7, 12, 14, 16–28, 30–38, 43–50, 55, 59–71, 73, 75, 77, 79, and 81 to the Ctrl state. Also, the Ctrl key used with the Alt and Del keys causes the system reset function; with the Scroll Lock key, the break function; and with the Num Lock key,the pause function. The system reset, break, and pause functions are described in "Special Handling" on the following pages.

Alt

This key temporarily shifts keys 2–13, 16–25, 30–38, 44–50, and 59–68 to the Alt state. Also, the Alt key is used with the Ctrl and Del keys to cause the system reset function described in "Special Handling" on the following pages.

The Alt key has another use. This key allows the user to enter any ASCII character code from 1 to 255 into the system from the keyboard. The user holds down the Alt key and types the decimal value of the characters desired using the numeric keypad (keys 71–73, 75–77, and 79–82). The Alt key is then released. If more than three digits are typed, a modulo-256 result is created. These three digits are interpreted as a character code and are transmitted through the keyboard routine to the system or application program. Alt is handled within the keyboard routine.

Caps Lock

This key shifts keys 16–25, 30–38, and 44–50 to uppercase. Pressing the Caps Lock key a second time reverses the action. Caps Lock is handled within the keyboard routine.

Scroll Lock

This key is interpreted by appropriate application programs as indicating that use of the cursor-control keys should cause windowing over the text rather than cursor movement. Pressing the Scroll Lock key a second time reverses the action. The keyboard routine simply records the current shift state of the Scroll Lock key. It is the responsibility of the system or application program to perform the function.

Shift Key Priorities and Combinations

If combinations of the Alt, Ctrl, and Shift keys are pressed and only one is valid, the precedence is as follows: the Alt key is first, the Ctrl key is second, and the Shift key is third. The only valid combination is Alt and Ctrl, which is used in the system reset function.

Special Handling

System Reset

The combination of the Alt, Ctrl, and Del keys will result in the keyboard routine initiating the equivalent of a system reset. System reset is handled within the keyboard routine.

Break

The combination of the Ctrl and Break keys will result in the keyboard routine signaling interrupt hex 1B. Also the extended characters (AL = hex 00, AH = hex 00) will be returned.

Pause

The combination of the Ctrl and Num Lock keys will cause the keyboard interrupt routine to loop, waiting for any key except the Num Lock key to be pressed. This provides a system- or application-transparent method of temporarily suspending list, print, and so on, and then resuming the operation. The "unpause" key is thrown away. Pause is handled within the keyboard routine.

Print Screen

The combination of the Shift and PrtSc keys will result in an interrupt invoking the print screen routine. This routine works in the alphameric or graphics mode, with unrecognizable characters printing as blanks.

Extended Functions

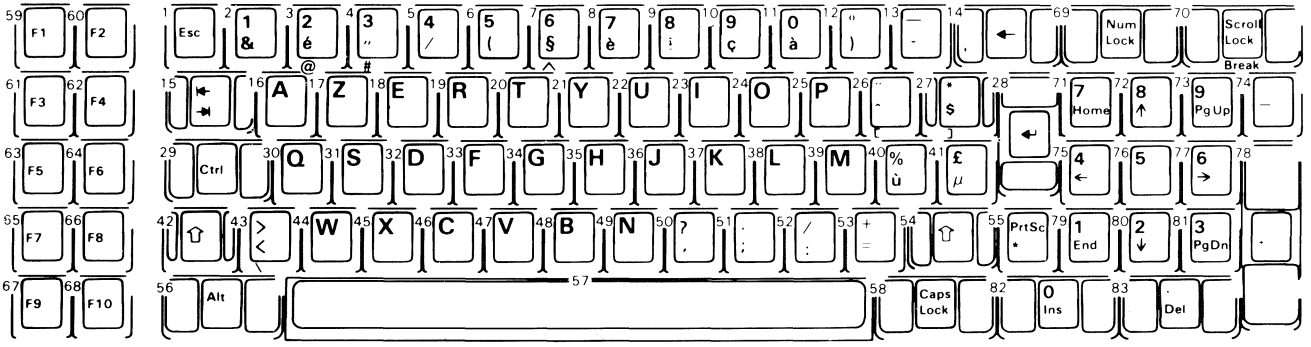
The keyboard routine does its own buffering. The keyboard buffer is large enough that few typists will ever fill it. However, if a key is pressed when the buffer is full, the key will be ignored and the "bell" will sound.

Also, the keyboard routine suppresses the typematic action of the following keys: Ctrl, Shift, Alt, Num Lock, Scroll Lock, Caps Lock, and Ins.

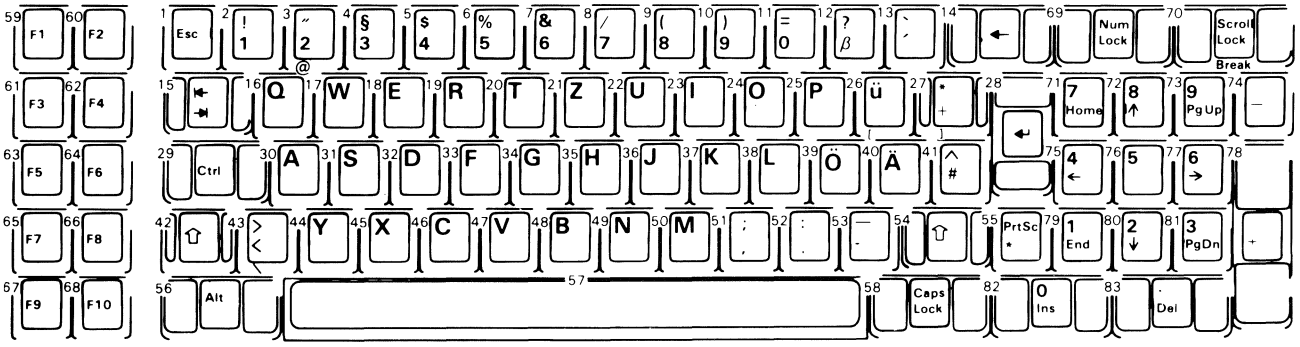
Keyboard Layouts

The IBM Personal Computer keyboard is available in six different layouts as shown on the following pages:

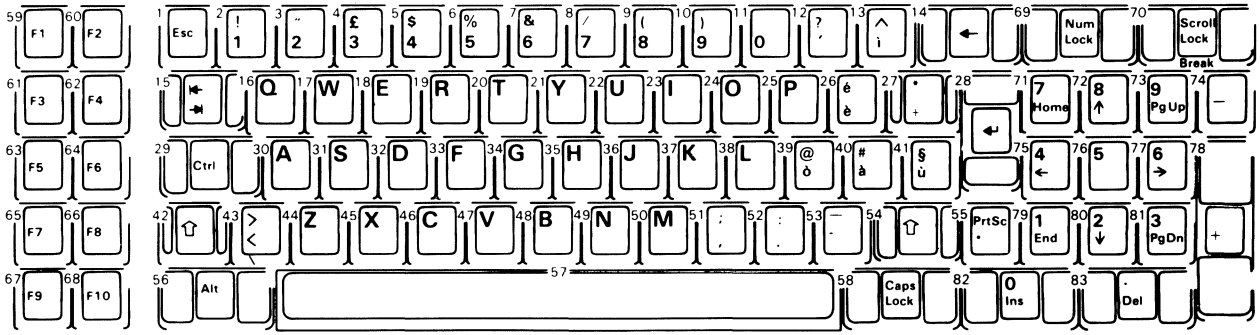
- French
- German
- Italian
- Spanish
- UK English
- US English



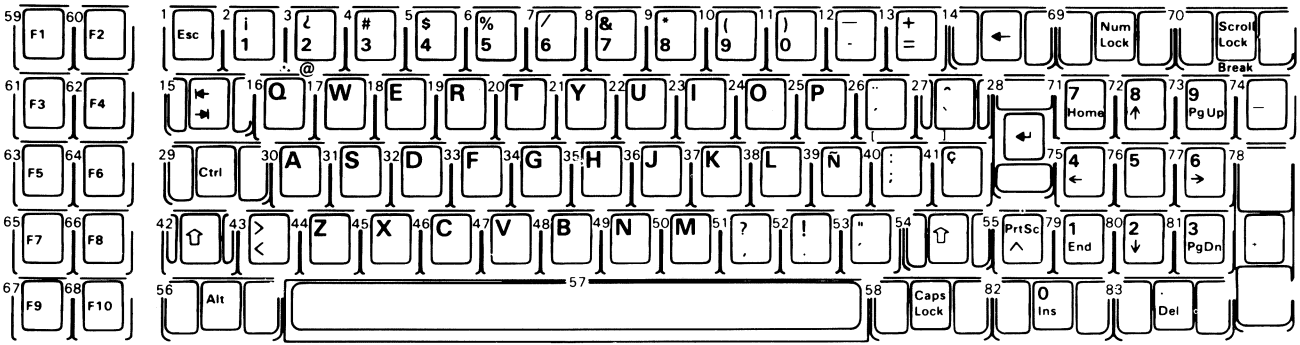
Note: Nomenclature is on both the top and front face of keybuttons as shown. The number to the upper left designates the button position.



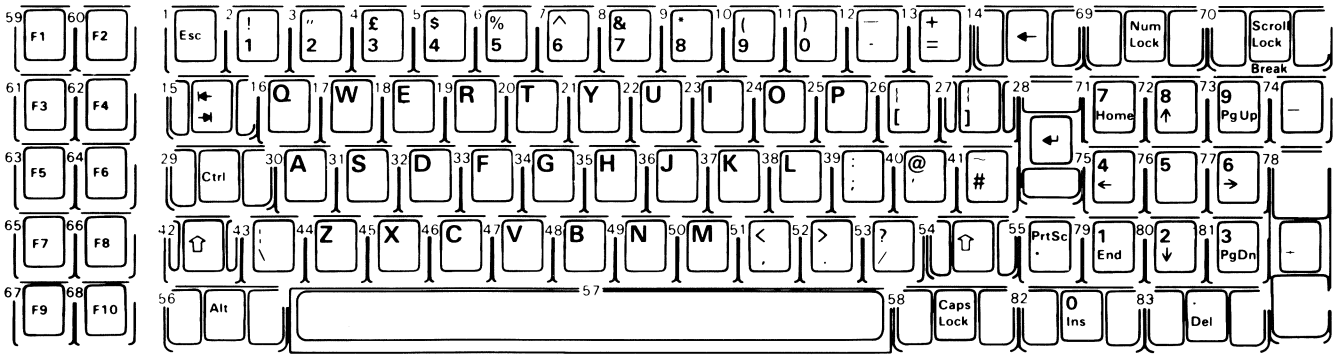
Note: Nomenclature is on both the top and front face of keybuttons as shown. The number to the upper left designates the button position.



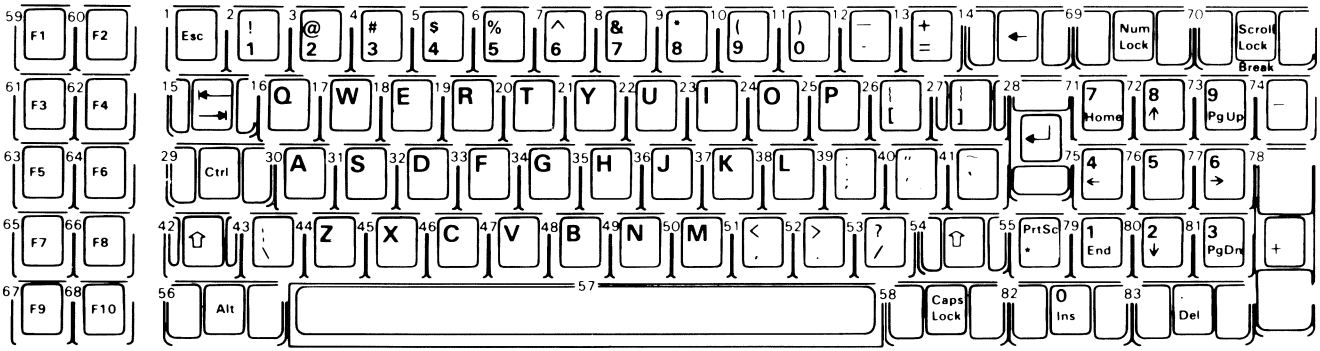
Note: Nomenclature is on both the top and front face of keybuttons as shown. The number to the upper left designates the button position.



Note: Nomenclature is on both the top and front face of keybuttons as shown. The number to the upper left designates the button position.

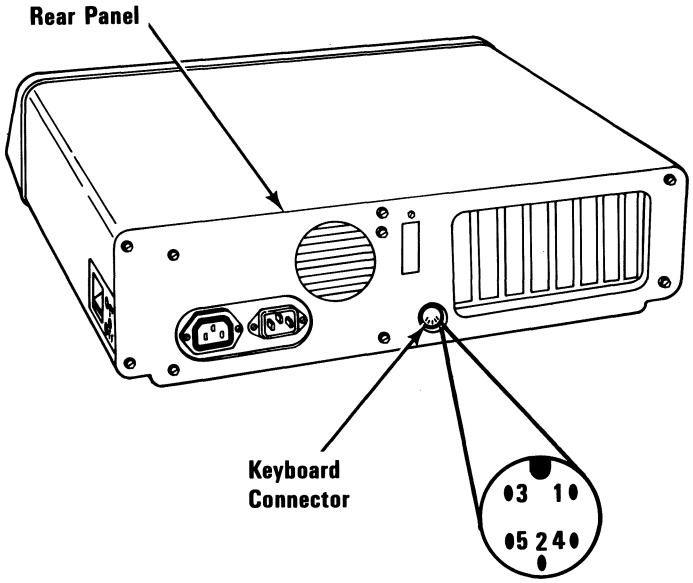


Note: Nomenclature is on both the top and front face of keybuttons as shown. The number to the upper left designates the button position.



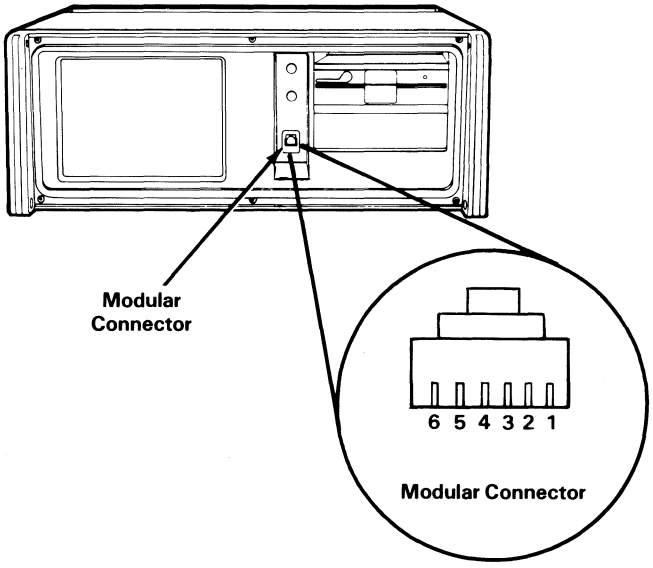
Note: Nomenclature is on both the top and front face of keybuttons as shown. The number to the upper left designates the button position.

Connector Specifications

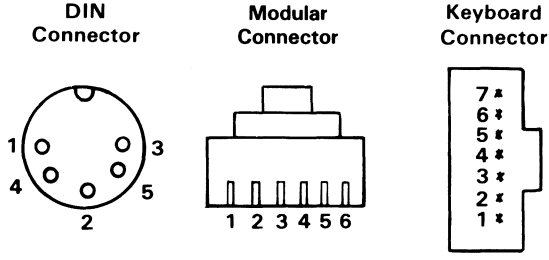


Pin	TTL Signal	Signal Level
1 2 3	+ Keyboard Clock + Keyboard Data - Keyboard Reset (Not used by keyboard	+ 5 Vdc + 5 Vdc
	Power Supply Voltages	Voltage
4 5	Ground + 5 Volts	0 + 5 Vdc

Keyboard Interface Connector Specifications



Keyboard Cable Connections

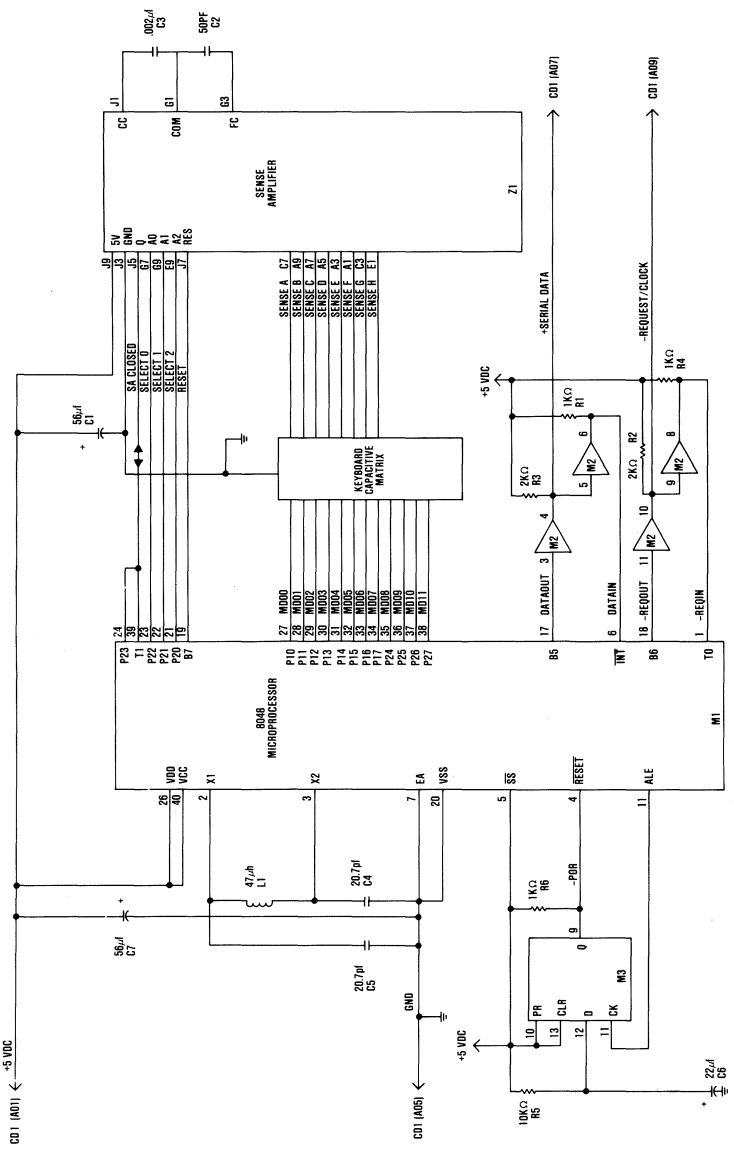


	Pin Side	Pin Side	Wire Side
Clock	1	4	6
Data	2	5	5
Ground	4	3	4
+5 Volts	5	2	2

Modular connector pin 1 is connected to the ground wire going to the chassis.

The ground wire at the keyboard connector is attached to the ground screw on the keyboard logic board.

Keyboard Logic Diagram



83-Key Keyboard

SECTION 4

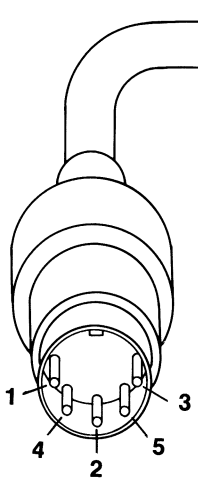
101/102-Key Keyboard

Description

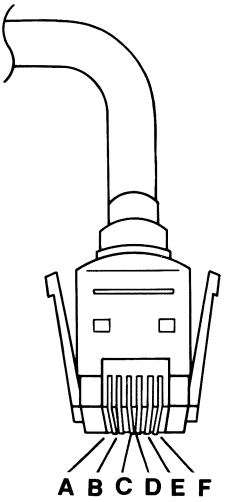
The keyboard has 101 keys (102 in countries outside the U. S.). At system power-on, the keyboard monitors the signals on the 'clock' and 'data' lines and establishes its line protocol.

Cables and Connectors

The keyboard cable connects to the system with a 5-pin DIN connector, and to the keyboard with a 6-position SDL connector. The following table shows the pin configuration and signal assignments.



DIN Connector



SDL Connector

DIN Connector Pins	SDL Connector Pins	Signal Name	Signal Type
1	C	+KBD CLK	Input/Output
2	E	+KBD DATA	Input/Output
3	A	Reserved	
4	D	Ground	Power
5	B	+5.0 Vdc	Power
	F	Not used	
Shield	Shield	Frame Ground	

SECTION 4

Sequencing Key-Code Scanning

The keyboard detects all keys pressed, and sends each scan code in the correct sequence. When not serviced by the system, the keyboard stores the scan codes in its buffer.

Keyboard Buffer

A 16-byte first-in-first-out (FIFO) buffer in the keyboard stores the scan codes until the system is ready to receive them.

A buffer-overrun condition occurs when more than 16 bytes are placed in the keyboard buffer. An overrun code replaces the 17th byte. If more keys are pressed before the system allows keyboard output, the additional data is lost.

When the keyboard is allowed to send data, the bytes in the buffer will be sent as in normal operation, and new data entered is detected and sent. Response codes do not occupy a buffer position.

If keystrokes generate a multiple-byte sequence, the entire sequence must fit into the available buffer space or the keystroke is discarded and a buffer-overrun condition occurs.

Keys

With the exception of the Pause key, all keys are *make/break*. The make scan code of a key is sent to the keyboard controller when the key is pressed. When the key is released, its break scan code is sent.

Additionally, except for the Pause key, all keys are *typematic*. When a key is pressed and held down, the keyboard sends the make code for that key, delays 500 milliseconds ± 20%, and begins sending a make code for that key at a rate of 10.9 characters per second ± 20%.

If two or more keys are held down, only the last key pressed repeats at the typematic rate. Typematic operation stops when the last key pressed is released, even if other keys are still held down. If a key is pressed and held down while keyboard transmission is inhibited, only the first make code is stored in the buffer. This prevents buffer overflow as a result of typematic action.

Power-On Routine

The following activities take place when power is first applied to the keyboard.

Power-On Reset

The keyboard logic generates a 'power-on reset' signal (POR) when power is first applied to the keyboard. POR occurs during 150 milliseconds to 2.0 seconds from the time power is first applied to the keyboard.

Basic Assurance Test

The basic assurance test (BAT) consists of a keyboard processor test, a checksum of the read-only memory (ROM), and a random-access memory (RAM) test. During the BAT, activity on the 'clock' and 'data' lines is ignored. The BAT takes from 300 to 500 milliseconds. This is in addition to the time required by the POR.

Upon satisfactory completion of the BAT, a completion code (hex AA) is sent to the system, and keyboard scanning begins. If a BAT failure occurs, the keyboard sends an error code to the system. The keyboard is then disabled pending command input. Completion codes are sent 450 milliseconds to 2.5 seconds after POR, and between 300 and 500 milliseconds after a Reset command is acknowledged.

Immediately following POR, the keyboard monitors the signals on the keyboard 'clock' and 'data' lines and sets the line protocol.

Commands from the System

Reset (Hex FF)

The system lowers the 'clock' line for a minimum of 12.5 milliseconds. The keyboard then begins to clock bits on the 'data' line. The result is a Reset command causing the keyboard to reset itself, perform a BAT, and return the appropriate completion code.

Commands to the System

The following table shows the commands that the keyboard may send to the system, and their hexadecimal values.

Command	Hex Value
BAT Completion Code	AA
BAT Failure Code	FC
Key Detection Error/Overrun	FF

The commands the keyboard sends to the system are described below, in alphabetic order.

BAT Completion Code (Hex AA)

Following satisfactory completion of the BAT, the keyboard sends hex AA. Any other code indicates a failure of the keyboard.

BAT Failure Code (Hex FC)

If a BAT failure occurs, the keyboard sends this code, discontinues scanning, and waits for a system response or reset.

Key Detection Error (Hex FF)

The keyboard sends a key detection error character (hex FF) if conditions in the keyboard make it impossible to identify a switch closure.

Overrun (Hex FF)

An overrun character (hex FF) is placed in the keyboard buffer and replaces the last code when the buffer capacity has been exceeded. The code is sent to the system when it reaches the top of the buffer queue.

Keyboard Scan Codes

Each key is assigned a base scan code and, in some cases, extra codes to generate artificial shift states in the system. The typematic scan codes are identical to the base scan code for each key.

Scan Code Tables

The following keys send the codes as shown, regardless of any shift states in the keyboard or the system. Refer to "Keyboard Layouts" beginning on page 4-44 to determine the character associated with each key number.

Key Number	Make Code	Break Code
1	29	A9
2	02	82
3	03	83
4	04	84
5	05	85
6	06	86
7	07	87
8	08	88
9	09	89
10	0A	8A
11	0B	8B
12	0C	8C
13	0D	8D
15	0E	8E
16	0F	8F
17	10	90
18	11	91
19	12	92
20	13	93
21	14	94
22	15	95
23	16	96
24	17	97
25	18	98
26	19	99
27	1A	9A
28	1B	9B
29 *	2B	AB
30	3A	BA
31	1E	9E
32	1F	9F
33	20	A0

* 101-key keyboard only.

Key Number	Make Code	Break Code
34	21	A1
35	22	A2
36	23	A3
37	24	A4
38	25	A5
39	26	A6
40	27	A7
41	28	A8
42 **	2B	AB
43	1C	9C
44	2A	AA
45 **	56	D6
46	2C	AC
47	2D	AD
48	2E	AE
49	2F	AF
50	30	B0
51	31	B1
52	32	B2
53	33	B3
54	34	B4
55	35	B5
57	36	B6
58	1D	9D
60	38	B8
61	39	B9
62	E0 38	E0 B8
64	E0 1D	E0 9D
90	45	C5
91	47	C7
92	4B	CB
93	4F	CF
96	48	C8
97	4C	CC
98	50	D0
99	52	D2
100	37	B7
101	49	C9
102	4D	CD
103	51	D1
104	53	D3
105	4A	CA
106	4E	CE
108	E0 1C	E0 9C
110	01	81
112	3B	BB
113	3C	BC
114	3D	BD
115	3E	BE
116	3F	BF
117	40	C0
118	41	C1
119	42	C2

** 102-key keyboard only.

Key Number	Make Code	Break Code
120	43	C3
121	44	C4
122	57	D7
123	58	D8
125	46	C6

The remaining keys send a series of codes dependent on the state of the various shift keys (Ctrl, Alt, and Shift), and the state of Num Lock (On or Off). Because the base scan code is identical to that of another key, an extra code (hex E0) has been added to the base code to make it unique.

Key No.	Base Case, or Shift+Num Lock Make/Break	Shift Case Make/Break *	Num Lock on Make/Break
75	E0 52 /E0 D2	E0 AA E0 52 /E0 D2 E0 2A	E0 2A E0 52 /E0 D2 E0 AA
76	E0 53 /E0 D3	E0 AA E0 53 /E0 D3 E0 2A	E0 2A E0 53 /E0 D3 E0 AA
79	E0 4B /E0 CB	E0 AA E0 4B /E0 CB E0 2A	E0 2A E0 4B /E0 CB E0 AA
80	E0 47 /E0 C7	E0 AA E0 47 /E0 C7 E0 2A	E0 2A E0 47 /E0 C7 E0 AA
81	E0 4F /E0 CF	E0 AA E0 4F /E0 CF E0 2A	E0 2A E0 4F /E0 CF E0 AA
83	E0 48 /E0 C8	E0 AA E0 48 /E0 C8 E0 2A	E0 2A E0 48 /E0 C8 E0 AA
84	E0 50 /E0 D0	E0 AA E0 50 /E0 D0 E0 2A	E0 2A E0 50 /E0 D0 E0 AA
85	E0 49 /E0 C9	E0 AA E0 49 /E0 C9 E0 2A	E0 2A E0 49 /E0 C9 E0 AA
86	E0 51 /E0 D1	E0 AA E0 51 /E0 D1 E0 2A	E0 2A E0 51 /E0 D1 E0 AA
89	E0 4D /E0 CD	E0 AA E0 4D /E0 CD E0 2A	E0 2A E0 4D /E0 CD E0 AA

* If the left Shift key is held down, the AA/2A shift break and make is sent with the other scan codes. If the right Shift key is held down, B6/36 is sent. If both Shift keys are down, both sets of codes are sent with the other scan code.

Key No.	Scan Code Make/Break	Shift Case Make/Break *
95	E0 35/E0 B5	E0 AA E0 35/E0 B5 E0 2A

* If the left Shift key is held down, the AA/2A shift break and make is sent with the other scan codes. If the right Shift key is held down, B6/36 is sent. If both Shift keys are down, both sets of codes are sent with the other scan code.

Key No.	Scan Code Make/Break	Ctrl Case, Shift Case Make/Break	Alt Case Make/Break
124	E0 2A E0 37 /E0 B7 E0 AA	E0 37/E0 B7	54/D4

Key No.	Make Code	Ctrl Key Pressed
126 *	E1 1D 45 E1 9D C5	E0 46 E0 C6

* This key is not typematic. All associated scan codes occur on the make of the key.

Clock and Data Signals

The keyboard and system communicate over the 'clock' and 'data' lines. The source of each of these lines is an open-collector device on the keyboard that allows either the keyboard or the system to force a line to an inactive (low) level. When no communication is occurring, the 'clock' line is at an active (high) level. The state of the 'data' line is held inactive (low) by the keyboard.

An inactive signal will have a value of at least 0, but not greater than +0.7 volts. A signal at the inactive level is a logical 0. An active signal will have a value of at least +2.4, but not greater than +5.5 volts. A signal at the active level is a logical 1. Voltages are measured between a signal source and the dc network ground.

The keyboard 'clock' line provides the clocking signals used to clock serial data from the keyboard. If the host system forces the 'clock' line to an inactive level, keyboard transmission is inhibited.

When the keyboard sends data to the system, it generates the 'clock' signal to time the data. The system can prevent the keyboard from sending data by forcing the 'clock' line to an inactive level, or by holding the 'data' line at an inactive level.

During the BAT, the keyboard allows the 'clock' and 'data' lines to go to an active level.

Data Stream

Data transmissions from the keyboard consist of a 9-bit data stream sent serially over the 'data' line. A logical 1 is sent at an active (high) level. The following table shows the functions of the bits.

Bit	Function
1	Start bit (always 1)
2	Data bit 0 (least-significant)
3	Data bit 1
4	Data bit 2
5	Data bit 3
6	Data bit 4
7	Data bit 5
8	Data bit 6
9	Data bit 7 (most-significant)

Keyboard Data Output

When the keyboard is ready to send data, it first checks the status of the keyboard 'clock' line. If the line is active (high), the keyboard issues a request-to-send (RTS) by making the 'clock' line inactive (low). The system must respond with a clear-to-send (CTS), generated by allowing the 'data' line to become active, within 250 microseconds after RTS, or data will be stored in the keyboard buffer. After receiving CTS, the keyboard begins sending the 9 serial bits. The leading edge of the first clock pulse will follow CTS by 60 to 120 microseconds. During each clock cycle, the keyboard clock is active for 25 to 50 microseconds. Each data bit is valid from 2.5 microseconds before the leading edge until 2.5 microseconds after the trailing edge of each keyboard clock cycle.

Keyboard Encoding and Usage

The keyboard routine, provided by IBM in the ROM BIOS, is responsible for converting the keyboard scan codes into what will be termed *Extended ASCII*. The extended ASCII codes returned by the ROM routine are mapped to the US English keyboard layout. Some operating systems may make provisions for alternate keyboard layouts by providing an interrupt replacer,

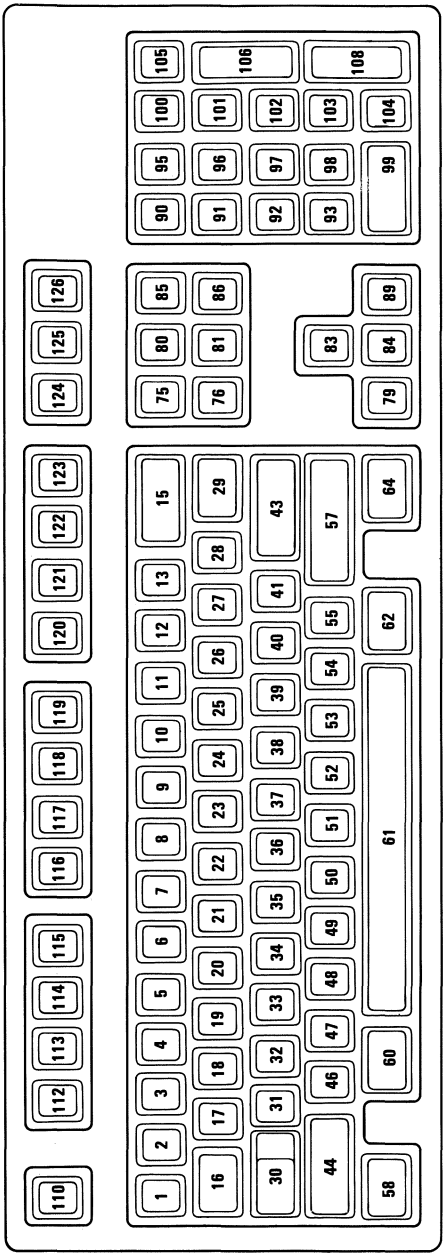
which resides in the read/write memory. This section discusses only the ROM routine.

Extended ASCII encompasses 1-byte character codes, with possible values of 0 to 255, an extended code for certain extended keyboard functions, and functions handled within the keyboard routine or through interrupts.

Character Codes

The character codes described later are passed through the BIOS keyboard routine to the system or application program. A "-1" means the combination is suppressed in the keyboard routine. The codes are returned in the AL register. See "Characters, Keystrokes, and Color" later in this manual for the exact codes.

The following figure shows the keyboard layout and key positions.



Key	Base Case	Uppercase	Ctrl	Alt
1	'	~	-1	(*)
2	1	!	-1	(*)
3	2	@	Nul(000) (*)	(*)
4	3	#	-1	(*)
5	4	$	-1	(*)
6	5	%	-1	(*)
7	6	^	RS(030)	(*)
8	7	&	-1	(*)
9	8	*	-1	(*)
10	9	(	-1	(*)
11	0	)	-1	(*)
12	-	_	US(031)	(*)
13	=	+	-1	(*)
15	Backspace (008)	Backspace (008)	Del(127)	(*)
16	→| (009)	|← (*)	(*)	(*)
17	q	Q	DC1(017)	(*)
18	w	W	ETB(023)	(*)
19	e	E	ENQ(005)	(*)
20	r	R	DC2(018)	(*)
21	t	T	DC4(020)	(*)
22	y	Y	EM(025)	(*)
23	u	U	NAK(021)	(*)
24	i	I	HT(009)	(*)
25	o	O	SI(015)	(*)
26	p	P	DLE(016)	(*)
27	{	{	Esc(027)	(*)
28	}	}	GS(029)	(*)
29	\	|	FS(028)	(*)
30 Caps Lock	-1	-1	-1	-1
31	a	A	SOH(001)	(*)
32	s	S	DC3(019)	(*)
33	d	D	EOT(004)	(*)
34	f	F	ACK(006)	(*)
35	g	G	BEL(007)	(*)
36	h	H	BS(008)	(*)
37	j	J	LF(010)	(*)
38	k	K	VT(011)	(*)
39	l	L	FF(012)	(*)
40	; ,	: "	-1	(*)
41			-1	(*)
43	CR	CR	LF(010)	(*)
44 Shift (Left)	-1	-1	-1	-1
46	z	Z	SUB(026)	(*)
47	x	X	CAN(024)	(*)
48	c	C	ETX(003)	(*)

Notes:
(*) Refer to "Extended Functions" in this section.

Character Codes (Part 1 of 2)

Key	Base Case	Uppercase	Ctrl	Alt
49	v	V	SYN(022)	(*)
50	b	B	STX(002)	(*)
51	n	N	SO(014)	(*)
52	m	M	CR(013)	(*)
53	,	<	-1	(*)
54	.	>	-1	(*)
55	/	?	-1	(*)
57 Shift (Right)	-1	-1	-1	-1
58 Ctrl (Left)	-1	-1	-1	-1
60 Alt (Left)	-1	-1	-1	-1
61	Space	Space	Space	Space
62 Alt (Right)	-1	-1	-1	-1
64 Ctrl (Right)	-1	-1	-1	-1
90 Num Lock	-1	-1	-1	-1
95	/	/	(*)	(*)
100	*	*	(*)	(*)
105	-	-	(*)	(*)
106	+	+	(*)	(*)
108	Enter	Enter	LF(010)	(*)
110	Esc	Esc	Esc	(*)
112	Null (*)	Null (*)	Null (*)	Null(*)
113	Null (*)	Null (*)	Null (*)	Null(*)
114	Null (*)	Null (*)	Null (*)	Null(*)
115	Null (*)	Null (*)	Null (*)	Null(*)
116	Null (*)	Null (*)	Null (*)	Null(*)
117	Null (*)	Null (*)	Null (*)	Null(*)
118	Null (*)	Null (*)	Null (*)	Null(*)
119	Null (*)	Null (*)	Null (*)	Null(*)
120	Null (*)	Null (*)	Null (*)	Null(*)
121	Null (*)	Null (*)	Null (*)	Null(*)
122	Null (*)	Null (*)	Null (*)	Null(*)
123	Null (*)	Null (*)	Null (*)	Null(*)
125 Scroll Lock	-1	-1	-1	-1
126	Pause(**)	Pause(**)	Break(**)	Pause(**)

Notes:
(*) Refer to "Extended Functions" in this section.
(**) Refer to "Special Handling" in this section.

Character Codes (Part 2 of 2)

The following table lists keys that have meaning only in Num Lock, Shift, or Ctrl states. The Shift key temporarily reverses the current Num Lock state.

Key	Num Lock	Base Case	Alt	Ctrl
91	7	Home (*)	-1	Clear Screen
92	4	← (*)	-1	Reverse Word(*)
93	1	End (*)	-1	Erase to EOL(*)
96	8	↑ (*)	-1	(*)
97	5	(*)	-1	(*)
98	2	↓ (*)	-1	(*)
99	0	Ins	-1	(*)
101	9	Page Up (*)	-1	Top of Text and Home
102	6	→ (*)	-1	Advance Word (*)
103	3	Page Down (*)	-1	Erase to EOS (*)
104	.	Delete (*,**)	(**)	(**)

Notes:
(*) Refer to "Extended Functions" in this section.
(**) Refer to "Special Handling" in this section.

Special Character Codes

Extended Functions

For certain functions that cannot be represented by a standard ASCII code, an extended code is used. A character code of 000 (null) is returned in AL. This indicates that the system or application program should examine a second code, which will indicate the actual function. Usually, but not always, this second code is the scan code of the primary key that was pressed. This code is returned in AH.

The following table is a list of the extended codes and their functions.

Second Code	Function
1	Alt Esc
3	Nul Character
14	Alt Backspace
15	|← (Back-tab)
16-25	Alt Q, W, E, R, T, Y, U, I, O, P
26-28	Alt [ ] ↵
30-38	Alt A, S, D, F, G, H, J, K, L
39-41	Alt ; ' `
43	Alt \
44-50	Alt Z, X, C, V, B, N, M
51-53	Alt , . /
55	Alt Keypad *
59-68	F1 to F10 Function Keys (Base Case)
71	Home
72	↑ (Cursor Up)
73	Page Up
74	Alt Keypad -
75	← (Cursor Left)
76	Center Cursor
77	→ (Cursor Right)
78	Alt Keypad +
79	End
80	↓ (Cursor Down)
81	Page Down
82	Ins (Insert)
83	Del (Delete)
84-93	Shift F1 to F10
94-103	Ctrl F1 to F10
104-113	Alt F1 to F10
114	Ctrl PrtSc (Start/Stop Echo to Printer)
115	Ctrl ← (Reverse Word)
116	Ctrl → (Advance Word)
117	Ctrl End (Erase to End of Line-EOL)
118	Ctrl PgDn (Erase to End of Screen-EOS)
119	Ctrl Home (Clear Screen and Home)
120-131	Alt 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, -, = keys 2-13
132	Ctrl PgUp (Top 25 Lines of Text and Cursor Home)
133-134	F11, F12
135-136	Shift F11, F12
137-138	Ctrl F11, F12
139-140	Alt F11, F12
141	Ctrl Up/8
142	Ctrl Keypad -
143	Ctrl Keypad 5
144	Ctrl Keypad +
145	Ctrl Down/2
146	Ctrl Ins/0
147	Ctrl Del/.
148	Ctrl Tab
149	Ctrl Keypad /
150	Ctrl Keypad *

Keyboard Extended Functions (Part 1 of 2)

Second Code	Function
151	Alt Home
152	Alt Up
153	Alt Page Up
155	Alt Left
157	Alt Right
159	Alt End
160	Alt Down
161	Alt Page Down
162	Alt Insert
163	Alt Delete
164	Alt Keypad /
165	Alt Tab
166	Alt Enter

Keyboard Extended Functions (Part 2 of 2)

Shift States

Most shift states are handled within the keyboard routine, and are not apparent to the system or application program. In any case, the current status of active shift states is available by calling an entry point in the BIOS keyboard routine. The following keys result in altered shift states:

Shift: This key temporarily shifts keys 1 through 13, 16 through 29, 31 through 41, and 46 through 55, to uppercase (base case if in Caps Lock state). Also, the Shift temporarily reverses the Num Lock or non-Num Lock state of keys 91 through 93, 96, 98, 99, and 101 through 104.

Ctrl: This key temporarily shifts keys 3, 7, 12, 15 through 29, 31 through 39, 43, 46 through 52, 75 through 89, 91 through 93, 95 through 108, 112 through 124 and 126 to the Ctrl state. The Ctrl key is also used with the Alt and Del keys to cause the system-reset function; with the Scroll Lock key to cause the break function; and with the Num Lock key to cause the pause function. The system-reset, break, and pause functions are described under "Special Handling" later in this section.

Alt: This key temporarily shifts keys 1 through 29, 31 through 43, 46 through 55, 75 through 89, 95, 100, and 105 through 124 to the Alt state. The Alt key is also used with the Ctrl and Del keys to cause a system reset.

The Alt key also allows the user to enter any character code from 0 to 255. The user holds down the Alt key and types the decimal value of the characters desired on the numeric keypad (keys 91 through 93, 96 through 99, and 101 through 103). The Alt key is then released. If the number is greater than 255, a modulo-256 value is used. This value is interpreted as a character code and is sent through the keyboard routine to the system or application program. Alt is handled internal to the keyboard routine.

Caps Lock: This key shifts keys 17 through 26, 31 through 39, and 46 through 52 to uppercase. When Caps Lock is pressed again, it reverses the action. Caps Lock is handled internal to the keyboard routine.

Scroll Lock: When interpreted by appropriate application programs, this key indicates that the cursor-control keys will cause windowing over the text rather than moving the cursor. When the Scroll Lock key is pressed again, it reverses the action. The keyboard routine simply records the current shift state of the Scroll Lock key. It is the responsibility of the application program to perform the function.

Num Lock: This key shifts keys 91 through 93, 96 through 99, and 101 through 104 to uppercase. When Num Lock is pressed again, it reverses the action. Num Lock is handled internal to the keyboard routine.

Shift Key Priorities and Combinations: If combinations of the Alt, Ctrl, and Shift keys are pressed and only one is valid, the priority is as follows: the Alt key is first, the Ctrl key is second, and the Shift key is third. The only valid combination is Alt and Ctrl, which is used in the system-reset function.

Special Handling

System Reset

The combination of any Alt, Ctrl, and Del keys results in the keyboard routine that starts a system reset or restart. System reset is handled by BIOS.

Break

The combination of the Ctrl and Pause/Break keys results in the keyboard routine signaling interrupt hex 1B. The extended characters AL=hex 00, and AH=hex 00 are also returned.

Pause

The Pause key causes the keyboard interrupt routine to loop, waiting for any character or function key to be pressed. This provides a method of temporarily suspending an operation, such as listing or printing, and then resuming the operation. The method is not apparent to either the system or the application program. The key stroke used to resume operation is discarded. Pause is handled internal to the keyboard routine.

Print Screen

The Print Screen key results in an interrupt invoking the print-screen routine. This routine works in the alphameric or graphics mode, with unrecognizable characters printing as blanks.

System Request

When the System Request (Alt and Print Screen) key is pressed, a hex 8500 is placed in AX, and an interrupt hex 15 is executed. When the Sys Req key is released, a hex 8501 is placed in AX, and another interrupt hex 15 is executed. If an application is to use System Request, the following rules must be observed:

Save the previous address.

Overlay interrupt vector hex 15.

Check AH for a value of hex 85:

If yes, process may begin.
If no, go to previous address.

The application program must preserve the value in all registers, except AX, upon return. System Request is handled internal to the keyboard routine.

Other Characteristics

The keyboard routine does its own buffering, and the keyboard buffer is large enough to support entries by a fast typist. However, if a key is pressed when the buffer is full, the key will be ignored and the "alarm" will sound.

The keyboard routine also suppresses the typematic action of the following keys: Ctrl, Shift, Alt, Num Lock, Scroll Lock, Caps Lock, and Ins.

During each interrupt hex 09 from the keyboard, an interrupt hex 15, function (AH)=hex 4F is generated by the BIOS after the scan code is read from the keyboard adapter. The scan code is passed in the (AL) register with the carry flag set. This is to allow an operating system to intercept each scan code prior to its being handled by the interrupt hex 09 routine, and have a chance to change or act on the scan code. If the carry flag is changed to 0 on return from interrupt hex 15, the scan code will be ignored by the interrupt handler.

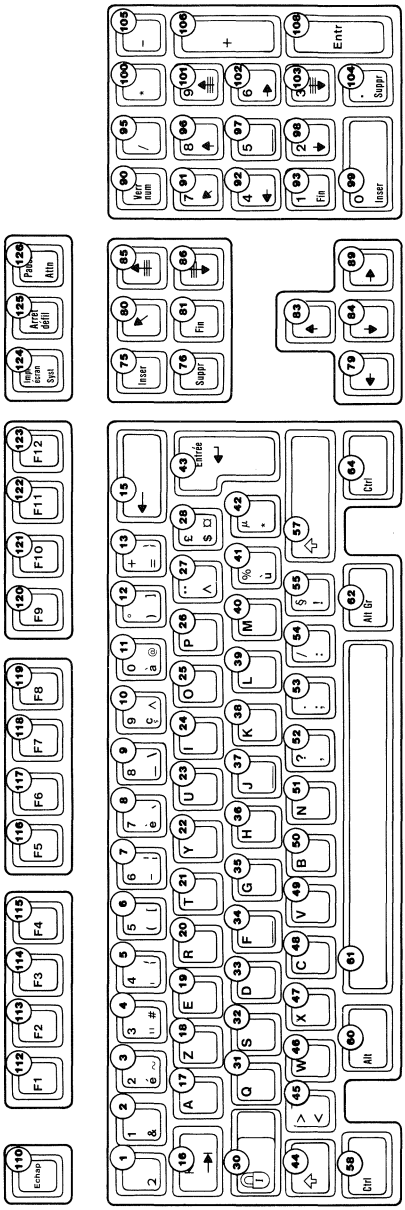
Keyboard Layouts

The keyboard is available in six layouts:

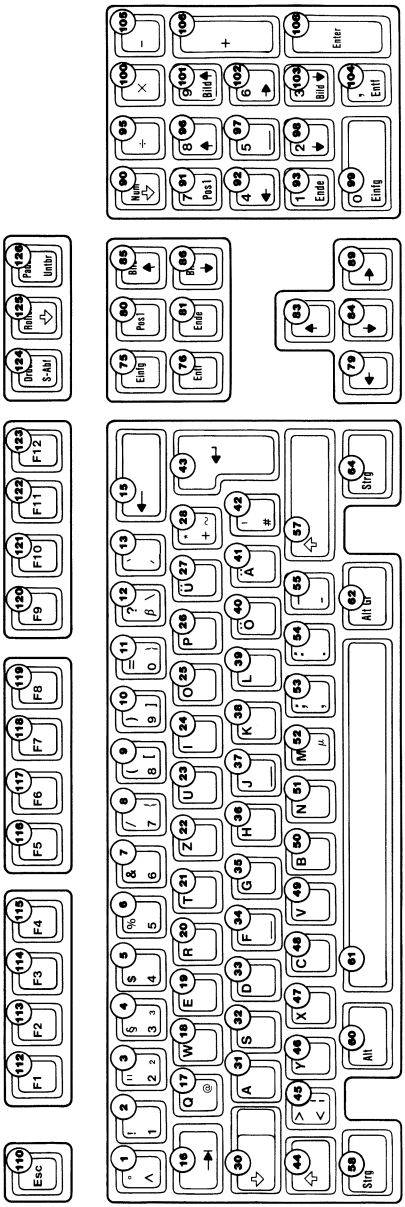
- French
- German
- Italian
- Spanish
- UK English
- US English

The various layouts are shown in alphabetic order on the following pages. Nomenclature is on both the top and front face of the keybuttons. The number to the upper right designates the keybutton position.

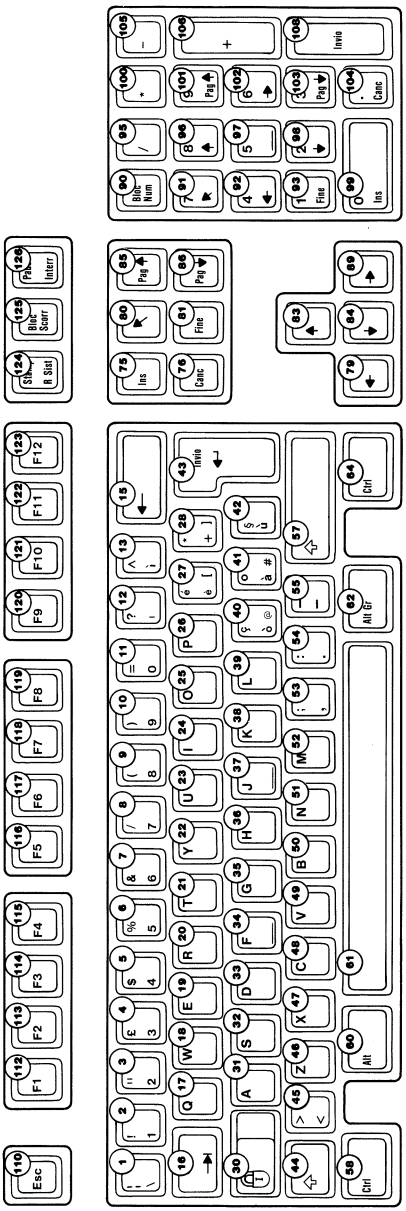
French Keyboard



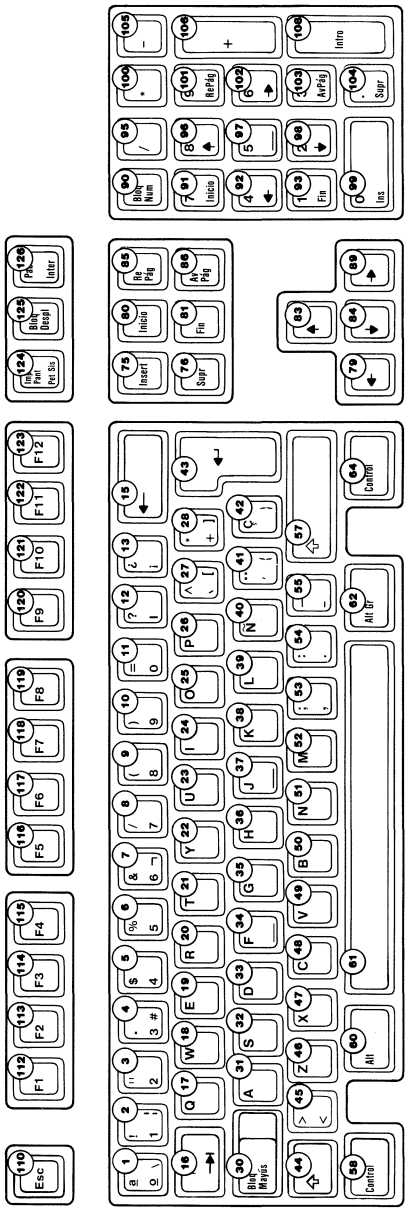
German Keyboard



Italian Keyboard

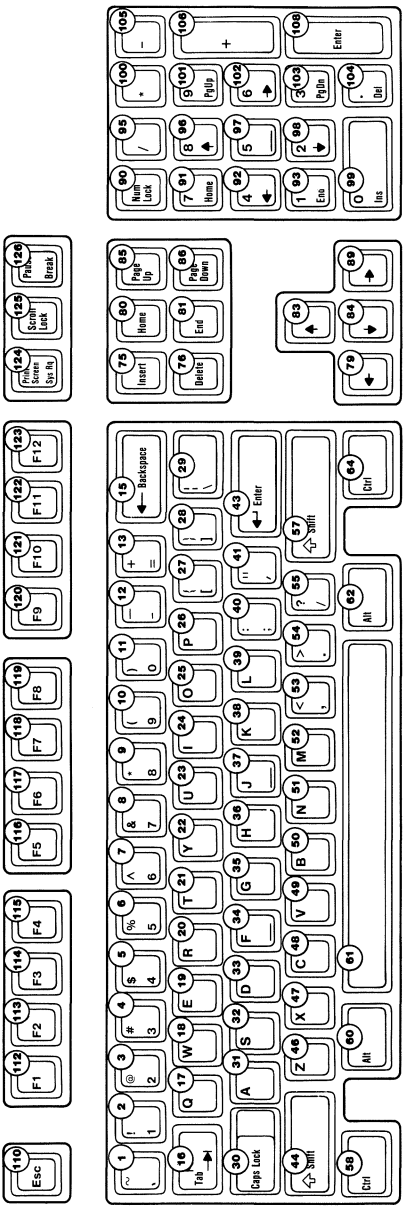


Spanish Keyboard



UK English Keyboard

US English Keyboard



Specifications

The specifications for the keyboard follow.

Power Requirements

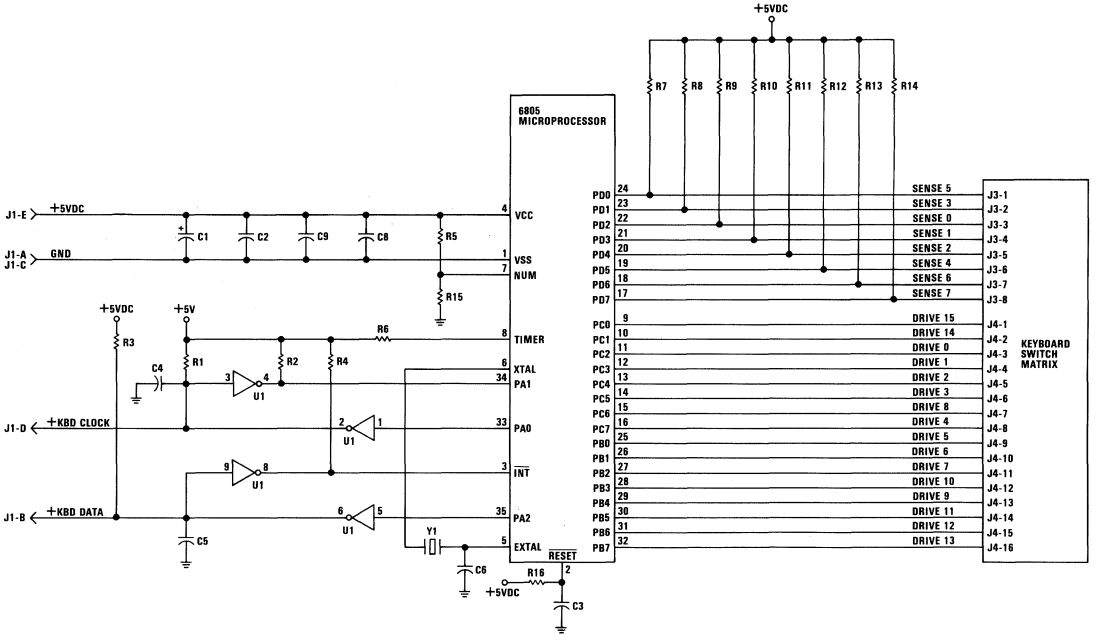
- +5 Vdc ± 10%
- Current cannot exceed 275 mA.

Size

- Length: 492 millimeters (19.4 inches)
- Depth: 210 millimeters (8.3 inches)
- Height: 58 millimeters (2.3 inches), legs extended

Weight

2.25 kilograms (5.0 pounds)



101/102-KEY KEYBOARD

SECTION 5. SYSTEM BIOS

Notes:

System BIOS Usage

The basic input/output system (BIOS) resides in ROM on the system board and provides device level control for the major I/O devices in the system. Additional ROM modules may be located on option adapters to provide device level control for that option adapter. (BIOS listings for an option adapter are located in the *Technical Reference* Options and Adapters manual.) BIOS routines enable the assembler language programmer to perform block (disk and diskette) or character-level I/O operations without concern for device address and operating characteristics. System services, such as time-of-day and memory size determination, are provided by the BIOS.

> **Note:** BIOS listings for both the 256/640 and 64/256 system boards are included in this manual.

The goal is to provide an operational interface to the system and relieve the programmer of the concern about the characteristics of hardware devices. The BIOS interface insulates the user from the hardware, thus allowing new devices to be added to the system, yet retaining the BIOS level interface to the device. In this manner, user programs become transparent to hardware modifications and enhancements.

The IBM Personal Computer *Macro Assembler* manual and the IBM Personal Computer *Disk Operating System (DOS)* manual provide useful programming information related to this section. A complete listing of the BIOS is given in this section.

Access to the BIOS is through the 8088 software interrupts. Each BIOS entry point is available through its own interrupt.

The software interrupts, hex 10 through hex 1A, each access a different BIOS routine. For example, to determine the amount of memory available in the system,

INT 12H

invokes the BIOS routine for determining memory size and returns the value to the caller.

Parameter Passing

All parameters passed to and from the BIOS routines go through the 8088 registers. The prologue of each BIOS function indicates the registers used on the call and the return. For the memory size example, no parameters are passed. The memory size, in 1K-byte increments, is returned in the AX register.

If a BIOS function has several possible operations, the AH register is used as input to indicate the desired operation. For example, to set the time of day, the following code is required:

```
MOV AH,1                ;function is to set time of day.

MOV CX,HIGH_COUNT       ;establish the current time.

MOV DX,LOW_COUNT

INT 1AH                 ;set the time.
```

To read the time of day:

```
MOV AH,0                ;function is to read time of day.

INT 1AH                 ;read the timer.
```

Generally, the BIOS routines save all registers except for AX and the flags. Other registers are modified on return only if they are returning a value to the caller. The exact register usage is in the prologue of each BIOS function.

Int	Address	Name	BIOS Entry
0	0-3	Divide by Zero	D11
1	4-7	Single Step	D11
2	8-B	Nonmaskable	NMI_INT
3	C-F	Breakpoint	D11
4	10-13	Overflow	D11
5	14-17	Print Screen	PRINT_SCREEN
6	18-1B	Reserved	D11
7	1C-1F	Reserved	D11
8	20-23	Timer	TIMER_INT
9	24-27	Keyboard	KB_INT
A	28-2B	Reserved	D11
B	2C-2F	Communications	D11
C	30-33	Communications	D11

8088 Software Interrupt Listing (Part 1 of 2)

Int	Address	Name	BIOS Entry
D	34-37	Alternate Printer	D11
E	38-3B	Diskette	DISK_INT
F	3C-3F	Printer	D11
10	40-43	Video	VIDEO_IO
11	44-47	Equipment Check	EQUIPMENT
12	48-4B	Memory	MEMORY_SIZE_DETERMINE
13	4C-4F	Diskette	DISKETTE_IO
14	50-53	Communications	RS232_IO
15	54-57	Cassette	CASSETTE_IO
16	58-5B	Keyboard	KEYBOARD_IO
17	5C-5F	Printer	PRINTER_IO
18	60-63	Resident BASIC	F600:0000
19	64-67	Bootstrap	BOOTSTRAP
1A	68-6B	Time of Day	TIME_OF_DAY
1B	6C-6F	Keyboard Break	DUMMY_RETURN
1C	70-73	Timer Tick	DUMMY_RETURN
1D	74-77	Video Initialization	VIDEO_PARMS
1E	78-7B	Diskette Parameters	DISK_BASE
1F	7C-7F	Video Graphics Chars	0
40	100-103	Diskette pointer save area for Fixed Disk	
41	104-107	Fixed Disk Parameters	FD_TBL
5A	168-16B	Cluster	D000:XXXX
5B	16C-16F	Used by Cluster Program	
60-67	180-19F	Reserved for User Programs	

8088 Software Interrupt Listing (Part 2 of 2)

Note: For BIOS index, see the BIOS Quick Reference on page 5-11 or 5-111.

Vectors with Special Meanings

Interrupt Hex 1B - Keyboard Break Address

This vector points to the code to be used when the Ctrl and Break keys are pressed on the keyboard. The vector is invoked while responding to the keyboard interrupt, and control should be returned through an IRET instruction. The power-on routines initialize this vector to an IRET instruction, so that nothing will occur when the Ctrl and Break keys are pressed unless the application program sets a different value.

Control may be retained by this routine, with the following problems. The Break may have occurred during interrupt

processing, so that one or more End of Interrupt commands must be sent to the 8259 Controller. Also, all I/O devices should be reset in case an operation was underway at that time.

Interrupt Hex 1C - Timer Tick

This vector points to the code to be executed on every system-clock tick. This vector is invoked while responding to the timer interrupt, and control should be returned through an IRET instruction. The power-on routines initialize this vector to point to an IRET instruction, so that nothing will occur unless the application modifies the pointer. It is the responsibility of the application to save and restore all registers that will be modified.

Interrupt Hex 1D - Video Parameters

This vector points to a data region containing the parameters required for the initialization of the 6845 on the video card. Note that there are four separate tables, and all four must be reproduced if all modes of operation are to be supported. The power-on routines initialize this vector to point to the parameters contained in the ROM video routines.

Interrupt Hex 1E - Diskette Parameters

This vector points to a data region containing the parameters required for the diskette drive. The power-on routines initialize the vector to point to the parameters contained in the ROM diskette routine. These default parameters represent the specified values for any IBM drives attached to the system. Changing this parameter block may be necessary to reflect the specifications of the other drives attached.

Interrupt Hex 1F - Graphics Character Extensions

When operating in the graphics modes of the IBM Color/Graphics Monitor Adapter (320 by 200 or 640 by 200), the read/write character interface forms the character from the ASCII code point, using a set of dot patterns. The dot patterns for the first 128 code points are contained in ROM. To access the second 128 code points, this vector must be established to point at a table of up to 1K bytes, where each code point is represented by eight bytes of graphic information. At power-on, this vector is initialized to 000:0, and it is the responsibility of the user to change this vector if additional code points are required.

Interrupt Hex 40 - Reserved

When an IBM Fixed Disk Adapter is installed, the BIOS routines use interrupt hex 30 to revector the diskette pointer.

Interrupt Hex 41 - Fixed Disk Parameters

This vector points to a data region containing the parameters required for the fixed disk drive. The power-on routines initialize the vector to point to the parameters contained in the ROM disk routine. These default parameters represent the specified values for any IBM fixed disk drives attached to the system. Changing this parameter block may be necessary to reflect the specifications of the other fixed disk drives attached.

Other Read/Write Memory Usage

The IBM BIOS routines use 256 bytes of memory from absolute hex 400 to hex 4FF. Locations hex 400 to hex 407 contain the base addresses of any RS-232C cards attached to the system. Locations hex 408 to hex 40F contain the base addresses of the Printer Adapter.

Memory locations hex 300 to hex 3FF are used as a stack area during the power-on initialization, and bootstrap when control is passed to it from power-on. If the user desires the stack in a different area, the area must be set by the application.

Interrupt	Address	Function
20	80-83	DOS program terminate
21	84-87	DOS function call
22	88-8B	DOS terminate address
23	8C-8F	DOS Ctrl Break exit address
24	90-93	DOS fatal error vector
25	94-97	DOS absolute disk read
26	98-9B	DOS absolute disk write
27	9C-9F	DOS terminate, fix in storage
28-3F	A0-FF	Reserved for DOS
40-5F	100-17F	Reserved for BIOS
60-67	180-19F	Reserved for user program interrupts
68-6F	1A0-1BF	Not used
80-85	200-217	Reserved for BASIC
86-F0	218-3C3	Used by BASIC interpreter while BASIC is running
F1-FF	3C4-3FF	Not used

Hardware, Basic, and DOS Interrupts

Address	Mode	Function
400-4A1	ROM BIOS	See BIOS listing
4A2-4EF		Reserved
4F0-4FF		Reserved as intra-application communication area for any application
500-5FF		Reserved for DOS and BASIC
500	DOS	Print screen status flag store 0=Print screen not active or successful print screen operation 1=Print screen in progress 255=Error encountered during print screen operation
504	DOS	Single drive mode status byte
510-511	BASIC	BASIC's segment address store
512-515	BASIC	Clock interrupt vector segment:offset store
516-519	BASIC	Break key interrupt vector segment:offset store
51A-51D	BASIC	Disk error interrupt vector segment:offset store

Reserved Memory Locations

If you do DEF SEG (Default workspace segment):

Offset	Length	
2E	2	Line number of current line being executed
347	2	Line number of last error
30	2	Offset into segment of start of program text
358	2	Offset into segment of start of variables (end of program text 1-1)
6A	1	Keyboard buffer contents 0=No characters in buffer 1=Characters in buffer
4E	1	Character color in graphics mode*

* Set to 1, 2, or 3 to get text in colors 1-3.
Do not set to 0. The default is 3.

Basic Workspace Variables

Example

```
100 PRINT PEEK (&H2E) + 256 x PEEK (&H2F)
```

L	H
Hex 64	Hex 00

Starting Address	
00000	BIOS interrupt vectors
00080	Available interrupt vectors
00400	BIOS data area
00500	User read/write memory
C8000	Disk Adapter
F0000	Read only memory
FE000	BIOS program area

BIOS Memory Map

BIOS Programming Hints

The BIOS code is invoked through software interrupts. The programmer should not "hard code" BIOS addresses into application programs. The internal workings and absolute addresses within BIOS are subject to change without notice.

If an error is reported by the disk or diskette code, you should reset the drive adapter and retry the operation. A specified number of retries should be required on diskette reads to ensure the problem is not due to motor startup.

When altering I/O-port bit values, the programmer should change only those bits that are necessary to the current task. Upon completion, the programmer should restore the original environment. Failure to adhere to this practice may be incompatible with present and future applications.

Adapter Cards with System-Accessible ROM Modules

The ROM BIOS provides a facility to integrate adapter cards with on-board ROM code into the system. During the POST, interrupt vectors are established for the BIOS calls. After the default vectors are in place, a scan for additional ROM modules takes place. At this point, a ROM routine on the adapter card may gain control. The routine may establish or intercept interrupt vectors to hook themselves into the system.

The absolute addresses hex C8000 through hex F4000 are scanned in 2K blocks in search of a valid adapter card ROM. A valid ROM is defined as follows:

Byte 0: Hex 55
Byte 1: Hex AA
Byte 2: A length indicator representing the number of 512-byte blocks in the ROM (length/512). A checksum is also done to test the integrity of the ROM module. Each byte in the defined ROM is summed modulo hex 100. This sum must be 0 for the module to be deemed valid.

When the POST identifies a valid ROM, it does a far call to byte 3 of the ROM (which should be executable code). The adapter card may now perform its power-on initialization tasks. The feature ROM should return control to the BIOS routines by executing a far return.

System BIOS Listing - 01/10/86

Quick Reference - 256/640K Board

Address	Publics by Name
F000:E729	A1
F000:15CC	ACT_DISP_PAGE
F000:6000	BASIC
F000:EC5C	BEEP
F000:1C4F	CASSETTE_IO_1
F000:E73C	CONF_TBL
F000:FA6E	CRT_CHAR_GEN
F000:FAI2	DDS
F000:0062	DISKETTE_IO_1
F000:EFC7	DISK_BASE
F000:0BC4	DISK_INT_1
F000:0BDB	DSKETTE_SETUP
F000:1D37	FILL
F000:0000	HEADER
F000:0D78	KB_INT_1
F000:0C57	KEYBOARD_IO_1
F000:F0E4	M5
F000:F0EC	M6
F000:F0F4	M7
F000:EF79	MD_TBL1
F000:EF86	MD_TBL2
F000:EF93	MD_TBL3
F000:EFA0	MD_TBL4
F000:EFAD	MD_TBL5
F000:EFBA	MD_TBL6
F000:0A40	NEC_OUTPUT
F000:12BE	PRINTER_IO_1
F000:FFF0	P_O_R
F000:1725	READ_AC_CURRENT
F000:15B5	READ_CURSOR
F000:1865	READ_DOT
F000:1BAB	READ_LPEN
F000:E05B	RESET
F000:0B32	RESULTS
F000:1344	RS232_IO_1
F000:16D3	SCROLL_DOWN
F000:1635	SCROLL_UP
F000:0A64	SEEK
F000:15EE	SET_COLOR
F000:158D	SET_CPOS
F000:156C	SET_CTYPE
F000:1485	SET_MODE
F000:144E	VIDEO_IO_1
F000:F0A4	VIDEO_PARMS
F000:1563	VIDEO_RETURN
F000:1614	VIDEO_STATE
F000:ECA0	WAITF
F000:1782	WRITE_AC_CURRENT
F000:17B4	WRITE_C_CURRENT
F000:1876	WRITE_DOT
F000:17E1	WRITE_STRING
F000:1B24	WRITE_TTY

Address	Publics by Value
F000:0000	HEADER
F000:0062	DISKETTE_IO_1
F000:0A40	NEC_OUTPUT
F000:0A64	SEEK
F000:0B32	RESULTS
F000:0BC4	DISK_INT_1
F000:0BDB	DSKETTE_SETUP
F000:0C57	KEYBOARD_IO_1
F000:0D78	KB_INT_1
F000:12BE	PRINTER_IO_1
F000:1344	RS232_IO_1
F000:144E	VIDEO_IO_1
F000:1485	SET_MODE
F000:1563	VIDEO_RETURN
F000:156C	SET_CTYPE
F000:158D	SET_CPOS
F000:15B5	READ_CURSOR
F000:15CC	ACT_DISP_PAGE
F000:15EE	SET_COLOR
F000:1614	VIDEO_STATE
F000:1635	SCROLL_UP
F000:16D3	SCROLL_DOWN
F000:1725	READ_AC_CURRENT
F000:1782	WRITE_AC_CURRENT
F000:17B4	WRITE_C_CURRENT
F000:17E1	WRITE_STRING
F000:1865	READ_DOT
F000:1876	WRITE_DOT
F000:1B24	WRITE_TTY
F000:1BAB	READ_LPEN
F000:1C4F	CASSETTE_IO_1
F000:1D37	FILL
F000:6000	BASIC
F000:E05B	RESET
F000:E729	A1
F000:E73C	CONF_TBL
F000:EC5C	BEEP
F000:ECA0	WAITF
F000:EF79	MD_TBL1
F000:EF86	MD_TBL2
F000:EF93	MD_TBL3
F000:EFA0	MD_TBL4
F000:EFAD	MD_TBL5
F000:EFBA	MD_TBL6
F000:EFC7	DISK_BASE
F000:F0A4	VIDEO_PARMS
F000:F0E4	M5
F000:F0EC	M6
F000:F0F4	M7
F000:FAI2	DDS
F000:FA6E	CRT_CHAR_GEN
F000:FFF0	P_O_R

```
                        PAGE 118,121
                        TITLE HEADER --- 01/08/86  POWER ON SELF TEST (POST)

                        ;--------------------------------------------------------------------------------
                        ;                                                                               :
                        ; BIOS I/O INTERFACE                                                            :
                        ;                                                                               :
                        ;       THESE LISTINGS PROVIDE INTERFACE INFORMATION FOR ACCESSING              :
                        ;       THE BIOS ROUTINES.  THE POWER ON SELF TEST IS INCLUDED.                 :
                        ;                                                                               :
                        ;       THE BIOS ROUTINES ARE MEANT TO BE ACCESSED THROUGH                      :
                        ;       SOFTWARE INTERRUPTS ONLY.  ANY ADDRESSES PRESENT IN                     :
                        ;       THESE LISTINGS ARE INCLUDED ONLY FOR COMPLETENESS,                      :
                        ;       NOT FOR REFERENCE.  APPLICATIONS WHICH REFERENCE ANY                    :
                        ;       ABSOLUTE ADDRESSES WITHIN THE CODE SEGMENTS OF BIOS                     :
                        ;       VIOLATE THE STRUCTURE AND DESIGN OF BIOS.                               :
                        ;                                                                               :
                        ;--------------------------------------------------------------------------------


                        ;--------------------------------------------------------------------------------
                        ;   MODULE REFERENCE                                                            :
                        ;                                                                               :
                        ;   HEADER.ASM      -->  DEFINITIONS                                            :
                        ;     DSEG.INC      -->   DATA SEGMENT LOCATIONS                                :
                        ;     POSTEQU.INC   -->   COMMON EQUATES FOR POST AND BIOS                      :
                        ;                                                                               :
                        ;   DSKETTE.ASM     -->  DISKETTE BIOS                                          :
                        ;                          DISKETTE_IO_1 - INT 13H BIOS ENTRY (40H)   -INT 13H  :
                        ;                          DISK_INT_1    - HARDWARE INTERRUPT HANDLER -INT 0EH  :
                        ;                          DSKETTE_SETUP - POST SETUP DRIVE TYPES               :
                        ;                                                                               :
                        ;   KEYBRD.ASM      -->  KEYBOARD BIOS                                          :
                        ;                          KEYBOARD_IO_1 - INT 16H BIOS ENTRY          -INT 16H  :
                        ;                          KB_INT_1      - HARDWARE INTERRUPT          -INT 09H  :
                        ;                          SND_DATA      - KEYBOARD TRANSMISSION                 :
                        ;                                                                               :
                        ;   PRT.ASM         -->  PRINTER ADAPTER BIOS                          -INT 17H  :
                        ;                                                                               :
                        ;   RS232.ASM       -->  COMMUNICATIONS BIOS FOR RS232                 -INT 14H  :
                        ;                                                                               :
                        ;   VIDEO.ASM       -->  VIDEO BIOS                                    -INT 10H  :
                        ;                                                                               :
                        ;   BIOS1.ASM       -->  INTERRUPT 15H BIOS ROUTINES                   -INT 15H  :
                        ;                          DEV_OPEN      - NULL DEVICE OPEN HANDLER              :
                        ;                          DEV_CLOSE     - NULL DEVICE CLOSE HANDLER             :
                        ;                          PROG_TERM     - NULL PROGRAM TERMINATION              :
                        ;                          JOY_STICK     - JOYSTICK PORT HANDLER                 :
                        ;                          SYS_REQ       - NULL SYSTEM REQUEST KEY               :
                        ;                          EXT_MEMORY    - EXTENDED MEMORY SIZE DETERMINE        :
                        ;                          DEVICE_BUSY   - NULL DEVICE BUSY HANDLER              :
                        ;                          INT_COMPLETE  - NULL INTERRUPT COMPLETE HANDLER       :
                        ;                                                                               :
                        ;   POST.ASM        -->  BIOS INTERRUPT ROUTINES                               :
                        ;                          POST          - POWER ON SELF TEST & INITIALIZATION   :
                        ;                          TIME_OF_DAY_1 - TIME OF DAY ROUTINES        -INT 1AH  :
                        ;                          PRINT_SCREEN1 - PRINT SCREEN ROUTINE        -INT 05H  :
                        ;                          TIMER_INT_1   - TIMER1 INTERRUPT HANDLER  ->INT 1CH   :
                        ;                          DDS           - LOAD (DS:) WITH DATA SEGMENT            :
                        ;                          BEEP          - SPEAKER BEEP CONTROL ROUTINE            :
                        ;                          WAITF         - FIXED TIME WAIT ROUTINE                 :
                        ;                                                                               :
                        ;--------------------------------------------------------------------------------
                        .LIST
```

```
                        PAGE
                C       INCLUDE POSTEQU.INC
                C       ;--------------------------------------
                C       ;       EQUATES USED BY POST AND BIOS   :
                C       ;--------------------------------------
                C
= 0000          C       SYSTEM          EQU     0               ; 0 PC-XT, 1 PC-AT
= 00FB          C       MODEL_BYTE      EQU     0FBH            ; SYSTEM MODEL BYTE
= 0000          C       SUB_MODEL_BYTE  EQU     000H            ; SYSTEM SUB-MODEL TYPE
= 0001          C       BIOS_LEVEL      EQU     001H            ; BIOS REVISION LEVEL
                C       ENDIF
                C
                C       ;--------- KEYBOARD INTERFACE AND DIAGNOSTIC CONTROL REGISTERS ----------
= 0060          C       PORT_A          EQU     060H            ; KEYBOARD SCAN CODE/CONTROL PORT
= 0061          C       PORT_B          EQU     061H            ; PORT B READ/WRITE DIAGNOSTIC REGISTER
= 0062          C       PORT_C          EQU     062H            ; 8255 PORT C ADDR
= 0063          C       CMD_PORT        EQU     063H
                C
                C
= 0060          C       KB_DATA         EQU     60H             ; KEYBOARD SCAN CODE PORT
= 0061          C       KB_CTL          EQU     61H             ; CONTROL BITS FOR KEYBOARD SENSE DATA
= 0054          C       ID_2A           EQU     054H            ; ALTERNATE 2ND ID CHAR FOR KBX
= 00E0          C       MC_E0           EQU     224             ; GENERAL MARKER CODE
= 00E1          C       MC_E1           EQU     225             ; PAUSE KEY MARKER CODE
                C
                C
= 00F3          C       RAM_PAR_ON      EQU     11110011B       ; AND MASK FOR PARITY CHECKING ENABLE ON
= 000C          C       RAM_PAR_OFF     EQU     00001100B       ; OR MASK FOR PARITY CHECKING ENABLE OFF
= 00C0          C       PARITY_ERR      EQU     11000000B       ; R/W MEMORY - I/O CHANNEL PARITY ERROR
= 0001          C       GATE2           EQU     00000001B       ; TIMER 2 INPUT GATE CLOCK BIT
= 0002          C       SPK2            EQU     00000010B       ; SPEAKER OUTPUT DATA ENABLE BIT
= 0010          C       REFRESH_BIT     EQU     00010000B       ; REFRESH TEST BIT
= 0020          C       OUT2            EQU     00100000B       ; SPEAKER TIMER OUT2 INPUT BIT
= 0040          C       IO_CHECK        EQU     01000000B       ; I/O (MEMORY) CHECK OCCURRED BIT MASK
= 0080          C       PARITY_CHECK    EQU     10000000B       ; MEMORY PARITY CHECK OCCURRED BIT MASK
                C       ENDIF
```

```
                        POSTEQU.INC - COMMON EQUATES

                        PAGE
                        ;---------- KEYBOARD RESPONSE ------------------------------------------
= 00AA                  KB_OK           EQU     0AAH            ; RESPONSE FROM SELF DIAGNOSTIC
= 00FA                  KB_ACK          EQU     0FAH            ; ACKNOWLEDGE FROM TRANSMISSION
= 00FE                  KB_RESEND       EQU     0FEH            ; RESEND REQUEST
= 00FF                  KB_OVER_RUN     EQU     0FFH            ; OVER RUN SCAN CODE

                        ;---------- FLAG EQUATES WITHIN  @KB_FLAG -----------------------------
= 0001                  RIGHT_SHIFT     EQU     00000001B       ; RIGHT SHIFT KEY DEPRESSED
= 0002                  LEFT_SHIFT      EQU     00000010B       ; LEFT SHIFT KEY DEPRESSED
= 0004                  CTL_SHIFT       EQU     00000100B       ; CONTROL SHIFT KEY DEPRESSED
= 0008                  ALT_SHIFT       EQU     00001000B       ; ALTERNATE SHIFT KEY DEPRESSED
= 0010                  SCROLL_STATE    EQU     00010000B       ; SCROLL LOCK STATE HAS BEEN TOGGLED
= 0020                  NUM_STATE       EQU     00100000B       ; NUM LOCK STATE HAS BEEN TOGGLED
= 0040                  CAPS_STATE      EQU     01000000B       ; CAPS LOCK STATE HAS BEEN TOGGLED
= 0080                  INS_STATE       EQU     10000000B       ; INSERT STATE IS ACTIVE

                        ;---------- FLAG EQUATES WITHIN  @KB_FLAG_1 ---------------------------
= 0004                  SYS_SHIFT       EQU     00000100B       ; SYSTEM KEY DEPRESSED AND HELD
= 0008                  HOLD_STATE      EQU     00001000B       ; SUSPEND KEY HAS BEEN TOGGLED
= 0010                  SCROLL_SHIFT    EQU     00010000B       ; SCROLL LOCK KEY IS DEPRESSED
= 0020                  NUM_SHIFT       EQU     00100000B       ; NUM LOCK KEY IS DEPRESSED
= 0040                  CAPS_SHIFT      EQU     01000000B       ; CAPS LOCK KEY IS DEPRESSED
= 0080                  INS_SHIFT       EQU     10000000B       ; INSERT KEY IS DEPRESSED

                        ;---------- FLAGS EQUATES WITHIN  @KB_FLAG_2 ---------------------------
= 0007                  KB_LEDS         EQU     00000111B       ; KEYBOARD LED STATE BITS
                        ;               EQU     00001000B       ; RESERVED (MUST BE ZERO)
= 0010                  KB_FA           EQU     00010000B       ; ACKNOWLEDGMENT RECEIVED
= 0020                  KB_FE           EQU     00100000B       ; RESEND RECEIVED FLAG
= 0040                  KB_PR_LED       EQU     01000000B       ; MODE INDICATOR UPDATE
= 0080                  KB_ERR          EQU     10000000B       ; KEYBOARD TRANSMIT ERROR FLAG

                        ;---------- FLAGS EQUATES WITHIN  @KB_FLAG_3 ---------------------------
= 0001                  LC_E1           EQU     00000001B       ; LAST CODE WAS THE E1 HIDDEN CODE
= 0002                  LC_E0           EQU     00000010B       ; LAST CODE WAS THE E0 HIDDEN CODE
= 0004                  R_CTL_SHIFT     EQU     00000100B       ; RIGHT CTL KEY DOWN
= 0008                  GRAPH_ON        EQU     00001000B       ; ALL GRAPHICS KEY DOWN (W.T. ONLY)
                        ;               EQU     00011000B       ; RESERVED (MUST BE ZERO)
= 0010                  KBX             EQU     00010000B       ; KBX INSTALLED
= 0020                  SET_NUM_LK      EQU     00100000B       ; FORCE NUM LOCK IF READ ID AND KBX
= 0040                  LC_AB           EQU     01000000B       ; LAST CHARACTER WAS FIRST ID CHARACTER
= 0080                  RD_ID           EQU     10000000B       ; DOING A READ ID (MUST BE BIT0)

                        ;---------- KEYBOARD SCAN CODES ----------------------------------------
= 00AB                  ID_1            EQU     0ABH            ; 1ST ID CHARACTER FOR KBX
= 0041                  ID_2            EQU     041H            ; 2ND ID CHARACTER FOR KBX
= 0038                  ALT_KEY         EQU     56              ; SCAN CODE FOR  ALTERNATE SHIFT KEY
= 001D                  CTL_KEY         EQU     29              ; SCAN CODE FOR  CONTROL KEY
= 003A                  CAPS_KEY        EQU     58              ; SCAN CODE FOR  SHIFT LOCK KEY
= 0053                  DEL_KEY         EQU     83              ; SCAN CODE FOR  DELETE KEY
= 0052                  INS_KEY         EQU     82              ; SCAN CODE FOR  INSERT KEY
= 002A                  LEFT_KEY        EQU     42              ; SCAN CODE FOR  LEFT SHIFT
= 0045                  NUM_KEY         EQU     69              ; SCAN CODE FOR  NUMBER LOCK KEY
= 0036                  RIGHT_KEY       EQU     54              ; SCAN CODE FOR  RIGHT SHIFT
= 0046                  SCROLL_KEY      EQU     70              ; SCAN CODE FOR  SCROLL LOCK KEY
= 0054                  SYS_KEY         EQU     84              ; SCAN CODE FOR  SYSTEM KEY
= 0057                  F11_M           EQU     87              ; F11 KEY MAKE
= 0058                  F12_M           EQU     88              ; F12 KEY MAKE
```

```
                        C  PAGE
                        C  ENDIF
                        C
                        C  ;---------- DISKETTE EQUATES ----------------------------------------------------
= 0050                  C  CARD_ID          EQU     01010000B       ; CONTROLLER CARD I.D. BIT
= 0001                  C  DUAL             EQU     00000001B       ; MASK FOR FDC ADAPTER I.D.
= 0080                  C  INT_FLAG         EQU     10000000B       ; INTERRUPT OCCURRENCE FLAG
= 0080                  C  DSK_CHG          EQU     10000000B       ; DISKETTE CHANGE FLAG MASK BIT
= 0010                  C  DETERMINED       EQU     00010000B       ; SET STATE DETERMINED IN STATE BITS
= 0010                  C  HOME             EQU     00010000B       ; TRACK 0 MASK
= 0004                  C  SENSE_DRV_ST     EQU     00000100B       ; SENSE DRIVE STATUS COMMAND
= 0030                  C  TRK_SLAP         EQU     030H            ; CRASH STOP (48 TPI DRIVES)
= 000A                  C  QUIET_SEEK       EQU     00AH            ; SEEK TO TRACK 10
= 0002                  C  MAX_DRV          EQU     2               ; MAX NUMBER OF DRIVES
= 000F                  C  HD12_SETTLE      EQU     15              ; 1.2 M HEAD SETTLE TIME
= 0014                  C  HD320_SETTLE     EQU     20              ; 320 K HEAD SETTLE TIME
= 0025                  C  MOTOR_WAIT       EQU     37              ; 2 SECONDS OF COUNTS FOR MOTOR TURN OFF
                        C
                        C  ;---------- DISKETTE ERRORS -----------------------------------------------------
= 0080                  C  TIME_OUT         EQU     080H            ; ATTACHMENT FAILED TO RESPOND
= 0040                  C  BAD_SEEK         EQU     040H            ; SEEK OPERATION FAILED
= 0020                  C  BAD_NEC          EQU     020H            ; DISKETTE CONTROLLER HAS FAILED
= 0010                  C  BAD_CRC          EQU     010H            ; BAD CRC ON DISKETTE READ
= 000C                  C  MED_NOT_FND      EQU     00CH            ; MEDIA TYPE FOUND
= 0009                  C  DMA_BOUNDARY     EQU     009H            ; ATTEMPT TO DMA ACROSS 64K BOUNDARY
= 0008                  C  BAD_DMA          EQU     008H            ; DMA OVERRUN ON OPERATION
= 0006                  C  MEDIA_CHANGE     EQU     006H            ; MEDIA REMOVED ON DUAL ATTACH CARD
= 0004                  C  RECORD_NOT_FND   EQU     004H            ; REQUESTED SECTOR NOT FOUND
= 0003                  C  WRITE_PROTECT    EQU     003H            ; WRITE ATTEMPTED ON WRITE PROTECT DISK
= 0002                  C  BAD_ADDR_MARK    EQU     002H            ; ADDRESS MARK NOT FOUND
= 0001                  C  BAD_CMD          EQU     001H            ; BAD COMMAND PASSED TO DISKETTE I/O
                        C
                        C  ;---------- DISK CHANGE LINE EQUATES --------------------------------------------
= 0001                  C  NOCHGLN          EQU     001H            ; NO DISK CHANGE LINE AVAILABLE
= 0002                  C  CHGLN            EQU     002H            ; DISK CHANGE LINE AVAILABLE
                        C
                        C  ;---------- MEDIA/DRIVE STATE INDICATORS ----------------------------------------
= 0001                  C  TRK_CAPA         EQU     00000001B       ; 80 TRACK CAPABILITY
= 0002                  C  FMT_CAPA         EQU     00000010B       ; MULTIPLE FORMAT CAPABILITY (1.2M)
= 0004                  C  DRV_DET          EQU     00000100B       ; DRIVE DETERMINED
= 0010                  C  MED_DET          EQU     00010000B       ; MEDIA DETERMINED BIT
= 0020                  C  DBL_STEP         EQU     00100000B       ; DOUBLE STEP BIT
= 00C0                  C  RATE_MSK         EQU     11000000B       ; MASK FOR CLEARING ALL BUT RATE
= 0000                  C  RATE_500         EQU     00000000B       ; 500 KBS DATA RATE
= 0040                  C  RATE_300         EQU     01000000B       ; 300 KBS DATA RATE
= 0080                  C  RATE_250         EQU     10000000B       ; 250 KBS DATA RATE
= 000C                  C  STRT_MSK         EQU     00001100B       ; OPERATION START RATE MASK
= 00C0                  C  SEND_MSK         EQU     11000000B       ; MASK FOR SEND RATE BITS
                        C
                        C  ;---------- MEDIA/DRIVE STATE INDICATORS COMPATIBILITY --------------------------
= 0000                  C  M3D3U            EQU     00000000B       ; 360 MEDIA/DRIVE NOT ESTABLISHED
= 0001                  C  M3D1U            EQU     00000001B       ; 360 MEDIA,1.2DRIVE NOT ESTABLISHED
= 0002                  C  M1D1U            EQU     00000010B       ; 1.2 MEDIA/DRIVE NOT ESTABLISHED
= 0007                  C  MED_UNK          EQU     00000111B       ; NONE OF THE ABOVE
```

POSTEQU.INC - COMMON EQUATES

```
                        C  PAGE
                        C  ;--------- INTERRUPT EQUATES ----------------------------------------------------
= 0020                  C  EOI          EQU     020H            ; END OF INTERRUPT COMMAND TO 8259
= 0020                  C  INTA00       EQU     020H            ; 8259 PORT
= 0021                  C  INTA01       EQU     021H            ; 8259 PORT
= 00A0                  C  INTB00       EQU     0A0H            ; 2ND 8259
= 00A1                  C  INTB01       EQU     0A1H            ;
= 0070                  C  INT_TYPE     EQU     070H            ; START OF 8259 INTERRUPT TABLE LOCATION
= 0010                  C  INT_VIDEO    EQU     010H            ; VIDEO VECTOR
                        C  ;-----------------------------------------------------------------------------
= 0008                  C  DMA08        EQU     008H            ; DMA STATUS REGISTER PORT ADDRESS
= 0000                  C  DMA          EQU     000H            ; DMA CH.0 ADDRESS REGISTER PORT ADDRESS
= 00D0                  C  DMA18        EQU     0D0H            ; 2ND DMA STATUS PORT ADDRESS
= 00C0                  C  DMA1         EQU     0C0H            ; 2ND DMA CH.0 ADDRESS REGISTER ADDRESS
                        C  ;-----------------------------------------------------------------------------
= 0040                  C  TIMER        EQU     040H            ; 8253 TIMER - BASE ADDRESS
= 0043                  C  TIM_CTL      EQU     043H            ; 8253 TIMER CONTROL PORT ADDR
= 0040                  C  TIMER0       EQU     040H            ; 8253 TIMER/CNTER 0 PORT ADDR
                        C
                        C  ;--------- MANUFACTURING PORT ----------------------------------------------------
= 0080                  C  MFG_PORT     EQU     80H             ; MANUFACTURING AND POST CHECKPOINT PORT
                        C                                       ;  DMA CHANNEL 0 PAGE REGISTER ADDRESS
                        C
                        C  ;--------- MANUFACTURING BIT DEFINITION FOR @MFG_ERR_FLAG+1 ----------------------
= 0001                  C  MEM_FAIL     EQU     00000001B       ; STORAGE TEST FAILED           (ERROR 20X)
= 0002                  C  PRO_FAIL     EQU     00000010B       ; VIRTUAL MODE TEST FAILED      (ERROR 104)
= 0004                  C  LWCS_FAIL    EQU     00000100B       ; LOW MEG CHIP SELECT FAILED    (ERROR 109)
= 0008                  C  KYCLK_FAIL   EQU     00001000B       ; KEYBOARD CLOCK TEST FAILED    (ERROR 304)
= 0010                  C  KY_SYS_FAIL  EQU     00010000B       ; KEYBOARD OR SYSTEM FAILED     (ERROR 303)
= 0020                  C  KYBD_FAIL    EQU     00100000B       ; KEYBOARD FAILED               (ERROR 301)
= 0040                  C  DSK_FAIL     EQU     01000000B       ; DISKETTE TEST FAILED          (ERROR 601)
= 0080                  C  KEY_FAIL     EQU     10000000B       ; KEYBOARD LOCKED               (ERROR 302)
                        C
                        C  ;-----------------------------------------------------------------------------
= 0081                  C  DMA_PAGE     EQU     081H            ; START OF DMA PAGE REGISTERS
= 008F                  C  LAST_DMA_PAGE EQU    08FH            ; LAST DMA PAGE REGISTER
                        C
                        C  ;-----------------------------------------------------------------------------
                        C  ;X287         EQU     0F0H            ; MATH COPROCESSOR CONTROL PORT
                        C
                        C  ;-----------------------------------------------------------------------------
= 0000                  C  POST_SS      EQU     00000H          ; POST STACK SEGMENT
= 8000                  C  POST_SP      EQU     08000H          ; POST STACK POINTER
= 0030                  C  STACK_SS     EQU     30H             ; STACK SEGMENT USED DURING POST
= 0100                  C  TOS          EQU     100H            ; STACK -- USED DURING POST ONLY
                        C                                       ;   USE WILL OVERLAY INTERRUPTS VECTORS
                        C
                        C
                        C  ;-----------------------------------------------------------------------------
= 000D                  C  CR           EQU     000DH           ; CARRIAGE RETURN CHARACTER
= 000A                  C  LF           EQU     000AH           ; LINE FEED CHARACTER
= 0008                  C  RVRT         EQU     00001000B       ; VIDEO VERTICAL RETRACE BIT
= 0001                  C  RHRZ         EQU     00000001B       ; VIDEO HORIZONTAL RETRACE BIT
= 0100                  C  H            EQU     256             ; HIGH BYTE FACTOR (X 100H)
= 0101                  C  X            EQU     H+1             ; HIGH AND LOW BYTE FACTOR (X 101H)

                            .LIST
```

```
                        PAGE
                C       INCLUDE DSEG.INC
                C       ELSE
                C       ;--------------------------------------
                C       ;       8088 INTERRUPT LOCATIONS       :
                C       ;       REFERENCED BY POST & BIOS      :
                C       ;--------------------------------------
                C       ENDIF
                C
0000            C       ABS0            SEGMENT AT 0            ; ADDRESS= 0000:0000
                C
0000 ??         C       @STG_LOC0       DB      ?               ; START OF INTERRUPT VECTOR TABLE
                C
0008            C                       ORG     4*002H
0008 ????????   C       @NMI_PTR        DD      ?               ; NON-MASKABLE INTERRUPT VECTOR
                C
0014            C                       ORG     4*005H
0014 ????????   C       @INT5_PTR       DD      ?               ; PRINT SCREEN INTERRUPT VECTOR
                C
0020            C                       ORG     4*008H
0020 ????????   C       @INT_PTR        DD      ?               ; HARDWARE INTERRUPT POINTER (8-F)
                C
0040            C                       ORG     4*010H
0040 ????????   C       @VIDEO_INT      DD      ?               ; VIDEO I/O INTERRUPT VECTOR
                C
004C            C                       ORG     4*013H
004C ????????   C       @ORG_VECTOR     DD      ?               ; DISKETTE/DISK INTERRUPT VECTOR
                C
0060            C                       ORG     4*018H
0060 ????????   C       @BASIC_PTR      DD      ?               ; POINTER TO CASSETTE BASIC
                C
0074            C                       ORG     4*01DH
0074 ????????   C       @PARM_PTR       DD      ?               ; POINTER TO VIDEO PARAMETERS
                C
0078            C                       ORG     4*01EH
0078 ????????   C       @DISK_POINTER   DD      ?               ; POINTER TO DISKETTE PARAMETER TABLE
                C
007C            C                       ORG     4*01FH
007C ????????   C       @EXT_PTR        DD      ?               ; POINTER TO GRAPHIC CHARACTERS 128-255
                C
0100            C                       ORG     4*040H
0100 ????????   C       @DISK_VECTOR    DD      ?               ; POINTER TO DISKETTE INTERRUPT CODE
                C
0104            C                       ORG     4*041H
0104 ????????   C       @HF_TBL_VEC     DD      ?               ; POINTER TO FIRST DISK PARAMETER TABLE
                C
0118            C                       ORG     4*046H
0118 ????????   C       @HF1_TBL_VEC    DD      ?               ; POINTER TO SECOND DISK PARAMETER TABLE
                C
01C0            C                       ORG     4*070H
01C0 ????????   C       @SLAVE_INT_PTR  DD      ?               ; POINTER TO SLAVE INTERRUPT HANDLER
                C
01D8            C                       ORG     4*076H
01D8 ????????   C       @HDISK_INT      DD      ?               ; POINTER TO FIXED DISK INTERRUPT CODE
                C
0400            C               ORG     400H
0400            C       DATA_AREA       LABEL   BYTE            ; ABSOLUTE LOCATION OF DATA SEGMENT
0400            C       DATA_WORD       LABEL   WORD
                C
0500            C                       ORG     0500H
0500            C       @MFG_TEST_RTN   LABEL   FAR             ; LOAD LOCATION FOR MANUFACTURING TESTS
                C
7C00            C                       ORG     7C00H
7C00            C       @BOOT_LOCN      LABEL   FAR             ; BOOT STRAP CODE LOAD LOCATION
                C
7C00            C       ABS0            ENDS
```

```
                        C  PAGE
                        C  ;--------------------------------------
                        C  ;        ROM BIOS DATA AREAS           :
                        C  ;--------------------------------------
                        C
0000                    C  DATA            SEGMENT AT 40H        ; ADDRESS= 0040:0000
0000                    C  DATA40          LABEL   BYTE
0000 ????               C  @RS232_BASE     DW      ?             ; BASE ADDRESSES OF RS232 ADAPTERS
0002 ????               C                  DW      ?             ;  SECOND LOGICAL RS232 ADAPTER
0004 ????               C                  DW      ?             ;   RESERVED
0006 ????               C                  DW      ?             ;   RESERVED
0008 ????               C  @PRINTER_BASE   DW      ?             ; BASE ADDRESSES OF PRINTER ADAPTERS
000A ????               C                  DW      ?             ;  SECOND LOGICAL PRINTER ADAPTER
000C ????               C                  DW      ?             ;  THIRD LOGICAL PRINTER ADAPTER
000E ????               C                  DW      ?             ;   RESERVED
0010 ????               C  @EQUIP_FLAG     DW      ?             ; INSTALLED HARDWARE FLAGS
0012 ??                 C  @MFG_TST        DB      ?             ; INITIALIZATION FLAGS
0013 ????               C  @MEMORY_SIZE    DW      ?             ; BASE MEMORY SIZE IN K BYTES  (X 1024)
0015 ??                 C  @MFG_ERR_FLAG   DB      ?             ; SCRATCHPAD FOR MANUFACTURING
0016 ??                 C                  DB      ?             ;  ERROR CODES
                        C
                        C  ;--------------------------------------
                        C  ;        KEYBOARD DATA AREAS           :
                        C  ;--------------------------------------
                        C
0017 ??                 C  @KB_FLAG        DB      ?             ; KEYBOARD SHIFT STATE AND STATUS FLAGS
0018 ??                 C  @KB_FLAG_1      DB      ?             ; SECOND BYTE OF KEYBOARD STATUS
0019 ??                 C  @ALT_INPUT      DB      ?             ; STORAGE FOR ALTERNATE KEY PAD ENTRY
001A ????               C  @BUFFER_HEAD    DW      ?             ; POINTER TO HEAD OF KEYBOARD BUFFER
001C ????               C  @BUFFER_TAIL    DW      ?             ; POINTER TO TAIL OF KEYBOARD BUFFER
                        C
                        C  ;------      HEAD = TAIL    INDICATES THAT THE BUFFER IS EMPTY
                        C
001E   10 [             C  @KB_BUFFER      DW      16 DUP(?)     ; ROOM FOR 15 SCAN CODE ENTRIES
          ????          C
                      ] C
                        C
                        C  ;--------------------------------------
                        C  ;        DISKETTE DATA AREAS           :
                        C  ;--------------------------------------
                        C
003E ??                 C  @SEEK_STATUS    DB      ?             ; DRIVE RECALIBRATION STATUS
                        C                                        ; BIT 3-0 = DRIVE 3-0 RECALIBRATION
                        C                                        ; BEFORE NEXT SEEK IF BIT IS = 0
003F ??                 C  @MOTOR_STATUS   DB      ?             ; MOTOR STATUS
                        C                                        ; BIT 3-0 = DRIVE 3-0 CURRENTLY RUNNING
                        C                                        ; BIT 7 = CURRENT OPERATION IS A WRITE
0040 ??                 C  @MOTOR_COUNT    DB      ?             ; TIME OUT COUNTER FOR MOTOR(S) TURN OFF
0041 ??                 C  @DSKETTE_STATUS DB      ?             ; RETURN CODE STATUS BYTE
                        C                                        ; CMD_BLOCK  IN STACK FOR DISK OPERATION
0042   07 [             C  @NEC_STATUS     DB      7 DUP(?)      ; STATUS BYTES FROM DISKETTE OPERATION
          ??            C
                      ] C
                        C
                        C  ;--------------------------------------
                        C  ;        VIDEO DISPLAY DATA AREA       :
                        C  ;--------------------------------------
                        C
0049 ??                 C  @CRT_MODE       DB      ?             ; CURRENT DISPLAY MODE (TYPE)
004A ????               C  @CRT_COLS       DW      ?             ; NUMBER OF COLUMNS ON SCREEN
004C ????               C  @CRT_LEN        DW      ?             ; LENGTH OF REGEN BUFFER IN BYTES
004E ????               C  @CRT_START      DW      ?             ; STARTING ADDRESS IN REGEN BUFFER
0050   08 [             C  @CURSOR_POSN    DW      8 DUP(?)      ; CURSOR FOR EACH OF UP TO 8 PAGES
          ????          C
                      ] C
                        C
                        C  ;--------------------------------------
                        C  ;        POST AND BIOS WORK DATA AREA  :
                        C  ;--------------------------------------
                        C
                        C                                        ; STACK SAVE, ETC.
0067 ????               C  @IO_ROM_INIT    DW      ?             ; POINTER TO ROM INITIALIZATION ROUTINE
0069 ????               C  @IO_ROM_SEG     DW      ?             ; POINTER TO I/O ROM SEGMENT
006B ??                 C  @INTR_FLAG      DB      ?             ; FLAG INDICATING AN INTERRUPT HAPPENED
                        C
                        C  ;--------------------------------------
                        C  ;        TIMER DATA AREA               :
                        C  ;--------------------------------------
                        C
006C ????               C  @TIMER_LOW      DW      ?             ; LOW WORD OF TIMER COUNT
006E ????               C  @TIMER_HIGH     DW      ?             ; HIGH WORD OF TIMER COUNT
0070 ??                 C  @TIMER_OFL      DB      ?             ; TIMER HAS ROLLED OVER SINCE LAST READ
                        C
                        C  ;--------------------------------------
                        C  ;        SYSTEM DATA AREA              :
                        C  ;--------------------------------------
                        C
0071 ??                 C  @BIOS_BREAK     DB      ?             ; BIT 7=1 IF BREAK KEY HAS BEEN PRESSED
0072 ????               C  @RESET_FLAG     DW      ?             ; WORD=1234H IF KEYBOARD RESET UNDERWAY
                        C
                        C  ;--------------------------------------
                        C  ;        FIXED DISK DATA AREAS         :
                        C  ;--------------------------------------
                        C
0074 ??                 C  @DISK_STATUS1   DB      ?             ; FIXED DISK STATUS
0075 ??                 C  @HF_NUM         DB      ?             ; COUNT OF FIXED DISK DRIVES
0076 ??                 C  @CONTROL_BYTE   DB      ?             ; HEAD CONTROL BYTE
0077 ??                 C  @PORT_OFF       DB      ?             ;  RESERVED (PORT OFFSET)
```

DSEG.INC - DATA SEGMENTS

```
                        C PAGE
                        C ;--------------------------------------
                        C ;       TIME-OUT VARIABLES             :
                        C ;--------------------------------------
                        C
0078 ??                 C @PRINT_TIM_OUT  DB      ?             ; TIME OUT COUNTERS FOR PRINTER RESPONSE
0079 ??                 C                 DB      ?             ;  SECOND LOGICAL PRINTER ADAPTER
007A ??                 C                 DB      ?             ;  THIRD LOGICAL PRINTER ADAPTER
007B ??                 C                 DB      ?             ;    RESERVED
007C ??                 C @RS232_TIM_OUT  DB      ?             ; TIME OUT COUNTERS FOR RS232 RESPONSE
007D ??                 C                 DB      ?             ;  SECOND LOGICAL RS232 ADAPTER
007E ??                 C                 DB      ?             ;    RESERVED
007F ??                 C                 DB      ?             ;    RESERVED
                        C
                        C ;--------------------------------------
                        C ;       ADDITIONAL KEYBOARD DATA AREA  :
                        C ;--------------------------------------
                        C
                        C                                       ; BUFFER LOCATION WITHIN SEGMENT 40H
0080 ????               C @BUFFER_START   DW      ?             ; OFFSET OF KEYBOARD BUFFER START
0082 ????               C @BUFFER_END     DW      ?             ; OFFSET OF END OF BUFFER
                        C
                        C ;--------------------------------------
                        C ;       EGA/PGA DISPLAY WORK AREA      :
                        C ;--------------------------------------
                        C
0084 ??                 C @ROWS           DB      ?             ; ROWS ON THE ACTIVE SCREEN (LESS 1)
0085 ????               C @POINTS         DW      ?             ; BYTES PER CHARACTER
0087 ??                 C @INFO           DB      ?             ; MODE OPTIONS
0088 ??                 C @INFO_3         DB      ?             ; FEATURE BIT SWITCHES
0089 ??                 C                 DB      ?             ; RESERVED FOR DISPLAY ADAPTERS
008A ??                 C                 DB      ?             ; RESERVED FOR DISPLAY ADAPTERS
                        C
                        C ;--------------------------------------
                        C ;       ADDITIONAL MEDIA DATA          :
                        C ;--------------------------------------
                        C
008B ??                 C @LASTRATE       DB      ?             ; LAST DISKETTE DATA RATE SELECTED
008C ??                 C @HF_STATUS      DB      ?             ; STATUS REGISTER
008D ??                 C @HF_ERROR       DB      ?             ; ERROR REGISTER
008E ??                 C @HF_INT_FLAG    DB      ?             ; FIXED DISK INTERRUPT FLAG
008F ??                 C @HF_CNTRL       DB      ?             ; BIT 0-> PC-1/DUAL FDC ADAPTER CARD
0090 ??                 C @DSK_STATE      DB      ?             ; DRIVE 0 MEDIA STATE
0091 ??                 C                 DB      ?             ; DRIVE 1 MEDIA STATE
0092 ??                 C                 DB      ?             ; DRIVE 0 OPERATION START STATE
0093 ??                 C                 DB      ?             ; DRIVE 1 OPERATION START STATE
0094 ??                 C @DSK_TRK        DB      ?             ; DRIVE 0 PRESENT CYLINDER
0095 ??                 C                 DB      ?             ; DRIVE 1 PRESENT CYLINDER
                        C
                        C ;--------------------------------------
                        C ;       ADDITIONAL KEYBOARD FLAGS      :
                        C ;--------------------------------------
                        C
0096 ??                 C @KB_FLAG_3      DB      ?             ; KEYBOARD MODE STATE AND TYPE FLAGS
0097 ??                 C @KB_FLAG_2      DB      ?             ; KEYBOARD LED FLAGS
                        C
                        C IFE SYSTEM
                        C ;--------------------------------------
                        C ;       REAL TIME CLOCK DATA AREA      :
                        C ;--------------------------------------
                        C
0098 ????               C @USER_FLAG      DW      ?             ; OFFSET ADDRESS OF USERS WAIT FLAG
009A ????               C @USER_FLAG_SEG  DW      ?             ; SEGMENT ADDRESS OF USER WAIT FLAG
009C ????               C @RTC_LOW        DW      ?             ; LOW WORD OF USER WAIT FLAG
009E ????               C @RTC_HIGH       DW      ?             ; HIGH WORD OF USER WAIT FLAG
00A0 ??                 C @RTC_WAIT_FLAG  DB      ?             ; WAIT ACTIVE FLAG (01=BUSY, 80=POSTED)
                        C ENDIF
                        C                                       ;               (00=POST ACKNOWLEDGED)
                        C ;--------------------------------------
                        C ;       AREA FOR NETWORK ADAPTER       :
                        C ;--------------------------------------
                        C
00A1    07 [            C @NET            DB      7 DUP(?)      ; RESERVED FOR NETWORK ADAPTERS
           ??           C
                    ]   C
                        C ;--------------------------------------
                        C ;       EGA/PGA PALETTE POINTER        :
                        C ;--------------------------------------
                        C
00A8 ????????           C @SAVE_PTR       DD      ?             ; POINTER TO EGA PARAMETER CONTROL BLOCK
                        C ;--------------------------------------
                        C ;       TIMER DATA                     :
                        C ;--------------------------------------
                        C
00CE                    C                 ORG     0CEH
00CE ????               C @DAY_COUNT      DW      ?             ; COUNT OF DAYS FROM 1-1-80
                        C                                       ; RESERVED
                        C ;--------------------------------------
                        C ;       DATA AREA - PRINT SCREEN       :
                        C ;--------------------------------------
                        C
0100                    C                 ORG     100H          ; ADDRESS= 0040:0100   (REF 0050:0000)
                        C
0100 ??                 C @STATUS_BYTE    DB      ?             ; PRINT SCREEN STATUS BYTE
                        C                                       ;  00=READY/OK,  01=BUSY,  FF=ERROR
                        C
0101                    C DATA            ENDS                  ; END OF BIOS DATA SEGMENT

                          .LIST
```

SECTION 5

```
                                PAGE
0000                            CODE    SEGMENT WORD PUBLIC

                                        PUBLIC  HEADER

                                        ASSUME  CS:CODE,DS:NOTHING,ES:NOTHING,SS:NOTHING

0000                            HEADER  PROC    NEAR

= 0000                          BEGIN   EQU     $
0000 36 32 58 30 38 35                  DB      '62X0854 COPR. IBM CORP. 1981,1986 '        ;COPYRIGHT NOTICE
     34 20 43 4F 50 52
     2E 20 49 42 4D 20
     43 4F 52 50 2E 20
     31 39 38 31 2C 31
     39 38 36 20
                                        EVEN                                                ;EVEN BOUNDARY
0022 20 20 20 20 20 20                  DB      '                           '               ;PAD
     20 20 20 20 20 20
     20 20 20 20 20 20
     20 20 20 20 20 20
0039 20 20 20 20 20 20                  DB      '                           '               ;PAD
     20 20 20 20 20 20
     20 20 20 20 20 20
     20 20 20 20 20 20

0050                            HEADER  ENDP
0050                            CODE    ENDS
                                        END
```

```
                        PAGE 118,121
                        TITLE DSKETTE -- 01/10/86  DISKETTE ADAPTER BIOS
                        .LIST
                        ;-- INT 13 ------------------------------------------------------------------
                        ; DISKETTE I/O
                        ;       THIS INTERFACE PROVIDES DISK ACCESS TO THE 5.25 INCH 360 KB,
                        ;       1.2 MB, AND 720 KB 80 TRACK DISKETTE DRIVES.
                        ; INPUT
                        ;       (AH)=0  RESET DISKETTE SYSTEM
                        ;               HARD RESET TO NEC, PREPARE COMMAND, RECALIBRATE REQUIRED
                        ;               ON ALL DRIVES
                        ;-----------------------------------------------------------------------------
                        ;       (AH)=1  READ THE STATUS OF THE SYSTEM INTO (AH)
                        ;               @DISKETTE_STATUS FROM LAST OPERATION IS USED
                        ;-----------------------------------------------------------------------------
                        ;       REGISTERS FOR READ/WRITE/VERIFY/FORMAT
                        ;       (DL) - DRIVE NUMBER (0-1 ALLOWED, VALUE CHECKED)
                        ;       (DH) - HEAD NUMBER (0-1 ALLOWED, NOT VALUE CHECKED)
                        ;       (CH) - TRACK NUMBER (NOT VALUE CHECKED)
                        ;                MEDIA       DRIVE           TRACK NUMBER
                        ;              320/360     320/360             0-39
                        ;              320/360      1.2M               0-39
                        ;               1.2M        1.2M               0-79
                        ;               720K        720K               0-79
                        ;       (CL) - SECTOR NUMBER (NOT VALUE CHECKED, NOT USED FOR FORMAT)
                        ;                MEDIA       DRIVE          SECTOR NUMBER
                        ;              320/360     320/360             1-8/9
                        ;              320/360      1.2M               1-8/9
                        ;               1.2M        1.2M               1-15
                        ;               720K        720K               1-9
                        ;       (AL) - NUMBER OF SECTORS (NOT VALUE CHECKED)
                        ;                MEDIA       DRIVE          MAX NUMBER OF SECTORS
                        ;              320/360     320/360              8/9
                        ;              320/360      1.2M                8/9
                        ;               1.2M        1.2M                15
                        ;               720K        720K                9
                        ;
                        ;       (ES:BX) - ADDRESS OF BUFFER (NOT REQUIRED FOR VERIFY)
                        ;
                        ;-----------------------------------------------------------------------------
                        ;       (AH)=2  READ THE DESIRED SECTORS INTO MEMORY
                        ;-----------------------------------------------------------------------------
                        ;       (AH)=3  WRITE THE DESIRED SECTORS FROM MEMORY
                        ;-----------------------------------------------------------------------------
                        ;       (AH)=4  VERIFY THE DESIRED SECTORS
                        ;-----------------------------------------------------------------------------
                        ;       (AH)=5  FORMAT THE DESIRED TRACK
                        ;               (ES:BX) MUST POINT TO THE COLLECTION OF DESIRED ADDRESS FIELDS
                        ;               FOR THE TRACK.  EACH FIELD IS COMPOSED OF 4 BYTES, (C,H,R,N),
                        ;               WHERE C = TRACK NUMBER, H=HEAD NUMBER, R = SECTOR NUMBER,
                        ;               N= NUMBER OF BYTES PER SECTOR (00=128, 01=256, 02=512, 03=1024).
                        ;               THERE MUST BE ONE ENTRY FOR EVERY SECTOR ON THE TRACK.
                        ;               THIS INFORMATION IS USED TO FIND THE REQUESTED SECTOR DURING
                        ;               READ/WRITE ACCESS.
                        ;
                        ;               PRIOR TO FORMATTING A DISKETTE, IF THERE EXISTS MORE THAN
                        ;               ONE SUPPORTED MEDIA FORMAT TYPE WITHIN THE DRIVE IN QUESTION,
                        ;               THEN "SET DASD TYPE" (INT 13H, AH = 17H) OR "SET MEDIA TYPE"
                        ;               (INT 13H, AH = 18H) MUST BE CALLED TO SET THE DISKETTE TYPE
                        ;               THAT IS TO BE FORMATED.  IF "SET DASD TYPE" OR "SET MEDIA TYPE"
                        ;               IS NOT CALLED, THE FORMAT ROUTINE WILL ASSUME THE MEDIA FORMAT
                        ;               TO BE THE MAXIMUM CAPACITY OF THE DRIVE.
                        ;
                        ;               THESE PARAMETERS OF DISK_BASE MUST BE CHANGED IN ORDER TO
                        ;               FORMAT THE FOLLOWING MEDIAS:
                        ;               ------------------------------------------
                        ;               : MEDIA   :       DRIVE       : PARM 1 : PARM 2 :
                        ;               ------------------------------------------
                        ;               : 320K    : 320K/360K/1.2M :  50H   :   8    :
                        ;               : 360K    : 320K/360K/1.2M :  50H   :   9    :
                        ;               : 1.2M    : 1.2M           :  54H   :  15    :
                        ;               : 720K    : 720K           :  50H   :   9    :
                        ;               ------------------------------------------
                        ;               NOTES: - PARM 1 = GAP LENGTH FOR FORMAT
                        ;                      - PARM 2 = EOT (LAST SECTOR ON TRACK)
                        ;                      - DISK_BASE IS POINTED TO BY DISK POINTER LOCATED
                        ;                        AT ABSOLUTE ADDRESS 0:78H.
                        ;                      - WHEN FORMAT OPERATIONS ARE COMPLETE, THE PARAMETERS
                        ;                        SHOULD BE RESTORED TO THEIR RESPECTIVE INITIAL VALUES.
                        ;
                        ;-----------------------------------------------------------------------------
                        ;       (AH)=8  READ DRIVE PARAMETERS
                        ;       REGISTERS
                        ;         INPUT
                        ;           (DL) - DRIVE NUMBER (0-1 ALLOWED, VALUE CHECKED)
                        ;         OUTPUT
                        ;           (ES:DI) POINTS TO DRIVE PARAMETERS TABLE
                        ;           (CH) - LOW ORDER 8 OF 10 BITS MAXIMUM NUMBER OF TRACKS
                        ;           (CL) - BITS 7 & 6 - HIGH ORDER TWO BITS OF MAXIMUM TRACKS
                        ;                - BITS 5 THRU 0 - MAXIMUM SECTORS PER TRACK
                        ;           (DH) - MAXIMUM HEAD NUMBER
                        ;           (DL) - NUMBER OF DISKETTE DRIVES INSTALLED
                        ;           (BH) - 0
                        ;           (BL) - BITS 7 THRU 4 - 0
                        ;                  BITS 3 THRU 0 - VALID DRIVE TYPE VALUE IN CMOS
                        ;           (AX) - 0
                        ;         UNDER THE FOLLOWING CIRCUMSTANCES:
                        ;           (1) THE DRIVE NUMBER IS INVALID,
                        ;           (2) THE DRIVE TYPE IS UNKNOWN AND CMOS IS NOT PRESENT,
                        ;           (3) THE DRIVE TYPE IS UNKNOWN AND CMOS IS BAD,
                        ;           (4) OR THE DRIVE TYPE IS UNKNOWN AND THE CMOS DRIVE TYPE IS INVALID
                        ;           THEN ES,AX,BX,CX,DH,DI=0 ; DL=NUMBER OF DRIVES.
                        ;           IF NO DRIVES ARE PRESENT THEN: ES,AX,BX,CX,DX,DI=0.
                        ;           @DSKETTE_STATUS = 0 AND CY IS RESET.
                        ;-----------------------------------------------------------------------------
                        ;       (AH)=15 READ DASD TYPE
                        ;       OUTPUT REGISTERS
                        ;       (AH) - ON RETURN IF CARRY FLAG NOT SET, OTHERWISE ERROR
                        ;                00 - DRIVE NOT PRESENT
                        ;                01 - DISKETTE, NO CHANGE LINE AVAILABLE
                        ;                02 - DISKETTE, CHANGE LINE AVAILABLE
                        ;                03 - RESERVED
                        ;       (DL) - DRIVE NUMBER (0-1 ALLOWED, VALUE CHECKED)
                        ;
```

```
;--------------------------------------------------------------------------------
;       (AH)=16 DISK CHANGE LINE STATUS
;       OUTPUT REGISTERS
;       (AH) - 00 - DISK CHANGE LINE NOT ACTIVE
;              06 - DISK CHANGE LINE ACTIVE & CARRY BIT ON
;       (DL) - DRIVE NUMBER (0-1 ALLOWED, VALUE CHECKED)
;
;--------------------------------------------------------------------------------
;       (AH)=17 SET DASD TYPE FOR FORMAT
;       INPUT REGISTERS
;       (AL) -   00 - NOT USED
;                01 - DISKETTE 320/360K IN 360K DRIVE
;                02 - DISKETTE 360K IN 1.2M DRIVE
;                03 - DISKETTE 1.2M IN 1.2M DRIVE
;                04 - DISKETTE 720K IN 720K DRIVE
;       (DL) - DRIVE NUMBER (0-1 ALLOWED, VALUE CHECKED;
;                DO NOT USE WHEN DISKETTE ATTACH CARD USED)
;--------------------------------------------------------------------------------
;       (AH)=18 SET MEDIA TYPE FOR FORMAT
;       INPUT REGISTERS
;       (CH) - LOW ORDER 8 OF 10 BITS MAXIMUM NUMBER OF TRACKS
;       (CL) - BITS 7 & 6 - HIGH ORDER TWO BITS OF MAXIMUM TRACKS
;            - BITS 5 THRU 0 - MAXIMUM SECTORS PER TRACK
;       (DL) - DRIVE NUMBER (0-1 ALLOWED, VALUE CHECKED)
;       OUTPUT REGISTERS
;       (ES:DI) - POINTER TO DRIVE PARAMETERS TABLE FOR THIS MEDIA TYPE,
;                 UNCHANGED IF (AH) IS NON-ZERO
;       (AH) - 00H, CY = 0, TRACK AND SECTORS/TRACK COMBINATION IS SUPPORTED
;            - 01H, CY = 1, FUNCTION IS NOT AVAILABLE
;            - 0CH, CY = 1, TRACK AND SECTORS/TRACK COMBINATION IS NOT SUPPORTED
;--------------------------------------------------------------------------------
;       DISK CHANGE STATUS IS ONLY CHECKED WHEN A MEDIA SPECIFIED IS OTHER
;       THAN 360 KB DRIVE.  IF THE DISK CHANGE LINE IS FOUND TO BE
;       ACTIVE THE FOLLOWING ACTIONS TAKE PLACE:
;               ATTEMPT TO RESET DISK CHANGE LINE TO INACTIVE STATE.
;               IF ATTEMPT SUCCEEDS SET DASD TYPE FOR FORMAT AND RETURN DISK
;               CHANGE ERROR CODE
;               IF ATTEMPT FAILS RETURN TIMEOUT ERROR CODE AND SET DASD TYPE
;               TO A PREDETERMINED STATE INDICATING MEDIA TYPE UNKNOWN.
;       IF THE DISK CHANGE LINE IN INACTIVE PERFORM SET DASD TYPE FOR FORMAT.
;
; DATA VARIABLE -- @DISK_POINTER
;       DOUBLE WORD POINTER TO THE CURRENT SET OF DISKETTE PARAMETERS
;--------------------------------------------------------------------------------
; OUTPUT FOR ALL FUNCTIONS
;       AH = STATUS OF OPERATION
;               STATUS BITS ARE DEFINED IN THE EQUATES FOR @DISKETTE_STATUS
;               VARIABLE IN THE DATA SEGMENT OF THIS MODULE
;       CY = 0  SUCCESSFUL OPERATION (AH=0 ON RETURN, EXCEPT FOR READ DASD
;               TYPE AH=(15)).
;       CY = 1  FAILED OPERATION (AH HAS ERROR REASON)
;       FOR READ/WRITE/VERIFY
;               DS,BX,DX,CX PRESERVED
;       NOTE: IF AN ERROR IS REPORTED BY THE DISKETTE CODE, THE APPROPRIATE
;               ACTION IS TO RESET THE DISKETTE, THEN RETRY THE OPERATION.
;               ON READ ACCESSES, NO MOTOR START DELAY IS TAKEN, SO THAT
;               THREE RETRIES ARE REQUIRED ON READS TO ENSURE THAT THE
;               PROBLEM IS NOT DUE TO MOTOR START-UP.
;--------------------------------------------------------------------------------
.LIST
; DISKETTE STATE MACHINE - ABSOLUTE ADDRESS 40:90 (DRIVE A) & 91 (DRIVE B)
.LIST
;   ---------------------------------------------------------------
;   |       |       |       |       |       |       |       |       |
;   |   7   |   6   |   5   |   4   |   3   |   2   |   1   |   0   |
;   |       |       |       |       |       |       |       |       |
;   ---------------------------------------------------------------
;       |       |       |       |       |       |       |       |
;       |       |       |       |       |       |       |       |
;       |       |       |       |       |       |       |       |
;       |       |       |       |       |   RESERVED            |
;       |       |       |       |       |           PRESENT STATE
;       |       |       |       |       |       000: 360K IN 360K DRIVE UNESTABLISHED
;       |       |       |       |       |       001: 360K IN 1.2M DRIVE UNESTABLISHED
;       |       |       |       |       |       010: 1.2M IN 1.2M DRIVE UNESTABLISHED
;       |       |       |       |       |       011: 360K IN 360K DRIVE ESTABLISHED
;       |       |       |       |       |       100: 360K IN 1.2M DRIVE ESTABLISHED
;       |       |       |       |       |       101: 1.2M IN 1.2M DRIVE ESTABLISHED
;       |       |       |       |       |       110: RESERVED
;       |       |       |       |       |       111: NONE OF THE ABOVE
;       |       |       |       |       |
;       |       |       |       |       ------> MEDIA/DRIVE ESTABLISHED
;       |       |       |       |
;       |       |       |       ---------------> DOUBLE STEPPING REQUIRED (360K IN 1.2M
;       |       |       |                        DRIVE)
;       |       |       |
;       ---------------------------------------> DATA TRANSFER RATE FOR THIS DRIVE:
;                                                       00: 500 KBS
;                                                       01: 300 KBS
;                                                       10: 250 KBS
;                                                       11: RESERVED
;
.LIST
;--------------------------------------------------------------------------------
; STATE OPERATION STARTED - ABSOLUTE ADDRESS 40:92 (DRIVE A) & 93 (DRIVE B)
;--------------------------------------------------------------------------------
; PRESENT CYLINDER NUMBER - ABSOLUTE ADDRESS 40:94 (DRIVE A) & 95 (DRIVE B)
;--------------------------------------------------------------------------------
```

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                        PAGE

                        MD_STRUC        STRUC
0000 ??                 MD_SPEC1        DB      ?       ; SRT=D, HD UNLOAD=0F - 1ST SPECIFY BYTE
0001 ??                 MD_SPEC2        DB      ?       ; HD LOAD=1, MODE=DMA - 2ND SPECIFY BYTE
0002 ??                 MD_OFF_TIM      DB      ?       ; WAIT TIME AFTER OPERATION TILL MOTOR OFF
0003 ??                 MD_BYT_SEC      DB      ?       ; 512 BYTES/SECTOR
0004 ??                 MD_SEC_TRK      DB      ?       ; EOT ( LAST SECTOR ON TRACK)
0005 ??                 MD_GAP          DB      ?       ; GAP LENGTH
0006 ??                 MD_DTL          DB      ?       ; DTL
0007 ??                 MD_GAP3         DB      ?       ; GAP LENGTH FOR FORMAT
0008 ??                 MD_FIL_BYT      DB      ?       ; FILL BYTE FOR FORMAT
0009 ??                 MD_HD_TIM       DB      ?       ; HEAD SETTLE TIME (MILLISECONDS)
000A ??                 MD_STR_TIM      DB      ?       ; MOTOR START TIME (1/8 SECONDS)
000B ??                 MD_MAX_TRK      DB      ?       ; MAX. TRACK NUMBER
000C ??                 MD_RATE         DB      ?       ; DATA TRANSFER RATE
000D                    MD_STRUC        ENDS

= 007F                  BIT7OFF         EQU     7FH
= 0080                  BIT7ON          EQU     80H

                                PUBLIC  DISK_INT_1
                                PUBLIC  DSKETTE_SETUP
                                PUBLIC  DISKETTE_IO_1
                                PUBLIC  NEC_OUTPUT
                                PUBLIC  RESULTS
                                PUBLIC  SEEK

                                EXTRN   DDS:NEAR
                                EXTRN   DISK_BASE:NEAR
                                EXTRN   WAITF:NEAR
                                EXTRN   MD_TBL1:NEAR
                                EXTRN   MD_TBL2:NEAR
                                EXTRN   MD_TBL3:NEAR
                                EXTRN   MD_TBL4:NEAR
                                EXTRN   MD_TBL5:NEAR
                                EXTRN   MD_TBL6:NEAR

0000                    CODE    SEGMENT BYTE PUBLIC

                                ASSUME  CS:CODE,DS:DATA,ES:DATA

                        ;--------------------------------------------------------
                        ;       DRIVE TYPE TABLE                                :
                        ;--------------------------------------------------------
0000                    DR_TYPE         LABEL   BYTE
0000 01                                 DB      01              ; DRIVE TYPE, MEDIA TABLE
0001 0000 E                             DW      OFFSET MD_TBL1
0003 82                                 DB      02+BIT7ON
0004 0000 E                             DW      OFFSET MD_TBL2
0006 02                                 DB      02
0007 0000 E                             DW      OFFSET MD_TBL3
0009 03                                 DB      03
000A 0000 E                             DW      OFFSET MD_TBL4
000C 84                                 DB      04+BIT7ON
000D 0000 E                             DW      OFFSET MD_TBL5
000F 04                                 DB      04
0010 0000 E                             DW      OFFSET MD_TBL6
= 0012                  DR_TYPE_E       =$                      ; END OF TABLE
= 0006                  DR_CNT          EQU     (DR_TYPE_E-DR_TYPE)/3   ; NUMBER OF DRIVE TYPES

0012                    DISKETTE_IO_1   PROC    FAR             ;>>> ENTRY POINT FOR ORG 0EC59H
0012 FB                         STI             BP              ; INTERRUPTS BACK ON
0013 55                         PUSH            DI              ; USER REGISTER
0014 57                         PUSH            DX              ; USER REGISTER
0015 52                         PUSH            BX              ; HEAD #, DRIVE # OR USER REGISTER
0016 53                         PUSH            CX              ; BUFFER OFFSET PARAMETER OR REGISTER
0017 51                         MOV             BP,SP           ; TRACK #-SECTOR # OR USER REGISTER
0018 8B EC                                                      ; BP    => PARAMETER LIST DEP. ON AH
                                                                ; [BP]    = SECTOR #
                                                                ; [BP+1]  = TRACK #
                                                                ; [BP+2]  = BUFFER OFFSET
                                                                ; FOR RETURN OF DRIVE PARAMETERS:
                                                                ; CL/[BP] = BITS 7&6 HI BITS OF MAX CYL
                                                                ;           BITS 0-5 MAX SECTORS/TRACK
                                                                ; CH/[BP+1] = LOW 8 BITS OF MAX CYL.
                                                                ; BL/[BP+2] = BITS 7-4 = 0
                                                                ;             BITS 3-0 = VALID CMOS TYPE
                                                                ; BH/[BP+3] = 0
                                                                ; DL/[BP+4] = # DRIVES INSTALLED
                                                                ; DH/[BP+5] = MAX HEAD #
                                                                ; DI/[BP+6] = OFFSET TO DISK BASE
001A 1E                         PUSH    DS                      ; BUFFER SEGMENT PARM OR USER REGISTER
001B 56                         PUSH    SI                      ; USER REGISTERS
001C E8 0000 E                  CALL    DDS                     ; SEGMENT OF BIOS DATA AREA TO DS
001F 80 FC 19                   CMP     AH,(FNC_TAE-FNC_TAB)/2  ; CHECK FOR > LARGEST FUNCTION
0022 72 02                      JB      OK_FUNC                 ; FUNCTION OK
0024 B4 14                      MOV     AH,14H                  ; REPLACE WITH KNOWN INVALID FUNCTION
0026                    OK_FUNC:
0026 80 FC 01                   CMP     AH,1                    ; RESET OR STATUS ?
0029 76 0C                      JBE     OK_DRV                  ; IF RESET OR STATUS DRIVE ALWAYS OK
002B 80 FC 08                   CMP     AH,8                    ; READ DRIVE PARMS ?
002E 74 07                      JZ      OK_DRV                  ; IF SO DRIVE CHECKED LATER
0030 80 FA 03                   CMP     DL,3                    ; DRIVES 0,1,2 AND 3 OK
0033 76 02                      JBE     OK_DRV                  ; IF 0 OR 1 THEN JUMP
0035 B4 14                      MOV     AH,14H                  ; REPLACE WITH KNOWN INVALID FUNCTION
0037                    OK_DRV:
0037 8A CC                      MOV     CL,AH                   ; CL = FUNCTION
0039 32 ED                      XOR     CH,CH                   ; CX = FUNCTION
003B D0 E1                      SHL     CL,1                    ; FUNCTION TIMES 2
003D BB 0060 R                  MOV     BX,OFFSET FNC_TAB       ; LOAD START OF FUNCTION TABLE
0040 03 D9                      ADD     BX,CX                   ; ADD OFFSET INTO TABLE => ROUTINE
0042 8A E6                      MOV     AH,DH                   ; AX = HEAD #,# OF SECTORS OR DASD TYPE
0044 32 F6                      XOR     DH,DH                   ; DX = DRIVE #
0046 8B F0                      MOV     SI,AX                   ; SI = HEAD #,# OF SECTORS OR DASD TYPE
0048 8B FA                      MOV     DI,DX                   ; DI = DRIVE #
004A 8A 26 0041 R               MOV     AH,@DSKETTE_STATUS      ; LOAD STATUS TO AH FOR STATUS FUNCTION
004E C6 06 0041 R 00            MOV     @DSKETTE_STATUS,0       ; INITIALIZE FOR ALL OTHERS

                        ;       THROUGHOUT THE DISKETTE BIOS, THE FOLLOWING INFORMATION IS CONTAINED IN
                        ;       THE FOLLOWING MEMORY LOCATIONS AND REGISTERS. NOT ALL DISKETTE BIOS
                        ;       FUNCTIONS REQUIRE ALL OF THESE PARAMETERS.
                        ;
                        ;               DI      : DRIVE #
```

SECTION 5

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                        ;               SI-HI   : HEAD #
                        ;               SI-LOW  : # OF SECTORS OR DASD TYPE FOR FORMAT
                        ;               ES      : BUFFER SEGMENT
                        ;               [BP]    : SECTOR #
                        ;               [BP+1]  : TRACK #
                        ;               [BP+2]  : BUFFER OFFSET
                        ;
                        ;       ACROSS CALLS TO SUBROUTINES THE CARRY FLAG (CY=1), WHERE INDICATED IN
                        ;       SUBROUTINE PROLOGUES, REPRESENTS AN EXCEPTION RETURN (NORMALLY AN ERROR
                        ;       CONDITION).  IN MOST CASES, WHEN CY = 1, @DSKETTE_STATUS CONTAINS THE
                        ;       SPECIFIC ERROR CODE.
                        ;                                               ; (AH) = @DSKETTE_STATUS
0053 2E: FF 17                  CALL    WORD PTR CS:[BX]                ; CALL THE REQUESTED FUNCTION
                        ;
0056 5E                         POP     SI                              ; RESTORE ALL REGISTERS
0057 1F                         POP     DS
0058 59                         POP     CX
0059 5B                         POP     BX
005A 5A                         POP     DX
005B 5F                         POP     DI
005C 5D                         POP     BP
005D CA 0002                    RET     2                               ; THROW AWAY SAVED FLAGS
                        ;
                        ;--------------------------------------------------------------------
0060 0092 R             FNC_TAB DW      DISK_RESET                      ; AH = 00; RESET
0062 00EA R                     DW      DISK_STATUS                     ; AH = 01; STATUS
0064 00F6 R                     DW      DISK_READ                       ; AH = 02; READ
0066 0102 R                     DW      DISK_WRITE                      ; AH = 03; WRITE
0068 010E R                     DW      DISK_VERF                       ; AH = 04; VERIFY
006A 011A R                     DW      DISK_FORMAT                     ; AH = 05; FORMAT
006C 017D R                     DW      FNC_ERR                         ; AH = 06; INVALID
006E 017D R                     DW      FNC_ERR                         ; AH = 07; INVALID
0070 0187 R                     DW      DISK_PARMS                      ; AH = 08; READ DRIVE PARAMETERS
0072 017D R                     DW      FNC_ERR                         ; AH = 09; INVALID
0074 017D R                     DW      FNC_ERR                         ; AH = 0A; INVALID
0076 017D R                     DW      FNC_ERR                         ; AH = 0B; INVALID
0078 017D R                     DW      FNC_ERR                         ; AH = 0C; INVALID
007A 017D R                     DW      FNC_ERR                         ; AH = 0D; INVALID
007C 017D R                     DW      FNC_ERR                         ; AH = 0E; INVALID
007E 017D R                     DW      FNC_ERR                         ; AH = 0F; INVALID
0080 017D R                     DW      FNC_ERR                         ; AH = 10; INVALID
0082 017D R                     DW      FNC_ERR                         ; AH = 11; INVALID
0084 017D R                     DW      FNC_ERR                         ; AH = 12; INVALID
0086 017D R                     DW      FNC_ERR                         ; AH = 13; INVALID
0088 017D R                     DW      FNC_ERR                         ; AH = 14; INVALID
008A 027C R                     DW      DISK_TYPE                       ; AH = 15; READ DASD TYPE
008C 02B0 R                     DW      DISK_CHANGE                     ; AH = 16; CHANGE STATUS
008E 02E5 R                     DW      FORMAT_SET                      ; AH = 17; SET DASD TYPE
0090 034D R                     DW      SET_MEDIA                       ; AH = 18; SET MEDIA TYPE
= 0092                  FNC_TAE EQU     $                               ; END
0092                    DISKETTE_IO_1   ENDP
                        ;--------------------------------------------------------------------
                        ; DISK_RESET                                                        :
                        ;       RESET THE DISKETTE SYSTEM.                                  :
                        ;                                                                   :
                        ; ON EXIT:     @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION     :
                        ;--------------------------------------------------------------------
0092                    DISK_RESET      PROC    NEAR
0092 BA 03F2                    MOV     DX,03F2H                        ; ADAPTER CONTROL PORT
0095 FA                         CLI                                     ; NO INTERRUPTS
0096 A0 003F R                  MOV     AL,@MOTOR_STATUS                ; GET DIGITAL OUTPUT REGISTER REFLECTION
0099 24 3F                      AND     AL,00111111B                    ; KEEP SELECTED AND MOTOR ON BITS
009B D0 C0                      ROL     AL,1                            ; MOTOR VALUE TO HIGH NIBBLE
009D D0 C0                      ROL     AL,1                            ; DRIVE SELECT TO LOW NIBBLE
009F D0 C0                      ROL     AL,1
00A1 D0 C0                      ROL     AL,1
00A3 0C 08                      OR      AL,00001000B                    ; TURN ON INTERRUPT ENABLE
00A5 EE                         OUT     DX,AL                           ; RESET THE ADAPTER
00A6 C6 06 003E R 00            MOV     @SEEK_STATUS,0                  ; SET RECALIBRATE REQUIRED ON ALL DRIVES
00AB EB 00                      JMP     $+2                             ; WAIT FOR I/O
00AD 0C 04                      OR      AL,00000100B                    ; TURN OFF RESET BIT
00AF EE                         OUT     DX,AL                           ; RESET THE ADAPTER
00B0 FB                         STI                                     ; ENABLE THE INTERRUPTS
00B1 E8 0ABA R                  CALL    WAIT_INT                        ; WAIT FOR THE INTERRUPT
00B4 72 2D                      JC      DR_ERR                          ; IF ERROR, RETURN IT
00B6 B9 00C0                    MOV     CX,11000000B                    ; CL = EXPECTED @NEC_STATUS
                        ;
00B9                    NXT_DRV:
00B9 51                         PUSH    CX                              ; SAVE FOR CALL
00BA B8 00E2 R                  MOV     AX,OFFSET DR_POP_ERR            ; LOAD NEC_OUTPUT ERROR ADDRESS
00BD 50                         PUSH    AX                              ; "
00BE B4 08                      MOV     AH,08H                          ; SENSE INTERRUPT STATUS COMMAND
00C0 E8 09F0 R                  CALL    NEC_OUTPUT
00C3 58                         POP     AX                              ; THROW AWAY ERROR RETURN
00C4 E8 0AE2 R                  CALL    RESULTS                         ; READ IN THE RESULTS
00C7 59                         POP     CX                              ; RESTORE AFTER CALL
00C8 72 19                      JC      DR_ERR                          ; ERROR RETURN
00CA 3A 0E 0042 R               CMP     CL,@NEC_STATUS                  ; TEST FOR DRIVE READY TRANSITION
00CE 75 13                      JNZ     DR_ERR                          ; EVERYTHING OK
00D0 FE C1                      INC     CL                              ; NEXT EXPECTED @NEC_STATUS
00D2 80 F9 C3                   CMP     CL,11000011B                    ; ALL POSSIBLE DRIVES CLEARED
00D5 76 E2                      JBE     NXT_DRV                         ; FALL THRU IF 11000100B OR >
                        ;
                        ;-----  SEND SPECIFY COMMAND TO NEC
00D7                    J7:
00D7 E8 03D1 R                  CALL    SEND_SPEC
00DA                    RESBAC:
00DA E8 0832 R                  CALL    SETUP_END                       ; VARIOUS CLEANUPS
00DD 8B DE                      MOV     BX,SI                           ; GET SAVED AL TO BL
00DF 8A C3                      MOV     AL,BL                           ; PUT BACK FOR RETURN
00E1 C3                         RET
                        ;
00E2                    DR_POP_ERR:
00E2 59                         POP     CX                              ; CLEAR STACK
00E3                    DR_ERR:                                         ;
00E3 80 0E 0041 R 20            OR      @DSKETTE_STATUS,BAD_NEC         ; SET ERROR CODE
00E8 EB F0                      JMP     SHORT RESBAC                    ; RETURN FROM RESET
00EA                    DISK_RESET      ENDP
                        ;
                        ;--------------------------------------------------------------------
                        ; DISK_STATUS                                                       :
                        ;       DISKETTE STATUS.                                            :
                        ; ON ENTRY:     AH = STATUS OF PREVIOUS OPERATION                   :
```

```
                        ;                                                                      :
                        ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION       :
                        ;--------------------------------------------------------------------------
00EA                    DISK_STATUS     PROC    NEAR
00EA 88 26 0041 R               MOV     @DSKETTE_STATUS,AH      ; PUT BACK FOR SETUP_END
00EE E8 0832 R                  CALL    SETUP_END               ; VARIOUS CLEANUPS
00F1 8B DE                      MOV     BX,SI                   ; GET SAVED AL TO BL
00F3 8A C4                      MOV     AL,AH                   ; STORE STATUS IN AL
00F5 C3                         RET
00F6                    DISK_STATUS     ENDP
                        ;--------------------------------------------------------------------------
                        ; DISK_READ                                                            :
                        ;       DISKETTE READ.                                                 :
                        ; ON ENTRY:     DI      = DRIVE #                                      :
                        ;               SI-HI   = HEAD #                                       :
                        ;               SI-LOW  = # OF SECTORS                                 :
                        ;               ES      = BUFFER SEGMENT                               :
                        ;               [BP]    = SECTOR #                                     :
                        ;               [BP+1]  = TRACK #                                      :
                        ;               [BP+2]  = BUFFER OFFSET                                :
                        ;                                                                      :
                        ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION       :
                        ;--------------------------------------------------------------------------
00F6                    DISK_READ       PROC    NEAR
00F6 80 26 003F R 7F            AND     @MOTOR_STATUS,01111111B ; INDICATE A READ OPERATION
00FB B8 E646                    MOV     AX,0E646H               ; AX = NEC COMMAND, DMA COMMAND
00FE E8 04B3 R                  CALL    RD_WR_VF                ; COMMON READ/WRITE/VERIFY
0101 C3                         RET
0102                    DISK_READ       ENDP
                        ;--------------------------------------------------------------------------
                        ; DISK_WRITE                                                           :
                        ;       DISKETTE WRITE.                                                :
                        ; ON ENTRY:     DI      = DRIVE #                                      :
                        ;               SI-HI   = HEAD #                                       :
                        ;               SI-LOW  = # OF SECTORS                                 :
                        ;               ES      = BUFFER SEGMENT                               :
                        ;               [BP]    = SECTOR #                                     :
                        ;               [BP+1]  = TRACK #                                      :
                        ;               [BP+2]  = BUFFER OFFSET                                :
                        ;                                                                      :
                        ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUScOF OPERATION       :
                        ;--------------------------------------------------------------------------
0102                    DISK_WRITE      PROC    NEAR
0102 B8 C54A                    MOV     AX,0C54AH               ; AX = NEC COMMAND, DMA COMMAND
0105 80 0E 003F R 80            OR      @MOTOR_STATUS,10000000B ; INDICATE WRITE OPERATION
010A E8 04B3 R                  CALL    RD_WR_VF                ; COMMON READ/WRITE/VERIFY
010D C3                         RET
010E                    DISK_WRITE      ENDP
                        ;--------------------------------------------------------------------------
                        ; DISK_VERF                                                            :
                        ;       DISKETTE VERIFY.                                               :
                        ; ON ENTRY:     DI      = DRIVE #                                      :
                        ;               SI-HI   = HEAD #                                       :
                        ;               SI-LOW  = # OF SECTORS                                 :
                        ;               ES      = BUFFER SEGMENT                               :
                        ;               [BP]    = SECTOR #                                     :
                        ;               [BP+1]  = TRACK #                                      :
                        ;               [BP+2]  = BUFFER OFFSET                                :
                        ;                                                                      :
                        ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION       :
                        ;--------------------------------------------------------------------------
010E                    DISK_VERF       PROC    NEAR
010E 80 26 003F R 7F            AND     @MOTOR_STATUS,01111111B ; INDICATE A READ OPERATION
0113 B8 E642                    MOV     AX,0E642H               ; AX = NEC COMMAND, DMA COMMAND
0116 E8 04B3 R                  CALL    RD_WR_VF                ; COMMON READ/WRITE/VERIFY
0119 C3                         RET
011A                    DISK_VERF       ENDP
                        ;--------------------------------------------------------------------------
                        ; DISK_FORMAT                                                          :
                        ;       DISKETTE FORMAT.                                               :
                        ; ON ENTRY:     DI      = DRIVE #                                      :
                        ;               SI-HI   = HEAD #                                       :
                        ;               SI-LOW  = # OF SECTORS                                 :
                        ;               ES      = BUFFER SEGMENT                               :
                        ;               [BP]    = SECTOR #                                     :
                        ;               [BP+1]  = TRACK #                                      :
                        ;               [BP+2]  = BUFFER OFFSET                                :
                        ;               @DISK_POINTER POINTS TO THE PARAMETER TABLE OF         :
                        ;                       THIS DRIVE                                     :
                        ;                                                                      :
                        ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION       :
                        ;--------------------------------------------------------------------------
011A                    DISK_FORMAT     PROC    NEAR
011A E8 0404 R                  CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
011D E8 05A0 R                  CALL    FMT_INIT                ; ESTABLISH STATE IF UNESTABLISHED
0120 80 0E 003F R 80            OR      @MOTOR_STATUS,10000000B ; INDICATE WRITE OPERATION
0125 F6 06 008F R 01            TEST    @HF_CNTRL_DUAL          ; TEST CONTROLLER I.D.
012A 74 05                      JZ      NO_CHG_CHECK
012C E8 05F5 R                  CALL    MED_CHANGE              ; CHECK MEDIA CHANGE AND RESET IF SO
012F 72 41                      JC      FM_DON                  ; MEDIA CHANGED, SKIP
0131                    NO_CHG_CHECK:
0131 E8 0658 R                  CALL    CHK_LASTRATE            ; ZF=1 ATTEMPT RATE IS SAME AS LAST RATE
0134 74 06                      JZ      FM_WR                   ; YES, SKIP SPECIFY COMMAND
0136 E8 03D1 R                  CALL    SEND_SPEC               ; SEND SPECIFY COMMAND TO NEC
0139 E8 0637 R                  CALL    SEND_RATE               ; SEND DATA RATE TO CONTROLLER
013C                    FM_WR:
013C B0 4A                      MOV     AL,04AH                 ; WILL WRITE TO THE DISKETTE
013E E8 0668 R                  CALL    DMA_SETUP               ; SET UP THE DMA
0141 72 2F                      JC      FM_DON                  ; RETURN WITH ERROR
0143 B4 4D                      MOV     AH,04DH                 ; ESTABLISH THE FORMAT COMMAND
0145 E8 06CB R                  CALL    NEC_INIT                ; INITIALIZE THE NEC
0148 72 28                      JC      FM_DON
014A B8 0172 R                  MOV     AX,OFFSET FM_DON        ; LOAD ERROR ADDRESS
014D 50                         PUSH    AX                      ; PUSH NEC_OUT ERROR RETURN
014E B2 03                      MOV     DL,3                    ; BYTES/SECTOR VALUE TO NEC
0150 E8 08FE R                  CALL    GET_PARM
0153 E8 09F0 R                  CALL    NEC_OUTPUT
0156 B2 04                      MOV     DL,4                    ; SECTORS/TRACK VALUE TO NEC
0158 E8 08FE R                  CALL    GET_PARM
015B E8 09F0 R                  CALL    NEC_OUTPUT
015E B2 07                      MOV     DL,7                    ; GAP LENGTH VALUE TO NEC
0160 E8 08FE R                  CALL    GET_PARM
0163 E8 09F0 R                  CALL    NEC_OUTPUT
0166 B2 08                      MOV     DL,8                    ; FILLER BYTE TO NEC
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0168 E8 08FE R                  CALL    GET_PARM
016B E8 09F0 R                  CALL    NEC_OUTPUT
016E 58                         POP     AX                      ; THROW AWAY ERROR
016F E8 0727 R                  CALL    NEC_TERM                ; TERMINATE, RECEIVE STATUS, ETC.
0172                    FM_DON:
0172 E8 0432 R                  CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
0175 E8 0832 R                  CALL    SETUP_END               ; VARIOUS CLEANUPS
0178 8B DE                      MOV     BX,SI                   ; GET SAVED AL TO BL
017A 8A C3                      MOV     AL,BL                   ; PUT BACK FOR RETURN
017C C3                         RET
017D                    DISK_FORMAT     ENDP
                        ;--------------------------------------------------------------
                        ; FNC_ERR                                                     :
                        ;       INVALID FUNCTION REQUESTED OR INVALID DRIVE;          :
                        ;       SET BAD COMMAND IN STATUS.                            :
                        ;                                                             :
                        ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION :
                        ;--------------------------------------------------------------
017D                    FNC_ERR PROC    NEAR                    ; INVALID FUNCTION REQUEST
017D 8B C6                      MOV     AX,SI                   ; RESTORE AL
017F B4 01                      MOV     AH,BAD_CMD              ; SET BAD COMMAND ERROR
0181 88 26 0041 R               MOV     @DSKETTE_STATUS,AH      ; STORE IN DATA AREA
0185 F9                         STC                             ; SET CARRY INDICATING ERROR
0186 C3                         RET
0187                    FNC_ERR ENDP
                        ;--------------------------------------------------------------
                        ; DISK_PARMS                                                  :
                        ;       READ DRIVE PARAMETERS.                                :
                        ; ON ENTRY:                                                   :
                        ;       DI = DRIVE #                                          :
                        ; ON EXIT:                                                    :
                        ;       CL/[BP]    = BITS 7 & 6 HIGH 2 BITS OF MAX CYLINDER   :
                        ;                    BITS 0-5 MAX SECTORS/TRACK               :
                        ;       CH/[BP+1]  = LOW 8 BITS OF MAX CYLINDER               :
                        ;       BL/[BP+2]  = BITS 7-4 = 0                             :
                        ;                    BITS 3-0 = VALID CMOS DRIVE TYPE         :
                        ;       BH/[BP+3]  = 0                                        :
                        ;       DL/[BP+4]  = # DRIVES INSTALLED                       :
                        ;       DH/[BP+5]  = MAX HEAD #                               :
                        ;       DI/[BP+6]  = OFFSET OF MEDIA/DRIVE PARAMETER TABLE    :
                        ;       ES         = SEGMENT OF MEDIA/DRIVE PARAMETER TABLE   :
                        ;       AX         = 0                                        :
                        ;                                                             :
                        ; NOTE : THE ABOVE INFORMATION IS STORED IN THE USERS STACK AT :
                        ;        THE LOCATIONS WHERE THE MAIN ROUTINE WILL POP THEM    :
                        ;        INTO THE APPROPRIATE REGISTERS BEFORE RETURNING TO THE :
                        ;        CALLER.                                              :
                        ;--------------------------------------------------------------
0187                    DISK_PARMS      PROC    NEAR
0187 81 FF 0080                 CMP     DI,80H                  ; CHECK FOR FIXED MEDIA TYPE REQUEST
018B 72 06                      JB      DISK_P2                 ; CONTINUE IF NOT REQUEST FALL THROUGH

                        ;-----  FIXED DISK REQUEST FALL THROUGH ERROR

018D 8B C6                      MOV     AX,SI                   ; RESTORE AL WITH CALLERS VALUE
018F B4 01                      MOV     AH,BAD_CMD              ; SET BAD COMMAND ERROR IN (AH)
0191 F9                         STC                             ; SET ERROR RETURN CODE
0192 C3                         RET

0193                    DISK_P2:
0193 E8 0404 R                  CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
0196 C7 46 02 0000              MOV     WORD PTR [BP+2],0       ; DRIVE TYPE = 0
019B A1 0010 R                  MOV     AX,@EQUIP_FLAG          ; LOAD EQUIPMENT FLAG FOR # DISKETTES
019E 24 C1                      AND     AL,11000001B            ; KEEP DISKETTE DRIVE BITS
01A0 D0 E8                      SHR     AL,1                    ; ARE THERE ANY DRIVES INSTALLED?
01A2 73 7C                      JNC     NON_DRV                 ; NC-->NO DRIVES, ZERO PARAMETERS
01A4 D0 C0                      ROL     AL,1                    ; ROTATE TO ORIGINAL POSITION
01A6 D0 C0                      ROL     AL,1                    ; ROTATE BITS 6 AND 7 TO 0 AND 1
01A8 D0 C0                      ROL     AL,1
01AA FE C0                      INC     AL                      ; CONVERT TO RELATIVE 1
01AC 88 46 04                   MOV     [BP+4],AL               ; STORE NUMBER OF DRIVES
01AF F6 06 008F R 01            TEST    @HF_CNTRL,DUAL          ; CHECK CONTROLLER 1.D.
01B4 75 03                      JNZ     DP1_CONT                ; CONTINUE WITH USUAL PARMS CHECK
01B6 E9 0256 R                  JMP     DET_PARMS               ; RETURN THIS CONTROLLERS PARMS
01B9                    DP1_CONT:
01B9 83 FF 01                   CMP     DI,1                    ; CHECK FOR VALID DRIVE
01BC 77 66                      JA      NON_DRV1                ; DRIVE INVALID
01BE C6 46 05 01                MOV     BYTE PTR[BP+5],1        ; MAXIMUM HEAD NUMBER = 1
01C2 E8 08CF R                  CALL    CMOS_TYPE               ; RETURN DRIVE TYPE IN AL
01C5 72 16                      JC      CHK_EST                 ; ON CMOS BAD CHECK ESTABLISHED
01C7 0A C0                      OR      AL,AL                   ; TEST FOR NO DRIVE TYPE
01C9 74 12                      JZ      CHK_EST                 ; JUMP IF SO
01CB E8 03B1 R                  CALL    DR_TYPE_CHECK           ; RTN CS:BX = MEDIA/DRIVE PARAM TBL
01CE 72 0D                      JC      CHK_EST                 ; TYPE NOT IN TABLE (POSSIBLE BAD CMOS)
01D0 88 46 02                   MOV     [BP+2],AL               ; STORE VALID CMOS DRIVE TYPE
01D3 2E: 8A 4F 04               MOV     CL,CS:[BX].MD_SEC_TRK   ; GET SECTOR/TRACK
01D7 2E: 8A 6F 0B               MOV     CH,CS:[BX].MD_MAX_TRK   ; GET MAX. TRACK NUMBER
01DB EB 32                      JMP     SHORT STO_CX            ; CMOS GOOD, USE CMOS

01DD                    CHK_EST:
01DD 8A A5 0090 R               MOV     AH,@DSK_STATE[DI]       ; LOAD STATE FOR THIS DRIVE
01E1 F6 C4 10                   TEST    AH,MED_DET              ; CHECK FOR ESTABLISHED STATE
01E4 74 3E                      JZ      NON_DRV1                ; CMOS BAD/INVALID AND UNESTABLISHED

01E6                    USE_EST:
01E6 80 E4 C0                   AND     AH,RATE_MSK             ; ISOLATE STATE
01E9 80 FC 80                   CMP     AH,RATE_250             ; RATE 250 ?
01EC 75 54                      JNE     USE_EST2                ; NO, GO CHECK OTHER RATE

                        ;--- DATA RATE IS 250 KBS, TRY 360 KB TABLE FIRST

01EE B0 01                      MOV     AL,01                   ; DRIVE TYPE 1 (360KB)
01F0 E8 03B1 R                  CALL    DR_TYPE_CHECK           ; RTN CS:BX = MEDIA/DRIVE PARAM TBL
01F3 2E: 8A 4F 04               MOV     CL,CS:[BX].MD_SEC_TRK   ; GET SECTOR/TRACK
01F7 2E: 8A 6F 0B               MOV     CH,CS:[BX].MD_MAX_TRK   ; GET MAX. TRACK NUMBER
01FB F6 85 0090 R 01            TEST    @DSK_STATE[DI],TRK_CAPA ; 80 TRACK ?
0200 74 0D                      JZ      STO_CX                  ; MUST BE 360KB DRIVE

                        ;--- IT IS HIGH DATA RATE/80 TRACK DRIVE

0202                    PARM_HDR_80T:
0202 B0 04                      MOV     AL,04                   ; DRIVE TYPE 4
0204 E8 03B1 R                  CALL    DR_TYPE_CHECK           ; RTN CS:BX = MEDIA/DRIVE PARAM TBL
0207 2E: 8A 4F 04               MOV     CL,CS:[BX].MD_SEC_TRK   ; GET SECTOR/TRACK
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020B 2E: 8A 6F 0B               MOV     CH,CS:[BX].MD_MAX_TRK   ; GET MAX. TRACK NUMBER

020F                            STO_CX:
020F 89 4E 00                   MOV     [BP],CX                 ; SAVE IN STACK FOR RETURN
0212                            ES_DI:
0212 89 5E 06                   MOV     [BP+6],BX               ; ADDRESS OF MEDIA/DRIVE PARM TABLE
0215 8C C8                      MOV     AX,CS                   ; SEGMENT MEDIA/DRIVE PARAMETER TABLE
0217 8E C0                      MOV     ES,AX                   ; ES IS SEGMENT OF TABLE

0219                            DP_OUT:
0219 E8 0432 R                  CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
021C 33 C0                      XOR     AX,AX                   ; CLEAR
021E F8                         CLC
021F C3                         RET

                                ;-----  NO DRIVE PRESENT HANDLER

0220                            NON_DRV:
0220 C6 46 04 00                MOV     BYTE PTR [BP+4],0       ; CLEAR NUMBER OF DRIVES

0224                            NON_DRV1:
0224 81 FF 0080                 CMP     DI,80H                  ; CHECK FOR FIXED MEDIA TYPE REQUEST
0228 72 09                      JB      NON_DRV2                ; CONTINUE IF NOT REQUEST FALL THROUGH

                                ;-----  FIXED DISK REQUEST FALL THROUGH ERROR

022A                            FD_REQ_ERR:
022A E8 0432 R                  CALL    XLAT_OLD                ; ELSE TRANSLATE TO COMPATIBLE MODE
022D 8B C6                      MOV     AX,SI                   ; RESTORE AL
022F B4 01                      MOV     AH,BAD_CMD              ; SET BAD COMMAND ERROR
0231 F9                         STC                             ; SET ERROR RETURN CODE
0232 C3                         RET

0233                            NON_DRV2:
0233 33 C0                      XOR     AX,AX                   ; CLEAR PARMS IF NO DRIVES OR CMOS BAD
0235 89 46 00                   MOV     [BP],AX                 ; TRACKS, SECTORS/TRACK = 0
0238 88 66 05                   MOV     [BP+5],AH               ; HEAD = 0
023B 89 46 06                   MOV     [BP+6],AX               ; OFFSET TO DISK_BASE = 0
023E 8E C0                      MOV     ES,AX                   ; ES IS SEGMENT OF TABLE
0240 EB D7                      JMP     SHORT DP_OUT

                                ;--- DATA RATE IS EITHER 300 KBS OR 500 KBS, TRY 1.2 MB TABLE FIRST

0242                            USE_EST2:
0242 B0 02                      MOV     AL,02                   ; DRIVE TYPE 2 (1.2MB)
0244 E8 03B1 R                  CALL    DR_TYPE_CHECK           ; RTN CS:BX = MEDIA/DRIVE PARAM TBL
0247 2E: 8A 4F 04               MOV     CL,CS:[BX].MD_SEC_TRK   ; GET SECTOR/TRACK
024B 2E: 8A 6F 0B               MOV     CH,CS:[BX].MD_MAX_TRK   ; GET MAX. TRACK NUMBER
024F 80 FC 40                   CMP     AH,RATE_300             ; RATE 300 ?
0252 74 BB                      JE      STO_CX                  ; MUST BE 1.2MB DRIVE
0254 EB AC                      JMP     SHORT PARM_HDR_80T      ; ELSE, HIGH DATA RATE/80 TRACK DRIVE
0256                            DET_PARMS:
0256 83 FF 03                   CMP     DI,3                    ; REQUEST FOR FIXED DISK?
0259 77 D8                      JA      NON_DRV2                ; YES-->DRIVE NUMBER INVALID
025B B1 09                      MOV     CL,9                    ; SET CMOS TYPE 1
025D F6 85 0090 R 01            TEST    @DSK_STATE[DI],TRK_CAPA ; IS DRIVE 80 TRACKS?(RELATIVE ZERO)
0262 B0 01                      MOV     AL,1                    ; NUMBER OF TRACKS (RELATIVE ZERO)
0264 B5 27                      MOV     CH,39                   ; IF ZERO TYPE =1
0266 74 04                      JZ      SET_TYP1                ; SET CMOS TYPE 3
0268 B0 03                      MOV     AL,3                    ; NUMBER OF TRACKS (RELATIVE ZERO)
026A B5 4F                      MOV     CH,79
026C                            SET_TYP1:
026C 88 46 02                   MOV     [BP+2],AL               ; STORE TYPE
026F C6 46 03 00                MOV     BYTE PTR [BP+3],0
0273 C6 46 05 01                MOV     BYTE PTR [BP+5],1       ; MAXIMUM HEAD NUMBER = 1
0277 E8 03B1 R                  CALL    DR_TYPE_CHECK           ; ADDRESS OF DISK BASE
027A EB 93                      JMP     STO_CX                  ; GO SET TRKS/SEC,CYL,ES:BX AND EXIT

027C                            DISK_PARMS      ENDP

                                ;--------------------------------------------------------
                                ; DISK_TYPE                                             :
                                ;       THIS ROUTINE RETURNS THE TYPE OF MEDIA INSTALLED. :
                                ;  ON ENTRY:    DI = DRIVE #                             :
                                ;                                                        :
                                ;  ON EXIT:     AH = DRIVE TYPE, CY=0                    :
                                ;--------------------------------------------------------
027C                            DISK_TYPE       PROC    NEAR
027C F6 06 008F R 01            TEST    @HF_CNTRL,DUAL          ; CHECK CONTROLLER I.D.
0281 74 22                      JZ      NO_CHNG
0283 E8 0404 R                  CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
0286 8A 85 0090 R               MOV     AL,@DSK_STATE[DI]       ; GET PRESENT STATE INFORMATION
028A 0A C0                      OR      AL,AL                   ; CHECK FOR NO DRIVE
028C 74 13                      JZ      NO_DRV
028E B4 01                      MOV     AH,NOCHGLN              ; NO CHANGE LINE FOR 40 TRACK DRIVE
0290 A8 01                      TEST    AL,TRK_CAPA             ; IS THIS DRIVE AN 80 TRACK DRIVE?
0292 74 02                      JZ      DT_BACK                 ; IF NO JUMP
0294 B4 02                      MOV     AH,CHGLN                ; CHANGE LINE FOR 80 TRACK DRIVE

0296                            DT_BACK:
0296 50                         PUSH    AX                      ; SAVE RETURN VALUE
0297 E8 0432 R                  CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
029A 58                         POP     AX                      ; RESTORE RETURN VALUE
029B                            DISK_TYPE_EX:                   ; EXIT DISK TYPE FUNCTION
029B F8                         CLC                             ; NO ERROR
029C 8B DE                      MOV     BX,SI                   ; GET SAVED AL TO BL
029E 8A C3                      MOV     AL,BL                   ; PUT BACK FOR RETURN
02A0 C3                         RET
02A1                            NO_DRV:
02A1 32 E4                      XOR     AH,AH                   ; NO DRIVE PRESENT OR UNKNOWN
02A3 EB F1                      JMP     SHORT DT_BACK
02A5                            NO_CHNG:
02A5 A1 0010 R                  MOV     AX,@EQUIP_FLAG          ; LOAD EQUIPMENT FLAG FOR # DISKETTES
02A8 D0 E8                      SHR     AL,1                    ; SHIFT DRIVES PRESENT BIT INTO CARRY
02AA 73 F5                      JNC     NO_DRV                  ; NO DRIVE IN SYSTEM
02AC B4 01                      MOV     AH,1                    ; DISKETTE NO CHANGE LINE AVAILABLE
02AE EB EB                      JMP     DISK_TYPE_EX
02B0                            DISK_TYPE ENDP
                                ;--------------------------------------------------------
                                ; DISK_CHANGE                                           :
                                ;       THIS ROUTINE RETURNS THE STATE OF THE DISK CHANGE LINE. :
                                ;                                                       :
                                ; ON ENTRY:     DI = DRIVE #                            :
                                ;                                                       :
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                        ; ON EXIT:      AH = @DSKETTE_STATUS                    ;
                        ;                       00 - DISK CHANGE LINE INACTIVE, CY = 0  ;
                        ;                       06 - DISK CHANGE LINE ACTIVE, CY = 1    ;
                        ;-----------------------------------------------------------------
02B0                    DISK_CHANGE     PROC    NEAR
02B0 F6 06 008F R 01            TEST    @HF_CNTRL,DUAL          ; TEST CONTROLLER I.D.
02B5 75 03                      JNZ     DC1
02B7 E9 017D R                  JMP     FNC_ERR                 ; ERROR FOR THIS KIND OF CONTROLLER
02BA                    DC1:
02BA E8 0404 R                  CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
02BD 8A 85 0090 R               MOV     AL,@DSK_STATE[DI]       ; GET MEDIA STATE INFORMATION
02C1 0A C0                      OR      AL,AL                   ; DRIVE PRESENT ?
02C3 74 19                      JZ      DC_NON                  ; JUMP IF NO DRIVE
02C5 A8 01                      TEST    AL,TRK_CAPA             ; 80 TRACK DRIVE ?
02C7 74 05                      JZ      SETIT                   ; IF SO , CHECK CHANGE LINE
                        
02C9 E8 0B21 R          DC0:    CALL    READ_DSKCHNG            ; GO CHECK STATE OF DISK CHANGE LINE
02CC 74 05                      JZ      FINIS                   ; CHANGE LINE NOT ACTIVE
                        
02CE C6 06 0041 R 06    SETIT:  MOV     @DSKETTE_STATUS,MEDIA_CHANGE    ; INDICATE MEDIA REMOVED
                        
02D3 E8 0432 R          FINIS:  CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
02D6 E8 0832 R                  CALL    SETUP_END               ; VARIOUS CLEANUPS
02D9 8B DE                      MOV     BX,SI                   ; GET SAVED AL TO BL
02DB 8A C3                      MOV     AL,BL                   ; PUT BACK FOR RETURN
02DD C3                         RET
                        
02DE                    DC_NON:
02DE 80 0E 0041 R 80            OR      @DSKETTE_STATUS,TIME_OUT        ; SET TIMEOUT, NO DRIVE
02E3 EB EE                      JMP     SHORT FINIS
02E5                    DISK_CHANGE     ENDP
                        
                        ;-----------------------------------------------------------------
                        ; FORMAT_SET                                                    :
                        ;       THIS ROUTINE IS USED TO ESTABLISH THE TYPE OF           :
                        ;       MEDIA TO BE USED FOR THE FOLLOWING FORMAT OPERATION.    :
                        ;                                                               :
                        ; ON ENTRY:     SI LOW = DASD TYPE FOR FORMAT                   :
                        ;               DI     = DRIVE #                                :
                        ;                                                               :
                        ; ON EXIT:      @DSKETTE_STATUS REFLECTS STATUS                 :
                        ;               AH = @DSKETTE_STATUS                            :
                        ;               CY = 1 IF ERROR                                 :
                        ;-----------------------------------------------------------------
02E5                    FORMAT_SET      PROC    NEAR
02E5 E8 0404 R                  CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
02E8 56                         PUSH    SI                      ; SAVE DASD TYPE
02E9 8B C6                      MOV     AX,SI                   ; AH = ? , AL = DASD TYPE
02EB 32 E4                      XOR     AH,AH                   ; AH = 0 , AL = DASD TYPE
02ED 8B F0                      MOV     SI,AX                   ; SI = DASD TYPE
02EF 80 A5 0090 R 0F            AND     @DSK_STATE[DI],NOT MED_DET+DBL_STEP+RATE_MSK    ; CLEAR STATE
02F4 4E                         DEC     SI                      ; CHECK FOR 320/360K MEDIA & DRIVE
02F5 75 07                      JNZ     NOT_320                 ; BYPASS IF NOT
02F7 80 8D 0090 R 90            OR      @DSK_STATE[DI],MED_DET+RATE_250 ; SET TO 320/360
02FC EB 3E                      JMP     SHORT S0
                        
02FE                    NOT_320:
02FE F6 06 008F R 01            TEST    @HF_CNTRL,DUAL          ; TEST CONTROLLER I.D.
0303 74 0A                      JZ      S3
0305 E8 05F5 R                  CALL    MED_CHANGE              ; CHECK FOR TIME_OUT
0308 80 3E 0041 R 80            CMP     @DSKETTE_STATUS,TIME_OUT
030D 74 2D                      JZ      S0                      ; IF TIME OUT TELL CALLER
                        
030F 4E                 S3:     DEC     SI                      ; CHECK FOR 320/360K IN 1.2M DRIVE
0310 75 07                      JNZ     NOT_320_12              ; BYPASS IF NOT
0312 80 8D 0090 R 70            OR      @DSK_STATE[DI],MED_DET+DBL_STEP+RATE_300 ; SET STATE
0317 EB 23                      JMP     SHORT S0
                        
0319                    NOT_320_12:
0319 4E                         DEC     SI                      ; CHECK FOR 1.2M MEDIA IN 1.2M DRIVE
031A 75 07                      JNZ     NOT_12                  ; BYPASS IF NOT
031C 80 8D 0090 R 10            OR      @DSK_STATE[DI],MED_DET+RATE_500 ; SET STATE VARIABLE
0321 EB 19                      JMP     SHORT S0                ; RETURN TO CALLER
                        
0323                    NOT_12:
0323 4E                         DEC     SI                      ; CHECK FOR SET DASD TYPE 04
0324 75 20                      JNZ     FS_ERR                  ; BAD COMMAND EXIT IF NOT VALID TYPE
                        
0326 F6 85 0090 R 04            TEST    @DSK_STATE[DI],DRV_DET  ; DRIVE DETERMINED ?
032B 74 09                      JZ      ASSUME                  ; IF STILL NOT DETERMINED ASSUME
032D B0 50                      MOV     AL,MED_DET+RATE_300
032F F6 85 0090 R 02            TEST    @DSK_STATE[DI],FMT_CAPA ; MULTIPLE FORMAT CAPABILITY ?
0334 75 02                      JNZ     OR_IT_IN                ; IF 1.2 M THEN DATA RATE 300
                        
0336                    ASSUME:
0336 B0 90                      MOV     AL,MED_DET+RATE_250     ; SET UP
                        
0338                    OR_IT_IN:
0338 08 85 0090 R               OR      @DSK_STATE[DI],AL       ; OR IN THE CORRECT STATE
                        
033C                    S0:
033C E8 0432 R                  CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
033F E8 0832 R                  CALL    SETUP_END               ; VARIOUS CLEANUPS
0342 5B                         POP     BX                      ; GET SAVED AL TO BL
0343 8A C3                      MOV     AL,BL                   ; PUT BACK FOR RETURN
0345 C3                         RET
                        
0346                    FS_ERR:
0346 C6 06 0041 R 01            MOV     @DSKETTE_STATUS,BAD_CMD ; UNKNOWN STATE,BAD COMMAND
034B EB EF                      JMP     SHORT S0
                        
034D                    FORMAT_SET      ENDP
                        
                        ;-----------------------------------------------------------------
                        ; SET_MEDIA                                                     :
                        ;       THIS ROUTINE SETS THE TYPE OF MEDIA AND DATA RATE       :
                        ;       TO BE USED FOR THE FOLLOWING FORMAT OPERATION.          :
                        ; ON ENTRY:                                                     :
                        ;       [BP]    = SECTOR PER TRACK                              :
                        ;       [BP+1]  = TRACK #                                       :
                        ;       DI      = DRIVE #                                       :
                        ; ON EXIT:                                                      :
                        ;       @DSKETTE_STATUS REFLECTS STATUS                         :
                        ;       IF NO ERROR:                                            :
```

```
                        ;           AH = 0                                          :
                        ;           CY = 0                                          :
                        ;           ES = SEGMENT OF MEDIA/DRIVE PARAMETER TABLE     :
                        ;           DI/[BP+6] = OFFSET OF MEDIA/DRIVE PARAMETER TABLE :
                        ;       IF ERROR:                                           :
                        ;           AH = @DSKETTE_STATUS                            :
                        ;           CY = 1                                          :
                        ;-------------------------------------------------------------
034D                    SET_MEDIA       PROC    NEAR
034D E8 0404 R                  CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
0350 33 DB                      XOR     BX,BX                   ; ZERO INDEX POINTER
0352 80 7E 01 27                CMP     BYTE PTR [BP+1],39      ; MAX. TRACK = 40 ?
0356 75 0B                      JNE     TBL_CHK1
0358 F6 85 0090 R 01            TEST    @DSK_STATE[DI],TRK_CAPA ; 80 TRACK DRIVE ?
035D 74 16                      JZ      MD_FND                  ; POINT TO TABLE ENTRY 1
035F B3 03                      MOV     BL,3                    ; POINT TO TABLE ENTRY 2
0361 EB 12                      JMP     SHORT MD_FND
0363                    TBL_CHK1:
0363 B3 06                      MOV     BL,6                    ; POINT TO TABLE ENTRY 3
0365 80 7E 00 0F                CMP     BYTE PTR [BP],15        ; SECTORS/TRACK = 15 ?
0369 74 0A                      JE      MD_FND
036B B3 12                      MOV     BL,18                   ; POINT TO TABLE ENTRY 6
036D 80 7E 00 12                CMP     BYTE PTR [BP],18        ; SECTORS/TRACK = 18 ?
0371 74 02                      JE      MD_FND
0373 B3 0C                      MOV     BL,12                   ; POINT TO TABLE ENTRY 4
0375                    MD_FND:
0375 2E: 8B 9F 0001 R           MOV     BX,CS:WORD PTR DR_TYPE[BX+1]    ; DI = MEDIA/DRIVE PARAMETER TAB
                                LE
037A 2E: 8A 47 04               MOV     AL,CS:[BX].MD_SEC_TRK   ; GET SECTOR/TRACK
037E 2E: 8A 67 0B               MOV     AH,CS:[BX].MD_MAX_TRK   ; GET MAX. TRACK #
0382 39 46 00                   CMP     [BP],AX                 ; MATCH ?
0385 75 23                      JNE     ER_RTN                  ; NOT SUPPORTED
0387 2E: 8A 47 0C               MOV     AL,CS:[BX].MD_RATE      ; GET RATE
038B 3C 40                      CMP     AL,RATE_300             ; DOUBLE STEP REQUIRED FOR RATE 300
038D 75 02                      JNE     MD_SET
038F 0C 20                      OR      AL,DBL_STEP
0391                    MD_SET:
0391 89 5E 06                   MOV     [BP+6],BX               ; SAVE TABLE POINTER IN STACK
0394 0C 10                      OR      AL,MED_DET              ; SET MESIA ESTABLISHED
0396 80 A5 0090 R 0F            AND     @DSK_STATE[DI],NOT MED_DET+DBL_STEP+RATE_MSK    ; CLEAR STATE
039B 08 85 0090 R               OR      @DSK_STATE[DI],AL       ; SET STATE
039F 8C C8                      MOV     AX,CS                   ; SEGMENT MEDIA/DRIVE PARAMETER TABLE
03A1 8E C0                      MOV     ES,AX                   ; ES IS SEGMENT OF TABLE
03A3                    SM_RTN:
03A3 E8 0432 R                  CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
03A6 E8 0832 R                  CALL    SETUP_END               ; VARIOUS CLEANUPS
03A9 C3                         RET
03AA                    ER_RTN:
03AA C6 06 0041 R 0C            MOV     @DSKETTE_STATUS,MED_NOT_FND     ; ERROR, MEDIA TYPE NOT FOUND
03AF EB F2                      JMP     SM_RTN
03B1                    SET_MEDIA       ENDP

                        ;-------------------------------------------------------------
                        ; DR_TYPE_CHECK                                              :
                        ;       CHECK IF THE GIVEN DRIVE TYPE IN REGISTER (AL)      :
                        ;       IS SUPPORTED IN BIOS DRIVE TYPE TABLE               :
                        ; ON ENTRY:                                                 :
                        ;       AL = DRIVE TYPE                                     :
                        ; ON EXIT:                                                  :
                        ;       CS = SEGMENT OF MEDIA/DRIVE PARAMETER TABLE (CODE)  :
                        ;       CY = 0   DRIVE TYPE SUPPORTED                       :
                        ;            BX = OFFSET TO MEDIA/DRIVE PARAMETER TABLE     :
                        ;       CY = 1   DRIVE TYPE NOT SUPPORTED                   :
                        ; REGISTERS ALTERED:  BX                                    :
                        ;-------------------------------------------------------------
03B1                    DR_TYPE_CHECK   PROC    NEAR
03B1 50                         PUSH    AX
03B2 51                         PUSH    CX
03B3 33 DB                      XOR     BX,BX                   ; BX = INDEX TO DR_TYPE TABLE
03B5 B9 0006                    MOV     CX,DR_CNT               ; CX = LOOP COUNT
03B8                    TYPE_CHK:
03B8 2E: 8A A7 0000 R           MOV     AH,CS:DR_TYPE[BX]       ; GET DRIVE TYPE
03BD 3A C4                      CMP     AL,AH                   ; DRIVE TYPE MATCH ?
03BF 74 08                      JE      DR_TYPE_VALID           ; YES, RETURN WITH CARRY RESET
03C1 83 C3 03                   ADD     BX,3                    ; CHECK NEXT DRIVE TYPE
03C4 E2 F2                      LOOP    TYPE_CHK
03C6 F9                         STC                             ; DRIVE TYPE NOT FOUND IN TABLE
03C7 EB 05                      JMP     SHORT TYPE_RTN
03C9                    DR_TYPE_VALID:
03C9 2E: 8B 9F 0001 R           MOV     BX,CS:WORD PTR DR_TYPE[BX+1]    ; BX = MEDIA TABLE
03CE                    TYPE_RTN:
03CE 59                         POP     CX
03CF 58                         POP     AX
03D0 C3                         RET
03D1                    DR_TYPE_CHECK   ENDP

                        ;-------------------------------------------------------------
                        ; SEND_SPEC                                                  :
                        ;       SEND THE SPECIFY COMMAND TO CONTROLLER USING DATA FROM  :
                        ;       THE DRIVE PARAMETER TABLE POINTED BY @DISK_POINTER   :
                        ; ON ENTRY:     @DISK_POINTER = DRIVE PARAMETER TABLE       :
                        ; ON EXIT :     NONE                                        :
                        ; REGISTERS ALTERED: AX                                     :
                        ;-------------------------------------------------------------
03D1                    SEND_SPEC       PROC    NEAR
03D1 B8 03EB R                  MOV     AX,OFFSET SPECBAC       ; LOAD ERROR ADDRESS
03D4 50                         PUSH    AX                      ; PUSH NEC_OUT ERROR RETURN
03D5 B4 03                      MOV     AH,03H                  ; SPECIFY COMMAND
03D7 E8 09F0 R                  CALL    NEC_OUTPUT              ; OUTPUT THE COMMAND
03DA 2A D2                      SUB     DL,DL                   ; FIRST SPECIFY BYTE
03DC E8 08FE R                  CALL    GET_PARM                ; GET PARAMETER TO AH
03DF E8 09F0 R                  CALL    NEC_OUTPUT              ; OUTPUT THE COMMAND
03E2 B2 01                      MOV     DL,1                    ; SECOND SPECIFY BYTE
03E4 E8 08FE R                  CALL    GET_PARM                ; GET PARAMETER TO AH
03E7 E8 09F0 R                  CALL    NEC_OUTPUT              ; OUTPUT THE COMMAND
03EA 58                         POP     AX                      ; POP ERROR RETURN
03EB                    SPECBAC:
03EB C3                         RET
03EC                    SEND_SPEC       ENDP

                        ;-------------------------------------------------------------
                        ; SEND_SPEC_MD                                               :
                        ;       SEND THE SPECIFY COMMAND TO CONTROLLER USING DATA FROM  :
                        ;       THE MEDIA/DRIVE PARAMETER TABLE POINTED BY (CS:BX)   :
```

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                        ; ON ENTRY:     CS:BX = MEDIA/DRIVE PARAMETER TABLE              :
                        ; ON EXIT :     NONE                                            :
                        ; REGISTERS ALTERED:  AX,CX,DX                                  :
                        ;-----------------------------------------------------------------
03EC                    SEND_SPEC_MD    PROC    NEAR
03EC B8 0403 R                  MOV     AX,OFFSET SPEC_ESBAC    ; LOAD ERROR ADDRESS
03EF 50                         PUSH    AX                      ; PUSH NEC_OUT ERROR RETURN
03F0 B4 03                      MOV     AH,03H                  ; SPECIFY COMMAND
03F2 E8 09F0 R                  CALL    NEC_OUTPUT              ; OUTPUT THE COMMAND
03F5 2E: 8A 27                  MOV     AH,CS:[BX].MD_SPEC1     ; GET 1ST SPECIFY BYTE
03F8 E8 09F0 R                  CALL    NEC_OUTPUT              ; OUTPUT THE COMMAND
03FB 2E: 8A 67 01               MOV     AH,CS:[BX].MD_SPEC2     ; GET SECOND SPECIFY BYTE
03FF E8 09F0 R                  CALL    NEC_OUTPUT              ; OUTPUT THE COMMAND
0402 58                         POP     AX                      ; POP ERROR RETURN
0403                    SPEC_ESBAC:
0403 C3                         RET
0404                    SEND_SPEC_MD    ENDP
                        ;-----------------------------------------------------------------
                        ; XLAT_NEW                                                       :
                        ;       TRANSLATES DISKETTE STATE LOCATIONS FROM COMPATIBLE      :
                        ;       MODE TO NEW ARCHITECTURE.                               :
                        ;                                                               :
                        ; ON ENTRY:     DI : DRIVE                                      :
                        ;-----------------------------------------------------------------
0404                    XLAT_NEW        PROC    NEAR
0404 F6 06 008F R 01            TEST    @HF_CNTRL,DUAL          ; TEST CONTROLLER 1.D.
0409 74 22                      JZ      XN_OUT
040B 83 FF 01                   CMP     DI,1                    ; VALID DRIVE ?
040E 77 1D                      JA      XN_OUT                  ; IF INVALID BACK
0410 80 BD 0090 R 00            CMP     @DSK_STATE[DI],0        ; NO DRIVE ?
0415 74 17                      JZ      DO_DET                  ; IF NO DRIVE ATTEMPT DETERMINE
0417 8B CF                      MOV     CX,DI                   ; CX = DRIVE NUMBER
0419 D0 E1                      SHL     CL,1                    ; CL = SHIFT COUNT, A=0, B=4
041B D0 E1                      SHL     CL,1
041D A0 008F R                  MOV     AL,@HF_CNTRL            ; DRIVE INFORMATION
0420 D2 C8                      ROR     AL,CL                   ; TO LOW NIBBLE
0422 24 07                      AND     AL,DRV_DET+FMT_CAPA+TRK_CAPA    ; KEEP DRIVE BITS
0424 80 A5 0090 R F8            AND     @DSK_STATE[DI],NOT DRV_DET+FMT_CAPA+TRK_CAPA
0429 08 85 0090 R               OR      @DSK_STATE[DI],AL       ; UPDATE DRIVE STATE
042D                    XN_OUT:
042D C3                         RET                             ;
                        ;
042E                    DO_DET:
042E E8 0B2B R                  CALL    DRIVE_DET               ; TRY TO DETERMINE
0431 C3                         RET
                        ;
0432                    XLAT_NEW        ENDP
                        ;-----------------------------------------------------------------
                        ; XLAT_OLD                                                       :
                        ;       TRANSLATES DISKETTE STATE LOCATIONS FROM NEW             :
                        ;       ARCHITECTURE TO COMPATIBLE MODE.                        :
                        ;                                                               :
                        ; ON ENTRY:     DI : DRIVE                                      :
                        ;-----------------------------------------------------------------
0432                    XLAT_OLD        PROC    NEAR
0432 F6 06 008F R 01            TEST    @HF_CNTRL,DUAL          ; TEST CONTROLLER 1.D.
0437 74 79                      JZ      XO_OUT
0439 83 FF 01                   CMP     DI,1                    ; VALID DRIVE ?
043C 77 74                      JA      XO_OUT                  ; IF INVALID BACK
043E 80 BD 0090 R 00            CMP     @DSK_STATE[DI],0        ; NO DRIVE ?
0443 74 6D                      JZ      XO_OUT                  ; IF NO DRIVE TRANSLATE DONE
                        ;
                        ;-----  TEST FOR SAVED DRIVE INFORMATION ALREADY SET
                        ;
0445 8B CF                      MOV     CX,DI                   ; CX = DRIVE NUMBER
0447 D0 E1                      SHL     CL,1                    ; CL = SHIFT COUNT, A=0, B=4
0449 D0 E1                      SHL     CL,1
044B B4 02                      MOV     AH,FMT_CAPA             ; LOAD MULTI DATA RATE BIT MASK
044D D2 CC                      ROR     AH,CL                   ; ROTATE BY MASK
044F 84 26 008F R               TEST    @HF_CNTRL,AH            ; MULTI-DATA RATE DETERMINED ?
0453 75 16                      JNZ     SAVE_SET                ; IF SO, NO NEED TO RE-SAVE
                        ;
                        ;-----  ERASE DRIVE BITS IN @HF_CNTRL FOR THIS DRIVE
                        ;
0455 B4 07                      MOV     AH,DRV_DET+FMT_CAPA+TRK_CAPA    ; MASK TO KEEP
0457 D2 CC                      ROR     AH,CL                   ; FIX MASK TO KEEP
0459 F6 D4                      NOT     AH                      ; TRANSLATE MASK
045B 20 26 008F R               AND     @HF_CNTRL,AH            ; KEEP BITS FROM OTHER DRIVE INTACT
                        ;
                        ;-----  ACCESS CURRENT DRIVE BITS AND STORE IN @HF_CNTRL
                        ;
045F 8A A5 0090 R               MOV     AL,@DSK_STATE[DI]       ; ACCESS STATE
0463 24 07                      AND     AL,DRV_DET+FMT_CAPA+TRK_CAPA    ; KEEP DRIVE BITS
0465 D2 C8                      ROR     AL,CL                   ; FIX FOR THIS DRIVE
0467 08 06 008F R               OR      @HF_CNTRL,AL            ; UPDATE SAVED DRIVE STATE
                        ;
                        ;-----  TRANSLATE TO COMPATIBILITY MODE
                        ;
046B                    SAVE_SET:
046B 8A A5 0090 R               MOV     AH,@DSK_STATE[DI]       ; ACCESS STATE
046F 8A FC                      MOV     BH,AH                   ; TO BH FOR LATER
0471 80 E4 C0                   AND     AH,RATE_MSK             ; KEEP ONLY RATE
0474 80 FC 00                   CMP     AH,RATE_500             ; RATE 500 ?
0477 74 10                      JZ      CHK_HDR_80T             ; YES 1.2/1.2 OR HIGH DATA RATE 80 TRK
0479 B0 01                      MOV     AL,M3D1U                ; AL = 360 IN 1.2 UNESTABLISHED
047B 80 FC 40                   CMP     AH,RATE_300             ; RATE 300 ?
047E 75 16                      JNZ     CHK_250                 ; NO, 360/360 ,720/720
0480 F6 C7 20                   TEST    BH,DBL_STEP             ; YES, DOUBLE STEP ?
0483 75 1D                      JNZ     TST_DET                 ; YES, MUST BE 360 IN 1.2
                        ;
0485                    UNKNO:
0485 B0 07                      MOV     AL,MED_UNK              ; 'NONE OF THE ABOVE'
0487 EB 20                      JMP     SHORT AL_SET            ; PROCESS COMPLETE
                        ;
0489                    CHK_HDR_80T:
0489 E8 08CF R                  CALL    CMOS_TYPE               ; RETURN DRIVE TYPE IN (AL)
048C 72 F7                      JC      UNKNO                   ; ERROR, SET 'NONE OF THE ABOVE'
048E 3C 02                      CMP     AL,02                   ; 1.2MB DRIVE ?
0490 75 F3                      JNE     UNKNO                   ; NO, GO SET 'NONE OF THE ABOVE'
0492 B0 02                      MOV     AL,M1D1U                ; AL = 1.2 IN 1.2 UNESTABLISHED
0494 EB 0C                      JMP     SHORT TST_DET
                        ;
0496                    CHK_250:
0496 B0 00                      MOV     AL,M3D3U                ; AL = 360 IN 360 UNESTABLISHED
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1126 0498 80 FC 80                      CMP     AH,RATE_250             ; RATE 250 ?
1127 049B 75 E8                         JNZ     UNKNO                   ; IF SO FALL THRU
1128 049D F6 C7 01                      TEST    BH,TRK_CAPA             ; 80 TRACK CAPABILITY ?
1129 04A0 75 E3                         JNZ     UNKNO                   ; IF SO JUMP, FALL THRU TEST DET
1130
1131 04A2                       TST_DET:
1132 04A2 F6 C7 10                      TEST    BH,MED_DET              ; DETERMINED ?
1133 04A5 74 02                         JZ      AL_SET                  ; IF NOT THEN SET
1134 04A7 04 03                         ADD     AL,3                    ; MAKE DETERMINED/ESTABLISHED
1135
1136 04A9                       AL_SET:
1137 04A9 80 A5 0090 R F8               AND     @DSK_STATE[DI],NOT DRV_DET+FMT_CAPA+TRK_CAPA  ; CLEAR DRIVE
1138 04AE 08 85 0090 R                  OR      @DSK_STATE[DI],AL       ; REPLACE WITH COMPATIBLE MODE
1139 04B2                       XO_OUT:
1140 04B2 C3                            RET
1141 04B3                       XLAT_OLD        ENDP
1142
1143                            ;--------------------------------------------------------------
1144                            ; RD_WR_VF                                                    :
1145                            ;       COMMON READ, WRITE AND VERIFY;                        :
1146                            ;       MAIN LOOP FOR STATE RETRIES.                          :
1147                            ;                                                             :
1148                            ; ON ENTRY:     AH : READ/WRITE/VERIFY NEC PARAMETER          :
1149                            ;               AL : READ/WRITE/VERIFY DMA PARAMETER          :
1150                            ;                                                             :
1151                            ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION :
1152                            ;--------------------------------------------------------------
1153 04B3                       RD_WR_VF        PROC    NEAR
1154 04B3 50                            PUSH    AX                      ; SAVE DMA, NEC PARAMETERS
1155 04B4 E8 0404 R                     CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
1156 04B7 E8 0561 R                     CALL    SETUP_STATE             ; INITIALIZE START AND END RATE
1157 04BA 58                            POP     AX                      ; RESTORE READ/WRITE/VERIFY
1158
1159 04BB                       DO_AGAIN:
1160 04BB F6 06 008F R 01               TEST    @HF_CNTRL,DUAL          ; TEST CONTROLLER I.D.
1161 04C0 74 0A                         JZ      RWV
1162 04C2 50                            PUSH    AX                      ; SAVE READ/WRITE/VERIFY PARAMETER
1163 04C3 E8 05F5 R                     CALL    MED_CHANGE              ; MEDIA CHANGE AND RESET IF CHANGED
1164 04C6 58                            POP     AX                      ; RESTORE READ/WRITE/VERIFY
1165 04C7 73 03                         JNC     RWV
1166 04C9 E9 0552 R                     JMP     RWV_END
1167 04CC                       RWV:
1168 04CC 50                            PUSH    AX                      ; SAVE READ/WRITE/VERIFY PARAMETER
1169
1170 04CD 8A B5 0090 R                  MOV     DH,@DSK_STATE[DI]       ; GET RATE STATE OF THIS DRIVE
1171 04D1 80 E6 C0                      AND     DH,RATE_MSK             ; KEEP ONLY RATE
1172
1173 04D4 E8 08CF R                     CALL    CMOS_TYPE               ; RETURN DRIVE TYPE IN (AL)
1174 04D7 0A C0                         OR      AL,AL                   ; TEST FOR NO DRIVE
1175 04D9 74 2F                         JZ      RWV_ASSUME              ; ASSUME TYPE, USE MAX TRACK
1176 04DB E8 03B1 R                     CALL    DR_TYPE_CHECK           ; RTN CS:BX = MEDIA/DRIVE PARAM TBL
1177 04DE 72 2A                         JC      RWV_ASSUME              ; TYPE NOT IN TABLE ASSUME DEFAULT
1178
1179                            ;--- SEARCH FOR MEDIA/DRIVE PARAMETER TABLE
1180
1181 04E0 57                            PUSH    DI                      ; SAVE DRIVE #
1182 04E1 33 DB                         XOR     BX,BX                   ; BX = INDEX TO DR_TYPE TABLE
1183 04E3 B9 0006                       MOV     CX,DR_CNT               ; CX = LOOP COUNT
1184 04E6                       RWV_DR_SEARCH:
1185 04E6 2E: 8A A7 0000 R              MOV     AH,CS:DR_TYPE[BX]       ; GET DRIVE TYPE
1186 04EB 80 E4 7F                      AND     AH,BIT7OFF              ; MASK OUT MSB
1187 04EE 3A C4                         CMP     AL,AH                   ; DRIVE TYPE MATCH ?
1188 04F0 75 0B                         JNE     RWV_NXT_MD              ; NO, CHECK NEXT DRIVE TYPE
1189 04F2                       RWV_DR_FND:
1190 04F2 2E: 8B BF 0001 R              MOV     DI,WORD PTR CS:DR_TYPE[BX+1]  ; DI = MEDIA/DRIVE PARAMETER TABLE
1191 04F7                       RWV_MD_SEARCH:
1192 04F7 2E: 3A 75 0C                  CMP     DH,CS:[DI].MD_RATE      ; MATCH ?
1193 04FB 74 1D                         JE      RWV_MD_FND              ; YES, GO GET 1ST SPECIFY BYTE
1194 04FD                       RWV_NXT_MD:
1195 04FD 83 C3 03                      ADD     BX,3                    ; CHECK NEXT DRIVE TYPE
1196 0500 E2 E4                         LOOP    RWV_DR_SEARCH
1197 0502 C6 06 0041 R FF               MOV     @DSKETTE_STATUS,0FFH    ; FORCE IT TO RETRY
1198 0507 5F                            POP     DI                      ; RESTORE DRIVE #
1199 0508 EB 3F                         JMP     SHORT CHK_RET           ; GO RETRY
1200
1201                            ;--- ASSUME PRIMARY DRIVE IS INSTALLED AS SHIPPED
1202
1203 050A                       RWV_ASSUME:
1204 050A BB 0000 E                     MOV     BX,OFFSET MD_TBL1       ; POINT TO 40 TK 250 KBS
1205 050D F6 85 0090 R 01               TEST    @DSK_STATE[DI],TRK_CAPA ; TEST FOR 80 TRACK
1206 0512 74 09                         JZ      RWV_MD_FND1             ; MUST BE 40 TRACK
1207 0514 BB 0000 E                     MOV     BX,OFFSET MD_TBL3       ; POINT TO 80 TK 500 KBS
1208 0517 EB 04 90                      JMP     RWV_MD_FND1             ; GO SET SPECIFY PARAMETERS
1209
1210                            ;--- CS:BX POINTS TO MEDIA/DRIVE PARAMETER TABLE
1211
1212 051A                       RWV_MD_FND:
1213 051A 8B DF                         MOV     BX,DI                   ; BX = MEDIA/DRIVE PARAMETER TABLE
1214 051C 5F                            POP     DI                      ; RESTORE DRIVE #
1215 051D                       RWV_MD_FND1:
1216
1217                            ;--- SEND THE SPECIFY COMMAND TO THE CONTROLLER
1218
1219 051D E8 03EC R                     CALL    SEND_SPEC_MD
1220 0520 E8 0658 R                     CALL    CHK_LASTRATE            ; ZF=1 ATTEMPT RATE IS SAME AS LAST RATE
1221 0523 74 03                         JZ      RWV_DBL                 ; YES, SKIP SEND RATE COMMAND
1222 0525 E8 0637 R                     CALL    SEND_RATE               ; SEND DATA RATE TO NEC
1223 0528                       RWV_DBL:
1224 0528 53                            PUSH    BX                      ; SAVE MEDIA/DRIVE PARAM ADDRESS
1225 0529 E8 084C R                     CALL    SETUP_DBL               ; CHECK FOR DOUBLE STEP
1226 052C 5B                            POP     BX                      ; RESTORE ADDRESS
1227 052D 72 1A                         JC      CHK_RET                 ; ERROR FROM READ ID, POSSIBLE RETRY
1228 052F 58                            POP     AX                      ; RESTORE NEC,DMA COMMAND
1229 0530 50                            PUSH    AX                      ; SAVE NEC COMMAND
1230 0531 53                            PUSH    BX                      ; SAVE MEDIA/DRIVE PARAM ADDRESS
1231 0532 E8 0668 R                     CALL    DMA_SETUP               ; SET UP THE DMA
1232 0535 5B                            POP     BX                      ; RESTORE ADDRESS
1233 0536 58                            POP     AX                      ; RESTORE NEC COMMAND
1234 0537 72 1F                         JC      RWV_BAC                 ; CHECK FOR DMA BOUNDARY ERROR
1235 0539 50                            PUSH    AX                      ; SAVE NEC COMMAND
1236 053A 53                            PUSH    BX                      ; SAVE MEDIA/DRIVE PARAM ADDRESS
1237 053B E8 06CB R                     CALL    NEC_INIT                ; INITIALIZE NEC
1238 053E 5B                            POP     BX                      ; RESTORE ADDRESS
```

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                        JC      CHK_RET                 ; IF ERROR DO NOT SEND MORE COMMANDS
                        CALL    RWV_COM                 ; OP CODE COMMON TO READ/WRITE/VERIFY
                        JC      CHK_RET                 ; IF ERROR DO NOT SEND MORE COMMANDS
                        CALL    NEC_TERM                ; TERMINATE, GET STATUS, ETC.

                CHK_RET:
                        CALL    RETRY                   ; CHECK FOR, SETUP RETRY
                        POP     AX                      ; RESTORE READ/WRITE/VERIFY PARAMETER
                        JNC     RWV_END                 ; CY = 0 NO RETRY
                        JMP     DO_AGAIN                ; CY = 1 MEANS RETRY

                RWV_END:
                        CALL    DSTATE                  ; ESTABLISH STATE IF SUCCESSFUL
                        CALL    NUM_TRANS               ; AL = NUMBER TRANSFERRED

                RWV_BAC:                                ; BAD DMA ERROR ENTRY
                        PUSH    AX                      ; SAVE NUMBER TRANSFERRED
                        CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
                        POP     AX                      ; RESTORE NUMBER TRANSFERRED
                        CALL    SETUP_END               ; VARIOUS CLEANUPS
                        RET
                RD_WR_VF        ENDP
                ;--------------------------------------------------------------------
                ; SETUP_STATE:  INITIALIZES START AND END RATES.                    :
                ;--------------------------------------------------------------------
                SETUP_STATE     PROC    NEAR
                        TEST    @HF_CNTRL,DUAL          ; TEST CONTROLLER 1.D.
                        JZ      J1C
                        TEST    @DSK_STATE[DI],MED_DET  ; MEDIA DETERMINED ?
                        JNZ     J1C                     ; NO STATES IF DETERMINED
                        MOV     AX,RATE_300*H+RATE_250  ; AH = START RATE,  AL = END RATE
                        TEST    @DSK_STATE[DI],DRV_DET  ; DRIVE ?
                        JZ      AX_SET                  ; DO NOT KNOW DRIVE
                        MOV     AL,RATE_500             ; SET UP FOR 1.2 M END RATE
                        TEST    @DSK_STATE[DI],FMT_CAPA ; 1.2 M ?
                        JNZ     AX_SET                  ; JUMP WITH FIXED END RATE
                        MOV     AX,RATE_250*X           ; START & END RATE = 250 FOR 360 DRIVE

                AX_SET:
                        AND     @DSK_STATE[DI],NOT RATE_MSK+DBL_STEP ; TURN OFF THE RATE
                        OR      @DSK_STATE[DI],AH       ; RATE FIRST TO TRY
                        AND     @LASTRATE,NOT STRT_MSK  ; ERASE LAST TO TRY RATE BITS
                        ROR     AL,1                    ; TO OPERATION LAST RATE LOCATION
                        ROR     AL,1
                        ROR     AL,1
                        ROR     AL,1
                        OR      @LASTRATE,AL            ; LAST RATE
                J1C:
                        RET
                SETUP_STATE     ENDP
                ;--------------------------------------------------------------------
                ;  FMT_INIT: ESTABLISH STATE IF UNESTABLISHED AT FORMAT TIME.       :
                ;--------------------------------------------------------------------
                FMT_INIT        PROC    NEAR
                        TEST    @HF_CNTRL,DUAL          ; TEST CONTROLLER 1.D.
                        JZ      F1_OUT
                        TEST    @DSK_STATE[DI],MED_DET  ; IS MEDIA ESTABLISHED
                        JNZ     F1_OUT                  ; IF SO RETURN
                        CALL    CMOS_TYPE               ; RETURN DRIVE TYPE IN AL
                        JC      CL_DRV                  ; ERROR IN CMOS ASSUME NO DRIVE
                        DEC     AL                      ; MAKE ZERO ORIGIN
                        JS      CL_DRV                  ; NO DRIVE IF AL 0
                        MOV     AH,@DSK_STATE[DI]       ; AH = CURRENT STATE
                        AND     AH,NOT MED_DET+DBL_STEP+RATE_MSK        ; CLEAR
                        OR      AL,AL                   ; CHECK FOR 360
                        JNZ     N_360                   ; IF 360 WILL BE 0
                        OR      AH,MED_DET+RATE_250     ; ESTABLISH MEDIA
                        JMP     SHORT SKP_STATE         ; SKIP OTHER STATE PROCESSING

                N_360:
                        DEC     AL                      ; 1.2 M DRIVE
                        JNZ     N_12                    ; JUMP IF NOT
                F1_RATE:OR      AH,MED_DET+RATE_500     ; SET FORMAT RATE
                        JMP     SHORT SKP_STATE         ; SKIP OTHER STATE PROCESSING

                N_12:
                        DEC     AL                      ; CHECK FOR TYPE 3
                        JNZ     N_720                   ; JUMP IF NOT
                        TEST    AH,DRV_DET              ; IS DRIVE DETERMINED
                        JZ      ISNT_12                 ; TREAT AS NON 1.2 DRIVE
                        TEST    AH,FMT_CAPA             ; IS 1.2M
                        JZ      ISNT_12                 ; JUMP IF NOT
                        OR      AH,MED_DET+RATE_300     ; RATE 300
                        JMP     SHORT SKP_STATE         ; CONTINUE
                N_720:
                        DEC     AL                      ; CHECK FOR TYPE 4
                        JNZ     CL_DRV                  ; NO DRIVE, CMOS BAD
                        JMP     SHORT F1_RATE
                ISNT_12:
                        OR      AH,MED_DET+RATE_250     ; MUST BE RATE 250
                SKP_STATE:
                        MOV     @DSK_STATE[DI],AH       ; STORE AWAY
                F1_OUT:
                        RET
                CL_DRV:
                        XOR     AH,AH                   ; CLEAR STATE
                        JMP     SHORT SKP_STATE         ; SAVE IT
                FMT_INIT        ENDP
                ;--------------------------------------------------------------------
                ; MED_CHANGE                                                        :
                ;       CHECKS FOR MEDIA CHANGE, RESETS MEDIA CHANGE,               :
                ;       CHECKS MEDIA CHANGE AGAIN.                                  :
                ;                                                                   :
                ; ON EXIT:      CY = 1 MEANS MEDIA CHANGE OR TIMEOUT                :
                ;               @DSKETTE_STATUS = ERROR CODE                        :
                ;--------------------------------------------------------------------
                MED_CHANGE      PROC    NEAR
                        TEST    @HF_CNTRL,DUAL          ; TEST CONTROLLER 1.D.
                        JZ      OK2
                        CALL    READ_DSKCHNG            ; READ DISK CHANGE LINE STATE
                        JZ      MC_OUT                  ; BYPASS HANDLING DISK CHANGE LINE
                        AND     @DSK_STATE[DI],NOT MED_DET      ; CLEAR STATE FOR THIS DRIVE

                ;       THIS SEQUENCE ENSURES WHENEVER A DISKETTE IS CHANGED THAT
```

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                        ;       ON THE NEXT OPERATION THE REQUIRED MOTOR START UP TIME WILL
                        ;       BE WAITED. (DRIVE MOTOR MAY GO OFF UPON DOOR OPENING).
0606 8B CF                      MOV     CX,DI                   ; CL = DRIVE #
0608 B0 01                      MOV     AL,1                    ; MOTOR ON BIT MASK
060A D2 E0                      SHL     AL,CL                   ; TO APPROPRIATE POSITION
060C F6 D0                      NOT     AL                      ; KEEP ALL BUT MOTOR ON
060E FA                         CLI                             ; NO INTERRUPTS
060F 20 06 003F R               AND     @MOTOR_STATUS,AL        ; TURN MOTOR OFF INDICATOR
0613 FB                         STI                             ; INTERRUPTS ENABLED
0614 E8 0913 R                  CALL    MOTOR_ON                ; TURN MOTOR ON
                        ;-----  THIS SEQUENCE OF SEEKS IS USED TO RESET DISKETTE CHANGE SIGNAL
0617 E8 0092 R                  CALL    DISK_RESET              ; RESET NEC
061A B5 01                      MOV     CH,0TH                  ; MOVE TO CYLINDER 1
061C E8 0A14 R                  CALL    SEEK                    ; ISSUE SEEK
061F 32 ED                      XOR     CH,CH                   ; MOVE TO CYLINDER 0
0621 E8 0A14 R                  CALL    SEEK                    ; ISSUE SEEK
0624 C6 06 0041 R 06            MOV     @DSKETTE_STATUS,MEDIA_CHANGE    ; STORE IN STATUS
0629 E8 0B21 R          OK1:    CALL    READ_DSKCHNG            ; CHECK MEDIA CHANGED AGAIN
062C 74 05                      JZ      OK2                     ; IF ACTIVE, NO DISKETTE, TIMEOUT
062E C6 06 0041 R 80    OK4:    MOV     @DSKETTE_STATUS,TIME_OUT; TIMEOUT IF DRIVE EMPTY
0633 F9                 OK2:    STC                             ; MEDIA CHANGED, SET CY
0634 C3                         RET
                        MC_OUT:
0635 F8                         CLC                             ; NO MEDIA CHANGED, CLEAR CY
0636 C3                         RET
0637                    MED_CHANGE      ENDP
                        ;--------------------------------------------------------------
                        ; SEND_RATE                                                   :
                        ;       SENDS DATA RATE COMMAND TO NEC                       :
                        ; ON ENTRY:     DI = DRIVE #                                 :
                        ; ON EXIT:      NONE                                         :
                        ; REGISTERS ALTERED: NONE                                    :
                        ;--------------------------------------------------------------
0637                    SEND_RATE       PROC    NEAR            ;
0637 F6 06 008F R 01            TEST    @HF_CNTRL,DUAL          ; TEST CONTROLLER I.D.
063C 74 19                      JZ      C_S_OUT
063E 50                         PUSH    AX                      ; SAVE REG.
063F 80 26 008B R 3F            AND     @LASTRATE,NOT SEND_MSK  ; ELSE CLEAR LAST RATE ATTEMPTED
0644 8A 85 0090 R               MOV     AL,@DSK_STATE[DI]       ; GET RATE STATE OF THIS DRIVE
0648 24 C0                      AND     AL,SEND_MSK             ; KEEP ONLY RATE BITS
064A 08 06 008B R               OR      @LASTRATE,AL            ; SAVE NEW RATE FOR NEXT CHECK
064E D0 C0                      ROL     AL,1                    ; MOVE TO BIT OUTPUT POSITIONS
0650 D0 C0                      ROL     AL,1
0652 BA 03F7                    MOV     DX,03F7H                ; OUTPUT NEW DATA RATE
0655 EE                         OUT     DX,AL
0656 58                         POP     AX                      ; RESTORE REG.
0657                    C_S_OUT:
0657 C3                         RET
0658                    SEND_RATE       ENDP
                        ;--------------------------------------------------------------
                        ; CHK_LASTRATE                                                :
                        ;       CHECK PREVIOUS DATA RATE SENT TO THE CONTROLLER.      :
                        ; ON ENTRY:                                                   :
                        ;       DI = DRIVE #                                         :
                        ; ON EXIT:                                                    :
                        ;       ZF = 1    DATA RATE IS THE SAME AS LAST RATE SENT TO NEC :
                        ;       ZF = 0    DATA RATE IS DIFFERENT FROM LAST RATE      :
                        ; REGISTERS ALTERED: NONE                                    :
                        ;--------------------------------------------------------------
0658                    CHK_LASTRATE    PROC    NEAR
0658 50                         PUSH    AX                      ; SAVE REG
0659 8A 26 008B R               MOV     AH,@LASTRATE            ; GET LAST DATA RATE SELECTED
065D 8A 85 0090 R               MOV     AL,@DSK_STATE[DI]       ; GET RATE STATE OF THIS DRIVE
0661 25 C0C0                    AND     AX,SEND_MSK*X           ; KEEP ONLY RATE BITS OF BOTH
0664 3A C4                      CMP     AL,AH                   ; COMPARE TO PREVIOUSLY TRIED
                                                                ; ZF = 1  RATE IS THE SAME
0666 58                         POP     AX                      ; RESTORE REG.
0667 C3                         RET
0668                    CHK_LASTRATE    ENDP
```

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                        PAGE
                        ;--------------------------------------------------------------
                        ; DMA_SETUP                                                   :
                        ;       THIS ROUTINE SETS UP THE DMA FOR READ/WRITE/VERIFY    :
                        ;       OPERATIONS.                                          :
                        ;                                                            :
                        ; ON ENTRY:     AL = DMA COMMAND                             :
                        ;                                                            :
                        ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION :
                        ;--------------------------------------------------------------
0668                    DMA_SETUP       PROC    NEAR
0668 FA                         CLI                             ; DISABLE INTERRUPTS DURING DMA SET-UP
0669 E6 0C                      OUT     DMA+12,AL               ; SET THE FIRST/LAST F/F
066B EB 00                      JMP     $+2                     ; WAIT FOR I/O
066D E6 0B                      OUT     DMA+11,AL               ; OUTPUT THE MODE BYTE
066F 3C 42                      CMP     AL,42H                  ; DMA VERIFY COMMAND
0671 75 04                      JNE     NOT_VERF                ; NO
0673 33 C0                      XOR     AX,AX                   ; START ADDRESS
0675 EB 15                      JMP     SHORT J33
0677                    NOT_VERF:
0677 8C C0                      MOV     AX,ES                   ; GET THE ES VALUE
0679 D1 C0                      ROL     AX,1                    ; ROTATE LEFT
067B D1 C0                      ROL     AX,1
067D D1 C0                      ROL     AX,1
067F D1 C0                      ROL     AX,1
0681 8A E8                      MOV     CH,AL                   ; GET HIGHEST NIBBLE OF ES TO CH
0683 24 F0                      AND     AL,11110000B            ; ZERO THE LOW NIBBLE FROM SEGMENT
0685 03 46 02                   ADD     AX,[BP+2]               ; TEST FOR CARRY FROM ADDITION
0688 73 02                      JNC     J33
068A FE C5                      INC     CH                      ; CARRY MEANS HIGH 4 BITS MUST BE INC
068C                    J33:
068C 50                         PUSH    AX                      ; SAVE START ADDRESS
068D E6 04                      OUT     DMA+4,AL                ; OUTPUT LOW ADDRESS
068F EB 00                      JMP     $+2                     ; WAIT FOR I/O
0691 8A C4                      MOV     AL,AH
0693 E6 04                      OUT     DMA+4,AL                ; OUTPUT HIGH ADDRESS
0695 8A C5                      MOV     AL,CH                   ; GET HIGH 4 BITS
0697 EB 00                      JMP     $+2                     ; I/O WAIT STATE
0699 24 0F                      AND     AL,00001111B
069B E6 81                      OUT     081H,AL                 ; OUTPUT HIGH 4 BITS TO PAGE REGISTER
                        ;-----  DETERMINE COUNT
069D 8B C6                      MOV     AX,SI                   ; AL = # OF SECTORS
069F 86 C4                      XCHG    AL,AH                   ; AH = # OF SECTORS
06A1 2A C0                      SUB     AL,AL                   ; AL = 0, AX = # OF SECTORS * 256
06A3 D1 E8                      SHR     AX,1                    ; AX = # SECTORS * 128
06A5 50                         PUSH    AX                      ; SAVE # OF SECTORS * 128
06A6 B2 03                      MOV     DL,3                    ; GET BYTES/SECTOR PARAMETER
06A8 E8 08FE R                  CALL    GET_PARM                ; "
06AB 8A CC                      MOV     CL,AH                   ; SHIFT COUNT (0=128, 1=256 ETC)
06AD 58                         POP     AX                      ; AX = # OF SECTORS * 128
06AE D3 E0                      SHL     AX,CL                   ; SHIFT BY PARAMETER VALUE
06B0 48                         DEC     AX                      ;-1 FOR DMA VALUE
06B1 50                         PUSH    AX                      ; SAVE COUNT VALUE
06B2 E6 05                      OUT     DMA+5,AL                ; LOW BYTE OF COUNT
06B4 EB 00                      JMP     $+2                     ; WAIT FOR I/O
06B6 8A C4                      MOV     AL,AH
06B8 E6 05                      OUT     DMA+5,AL                ; HIGH BYTE OF COUNT
06BA FB                         STI                             ; RE-ENABLE INTERRUPTS
06BB 59                         POP     CX                      ; RECOVER COUNT VALUE
06BC 58                         POP     AX                      ; RECOVER ADDRESS VALUE
06BD 03 C1                      ADD     AX,CX                   ; ADD, TEST FOR 64K OVERFLOW
06BF B0 02                      MOV     AL,2                    ; MODE FOR 8237
06C1 E6 0A                      OUT     DMA+10,AL               ; INITIALIZE THE DISKETTE CHANNEL

06C3 73 05                      JNC     NO_BAD                  ; CHECK FOR ERROR
06C5 C6 06 0041 R 09            MOV     @DSKETTE_STATUS,DMA_BOUNDARY    ; SET ERROR

06CA                    NO_BAD:
06CA C3                         RET                             ; CY SET BY ABOVE IF ERROR
06CB                    DMA_SETUP       ENDP
                        ;--------------------------------------------------------------
                        ; NEC_INIT                                                   :
                        ;       THIS ROUTINE SEEKS TO THE REQUESTED TRACK AND        :
                        ;       INITIALIZES THE NEC FOR THE READ/WRITE/VERIFY/FORMAT :
                        ;       OPERATION.                                           :
                        ;                                                            :
                        ; ON ENTRY:     AH : NEC COMMAND TO BE PERFORMED             :
                        ;                                                            :
                        ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION :
                        ;--------------------------------------------------------------
06CB                    NEC_INIT        PROC    NEAR
06CB 50                         PUSH    AX                      ; SAVE NEC COMMAND
06CC E8 0913 R                  CALL    MOTOR_ON                ; TURN MOTOR ON FOR SPECIFIC DRIVE

                        ;-----  DO THE SEEK OPERATION

06CF 8A 6E 01                   MOV     CH,[BP+1]               ; CH = TRACK #
06D2 E8 0A14 R                  CALL    SEEK                    ; MOVE TO CORRECT TRACK
06D5 58                         POP     AX                      ; RECOVER COMMAND
06D6 72 18                      JC      ER_1                    ; ERROR ON SEEK
06D8 8B 06F0 R                  MOV     BX,OFFSET ER_1          ; LOAD ERROR ADDRESS
06DB 53                         PUSH    BX                      ; PUSH NEC_OUT ERROR RETURN

                        ;-----  SEND OUT THE PARAMETERS TO THE CONTROLLER

06DC E8 09F0 R                  CALL    NEC_OUTPUT              ; OUTPUT THE OPERATION COMMAND
06DF 8B C6                      MOV     AX,SI                   ; AH = HEAD #
06E1 8B DF                      MOV     BX,DI                   ; BL = DRIVE #
06E3 D0 E4                      SAL     AH,1                    ; MOVE IT TO BIT 2
06E5 D0 E4                      SAL     AH,1
06E7 80 E4 04                   AND     AH,00000100B            ; ISOLATE THAT BIT
06EA 0A E3                      OR      AH,BL                   ; OR IN THE DRIVE NUMBER
06EC E8 09F0 R                  CALL    NEC_OUTPUT              ; FALL THRU CY SET IF ERROR
06EF 5B                         POP     BX                      ; THROW AWAY ERROR RETURN
06F0                    ER_1:
06F0 C3                         RET
06F1                    NEC_INIT        ENDP
                        ;--------------------------------------------------------------
                        ; RWV_COM                                                    :
                        ;       THIS ROUTINE SENDS PARAMETERS TO THE NEC SPECIFIC    :
                        ;       TO THE READ/WRITE/VERIFY OPERATIONS.                 :
                        ;                                                            :
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                        ; ON ENTRY:     CS:BX = ADDRESS OF MEDIA/DRIVE PARAMETER TABLE  :
                        ; ON EXIT :     @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION :
                        ;-----------------------------------------------------------------
06F1                    RWV_COM PROC    NEAR
06F1 B8 0726 R                  MOV     AX,OFFSET ER_2          ; LOAD ERROR ADDRESS
06F4 50                         PUSH    AX                      ; PUSH NEC_OUT ERROR RETURN
06F5 8A 66 01                   MOV     AH,[BP+1]               ; OUTPUT TRACK #
06F8 E8 09F0 R                  CALL    NEC_OUTPUT
06FB 8B C6                      MOV     AX,SI                   ; OUTPUT HEAD #
06FD E8 09F0 R                  CALL    NEC_OUTPUT
0700 8A 66 00                   MOV     AH,[BP]                 ; OUTPUT SECTOR #
0703 E8 09F0 R                  CALL    NEC_OUTPUT
0706 B2 03                      MOV     DL,3                    ; BYTES/SECTOR PARAMETER FROM BLOCK
0708 E8 08FE R                  CALL    GET_PARM                ; . TO THE NEC
070B E8 09F0 R                  CALL    NEC_OUTPUT              ; OUTPUT TO CONTROLLER
070E B2 04                      MOV     DL,4                    ; EOT PARAMETER FROM BLOCK
0710 E8 08FE R                  CALL    GET_PARM                ; . TO THE NEC
0713 E8 09F0 R                  CALL    NEC_OUTPUT              ; OUTPUT TO CONTROLLER
0716 2E: 8A 67 05               MOV     AH,CS:[BX].MD_GAP        ; GET GAP LENGTH
071A                    R15:
071A E8 09F0 R                  CALL    NEC_OUTPUT
071D B2 06                      MOV     DL,6                    ; DTL PARAMETER FROM BLOCK
071F E8 08FE R                  CALL    GET_PARM                ;  TO THE NEC
0722 E8 09F0 R                  CALL    NEC_OUTPUT              ; OUTPUT TO CONTROLLER
0725 58                         POP     AX                      ; THROW AWAY ERROR EXIT
                        ER_2:
0726 C3                         RET
0727                    RWV_COM ENDP
                        ;-----------------------------------------------------------------
                        ; NEC_TERM                                                       :
                        ;       THIS ROUTINE WAITS FOR THE OPERATION THEN ACCEPTS        :
                        ;       THE STATUS FROM THE NEC FOR THE READ/WRITE/VERIFY/       :
                        ;       FORMAT OPERATION.                                       :
                        ;                                                               :
                        ; ON EXIT:       @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION :
                        ;-----------------------------------------------------------------
0727                    NEC_TERM        PROC    NEAR

                        ;-----  LET THE OPERATION HAPPEN

0727 56                         PUSH    SI                      ; SAVE HEAD #, # OF SECTORS
0728 E8 0ABA R                  CALL    WAIT_INT                ; WAIT FOR THE INTERRUPT
072B 9C                         PUSHF
072C E8 0AE2 R                  CALL    RESULTS                 ; GET THE NEC STATUS
072F 72 47                      JC      SET_END_POP
0731 9D                         POPF
0732 72 3C                      JC      SET_END                 ; LOOK FOR ERROR

                        ;-----  CHECK THE RESULTS RETURNED BY THE CONTROLLER

0734 FC                         CLD                             ; SET THE CORRECT DIRECTION
0735 BE 0042 R                  MOV     SI,OFFSET @NEC_STATUS   ; POINT TO STATUS FIELD
0738 AC                         LODS    @NEC_STATUS             ; GET ST0
0739 24 C0                      AND     AL,11000000B            ; TEST FOR NORMAL TERMINATION
073B 74 33                      JZ      SET_END                 ;
073D 3C 40                      CMP     AL,01000000B            ; TEST FOR ABNORMAL TERMINATION
073F 75 29                      JNZ     J18                     ; NOT ABNORMAL, BAD NEC

                        ;-----  ABNORMAL TERMINATION, FIND OUT WHY

0741 AC                         LODS    @NEC_STATUS             ; GET ST1
0742 D0 E0                      SAL     AL,1                    ; TEST FOR EOT FOUND
0744 B4 04                      MOV     AH,RECORD_NOT_FND
0746 72 24                      JC      J19
0748 D0 E0                      SAL     AL,1
074A D0 E0                      SAL     AL,1
074C B4 10                      MOV     AH,BAD_CRC
074E 72 1C                      JC      J19
0750 D0 E0                      SAL     AL,1                    ; TEST FOR DMA OVERRUN
0752 B4 08                      MOV     AH,BAD_DMA
0754 72 16                      JC      J19
0756 D0 E0                      SAL     AL,1                    ; TEST FOR RECORD NOT FOUND
0758 D0 E0                      SAL     AL,1
075A B4 04                      MOV     AH,RECORD_NOT_FND
075C 72 0E                      JC      J19
075E D0 E0                      SAL     AL,1
0760 B4 03                      MOV     AH,WRITE_PROTECT        ; TEST FOR WRITE_PROTECT
0762 72 08                      JC      J19
0764 D0 E0                      SAL     AL,1                    ; TEST MISSING ADDRESS MARK
0766 B4 02                      MOV     AH,BAD_ADDR_MARK
0768 72 02                      JC      J19
                        ;-----
                        J18:    NEC MUST HAVE FAILED

076A                    J19:    MOV     AH,BAD_NEC
076C
076C 08 26 0041 R       SET_END:OR      @DSKETTE_STATUS,AH
0770
0770 80 3E 0041 R 01            CMP     @DSKETTE_STATUS,1       ; SET ERROR CONDITION
0775 F5                         CMC                             ;
0776 5E                         POP     SI                      ; RESTORE HEAD #, # OF SECTORS
0777 C3                         RET

0778                    SET_END_POP:
0778 9D                         POPF
0779 EB F5                      JMP     SHORT SET_END
077B                    NEC_TERM        ENDP
                        ;-----------------------------------------------------------------
                        ; DSTATE:        ESTABLISH STATE UPON SUCCESSFUL OPERATION.      :
                        ;-----------------------------------------------------------------
077B                    DSTATE  PROC    NEAR
077B F6 06 008F R 01            TEST    @HF_CNTRL,DUAL          ; TEST CONTROLLER I.D.
0780 74 3B                      JZ      SETBAC
0782 80 3E 0041 R 00            CMP     @DSKETTE_STATUS,0       ; CHECK FOR ERROR
0787 75 34                      JNZ     SETBAC                  ; IF ERROR JUMP
0789 80 8D 0090 R 10            OR      @DSK_STATE[DI],MED_DET  ; NO ERROR, MARK MEDIA AS DETERMINED
078E F6 85 0090 R 04            TEST    @DSK_STATE[DI],DRV_DET  ; DRIVE DETERMINED ?
0793 75 28                      JNZ     SETBAC                  ; IF DETERMINED NO TRY TO DETERMINE
0795 8A 85 0090 R               MOV     AL,@DSK_STATE[DI]       ; LOAD STATE
0799 24 C0                      AND     AL,RATE_MSK             ; KEEP ONLY RATE
079B 3C 80                      CMP     AL,RATE_250             ; RATE 250 ?
079D 75 19                      JNE     M_12                    ; NO MUST BE 1.2M OR HI DATA RATE 80 TRK

                        ;--- CHECK FOR HIGH DATA RATE 80 TRACK
```

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                                        CALL    CMOS_TYPE               ; RETURN DRIVE TYPE IN (AL)
                                        JC      M_12                    ; CMOS BAD ASSUME DEFAULT
                                        CMP     AL,2                    ; TYPE 2 DRIVE ?
                                        JE      M_12                    ; YES-->ASSUME MULTI FORMAT CAPABILITY
                                        CMP     AL,4                    ; TYPE 4 DRIVE ?
                                        JE      M_12                    ; YES-->ASSUME MULTI FORMAT CAPABILITY
                                M_720:
                                        AND     @DSK_STATE[DI],NOT FMT_CAPA     ; TURN OFF FORMAT CAPABILITY
                                        OR      @DSK_STATE[DI],DRV_DET  ; MARK DRIVE DETERMINED
                                        JMP     SHORT SETBAC            ; BACK

                                M_12:
                                        OR      @DSK_STATE[DI],DRV_DET+FMT_CAPA  ; TURN ON DETERMINED & FMT CAPA

                                SETBAC:
                                        RET
                                DSTATE  ENDP
                                ;--------------------------------------------------------------
                                ; RETRY                                                       :
                                ;       DETERMINES WHETHER A RETRY IS NECESSARY. IF RETRY IS    :
                                ;       REQUIRED THEN STATE INFORMATION IS UPDATED FOR RETRY.   :
                                ;                                                              :
                                ; ON EXIT:      CY = 1 FOR RETRY, CY = 0 FOR NO RETRY          :
                                ;--------------------------------------------------------------
                                RETRY   PROC    NEAR
                                        CMP     @DSKETTE_STATUS,0       ; GET STATUS OF OPERATION
                                        JZ      NO_RETRY                ; SUCCESSFUL OPERATION
                                        CMP     @DSKETTE_STATUS,TIME_OUT        ; IF TIME OUT NO RETRY
                                        JZ      NO_RETRY                ;
                                        MOV     AH,@DSK_STATE[DI]       ; GET MEDIA STATE OF DRIVE
                                        TEST    AH,MED_DET              ; ESTABLISHED/DETERMINED ?
                                        JNZ     NO_RETRY                ; IF ESTABLISHED STATE THEN TRUE ERROR
                                        AND     AH,RATE_MSK             ; ISOLATE RATE
                                        MOV     CH,@LASTRATE            ; GET START OPERATION STATE
                                        ROL     CH,1                    ; TO CORRESPONDING BITS
                                        ROL     CH,1
                                        ROL     CH,1
                                        ROL     CH,1
                                        AND     CH,RATE_MSK             ; ISOLATE RATE BITS
                                        CMP     CH,AH                   ; ALL RATES TRIED
                                        JE      NO_RETRY                ; IF YES, THEN TRUE ERROR

                                ;       SETUP STATE INDICATOR FOR RETRY ATTEMPT TO NEXT RATE
                                ;         00000000B (500) -> 10000000B (250)
                                ;         10000000B (250) -> 01000000B (300)
                                ;         01000000B (300) -> 00000000B (500)

                                        CMP     AH,RATE_500+1           ; SET CY FOR RATE 500
                                        RCR     AH,1                    ; TO NEXT STATE
                                        AND     AH,RATE_MSK             ; KEEP ONLY RATE BITS
                                        AND     @DSK_STATE[DI],NOT RATE_MSK+DBL_STEP    ; RATE, DBL STEP OFF
                                        OR      @DSK_STATE[DI],AH       ; TURN ON NEW RATE
                                        MOV     @DSKETTE_STATUS,0       ; RESET STATUS FOR RETRY
                                        STC                             ; SET CARRY FOR RETRY
                                        RET                             ; RETRY RETURN

                                NO_RETRY:
                                        CLC                             ; CLEAR CARRY NO RETRY
                                        RET                             ; NO RETRY RETURN
                                RETRY   ENDP
                                ;--------------------------------------------------------------
                                ; NUM_TRANS                                                   :
                                ;       THIS ROUTINE CALCULATES THE NUMBER OF SECTORS THAT      :
                                ;       WERE ACTUALLY TRANSFERRED TO/FROM THE DISKETTE.         :
                                ;                                                              :
                                ; ON ENTRY:     [BP+1] = TRACK                                 :
                                ;               SI-HI  = HEAD                                  :
                                ;               [BP]   = START SECTOR                          :
                                ;                                                              :
                                ; ON EXIT:      AL = NUMBER ACTUALLY TRANSFERRED               :
                                ;--------------------------------------------------------------
                                NUM_TRANS       PROC    NEAR
                                        XOR     AL,AL                   ; CLEAR FOR ERROR
                                        CMP     @DSKETTE_STATUS,0       ; CHECK FOR ERROR
                                        JNZ     NT_OUT                  ; IF ERROR 0 TRANSFERRED
                                        MOV     DL,4                    ; SECTORS/TRACK OFFSET TO DL
                                        CALL    GET_PARM                ; AH = SECTORS/TRACK
                                        MOV     BL,@NEC_STATUS+5        ; GET ENDING SECTOR
                                        MOV     CX,SI                   ; CH = HEAD # STARTED
                                        CMP     CH,@NEC_STATUS+4        ; GET HEAD ENDED UP ON
                                        JNZ     DIF_HD                  ; IF ON SAME HEAD, THEN NO ADJUST

                                        MOV     CH,@NEC_STATUS+3        ; GET TRACK ENDED UP ON
                                        CMP     CH,[BP+1]               ; IS IT ASKED FOR TRACK
                                        JZ      SAME_TRK                ; IF SAME TRACK NO INCREASE

                                        ADD     BL,AH                   ; ADD SECTORS/TRACK
                                DIF_HD:
                                        ADD     BL,AH                   ; ADD SECTORS/TRACK
                                SAME_TRK:
                                        SUB     BL,[BP]                 ; SUBTRACT START FROM END
                                        MOV     AL,BL                   ; TO AL

                                NT_OUT:
                                        RET
                                NUM_TRANS       ENDP
                                ;--------------------------------------------------------------
                                ; SETUP_END                                                   :
                                ;       RESTORES @MOTOR_COUNT TO PARAMETER PROVIDED IN TABLE    :
                                ;       AND LOADS @DSKETTE_STATUS TO AH, AND SETS CY.           :
                                ; ON EXIT:                                                     :
                                ;       AH, @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION    :
                                ;--------------------------------------------------------------
                                SETUP_END       PROC    NEAR
                                        MOV     DL,2                    ; GET THE MOTOR WAIT PARAMETER
                                        PUSH    AX                      ; SAVE NUMBER TRANSFERRED
                                        CALL    GET_PARM
                                        MOV     @MOTOR_COUNT,AH         ; STORE UPON RETURN
                                        POP     AX                      ; RESTORE NUMBER TRANSFERRED
                                        MOV     AH,@DSKETTE_STATUS      ; GET STATUS OF OPERATION
                                        OR      AH,AH                   ; CHECK FOR ERROR
                                        JZ      NUN_ERR                 ; NO ERROR
                                        XOR     AL,AL                   ; CLEAR NUMBER RETURNED
```

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                        NUN_ERR:
                                CMP     AH,1                    ; SET THE CARRY FLAG TO INDICATE
                                CMC                             ; SUCCESS OR FAILURE
                                RET
                        SETUP_END       ENDP
                        ;--------------------------------------------------------------
                        ; SETUP_DBL                                                   :
                        ;       CHECK DOUBLE STEP.                                    :
                        ; ON ENTRY:     DI = DRIVE                                    :
                        ;                                                             :
                        ; ON EXIT :     CY = 1 MEANS ERROR                            :
                        ;--------------------------------------------------------------
0847                    SETUP_DBL       PROC    NEAR
084C F6 06 008F R 01            TEST    @HF_CNTRL,DUAL          ; TEST CONTROLLER I.D.
0851 74 65                      JZ      NO_DBL                  ; NO DOUBLE STEPPING REQUIRED
0853 8A A5 0090 R               MOV     AH,@DSK_STATE[DI]       ; ACCESS STATE
0857 F6 C4 10                   TEST    AH,MED_DET              ; ESTABLISHED STATE ?
085A 75 5C                      JNZ     NO_DBL                  ; IF ESTABLISHED THEN DOUBLE DONE

                        ;-----  CHECK FOR TRACK 0 TO SPEED UP ACKNOWLEDGE OF UNFORMATTED DISKETTE

085C C6 06 003E R 00            MOV     @SEEK_STATUS,0          ; SET RECALIBRATE REQUIRED ON ALL DRIVES
0861 E8 0913 R                  CALL    MOTOR_ON                ; ENSURE MOTOR STAY ON
0864 B5 00                      MOV     CH,0                    ; LOAD TRACK 0
0866 E8 0A14 R                  CALL    SEEK                    ; SEEK TO TRACK 0
0869 E8 08BA R                  CALL    READ_ID                 ; READ ID FUNCTION
086C 72 35                      JC      SD_ERR                  ; IF ERROR NO TRACK 0

                        ;-----  INITIALIZE START AND MAX TRACKS (TIMES 2 FOR BOTH HEADS)

086E B9 0450                    MOV     CX,0450H                ; START, MAX TRACKS
0871 F6 85 0090 R 01            TEST    @DSK_STATE[DI],TRK_CAPA ; TEST FOR 80 TRACK CAPABILITY
0876 74 02                      JZ      CNT_OK                  ; IF NOT COUNT IS SETUP
0878 B1 A0                      MOV     CL,0A0H                 ; MAXIMUM TRACK 1.2 MB

                        ;       ATTEMPT READ ID OF ALL TRACKS, ALL HEADS UNTIL SUCCESS; UPON SUCCESS,
                        ;       MUST SEE IF ASKED FOR TRACK IN SINGLE STEP MODE = TRACK ID READ; IF NOT
                        ;       THEN SET DOUBLE STEP ON.

087A                    CNT_OK:
087A 51                         PUSH    CX                      ; SAVE TRACK, COUNT
087B C6 06 0041 R 00            MOV     @DSKETTE_STATUS,0       ; CLEAR STATUS, EXPECT ERRORS
0880 33 C0                      XOR     AX,AX                   ; CLEAR AX
0882 D0 ED                      SHR     CH,1                    ; HALVE TRACK, CY = HEAD
0884 D0 D0                      RCL     AL,1                    ; AX = HEAD IN CORRECT BIT
0886 D0 D0                      RCL     AL,1
0888 D0 D0                      RCL     AL,1
088A 50                         PUSH    AX                      ; SAVE HEAD
088B E8 0A14 R                  CALL    SEEK                    ; SEEK TO TRACK
088E 58                         POP     AX                      ; RESTORE HEAD
088F 0B F8                      OR      DI,AX                   ; DI = HEAD OR'ED DRIVE
0891 E8 08BA R                  CALL    READ_ID                 ; READ ID HEAD 0
0894 9C                         PUSHF                           ; SAVE RETURN FROM READ_ID
0895 81 E7 00FB                 AND     DI,11111011B            ; TURN OFF HEAD 1 BIT
0899 9D                         POPF                            ; RESTORE ERROR RETURN
089A 59                         POP     CX                      ; RESTORE COUNT
089B 73 08                      JNC     DO_CHK                  ; IF OK, ASKED = RETURNED TRACK ?
089D FE C5                      INC     CH                      ; INC FOR NEXT TRACK
089F 3A E9                      CMP     CH,CL                   ; REACHED MAXIMUM YET
08A1 75 D7                      JNZ     CNT_OK                  ; CONTINUE TILL ALL TRIED

                        ;-----  FALL THRU, READ ID FAILED FOR ALL TRACKS

08A3                    SD_ERR:
08A3 F9                         STC                             ; SET CARRY FOR ERROR
08A4 C3                         RET                             ; SETUP_DBL ERROR EXIT

08A5                    DO_CHK:
08A5 8A 0E 0045 R               MOV     CL,@NEC_STATUS+3        ; LOAD RETURNED TRACK
08A9 88 8D 0094 R               MOV     @DSK_TRK[DI],CL         ; STORE TRACK NUMBER
08AD D0 ED                      SHR     CH,1                    ; HALVE TRACK
08AF 3A E9                      CMP     CH,CL                   ; IS IT THE SAME AS ASKED FOR TRACK
08B1 74 05                      JZ      NO_DBL                  ; IF SAME THEN NO DOUBLE STEP
08B3 80 8D 0090 R 20            OR      @DSK_STATE[DI],DBL_STEP ; TURN ON DOUBLE STEP REQUIRED

08B8                    NO_DBL:
08B8 F8                         CLC                             ; CLEAR ERROR FLAG
08B9 C3                         RET
08BA                    SETUP_DBL       ENDP
                        ;--------------------------------------------------------------
                        ; READ_ID                                                     :
                        ;       READ ID FUNCTION.                                     :
                        ; ON ENTRY:     DI = BIT 2 = HEAD; BITS 1,0 = DRIVE           :
                        ;                                                             :
                        ; ON EXIT:      DI = BIT 2 IS RESET, BITS 1,0 = DRIVE         :
                        ;               @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION :
                        ;--------------------------------------------------------------
08BA                    READ_ID PROC    NEAR
08BA B8 08CE R                  MOV     AX,OFFSET ER_3          ; MOVE NEC OUTPUT ERROR ADDRESS
08BD 50                         PUSH    AX
08BE B4 4A                      MOV     AH,4AH                  ; READ ID COMMAND
08C0 E8 09F0 R                  CALL    NEC_OUTPUT              ; TO CONTROLLER
08C3 8B C7                      MOV     AX,DI                   ; DRIVE # TO AH, HEAD 0
08C5 8A E0                      MOV     AH,AL
08C7 E8 09F0 R                  CALL    NEC_OUTPUT              ; TO CONTROLLER
08CA E8 0727 R                  CALL    NEC_TERM                ; WAIT FOR OPERATION, GET STATUS
08CD 58                         POP     AX                      ; THROW AWAY ERROR ADDRESS
08CE                    ER_3:
08CE C3                         RET
08CF                    READ_ID ENDP
                        ;--------------------------------------------------------------
                        ; CMOS_TYPE                                                   :
                        ;       RETURNS DISKETTE TYPE FROM CMOS                       :
                        ;                                                             :
                        ; ON ENTRY:     DI = DRIVE #                                  :
                        ;                                                             :
                        ; ON EXIT:      AL = TYPE; CY REFLECTS STATUS                 :
                        ;--------------------------------------------------------------
08CF                    CMOS_TYPE       PROC    NEAR
08CF A0 0010 R                  MOV     AL,BYTE PTR @EQUIP_FLAG ; LOAD EQUIPMENT FLAG FOR # DISKETTES
08D2 24 C1                      AND     AL,11000001B            ; KEEP DISKETTE DRIVE BITS
08D4 D0 E8                      SHR     AL,1                    ; ARE THERE ANY DRIVES INSTALLED?
08D6 73 20                      JNC     TYP_ZERO                ; NC-->NO DRIVES TYPE ZERO
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                        ROL     AL,1                    ; ROTATE TO ORIGINAL POSITION
                        ROL     AL,1                    ; ROTATE BITS 6 AND 7 TO 0 AND 1
                        ROL     AL,1
                        XOR     AH,AH                   ; AX=NUMBER OF DRIVES
                        CMP     AX,DI                   ; IS DRIVE REQUESTED PRESENT
                        JC      TYP_ZERO                ; C-->REQUESTED DRIVE NOT PRESENT
                        TEST    @HF_CNTRL,DUAL          ; TEST CONTROLLER 1.D.
                        JNZ     CR2
                        TEST    @DSK_STATE[DI],TRK_CAPA ; TEST FOR 80 TRACKS
                        MOV     AL,1                    ; DRIVE TYPE HAS 40 TRACKS
                        JZ      CR1
                        MOV     AL,3                    ; DRIVE TYPE HAS 80 TRACKS
                        JMP     SHORT CR1
                TYP_ZERO:
                        XOR     AL,AL                   ; DRIVE TYPE 0
                CR1:                                    ; EXIT WITH AL=TYPE ACCORDING TO TRACKS
                        RET
                CR2:
                        STC
                        JMP     CR1                     ; EXIT WITH CARRY IF DUAL CARD
                CMOS_TYPE       ENDP
                ;--------------------------------------------------------------------
                ; GET_PARM                                                          :
                ;       THIS ROUTINE FETCHES THE INDEXED POINTER FROM THE           :
                ;       DISK_BASE BLOCK POINTED TO BY THE DATA VARIABLE             :
                ;       @DISK_POINTER. A BYTE FROM THAT TABLE IS THEN MOVED         :
                ;       INTO AH, THE INDEX OF THAT BYTE BEING THE PARAMETER         :
                ;       IN DL.                                                      :
                ;                                                                   :
                ; ON ENTRY:     DL = INDEX OF BYTE TO BE FETCHED                    :
                ;                                                                   :
                ; ON EXIT:      AH = THAT BYTE FROM BLOCK                           :
                ;               AL,DH DESTROYED                                     :
                ;--------------------------------------------------------------------
                GET_PARM        PROC    NEAR
                        PUSH    DS
                        PUSH    SI
                        SUB     AX,AX                   ; DS = 0 , BIOS DATA AREA
                        MOV     DS,AX
                        XCHG    DX,BX                   ; BL = INDEX
                        SUB     BH,BH                   ; BX = INDEX
                        ASSUME  DS:ABS0
                        LDS     SI,@DISK_POINTER        ; POINT TO BLOCK
                        MOV     AH,[SI+BX]              ; GET THE WORD
                        XCHG    DX,BX                   ; RESTORE BX
                        POP     SI
                        POP     DS
                        RET
                        ASSUME  DS:DATA
                GET_PARM        ENDP
                ;--------------------------------------------------------------------
                ; MOTOR_ON                                                          :
                ;       TURN MOTOR ON AND WAIT FOR MOTOR START UP TIME. THE @MOTOR_COUNT:
                ;       IS REPLACED WITH A SUFFICIENTLY HIGH NUMBER (0FFH) TO ENSURE :
                ;       THAT THE MOTOR DOES NOT GO OFF DURING THE OPERATION. IF THE  :
                ;       MOTOR NEEDED TO BE TURNED ON, THE MULTITASKING HOOK FUNCTION :
                ;       (AX=90FDH, INT 15H) IS CALLED TELLING THE OPERATING SYSTEM   :
                ;       THAT THE BIOS IS ABOUT TO WAIT FOR MOTOR START UP. IF THIS   :
                ;       FUNCTION RETURNS WITH CY = 1, IT MEANS THAT THE MINIMUM WAIT :
                ;       HAS BEEN COMPLETED. AT THIS POINT A CHECK IS MADE TO ENSURE  :
                ;       THAT THE MOTOR WASN'T TURNED OFF BY THE TIMER. IF THE HOOK DID :
                ;       NOT WAIT, THE WAIT FUNCTION (AH=086H) IS CALLED TO WAIT THE  :
                ;       PRESCRIBED AMOUNT OF TIME. IF THE CARRY FLAG IS SET ON RETURN, :
                ;       IT MEANS THAT THE FUNCTION IS IN USE AND DID NOT PERFORM THE :
                ;       WAIT. A TIMER 1 WAIT LOOP WILL THEN DO THE WAIT.             :
                ;                                                                    :
                ; ON ENTRY:     DI = DRIVE #                                        :
                ;                                                                    :
                ; ON EXIT:      AX,CX,DX DESTROYED                                  :
                ;--------------------------------------------------------------------
                MOTOR_ON        PROC    NEAR
                        PUSH    BX                      ; SAVE REG.
                        CALL    TURN_ON                 ; TURN ON MOTOR
                        JC      MOT_TS_ON               ; IF CY=1 NO WAIT
                        CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
                        MOV     AX,090FDH               ; LOAD WAIT CODE & TYPE
                        INT     15H                     ; TELL OPERATING SYSTEM ABOUT TO DO WAIT
                        PUSHF                           ; SAVE CY FOR TEST
                        CALL    XLAT_NEW                ; TRANSLATE STATE TO PRESENT ARCH.
                        POPF                            ; RESTORE CY FOR TEST
                        JNC     M_WAIT                  ; BYPASS LOOP IF OP SYSTEM HANDLED WAIT
                        CALL    TURN_ON                 ; CHECK AGAIN IF MOTOR ON
                        JC      MOT_TS_ON               ; IF NO WAIT MEANS IT IS ON

                M_WAIT:
                        MOV     DL,10                   ; GET THE MOTOR WAIT PARAMETER
                        CALL    GET_PARM
                        MOV     AL,AH                   ; AL = MOTOR WAIT PARAMETER
                        XOR     AH,AH                   ; AX = MOTOR WAIT PARAMETER
                        CMP     AL,8                    ; SEE IF AT LEAST A SECOND IS SPECIFIED
                        JAE     GP2                     ; IF YES, CONTINUE
                        MOV     AL,8                    ; ONE SECOND WAIT FOR MOTOR START UP

                ;-----  AX CONTAINS NUMBER OF 1/8 SECONDS (125000 MICROSECONDS) TO WAIT

                GP2:    PUSH    AX                      ; SAVE WAIT PARAMETER
                        MOV     DX,62500                ; LOAD LARGEST POSSIBLE MULTIPLIER
                        MUL     DX                      ; MULTIPLY BY HALF OF WHAT'S NECESSARY
                        MOV     CX,DX                   ; CX = HIGH WORD
                        MOV     DX,AX                   ; CX,DX = 1/2 * (# OF MICROSECONDS)
                        CLC                             ; CLEAR CARRY FOR ROTATE
                        RCL     DX,1                    ; DOUBLE LOW WORD, CY CONTAINS OVERFLOW
                        RCL     CX,1                    ; DOUBLE HI, INCLUDING LOW WORD OVERFLOW
                        MOV     AH,86H                  ; LOAD WAIT CODE
                        INT     15H                     ; PERFORM WAIT
                        POP     AX                      ; RESTORE WAIT PARAMETER
                        JNC     MOT_IS_ON               ; CY MEANS WAIT COULD NOT BE DONE

                ;-----  FOLLOWING LOOPS REQUIRED WHEN RTC WAIT FUNCTION IS ALREADY IN USE

                J13:                                    ;       WAIT FOR 1/8 SECOND PER (AL)
                        MOV     CX,8286                 ; COUNT FOR 1/8 SECOND AT 15.085737 US
                        CALL    WAITF                   ; GO TO FIXED WAIT ROUTINE
                        DEC     AL                      ; DECREMENT TIME VALUE
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                        JNZ     J13                     ; ARE WE DONE YET
                MOT_IS_ON:
                        POP     BX                      ; RESTORE REG.
                        RET
                MOTOR_ON        ENDP
                ;--------------------------------------------------------------
                ; TURN_ON                                                     :
                ;       TURN MOTOR ON AND RETURN WAIT STATE.                  :
                ;                                                             :
                ; ON ENTRY:     DI = DRIVE #                                  :
                ;                                                             :
                ; ON EXIT:      CY = 0 MEANS WAIT REQUIRED                    :
                ;               CY = 1 MEANS NO WAIT REQUIRED                 :
                ;               AX,BX,CX,DX DESTROYED                         :
                ;--------------------------------------------------------------
                TURN_ON PROC    NEAR
                        MOV     BX,DI                   ; BX = DRIVE #
                        MOV     CL,BL                   ; CL = DRIVE #
                        ROL     BL,1                    ; BL = DRIVE SELECT
                        ROL     BL,1
                        ROL     BL,1
                        ROL     BL,1
                        CLI                             ; NO INTERRUPTS WHILE DETERMINING STATUS
                        MOV     @MOTOR_COUNT,0FFH       ; ENSURE MOTOR STAYS ON FOR OPERATION
                        MOV     AL,@MOTOR_STATUS        ; GET DIGITAL OUTPUT REGISTER REFLECTION
                        AND     AL,00110000B            ; KEEP ONLY DRIVE SELECT BITS
                        MOV     AH,1                    ; MASK FOR DETERMINING MOTOR BIT
                        SHL     AH,CL                   ; AH = MOTOR ON, A=00000001, B=00000010

                ;  AL = DRIVE SELECT FROM @MOTOR_STATUS
                ;  BL = DRIVE SELECT DESIRED
                ;  AH = MOTOR ON MASK DESIRED

                        CMP     AL,BL                   ; REQUESTED DRIVE ALREADY SELECTED ?
                        JNZ     TURN_IT_ON              ; IF NOT SELECTED JUMP
                        TEST    AH,@MOTOR_STATUS        ; TEST MOTOR ON BIT
                        JNZ     NO_MOT_WAIT             ; JUMP IF MOTOR ON AND SELECTED

                TURN_IT_ON:
                        OR      AH,BL                   ; AH = DRIVE SELECT AND MOTOR ON
                        MOV     BH,@MOTOR_STATUS        ; SAVE COPY OF @MOTOR_STATUS BEFORE
                        AND     BH,00001111B            ; KEEP ONLY MOTOR BITS
                        AND     @MOTOR_STATUS,11000000B ; CLEAR OUT DRIVE SELECT AND MOTORS
                        OR      @MOTOR_STATUS,AH        ; OR IN DRIVE SELECTED
                        MOV     AL,@MOTOR_STATUS        ; GET DIGITAL OUTPUT REGISTER REFLECTION
                        MOV     BL,AL                   ; BL=@MOTOR_STATUS AFTER, BH=BEFORE
                        AND     BL,00001111B            ; KEEP ONLY MOTOR BITS
                        STI                             ; ENABLE INTERRUPTS AGAIN
                        AND     AL,00111111B            ; STRIP AWAY UNWANTED BITS
                        ROL     AL,1                    ; PUT BITS IN DESIRED POSITIONS
                        ROL     AL,1
                        ROL     AL,1
                        ROL     AL,1
                        OR      AL,00001100B            ; NO RESET, ENABLE DMA/INTERRUPT
                        MOV     DX,03F2H                ; SELECT DRIVE AND TURN ON MOTOR
                        OUT     DX,AL                   ; "
                        CMP     BL,BH                   ; NEW MOTOR TURNED ON ?
                        JZ      NO_MOT_WAIT             ; NO WAIT REQUIRED IF JUST SELECT
                        CLC                             ; SET CARRY MEANING WAIT
                        RET

                NO_MOT_WAIT:
                        STC                             ; SET NO WAIT REQUIRED
                        STI                             ; INTERRUPTS BACK ON
                        RET
                TURN_ON ENDP
                ;--------------------------------------------------------------
                ; HD_WAIT                                                     :
                ;       WAIT FOR HEAD SETTLE TIME.                            :
                ;                                                             :
                ; ON ENTRY:     DI : DRIVE #                                  :
                ;                                                             :
                ; ON EXIT:      AX,BX,CX,DX DESTROYED                         :
                ;--------------------------------------------------------------
                HD_WAIT         PROC    NEAR
                        MOV     DL,9                    ; POINT TO HEAD SETTLE PARAMETER
                        CALL    GET_PARM                ; GET PARAMETER
                        TEST    @MOTOR_STATUS,10000000B ; SEE IF A WRITE OPERATION
                        JZ      ISNT_WRITE              ; IF NOT, DO NOT ENFORCE ANY VALUES
                        CMP     AH,15                   ; IS WAIT IS MILLISECONDS OR GREATER?
                        JAE     DO_WAT                  ; IF THERE DO NOT ENFORCE
                        MOV     AH,15                   ; HEAD SETTLE MINIMUM
                        JMP     SHORT DO_WAT            ; DO WAIT OPERATION
                ISNT_WRITE:
                        OR      AH,AH                   ; CHECK FOR WAIT TO BE ZERO
                        JZ      HW_DONE                 ; IF NOT WRITE AND 0 THEN EXIT

                ;-----  AH CONTAINS NUMBER OF MILLISECONDS TO WAIT

                DO_WAT:
                        MOV     AL,AH                   ; AL = # MILLISECONDS
                        XOR     AH,AH                   ; AX = # MILLISECONDS
                        PUSH    AX                      ; SAVE HEAD SETTLE PARAMETER
                        MOV     DX,1000                 ; SET UP FOR MULTIPLY TO MICROSECONDS
                        MUL     DX                      ; DX,AX = # MICROSECONDS
                        MOV     CX,DX                   ; CX,AX = # MICROSECONDS
                        MOV     DX,AX                   ; CX,DX = # MICROSECONDS
                        MOV     AH,86H                  ; LOAD WAIT CODE
                        INT     15H                     ; PERFORM WAIT
                        POP     AX                      ; RESTORE HEAD SETTLE PARAMETER
                        JNC     HW_DONE                 ; CHECK FOR EVENT WAIT ACTIVE

                J29:                                    ;       1 MILLISECOND LOOP
                        MOV     CX,66                   ; COUNT AT 15.085737 US PER COUNT
                        CALL    WAITF                   ; DELAY FOR 1 MILLISECOND
                        DEC     AL                      ; DECREMENT THE COUNT
                        JNZ     J29                     ; DO AL MILLISECOND # OF TIMES
                HW_DONE:
                        RET
                HD_WAIT         ENDP
                ;--------------------------------------------------------------
                ; NEC_OUTPUT                                                  :
                ;       THIS ROUTINE SENDS A BYTE TO THE NEC CONTROLLER AFTER  :
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                        ;       TESTING FOR CORRECT DIRECTION AND CONTROLLER READY THIS :
                        ;       ROUTINE WILL TIME OUT IF THE BYTE IS NOT ACCEPTED WITHIN:
                        ;       A REASONABLE AMOUNT OF TIME, SETTING THE DISKETTE STATUS:
                        ;       ON COMPLETION.                                          :
                        ;                                                               :
                        ; ON ENTRY:                                                     :
                        ;       AH = BYTE TO BE OUTPUT                                  :
                        ; ON EXIT:                                                      :
                        ;       CY = 0  SUCCESS                                         :
                        ;       CY = 1  FAILURE -- DISKETTE STATUS UPDATED              :
                        ;               IF A FAILURE HAS OCCURRED, THE RETURN IS MADE   :
                        ;               ONE LEVEL HIGHER THAN THE CALLER OF NEC_OUTPUT. :
                        ;               THIS REMOVES THE REQUIREMENT OF TESTING AFTER   :
                        ;               EVERY CALL OF NEC_OUTPUT.                       :
                        ;       AX,CX,DX DESTROYED                                      :
                        ;-------------------------------------------------------------------
0A30 09F0               NEC_OUTPUT      PROC    NEAR
0A31 09F0 53                    PUSH    BX                      ; SAVE REG.
0A32 09F1 BA 03F4               MOV     DX,03F4H                ; STATUS PORT
0A35 09F4 B3 02                 MOV     BL,2                    ; HIGH ORDER COUNTER
0A37 09F6 33 C9                 XOR     CX,CX                   ; COUNT FOR TIME OUT
0A39
0A39 09F8 EC            J23:    IN      AL,DX                   ; GET STATUS
0A3A 09F9 24 C0                 AND     AL,11000000B            ; KEEP STATUS AND DIRECTION
0A3C 09FB 3C 80                 CMP     AL,10000000B            ; STATUS 1 AND DIRECTION 0 ?
0A3E 09FD 74 0F                 JZ      J27                     ; STATUS AND DIRECTION OK
0A40 09FF E2 F7                 LOOP    J23                     ; CONTINUE TILL CX EXHAUSTED
0A42
0A42 0A01 FE CB                 DEC     BL                      ; DECREMENT COUNTER
0A44 0A03 75 F3                 JNZ     J23                     ; REPEAT TILL DELAY FINISHED, CX = 0
0A46
0A46                    ;-----  FALL THRU TO ERROR RETURN
0A46
0A47 0A05 80 0E 0041 R 80       OR      @DSKETTE_STATUS,TIME_OUT
0A4D
0A4D 0A0A 5B                    POP     BX                      ; RESTORE REG.
0A4E
0A4E 0A0B 58                    POP     AX                      ; DISCARD THE RETURN ADDRESS
0A4F 0A0C F9                    STC                             ; INDICATE ERROR TO CALLER
0A50 0A0D C3                    RET
0A51
0A51                    ;-----  DIRECTION AND STATUS OK; OUTPUT BYTE
0A51
0A51 0A0E 8A C4         J27:    MOV     AL,AH                   ; GET BYTE TO OUTPUT
0A53 0A10 42                    INC     DX                      ; DATA PORT = STATUS PORT + 1
0A54 0A11 EE                    OUT     DX,AL                   ; OUTPUT THE BYTE
0A55
0A55 0A12 5B                    POP     BX                      ; RESTORE REG.
0A56 0A13 C3                    RET                             ; CY = 0 FROM TEST INSTRUCTION
0A57 0A14               NEC_OUTPUT      ENDP
                        ;-------------------------------------------------------------------
                        ; SEEK                                                          :
                        ;       THIS ROUTINE WILL MOVE THE HEAD ON THE NAMED DRIVE      :
                        ;       TO THE NAMED TRACK.  IF THE DRIVE HAS NOT BEEN ACCESSED :
                        ;       SINCE THE DRIVE RESET COMMAND WAS ISSUED, THE DRIVE     :
                        ;       WILL BE RECALIBRATED.                                   :
                        ;                                                               :
                        ; ON ENTRY:    DI = DRIVE #                                     :
                        ;               CH = TRACK #                                    :
                        ;                                                               :
                        ; ON EXIT:     @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION.:
                        ;               AX,BX,CX,DX DESTROYED                           :
                        ;-------------------------------------------------------------------
0A57 0A14               SEEK    PROC    NEAR
0A57 0A14 8B DF                 MOV     BX,DI                   ; BX = DRIVE #
0A59 0A16 BA 0A7B R             MOV     DX,OFFSET NEC_ERR       ; LOAD RETURN ADDRESS
0A5C 0A19 52                    PUSH    DX                      ; ON STACK FOR NEC_OUTPUT ERROR
0A5D 0A1A B0 01                 MOV     AL,1                    ; ESTABLISH MASK FOR RECALIBRATE TEST
0A5F 0A1C 86 CB                 XCHG    CL,BL                   ; GET DRIVE VALUE INTO CL
0A61 0A1E D2 C0                 ROL     AL,CL                   ; SHIFT MASK BY THE DRIVE VALUE
0A63 0A20 86 CB                 XCHG    CL,BL                   ; RECOVER TRACK VALUE
0A65 0A22 84 06 003E R          TEST    AL,@SEEK_STATUS         ; TEST FOR RECALIBRATE REQUIRED
0A69 0A26 75 21                 JNZ     J28A                    ; JUMP IF RECALIBRATE NOT REQUIRED
0A6B
0A6B 0A28 08 06 003E R          OR      @SEEK_STATUS,AL         ; TURN ON THE NO RECALIBRATE BIT IN FLAG
0A6F 0A2C E8 0A7C R             CALL    RECAL                   ; RECALIBRATE DRIVE
0A72 0A2F 73 0A                 JNC     AFT_RECAL               ; RECALIBRATE DONE
0A74
0A74                    ;-----  ISSUE RECALIBRATE FOR 80 TRACK DISKETTES
0A74
0A74 0A31 C6 06 0041 R 00       MOV     @DSKETTE_STATUS,0       ; CLEAR OUT INVALID STATUS
0A79 0A36 E8 0A7C R             CALL    RECAL                   ; RECALIBRATE DRIVE
0A7C 0A39 72 3F                 JC      RB                      ; IF RECALIBRATE FAILS TWICE THEN ERROR
0A7E                    ;
0A7E 0A3B               AFT_RECAL:
0A7E 0A3B 83 FF 01              CMP     DI,1                    ; IF REQUEST FOR DRIVE > 2
0A81 0A3E 77 21                 JA      R8                      ; DO SEEK EVERY TIME
0A83 0A40 C6 85 0094 R 00       MOV     @DSK_TRK[DI],0          ; SAVE NEW CYLINDER AS PRESENT POSITION
0A88 0A45 0A ED                 OR      CH,CH                   ; CHECK FOR SEEK TO TRACK 0
0A8A 0A47 74 2C                 JZ      DO_WAIT                 ; HEAD SETTLE, CY = 0 IF JUMP
0A8C
0A8C                    ;-----  DRIVE IS IN SYNCHRONIZATION WITH CONTROLLER, SEEK TO TRACK
0A8C
0A8C 0A49               J28A:
0A8C 0A49 83 FF 01              CMP     DI,1                    ; IF REQUEST FOR DRIVE > 2
0A8F 0A4C 77 13                 JA      R8                      ; DO SEEK EVERY TIME
0A91 0A4E F6 85 0090 R 20       TEST    @DSK_STATE[DI],DBL_STEP ; CHECK FOR DOUBLE STEP REQUIRED
0A96 0A53 74 02                 JZ      R7                      ; SINGLE STEP REQUIRED BYPASS DOUBLE
0A98 0A55 D0 E5                 SHL     CH,1                    ; DOUBLE NUMBER OF STEP TO TAKE
0A9A
0A9A 0A57 3A AD 0094 R  R7:     CMP     CH,@DSK_TRK[DI]         ; SEE IF ALREADY AT THE DESIRED TRACK
0A9E 0A5B 74 1D                 JE      RB                      ; IF YES, DO NOT NEED TO SEEK
0AA0
0AA0 0A5D 88 AD 0094 R          MOV     @DSK_TRK[DI],CH         ; SAVE NEW CYLINDER AS PRESENT POSITION
0AA4 0A61               R8:
0AA4 0A61 51                    PUSH    CX                      ; SAVE CYLINDER #
0AA5 0A62 B4 0F                 MOV     AH,0FH                  ; SEEK COMMAND TO NEC
0AA7 0A64 E8 09F0 R             CALL    NEC_OUTPUT
0AAA 0A67 8B DF                 MOV     BX,DI                   ; BX = DRIVE #
0AAC 0A69 8A E3                 MOV     AH,BL                   ; OUTPUT DRIVE NUMBER
0AAE 0A6B E8 09F0 R             CALL    NEC_OUTPUT
0AB1 0A6E 58                    POP     AX                      ; RESTORE CYLINDER # FOR NEC_OUTPUT
0AB2 0A6F E8 09F0 R             CALL    NEC_OUTPUT
0AB5 0A72 E8 0A93 R             CALL    CHK_STAT_2              ; ENDING INTERRUPT AND SENSE STATUS
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                        ;-----  WAIT FOR HEAD SETTLE

                        DO_WAIT:
                                PUSHF                   ; SAVE STATUS
                                CALL    HD_WAIT         ; WAIT FOR HEAD SETTLE TIME
                                POPF                    ; RESTORE STATUS
                        RB:
                                POP     AX              ; CLEAR ERROR RETURN FROM NEC_OUTPUT
                        NEC_ERR:
                                RET                     ; RETURN TO CALLER
                        SEEK    ENDP
                        ;--------------------------------------------------------------
                        ; RECAL                                                       :
                        ;       RECALIBRATE DRIVE                                    :
                        ;                                                            :
                        ; ON ENTRY      DI = DRIVE #                                  :
                        ;                                                            :
                        ; ON EXIT:      CY  REFLECTS STATUS OF OPERATION.             :
                        ;--------------------------------------------------------------
                        RECAL   PROC    NEAR
                                PUSH    CX
                                MOV     AX,OFFSET RC_BACK       ; LOAD NEC_OUTPUT ERROR
                                PUSH    AX
                                MOV     AH,07H                  ; RECALIBRATE COMMAND
                                CALL    NEC_OUTPUT
                                MOV     BX,DI                   ; BX = DRIVE #
                                MOV     AH,BL
                                CALL    NEC_OUTPUT              ; OUTPUT THE DRIVE NUMBER
                                CALL    CHK_STAT_2              ; GET THE INTERRUPT AND SENSE INT STATUS
                                POP     AX                      ; THROW AWAY ERROR
                        RC_BACK:
                                POP     CX
                                RET
                        RECAL   ENDP
                        ;--------------------------------------------------------------
                        ; CHK_STAT_2                                                  :
                        ;       THIS ROUTINE HANDLES THE INTERRUPT RECEIVED AFTER     :
                        ;       RECALIBRATE, SEEK, OR RESET TO THE ADAPTER. THE      :
                        ;       INTERRUPT IS WAITED FOR, THE INTERRUPT STATUS SENSED,:
                        ;       AND THE RESULT RETURNED TO THE CALLER.               :
                        ;                                                            :
                        ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION.:
                        ;--------------------------------------------------------------
                        CHK_STAT_2      PROC    NEAR
                                MOV     AX,OFFSET CS_BACK       ; LOAD NEC_OUTPUT ERROR ADDRESS
                                PUSH    AX
                                CALL    WAIT_INT                ; WAIT FOR THE INTERRUPT
                                JC      J34                     ; IF ERROR, RETURN IT
                                MOV     AH,08H                  ; SENSE INTERRUPT STATUS COMMAND
                                CALL    NEC_OUTPUT
                                CALL    RESULTS                 ; READ IN THE RESULTS
                                JC      J34
                                MOV     AL,@NEC_STATUS          ; GET THE FIRST STATUS BYTE
                                AND     AL,01100000B            ; ISOLATE THE BITS
                                CMP     AL,01100000B            ; TEST FOR CORRECT VALUE
                                JZ      J35                     ; IF ERROR, GO MARK IT
                                CLC                             ; GOOD RETURN
                        J34:
                                POP     AX                      ; THROW AWAY ERROR RETURN
                        CS_BACK:
                                RET

                        J35:
                                OR      @DSKETTE_STATUS,BAD_SEEK
                                STC                             ; ERROR RETURN CODE
                                JMP     SHORT J34
                        CHK_STAT_2      ENDP
                        ;--------------------------------------------------------------
                        ; WAIT_INT                                                    :
                        ;       THIS ROUTINE WAITS FOR AN INTERRUPT TO OCCUR A TIME OUT :
                        ;       ROUTINE TAKES PLACE DURING THE WAIT, SO THAT AN ERROR  :
                        ;       MAY BE RETURNED IF THE DRIVE IS NOT READY.           :
                        ;                                                            :
                        ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION.:
                        ;--------------------------------------------------------------
                        WAIT_INT        PROC    NEAR
                                STI                             ; TURN ON INTERRUPTS, JUST IN CASE
                                CLC                             ; CLEAR TIMEOUT INDICATOR
                                MOV     AX,09001H               ; LOAD WAIT CODE AND TYPE
                                INT     15H                     ; PERFORM OTHER FUNCTION
                                JC      J36A                    ; BYPASS TIMING LOOP IF TIMEOUT DONE

                                MOV     BL,4                    ; CLEAR THE COUNTERS
                                XOR     CX,CX                   ; FOR 2 SECOND WAIT
                        J36:
                                TEST    @SEEK_STATUS,INT_FLAG   ; TEST FOR INTERRUPT OCCURRING
                                JNZ     J37
                                LOOP    J36                     ; COUNT DOWN WHILE WAITING
                                DEC     BL                      ; SECOND LEVEL COUNTER
                                JNZ     J36

                        J36A:   OR      @DSKETTE_STATUS,TIME_OUT        ; NOTHING HAPPENED
                                STC                             ; ERROR RETURN
                        J37:
                                PUSHF                           ; SAVE CURRENT CARRY
                                AND     @SEEK_STATUS,NOT INT_FLAG       ; TURN OFF INTERRUPT FLAG
                                POPF                            ; RECOVER CARRY
                                RET                             ; GOOD RETURN CODE
                        WAIT_INT        ENDP
                        ;--------------------------------------------------------------
                        ; RESULTS                                                     :
                        ;       THIS ROUTINE WILL READ ANYTHING THAT THE NEC CONTROLLER :
                        ;       RETURNS FOLLOWING AN INTERRUPT.                      :
                        ;                                                            :
                        ; ON EXIT:      @DSKETTE_STATUS, CY REFLECT STATUS OF OPERATION.:
                        ;               AX,BX,CX,DX DESTROYED                        :
                        ;--------------------------------------------------------------
                        RESULTS PROC    NEAR
                                PUSH    DI
                                MOV     DI,OFFSET @NEC_STATUS   ; POINTER TO DATA AREA
                                MOV     BL,7                    ; MAX STATUS BYTES
                                MOV     DX,03F4H                ; STATUS PORT
```

```
                        ;-----  WAIT FOR REQUEST FOR MASTER

0AEB B7 02              R10:    MOV     BH,2                    ; HIGH ORDER COUNTER
0AED 33 C9                      XOR     CX,CX                   ; COUNTER
0AEF                    J39:                                    ; WAIT FOR MASTER
0AEF EC                         IN      AL,DX                   ; GET STATUS
0AF0 24 C0                      AND     AL,11000000B            ; KEEP ONLY STATUS AND DIRECTION
0AF2 3C C0                      CMP     AL,11000000B            ; STATUS 1 AND DIRECTION 0 ?
0AF4 74 0E                      JZ      J42                     ; STATUS AND DIRECTION OK
0AF6 E2 F7                      LOOP    J39                     ; LOOP TILL TIMEOUT

0AF8 FE CF                      DEC     BH                      ; DECREMENT HIGH ORDER COUNTER
0AFA 75 F3                      JNZ     J39                     ; REPEAT TILL DELAY DONE

0AFC 80 0E 0041 R 80            OR      @DSKETTE_STATUS,TIME_OUT
0B01 F9                         STC                             ; SET ERROR RETURN
0B02 EB 1B                      JMP     SHORT POPRES            ; POP REGISTERS AND RETURN

                        ;-----  READ IN THE STATUS

0B04                    J42:
0B04 42                         INC     DX                      ; POINT AT DATA PORT
0B05 EC                         IN      AL,DX                   ; GET THE DATA
0B06 88 05                      MOV     [DI],AL                 ; STORE THE BYTE
0B08 47                         INC     DI                      ; INCREMENT THE POINTER

0B09 B9 0002                    MOV     CX,2                    ; MINIMUM 12 MICROSECONDS FOR NEC
0B0C E8 0000 E                  CALL    WAITF                   ; WAIT 15 TO 30 MICROSECONDS
0B0F 4A                         DEC     DX                      ; POINT AT STATUS PORT
0B10 EC                         IN      AL,DX                   ; GET STATUS
0B11 A8 10                      TEST    AL,00010000B            ; TEST FOR NEC STILL BUSY
0B13 74 0A                      JZ      POPRES                  ; RESULTS DONE ?

0B15 FE CB                      DEC     BL                      ; DECREMENT THE STATUS COUNTER
0B17 75 D2                      JNZ     R10                     ; GO BACK FOR MORE
0B19 80 0E 0041 R 20            OR      @DSKETTE_STATUS,BAD_NEC ; TOO MANY STATUS BYTES
0B1E F9                         STC                             ; SET ERROR FLAG

                        ;-----  RESULT OPERATION IS DONE

0B1F                    POPRES:
0B1F 5F                         POP     DI
0B20 C3                         RET                             ; RETURN WITH CARRY SET
0B21                    RESULTS ENDP
                        ;--------------------------------------------------------------
                        ; READ_DSKCHNG                                                :
                        ;       READS THE STATE OF THE DISK CHANGE LINE.              :
                        ;                                                             :
                        ; ON ENTRY:     DI = DRIVE #                                  :
                        ;                                                             :
                        ; ON EXIT:      DI = DRIVE #                                  :
                        ;               ZF = 0 : DISK CHANGE LINE INACTIVE            :
                        ;               ZF = 1 : DISK CHANGE LINE ACTIVE              :
                        ;               AX,CX,DX DESTROYED                            :
                        ;--------------------------------------------------------------
0B21                    READ_DSKCHNG    PROC    NEAR
0B21 E8 0913 R                  CALL    MOTOR_ON                ; TURN ON THE MOTOR IF OFF
0B24 BA 03F7                    MOV     DX,03F7H                ; ADDRESS DIGITAL INPUT REGISTER
0B27 EC                         IN      AL,DX                   ; INPUT DIGITAL INPUT REGISTER
0B28 A8 80                      TEST    AL,DSK_CHG              ; CHECK FOR DISK CHANGE LINE ACTIVE
0B2A C3                         RET                             ; RETURN TO CALLER WITH ZERO FLAG SET
0B2B                    READ_DSKCHNG    ENDP
                        ;--------------------------------------------------------------
                        ; DRIVE_DET                                                   :
                        ;       DETERMINES WHETHER DRIVE IS 80 OR 40 TRACKS AND       :
                        ;       UPDATES STATE INFORMATION ACCORDINGLY.                :
                        ;                                                             :
                        ; ON ENTRY:     DI = DRIVE #                                  :
                        ;--------------------------------------------------------------
0B2B                    DRIVE_DET       PROC    NEAR
0B2B E8 0913 R                  CALL    MOTOR_ON                ; TURN ON MOTOR IF NOT ALREADY ON
0B2E E8 0A7C R                  CALL    RECAL                   ; RECALIBRATE DRIVE
0B31 72 3E                      JC      DD_BAC                  ; ASSUME NO DRIVE PRESENT
0B33 B6 30                      MOV     CH,TRK_SLAP             ; SEEK TO TRACK 48
0B35 E8 0A14 R                  CALL    SEEK                    ; "
0B38 72 37                      JC      DD_BAC                  ; ERROR NO DRIVE
0B3A B5 0B                      MOV     CH,QUIET_SEEK+1         ; SEEK TO TRACK 10
0B3C                    SK_GIN:
0B3C FE CD                      DEC     CH                      ; DECREMENT TO NEXT TRACK
0B3E 78 26                      JS      IS_40                   ; END LOOP IF CYLINDER COUNT NEGATIVE
0B40 51                         PUSH    CX                      ; SAVE TRACK
0B41 E8 0A14 R                  CALL    SEEK                    ; "
0B44 72 2C                      JC      POP_BAC                 ; POP AND RETURN
0B46 B8 0B71 R                  MOV     AX,OFFSET DD_BAC        ; LOAD NEC OUTPUT ERROR ADDRESS
0B49 50                         PUSH    AX                      ; "
0B4A B4 04                      MOV     AH,SENSE_DRV_ST         ; SENSE DRIVE STATUS COMMAND BYTE
0B4C E8 09F0 R                  CALL    NEC_OUTPUT              ; OUTPUT TO NEC
0B4F 8B C7                      MOV     AX,DI                   ; AL = DRIVE
0B51 8A E0                      MOV     AH,AL                   ; AH = DRIVE
0B53 E8 09F0 R                  CALL    NEC_OUTPUT              ; OUTPUT TO NEC
0B56 E8 0AE2 R                  CALL    RESULTS                 ; GO GET STATUS
0B59 58                         POP     AX                      ; THROW AWAY ERROR ADDRESS
0B5A 59                         POP     CX                      ; RESTORE TRACK
0B5B F6 06 0042 R 10            TEST    @NEC_STATUS,HOME        ; TRACK 0 ?
0B60 74 DA                      JZ      SK_GIN                  ; GO TILL TRACK 0
0B62 0A ED                      OR      CH,CH                   ; IS HOME AT TRACK 0 ?
0B64 74 06                      JZ      IS_80                   ; MUST BE 80 TRACK DRIVE

                        ;       DRIVE IS A 360; SET DRIVE TO DETERMINED;
                        ;       SET MEDIA TO DETERMINED AT RATE 250.
0B66                    IS_40:
0B66 80 8D 0090 R 94            OR      @DSK_STATE[DI],DRV_DET+MED_DET+RATE_250
0B6B C3                         RET                             ; ALL INFORMATION SET

0B6C                    IS_80:
0B6C 80 8D 0090 R 01            OR      @DSK_STATE[DI],TRK_CAPA ; SETUP 80 TRACK CAPABILITY
0B71                    DD_BAC:
0B71 C3                         RET

0B72                    POP_BAC:
0B72 59                         POP     CX                      ; THROW AWAY
0B73 C3                         RET

0B74                    DRIVE_DET       ENDP
```

```
                        ;--------------------------------------------------------
                        ; DISK_INT                                              :
                        ;       THIS ROUTINE HANDLES THE DISKETTE INTERRUPT.    :
                        ;                                                       :
                        ; ON EXIT:      THE INTERRUPT FLAG IS SET IN @SEEK_STATUS.      :
                        ;--------------------------------------------------------
0B74                    DISK_INT_1      PROC    FAR             ; ENTRY POINT FOR ORG 0EF57H
0B74 FB                         STI                             ; RE-ENABLE INTERRUPTS
0B75 50                         PUSH    AX                      ; SAVE WORK REGISTER
0B76 1E                         PUSH    DS                      ; SAVE REGISTERS
0B77 E8 0000 E                  CALL    DDS                     ; SETUP DATA ADDRESSING
0B7A 80 0E 003E R 80            OR      @SEEK_STATUS,INT_FLAG   ; TURN ON INTERRUPT OCCURRED
0B7F 1F                         POP     DS                      ; RESTORE USER (DS)
0B80 B0 20                      MOV     AL,EOI                  ; END OF INTERRUPT MARKER
0B82 E6 20                      OUT     INTA00,AL               ; INTERRUPT CONTROL PORT
0B84 B8 9101                    MOV     AX,09101H               ; INTERRUPT POST CODE AND TYPE
0B87 CD 15                      INT     15H                     ; GO PERFORM OTHER TASK
0B89 58                         POP     AX                      ; RECOVER REGISTER
0B8A CF                         IRET                            ; RETURN FROM INTERRUPT
0B8B                    DISK_INT_1      ENDP
                        ;--------------------------------------------------------
                        ; DSKETTE_SETUP                                         :
                        ;       THIS ROUTINE DOES A PRELIMINARY CHECK TO SEE WHAT TYPE  :
                        ;       OF DISKETTE DRIVES ARE ATTACHED TO THE SYSTEM.  :
                        ;--------------------------------------------------------
0B8B                    DSKETTE_SETUP PROC      NEAR
0B8B 50                         PUSH    AX                      ; SAVE REGISTERS
0B8C 53                         PUSH    BX
0B8D 51                         PUSH    CX
0B8E 52                         PUSH    DX
0B8F 57                         PUSH    DI
0B90 56                         PUSH    SI
0B91 1E                         PUSH    DS
0B92 E8 0000 E                  CALL    DDS                     ; POINT DATA SEGMENT TO BIOS DATA AREA
0B95 80 0E 00A0 R 01            OR      @RTC_WAIT_FLAG,01       ; NO RTC WAIT, FORCE USE OF LOOP
0B9A C7 06 0090 R 0000          MOV     WORD PTR @DSK_STATE,0   ; INITIALIZE STATES
0BA0 80 26 008B R 33            AND     @LASTRATE,NOT STRT_MSK+SEND_MSK  ; CLEAR START & SEND
0BA5 80 0E 008B R C0            OR      @LASTRATE,SEND_MSK      ; INITIALIZE SENT TO IMPOSSIBLE
0BAA C6 06 003E R 00            MOV     @SEEK_STATUS,0          ; INDICATE RECALIBRATE NEEDED
0BAF C6 06 0040 R 00            MOV     @MOTOR_COUNT,0          ; INITIALIZE MOTOR COUNT
0BB4 C6 06 003F R 00            MOV     @MOTOR_STATUS,0         ; INITIALIZE DRIVES TO OFF STATE
0BB9 C6 06 0041 R 00            MOV     @DSKETTE_STATUS,0       ; NO ERRORS
0BBE A0 0010 R                  MOV     AL,BYTE PTR @EQUIP_FLAG ; GET EQUIPMENT STATUS
0BC1 D0 C0                      ROL     AL,1                    ; SHIFT BITS 7,6 TO 1,0
0BC3 D0 C0                      ROL     AL,1
0BC5 24 03                      AND     AL,3                    ; MASK DRIVE BITS
0BC7 32 E4                      XOR     AH,AH                   ; AX=NUMBER OF DRIVES(RELATIVE ZERO)
0BC9 33 FF                      XOR     DI,DI                   ; DI=INITIAL DRIVE TO BE ESTABLISHED
0BCB BE 0010                    MOV     SI,HOME                 ; SI=HOME MASK FOR ALL DRIVES
0BCE                    SUP0:
0BCE F6 06 008F R 01            TEST    @HF_CNTRL,DUAL          ; TEST CONTROLLER TYPE
0BD3 75 05                      JNZ     SUP1
0BD5 C6 85 0090 R 94            MOV     @DSK_STATE[DI],DRV_DET+MED_DET+RATE_250
0BDA                    SUP1:
0BDA 50                         PUSH    AX                      ; SAVE DRIVE COUNT
0BDB E8 0B2B R                  CALL    DRIVE_DET               ; DETERMINE DRIVE
0BDE E8 0432 R                  CALL    XLAT_OLD                ; TRANSLATE STATE TO COMPATIBLE MODE
0BE1 23 36 0042 R               AND     SI,WORD PTR @NEC_STATUS ; AND @NEC_STATUS WITH HOME MASK
0BE5 58                         POP     AX                      ; RESTORE DRIVE COUNT
0BE6 47                         INC     DI                      ; POINT TO NEXT DRIVE
0BE7 3B F8                      CMP     DI,AX
0BE9 76 E3                      JNA     SUP0                    ; REPEAT FOR EACH DRIVE
0BEB                    SUP2:
0BEB C6 06 003E R 00            MOV     @SEEK_STATUS,0          ; FORCE RECALIBRATE
0BF0 80 26 00A0 R FE            AND     @RTC_WAIT_FLAG,0FEH     ; ALLOW FOR RTC WAIT
0BF5 E8 0832 R                  CALL    SETUP_END               ; VARIOUS CLEANUPS
0BF8 72 05                      JC      HOME_OK                 ; EXIT WITH CY FLAG FROM SETUP_END
0BFA 0B F6                      OR      SI,SI                   ; TEST HOME INDICATORS FOR ALL DRIVES
0BFC 75 01                      JNZ     HOME_OK
0BFE F9                         STC                             ; ERROR-->HOME INDICATOR BAD
0BFF                    HOME_OK:
0BFF 1F                         POP     DS                      ; RESTORE CALLERS RESISTERS
0C00 5E                         POP     SI
0C01 5F                         POP     DI
0C02 5A                         POP     DX
0C03 59                         POP     CX
0C04 5B                         POP     BX
0C05 58                         POP     AX
0C06 C3                         RET
0C07                    DSKETTE_SETUP ENDP
0C07                    CODE    ENDS
                                END
```

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                        PAGE 118,121
                        TITLE KEYBRD --- 01/10/86  KEYBOARD ADAPTER BIOS
                        ;---- INT 16 ------------------------------------------------------------------
                        ; KEYBOARD I/O                                                               :
                        ;       THESE ROUTINES PROVIDE KEYBOARD SUPPORT                              :
                        ; INPUT                                                                      :
                        ;       (AH)=0  READ THE NEXT ASCII CHARACTER STRUCK FROM THE KEYBOARD       :
                        ;               RETURN THE RESULT IN (AL), SCAN CODE IN (AH)                 :
                        ;       (AH)=1  SET THE Z FLAG TO INDICATE IF AN ASCII CHARACTER IS          :
                        ;               AVAILABLE TO BE READ.                                        :
                        ;                       (ZF)=1 -- NO CODE AVAILABLE                          :
                        ;                       (ZF)=0 -- CODE IS AVAILABLE                          :
                        ;                       IF ZF = 0, THE NEXT CHARACTER IN THE BUFFER TO BE READ :
                        ;                       IS IN AX, AND THE ENTRY REMAINS IN THE BUFFER        :
                        ;       (AH)=2  RETURN THE CURRENT SHIFT STATUS IN AL REGISTER               :
                        ;               THE BIT SETTINGS FOR THIS CODE ARE INDICATED IN THE          :
                        ;               THE EQUATES FOR @KB_FLAG                                     :
                        ;       (AH)=5  PLACE ASCII CHARACTER/SCAN CODE COMBINATION IN KEYBOARD      :
                        ;               BUFFER AS IF STRUCK FROM KEYBOARD                            :
                        ;                                                                            :
                        ;                       ENTRY:  (CL) = ASCII CHARACTER                       :
                        ;                               (CH) = SCAN CODE                             :
                        ;                                                                            :
                        ;                       EXIT:   (AL) = 00H = SUCCESSFUL OPERATION            :
                        ;                               (AL) = 01H = UNSUCCESSFUL - BUFFER FULL      :
                        ;                                                                            :
                        ;                                                                            :
                        ;      (AH)=10H EXTENDED READ INTERFACE FOR THE ENHANCED KEYBOARD            :
                        ;      (AH)=11H EXTENDED ASCII STATUS FOR THE ENHANCED KEYBOARD,             :
                        ;               OTHERWISE SAME AS FUNCTION AH=1                              :
                        ;      (AH)=12H RETURN THE EXTENDED SHIFT STATUS IN AX REGISTER              :
                        ;               AL = BITS FROM @KB_FLAG, AH = BITS FOR LEFT AND RIGHT        :
                        ;               CTL AND ALT KEYS FROM @KB_FLAG_1 AND @KB_FLAG_3              :
                        ;                                                                            :
                        ;                       EXIT:                                                :
                        ;                        ---------------                                     :
                        ;                       |7|6|5|4|3|2|1|0|     AH REGISTER                   :
                        ;                        ---------------                                     :
                        ;                        | | | | | | | |                                     :
                        ;                        | | | | | | | *----- LEFT CONTROL KEY IS DEPRESSED  :
                        ;                        | | | | | | *------- LEFT ALTERNATE SHIFT KEY IS DEPRESSED :
                        ;                        | | | | | *--------- RIGHT CONTROL KEY IS DEPRESSED :
                        ;                        | | | | *----------- RIGHT ALTERNATE SHIFT KEY IS DEPRESSED :
                        ;                        | | | *------------- SCROLL LOCK KEY IS DEPRESSED :
                        ;                        | | *--------------- NUM LOCK KEY IS DEPRESSED   :
                        ;                        | *----------------- CAPS LOCK KEY IS DEPRESSED  :
                        ;                        *------------------- SYSTEM KEY IS DEPRESSED      :
                        ;                                                                            :
                        ;                        ---------------                                     :
                        ;                       |7|6|5|4|3|2|1|0|     AL REGISTER                   :
                        ;                        ---------------                                     :
                        ;                        | | | | | | | |                                     :
                        ;                        | | | | | | | *----- RIGHT SHIFT KEY IS DEPRESSED  :
                        ;                        | | | | | | *------- LEFT SHIFT KEY IS DEPRESSED   :
                        ;                        | | | | | *--------- CONTROL SHIFT KEY IS DEPRESSED :
                        ;                        | | | | *----------- ALTERNATE SHIFT KEY IS DEPRESSED :
                        ;                        | | | *------------- SCROLL LOCK STATE HAS BEEN TOGGLED :
                        ;                        | | *--------------- NUM LOCK STATE HAS BEEN TOGGLED :
                        ;                        | *----------------- CAPS LOCK STATE HAS BEEN TOGGLED :
                        ;                        *------------------- INSERT STATE IS ACTIVE       :
                        ;                                                                            :
                        ; OUTPUT                                                                     :
                        ;       AS NOTED ABOVE, ONLY AX AND FLAGS CHANGED                            :
                        ;       ALL OTHER REGISTERS PRESERVED                                        :
                        ;--------------------------------------------------------------------------
                        
                        EXTRN   DDS:NEAR
                        EXTRN   RESET:NEAR
                        EXTRN   BEEP:NEAR
                        
                        PUBLIC  KEYBOARD_IO_1
                        PUBLIC  KB_INT_1
                        
                        .LIST
                        
0000                    CODE    SEGMENT BYTE    PUBLIC
                                ASSUME  CS:CODE,DS:DATA
0000                    KEYBOARD_IO_1   PROC    FAR     ;
0000 FB                         STI                     ; INTERRUPTS BACK ON
0001 1E                         PUSH    DS              ; SAVE CURRENT DS
0002 53                         PUSH    BX              ; SAVE BX TEMPORARILY
0003 51                         PUSH    CX
0004 E8 0000 E                  CALL    DDS             ; ESTABLISH POINTER TO DATA REGION
0007 0A E4                      OR      AH,AH           ; AH=0
0009 74 26                      JZ      K1              ; ASCII_READ
000B FE CC                      DEC     AH              ; AH=1
000D 74 37                      JZ      K2              ; ASCII_STATUS
000F FE CC                      DEC     AH              ; AH=2
0011 74 64                      JZ      K3              ; SHIFT_STATUS
0013 80 EC 03                   SUB     AH,3            ; AH=5
0016 74 64                      JZ      K500            ; KEYBOARD WRITE
0018 80 EC 0B                   SUB     AH,0BH          ; AH=10
001B 74 0C                      JZ      K1E             ; EXTENDED_ASCII_READ
001D FE CC                      DEC     AH              ; AH=11
001F 74 1A                      JZ      K2E             ; EXTENDED_ASCII_STATUS
0021 FE CC                      DEC     AH              ; AH=12
0023 74 39                      JZ      K3E             ; EXTENDED_SHIFT_STATUS
0025                    KIO_EXIT:
0025 59                         POP     CX
0026 5B                         POP     BX              ; RECOVER REGISTER
0027 1F                         POP     DS              ; RECOVER SEGMENT
0028 CF                         IRET                    ; INVALID COMMAND
                        
                        ;------ ASCII CHARACTER
                        
0029 E8 009E R          K1E:    CALL    K1S             ; GET A CHARACTER FROM THE BUFFER (EXTENDED)
002C E8 00D1 R                  CALL    KIO_E_XLAT      ; ROUTINE TO XLATE FOR EXTENDED CALLS
002F EB F4                      JMP     KIO_EXIT        ; GIVE IT TO THE CALLER
                        
0031 E8 009E R          K1:     CALL    K1S             ; GET A CHARACTER FROM THE BUFFER
0034 E8 00DC R                  CALL    KIO_S_XLAT      ; ROUTINE TO XLATE FOR STANDARD CALLS
0037 72 F8                      JC      K1              ; CARRY SET MEANS THROW CODE AWAY
0039 EB EA                      JMP     KIO_EXIT
                        
```

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                        ;------ ASCII STATUS
                        
003B E8 00C4 R          K2E:    CALL    K2S             ; TEST FOR CHARACTER IN BUFFER (EXTENDED)
003E 74 18                      JZ      K2B             ; RETURN IF BUFFER EMPTY
0040 9C                         PUSHF                   ; SAVE ZF FROM TEST
0041 E8 00D1 R                  CALL    K10_E_XLAT      ; ROUTINE TO XLATE FOR EXTENDED CALLS
0044 EB 11                      JMP     SHORT K2A       ; GIVE IT TO THE CALLER
                        
0046 E8 00C4 R          K2:     CALL    K2S             ; TEST FOR CHARACTER IN BUFFER
0049 74 0D                      JZ      K2B             ; RETURN IF BUFFER EMPTY
004B 9C                         PUSHF                   ; SAVE ZF FROM TEST
004C E8 00DC R                  CALL    K10_S_XLAT      ; ROUTINE TO XLATE FOR STANDARD CALLS
004F 73 06                      JNC     K2A             ; CARRY CLEAR MEANS PASS VALID CODE
0051 9D                         POPF                    ;  INVALID CODE FOR THIS TYPE OF CALL
0052 E8 009E R                  CALL    K1S             ;  THROW THE CHARACTER AWAY
0055 EB EF                      JMP     K2              ; GO LOOK FOR NEXT CHAR, IF ANY
                        
0057 9D                 K2A:    POPF                    ; RESTORE ZF FROM TEST
0058 59                 K2B:    POP     CX
0059 5B                         POP     BX              ; RECOVER REGISTER
005A 1F                         POP     DS              ; RECOVER SEGMENT
005B CA 0002                    RET     2               ; THROW AWAY FLAGS
                        
                        ;------ SHIFT STATUS
                        
005E                    K3E:                            ; GET THE EXTENDED SHIFT STATUS FLAGS
005E 8A 26 0018 R               MOV     AH,@KB_FLAG_1   ; GET SYSTEM SHIFT KEY STATUS
0062 80 E4 04                   AND     AH,SYS_SHIFT    ; MASK ALL BUT SYS KEY BIT
0065 B1 05                      MOV     CL,5            ; SHIFT THE SYSTEM KEY BIT OVER TO
0067 D2 E4                      SHL     AH,CL           ;  BIT 7 POSITION
0069 A0 0018 R                  MOV     AL,@KB_FLAG_1   ; GET SHIFT STATES BACK
006C 24 73                      AND     AL,01110011B    ; ELIMINATE SYS_SHIFT, HOLD_STATE, AND INS_SHIFT
006E 0A E0                      OR      AH,AL           ; MERGE THE REMAINING BITS INTO AH
0070 A0 0096 R                  MOV     AL,@KB_FLAG_3   ; GET RIGHT CTL AND ALT
0073 24 0C                      AND     AL,00001100B    ; ELIMINATE LC_E0 AND LC_E1
0075 0A E0                      OR      AH,AL           ; OR THE SHIFT FLAGS TOGETHER
0077 A0 0017 R          K3:     MOV     AL,@KB_FLAG     ; GET THE SHIFT STATUS FLAGS
007A EB A9                      JMP     K10_EXIT        ; RETURN TO CALLER
                        
                        ;------ WRITE TO KEYBOARD BUFFER
                        
007C                    K500:
007C 56                         PUSH    SI
007D FA                         CLI
007E 8B 1E 001C R               MOV     BX,[@BUFFER_TAIL]; GET THE "IN TO" POINTER TO THE BUFFER
0082 8B F3                      MOV     SI,BX           ; SAVE A COPY IN CASE BUFFER NOT FULL
0084 E8 0114 R                  CALL    K4              ; BUMP THE POINTER TO SEE IF BUFFER IS FULL
0087 3B 1E 001A R               CMP     BX,[@BUFFER_HEAD]; WILL THE BUFFER OVERRUN IF WE STORE THIS?
008B 74 0B                      JE      K502            ;  YES - INFORM CALLER OF ERROR
008D 89 0C                      MOV     [SI],CX         ;  NO  - PUT THE ASCII/SCAN CODE INTO BUFFER
008F 89 1E 001C R               MOV     [@BUFFER_TAIL],BX; ADJUST "IN TO" POINTER TO REFLECT CHANGE
0093 2A C0                      SUB     AL,AL           ; TELL CALLER THAT OPERATION WAS SUCCESSFUL
0095 EB 03 90                   JMP     K504            ; SUB INSTRUCTION ALSO RESETS CARRY FLAG
0098                    K502:
0098 B0 01                      MOV     AL,01H          ; BUFFER FULL INDICATION
009A                    K504:
009A FB                         STI
009B 5E                         POP     SI
009C EB 87                      JMP     K10_EXIT        ; RETURN TO CALLER WITH STATUS IN AL
                        
009E                    KEYBOARD_IO_1 ENDP
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                        PAGE
                        ;------ READ THE KEY TO FIGURE OUT WHAT TO DO ------------------------
009E                    K1S     PROC    NEAR
009E 8B 1E 001A R               MOV     BX,@BUFFER_HEAD ; GET POINTER TO HEAD OF BUFFER
00A2 3B 1E 001C R               CMP     BX,@BUFFER_TAIL ; TEST END OF BUFFER
00A6 75 05                      JNE     K1T             ; IF ANYTHING IN BUFFER DONT DO INTERRUPT
                        
00A8 B8 9002                    MOV     AX,09002H       ; MOVE IN WAIT CODE & TYPE
00AB CD 15                      INT     15H             ; PERFORM OTHER FUNCTION
00AD                    K1T:                            ; ASCII READ
00AD FB                         STI                     ; INTERRUPTS BACK ON DURING LOOP
00AE 90                         NOP                     ; ALLOW AN INTERRUPT TO OCCUR
00AF FA                         CLI                     ; INTERRUPTS BACK OFF
00B0 8B 1E 001A R               MOV     BX,@BUFFER_HEAD ; GET POINTER TO HEAD OF BUFFER
00B4 3B 1E 001C R               CMP     BX,@BUFFER_TAIL ; TEST END OF BUFFER
00B8 74 F3                      JE      K1T             ; LOOP UNTIL SOMETHING IN BUFFER
00BA 8B 07                      MOV     AX,[BX]         ; GET SCAN CODE AND ASCII CODE
00BC E8 0114 R                  CALL    K4              ; MOVE POINTER TO NEXT POSITION
00BF 89 1E 001A R               MOV     @BUFFER_HEAD,BX ; STORE VALUE IN VARIABLE
00C3 C3                         RET                     ; RETURN
00C4                    K1S     ENDP
                        
                        
                        ;------ READ THE KEY TO SEE IF ONE IS PRESENT ------------------------
                        
00C4                    K2S     PROC    NEAR
00C4 FA                         CLI                     ; INTERRUPTS OFF
00C5 8B 1E 001A R               MOV     BX,@BUFFER_HEAD ; GET HEAD POINTER
00C9 3B 1E 001C R               CMP     BX,@BUFFER_TAIL ; IF EQUAL (Z=1) THEN NOTHING THERE
00CD 8B 07                      MOV     AX,[BX]
00CF FB                         STI                     ; INTERRUPTS BACK ON
00D0 C3                         RET                     ; RETURN
00D1                    K2S     ENDP
                        
                        
                        ;------ ROUTINE TO TRANSLATE SCAN CODE PAIRS FOR EXTENDED CALLS
                        
00D1                    K10_E_XLAT:
00D1 3C F0                      CMP     AL,0F0h         ; IS IT ONE OF THE FILL-INs?
00D3 75 06                      JNE     K10_E_RET       ;  NO, PASS IT ON
00D5 0A E4                      OR      AH,AH           ; AH = 0 IS SPECIAL CASE
00D7 74 02                      JZ      K10_E_RET       ;  PASS THIS ON UNCHANGED
00D9 32 C0                      XOR     AL,AL           ;  OTHERWISE SET AL = 0
00DB                    K10_E_RET:
00DB C3                         RET                     ; GO BACK
                        
                        
                        ;------ ROUTINE TO TRANSLATE SCAN CODE PAIRS FOR STANDARD CALLS
                        
00DC                    K10_S_XLAT:
00DC 80 FC E0                   CMP     AH,0E0h         ; IS IT KEYPAD ENTER OR / ?
00DF 75 12                      JNE     K10_S2          ;  NO, CONTINUE
00E1 3C 0D                      CMP     AL,0Dh          ; KEYPAD ENTER CODE?
00E3 74 09                      JE      K10_S1          ;  YES, MASSAGE A BIT
00E5 3C 0A                      CMP     AL,0Ah          ; CTRL KEYPAD ENTER CODE?
00E7 74 05                      JE      K10_S1          ;  YES, MASSAGE THE SAME
00E9 B4 35                      MOV     AH,35h          ;  NO, MUST BE KEYPAD /
00EB EB 23 90                   JMP     K10_USE         ; GIVE TO CALLER
00EE B4 1C              K10_S1: MOV     AH,1Ch          ; CONVERT TO COMPATIBLE OUTPUT
00F0 EB 1E 90                   JMP     K10_USE         ; GIVE TO CALLER
                        
00F3 80 FC 84           K10_S2: CMP     AH,84h          ; IS IT ONE OF THE EXTENDED ONES?
00F6 77 1A                      JA      K10_DIS         ;  YES, THROW AWAY AND GET ANOTHER CHAR
                        
00F8 3C F0                      CMP     AL,0F0h         ; IS IT ONE OF THE FILL-INs?
00FA 75 07                      JNE     K10_S3          ;  NO, TRY LAST TEST
00FC 0A E4                      OR      AH,AH           ; AH = 0 IS SPECIAL CASE
00FE 74 10                      JZ      K10_USE         ;  PASS THIS ON UNCHANGED
0100 EB 10 90                   JMP     K10_DIS         ;  THROW AWAY THE REST
                        
0103 3C E0              K10_S3: CMP     AL,0E0h         ; IS IT AN EXTENSION OF A PREVIOUS ONE?
0105 75 09                      JNE     K10_USE         ;  NO, MUST BE A STANDARD CODE
0107 0A E4                      OR      AH,AH           ; AH = 0 IS SPECIAL CASE
0109 74 05                      JZ      K10_USE         ; JUMP IF AH = 0
010B 32 C0                      XOR     AL,AL           ; CONVERT TO COMPATIBLE OUTPUT
010D EB 01 90                   JMP     K10_USE         ; PASS IT ON TO CALLER
                        
0110                    K10_USE:
0110 F8                         CLC                     ; CLEAR CARRY TO INDICATE GOOD CODE
0111 C3                         RET                     ; RETURN
0112                    K10_DIS:
0112 F9                         STC                     ; SET CARRY TO INDICATE DISCARD CODE
0113 C3                         RET                     ; RETURN
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                        PAGE
                        ;--------------------------------------------------------------------------
                        ;       INCREMENT BUFFER POINTER ROUTINE                                  -
                        ;--------------------------------------------------------------------------

0114                    K4      PROC    NEAR
0114 43                         INC     BX                      ; MOVE TO NEXT WORD IN LIST
0115 43                         INC     BX

0116 3B 1E 0082 R               CMP     BX,@BUFFER_END          ; AT END OF BUFFER?
011A 72 04                      JB      K5                      ; NO, CONTINUE
011C 8B 1E 0080 R               MOV     BX,@BUFFER_START        ; YES, RESET TO BUFFER BEGINNING
0120 C3                 K5:     RET
0121                    K4      ENDP


                        ;----- KEYBOARD INTERRUPT ROUTINE

0121                    KB_INT_1 PROC    FAR
0121 50                         PUSH    AX              ; SAVE THE STI UNTIL AFTER KEYBOARD RESET
0122 53                         PUSH    BX
0123 51                         PUSH    CX
0124 52                         PUSH    DX
0125 56                         PUSH    SI
0126 57                         PUSH    DI
0127 1E                         PUSH    DS
0128 06                         PUSH    ES
0129 FC                         CLD                     ; FORWARD DIRECTION
012A E8 0000 E                  CALL    DDS             ; SET UP ADDRESSING TO DATA SEGMENT
012D E4 60                      IN      AL,KB_DATA      ; READ IN THE CHARACTER
012F 93                         XCHG    BX,AX           ; SAVE IT

                        ;-----  RESET THE SHIFT REGISTER ON THE PLANAR IF ENABLED, OR DO NOTHING IF
                        ;-----  IT IS DISABLED

0130 E4 61                      IN      AL,KB_CTL       ; GET THE CONTROL PORT
0132 8A E0                      MOV     AH,AL           ; SAVE VALUE
0134 0C 80                      OR      AL,80H          ; RESET BIT FOR KEYBOARD
0136 E6 61                      OUT     KB_CTL,AL
0138 86 E0                      XCHG    AH,AL           ; GET BACK ORIGINAL CONTROL
013A E6 61                      OUT     KB_CTL,AL       ; KB HAS BEEN RESET
013C FB                         STI
013D 93                         XCHG    AX,BX           ; RESTORE DATA IN

                        ;-----  SYSTEM HOOK  INT 15H - FUNCTION 4FH  (ON HARDWARE INTERRUPT LEVEL 9H)

013E B4 4F                      MOV     AH,04FH         ; SYSTEM INTERCEPT - KEY CODE FUNCTION
0140 F9                         STC                     ; SET CY= 1 (IN CASE OF IRET)
0141 CD 15                      INT     15H             ; CASSETTE CALL   (AL)= KEY SCAN CODE
                                                        ;  RETURNS CY= 1 FOR INVALID FUNCTION
0143 72 03                      JC      KB_INT_PC       ; CONTINUE IF CARRY FLAG SET ((AL)=CODE)
0145 E9 02CA R                  JMP     K26             ; EXIT IF SYSTEM HANDLED SCAN CODE
                                                        ;  EXIT HANDLES HARDWARE EOI AND ENABLE
0148                    KB_INT_PC:
0148 8A E0                      MOV     AH,AL           ; SAVE SCAN CODE IN AH ALSO

                        ;------ TEST FOR OVERRUN SCAN CODE FROM KEYBOARD

014A 3C FF                      CMP     AL,0FFH                 ; IS THIS AN OVERRUN CHAR
014C 75 03                      JNZ     K16                     ; NO, TEST FOR SHIFT KEY
014E E9 0540 R                  JMP     K62                     ; BUFFER_FULL_BEEP

0151 0E                 K16:    PUSH    CS
0152 07                         POP     ES                      ; ESTABLISH ADDRESS OF TABLES
0153 8A 3E 0096 R               MOV     BH,@KB_FLAG_3           ; LOAD FLAGS FOR TESTING

0157                    TEST_E0:
0157 3C E0                      CMP     AL,MC_E0                ; IS THIS THE GENERAL MARKER CODE?
0159 75 07                      JNE     TEST_E1                 ;
015B 80 0E 0096 R 12            OR      @KB_FLAG_3,LC_E0+KBX    ; SET FLAG BIT, SET KBX, AND
0160 EB 09                      JMP     SHORT EXIT_K            ; THROW AWAY THIS CODE

0162                    TEST_E1:
0162 3C E1                      CMP     AL,MC_E1                ; IS THIS THE PAUSE KEY?
0164 75 08                      JNE     NOT_HC                  ;
0166 80 0E 0096 R 11            OR      @KB_FLAG_3,LC_E1+KBX    ; SET FLAG, PAUSE KEY MARKER CODE
016B E9 02CF R          EXIT_K: JMP     K26A                    ; THROW AWAY THIS CODE

016E                    NOT_HC:
016E 24 7F                      AND     AL,07FH                 ; TURN OFF THE BREAK BIT
0170 F6 C7 02                   TEST    BH,LC_E0                ; WAS LAST CODE THE E0 MARKER CODE?
0173 74 0C                      JZ      NOT_LC_E0               ; JUMP IF NOT

0175 B9 0002                    MOV     CX,2                    ; LENGTH OF SEARCH
0178 BF 0555 R                  MOV     DI,OFFSET K6+6          ; IS THIS A SHIFT KEY?
017B F2/ AE                     REPNE   SCASB                   ; CHECK IT
017D 75 54                      JNE     K16A                    ; NO, CONTINUE KEY PROCESSING
017F EB 3D                      JMP     SHORT K16B              ; YES, THROW AWAY & RESET FLAG

0181                    NOT_LC_E0:
0181 F6 C7 01                   TEST    BH,LC_E1                ; WAS LAST CODE THE E1 MARKER CODE?
0184 74 16                      JZ      T_SYS_KEY               ; JUMP IF NOT

0186 B9 0004                    MOV     CX,4                    ; LENGTH OF SEARCH
0189 BF 0553 R                  MOV     DI,OFFSET K6+4          ; IS THIS AN ALT, CTL, OR SHIFT?
018C F2/ AE                     REPNE   SCASB                   ; CHECK IT
018E 74 DB                      JE      EXIT_K                  ; THROW AWAY IF SO

0190 3C 45                      CMP     AL,NUM_KEY              ; IS IT THE PAUSE KEY?
0192 75 2A                      JNE     K16B                    ; NO, THROW AWAY & RESET FLAG
0194 F6 C4 80                   TEST    AH,80H                  ; YES, IS IT THE BREAK OF THE KEY?
0197 75 25                      JNZ     K16B                    ;  YES, THROW THIS AWAY, TOO
0199 E9 03FF R                  JMP     K39P                    ;  NO, THIS IS THE REAL PAUSE STATE
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                        PAGE
                        ;------ TEST FOR SYSTEM KEY
                        T_SYS_KEY:
                                CMP     AL,SYS_KEY              ; IS IT THE SYSTEM KEY?
                                JNE     K16A                    ; CONTINUE IF NOT

                                TEST    AH,080H                 ; CHECK IF THIS A BREAK CODE
                                JNZ     K16C                    ; DONT TOUCH SYSTEM INDICATOR IF TRUE

                                TEST    @KB_FLAG_1,SYS_SHIFT    ; SEE IF IN SYSTEM KEY HELD DOWN
                                JNZ     K16B                    ; IF YES, DONT PROCESS SYSTEM INDICATOR

                                OR      @KB_FLAG_1,SYS_SHIFT    ; INDICATE SYSTEM KEY DEPRESSED
                                MOV     AL,EOI                  ; END OF INTERRUPT COMMAND
                                OUT     020H,AL                 ; SEND COMMAND TO INTERRUPT CONTROL PORT
                                                                ; INTERRUPT-RETURN-NO-EOI
                                MOV     AX,08500H               ; FUNCTION VALUE FOR MAKE OF SYSTEM KEY
                                STI                             ; MAKE SURE INTERRUPTS ENABLED
                                INT     15H                     ; USER INTERRUPT
                                JMP     K27                     ; END PROCESSING

                        K16B:   JMP     K26                     ; IGNORE SYSTEM KEY

                        K16C:   AND     @KB_FLAG_1,NOT SYS_SHIFT; TURN OFF SHIFT KEY HELD DOWN
                                MOV     AL,EOI                  ; END OF INTERRUPT COMMAND
                                OUT     020H,AL                 ; SEND COMMAND TO INTERRUPT CONTROL PORT
                                                                ; INTERRUPT-RETURN-NO-EOI
                                MOV     AX,08501H               ; FUNCTION VALUE FOR BREAK OF SYSTEM KEY
                                STI                             ; MAKE SURE INTERRUPTS ENABLED
                                INT     15H                     ; USER INTERRUPT
                                JMP     K27                     ; IGNORE SYSTEM KEY

                        ;------ TEST FOR SHIFT KEYS

                        K16A:   MOV     BL,@KB_FLAG             ; PUT STATE FLAGS IN BL
                                MOV     DI,OFFSET K6            ; SHIFT KEY TABLE
                                MOV     CX,K6L                  ; LENGTH
                                REPNE   SCASB                   ; LOOK THROUGH THE TABLE FOR A MATCH
                                MOV     AL,AH                   ; RECOVER SCAN CODE
                                JE      K17                     ; JUMP IF MATCH FOUND
                                JMP     K25                     ; IF NO MATCH, THEN SHIFT NOT FOUND

                        ;------ SHIFT KEY FOUND

                        K17:    SUB     DI,OFFSET K6+1          ; ADJUST PTR TO SCAN CODE MTCH
                                MOV     AH,CS:K7[DI]            ; GET MASK INTO AH
                                MOV     CL,2                    ; SET UP COUNT FOR FLAG SHIFTS
                                TEST    AL,80H                  ; TEST FOR KEY BREAK
                                JZ      K17C
                                JMP     K23                     ; JUMP IF BREAK

                        ;------ SHIFT MAKE FOUND, DETERMINE SET OR TOGGLE

                        K17C:   CMP     AH,SCROLL_SHIFT
                                JAE     K18                     ; IF SCROLL SHIFT OR ABOVE, TOGGLE KEY

                        ;------ PLAIN SHIFT KEY, SET SHIFT ON

                                OR      @KB_FLAG,AH             ; TURN ON SHIFT BIT
                                TEST    AH,CTL_SHIFT+ALT_SHIFT  ; IS IT ALT OR CTRL?
                                JNZ     K17D                    ;  YES, MORE FLAGS TO SET
                                JMP     K26                     ;  NO, INTERRUPT_RETURN
                        K17D:   TEST    BH,LC_E0                ; IS THIS ONE OF THE NEW KEYS?
                                JZ      K17E                    ;  NO, JUMP
                                OR      @KB_FLAG_3,AH           ; SET BITS FOR RIGHT CTRL, ALT
                                JMP     K26                     ; INTERRUPT_RETURN
                        K17E:   SHR     AH,CL                   ; MOVE FLAG BITS TWO POSITIONS
                                OR      @KB_FLAG_1,AH           ; SET BITS FOR LEFT CTRL, ALT
                                JMP     K26                     ; INTERRUPT_RETURN

                        ;------ TOGGLED SHIFT KEY, TEST FOR 1ST MAKE OR NOT

                        K18:                                    ; SHIFT-TOGGLE
                                TEST    BL,CTL_SHIFT            ; CHECK CTL SHIFT STATE
                                JZ      K18A                    ; JUMP IF NOT CTL STATE
                                JMP     K25                     ; JUMP IF CTL STATE
                        K18A:   CMP     AL,INS_KEY              ; CHECK FOR INSERT KEY
                                JNE     K22                     ; JUMP IF NOT INSERT KEY
                                TEST    BL,ALT_SHIFT            ; CHECK FOR ALTERNATE SHIFT
                                JZ      K18B                    ; JUMP IF NOT ALTERNATE SHIFT
                                JMP     K25                     ; JUMP IF ALTERNATE SHIFT
                        K18B:   TEST    BH,LC_E0                ; IS THIS THE NEW INSERT KEY?
                                JNZ     K22                     ; YES, THIS ONE'S NEVER A "0"
                        K19:    TEST    BL,NUM_STATE            ; CHECK FOR BASE STATE
                                JNZ     K21                     ; JUMP IF NUM LOCK IS ON
                                TEST    BL,LEFT_SHIFT+RIGHT_SHIFT  ; TEST FOR SHIFT STATE
                                JZ      K22                     ; JUMP IF BASE STATE
                        K20:
                                MOV     AH,AL                   ; PUT SCAN CODE BACK INTO AH
                                JMP     K25                     ; NUMERAL "0", STNDRD. PROCESSING

                        K21:    TEST    BL,LEFT_SHIFT+RIGHT_SHIFT  ; MIGHT BE NUMERIC
                                JZ      K20                     ; IS NUMERIC, STD. PROC.

                        K22:                                    ; SHIFT TOGGLE KEY HIT; PROCESS IT
                                TEST    AH,@KB_FLAG_1           ; IS KEY ALREADY DEPRESSED
                                JZ      K22A
                                JMP     K26                     ; JUMP IF KEY ALREADY DEPRESSED
                        K22A:   OR      @KB_FLAG_1,AH           ; INDICATE THAT THE KEY IS DEPRESSED
                                XOR     @KB_FLAG,AH             ; TOGGLE THE SHIFT STATE
                                CMP     AL,INS_KEY              ; TEST FOR 1ST MAKE OF INSERT KEY
                                JNE     K26                     ; JUMP IF NOT INSERT KEY
                                MOV     AH,AL                   ; SCAN CODE IN BOTH HALVES OF AX
                                JMP     K28                     ; FLAGS UPDATED, PROC. FOR BUFFER

                        ;------ BREAK SHIFT FOUND

                        K23:                                    ; BREAK-SHIFT-FOUND
                                CMP     AH,SCROLL_SHIFT         ; IS THIS A TOGGLE KEY?
                                NOT     AH                      ; INVERT MASK
                                JAE     K24                     ; YES, HANDLE BREAK TOGGLE
                                AND     @KB_FLAG,AH             ; TURN OFF SHIFT BIT
                                CMP     AH,NOT CTL_SHIFT        ; IS THIS ALT OR CTL?
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0274 77 26                      JA      K23D                    ;  NO, ALL DONE

0276 F6 C7 02                   TEST    BH,LC_E0                ; 2ND ALT OR CTL?
0279 74 06                      JZ      K23A                    ; NO, HANDLE NORMALLY
027B 20 26 0096 R               AND     @KB_FLAG_3,AH           ; RESET BIT FOR RIGHT ALT OR CTL
027F EB 06                      JMP     SHORT K23B              ; CONTINUE
0281 D2 FC              K23A:   SAR     AH,CL                   ; MOVE THE MASK BIT TWO POSITIONS
0283 20 26 0018 R               AND     @KB_FLAG_1,AH           ; RESET BIT FOR LEFT ALT OR CTL
0287 8A E0              K23B:   MOV     AH,AL                   ; SAVE SCAN CODE
0289 A0 0096 R                  MOV     AL,@KB_FLAG_3           ; GET RIGHT ALT & CTRL FLAGS
028C D2 E8                      SHR     AL,CL                   ; MOVE TO BITS 1 & 0
028E 0A 06 0018 R               OR      AL,@KB_FLAG_1           ; PUT IN LEFT ALT & CTL FLAGS
0292 D2 E0                      SHL     AL,CL                   ; MOVE BACK TO BITS 3 & 2
0294 24 0C                      AND     AL,ALT_SHIFT+CTL_SHIFT  ; FILTER OUT OTHER GARBAGE
0296 08 06 0017 R               OR      @KB_FLAG,AL             ; PUT RESULT IN THE REAL FLAGS
029A 8A C4                      MOV     AL,AH                   ; RECOVER SAVED SCAN CODE

029C 3C B8              K23D:   CMP     AL,ALT_KEY+80H          ; IS THIS ALTERNATE SHIFT RELEASE
029E 75 2A                      JNE     K26                     ; INTERRUPT_RETURN

                        ;------ ALTERNATE SHIFT KEY RELEASED, GET THE VALUE INTO BUFFER

02A0 A0 0019 R                  MOV     AL,@ALT_INPUT
02A3 B4 00                      MOV     AH,0                    ; SCAN CODE OF 0
02A5 88 26 0019 R               MOV     @ALT_INPUT,AH           ; ZERO OUT THE FIELD
02A9 3C 00                      CMP     AL,0                    ; WAS THE INPUT = 0?
02AB 74 1D                      JE      K26                     ; INTERRUPT_RETURN
02AD E9 0519 R                  JMP     K61                     ; IT WASN'T, SO PUT IN BUFFER

02B0                    K24:                                    ; BREAK-TOGGLE
02B0 20 26 0018 R               AND     @KB_FLAG_1,AH           ; INDICATE NO LONGER DEPRESSED
02B4 EB 14                      JMP     SHORT K26               ; INTERRUPT_RETURN

                        ;------ TEST FOR HOLD STATE

02B6                    K25:                                    ; AL, AH = SCAN CODE
                                                                ; NO-SHIFT-FOUND
02B6 3C 80                      CMP     AL,80H                  ; TEST FOR BREAK KEY
02B8 73 10                      JAE     K26                     ; NOTHING FOR BREAK CHARS FROM HERE ON
02BA F6 06 0018 R 08            TEST    @KB_FLAG_1,HOLD_STATE   ; ARE WE IN HOLD STATE
02BF 74 1C                      JZ      K28                     ; BRANCH AROUND TEST IF NOT
02C1 3C 45                      CMP     AL,NUM_KEY
02C3 74 05                      JE      K26                     ; CAN'T END HOLD ON NUM_LOCK
02C5 80 26 0018 R F7            AND     @KB_FLAG_1,NOT HOLD_STATE       ; TURN OFF THE HOLD STATE BIT

02CA                    K26:
02CA 80 26 0096 R FC            AND     @KB_FLAG_3,NOT LC_E0+LC_E1      ; RESET LAST CHAR H.C. FLAG

02CF                    K26A:                                   ; INTERRUPT-RETURN
02CF FA                         CLI                             ; TURN OFF INTERRUPTS
02D0 B0 20                      MOV     AL,EOI                  ; END OF INTERRUPT COMMAND
02D2 E6 20                      OUT     020H,AL                 ; SEND COMMAND TO INTERRUPT CONTROL PORT

02D4                    K27:                                    ; INTERRUPT-RETURN-NO-EOI
02D4 07                         POP     ES                      ; RESTORE REGISTERS
02D5 1F                         POP     DS
02D6 5F                         POP     DI
02D7 5E                         POP     SI
02D8 5A                         POP     DX
02D9 59                         POP     CX
02DA 5B                         POP     BX
02DB 58                         POP     AX
02DC CF                         IRET                            ; RETURN, INTERRUPTS BACK ON
                                                                ;  WITH FLAG CHANGE
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                        PAGE
                        ;------ NOT IN HOLD STATE
                                                        ; AL, AH = SCAN CODE (ALL MAKES)
02DD                    K28:                            ; NO-HOLD-STATE
02DD 3C 58                      CMP     AL,88           ; TEST FOR OUT-OF-RANGE SCAN CODES
02DF 77 E9                      JA      K26             ; IGNORE IF OUT-OF-RANGE
                        
02E1 F6 C3 08                   TEST    BL,ALT_SHIFT    ; ARE WE IN ALTERNATE SHIFT?
02E4 74 0C                      JZ      K28A            ; JUMP IF NOT ALTERNATE
                        
02E6 F6 C7 10                   TEST    BH,KBX          ; IS THIS THE ENHANCED KEYBOARD?
02E9 74 0A                      JZ      K29             ; NO, ALT STATE IS REAL
                        
02EB F6 06 0018 R 04            TEST    @KB_FLAG_1,SYS_SHIFT    ; YES, IS SYSREQ KEY DOWN?
02F0 74 03                      JZ      K29             ;  NO, ALT STATE IS REAL
02F2 E9 03CC R          K28A:   JMP     K38             ;  YES, THIS IS PHONY ALT STATE
                                                        ;       DUE TO PRESSING SYSREQ
                        
                        ;------ TEST FOR RESET KEY SEQUENCE (CTL ALT DEL)
                        
02F5                    K29:                            ; TEST-RESET
02F5 F6 C3 04                   TEST    BL,CTL_SHIFT    ; ARE WE IN CONTROL SHIFT ALSO?
02F8 74 37                      JZ      K31             ; NO_RESET
02FA 3C 53                      CMP     AL,DEL_KEY      ; SHIFT STATE IS THERE, TEST KEY
02FC 75 33                      JNE     K31             ; NO_RESET,  IGNORE
                        
                        ;------ CTL-ALT-DEL HAS BEEN FOUND, DO I/O CLEANUP
                        
02FE C7 06 0072 R 1234          MOV     @RESET_FLAG,1234H       ; SET FLAG FOR RESET FUNCTION
0304 81 26 0096 R 0010          AND     WORD PTR @KB_FLAG_3,KBX ; CLEAR ALL FLAG BITS EXCEPT KBX
030A E9 0000 E                  JMP     RESET           ; JUMP TO POWER ON DIAGNOSTICS
                        
                        ;------ ALT-INPUT-TABLE
030D                    K30     LABEL   BYTE
030D 52 4F 50 51 4B             DB      82,79,80,81,75
0312 4C 4D 47 48 49             DB      76,77,71,72,73          ; 10 NUMBERS ON KEYPAD
                        ;------ SUPER-SHIFT-TABLE
0317 10 11 12 13 14 15          DB      16,17,18,19,20,21       ; A-Z TYPEWRITER CHARS
031D 16 17 18 19 1E 1F          DB      22,23,24,25,30,31
0323 20 21 22 23 24 25          DB      32,33,34,35,36,37
0329 26 2C 2D 2E 2F 30          DB      38,44,45,46,47,48
032F 31 32                      DB      49,50
                        
                        ;------ IN ALTERNATE SHIFT, RESET NOT FOUND
                        
0331                    K31:                            ; NO-RESET
0331 3C 39                      CMP     AL,57           ; TEST FOR SPACE KEY
0333 75 05                      JNE     K311            ; NOT THERE
0335 B0 20                      MOV     AL,' '          ; SET SPACE CHAR
0337 E9 050D R                  JMP     K57             ; BUFFER_FILL
033A                    K311:
033A 3C 0F                      CMP     AL,15           ; TEST FOR TAB KEY
033C 75 06                      JNE     K312            ; NOT THERE
033E B8 A500                    MOV     AX,0A500h       ; SET SPECIAL CODE FOR ALT-TAB
0341 E9 050D R                  JMP     K57             ; BUFFER_FILL
0344                    K312:
0344 3C 4A                      CMP     AL,74           ; TEST FOR KEYPAD -
0346 74 79                      JE      K37B            ; GO PROCESS
0348 3C 4E                      CMP     AL,78           ; TEST FOR KEYPAD +
034A 74 75                      JE      K37B            ; GO PROCESS
                        
                        ;------ LOOK FOR KEY PAD ENTRY
                        
034C                    K32:                            ; ALT-KEY-PAD
034C BF 030D R                  MOV     DI,OFFSET K30   ; ALT-INPUT-TABLE
034F B9 000A                    MOV     CX,10           ; LOOK FOR ENTRY USING KEYPAD
0352 F2/ AE                     REPNE   SCASB           ; LOOK FOR MATCH
0354 75 18                      JNE     K33             ; NO_ALT_KEYPAD
0356 F6 C7 02                   TEST    BH,LC_E0        ; IS THIS ONE OF THE NEW KEYS?
0359 75 6B                      JNZ     K37C            ;  YES, JUMP, NOT NUMPAD KEY
035B 81 EF 030E R               SUB     DI,OFFSET K30+1 ; DI NOW HAS ENTRY VALUE
035F A0 0019 R                  MOV     AL,@ALT_INPUT   ; GET THE CURRENT BYTE
0362 B4 0A                      MOV     AH,10           ; MULTIPLY BY 10
0364 F6 E4                      MUL     AH
0366 03 C7                      ADD     AX,DI           ; ADD IN THE LATEST ENTRY
0368 A2 0019 R                  MOV     @ALT_INPUT,AL   ; STORE IT AWAY
036B E9 02CA R          K32A:   JMP     K26             ; THROW AWAY THAT KEYSTROKE
                        
                        ;------ LOOK FOR SUPERSHIFT ENTRY
                        
036E                    K33:                            ; NO-ALT-KEYPAD
036E C6 06 0019 R 00            MOV     @ALT_INPUT,0    ; ZERO ANY PREVIOUS ENTRY INTO INPUT
0373 B9 001A                    MOV     CX,26           ; DI,ES ALREADY POINTING
0376 F2/ AE                     REPNE   SCASB           ; LOOK FOR MATCH IN ALPHABET
0378 74 42                      JE      K37A            ; MATCH FOUND, GO FILL THE BUFFER
                        
                        ;------ LOOK FOR TOP ROW OF ALTERNATE SHIFT
                        
037A                    K34:                            ; ALT-TOP-ROW
037A 3C 02                      CMP     AL,2            ; KEY WITH '1' ON IT
037C 72 43                      JB      K37B            ; NOT ONE OF INTERESTING KEYS
037E 3C 0D                      CMP     AL,13           ; IS IT IN THE REGION
0380 77 05                      JA      K35             ; ALT-FUNCTION
0382 80 C4 76                   ADD     AH,118          ; CONVERT PSEUDO SCAN CODE TO RANGE
0385 EB 35                      JMP     SHORT K37A      ; GO FILL THE BUFFER
                        
                        ;------ TRANSLATE ALTERNATE SHIFT PSEUDO SCAN CODES
                        
0387                    K35:                            ; ALT-FUNCTION
0387 3C 57                      CMP     AL,F11_M        ; IS IT F11?
0389 72 09                      JB      K35A            ;  NO, BRANCH
038B 3C 58                      CMP     AL,F12_M        ; IS IT F12?
038D 77 05                      JA      K35A            ;  NO, BRANCH
038F 80 C4 34                   ADD     AH,52           ; CONVERT TO PSEUDO SCAN CODE
0392 EB 28                      JMP     SHORT K37A      ; GO FILL THE BUFFER
                        
0394 F6 C7 02           K35A:   TEST    BH,LC_E0        ; DO WE HAVE ONE OF THE NEW KEYS?
0397 74 18                      JZ      K37             ;  NO, JUMP
0399 3C 1C                      CMP     AL,28           ; TEST FOR KEYPAD ENTER
039B 75 06                      JNE     K35B            ; NOT THERE
039D B8 A600                    MOV     AX,0A600h       ; SPECIAL CODE
03A0 E9 050D R                  JMP     K57             ; BUFFER FILL
03A3 3C 53              K35B:   CMP     AL,83           ; TEST FOR DELETE KEY
03A5 74 1F                      JE      K37C            ; HANDLE WITH OTHER EDIT KEYS
```

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03A7 3C 35                      CMP     AL,53                   ; TEST FOR KEYPAD /
03A9 75 C0                      JNE     K32A                    ; NOT THERE, NO OTHER E0 SPECIALS
03AB B8 A400                    MOV     AX,0A400h               ; SPECIAL CODE
03AE E9 050D R                  JMP     K57                     ; BUFFER FILL

03B1 3C 3B              K37:    CMP     AL,59                   ; TEST FOR IN TABLE
03B3 72 0C                      JB      K37B                    ; ALT-CONTINUE
03B5 3C 44                      CMP     AL,68                   ; IN KEYPAD REGION?
                                                                ; OR NUMLOCK, SCROLLOCK?
03B7 77 B2                      JA      K32A                    ; IF SO, IGNORE
03B9 80 C4 2D                   ADD     AH,45                   ; CONVERT TO PSEUDO SCAN CODE

03BC B0 00              K37A:   MOV     AL,0                    ; ASCII CODE OF ZERO
03BE E9 050D R                  JMP     K57                     ; PUT IT IN THE BUFFER

03C1 B0 F0              K37B:   MOV     AL,0F0h                 ; USE SPECIAL ASCII CODE
03C3 E9 050D R                  JMP     K57                     ; PUT IT IN THE BUFFER

03C6 04 50              K37C:   ADD     AL,80                   ; CONVERT SCAN CODE (EDIT KEYS)
03C8 8A E0                      MOV     AH,AL                   ; (SCAN CODE NOT IN AH FOR INSERT)
03CA EB F0                      JMP     K37A                    ; PUT IT IN THE BUFFER

                        ;------ NOT IN ALTERNATE SHIFT

03CC                    K38:                                    ; NOT-ALT-SHIFT
                                                                ; BL STILL HAS SHIFT FLAGS
03CC F6 C3 04                   TEST    BL,CTL_SHIFT            ; ARE WE IN CONTROL SHIFT?
03CF 75 03                      JNZ     K38A                    ;  YES, START PROCESSING
03D1 E9 0454 R                  JMP     K44                     ; NOT-CTL-SHIFT

                        ;------ CONTROL SHIFT, TEST SPECIAL CHARACTERS

                        ;------ TEST FOR BREAK

03D4 3C 46              K38A:   CMP     AL,SCROLL_KEY           ; TEST FOR BREAK
03D6 75 1E                      JNE     K39                     ; JUMP, NO-BREAK
03D8 F6 C7 10                   TEST    BH,KBX                  ; IS THIS THE ENHANCED KEYBOARD?
03DB 74 05                      JZ      K38B                    ;  NO, BREAK IS VALID
03DD F6 C7 02                   TEST    BH,LC_E0                ;  YES, WAS LAST CODE AN E0?
03E0 74 14                      JZ      K39                     ;   NO-BREAK, TEST FOR PAUSE

03E2 8B 1E 001A R       K38B:   MOV     BX,@BUFFER_HEAD         ; RESET BUFFER TO EMPTY
03E6 89 1E 001C R               MOV     @BUFFER_TAIL,BX         ;
03EA C6 06 0071 R 80            MOV     @BIOS_BREAK,80H         ; TURN ON BIOS_BREAK BIT
03EF CD 1B                      INT     1BH                     ; BREAK INTERRUPT VECTOR
03F1 2B C0                      SUB     AX,AX                   ; PUT OUT DUMMY CHARACTER
03F3 E9 050D R                  JMP     K57                     ; BUFFER_FILL

                        ;-------- TEST FOR PAUSE

03F6                    K39:                                    ; NO-BREAK
03F6 F6 C7 10                   TEST    BH,KBX                  ; IS THIS THE ENHANCED KEYBOARD?
03F9 75 25                      JNZ     K41                     ; YES, THEN THIS CAN'T BE PAUSE
03FB 3C 45                      CMP     AL,NUM_KEY              ; LOOK FOR PAUSE KEY
03FD 75 21                      JNE     K41                     ; NO-PAUSE
03FF 80 0E 0018 R 08    K39P:   OR      @KB_FLAG_1,HOLD_STATE   ; TURN ON THE HOLD FLAG
0404 B0 20                      MOV     AL,EOI                  ; END OF INTERRUPT TO CONTROL PORT
0406 E6 20                      OUT     020H,AL                 ; ALLOW FURTHER KEYSTROKE INTS

                        ;------ DURING PAUSE INTERVAL, TURN CRT BACK ON

0408 80 3E 0049 R 07            CMP     @CRT_MODE,7             ; IS THIS BLACK AND WHITE CARD
040D 74 07                      JE      K40                     ; YES, NOTHING TO DO
040F BA 03D8                    MOV     DX,03D8H                ; PORT FOR COLOR CARD
0412 A0 0065 R                  MOV     AL,@CRT_MODE_SET        ; GET THE VALUE OF THE CURRENT MODE
0415 EE                         OUT     DX,AL                   ; SET THE CRT MODE, SO THAT CRT IS ON
0416                    K40:                                    ; PAUSE-LOOP
0416 F6 06 0018 R 08            TEST    @KB_FLAG_1,HOLD_STATE
041B 75 F9                      JNZ     K40                     ; LOOP UNTIL FLAG TURNED OFF
041D E9 02D4 R                  JMP     K27                     ; INTERRUPT_RETURN_NO_EOI

                        ;------ TEST SPECIAL CASE KEY 55

0420                    K41:                                    ; NO-PAUSE
0420 3C 37                      CMP     AL,55                   ; TEST FOR */PRTSC KEY
0422 75 10                      JNE     K42                     ; NOT-KEY-55
0424 F6 C7 10                   TEST    BH,KBX                  ; IS THIS THE ENHANCED KEYBOARD?
0427 74 05                      JZ      K41A                    ;  NO, CTL-PRTSC IS VALID
0429 F6 C7 02                   TEST    BH,LC_E0                ;  YES, WAS LAST CODE AN E0?
042C 74 20                      JZ      K42B                    ;   NO, TRANSLATE TO A FUNCTION
042E B8 7200            K41A:   MOV     AX,114*256              ; START/STOP PRINTING SWITCH
0431 E9 050D R                  JMP     K57                     ; BUFFER_FILL

                        ;------ SET UP TO TRANSLATE CONTROL SHIFT

0434                    K42:                                    ; NOT-KEY-55
0434 3C 0F                      CMP     AL,15                   ; IS IT THE TAB KEY?
0436 74 16                      JE      K42B                    ;  YES, XLATE TO FUNCTION CODE
0438 3C 35                      CMP     AL,53                   ; IS IT THE / KEY?
043A 75 0B                      JNE     K42A                    ;  NO, NO MORE SPECIAL CASES
043C F6 C7 02                   TEST    BH,LC_E0                ;  YES, IS IT FROM THE KEYPAD?
043F 74 06                      JZ      K42A                    ;   NO, JUST TRANSLATE
0441 B8 9500                    MOV     AX,9500h                ;   YES, SPECIAL CODE FOR THIS ONE
0444 E9 050D R                  JMP     K57                     ;   BUFFER FILL

0447 BB 055F R          K42A:   MOV     BX,OFFSET K8            ; SET UP TO TRANSLATE CTL
044A 3C 3B                      CMP     AL,59                   ; IS IT IN CHARACTER TABLE?
044C 72 57                      JB      K45F                    ;  YES, GO TRANSLATE CHAR
044E BB 055F R          K42B:   MOV     BX,OFFSET K8            ; SET UP TO TRANSLATE CTL
0451 E9 04FC R                  JMP     K64                     ;  NO, GO TRANSLATE_SCAN

                        ;------ NOT IN CONTROL SHIFT

0454 3C 37              K44:    CMP     AL,55                   ; PRINT SCREEN KEY?
0456 75 1F                      JNE     K45                     ; NOT-PRINT-SCREEN
0458 F6 C7 10                   TEST    BH,KBX                  ; IS THIS ENHANCED KEYBOARD?
045B 74 07                      JZ      K44A                    ; NO, TEST FOR SHIFT STATE
045D F6 C7 02                   TEST    BH,LC_E0                ; YES, LAST CODE A MARKER?
0460 75 07                      JNZ     K44B                    ;  YES, IS PRINT SCREEN
0462 EB 34                      JMP     SHORT K45C              ;  NO, XLATE TO "*" CHARACTER
0464 F6 C3 03           K44A:   TEST    BL,LEFT_SHIFT+RIGHT_SHIFT ;NOT 101 KBD, SHIFT KEY DOWN?
0467 74 2F                      JZ      K45C                    ; NO, XLATE TO "*" CHARACTER

                        ;------ ISSUE INTERRUPT TO PERFORM PRINT SCREEN FUNCTION
```

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0469 B0 20              K44B:   MOV     AL,EOI                  ; END OF CURRENT INTERRUPT
046B E6 20                      OUT     020H,AL                 ;  SO FURTHER THINGS CAN HAPPEN
046D CD 05                      INT     5H                      ; ISSUE PRINT SCREEN INTERRUPT
046F 80 26 0096 R FC            AND     @KB_FLAG_3,NOT LC_E0+LC_E1;ZERO OUT THESE FLAGS
0474 E9 02D4 R                  JMP     K27                     ; GO BACK WITHOUT EOI OCCURRING


                        ;------ HANDLE THE IN-CORE KEYS
0477                    K45:                                    ; NOT-PRINT-SCREEN
0477 3C 3A                      CMP     AL,58                   ; TEST FOR IN-CORE AREA
0479 77 2C                      JA      K46                     ; JUMP IF NOT

047B 3C 35                      CMP     AL,53                   ; IS THIS THE "/" KEY?
047D 75 05                      JNE     K45A                    ;  NO, JUMP
047F F6 C7 02                   TEST    BH,LC_E0                ; WAS LAST CODE THE MARKER?
0482 75 14                      JNZ     K45C                    ;  YES, TRANSLATE TO CHARACTER

0484 B9 001A            K45A:   MOV     CX,26                   ; LENGTH OF SEARCH
0487 BF 0317 R                  MOV     DI,OFFSET K30+10        ; POINT TO TABLE OF A-Z CHARS
048A F2/ AE                     REPNE   SCASB                   ; IS THIS A LETTER KEY?
048C 75 05                      JNE     K45B                    ;  NO, SYMBOL KEY

048E F6 C3 40                   TEST    BL,CAPS_STATE           ; ARE WE IN CAPS_LOCK?
0491 75 0A                      JNZ     K45D                    ; TEST FOR SURE
0493 F6 C3 03           K45B:   TEST    BL,LEFT_SHIFT+RIGHT_SHIFT ; ARE WE IN SHIFT STATE?
0496 75 0A                      JNZ     K45E                    ;  YES, UPPERCASE
                                                                ;  NO, LOWERCASE
0498 BB 05B7 R          K45C:   MOV     BX,OFFSET K10           ; TRANSLATE TO LOWERCASE LETTERS
049B EB 50                      JMP     SHORT K56
049D                    K45D:                                   ; ALMOST-CAPS-STATE
049D F6 C3 03                   TEST    BL,LEFT_SHIFT+RIGHT_SHIFT ; CL ON. IS SHIFT ON, TOO?
04A0 75 F6                      JNZ     K45C                    ; SHIFTED TEMP OUT OF CAPS STATE
04A2 BB 060F R          K45E:   MOV     BX,OFFSET K11           ; TRANSLATE TO UPPERCASE LETTERS
04A5 EB 46              K45F:   JMP     SHORT K56


                        ;------ TEST FOR KEYS F1 - F10
04A7                    K46:                                    ; NOT IN-CORE AREA
04A7 3C 44                      CMP     AL,68                   ; TEST FOR F1 - F10
04A9 77 02                      JA      K47                     ; JUMP IF NOT
04AB EB 36                      JMP     SHORT K53               ; YES, GO DO FN KEY PROCESS


                        ;------ HANDLE THE NUMERIC PAD KEYS

04AD                    K47:                                    ; NOT F1 - F10
04AD 3C 53                      CMP     AL,83                   ; TEST FOR NUMPAD KEYS
04AF 77 2C                      JA      K52                     ; JUMP IF NOT

                        ;------ KEYPAD KEYS, MUST TEST NUM LOCK FOR DETERMINATION
04B1 3C 4A              K48:    CMP     AL,74                   ; SPECIAL CASE FOR MINUS
04B3 74 ED                      JE      K45E                    ; GO TRANSLATE
04B5 3C 4E                      CMP     AL,78                   ; SPECIAL CASE FOR PLUS
04B7 74 E9                      JE      K45E                    ; GO TRANSLATE
04B9 F6 C7 02                   TEST    BH,LC_E0                ; IS THIS ONE OF THE NEW KEYS?
04BC 75 0A                      JNZ     K49                     ;  YES, TRANSLATE TO BASE STATE

04BE F6 C3 20                   TEST    BL,NUM_STATE            ; ARE WE IN NUM_LOCK?
04C1 75 13                      JNZ     K50                     ; TEST FOR SURE
04C3 F6 C3 03                   TEST    BL,LEFT_SHIFT+RIGHT_SHIFT  ; ARE WE IN SHIFT STATE?
04C6 75 13                      JNZ     K51                     ;  IF SHIFTED, REALLY NUM STATE

                        ;------ BASE CASE FOR KEYPAD
04C8 3C 4C              K49:    CMP     AL,76                   ; SPECIAL CASE FOR BASE STATE 5
04CA 75 05                      JNE     K49A                    ; CONTINUE IF NOT KEYPAD 5
04CC B0 F0                      MOV     AL,0F0h                 ; SPECIAL ASCII CODE
04CE EB 3D 90                   JMP     K57                     ; BUFFER FILL
04D1 BB 05B7 R          K49A:   MOV     BX,OFFSET K10           ; BASE CASE TABLE
04D4 EB 26                      JMP     SHORT K64               ; CONVERT TO PSEUDO SCAN

                        ;------ MIGHT BE NUM LOCK, TEST SHIFT STATUS
04D6 F6 C3 03           K50:    TEST    BL,LEFT_SHIFT+RIGHT_SHIFT       ;ALMOST-NUM-STATE
04D9 75 ED                      JNZ     K49                     ; SHIFTED TEMP OUT OF NUM STATE
04DB EB C5              K51:    JMP     SHORT K45E              ; REALLY_NUM_STATE


                        ;------ TEST FOR THE NEW KEY ON WT KEYBOARDS

04DD                    K52:                                    ; NOT A NUMPAD KEY
04DD 3C 56                      CMP     AL,86                   ; IS IT THE NEW WT KEY?
04DF 75 02                      JNE     K53                     ; JUMP IF NOT
04E1 EB B0                      JMP     SHORT K45B              ; HANDLE WITH REST OF LETTER KEYS


                        ;------ MUST BE F11 OR F12
                                                                ; F1 - F10 COME HERE, TOO
04E3 F6 C3 03           K53:    TEST    BL,LEFT_SHIFT+RIGHT_SHIFT ;TEST SHIFT STATE
04E6 74 E0                      JZ      K49                     ;  JUMP, LOWERCASE PSEUDO SC'S

04E8 BB 060F R                  MOV     BX,OFFSET K11           ; UPPER CASE PSEUDO SCAN CODES
04EB EB 0F                      JMP     SHORT K64               ; TRANSLATE_SCAN

                        ;------ TRANSLATE THE CHARACTER

04ED                    K56:                                    ; TRANSLATE-CHAR
04ED FE C8                      DEC     AL                      ; CONVERT ORIGIN
04EF 2E: D7                     XLAT    CS:K11                  ; CONVERT THE SCAN CODE TO ASCII
04F1 F6 06 0096 R 02            TEST    @KB_FLAG_3,LC_E0        ; IS THIS A NEW KEY?
04F6 74 15                      JZ      K57                     ;  NO, GO FILL BUFFER
04F8 B4 E0                      MOV     AH,MC_E0                ;  YES, PUT SPECIAL MARKER IN AH
04FA EB 11                      JMP     SHORT K57               ; PUT IT INTO THE BUFFER

                        ;------ TRANSLATE SCAN FOR PSEUDO SCAN CODES

04FC                    K64:                                    ; TRANSLATE-SCAN-ORGD
04FC FE C8                      DEC     AL                      ; CONVERT ORIGIN
04FE 2E: D7                     XLAT    CS:K8                   ; CTL TABLE SCAN
0500 8A E0                      MOV     AH,AL                   ; PUT VALUE INTO AH
0502 B0 00                      MOV     AL,0                    ; ZERO ASCII CODE
0504 F6 06 0096 R 02            TEST    @KB_FLAG_3,LC_E0        ; IS THIS A NEW KEY?
0509 74 02                      JZ      K57                     ;  NO, GO FILL BUFFER
050B B0 E0                      MOV     AL,MC_E0                ;  YES, PUT SPECIAL MARKER IN AL


                        ;------ PUT CHARACTER INTO BUFFER
```

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                        K57:                                    ; BUFFER-FILL
050D 3C FF                      CMP     AL,-1                   ; IS THIS AN IGNORE CHAR
050F 74 05                      JE      K59                     ; YES, DO NOTHING WITH IT
0511 80 FC FF                   CMP     AH,-1                   ; LOOK FOR -1 PSEUDO SCAN
0514 75 03                      JNE     K61                     ; NEAR_INTERRUPT_RETURN

                        K59:                                    ; NEAR-INTERRUPT-RETURN
0516 E9 02CA R                  JMP     K26                     ; INTERRUPT_RETURN

                        K61:
0519 FA                         CLI                             ; TURN OFF INTERRUPTS
051A 8B 1E 001C R               MOV     BX,@BUFFER_TAIL         ; GET THE END POINTER TO THE BUFFER
051E 8B F3                      MOV     SI,BX                   ; SAVE THE VALUE
0520 E8 0114 R                  CALL    K4                      ; ADVANCE THE TAIL
0523 3B 1E 001A R               CMP     BX,@BUFFER_HEAD         ; HAS THE BUFFER WRAPPED AROUND
0527 74 17                      JE      K62                     ; BUFFER_FULL_BEEP
0529 89 04                      MOV     [SI],AX                 ; STORE THE VALUE
052B 89 1E 001C R               MOV     @BUFFER_TAIL,BX         ; MOVE THE POINTER UP
052F B0 20                      MOV     AL,EOI                  ; END OF INTERRUPT COMMAND
0531 E6 20                      OUT     020H,AL                 ; SEND COMMAND TO INTERRUPT CONTROL PORT
0533 B8 9102                    MOV     AX,09102H               ; MOVE IN POST CODE & TYPE
0536 CD 15                      INT     15H                     ; PERFORM OTHER FUNCTION
0538 80 26 0096 R FC            AND     @KB_FLAG_3,NOT LC_E0+LC_E1      ; RESET LAST CHAR H.C. FLAG
053D E9 02D4 R                  JMP     K27                     ; INTERRUPT_RETURN

                        ;------ BUFFER IS FULL SOUND THE BEEPER

                        K62:
0540 B0 20                      MOV     AL,EOI                  ; ENABLE INTERRUPT CONTROLLER CHIP
0542 E6 20                      OUT     INTA00,AL               ;
0544 B9 02A6                    MOV     CX,678                  ; DIVISOR FOR 1760 HZ
0547 B3 04                      MOV     BL,4                    ; SHORT BEEP COUNT (1/16 + 1/64 DELAY)
0549 E8 0000 E                  CALL    BEEP                    ; GO TO COMMON BEEP HANDLER
054C E9 02D4 R                  JMP     K27                     ; EXIT

054F                    KB_INT_1  ENDP
```

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                        PAGE
                        ;--------------------------------------------------------------------------
                        ;       KEY IDENTIFICATION SCAN TABLES                                     -
                        ;--------------------------------------------------------------------------


                        ;--------------  TABLE OF SHIFT KEYS AND MASK VALUES  ----------------
                        ;------ KEY_TABLE
055F                    K6      LABEL   BYTE
054F 52                         DB      INS_KEY                 ; INSERT KEY
0550 3A 45 46 38 1D             DB      CAPS_KEY,NUM_KEY,SCROLL_KEY,ALT_KEY,CTL_KEY
0555 2A 36                      DB      LEFT_KEY,RIGHT_KEY
= 0008                  K6L     EQU     $-K6

                        ;------ MASK_TABLE
0557                    K7      LABEL   BYTE
0557 80                         DB      INS_SHIFT               ; INSERT MODE SHIFT
0558 40 20 10 08 04             DB      CAPS_SHIFT,NUM_SHIFT,SCROLL_SHIFT,ALT_SHIFT,CTL_SHIFT
055D 02 01                      DB      LEFT_SHIFT,RIGHT_SHIFT

                        ;----------------------  TABLES FOR CTRL CASE  -----------------------

055F                    K8      LABEL   BYTE                    ;-------- CHARACTERS ---------
055F 1B FF 00 FF FF FF          DB      27,-1,00,-1,-1,-1       ; Esc, 1, 2, 3, 4, 5
0565 1E FF FF FF FF 1F          DB      30,-1,-1,-1,-1,31       ; 6, 7, 8, 9, 0, -
056B FF 7F 94 11 17 05          DB      -1,127,148,17,23,5      ; =, Bksp, Tab, Q, W, E
0571 12 14 19 15 09 0F          DB      18,20,25,21,09,15       ; R, T, Y, U, I, O
0577 10 1B 1D 0A FF 01          DB      16,27,29,10,-1,01       ; P, [,], Enter, Ctrl, A
057D 13 04 06 07 08 0A          DB      19,04,06,07,08,10       ; S, D, F, G, H, J
0583 0B 0C FF FF FF FF          DB      11,12,-1,-1,-1,-1       ; K, L, ;, ', `, LShift
0589 1C 1A 18 03 16 02          DB      28,26,24,03,22,02       ; \, Z, X, C, V, B
058F 0E 0D FF FF FF FF          DB      14,13,-1,-1,-1,-1       ; N, M, ,, ., /, RShift
0595 96 FF 20 FF                DB      150,-1,' ',-1           ; *, Alt, Space, CL
                                                                ;--------- FUNCTIONS ---------
0599 5E 5F 60 61 62 63          DB      94,95,96,97,98,99       ; F1 - F6
059F 64 65 66 67 FF FF          DB      100,101,102,103,-1,-1   ; F7 - F10, NL, SL
05A5 77 8D 84 8E 73 8F          DB      119,141,132,142,115,143 ; Home, Up, PgUp, -, Left, Pad5
05AB 74 90 75 91 76 92          DB      116,144,117,145,118,146 ; Right, +, End, Down, PgDn, Ins
05B1 93 FF FF FF 89 8A          DB      147,-1,-1,-1,137,138    ; Del, SysReq, Undef, WT, F11, F12
                        ;--------------------  TABLES FOR LOWER CASE  ----------------------

05B7                    K10     LABEL   BYTE
05B7 1B 31 32 33 34 35          DB      27,'12345'
05BD 36 37 38 39 30 2D          DB      '67890-'
05C3 3D 08 09 71 77 65          DB      '=',08,09,'qwe'
05C9 72 74 79 75 69 6F          DB      'rtyuio'
05CF 70 5B 5D 0D FF 61          DB      'p[]',0DH,-1,'a'        ; LETTERS, Return, Ctrl
05D5 73 64 66 67 68 6A          DB      'sdfghj'
05DB 6B 6C 3B 27 60 FF          DB      'kl;'',-1               ; LETTERS, L Shift
05E1 5C 7A 78 63 76 62          DB      '\zxcvb'
05E7 6E 6D 2C 2E 2F             DB      'nm,./'
05EC FF 2A FF 20 FF             DB      -1,'*',-1,' ',-1        ; R Shift,*, Alt, Space, CL

                        ;------ LC TABLE SCAN
05F1 3B 3C 3D 3E 3F             DB      59,60,61,62,63          ; BASE STATE OF F1 - F10
05F6 40 41 42 43 44             DB      64,65,66,67,68
05FB FF FF                      DB      -1,-1                   ; NL, SL

                        ;------ KEYPAD TABLE
05FD                    K15     LABEL   BYTE
05FD 47 48 49 FF 4B FF          DB      71,72,73,-1,75,-1       ; BASE STATE OF KEYPAD KEYS
0603 4D FF 4F 50 51 52          DB      77,-1,79,80,81,82
0609 53                         DB      83
060A FF FF 5C 85 86             DB      -1,-1,'\',133,134       ; SysRq, Undef, WT, F11, F12

                        ;----------------------  TABLES FOR UPPER CASE  ----------------------

060F                    K11     LABEL   BYTE
060F 1B 21 40 23 24 25          DB      27,'!@#$%'
0615 5E 26 2A 28 29 5F          DB      '^&*()_'
061B 2B 08 00 51 57 45          DB      '+',08,00,'QWE'
0621 52 54 59 55 49 4F          DB      'RTYUIO'
0627 50 7B 7D 0D FF 41          DB      'P{}',0DH,-1,'A'        ; LETTERS, Return, Ctrl
062D 53 44 46 47 48 4A          DB      'SDFGHJ'
0633 4B 4C 3A 22 7E FF          DB      'KL:"~',-1              ; LETTERS, L Shift
0639 7C 5A 58 43 56 42          DB      '|ZXCVB'
063F 4E 4D 3C 3E 3F             DB      'NM<>?'
0644 FF 2A FF 20 FF             DB      -1,'*',-1,' ',-1        ; R Shift,*, Alt, Space, CL

                        ;------ UC TABLE SCAN
0649                    K12     LABEL   BYTE
0649 54 55 56 57 58             DB      84,85,86,87,88          ; SHIFTED STATE OF F1 - F10
064E 59 5A 5B 5C 5D             DB      89,90,91,92,93
0653 FF FF                      DB      -1,-1                   ; NL, SL

                        ;------ NUM STATE TABLE
0655                    K14     LABEL   BYTE
0655 37 38 39 2D 34 35          DB      '789-456+1230.'         ; NUMLOCK STATE OF KEYPAD KEYS
     36 2B 31 32 33 30
     2E
0662 FF FF 7C 87 88             DB      -1,-1,'|',135,136       ; SysRq, Undef, WT, F11, F12
0667                    CODE    ENDS
                        END
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                        PAGE 118,121
                        TITLE PRT ------ 01/10/86  PRINTER ADAPTER BIOS
                        .LIST

0000                    CODE    SEGMENT BYTE PUBLIC

                                PUBLIC  PRINTER_IO_1

                                EXTRN   DDS:NEAR

                        ;--- INT  17 H ----------------------------------------------------------------
                        ; PRINTER_IO                                                                  :
                        ;       THIS ROUTINE PROVIDES COMMUNICATION WITH THE PRINTER                  :
                        ; INPUT                                                                       :
                        ;       (AH)= 00H  PRINT THE CHARACTER IN (AL)                                :
                        ;                   ON RETURN, (AH)= 1 IF CHARACTER NOT PRINTED (TIME OUT)    :
                        ;                   OTHER BITS SET AS ON NORMAL STATUS CALL                   :
                        ;       (AH)= 01H  INITIALIZE THE PRINTER PORT                                :
                        ;                   RETURNS WITH (AH) SET WITH PRINTER STATUS                 :
                        ;       (AH)= 02H  READ THE PRINTER STATUS INTO (AH)                          :
                        ;                   7     6     5     4     3     2-1   0                     :
                        ;                   |     |     |     |     |     |     |_ 1 = TIME OUT       :
                        ;                   |     |     |     |     |     |                           :
                        ;                   |     |     |     |     |     |_ UNUSED                   :
                        ;                   |     |     |     |     |                                 :
                        ;                   |     |     |     |     |_ 1 = I/O ERROR                  :
                        ;                   |     |     |     |                                       :
                        ;                   |     |     |     |_ 1 = SELECTED                         :
                        ;                   |     |     |                                             :
                        ;                   |     |     |_ 1 = OUT OF PAPER                           :
                        ;                   |     |                                                   :
                        ;                   |     |_ 1 = ACKNOWLEDGE                                  :
                        ;                   |                                                         :
                        ;                   |_ 1 = NOT BUSY                                           :
                        ;                                                                             :
                        ;       (DX) = PRINTER TO BE USED (0,1,2) CORRESPONDING TO ACTUAL VALUES      :
                        ;                   IN @PRINTER_BASE AREA                                     :
                        ; DATA AREA @PRINTER_BASE CONTAINS THE BASE ADDRESS OF THE PRINTER CARD(S)    :
                        ; AVAILABLE (LOCATED AT BEGINNING OF DATA SEGMENT, 408H ABSOLUTE, 3 WORDS)    :
                        ;                                                                             :
                        ; DATA AREA @PRINT_TIM_OUT (BYTE) MAY BE CHANGE TO CAUSE DIFFERENT            :
                        ; TIME OUT WAITS. DEFAULT=20                                                   :
                        ;                                                                             :
                        ; REGISTERS      (AH) IS MODIFIED WITH STATUS INFORMATION                     :
                        ;                ALL OTHERS UNCHANGED                                         :
                        ;-------------------------------------------------------------------------------

                                ASSUME  CS:CODE,DS:DATA

0000                    PRINTER_IO_1    PROC    FAR             ; ENTRY POINT FOR ORG 0EFD2H

0000 FB                         STI                             ; INTERRUPTS BACK ON
0001 52                         PUSH    DX                      ; SAVE WORK REGISTERS
0002 53                         PUSH    BX
0003 83 FA 03                   CMP     DX,03H                  ; CHECK FOR PRINTER NUMBER VALID 0-3
0006 77 25                      JA      B10                     ; ERROR EXIT IF OUT OF RANGE

0008 8A F8                      MOV     BH,AL                   ; SAVE CHARACTER TO BE PRINTED
000A 1E                         PUSH    DS                      ; SAVE SEGMENT
000B E8 0000 E                  CALL    DDS                     ; ADDRESS DATA SEGMENT

000E 56                         PUSH    SI                      ; SAVE WORK POINTER REGISTER
000F 8B F2                      MOV     SI,DX                   ; GET PRINTER PARAMETER
0011 8A 9C 0078 R               MOV     BL,@PRINT_TIM_OUT[SI]   ; LOAD TIMEOUT VALUE
0015 D1 E6                      SHL     SI,1                    ; WORD OFFSET INTO TABLE INTO (SI)
0017 8B 94 0008 R               MOV     DX,@PRINTER_BASE[SI]    ; GET BASE ADDRESS FOR PRINTER CARD
001B 5E                         POP     SI                      ; RECOVER CALLERS (SI) REGISTER
001C 1F                         POP     DS                      ;  AND (DS) SEGMENT REGISTER
                                ASSUME  DS:NOTHING
001D 0B D2                      OR      DX,DX                   ; TEST DX = ZERO, INDICATING NO PRINTER
001F 74 0C                      JZ      B10                     ; EXIT,  NO PRINTER ADAPTER AT OFFSET

0021 0A E4                      OR      AH,AH                   ; TEST FOR (AH)= 00H
0023 74 0D                      JZ      B30                     ;  PRINT CHARACTER IN (AL)

0025 FE CC                      DEC     AH                      ; TEST FOR (AH)= 01H
0027 74 4B                      JZ      B80                     ;  INITIALIZE PRINTER

0029 FE CC                      DEC     AH                      ; TEST FOR (AH)= 02H
002B 74 39                      JZ      B60                     ;  GET PRINTER STATUS

002D                    B10:
002D B4 29                      MOV     AH,029H                 ; RETURN ERROR BITS FOR INVALID CALLS

002F                    B20:
002F 5B                         POP     BX                      ; RETURN
0030 5A                         POP     DX                      ; RECOVER REGISTERS
0031 CF                         IRET                            ; RETURN TO CALLING PROGRAM (AH)= STATUS


                        ;-----  PRINT THE CHARACTER IN (AL)

0032                    B30:
0032 EE                         OUT     DX,AL                   ; OUTPUT CHARACTER TO DATA PORT
0033 42                         INC     DX                      ; POINT TO STATUS PORT
```

```
                        PAGE
                        ;-----  CHECK FOR PRINTER BUSY
                                IN      AL,DX                   ; PRE-CHARGE +BUSY LINE IF FLOATING
0034 EC                         IN      AL,DX                   ; GET STATUS PORT VALUE
0035 EC
0036 A8 80                      TEST    AL,80H                  ; IS THE PRINTER CURRENTLY BUSY
0038 75 05                      JNZ     B40                     ; SKIP SYSTEM DEVICE BUSY CALL IF NOT

                        ;-----  INT 15 H -- DEVICE BUSY

003A B8 90FE                    MOV     AX,90FEH                ; FUNCTION 90 PRINTER ID
003D CD 15                      INT     15H                     ; SYSTEM CALL

                        ;-----  WAIT BUSY

003F                    B40:
003F 51                         PUSH    CX                      ; SAVE CALLERS (CX) REGISTER
0040 2B C9                      SUB     CX,CX                   ; INNER LOOP (64K)
0042                    B45:
0042 EC                         IN      AL,DX                   ; GET STATUS
0043 8A E0                      MOV     AH,AL                   ; STATUS TO (AH) ALSO
0045 A8 80                      TEST    AL,80H                  ; IS THE PRINTER CURRENTLY BUSY
0047 75 0F                      JNZ     B50                     ; GO TO OUTPUT STROBE

0049 E2 F7                      LOOP    B45                     ; LOOP IF NOT

004B FE CB                      DEC     BL                      ; DECREMENT OUTER LOOP COUNT
004D 75 F3                      JNZ     B45                     ; MAKE ANOTHER PASS IF NOT ZERO

004F 59                         POP     CX                      ; RESTORE (CX) WITH CALLERS VALUE
0050 80 CC 01                   OR      AH,1                    ; SET ERROR FLAG
0053 80 E4 F9                   AND     AH,0F9H                 ; TURN OFF THE UNUSED BITS
0056 EB 15                      JMP     SHORT B70               ; RETURN WITH ERROR FLAG SET

0058                    B50:                                    ;       SEND STROBE PULSE
0058 59                         POP     CX                      ; RESTORE (CX) WITH CALLERS VALUE
0059 B0 0D                      MOV     AL,0DH                  ; SET THE STROBE LOW (BIT ON)
005B 42                         INC     DX                      ; OUTPUT STROBE TO CONTROL PORT
005C FA                         CLI                             ; PREVENT INTERRUPT PULSE STRETCHING
005D EE                         OUT     DX,AL                   ; OUTPUT STROBE BIT   > 1us  < 5us
005E EB 00                      JMP     $+2                     ; I/O DELAY TO ALLOW FOR LINE LOADING
                                                                ;   AND FOR CORRECT PULSE WIDTH
0060 B0 0C                      MOV     AL,0CH                  ; SET THE -STROBE HIGH
0062 EE                         OUT     DX,AL
0063 FB                         STI                             ; INTERRUPTS BACK ON
0064 4A                         DEC     DX                      ; ADJUST BACK TO BASE ADDRESS
0065 4A                         DEC     DX                      ;  FOR STATUS ROUTINE EXIT


                        ;-----  PRINTER STATUS

0066                    B60:
0066 42                         INC     DX                      ; POINT TO CONTROL PORT
0067 EC                         IN      AL,DX                   ; PRE-CHARGE +BUSY LINE IF FLOATING
0068 EC                         IN      AL,DX                   ; GET PRINTER STATUS HARDWARE BITS
0069 24 F8                      AND     AL,0F8H                 ; TURN OFF UNUSED BITS
006B 8A E0                      MOV     AH,AL                   ; SAVE
006D                    B70:
006D 8A C7                      MOV     AL,BH                   ; RECOVER CHARACTER INTO (AL) REGISTER
006F 80 F4 48                   XOR     AH,48H                  ; FLIP A COUPLE OF BITS IN STATUS
0072 EB BB                      JMP     B20                     ; RETURN FROM ROUTINE WITH STATUS IN AH


                        ;-----  INITIALIZE THE PRINTER PORT

0074                    B80:
0074 42                         INC     DX                      ; POINT TO OUTPUT PORT
0075 42                         INC     DX
0076 B0 08                      MOV     AL,8                    ; SET INIT LINE LOW
0078 EE                         OUT     DX,AL
0079 B8 03E8                    MOV     AX,1000                 ; ADJUST FOR INITIALIZATION DELAY LOOP
007C                    B90:
007C 48                         DEC     AX                      ; DECREMENT DELAY COUNTER
007D 75 FD                      JNZ     B90                     ; LOOP FOR RESET TO TAKE

007F B0 0C                      MOV     AL,0CH                  ; NO INTERRUPTS, NON AUTO LF, INIT HIGH
0081 EE                         OUT     DX,AL                   ; SET DEFAULT INITIAL OUTPUTS
0082 4A                         DEC     DX                      ; ADJUST BACK TO BASE ADDRESS
0083 4A                         DEC     DX                      ;  FOR STATUS ROUTINE EXIT
0084 EB E0                      JMP     B60                     ; EXIT THROUGH STATUS ROUTINE

0086                    PRINTER_IO_1    ENDP

0086                            CODE    ENDS
                                END
```

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                        PAGE 118,121
                        TITLE RS232 ---- 01/10/86  COMMUNICATIONS BIOS (RS232)
                        .LIST
0000                    CODE    SEGMENT BYTE PUBLIC

                                PUBLIC  RS232_IO_1
                                EXTRN   A1:NEAR
                                EXTRN   DDS:NEAR

                        ;--- INT 14 H ----------------------------------------------------------------
                        ;RS232_IO                                                                     :
                        ;       THIS ROUTINE PROVIDES BYTE STREAM I/O TO THE COMMUNICATIONS        :
                        ;       PORT ACCORDING TO THE PARAMETERS:                                  :
                        ;                                                                          :
                        ;       (AH)= 00H  INITIALIZE THE COMMUNICATIONS PORT                      :
                        ;                  (AL) HAS PARAMETERS FOR INITIALIZATION                  :
                        ;                                                                          :
                        ;                  7      6      5      4      3      2      1      0       :
                        ;                  ----- BAUD RATE --      -PARITY--     STOPBIT   --WORD LENGTH--:
                        ;                                                                          :
                        ;                  000 - 110              X0 - NONE      0 - 1    10 - 7 BITS  :
                        ;                  001 - 150              01 - ODD       1 - 2    11 - 8 BITS  :
                        ;                  010 - 300              11 - EVEN                          :
                        ;                  011 - 600                                                 :
                        ;                  100 - 1200                                                :
                        ;                  101 - 2400                                                :
                        ;                  110 - 4800                                                :
                        ;                  111 - 9600                                                :
                        ;                  ON RETURN, CONDITIONS SET AS IN CALL TO COMMO STATUS (AH=03H) :
                        ;                                                                          :
                        ;       (AH)= 01H  SEND THE CHARACTER IN (AL) OVER THE COMMO LINE          :
                        ;                  (AL) REGISTER IS PRESERVED                              :
                        ;                  ON EXIT, BIT 7 OF AH IS SET IF THE ROUTINE WAS UNABLE TO :
                        ;                       TO TRANSMIT THE BYTE OF DATA OVER THE LINE.        :
                        ;                       IF BIT 7 OF AH IS NOT SET, THE                     :
                        ;                       REMAINDER OF (AH) IS SET AS IN A STATUS REQUEST,   :
                        ;                       REFLECTING THE CURRENT STATUS OF THE LINE.         :
                        ;       (AH)= 02H  RECEIVE A CHARACTER IN (AL) FROM COMMO LINE BEFORE      :
                        ;                  RETURNING TO CALLER                                     :
                        ;                  ON EXIT, (AH) HAS THE CURRENT LINE STATUS, AS SET BY THE :
                        ;                       THE STATUS ROUTINE, EXCEPT THAT THE ONLY BITS      :
                        ;                       LEFT ON ARE THE ERROR BITS (7,4,3,2,1)             :
                        ;                       IF (AH) HAS BIT 7 ON (TIME OUT) THE REMAINING      :
                        ;                       BITS ARE NOT PREDICTABLE.                          :
                        ;                       THUS, (AH) IS NON ZERO ONLY WHEN AN ERROR OCCURRED. :
                        ;       (AH)= 03H  RETURN THE COMMO PORT STATUS IN (AX)                    :
                        ;                   (AH) CONTAINS THE LINE CONTROL STATUS                  :
                        ;                        BIT 7 = TIME OUT                                  :
                        ;                        BIT 6 = TRANSMIT SHIFT REGISTER EMPTY             :
                        ;                        BIT 5 = TRANSMIT HOLDING REGISTER EMPTY           :
                        ;                        BIT 4 = BREAK DETECT                              :
                        ;                        BIT 3 = FRAMING ERROR                             :
                        ;                        BIT 2 = PARITY ERROR                              :
                        ;                        BIT 1 = OVERRUN ERROR                             :
                        ;                        BIT 0 = DATA READY                                :
                        ;                   (AL) CONTAINS THE MODEM STATUS                         :
                        ;                        BIT 7 = RECEIVE LINE SIGNAL DETECT                :
                        ;                        BIT 6 = RING INDICATOR                            :
                        ;                        BIT 5 = DATA SET READY                            :
                        ;                        BIT 4 = CLEAR TO SEND                             :
                        ;                        BIT 3 = DELTA RECEIVE LINE SIGNAL DETECT          :
                        ;                        BIT 2 = TRAILING EDGE RING DETECTOR               :
                        ;                        BIT 1 = DELTA DATA SET READY                      :
                        ;                        BIT 0 = DELTA CLEAR TO SEND                       :
                        ;                                                                          :
                        ;       (DX) = PARAMETER INDICATING WHICH RS232 CARD (0,1 ALLOWED)         :
                        ;                                                                          :
                        ; DATA AREA @RS232_BASE CONTAINS THE BASE ADDRESS OF THE 8250 ON THE CARD  :
                        ;       LOCATION 400H CONTAINS UP TO 4 RS232 ADDRESSES POSSIBLE            :
                        ;       DATA AREA LABEL @RS232_TIM_OUT (BYTE) CONTAINS OUTER LOOP COUNT    :
                        ;       VALUE FOR TIMEOUT (DEFAULT=1)                                      :
                        ;OUTPUT                                                                    :
                        ;                  AX MODIFIED ACCORDING TO PARAMETERS OF CALL             :
                        ;                  ALL OTHERS UNCHANGED                                    :
                        ;-------------------------------------------------------------------------
                                ASSUME  CS:CODE,DS:DATA

0000                    RS232_IO_1      PROC    FAR
0000 FB                         STI                             ; INTERRUPTS BACK ON
0001 1E                         PUSH    DS                      ; SAVE SEGMENT
0002 52                         PUSH    DX
0003 56                         PUSH    SI
0004 57                         PUSH    DI
0005 51                         PUSH    CX
0006 53                         PUSH    BX
0007 83 FA 03                   CMP     DX,03H                  ; CHECK FOR ADAPTER NUMBER VALID 0-3
000A 77 24                      JA      A3E                     ; ERROR EXIT IF OUT OF RANGE
000C 8B F2                      MOV     SI,DX                   ; RS232 VALUE TO (SI)
000E 8B FA                      MOV     DI,DX                   ; AND TO (DI) (FOR TIMEOUTS)
0010 D1 E6                      SHL     SI,1                    ; WORD OFFSET
0012 E8 0000 E                  CALL    DDS
0015 8B 94 0000 R               MOV     DX,@RS232_BASE[SI]      ; GET BASE ADDRESS
0019 0B D2                      OR      DX,DX                   ; TEST FOR 0 BASE ADDRESS
001B 74 13                      JZ      A3E                     ; RETURN
001D 0A E4                      OR      AH,AH                   ; TEST FOR (AH)= 00H
001F 74 18                      JZ      A4                      ; COMMO INITIALIZATION
0021 FE CC                      DEC     AH                      ; TEST FOR (AH)= 01H
0023 74 4B                      JZ      A5                      ; SEND (AL)
0025 FE CC                      DEC     AH                      ; TEST FOR (AH)= 02H
0027 74 70                      JZ      A12                     ; RECEIVE INTO (AL)
0029                    A2:
0029 FE CC                      DEC     AH                      ; TEST FOR (AH)= 03H
002B 75 03                      JNZ     A3E                     ;  ERROR IF BAD COMMAND
002D E9 00BB R                  JMP     A18                     ; COMMUNICATION STATUS
0030                    A3E:
0030 B4 80                      MOV     AH,080H                 ; SET ERROR RETURN CODE
0032                    A3:
0032 5B                         POP     BX                      ; RETURN FROM RS232
0033 59                         POP     CX
0034 5F                         POP     DI
0035 5E                         POP     SI
0036 5A                         POP     DX
0037 1F                         POP     DS
0038 CF                         IRET                            ; RETURN TO CALLER, NO ACTION
```

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                        PAGE
                        ;-----  INITIALIZE THE COMMUNICATIONS PORT
                        A4:
0039 8A E0                      MOV     AH,AL                   ; SAVE INITIALIZATION PARAMETERS IN (AH)
003B 83 C2 03                   ADD     DX,3                    ; POINT TO 8250 CONTROL REGISTER
003E B0 80                      MOV     AL,80H
0040 EE                         OUT     DX,AL                   ; SET DLAB=1

                        ;-----  DETERMINE BAUD RATE DIVISOR

0041 8A D4                      MOV     DL,AH                   ; GET PARAMETERS TO (DL)
0043 B1 04                      MOV     CL,4
0045 D2 C2                      ROL     DL,CL
0047 81 E2 000E                 AND     DX,0EH                  ; ISOLATE THEM
004B BF 0000 E                  MOV     DI,OFFSET A1            ; BASE OF TABLE
004E 03 FA                      ADD     DI,DX                   ; PUT INTO INDEX REGISTER
0050 8B 94 0000 R               MOV     DX,@RS232_BASE[SI]      ; POINT TO HIGH ORDER OF DIVISOR
0054 42                         INC     DX
0055 2E: 8A 45 01               MOV     AL,CS:[DI]+1            ; GET HIGH ORDER OF DIVISOR
0059 EE                         OUT     DX,AL                   ; SET ms OF DIVISOR TO 0
005A 4A                         DEC     DX
005B 90                         NOP                             ; I/O DELAY
005C 2E: 8A 05                  MOV     AL,CS:[DI]              ; GET LOW ORDER OF DIVISOR
005F EE                         OUT     DX,AL                   ; SET LOW OF DIVISOR
0060 83 C2 03                   ADD     DX,3
0063 8A C4                      MOV     AL,AH                   ; GET PARAMETERS BACK
0065 24 1F                      AND     AL,01FH                 ; STRIP OFF THE BAUD BITS
0067 EE                         OUT     DX,AL                   ; LINE CONTROL TO 8 BITS
0068 4A                         DEC     DX
0069 4A                         DEC     DX
006A 90                         NOP                             ; I/O DELAY
006B B0 00                      MOV     AL,0
006D EE                         OUT     DX,AL                   ; INTERRUPT ENABLES ALL OFF
006E EB 4B                      JMP     SHORT A18               ; COM_STATUS

                        ;-----  SEND CHARACTER IN (AL) OVER COMMO LINE

                        A5:
0070                            PUSH    AX                      ; SAVE CHAR TO SEND
0070 50                         ADD     DX,4                    ; MODEM CONTROL REGISTER
0071 83 C2 04                   MOV     AL,3                    ; DTR AND RTS
0074 B0 03                      OUT     DX,AL                   ; DATA TERMINAL READY, REQUEST TO SEND
0076 EE                         INC     DX                      ; MODEM STATUS REGISTER
0077 42                         INC     DX
0078 42                         MOV     BH,30H                  ; DATA SET READY & CLEAR TO SEND
0079 B7 30                      CALL    WAIT_FOR_STATUS         ; ARE BOTH TRUE
007B E8 00CA R                  JE      A9                      ; YES, READY TO TRANSMIT CHAR
007E 74 08                      POP     CX
0080                            MOV     AL,CL                   ; RELOAD DATA BYTE
0080 59                         OR      AH,80H                  ; INDICATE TIME OUT
0081 8A C1                      JMP     A3                      ; RETURN
0083 80 CC 80
0086 EB AA
                        A9:                                     ; CLEAR TO SEND
0088                            DEC     DX                      ; LINE STATUS REGISTER
0088 4A                         MOV     BH,20H                  ; WAIT SEND
0089                            CALL    WAIT_FOR_STATUS         ; IS TRANSMITTER READY
0089 B7 20                      JNZ     A7                      ; TEST FOR TRANSMITTER READY
008B E8 00CA R                  POP     CX                      ; RETURN WITH TIME OUT SET
008E 75 F0                      SUB     DX,5                    ; OUT_CHAR
0090                            POP     CX                      ; DATA PORT
0090 83 EA 05                   MOV     AL,CL                   ; RECOVER IN CX TEMPORARILY
0093 59                         OUT     DX,AL                   ; MOVE CHAR TO AL FOR OUT, STATUS IN AH
0094 8A C1                      JMP     A3                      ; OUTPUT CHARACTER
0096 EE                                                         ; RETURN
0097 EB 99
                        A10:
                        A11:
                        A7:
                        A8:

                        ;-----  RECEIVE CHARACTER FROM COMMO LINE

                        A12:
0099                            ADD     DX,4                    ; MODEM CONTROL REGISTER
0099 83 C2 04                   MOV     AL,1                    ; DATA TERMINAL READY
009C B0 01                      OUT     DX,AL
009E EE                         INC     DX                      ; MODEM STATUS REGISTER
009F 42                         INC     DX
00A0 42                         MOV     BH,20H                  ; WAIT_DSR
00A1                            CALL    WAIT_FOR_STATUS         ; DATA_SET_READY
00A1 B7 20                      JNZ     A8                      ; TEST FOR DSR
00A3 E8 00CA R                  MOV     AH,00011110B            ; RETURN WITH ERROR
00A6 75 DB                      DEC     DX                      ; WAIT_DSR_END
00A8                            MOV     BH,1                    ; LINE STATUS REGISTER
00A8 4A                         CALL    WAIT_FOR_STATUS         ; WAIT_RECV
00A9                            JNZ     A8                      ; RECEIVE BUFFER FULL
00A9 B7 01                      IN      AL,DX                   ; TEST FOR RECEIVE BUFFER FULL
00AB E8 00CA R                  JMP     A3                      ; SET TIME OUT ERROR
00AE 75 D3                                                      ; GET_CHAR
00B0                            AND     AH,00011110B            ; TEST FOR ERROR CONDITIONS ON RECEIVE
00B0 80 E4 1E                   MOV     DX,@RS232_BASE[SI]      ; DATA PORT
00B3 8B 94 0000 R               IN      AL,DX                   ; GET CHARACTER FROM LINE
00B7 EC                         JMP     A3                      ; RETURN
00B8 E9 0032 R

                        ;-----  COMMO PORT STATUS ROUTINE

                        A13:
                        A14:
                        A15:
                        A16:
                        A17:
                        A18:
00BB                            MOV     DX,@RS232_BASE[SI]
00BB 8B 94 0000 R               ADD     DX,5                    ; CONTROL PORT
00BF 83 C2 05                   IN      AL,DX                   ; GET LINE CONTROL STATUS
00C2 EC                         MOV     AH,AL                   ; PUT IN (AH) FOR RETURN
00C3 8A E0                      INC     DX                      ; POINT TO MODEM STATUS REGISTER
00C5 42                         IN      AL,DX                   ; GET MODEM CONTROL STATUS
00C6 EC                         JMP     A3                      ; RETURN
00C7 E9 0032 R
```

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                        PAGE
                        ;--------------------------------------
                        ;       WAIT FOR STATUS ROUTINE        :
                        ;ENTRY: (BH)= STATUS BIT(S) TO LOOK FOR :
                        ;       (DX)= ADDRESS OF STATUS REG    :
                        ;EXIT:  ZERO FLAG ON = STATUS FOUND    :
                        ;       ZERO FLAG OFF = TIMEOUT.       :
                        ;       (AH)= LAST STATUS READ         :
                        ;--------------------------------------

00CA                    WAIT_FOR_STATUS PROC    NEAR

00CA 8A 9D 007C R               MOV     BL,@RS232_TIM_OUT[DI]   ; LOAD OUTER LOOP COUNT
00CE                    WFS0:
00CE 2B C9                      SUB     CX,CX
00D0                    WFS1:
00D0 EC                         IN      AL,DX                   ; GET STATUS
00D1 8A E0                      MOV     AH,AL                   ; MOVE TO (AH)
00D3 22 C7                      AND     AL,BH                   ; ISOLATE BITS TO TEST
00D5 3A C7                      CMP     AL,BH                   ; EXACTLY = TO MASK
00D7 74 08                      JE      WFS_END                 ; RETURN WITH ZERO FLAG ON

00D9 E2 F5                      LOOP    WFS1                    ; TRY AGAIN

00DB FE CB                      DEC     BL                      ; DECREMENT LOOP COUNTER
00DD 75 EF                      JNZ     WFS0

00DF 0A FF                      OR      BH,BH                   ; SET ZERO FLAG OFF
00E1                    WFS_END:
00E1 C3                         RET

00E2                    WAIT_FOR_STATUS ENDP

00E2                    RS232_IO_1      ENDP

00E2                    CODE    ENDS
                        END
```

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                        PAGE 118,121
                        TITLE VIDEO ---- 01/10/86  VIDEO DISPLAY BIOS
                        .LIST
0000                    CODE    SEGMENT BYTE PUBLIC

                                PUBLIC  ACT_DISP_PAGE
                                PUBLIC  READ_AC_CURRENT
                                PUBLIC  READ_CURSOR
                                PUBLIC  READ_DOT
                                PUBLIC  READ_LPEN
                                PUBLIC  SCROLL_DOWN
                                PUBLIC  SCROLL_UP
                                PUBLIC  SET_COLOR
                                PUBLIC  SET_CPOS
                                PUBLIC  SET_CTYPE
                                PUBLIC  SET_MODE
                                PUBLIC  WRITE_AC_CURRENT
                                PUBLIC  WRITE_C_CURRENT
                                PUBLIC  WRITE_DOT
                                PUBLIC  WRITE_TTY
                                PUBLIC  VIDEO_IO_1
                                PUBLIC  VIDEO_STATE

                                PUBLIC  SET_MODE
                                PUBLIC  SET_CTYPE
                                PUBLIC  SET_CPOS
                                PUBLIC  READ_CURSOR
                                PUBLIC  READ_LPEN
                                PUBLIC  ACT_DISP_PAGE
                                PUBLIC  SCROLL_UP
                                PUBLIC  SCROLL_DOWN
                                PUBLIC  READ_AC_CURRENT
                                PUBLIC  WRITE_AC_CURRENT
                                PUBLIC  WRITE_C_CURRENT
                                PUBLIC  SET_COLOR
                                PUBLIC  WRITE_DOT
                                PUBLIC  READ_DOT
                                PUBLIC  WRITE_TTY
                                PUBLIC  VIDEO_STATE
                                PUBLIC  VIDEO_RETURN
                                PUBLIC  VIDEO_RETURN
                                PUBLIC  VIDEO_RETURN
                                PUBLIC  WRITE_STRING

                                EXTRN   BEEP:NEAR               ; SPEAKER BEEP ROUTINE
                                EXTRN   CRT_CHAR_GEN:NEAR       ; CHARACTER GENERATOR GRAPHICS TABLE
                                EXTRN   DDS:NEAR                ; LOAD (DS) WITH DATA SEGMENT SELECTOR
                                EXTRN   M5:WORD                 ; REGEN BUFFER LENGTH TABLE
                                EXTRN   M6:BYTE                 ; COLUMNS PER MODE TABLE
                                EXTRN   M7:BYTE                 ; MODE SET VALUE PER MODE TABLE

                        ;--- INT 10 H ----------------------------------------------------------------
                        ;                                                                           :
                        ; VIDEO_IO                                                                  :
                        ;       THESE ROUTINES PROVIDE THE CRT DISPLAY INTERFACE                    :
                        ;       THE FOLLOWING FUNCTIONS ARE PROVIDED:                               :
                        ;                                                                           :
                        ;    (AH)= 00H  SET MODE (AL) CONTAINS MODE VALUE                           :
                        ;                (AL) = 00H  40X25 BW MODE (POWER ON DEFAULT)               :
                        ;                (AL) = 01H  40X25 COLOR                                    :
                        ;                (AL) = 02H  80X25 BW                                       :
                        ;                (AL) = 03H  80X25 COLOR                                    :
                        ;                            GRAPHICS MODES                                 :
                        ;                (AL) = 04H  320X200 COLOR                                  :
                        ;                (AL) = 05H  320X200 BW MODE                                :
                        ;                (AL) = 06H  640X200 BW MODE                                :
                        ;                (AL) = 07H    80X25 MONOCHROME (USED INTERNAL TO VIDEO ONLY)   :
                        ;                *** NOTES -BW MODES OPERATE SAME AS COLOR MODES, BUT COLOR  :
                        ;                           BURST IS NOT ENABLED                            :
                        ;                          -CURSOR IS NOT DISPLAYED IN GRAPHICS MODE        :
                        ;    (AH)= 01H  SET CURSOR TYPE                                             :
                        ;                (CH) =  BITS 4-0 = START LINE FOR CURSOR                   :
                        ;                        ** HARDWARE WILL ALWAYS CAUSE BLINK                :
                        ;                        ** SETTING BIT 5 OR 6 WILL CAUSE ERRATIC BLINKING  :
                        ;                           OR NO CURSOR AT ALL                             :
                        ;                (CL) =  BITS 4-0 = END LINE FOR CURSOR                     :
                        ;    (AH)= 02H  SET CURSOR POSITION                                         :
                        ;                (DH,DL) = ROW,COLUMN  (00H,00H) IS UPPER LEFT              :
                        ;                (BH) = PAGE NUMBER (MUST BE 00H FOR GRAPHICS MODES)        :
                        ;    (AH)= 03H  READ CURSOR POSITION                                        :
                        ;                (BH) = PAGE NUMBER (MUST BE 00H FOR GRAPHICS MODES)        :
                        ;                ON EXIT (DH,DL) = ROW,COLUMN OF CURRENT CURSOR             :
                        ;                        (CH,CL) = CURSOR MODE CURRENTLY SET                :
                        ;    (AH)= 04H  READ LIGHT PEN POSITION                                     :
                        ;                ON EXIT:                                                   :
                        ;                (AH) = 00H -- LIGHT PEN SWITCH NOT DOWN/NOT TRIGGERED      :
                        ;                (AH) = 01H -- VALID LIGHT PEN VALUE IN REGISTERS           :
                        ;                        (DH,DL) = ROW,COLUMN OF CHARACTER LP POSITION      :
                        ;                        (CH) = RASTER LINE (0-199)                         :
                        ;                        (BX) = PIXEL COLUMN (0-319,639)                    :
                        ;    (AH)= 05H  SELECT ACTIVE DISPLAY PAGE (VALID ONLY FOR ALPHA MODES)     :
                        ;                (AL) = NEW PAGE VALUE (0-7 FOR MODES 0&1, 0-3 FOR MODES 2&3)  :
                        ;    (AH)= 06H  SCROLL ACTIVE PAGE UP                                      :
                        ;                (AL) = NUMBER OF LINES, ( LINES BLANKED AT BOTTOM OF WINDOW ) :
                        ;                        (AL) = 00H MEANS BLANK ENTIRE WINDOW               :
                        ;                (CH,CL) = ROW,COLUMN OF UPPER LEFT CORNER OF SCROLL        :
                        ;                (DH,DL) = ROW,COLUMN OF LOWER RIGHT CORNER OF SCROLL       :
                        ;                (BH) = ATTRIBUTE TO BE USED ON BLANK LINE                  :
                        ;    (AH)= 07H  SCROLL ACTIVE PAGE DOWN                                     :
                        ;                (AL) = NUMBER OF LINES, INPUT LINES BLANKED AT TOP OF WINDOW :
                        ;                        (AL) = 00H MEANS BLANK ENTIRE WINDOW               :
                        ;                (CH,CL) = ROW,COLUMN OF UPPER LEFT CORNER OF SCROLL        :
                        ;                (DH,DL) = ROW,COLUMN OF LOWER RIGHT CORNER OF SCROLL       :
                        ;                (BH) = ATTRIBUTE TO BE USED ON BLANK LINE                  :
                        ;                                                                           :
                        ;   CHARACTER HANDLING ROUTINES                                             :
                        ;                                                                           :
                        ;    (AH)= 08H  READ ATTRIBUTE/CHARACTER AT CURSOR POSITION                 :
                        ;                (BH) = DISPLAY PAGE (VALID FOR ALPHA MODES ONLY)           :
                        ;                ON EXIT:                                                   :
                        ;                (AL) = CHAR READ                                           :
                        ;                (AH) = ATTRIBUTE OF CHARACTER READ (ALPHA MODES ONLY)      :
                        ;    (AH)= 09H  WRITE ATTRIBUTE/CHARACTER AT CURRENT CURSOR POSITION        :
                        ;                (BH) = DISPLAY PAGE (VALID FOR ALPHA MODES ONLY)           :
```

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                        ;               (CX) = COUNT OF CHARACTERS TO WRITE                                     :
                        ;               (AL) = CHAR TO WRITE                                                    :
                        ;               (BL) = ATTRIBUTE OF CHARACTER (ALPHA)/COLOR OF CHAR (GRAPHICS)          :
                        ;                       SEE NOTE ON WRITE DOT FOR BIT 7 OF BL = 1.                      :
                        ;       (AH)= 0AH  WRITE CHARACTER ONLY AT CURRENT CURSOR POSITION                      :
                        ;               (BH) = DISPLAY PAGE (VALID FOR ALPHA MODES ONLY)                        :
                        ;               (CX) = COUNT OF CHARACTERS TO WRITE                                     :
                        ;               (AL) = CHAR TO WRITE                                                    :
                        ;                       NOTE: USE FUNCTION (AH)= 09H IN GRAPHICS MODES                  :
                        ;           FOR READ/WRITE CHARACTER INTERFACE WHILE IN GRAPHICS MODE, THE               :
                        ;               CHARACTERS ARE FORMED FROM A CHARACTER GENERATOR IMAGE                   :
                        ;               MAINTAINED IN THE SYSTEM ROM.  ONLY THE 1ST 128 CHARS                   :
                        ;               ARE CONTAINED THERE.  TO READ/WRITE THE SECOND 128 CHARS,               :
                        ;               THE USER MUST INITIALIZE THE POINTER AT INTERRUPT 1FH                   :
                        ;               (LOCATION 0007CH) TO POINT TO THE 1K BYTE TABLE CONTAINING               :
                        ;               THE CODE POINTS FOR THE SECOND 128 CHARS (128-255).                     :
                        ;           FOR WRITE CHARACTER INTERFACE IN GRAPHICS MODE, THE REPLICATION FACTOR       :
                        ;               CONTAINED IN (CX) ON ENTRY WILL PRODUCE VALID RESULTS ONLY              :
                        ;               FOR CHARACTERS CONTAINED ON THE SAME ROW.  CONTINUATION TO               :
                        ;               SUCCEEDING LINES WILL NOT PRODUCE CORRECTLY.                             :
                        ;                                                                                       :
                        ;       GRAPHICS INTERFACE                                                              :
                        ;                                                                                       :
                        ;       (AH)= 0BH  SET COLOR PALETTE                                                    :
                        ;               (BH) = PALETTE COLOR ID BEING SET (0-127)                               :
                        ;               (BL) = COLOR VALUE TO BE USED WITH THAT COLOR ID                        :
                        ;                       NOTE: FOR THE CURRENT COLOR CARD, THIS ENTRY POINT HAS          :
                        ;                               MEANING ONLY FOR 320X200 GRAPHICS.                      :
                        ;                       COLOR ID = 0 SELECTS THE BACKGROUND COLOR (0-15)                 :
                        ;                       COLOR ID = 1 SELECTS THE PALETTE TO BE USED:                     :
                        ;                               0 = GREEN(1)/RED(2)/YELLOW(3)                           :
                        ;                               1 = CYAN(1)/MAGENTA(2)/WHITE(3)                         :
                        ;                       IN 40X25 OR 80X25 ALPHA MODES, THE VALUE SET FOR                :
                        ;                               PALETTE COLOR 0 INDICATES THE BORDER COLOR              :
                        ;                               TO BE USED (VALUES 0-31, WHERE 16-31 SELECT             :
                        ;                               THE HIGH INTENSITY BACKGROUND SET.                      :
                        ;       (AH)= 0CH  WRITE DOT                                                            :
                        ;               (DX) = ROW NUMBER                                                       :
                        ;               (CX) = COLUMN NUMBER                                                    :
                        ;               (AL) = COLOR VALUE                                                      :
                        ;                       IF BIT 7 OF AL = 1, THEN THE COLOR VALUE IS EXCLUSIVE           :
                        ;                       ORed WITH THE CURRENT CONTENTS OF THE DOT                        :
                        ;       (AH)= 0DH  READ DOT                                                             :
                        ;               (DX) = ROW NUMBER                                                       :
                        ;               (CX) = COLUMN NUMBER                                                    :
                        ;               (AL) RETURNS THE DOT READ                                               :
                        ;                                                                                       :
                        ;       ASCII TELETYPE ROUTINE FOR OUTPUT                                               :
                        ;                                                                                       :
                        ;       (AH)= 0EH  WRITE TELETYPE TO ACTIVE PAGE                                        :
                        ;               (AL) = CHAR TO WRITE                                                    :
                        ;               (BL) = FOREGROUND COLOR IN GRAPHICS MODE                                :
                        ;               NOTE -- SCREEN WIDTH IS CONTROLLED BY PREVIOUS MODE SET                 :
                        ;       (AH)= 0FH  CURRENT VIDEO STATE                                                  :
                        ;               RETURNS THE CURRENT VIDEO STATE                                         :
                        ;               (AL) = MODE CURRENTLY SET ( SEE (AH)= 00H FOR EXPLANATION)              :
                        ;               (AH) = NUMBER OF CHARACTER COLUMNS ON SCREEN                            :
                        ;               (BH) = CURRENT ACTIVE DISPLAY PAGE                                      :
                        ;       (AH)= 10H  RESERVED                                                             :
                        ;       (AH)= 11H  RESERVED                                                             :
                        ;       (AH)= 12H  RESERVED                                                             :
                        ;       (AH)= 13H  WRITE STRING                                                         :
                        ;                               ES:BP  -  POINTER TO STRING TO BE WRITTEN               :
                        ;                               CX     -  LENGTH OF CHARACTER STRING TO WRITTEN         :
                        ;                               DX     -  CURSOR POSITION FOR STRING TO BE WRITTEN      :
                        ;                               BH     -  PAGE NUMBER                                   :
                        ;                       (AL)= 00H  WRITE CHARACTER STRING                               :
                        ;                               BL     -  ATTRIBUTE                                     :
                        ;                               STRING IS  <CHAR,CHAR, ... ,CHAR>                       :
                        ;                               CURSOR NOT MOVED                                        :
                        ;                       (AL)= 01H  WRITE CHARACTER STRING AND MOVE CURSOR               :
                        ;                               BL     -  ATTRIBUTE                                     :
                        ;                               STRING IS  <CHAR,CHAR, ... ,CHAR>                       :
                        ;                               CURSOR IS MOVED                                         :
                        ;                       (AL)= 02H  WRITE CHARACTER AND ATTRIBUTE STRING                 :
                        ;                                       (VALID FOR ALPHA MODES ONLY)                    :
                        ;                               STRING IS  <CHAR,ATTR,CHAR,ATTR ..  ,CHAR,ATTR>         :
                        ;                               CURSOR IS NOT MOVED                                     :
                        ;                       (AL)= 03H  WRITE CHARACTER AND ATTRIBUTE STRING AND MOVE CURSOR :
                        ;                                       (VALID FOR ALPHA MODES ONLY)                    :
                        ;                               STRING IS  <CHAR,ATTR,CHAR,ATTR ..  ,CHAR,ATTR>         :
                        ;                               CURSOR IS MOVED                                         :
                        ;                         NOTE:  CARRIAGE RETURN, LINE FEED, BACKSPACE, AND BELL ARE    :
                        ;                                TREATED AS COMMANDS RATHER THAN PRINTABLE CHARACTERS.  :
                        ;                                                                                       :
                        ;       BX,CX,DX,SI,DI,BP,SP,DS,ES,SS PRESERVED DURING CALLS EXCEPT FOR                 :
                        ;       BX,CX,DX RETURN VALUES ON FUNCTIONS 03H,04H,0DH AND 0DH. ON ALL CALLS           :
                        ;       AX IS MODIFIED.                                                                 :
                        ;-----------------------------------------------------------------------------------------

                                ASSUME  CS:CODE,DS:DATA,ES:NOTHING

0000 005F R             M1      DW      OFFSET  SET_MODE        ;  TABLE OF ROUTINES WITHIN VIDEO I/O
0002 0146 R                     DW      OFFSET  SET_CTYPE
0004 0167 R                     DW      OFFSET  SET_CPOS
0006 018F R                     DW      OFFSET  READ_CURSOR
0008 0785 R                     DW      OFFSET  READ_LPEN
000A 01A6 R                     DW      OFFSET  ACT_DISP_PAGE
000C 020F R                     DW      OFFSET  SCROLL_UP
000E 02AD R                     DW      OFFSET  SCROLL_DOWN
0010 02FF R                     DW      OFFSET  READ_AC_CURRENT
0012 035C R                     DW      OFFSET  WRITE_AC_CURRENT
0014 038E R                     DW      OFFSET  WRITE_C_CURRENT
0016 01C8 R                     DW      OFFSET  SET_COLOR
0018 0450 R                     DW      OFFSET  WRITE_DOT
001A 043F R                     DW      OFFSET  READ_DOT
001C 06FE R                     DW      OFFSET  WRITE_TTY
001E 01EE R                     DW      OFFSET  VIDEO_STATE
0020 013D R                     DW      OFFSET  VIDEO_RETURN    ; RESERVED
0022 013D R                     DW      OFFSET  VIDEO_RETURN    ; RESERVED
0024 013D R                     DW      OFFSET  VIDEO_RETURN    ; RESERVED
0026 03BB R                     DW      OFFSET  WRITE_STRING    ; CASE 13H, WRITE STRING
= 0028                  M1L     EQU     $-M1
```

SECTION 5

```
0028                    VIDEO_IO_1      PROC    NEAR                    ;       ENTRY POINT FOR ORG 0F065H
0028 FB                                 STI                             ; INTERRUPTS BACK ON
0029 FC                                 CLD                             ; SET DIRECTION FORWARD
002A 80 FC 14                           CMP     AH,MIL/2                ; TEST FOR WITHIN TABLE RANGE
002D 73 2F                              JNB     M4                      ; BRANCH TO EXIT IF NOT A VALID COMMAND

002F 06                                 PUSH    ES
0030 1E                                 PUSH    DS                      ; SAVE WORK AND PARAMETER REGISTERS
0031 52                                 PUSH    DX
0032 51                                 PUSH    CX
0033 53                                 PUSH    BX
0034 56                                 PUSH    SI
0035 57                                 PUSH    DI
0036 55                                 PUSH    BP
0037 BE ---- R                          MOV     SI,DATA                 ; POINT DS: TO DATA SEGMENT
003A 8E DE                              MOV     DS,SI
003C 8B F0                              MOV     SI,AX                   ; SAVE COMMAND/DATA INTO (SI) REGISTER
003E A0 0010 R                          MOV     AL,BYTE PTR @EQUIP_FLAG ; GET THE EQUIPMENT FLAG VIDEO BITS
0041 24 30                              AND     AL,30H                  ; ISOLATE CRT SWITCHES
0043 3C 30                              CMP     AL,30H                  ; IS SETTING FOR MONOCHROME CARD?
0045 BF B800                            MOV     DI,0B800H               ; GET SEGMENT FOR COLOR CARD
0048 75 03                              JNE     M2                      ; SKIP IF NOT MONOCHROME CARD
004A BF B000                            MOV     DI,0B000H               ; ELSE GET SEGMENT FOR MONOCHROME CARD
004D                    M2:
004D 8E C7                              MOV     ES,DI                   ; SET UP TO POINT AT VIDEO MEMORY AREAS
004F 8A C4                              MOV     AL,AH                   ; PLACE COMMAND IN LOW BYTE OF (AX)
0051 98                                 CBW                             ; AND FORM BYTE OFFSET WITH COMMAND
0052 D1 E0                              SAL     AX,1                    ; TIMES 2 FOR WORD TABLE LOOKUP
0054 96                                 XCHG    SI,AX                   ; MOVE OFFSET INTO LOOK UP REGISTER (SI)
                                                                        ;   AND RESTORE COMMAND/DATA INTO (AX)
0055 8A 26 0049 R                       MOV     AH,@CRT_MODE            ; MOVE CURRENT MODE INTO (AH) REGISTER

0059 2E: FF A4 0000 R                   JMP     WORD PTR CS:[SI+OFFSET M1]      ; GO TO SELECTED FUNCTION

005E                    M4:                                             ;       COMMAND NOT VALID
005E CF                                 IRET                            ; DO NOTHING IF NOT IN VALID RANGE
005F                    VIDEO_IO_1      ENDP
                        ;--------------------------------------------------------
                        ; SET_MODE                                             :
                        ;       THIS ROUTINE INITIALIZES THE ATTACHMENT TO      :
                        ;       THE SELECTED MODE.  THE SCREEN IS BLANKED.      :
                        ; INPUT                                                 :
                        ;       @EQUIP_FLAG BITS 5-4 = MODE/WIDTH               :
                        ;           11 = MONOCHROME (FORCES MODE 7)             :
                        ;           01 = COLOR ADAPTER 40x25 (MODE 0 DEFAULT)   :
                        ;           10 = COLOR ADAPTER 80x25 (MODE 2 DEFAULT)   :
                        ;         (AL) = COLOR MODE REQUESTED ( RANGE  0 - 6 )  :
                        ; OUTPUT                                                :
                        ;       NONE                                            :
                        ;--------------------------------------------------------
005F                    SET_MODE        PROC    NEAR
005F BA 03D4                            MOV     DX,03D4H                ; ADDRESS OF COLOR CARD
0062 8B 3E 0010 R                       MOV     DI,@EQUIP_FLAG          ; GET EQUIPMENT FLAGS SETTING
0066 81 E7 0030                         AND     DI,30H                  ; ISOLATE CRT SWITCHES
006A 83 FF 30                           CMP     DI,30H                  ; IS BW CARD INSTALLED AS PRIMARY
006D 75 06                              JNE     M8C                     ; SKIP AND CHECK IF COLOR
006F B0 07                              MOV     AL,7                    ; ELSE INDICATE INTERNAL BW CARD MODE
0071 B2 B4                              MOV     DL,0B4H                 ; SET ADDRESS OF BW (MONOCHROME) CARD
0073 EB 0D                              JMP     SHORT M8                ; CONTINUE WITH FORCED MODE 7
0075                    M8C:
0075 3C 07                              CMP     AL,7                    ; CHECK FOR VALID COLOR MODES 0-6
0077 72 09                              JB      M8                      ; CONTINUE IF BELOW MODE 7
0079 B0 00                              MOV     AL,0                    ; FORCE DEFAULT 40x25 BW MODE
007B 83 FF 20                           CMP     DI,20H                  ; CHECK FOR @EQUIP_FLAG AT 80x25 BW
007E 74 02                              JE      M8                      ; CONTINUE WITH MODE 0 IF NOT
0080 B0 02                              MOV     AL,2                    ; ELSE FORCE MODE 2
0082                    M8:
0082 A2 0049 R                          MOV     @CRT_MODE,AL            ; SAVE MODE IN GLOBAL VARIABLE
0085 89 16 0063 R                       MOV     @ADDR_6845,DX           ; SAVE ADDRESS OF BASE
0089 C6 06 0084 R 18                    MOV     @ROWS,25-1              ; INITIALIZE DEFAULT ROW COUNT OF 25
008E 1E                                 PUSH    DS                      ; SAVE POINTER TO DATA SEGMENT
008F 50                                 PUSH    AX                      ; SAVE MODE NUMBER (AL)
0090 98                                 CBW                             ; CLEAR HIGH BYTE OF MODE
0091 8B F0                              MOV     SI,AX                   ; SET TABLE POINTER, INDEXED BY MODE
0093 2E: 8A 84 0000 E                   MOV     AL,CS:[SI + OFFSET M7]  ; GET THE MODE SET VALUE FROM TABLE
0098 A2 0065 R                          MOV     @CRT_MODE_SET,AL        ; SAVE THE MODE SET VALUE
009B 24 37                              AND     AL,037H                 ; VIDEO OFF, SAVE HIGH RESOLUTION BIT
009D 52                                 PUSH    DX                      ; SAVE OUTPUT PORT VALUE
009E 83 C2 04                           ADD     DX,4                    ; POINT TO CONTROL REGISTER
00A1 EE                                 OUT     DX,AL                   ; RESET VIDEO TO OFF TO SUPPRESS ROLLING
00A2 5A                                 POP     DX                      ; BACK TO BASE REGISTER
                                        ASSUME  DS:ABS0
00A3 2B DB                              SUB     BX,BX                   ; SET UP FOR ABS0 SEGMENT
00A5 8E DB                              MOV     DS,BX                   ; ESTABLISH VECTOR TABLE ADDRESSING
00A7 C5 1E 0074 R                       LDS     BX,@PARM_PTR            ; GET POINTER TO VIDEO PARMS
                                        ASSUME  DS:CODE
00AB 58                                 POP     AX                      ; RECOVER MODE NUMBER IN (AL)
00AC B9 0010                            MOV     CX,16                   ; LENGTH OF EACH ROW OF TABLE
00AF 3C 02                              CMP     AL,2                    ; DETERMINE WHICH ONE TO USE
00B1 72 0E                              JC      M9                      ; MODE IS 0 OR 1
00B3 03 D9                              ADD     BX,CX                   ; NEXT ROW OF INITIALIZATION TABLE
00B5 3C 04                              CMP     AL,4
00B7 72 08                              JC      M9                      ; MODE IS 2 OR 3
00B9 03 D9                              ADD     BX,CX                   ; MOVE TO GRAPHICS ROW OF INIT_TABLE
00BB 3C 07                              CMP     AL,7
00BD 72 02                              JC      M9                      ; MODE IS 4,5, OR 6
00BF 03 D9                              ADD     BX,CX                   ; MOVE TO BW CARD ROW OF INIT_TABLE

                        ;-----  BX POINTS TO CORRECT ROW OF INITIALIZATION TABLE

00C1                    M9:                                             ; OUT_INIT
00C1 50                                 PUSH    AX                      ; SAVE MODE IN (AL)
00C2 8B 47 0A                           MOV     AX,[BX+10]              ; GET THE CURSOR MODE FROM THE TABLE
00C5 86 E0                              XCHG    AH,AL                   ; PUT CURSOR MODE IN CORRECT POSITION
00C7 1E                                 PUSH    DS                      ; SAVE TABLE SEGMENT POINTER
                                        ASSUME  DS:DATA
00C8 E8 0000 E                          CALL    DDS                     ; POINT DS TO DATA SEGMENT
00CB A3 0060 R                          MOV     @CURSOR_MODE,AX         ; PLACE INTO BIOS DATA SAVE AREA
                                        ASSUME  DS:CODE
00CE 1F                                 POP     DS                      ; RESTORE THE TABLE SEGMENT POINTER
00CF 32 E4                              XOR     AH,AH                   ; AH IS REGISTER NUMBER DURING LOOP

                        ;-----  LOOP THROUGH TABLE, OUTPUTTING REGISTER ADDRESS, THEN VALUE FROM TABLE
```

```
00D1                    M10:                                    ;  INITIALIZATION LOOP
00D1 8A C4                      MOV     AL,AH                   ; GET 6845 REGISTER NUMBER
00D3 EE                         OUT     DX,AL
00D4 42                         INC     DX                      ; POINT TO DATA PORT
00D5 FE C4                      INC     AH                      ; NEXT REGISTER VALUE
00D7 8A 07                      MOV     AL,[BX]                 ; GET TABLE VALUE
00D9 EE                         OUT     DX,AL                   ; OUT TO CHIP
00DA 43                         INC     BX                      ; NEXT IN TABLE
00DB 4A                         DEC     DX                      ; BACK TO POINTER REGISTER
00DC E2 F3                      LOOP    M10                     ; DO THE WHOLE TABLE
00DE 58                         POP     AX                      ; GET MODE BACK INTO (AL)
00DF 1F                         POP     DS                      ; RECOVER SEGMENT VALUE
                                ASSUME  DS:DATA
                        ;-----  FILL REGEN AREA WITH BLANK
00E0 33 FF                      XOR     DI,DI                   ; SET UP POINTER FOR REGEN
00E2 89 3E 004E R               MOV     @CRT_START,DI           ; START ADDRESS SAVED IN GLOBAL
00E6 C6 06 0062 R 00            MOV     @ACTIVE_PAGE,0          ; SET PAGE VALUE
00EB B9 2000                    MOV     CX,8192                 ; NUMBER OF WORDS IN COLOR CARD
00EE 3C 04                      CMP     AL,4                    ; TEST FOR GRAPHICS
00F0 72 0A                      JC      M12                     ; NO_GRAPHICS_INIT
00F2 3C 07                      CMP     AL,7                    ; TEST FOR BW CARD
00F4 74 04                      JE      M11                     ; BW_CARD_INIT
00F6 33 C0                      XOR     AX,AX                   ; FILL FOR GRAPHICS MODE
00F8 EB 05                      JMP     SHORT M13               ; CLEAR_BUFFER
00FA                    M11:                                    ; BW_CARD_INIT
00FA B5 08                      MOV     CH,08H                  ; BUFFER SIZE ON BW CARD (2048)
00FC                    M12:                                    ; NO_GRAPHICS_INIT
00FC B8 0720                    MOV     AX,' '+7*H              ; FILL CHAR FOR ALPHA + ATTRIBUTE
00FF                    M13:                                    ; CLEAR_BUFFER
00FF F3/ AB                     REP     STOSW                   ; FILL THE REGEN BUFFER WITH BLANKS
                        ;-----  ENABLE VIDEO AND CORRECT PORT SETTING
0101 8B 16 0063 R               MOV     DX,@ADDR_6845           ; PREPARE TO OUTPUT TO VIDEO ENABLE PORT
0105 83 C2 04                   ADD     DX,4                    ; POINT TO THE MODE CONTROL REGISTER
0108 A0 0065 R                  MOV     AL,@CRT_MODE_SET        ; GET THE MODE SET VALUE
010B EE                         OUT     DX,AL                   ; SET VIDEO ENABLE PORT
                        ;-----  DETERMINE NUMBER OF COLUMNS, BOTH FOR ENTIRE DISPLAY
                        ;-----  AND THE NUMBER TO BE USED FOR TTY INTERFACE
010C 2E: 8A 84 0000 E           MOV     AL,CS:[SI + OFFSET M6]  ; GET NUMBER OF COLUMNS ON THIS SCREEN
0111 98                         CBW                             ; CLEAR HIGH BYTE
0112 A3 004A R                  MOV     @CRT_COLS,AX            ; INITIALIZE NUMBER OF COLUMNS COUNT
                        ;-----  SET CURSOR POSITIONS
0115 81 E6 000E                 AND     SI,000EH                ; WORD OFFSET INTO CLEAR LENGTH TABLE
0119 2E: 8B 84 0000 E           MOV     AX,CS:[SI + OFFSET M5]  ; LENGTH TO CLEAR
011E A3 004C R                  MOV     @CRT_LEN,AX             ; SAVE LENGTH OF CRT -- NOT USED FOR BW
0121 B9 0008                    MOV     CX,8                    ; CLEAR ALL CURSOR POSITIONS
0124 BF 0050 R                  MOV     DI,OFFSET @CURSOR_POSN
0127 1E                         PUSH    DS                      ; ESTABLISH SEGMENT
0128 07                         POP     ES                      ;   ADDRESSING
0129 33 C0                      XOR     AX,AX
012B F3/ AB                     REP     STOSW                   ; FILL WITH ZEROES
                        ;-----  SET UP OVERSCAN REGISTER
012D 42                         INC     DX                      ; SET OVERSCAN PORT TO A DEFAULT
012E B0 30                      MOV     AL,30H                  ; 30H VALUE FOR ALL MODES EXCEPT 640X200
0130 80 3E 0049 R 06            CMP     @CRT_MODE,6             ; SEE IF THE MODE IS 640X200 BW
0135 75 02                      JNZ     M14                     ; IF NOT 640X200, THEN GO TO REGULAR
0137 B0 3F                      MOV     AL,3FH                  ; IF IT IS 640X200, THEN PUT IN 3FH
0139                    M14:
0139 EE                         OUT     DX,AL                   ; OUTPUT THE CORRECT VALUE TO 3D9 PORT
013A A2 0066 R                  MOV     @CRT_PALETTE,AL         ; SAVE THE VALUE FOR FUTURE USE
                        ;-----  NORMAL RETURN FROM ALL VIDEO RETURNS
013D                    VIDEO_RETURN:
013D 5D                         POP     BP
013E 5F                         POP     DI
013F 5E                         POP     SI
0140 5B                         POP     BX
0141                    M15:                                    ; VIDEO_RETURN_C
0141 59                         POP     CX
0142 5A                         POP     DX
0143 1F                         POP     DS
0144 07                         POP     ES                      ; RECOVER SEGMENTS
0145 CF                         IRET                            ; ALL DONE
0146                    SET_MODE        ENDP
                        ;--------------------------------------------------
                        ; SET_CTYPE
                        ;       THIS ROUTINE SETS THE CURSOR VALUE
                        ; INPUT
                        ;       (CX) HAS CURSOR VALUE CH-START LINE, CL-STOP LINE
                        ; OUTPUT
                        ;       NONE
                        ;--------------------------------------------------
0146                    SET_CTYPE       PROC    NEAR
0146 B4 0A                      MOV     AH,10                   ; 6845 REGISTER FOR CURSOR SET
0148 89 0E 0060 R               MOV     @CURSOR_MODE,CX         ; SAVE IN DATA AREA
014C E8 0151 R                  CALL    M16                     ; OUTPUT CX REGISTER
014F EB EC                      JMP     VIDEO_RETURN
                        ;-----  THIS ROUTINE OUTPUTS THE CX REGISTER TO THE 6845 REGISTERS NAMED IN (AH)
0151                    M16:
0151 8B 16 0063 R               MOV     DX,@ADDR_6845           ; ADDRESS REGISTER
0155 8A C4                      MOV     AL,AH                   ; GET VALUE
0157 EE                         OUT     DX,AL                   ; REGISTER SET
0158 42                         INC     DX                      ; DATA REGISTER
0159 8A C5                      MOV     AL,CH                   ; DATA
015B EE                         OUT     DX,AL
015C 4A                         DEC     DX
015D 8A C4                      MOV     AL,AH
015F FE C0                      INC     AL                      ; POINT TO OTHER DATA REGISTER
0161 EE                         OUT     DX,AL                   ; SET FOR SECOND REGISTER
0162 42                         INC     DX
0163 8A C1                      MOV     AL,CL                   ; SECOND DATA VALUE
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0165 EE                         OUT     DX,AL
0166 C3                         RET                             ; ALL DONE
0167                    SET_CTYPE       ENDP

                        ;--------------------------------------------
                        ; SET_CPOS                                                      :
                        ;       THIS ROUTINE SETS THE CURSOR POSITION TO THE            :
                        ;       NEW X-Y VALUES PASSED                                   :
                        ; INPUT                                                         :
                        ;       DX - ROW,COLUMN OF NEW CURSOR                           :
                        ;       BH - DISPLAY PAGE OF CURSOR                             :
                        ; OUTPUT                                                        :
                        ;       CURSOR IS SET AT 6845 IF DISPLAY PAGE IS CURRENT DISPLAY :
                        ;--------------------------------------------
0167                    SET_CPOS        PROC    NEAR
0167 8A C7                      MOV     AL,BH                   ; MOVE PAGE NUMBER TO WORK REGISTER
0169 98                         CBW                             ; CONVERT PAGE TO WORD VALUE
016A D1 E0                      SAL     AX,1                    ; WORD OFFSET
016C 96                         XCHG    AX,SI                   ; USE INDEX REGISTER
016D 89 94 0050 R               MOV     [SI+OFFSET @CURSOR_POSN],DX     ; SAVE THE POINTER
0171 38 3E 0062 R               CMP     @ACTIVE_PAGE,BH
0175 75 05                      JNZ     M17                     ; SET_CPOS_RETURN
0177 8B C2                      MOV     AX,DX                   ; GET ROW/COLUMN TO AX
0179 E8 017E R                  CALL    M18                     ; CURSOR_SET
017C                    M17:                                    ; SET_CPOS_RETURN
017C EB BF                      JMP     VIDEO_RETURN
017E                    SET_CPOS        ENDP

                        ;-----  SET CURSOR POSITION, AX HAS ROW/COLUMN FOR CURSOR

017E                    M18     PROC    NEAR
017E E8 0200 R                  CALL    POSITION                ; DETERMINE LOCATION IN REGEN BUFFER
0181 8B C8                      MOV     CX,AX
0183 03 0E 004E R               ADD     CX,@CRT_START           ; ADD IN THE START ADDRESS FOR THIS PAGE
0187 D1 F9                      SAR     CX,1                    ; DIVIDE BY 2 FOR CHAR ONLY COUNT
0189 B4 0E                      MOV     AH,14                   ; REGISTER NUMBER FOR CURSOR
018B E8 0151 R                  CALL    M16                     ; OUTPUT THE VALUE TO THE 6845
018E C3                         RET
018F                    M18     ENDP
                        ;--------------------------------------------------
                        ; READ_CURSOR                                                   :
                        ;       THIS ROUTINE READS THE CURRENT CURSOR VALUE FROM THE     :
                        ;       6845, FORMATS IT, AND SENDS IT BACK TO THE CALLER       :
                        ; INPUT                                                         :
                        ;       BH - PAGE OF CURSOR                                     :
                        ; OUTPUT                                                        :
                        ;       DX - ROW, COLUMN OF THE CURRENT CURSOR POSITION         :
                        ;       CX - CURRENT CURSOR MODE                                :
                        ;--------------------------------------------
018F                    READ_CURSOR     PROC    NEAR
018F 8A DF                      MOV     BL,BH
0191 32 FF                      XOR     BH,BH
0193 D1 E3                      SAL     BX,1                    ; WORD OFFSET
0195 8B 97 0050 R               MOV     DX,[BX+OFFSET @CURSOR_POSN]
0199 8B 0E 0060 R               MOV     CX,@CURSOR_MODE
019D 5D                         POP     BP
019E 5F                         POP     DI
019F 5E                         POP     SI
01A0 5B                         POP     BX
01A1 58                         POP     AX                      ; DISCARD SAVED CX AND DX
01A2 58                         POP     AX
01A3 1F                         POP     DS
01A4 07                         POP     ES
01A5 CF                         IRET
01A6                    READ_CURSOR     ENDP
                        ;--------------------------------------------
                        ; ACT_DISP_PAGE                                                 :
                        ;       THIS ROUTINE SETS THE ACTIVE DISPLAY PAGE, ALLOWING     :
                        ;       THE FULL USE OF THE MEMORY SET ASIDE FOR THE VIDEO ATTACHMENT
                        ; INPUT                                                         :
                        ;       AL HAS THE NEW ACTIVE DISPLAY PAGE                      :
                        ; OUTPUT                                                        :
                        ;       THE 6845 IS RESET TO DISPLAY THAT PAGE                  :
                        ;--------------------------------------------
01A6                    ACT_DISP_PAGE   PROC    NEAR
01A6 A2 0062 R                  MOV     @ACTIVE_PAGE,AL         ; SAVE ACTIVE PAGE VALUE
01A9 98                         CBW                             ; CONVERT (AL) TO WORD
01AA 50                         PUSH    AX                      ; SAVE PAGE VALUE
01AB F7 26 004C R               MUL     WORD PTR @CRT_LEN       ; DISPLAY PAGE TIMES REGEN LENGTH
01AF A3 004E R                  MOV     @CRT_START,AX           ; SAVE START ADDRESS FOR LATER
01B2 8B C8                      MOV     CX,AX                   ; START ADDRESS TO CX
01B4 D1 F9                      SAR     CX,1                    ; DIVIDE BY 2 FOR 6845 HANDLING
01B6 B4 0C                      MOV     AH,12                   ; 6845 REGISTER FOR START ADDRESS
01B8 E8 0151 R                  CALL    M16
01BB 5B                         POP     BX                      ; RECOVER PAGE VALUE
01BC D1 E3                      SAL     BX,1                    ; *2 FOR WORD OFFSET
01BE 8B 87 0050 R               MOV     AX,[BX + OFFSET @CURSOR_POSN]   ; GET CURSOR FOR THIS PAGE
01C2 E8 017E R                  CALL    M18                     ; SET THE CURSOR POSITION
01C5 E9 013D R                  JMP     VIDEO_RETURN
01C8                    ACT_DISP_PAGE   ENDP
                        ;--------------------------------------------
                        ; SET COLOR                                                     :
                        ;       THIS ROUTINE WILL ESTABLISH THE BACKGROUND COLOR, THE OVERSCAN COLOR,
                        ;       AND THE FOREGROUND COLOR SET FOR MEDIUM RESOLUTION GRAPHICS
                        ; INPUT                                                         :
                        ;       (BH) HAS COLOR ID                                       :
                        ;               IF BH=0, THE BACKGROUND COLOR VALUE IS SET      :
                        ;                       FROM THE LOW BITS OF BL (0-31)          :
                        ;               IF BH=1, THE PALETTE SELECTION IS MADE          :
                        ;                       BASED ON THE LOW BIT OF BL:             :
                        ;                               0 = GREEN, RED, YELLOW FOR COLORS 1,2,3
                        ;                               1 = BLUE, CYAN, MAGENTA FOR COLORS 1,2,3
                        ;       (BL) HAS THE COLOR VALUE TO BE USED                     :
                        ; OUTPUT                                                        :
                        ;       THE COLOR SELECTION IS UPDATED                          :
                        ;--------------------------------------------
01C8                    SET_COLOR       PROC    NEAR
01C8 8B 16 0063 R               MOV     DX,@ADDR_6845           ; I/O PORT FOR PALETTE
01CC 83 C2 05                   ADD     DX,5                    ; OVERSCAN PORT
01CF A0 0066 R                  MOV     AL,@CRT_PALETTE         ; GET THE CURRENT PALETTE VALUE
01D2 0A FF                      OR      BH,BH                   ; IS THIS COLOR 0?
01D4 75 0E                      JNZ     M20                     ; OUTPUT COLOR 1

                        ;-----  HANDLE COLOR 0 BY SETTING THE BACKGROUND COLOR
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                        AND     AL,0E0H                 ; TURN OFF LOW 5 BITS OF CURRENT
                        AND     BL,01FH                 ; TURN OFF HIGH 3 BITS OF INPUT VALUE
                        OR      AL,BL                   ; PUT VALUE INTO REGISTER
                M19:                                    ; OUTPUT THE PALETTE
                        OUT     DX,AL                   ; OUTPUT COLOR SELECTION TO 3D9 PORT
                        MOV     @CRT_PALETTE,AL         ; SAVE THE COLOR VALUE
                        JMP     VIDEO_RETURN

                ;-----  HANDLE COLOR 1 BY SELECTING THE PALETTE TO BE USED

                M20:
                        AND     AL,0DFH                 ; TURN OFF PALETTE SELECT BIT
                        SHR     BL,1                    ; TEST THE LOW ORDER BIT OF BL
                        JNC     M19                     ; ALREADY DONE
                        OR      AL,20H                  ; TURN ON PALETTE SELECT BIT
                        JMP     M19                     ; GO DO IT
                SET_COLOR       ENDP
                ;--------------------------------------------------------
                ; VIDEO STATE
                ;  RETURNS THE CURRENT VIDEO STATE IN AX
                ;  AH = NUMBER OF COLUMNS ON THE SCREEN
                ;  AL = CURRENT VIDEO MODE
                ;  BH = CURRENT ACTIVE PAGE
                ;--------------------------------------------------------
                VIDEO_STATE     PROC    NEAR
                        MOV     AH,BYTE PTR @CRT_COLS   ; GET NUMBER OF COLUMNS
                        MOV     AL,@CRT_MODE            ; CURRENT MODE
                        MOV     BH,@ACTIVE_PAGE         ; GET CURRENT ACTIVE PAGE
                        POP     BP                      ; RECOVER REGISTERS
                        POP     DI
                        POP     SI
                        POP     CX                      ; DISCARD SAVED BX
                        JMP     M15                     ; RETURN TO CALLER
                VIDEO_STATE     ENDP
                ;--------------------------------------
                ; POSITION
                ;       THIS SERVICE ROUTINE CALCULATES THE REGEN BUFFER ADDRESS
                ;       OF A CHARACTER IN THE ALPHA MODE
                ; INPUT
                ;       AX = ROW, COLUMN POSITION
                ; OUTPUT
                ;       AX = OFFSET OF CHAR POSITION IN REGEN BUFFER
                ;--------------------------------------
                POSITION        PROC    NEAR
                        PUSH    BX                      ; SAVE REGISTER
                        XCHG    BX,AX                   ; SAVE ROW/COLUNM POSITION IN (BX)
                        MOV     AL,BYTE PTR @CRT_COLS   ; GET COLUMNS PER ROW COUNT
                        MUL     BH                      ; DETERMINE BYTES TO ROW
                        XOR     BH,BH
                        ADD     AX,BX                   ; ADD IN COLUMN VALUE
                        SAL     AX,1                    ; * 2 FOR ATTRIBUTE BYTES
                        POP     BX
                        RET
                POSITION        ENDP
                ;----------------------------------------
                ; SCROLL UP
                ;       THIS ROUTINE MOVES A BLOCK OF CHARACTERS UP
                ;       ON THE SCREEN
                ; INPUT
                ;       (AH) = CURRENT CRT MODE
                ;       (AL) = NUMBER OF ROWS TO SCROLL
                ;       (CX) = ROW/COLUMN OF UPPER LEFT CORNER
                ;       (DX) = ROW/COLUMN OF LOWER RIGHT CORNER
                ;       (BH) = ATTRIBUTE TO BE USED ON BLANKED LINE
                ;       (DS) = DATA SEGMENT
                ;       (ES) = REGEN BUFFER SEGMENT
                ; OUTPUT
                ;       NONE -- THE REGEN BUFFER IS MODIFIED
                ;----------------------------------------
                        ASSUME  DS:DATA,ES:DATA
                SCROLL_UP       PROC    NEAR

                        CALL    TEST_LINE_COUNT
                        CMP     AH,4
                        JC      N1                      ; HANDLE SEPARATELY
                        CMP     AH,7                    ; TEST FOR BW CARD
                        JE      N1
                        JMP     GRAPHICS_UP
                N1:                                     ; UP_CONTINUE
                        PUSH    BX                      ; SAVE FILL ATTRIBUTE IN BH
                        MOV     AX,CX                   ; UPPER LEFT POSITION
                        CALL    SCROLL_POSITION         ; DO SETUP FOR SCROLL
                        JZ      N7                      ; BLANK_FIELD
                        ADD     SI,AX                   ; FROM ADDRESS
                        MOV     AH,DH                   ; # ROWS IN BLOCK
                        SUB     AH,BL                   ; # ROWS TO BE MOVED
                N2:                                     ; ROW_LOOP
                        CALL    N10                     ; MOVE ONE ROW
                        ADD     SI,BP
                        ADD     DI,BP                   ; POINT TO NEXT LINE IN BLOCK
                        DEC     AH                      ; COUNT OF LINES TO MOVE
                        JNZ     N2                      ; ROW_LOOP
                N3:                                     ; CLEAR_ENTRY
                        POP     AX                      ; RECOVER ATTRIBUTE IN AH
                        MOV     AL,' '                  ; FILL WITH BLANKS
                N4:                                     ; CLEAR_LOOP
                        CALL    N11                     ; CLEAR THE ROW
                        ADD     DI,BP                   ; POINT TO NEXT LINE
                        DEC     BL                      ; COUNTER OF LINES TO SCROLL
                        JNZ     N4                      ; CLEAR_LOOP
                N5:                                     ; SCROLL_END
                        CALL    DDS
                        CMP     @CRT_MODE,7             ; IS THIS THE BLACK AND WHITE CARD
                        JE      N6                      ; IF SO, SKIP THE MODE RESET
                        MOV     AL,@CRT_MODE_SET        ; GET THE VALUE OF THE MODE SET
                        MOV     DX,03D8H                ; ALWAYS SET COLOR CARD PORT
                        OUT     DX,AL
                N6:                                     ; VIDEO_RET_HERE
                        JMP     VIDEO_RETURN
                N7:                                     ; BLANK_FIELD
                        MOV     BL,DH                   ; GET ROW COUNT
                        JMP     N3                      ; GO CLEAR THAT AREA
                SCROLL_UP       ENDP
```

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                        ;-----  HANDLE COMMON SCROLL SET UP HERE
                        
025C                    SCROLL_POSITION PROC    NEAR
025C E8 0200 R                  CALL    POSITION                ; CONVERT TO REGEN POINTER
025F 03 06 004E R               ADD     AX,@CRT_START           ; OFFSET OF ACTIVE PAGE
0263 8B F8                      MOV     DI,AX                   ; TO ADDRESS FOR SCROLL
0265 8B F0                      MOV     SI,AX                   ; FROM ADDRESS FOR SCROLL
0267 2B D1                      SUB     DX,CX                   ; DX = #ROWS, #COLS IN BLOCK
0269 FE C6                      INC     DH
026B FE C2                      INC     DL                      ; INCREMENT FOR 0 ORIGIN
026D 32 ED                      XOR     CH,CH                   ; SET HIGH BYTE OF COUNT TO ZERO
026F 8B 2E 004A R               MOV     BP,@CRT_COLS            ; GET NUMBER OF COLUMNS IN DISPLAY
0273 03 ED                      ADD     BP,BP                   ; TIMES 2 FOR ATTRIBUTE BYTE
0275 A0 004A R                  MOV     AL,BYTE PTR @CRT_COLS   ; GET CHARACTERS PER LINE COUNT
0278 F6 E3                      MUL     BL                      ; DETERMINE OFFSET TO FROM ADDRESS
027A 03 C0                      ADD     AX,AX                   ; *2 FOR ATTRIBUTE BYTE
027C 50                         PUSH    AX                      ; SAVE LINE COUNT
027D A0 0049 R                  MOV     AL,@CRT_MODE            ; GET CURRENT MODE
0280 06                         PUSH    ES                      ; ESTABLISH ADDRESSING TO REGEN BUFFER
0281 1F                         POP     DS                      ;  FOR BOTH POINTERS
0282 3C 02                      CMP     AL,2                    ; TEST FOR COLOR CARD SPECIAL CASES HERE
0284 72 13                      JB      N9                      ; HAVE TO HANDLE 80X25 SEPARATELY
0286 3C 03                      CMP     AL,3
0288 77 0F                      JA      N9
                        ;-----
                                                                ; 80X25 COLOR CARD SCROLL
028A 52                         PUSH    DX
028B BA 03DA                    MOV     DX,3DAH                 ; GUARANTEED TO BE COLOR CARD HERE
                        N8:                                     ; WAIT_DISP_ENABLE
028E EC                         IN      AL,DX                   ; GET PORT
028F A8 08                      TEST    AL,RVRT                 ; WAIT FOR VERTICAL RETRACE
0291 74 FB                      JZ      N8                      ; WAIT_DISP_ENABLE
0293 B0 25                      MOV     AL,25H
0295 B2 D8                      MOV     DL,0D8H                 ; ADDRESS CONTROL PORT
0297 EE                         OUT     DX,AL                   ; TURN OFF VIDEO DURING VERTICAL RETRACE
0298 5A                         POP     DX
0299                    N9:
0299 58                         POP     AX                      ; RESTORE LINE COUNT
029A 0A DB                      OR      BL,BL                   ; 0 SCROLL MEANS BLANK FIELD
029C C3                         RET                             ; RETURN WITH FLAGS SET
029D                    SCROLL_POSITION ENDP
                        
                        ;-----  MOVE_ROW
029D                    N10     PROC    NEAR
029D 8A CA                      MOV     CL,DL                   ; GET # OF COLS TO MOVE
029F 56                         PUSH    SI
02A0 57                         PUSH    DI                      ; SAVE START ADDRESS
02A1 F3/ A5                     REP     MOVSW                   ; MOVE THAT LINE ON SCREEN
02A3 5F                         POP     DI
02A4 5E                         POP     SI                      ; RECOVER ADDRESSES
02A5 C3                         RET
02A6                    N10     ENDP
                        
                        ;-----  CLEAR_ROW
02A6                    N11     PROC    NEAR
02A6 8A CA                      MOV     CL,DL                   ; GET # COLUMNS TO CLEAR
02A8 57                         PUSH    DI
02A9 F3/ AB                     REP     STOSW                   ; STORE THE FILL CHARACTER
02AB 5F                         POP     DI
02AC C3                         RET
02AD                    N11     ENDP
                        ;--------------------------------------
                        ; SCROLL_DOWN
                        ;       THIS ROUTINE MOVES THE CHARACTERS WITHIN A DEFINED
                        ;       BLOCK DOWN ON THE SCREEN, FILLING THE TOP LINES
                        ;       WITH A DEFINED CHARACTER
                        ; INPUT
                        ;       (AH) = CURRENT CRT MODE
                        ;       (AL) = NUMBER OF LINES TO SCROLL
                        ;       (CX) = UPPER LEFT CORNER OF REGION
                        ;       (DX) = LOWER RIGHT CORNER OF REGION
                        ;       (BH) = FILL CHARACTER
                        ;       (DS) = DATA SEGMENT
                        ;       (ES) = REGEN SEGMENT
                        ; OUTPUT
                        ;       NONE -- SCREEN IS SCROLLED
                        ;--------------------------------------
02AD                    SCROLL_DOWN     PROC    NEAR
02AD FD                         STD                             ; DIRECTION FOR SCROLL DOWN
02AE E8 02EA R                  CALL    TEST_LINE_COUNT         ;
02B1 80 FC 04                   CMP     AH,4                    ; TEST FOR GRAPHICS
02B4 72 08                      JC      N12
02B6 80 FC 07                   CMP     AH,7                    ; TEST FOR BW CARD
02B9 74 03                      JE      N12
02BB E9 0503 R                  JMP     GRAPHICS_DOWN
02BE                    N12:                                    ; CONTINUE_DOWN
02BE 53                         PUSH    BX                      ; SAVE ATTRIBUTE IN BH
02BF 8B C2                      MOV     AX,DX                   ; LOWER RIGHT CORNER
02C1 E8 025C R                  CALL    SCROLL_POSITION         ; GET REGEN LOCATION
02C4 74 20                      JZ      N16
02C6 2B F0                      SUB     SI,AX                   ; SI IS FROM ADDRESS
02C8 8A E6                      MOV     AH,DH                   ; GET TOTAL # ROWS
02CA 2A E3                      SUB     AH,BL                   ; COUNT TO MOVE IN SCROLL
02CC                    N13:
02CC E8 029D R                  CALL    N10                     ; MOVE ONE ROW
02CF 2B F5                      SUB     SI,BP
02D1 2B FD                      SUB     DI,BP
02D3 FE CC                      DEC     AH
02D5 75 F5                      JNZ     N13
02D7                    N14:
02D7 58                         POP     AX                      ; RECOVER ATTRIBUTE IN AH
02D8 B0 20                      MOV     AL,' '
02DA                    N15:
02DA E8 02A6 R                  CALL    N11                     ; CLEAR ONE ROW
02DD 2B FD                      SUB     DI,BP                   ; GO TO NEXT ROW
02DF FE CB                      DEC     BL
02E1 75 F7                      JNZ     N15
02E3 E9 0244 R                  JMP     N5                      ; SCROLL_END
02E6                    N16:
02E6 8A DE                      MOV     BL,DH
02E8 EB ED                      JMP     N14
02EA                    SCROLL_DOWN     ENDP
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                        PAGE
                        ;-----  IF  AMOUNT OF LINES TO BE SCROLLED = AMOUNT OF LINES IN WINDOW
                        ;-----   THEN  ADJUST AL; ELSE  RETURN;
                        
02EA                    TEST_LINE_COUNT PROC    NEAR
                        
02EA 8A D8                      MOV     BL,AL                   ; SAVE LINE COUNT IN BL
02EC 0A C0                      OR      AL,AL                   ; TEST IF AL IS ALREADY ZERO
02EE 74 0E                      JZ      BL_SET                  ; IF IT IS THEN RETURN...
02F0 50                         PUSH    AX                      ; SAVE AX
02F1 8A C6                      MOV     AL,DH                   ; SUBTRACT LOWER ROW FROM UPPER ROW
02F3 2A C5                      SUB     AL,CH
02F5 FE C0                      INC     AL                      ; ADJUST DIFFERENCE BY 1
02F7 3A C3                      CMP     AL,BL                   ; LINE COUNT = AMOUNT OF ROWS IN WINDOW?
02F9 58                         POP     AX                      ; RESTORE AX
02FA 75 02                      JNE     BL_SET                  ; IF NOT THEN WE'RE ALL SET
02FC 2A DB                      SUB     BL,BL                   ; OTHERWISE SET BL TO ZERO
02FE                    BL_SET:
02FE C3                         RET                             ; RETURN
02FF                    TEST_LINE_COUNT ENDP
                        
                        ;--------------------------------------------------------------------------------
                        ; READ_AC_CURRENT                                                              :
                        ;       THIS ROUTINE READS THE ATTRIBUTE AND CHARACTER AT THE CURRENT          :
                        ;       CURSOR POSITION AND RETURNS THEM TO THE CALLER                        :
                        ; INPUT                                                                       :
                        ;       (AH) = CURRENT CRT MODE                                               :
                        ;       (BH) = DISPLAY PAGE ( ALPHA MODES ONLY )                              :
                        ;       (DS) = DATA SEGMENT                                                   :
                        ;       (ES) = REGEN SEGMENT                                                  :
                        ; OUTPUT                                                                      :
                        ;       (AL) = CHARACTER READ                                                 :
                        ;       (AH) = ATTRIBUTE READ                                                 :
                        ;--------------------------------------------------------------------------------
                                ASSUME  DS:DATA,ES:DATA
                        
02FF                    READ_AC_CURRENT PROC    NEAR
02FF 80 FC 04                   CMP     AH,4                    ; IS THIS GRAPHICS
0302 72 08                      JC      P10
                        
0304 80 FC 07                   CMP     AH,7                    ; IS THIS BW CARD
0307 74 03                      JE      P10
                        
0309 E9 063E R                  JMP     GRAPHICS_READ
030C                    P10:                                    ;  READ_AC_CONTINUE
030C E8 0328 R                  CALL    FIND_POSITION           ; GET REGEN LOCATION AND PORT ADDRESS
030F 8B F7                      MOV     SI,DI                   ; ESTABLISH ADDRESSING IN SI
0311 06                         PUSH    ES                      ; GET REGEN SEGMENT FOR QUICK ACCESS
0312 1F                         POP     DS
                        
                        ;-----  WAIT FOR HORIZONTAL RETRACE OR VERTICAL RETRACE IF COLOR 80
                        
0313 0A DB                      OR      BL,BL                   ; CHECK MODE FLAG FOR COLOR CARD IN 80
0315 75 0D                      JNZ     P13                     ; ELSE SKIP RETRACE WAIT - DO FAST READ
0317                    P11:                                    ;  WAIT FOR HORZ RETRACE LOW OR VERTICAL
0317 FB                         STI                             ; ENABLE INTERRUPTS FIRST
0318 90                         NOP                             ; ALLOW FOR SMALL INTERRUPT WINDOW
0319 FA                         CLI                             ; BLOCK INTERRUPTS FOR SINGLE LOOP
031A EC                         IN      AL,DX                   ; GET STATUS FROM THE ADAPTER
031B A8 01                      TEST    AL,RHRZ                 ; IS HORIZONTAL RETRACE LOW
031D 75 F8                      JNZ     P11                     ; WAIT UNTIL IT IS
031F                    P12:                                    ;  NOW WAIT FOR EITHER RETRACE HIGH
031F EC                         IN      AL,DX                   ; GET STATUS
0320 A8 09                      TEST    AL,RVRT+RHRZ            ; IS HORIZONTAL OR VERTICAL RETRACE HIGH
0322 74 FB                      JZ      P12                     ; WAIT UNTIL EITHER IS ACTIVE
0324                    P13:
0324 AD                         LODSW                           ; GET THE CHARACTER AND ATTRIBUTE
0325 E9 013D R                  JMP     VIDEO_RETURN            ;  EXIT WITH (AX)
                        
0328                    READ_AC_CURRENT ENDP
                        
                        
                        
0328                    FIND_POSITION   PROC    NEAR            ;       SETUP FOR BUFFER READ OR WRITE
0328 86 E3                      XCHG    AH,BL                   ; SWAP MODE TYPE WITH ATTRIBUTE
032A 8B E8                      MOV     BP,AX                   ; SAVE CHARACTER/ATTR IN (BP) REGISTER
032C 80 EB 02                   SUB     BL,2                    ; CONVERT DISPLAY MODE TYPE TO A
032F D0 EB                      SHR     BL,1                    ;  ZERO VALUE FOR COLOR IN 80 COLUMN
0331 8A C7                      MOV     AL,BH                   ; MOVE DISPLAY PAGE TO LOW BYTE
0333 98                         CBW                             ; CLEAR HIGH BYTE FOR BYTE OFFSET
0334 8B F8                      MOV     DI,AX                   ; MOVE DISPLAY PAGE (COUNT) TO WORK REG
0336 D1 E7                      SAL     DI,1                    ; TIMES 2 FOR WORD OFFSET
0338 8B 95 0050 R               MOV     DX,[DI+OFFSET @CURSOR_POSN]     ; GET ROW/COLUMN OF THAT PAGE
033C 74 09                      JZ      P21                     ; SKIP BUFFER ADJUSTMENT IF PAGE ZERO
                        
033E 33 FF                      XOR     DI,DI                   ; ELSE SET BUFFER START ADDRESS TO ZERO
0340                    P20:
0340 03 3E 004C R               ADD     DI,@CRT_LEN             ; ADD LENGTH OF BUFFER FOR ONE PAGE
0344 48                         DEC     AX                      ; DECREMENT PAGE COUNT
0345 75 F9                      JNZ     P20                     ; LOOP TILL PAGE COUNT EXHAUSTED
                        
0347                    P21:                                    ; DETERMINE LOCATION IN REGEN IN PAGE
0347 A0 004A R                  MOV     AL,BYTE PTR @CRT_COLS   ; GET COLUMNS PER ROW COUNT
034A F6 E6                      MUL     DH                      ; DETERMINE BYTES TO ROW
034C 32 F6                      XOR     DH,DH
034E 03 C2                      ADD     AX,DX                   ; ADD IN COLUMN VALUE
0350 D1 E0                      SAL     AX,1                    ; * 2 FOR ATTRIBUTE BYTES
0352 03 F8                      ADD     DI,AX                   ; ADD LOCATION TO START OF REGEN PAGE
0354 8B 16 0063 R               MOV     DX,@ADDR_6845           ; GET BASE ADDRESS OF ACTIVE DISPLAY
0358 83 C2 06                   ADD     DX,6                    ;  DX= STATUS PORT ADDRESS OF ADAPTER
035B C3                         RET                             ;  BP= ATTRIBUTE/CHARACTER (FROM BL/AL)
                                                                ;  DI= POSITION (OFFSET IN REGEN BUFFER)
035C                    FIND_POSITION   ENDP                    ;  BL= MODE FLAG (ZERO FOR 80X25 COLOR)
```

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                        PAGE
                        ;--------------------------------------------------------------------------------
                        ; WRITE_AC_CURRENT                                                              :
                        ;       THIS ROUTINE WRITES THE ATTRIBUTE AND CHARACTER                         :
                        ;       AT THE CURRENT CURSOR POSITION                                         :
                        ; INPUT                                                                        :
                        ;       (AH) = CURRENT CRT MODE                                                :
                        ;       (BH) = DISPLAY PAGE                                                    :
                        ;       (CX) = COUNT OF CHARACTERS TO WRITE                                    :
                        ;       (AL) = CHAR TO WRITE                                                   :
                        ;       (BL) = ATTRIBUTE OF CHAR TO WRITE                                      :
                        ;       (DS) = DATA SEGMENT                                                    :
                        ;       (ES) = REGEN SEGMENT                                                   :
                        ; OUTPUT                                                                       :
                        ;       DISPLAY REGEN BUFFER UPDATED                                           :
                        ;--------------------------------------------------------------------------------

 035C                   WRITE_AC_CURRENT        PROC    NEAR
 035C 80 FC 04                  CMP     AH,4                    ; IS THIS GRAPHICS
 035F 72 08                     JC      P30
 0361 80 FC 07                  CMP     AH,7                    ; IS THIS BW CARD
 0364 74 03                     JE      P30
 0366 E9 058A R                 JMP     GRAPHICS_WRITE
 0369                   P30:                                    ;  WRITE_AC_CONTINUE
 0369 E8 0328 R                 CALL    FIND_POSITION           ; GET REGEN LOCATION AND PORT ADDRESS
                                                                ; ADDRESS IN (DI) REGISTER
 036C 0A DB                     OR      BL,BL                   ; CHECK MODE FLAG FOR COLOR CARD AT 80
 036E 74 06                     JZ      P32                     ; SKIP TO RETRACE WAIT IF COLOR AT 80

 0370 95                        XCHG    AX,BP                   ; GET THE ATTR/CHAR SAVED FOR FAST WRITE
 0371 F3/ AB                    REP     STOSW                   ; STRING WRITE THE ATTRIBUTE & CHARACTER
 0373 EB 16                     JMP     SHORT  P35              ; EXIT FAST WRITE ROUTINE

                        ;-----  WAIT FOR HORIZONTAL RETRACE OR VERTICAL RETRACE IF COLOR 80

 0375                   P31:                                    ;  LOOP FOR EACH ATTR/CHAR WRITE
 0375 95                        XCHG    BP,AX                   ; PLACE ATTR/CHAR BACK IN SAVE REGISTER
 0376                   P32:                                    ;  WAIT FOR HORZ RETRACE LOW OR VERTICAL
 0376 FB                        STI                             ; ENABLE INTERRUPTS FIRST
 0377 90                        NOP                             ; ALLOW FOR INTERRUPT WINDOW
 0378 FA                        CLI                             ; BLOCK INTERRUPTS FOR SINGLE LOOP
 0379 EC                        IN      AL,DX                   ; GET STATUS FROM THE ADAPTER
 037A A8 08                     TEST    AL,RVRT                 ; CHECK FOR VERTICAL RETRACE FIRST
 037C 75 09                     JNZ     P34                     ; DO FAST WRITE NOW IF VERTICAL RETRACE
 037E A8 01                     TEST    AL,RHRZ                 ; IS HORIZONTAL RETRACE LOW THEN
 0380 75 F4                     JNZ     P32                     ; WAIT UNTIL IT IS
 0382                   P33:                                    ;  WAIT FOR EITHER RETRACE HIGH
 0382 EC                        IN      AL,DX                   ; GET STATUS AGAIN
 0383 A8 09                     TEST    AL,RVRT+RHRZ            ; IS HORIZONTAL OR VERTICAL RETRACE HIGH
 0385 74 FB                     JZ      P33                     ; WAIT UNTIL EITHER IS ACTIVE
 0387                   P34:
 0387 95                        XCHG    AX,BP                   ; GET THE ATTR/CHAR SAVED IN (BP)
 0388 AB                        STOSW                           ; WRITE THE ATTRIBUTE AND CHARACTER
 0389 E2 EA                     LOOP    P31                     ; AS MANY TIMES AS REQUESTED - TILL CX=0
 038B                   P35:
 038B E9 013D R                 JMP     VIDEO_RETURN            ; EXIT

 038E                   WRITE_AC_CURRENT        ENDP

                        ;--------------------------------------------------------------------------------
                        ; WRITE_C_CURRENT                                                               :
                        ;       THIS ROUTINE WRITES THE CHARACTER AT                                   :
                        ;       THE CURRENT CURSOR POSITION, ATTRIBUTE UNCHANGED                       :
                        ; INPUT                                                                        :
                        ;       (AH) = CURRENT CRT MODE                                                :
                        ;       (BH) = DISPLAY PAGE                                                    :
                        ;       (CX) = COUNT OF CHARACTERS TO WRITE                                    :
                        ;       (AL) = CHAR TO WRITE                                                   :
                        ;       (DS) = DATA SEGMENT                                                    :
                        ;       (ES) = REGEN SEGMENT                                                   :
                        ; OUTPUT                                                                       :
                        ;       DISPLAY REGEN BUFFER UPDATED                                           :
                        ;--------------------------------------------------------------------------------

 038E                   WRITE_C_CURRENT PROC    NEAR
 038E 80 FC 04                  CMP     AH,4                    ; IS THIS GRAPHICS
 0391 72 08                     JC      P40
 0393 80 FC 07                  CMP     AH,7                    ; IS THIS BW CARD
 0396 74 03                     JE      P40
 0398 E9 058A R                 JMP     GRAPHICS_WRITE
 039B                   P40:
 039B E8 0328 R                 CALL    FIND_POSITION           ; GET REGEN LOCATION AND PORT ADDRESS
                                                                ; ADDRESS OF LOCATION IN (DI)

                        ;-----  WAIT FOR HORIZONTAL RETRACE OR VERTICAL RETRACE IF COLOR 80

 039E                   P41:                                    ;  WAIT FOR HORZ RETRACE LOW OR VERTICAL
 039E FB                        STI                             ; ENABLE INTERRUPTS FIRST
 039F 0A DB                     OR      BL,BL                   ; CHECK MODE FLAG FOR COLOR CARD IN 80
 03A1 75 0F                     JNZ     P43                     ; ELSE SKIP RETRACE WAIT - DO FAST WRITE
 03A3 FA                        CLI                             ; BLOCK INTERRUPTS FOR SINGLE LOOP
 03A4 EC                        IN      AL,DX                   ; GET STATUS FROM THE ADAPTER
 03A5 A8 08                     TEST    AL,RVRT                 ; CHECK FOR VERTICAL RETRACE FIRST
 03A7 75 09                     JNZ     P43                     ; DO FAST WRITE NOW IF VERTICAL RETRACE
 03A9 A8 01                     TEST    AL,RHRZ                 ; IS HORIZONTAL RETRACE LOW THEN
 03AB 75 F1                     JNZ     P41                     ; WAIT UNTIL IT IS
 03AD                   P42:                                    ;  WAIT FOR EITHER RETRACE HIGH
 03AD EC                        IN      AL,DX                   ; GET STATUS AGAIN
 03AE A8 09                     TEST    AL,RVRT+RHRZ            ; IS HORIZONTAL OR VERTICAL RETRACE HIGH
 03B0 74 FB                     JZ      P42                     ; WAIT UNTIL EITHER RETRACE ACTIVE
 03B2                   P43:
 03B2 8B C5                     MOV     AX,BP                   ; GET THE CHARACTER SAVE IN (BP)
 03B4 AA                        STOSB                           ; PUT THE CHARACTER INTO REGEN BUFFER
 03B5 47                        INC     DI                      ; BUMP POINTER PAST ATTRIBUTE
 03B6 E2 E6                     LOOP    P41                     ;  AS MANY TIMES AS REQUESTED

 03B8 E9 013D R                 JMP     VIDEO_RETURN

 03BB                   WRITE_C_CURRENT ENDP
```

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                        PAGE
                        ;--------------------------------------------------------------------------------
                        ; WRITE_STRING                                                                  :
                        ;       THIS ROUTINE WRITES A STRING OF CHARACTERS TO THE CRT.                  :
                        ;                                                                              :
                        ; INPUT                                                                        :
                        ;       (AL) = WRITE STRING COMMAND  0 - 3                                     :
                        ;       (BH) = DISPLAY PAGE (ACTIVE PAGE)                                      :
                        ;       (CX) = COUNT OF CHARACTERS TO WRITE, IF (CX) = 0 THEN RETURN            :
                        ;       (DX) = CURSOR POSITION FOR START OF STRING WRITE                        :
                        ;       (BL) = ATTRIBUTE OF CHARACTER TO WRITE IF (AL) = 0  OR  (AL) = 1        :
                        ;       (BP) = SOURCE STRING OFFSET                                            :
                        ;       [0E] = SOURCE STRING SEGMENT (FOR USE IN (ES) IN STACK +14)            :
                        ; OUTPUT                                                                       :
                        ;       NONE                                                                   :
                        ;--------------------------------------------------------------------------------
 03BB                   WRITE_STRING    PROC    NEAR
 03BB 55                        PUSH    BP                      ; SAVE BUFFER OFFSET (BP) IN STACK
 03BC 8B EC                     MOV     BP,SP                   ; GET POINTER TO STACKED REGISTERS
 03BE 8E 46 10                  MOV     ES,[BP]+14+2            ; RECOVER ENTRY (ES) SEGMENT REGISTER
 03C1 5D                        POP     BP                      ; RESTORE BUFFER OFFSET
 03C2 98                        CBW                             ; CLEAR (AH) REGISTER
 03C3 8B F8                     MOV     DI,AX                   ; SAVE (AL) COMMAND IN (DI) REGISTER
 03C5 3C 04                     CMP     AL,04                   ; TEST FOR INVALID WRITE STRING OPTION
 03C7 73 73                     JNB     P59                     ; IF OPTION INVALID THEN RETURN
                        
 03C9 E3 71                     JCXZ    P59                     ; IF ZERO LENGTH STRING THEN RETURN
                        
 03CB 8B F3                     MOV     SI,BX                   ; SAVE CURRENT CURSOR PAGE
 03CD 8A DF                     MOV     BL,BH                   ; MOVE PAGE TO LOW BYTE
 03CF 32 FF                     XOR     BH,BH                   ; CLEAR HIGH BYTE
 03D1 87 F3                     XCHG    SI,BX                   ; MOVE OFFSET AND RESTORE PAGE REGISTER
 03D3 D1 E6                     SAL     SI,1                    ; CONVERT TO PAGE OFFSET  (SI= PAGE)
 03D5 FF B4 0050 R              PUSH    [SI+OFFSET @CURSOR_POSN]; SAVE CURRENT CURSOR POSITION IN STACK
 03D9 B8 0200                   MOV     AX,0200H                ; SET NEW CURSOR POSITION
 03DC CD 10                     INT     10H
 03DE                   P50:
 03DE 26: 8A 46 00              MOV     AL,ES:[BP]              ; GET CHARACTER FROM INPUT STRING
 03E2 45                        INC     BP                      ; BUMP POINTER TO CHARACTER
                        
                        ;-----  TEST FOR SPECIAL CHARACTER'S
                        
 03E3 3C 08                     CMP     AL,08H                  ; IS IT A BACKSPACE
 03E5 74 0C                     JE      P51                     ; BACK_SPACE
 03E7 3C 0D                     CMP     AL,CR                   ; IS IT CARRIAGE RETURN
 03E9 74 08                     JE      P51                     ; CAR_RET
 03EB 3C 0A                     CMP     AL,LF                   ; IS IT A LINE FEED
 03ED 74 04                     JE      P51                     ; LINE_FEED
 03EF 3C 07                     CMP     AL,07H                  ; IS IT A BELL
 03F1 75 0A                     JNE     P52                     ; IF NOT THEN DO WRITE CHARACTER
 03F3                   P51:
 03F3 B4 0E                     MOV     AH,0EH                  ; TTY_CHARACTER WRITE
 03F5 CD 10                     INT     10H                             ; WRITE TTY CHARACTER TO THE CRT
 03F7 8B 94 0050 R              MOV     DX,[SI+OFFSET @CURSOR_POSN] ; GET CURRENT CURSOR POSITION
 03FB EB 2D                     JMP     SHORT P54                       ; SET CURSOR POSITION AND CONTINUE
                        
 03FD                   P52:
 03FD 51                        PUSH    CX
 03FE 53                        PUSH    BX
 03FF B9 0001                   MOV     CX,1                    ; SET CHARACTER WRITE AMOUNT TO ONE
 0402 83 FF 02                  CMP     DI,2                    ; IS THE ATTRIBUTE IN THE STRING
 0405 72 05                     JB      P53                     ; IF NOT THEN SKIP
 0407 26: 8A 5E 00              MOV     BL,ES:[BP]              ; ELSE GET NEW ATTRIBUTE
 040B 45                        INC     BP                      ; BUMP STRING POINTER
 040C                   P53:
 040C B4 09                     MOV     AH,09H                  ;  GOT_CHARACTER
 040E CD 10                     INT     10H                     ; WRITE CHARACTER TO THE CRT
 0410 5B                        POP     BX                      ; RESTORE REGISTERS
 0411 59                        POP     CX
 0412 FE C2                     INC     DL                      ; INCREMENT COLUMN COUNTER
 0414 3A 16 004A R              CMP     DL,BYTE PTR @CRT_COLS   ; IF COLS ARE WITHIN RANGE FOR THIS MODE
 0418 72 10                     JB      P54                     ;    THEN GO TO COLUMNS SET
 041A FE C6                     INC     DH                      ; BUMP ROW COUNTER BY ONE
 041C 2A D2                     SUB     DL,DL                   ; SET COLUMN COUNTER TO ZERO
 041E 80 FE 19                  CMP     DH,25                   ; IF ROWS ARE LESS THAN 25 THEN
 0421 72 07                     JB      P54                     ;    GO TO ROWS_COLUMNS_SET
                        
 0423 B8 0E0A                   MOV     AX,0E0AH                ; ELSE SCROLL SCREEN ONE LINE
 0426 CD 10                     INT     10H                     ; RESET ROW COUNTER TO 24
 0428 FE CE                     DEC     DH
 042A                   P54:                                    ;  ROW_COLUMNS_SET
 042A B8 0200                   MOV     AX,0200H                ; SET NEW CURSOR POSITION COMMAND
 042D CD 10                     INT     10H                     ; ESTABLISH NEW CURSOR POSITION
 042F E2 AD                     LOOP    P50                     ; DO IT ONCE MORE UNTIL (CX) = ZERO
                        
 0431 5A                        POP     DX                      ; RESTORE OLD CURSOR COORDINATES
 0432 97                        XCHG    AX,DI                   ; RECOVER WRITE STRING COMMAND
 0433 A8 01                     TEST    AL,01H                  ; IF CURSOR WAS NOT TO BE MOVED THEN
 0435 75 05                     JNZ     P59                     ;   THEN EXIT WITHOUT RESETTING OLD VALUE
 0437 B8 0200                   MOV     AX,0200H                ; ELSE RESTORE OLD CURSOR POSITION
 043A CD 10                     INT     10H
 043C                   P59:                                    ;  DONE - EXIT WRITE STRING
 043C E9 013D R                 JMP     VIDEO_RETURN            ; RETURN TO CALLER
                        
 043F                   WRITE_STRING    ENDP
```

SECTION 5

```
                        PAGE
                        ;--------------------------------------------
                        ; READ DOT  -- WRITE DOT
                        ; THESE ROUTINES WILL WRITE A DOT, OR READ THE
                        ;  DOT AT THE INDICATED LOCATION
                        ; ENTRY --
                        ;   DX = ROW (0-199)     (THE ACTUAL VALUE DEPENDS ON THE MODE)
                        ;   CX = COLUMN ( 0-639) ( THE VALUES ARE NOT RANGE CHECKED )
                        ;   AL = DOT VALUE TO WRITE (1,2 OR 4 BITS DEPENDING ON MODE,
                        ;        REQUIRED FOR WRITE DOT ONLY, RIGHT JUSTIFIED)
                        ;        BIT 7 OF AL = 1 INDICATES XOR THE VALUE INTO THE LOCATION
                        ;   DS = DATA SEGMENT
                        ;   ES = REGEN SEGMENT
                        ;
                        ; EXIT
                        ;       AL = DOT VALUE READ, RIGHT JUSTIFIED, READ ONLY
                        ;--------------------------------------------
                                ASSUME  DS:DATA,ES:DATA
 043F                   READ_DOT        PROC    NEAR
 043F E8 0473 R                 CALL    R3                      ; DETERMINE BYTE POSITION OF DOT
 0442 26: 8A 04                 MOV     AL,ES:[SI]              ; GET THE BYTE
 0445 22 C4                     AND     AL,AH                   ; MASK OFF THE OTHER BITS IN THE BYTE
 0447 D2 E0                     SHL     AL,CL                   ; LEFT JUSTIFY THE VALUE
 0449 8A CE                     MOV     CL,DH                   ; GET NUMBER OF BITS IN RESULT
 044B D2 C0                     ROL     AL,CL                   ; RIGHT JUSTIFY THE RESULT
 044D E9 013D R                 JMP     VIDEO_RETURN            ; RETURN FROM VIDEO I/O
 0450                   READ_DOT        ENDP
                        ;
 0450                   WRITE_DOT       PROC    NEAR
 0450 50                        PUSH    AX                      ; SAVE DOT VALUE
 0451 50                        PUSH    AX                      ;  TWICE
 0452 E8 0473 R                 CALL    R3                      ; DETERMINE BYTE POSITION OF THE DOT
 0455 D2 E8                     SHR     AL,CL                   ; SHIFT TO SET UP THE BITS FOR OUTPUT
 0457 22 C4                     AND     AL,AH                   ; STRIP OFF THE OTHER BITS
 0459 26: 8A 0C                 MOV     CL,ES:[SI]              ; GET THE CURRENT BYTE
 045C 5B                        POP     BX                      ; RECOVER XOR FLAG
 045D F6 C3 80                  TEST    BL,80H                  ; IS IT ON
 0460 75 0D                     JNZ     R2                      ; YES,eXOR THE DOT
 0462 F6 D4                     NOT     AH                      ; SET MASK TO REMOVE THE INDICATED BITS
 0464 22 CC                     AND     CL,AH
 0466 0A C1                     OR      AL,CL                   ; OR IN THE NEW VALUE OF THOSE BITS
 0468                   R1:                                     ; FINISH_DOT
 0468 26: 88 04                 MOV     ES:[SI],AL              ; RESTORE THE BYTE IN MEMORY
 046B 58                        POP     AX
 046C E9 013D R                 JMP     VIDEO_RETURN            ; RETURN FROM VIDEO I/O
 046F                   R2:                                     ; XOR_DOT
 046F 32 C1                     XOR     AL,CL                   ; EXCLUSIVE OR THE DOTS
 0471 EB F5                     JMP     R1                      ; FINISH UP THE WRITING
 0473                   WRITE_DOT       ENDP
                        ;--------------------------------------------
                        ; THIS SUBROUTINE DETERMINES THE REGEN BYTE LOCATION OF THE
                        ; INDICATED ROW COLUMN VALUE IN GRAPHICS MODE.
                        ; ENTRY --
                        ;  DX = ROW VALUE (0-199)
                        ;  CX = COLUMN VALUE (0-639)
                        ; EXIT --
                        ;  SI = OFFSET INTO REGEN BUFFER FOR BYTE OF INTEREST
                        ;  AH = MASK TO STRIP OFF THE BITS OF INTEREST
                        ;  CL = BITS TO SHIFT TO RIGHT JUSTIFY THE MASK IN AH
                        ;  DH = # BITS IN RESULT
                        ;  BX = MODIFIED
                        ;--------------------------------------------
 0473                   R3      PROC    NEAR
                        ;
                        ;-----  DETERMINE 1ST BYTE IN INDICATED ROW BY MULTIPLYING ROW VALUE BY 40
                        ;-----   ( LOW BIT OF ROW DETERMINES EVEN/ODD, 80 BYTES/ROW )
                        ;
 0473 96                        XCHG    SI,AX                   ; WILL SAVE AL AND AH DURING OPERATION
 0474 B0 28                     MOV     AL,40
 0476 F6 E2                     MUL     DL                      ; AX= ADDRESS OF START OF INDICATED ROW
 0478 A8 08                     TEST    AL,008H                 ; TEST FOR EVEN/ODD ROW CALCULATED
 047A 74 03                     JZ      R4                      ; JUMP IF EVEN ROW
 047C 05 1FD8                   ADD     AX,2000H-40             ; OFFSET TO LOCATION OF ODD ROWS ADJUST
 047F                   R4:                                     ; EVEN_ROW
 047F 96                        XCHG    SI,AX                   ; MOVE POINTER TO (SI) AND RECOVER (AX)
 0480 8B D1                     MOV     DX,CX                   ; COLUMN VALUE TO DX
                        ;
                        ;-----  DETERMINE GRAPHICS MODE CURRENTLY IN EFFECT
                        ;
                        ; SET UP THE REGISTERS ACCORDING TO THE MODE
                        ; CH = MASK FOR LOW OF COLUMN ADDRESS ( 7/3 FOR HIGH/MED RES )
                        ; CL = # OF ADDRESS BITS IN COLUMN VALUE ( 3/2 FOR H/M )
                        ; BL = MASK TO SELECT BITS FROM POINTED BYTE ( 80H/C0H FOR H/M )
                        ; BH = NUMBER OF VALID BITS IN POINTED BYTE ( 1/2 FOR H/M )
                        ;
 0482 BB 02C0                   MOV     BX,2C0H
 0485 B9 0302                   MOV     CX,302H                 ; SET PARMS FOR MED RES
 0488 80 3E 0049 R 06           CMP     @CRT_MODE,6
 048D 72 06                     JC      R5                      ; HANDLE IF MED RES
 048F BB 0180                   MOV     BX,180H
 0492 B9 0703                   MOV     CX,703H                 ; SET PARMS FOR HIGH RES
                        ;
                        ;-----  DETERMINE BIT OFFSET IN BYTE FROM COLUMN MASK
 0495                   R5:
 0495 22 EA                     AND     CH,DL                   ; ADDRESS OF PEL WITHIN BYTE TO CH
                        ;
                        ;-----  DETERMINE BYTE OFFSET FOR THIS LOCATION IN COLUMN
                        ;
 0497 D3 EA                     SHR     DX,CL                   ; SHIFT BY CORRECT AMOUNT
 0499 03 F2                     ADD     SI,DX                   ; INCREMENT THE POINTER
 049B 8A F7                     MOV     DH,BH                   ; GET THE # OF BITS IN RESULT TO DH
                        ;
                        ;-----  MULTIPLY BH (VALID BITS IN BYTE) BY CH (BIT OFFSET)
                        ;
 049D 2A C9                     SUB     CL,CL                   ; ZERO INTO STORAGE LOCATION
 049F                   R6:
 049F D0 C8                     ROR     AL,1                    ; LEFT JUSTIFY VALUE IN AL (FOR WRITE)
 04A1 02 CD                     ADD     CL,CH                   ; ADD IN THE BIT OFFSET VALUE
 04A3 FE CF                     DEC     BH                      ; LOOP CONTROL
 04A5 75 F8                     JNZ     R6                      ; ON EXIT, CL HAS COUNT TO RESTORE BITS
 04A7 8A E3                     MOV     AH,BL                   ;  GET MASK TO AH
 04A9 D2 EC                     SHR     AH,CL                   ;  MOVE THE MASK TO CORRECT LOCATION
 04AB C3                        RET                             ;  RETURN WITH EVERYTHING SET UP
 04AC                   R3      ENDP
```

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                        ;--------------------------------------------------------
                        ;  SCROLL UP
                        ;    THIS ROUTINE SCROLLS UP THE INFORMATION ON THE CRT
                        ; ENTRY --
                        ;  CH,CL = UPPER LEFT CORNER OF REGION TO SCROLL
                        ;  DH,DL = LOWER RIGHT CORNER OF REGION TO SCROLL
                        ;    BOTH OF THE ABOVE ARE IN CHARACTER POSITIONS
                        ;  BH = FILL VALUE FOR BLANKED LINES
                        ;  AL = # LINES TO SCROLL (AL=0 MEANS BLANK THE ENTIRE FIELD)
                        ;  DS = DATA SEGMENT
                        ;  ES = REGEN SEGMENT
                        ; EXIT --
                        ;  NOTHING, THE SCREEN IS SCROLLED
                        ;--------------------------------------------------------
1231 04AC               GRAPHICS_UP     PROC    NEAR
1232 04AC 8A D8                 MOV     BL,AL                   ; SAVE LINE COUNT IN BL
1233 04AE 8B C1                 MOV     AX,CX                   ; GET UPPER LEFT POSITION INTO AX REG
1234
1235                    ;-----  USE CHARACTER SUBROUTINE FOR POSITIONING
1236                    ;-----  ADDRESS RETURNED IS MULTIPLIED BY 2 FROM CORRECT VALUE
1237
1238 04B0 E8 06EC R              CALL    GRAPH_POSN
1239 04B3 8B F8                 MOV     DI,AX                   ; SAVE RESULT AS DESTINATION ADDRESS
1240
1241                    ;-----  DETERMINE SIZE OF WINDOW
1242
1243 04B5 2B D1                 SUB     DX,CX
1244 04B7 81 C2 0101            ADD     DX,101H                 ; ADJUST VALUES
1245 04BB D0 E6                 SAL     DH,1                    ; MULTIPLY ROWS BY 4 AT 8 VERT DOTS/CHAR
1246 04BD D0 E6                 SAL     DH,1                    ;  AND EVEN/ODD ROWS
1247
1248                    ;-----  DETERMINE CRT MODE
1249
1250 04BF 80 3E 0049 R 06       CMP     @CRT_MODE,6             ; TEST FOR MEDIUM RES
1251 04C4 73 04                 JNC     R7                      ; FIND_SOURCE
1252
1253                    ;-----  MEDIUM RES UP
1254 04C6 D0 E2                 SAL     DL,1                    ; # COLUMNS * 2, SINCE 2 BYTES/CHAR
1255 04C8 D1 E7                 SAL     DI,1                    ; OFFSET *2 SINCE 2 BYTES/CHAR
1256
1257                    ;-----  DETERMINE THE SOURCE ADDRESS IN THE BUFFER
1258 04CA               R7:                                     ; FIND_SOURCE
1259 04CA 06                    PUSH    ES                      ; GET SEGMENTS BOTH POINTING TO REGEN
1260 04CB 1F                    POP     DS
1261 04CC 2A ED                 SUB     CH,CH                   ; ZERO TO HIGH OF COUNT REGISTER
1262 04CE D0 E3                 SAL     BL,1                    ; MULTIPLY NUMBER OF LINES BY 4
1263 04D0 D0 E3                 SAL     BL,1
1264 04D2 74 2B                 JZ      R11                     ; IF ZERO, THEN BLANK ENTIRE FIELD
1265 04D4 B0 50                 MOV     AL,80                   ; 80 BYTES/ROW
1266 04D6 F6 E3                 MUL     BL                      ; DETERMINE OFFSET TO SOURCE
1267 04D8 8B F7                 MOV     SI,DI                   ; SET UP SOURCE
1268 04DA 03 F0                 ADD     SI,AX                   ;  ADD IN OFFSET TO IT
1269 04DC 8A E6                 MOV     AH,DH                   ; NUMBER OF ROWS IN FIELD
1270 04DE 2A E3                 SUB     AH,BL                   ; DETERMINE NUMBER TO MOVE
1271
1272                    ;-----  LOOP THROUGH, MOVING ONE ROW AT A TIME, BOTH EVEN AND ODD FIELDS
1273 04E0               R8:                                     ; ROW_LOOP
1274 04E0 E8 0560 R             CALL    R17                     ; MOVE ONE ROW
1275 04E3 81 EE 1FB0            SUB     SI,2000H-80             ; MOVE TO NEXT ROW
1276 04E7 81 EF 1FB0            SUB     DI,2000H-80
1277 04EB FE CC                 DEC     AH                      ; NUMBER OF ROWS TO MOVE
1278 04ED 75 F1                 JNZ     R8                      ; CONTINUE TILL ALL MOVED
1279
1280                    ;-----  FILL IN THE VACATED LINE(S)
1281 04EF               R9:                                     ; CLEAR_ENTRY
1282 04EF 8A C7                 MOV     AL,BH                   ; ATTRIBUTE TO FILL WITH
1283 04F1               R10:
1284 04F1 E8 0579 R             CALL    R18                     ; CLEAR THAT ROW
1285 04F4 81 EF 1FB0            SUB     DI,2000H-80             ; POINT TO NEXT LINE
1286 04F8 FE CB                 DEC     BL                      ; NUMBER OF LINES TO FILL
1287 04FA 75 F5                 JNZ     R10                     ; CLEAR_LOOP
1288 04FC E9 013D R             JMP     VIDEO_RETURN            ; EVERYTHING DONE
1289
1290 04FF               R11:                                    ; BLANK_FIELD
1291 04FF 8A DE                 MOV     BL,DH                   ; SET BLANK COUNT TO EVERYTHING IN FIELD
1292 0501 EB EC                 JMP     R9                      ; CLEAR THE FIELD
1293 0503               GRAPHICS_UP     ENDP
1294                    ;--------------------------------------------------------
1295                    ; SCROLL DOWN
1296                    ;  THIS ROUTINE SCROLLS DOWN THE INFORMATION ON THE CRT
1297                    ; ENTRY --
1298                    ;  CH,CL = UPPER LEFT CORNER OF REGION TO SCROLL
1299                    ;  DH,DL = LOWER RIGHT CORNER OF REGION TO SCROLL
1300                    ;    BOTH OF THE ABOVE ARE IN CHARACTER POSITIONS
1301                    ;  BH = FILL VALUE FOR BLANKED LINES
1302                    ;  AL = # LINES TO SCROLL (AL=0 MEANS BLANK THE ENTIRE FIELD)
1303                    ;  DS = DATA SEGMENT
1304                    ;  ES = REGEN SEGMENT
1305                    ; EXIT --
1306                    ;  NOTHING, THE SCREEN IS SCROLLED
1307                    ;--------------------------------------------------------
1308
1309 0503               GRAPHICS_DOWN   PROC    NEAR
1310 0503 FD                   STD                             ; SET DIRECTION
1311 0504 8A D8                 MOV     BL,AL                   ; SAVE LINE COUNT IN BL
1312 0506 8B C2                 MOV     AX,DX                   ; GET LOWER RIGHT POSITION INTO AX REG
1313
1314                    ;-----  USE CHARACTER SUBROUTINE FOR POSITIONING
1315                    ;-----  ADDRESS RETURNED IS MULTIPLIED BY 2 FROM CORRECT VALUE
1316
1317 0508 E8 06EC R              CALL    GRAPH_POSN
1318 050B 8B F8                 MOV     DI,AX                   ; SAVE RESULT AS DESTINATION ADDRESS
1319
1320                    ;-----  DETERMINE SIZE OF WINDOW
1321
1322 050D 2B D1                 SUB     DX,CX
1323 050F 81 C2 0101            ADD     DX,101H                 ; ADJUST VALUES
1324 0513 D0 E6                 SAL     DH,1                    ; MULTIPLY ROWS BY 4 AT 8 VERT DOTS/CHAR
1325 0515 D0 E6                 SAL     DH,1                    ;  AND EVEN/ODD ROWS
1326
1327                    ;-----  DETERMINE CRT MODE
1328
1329 0517 80 3E 0049 R 06       CMP     @CRT_MODE,6             ; TEST FOR MEDIUM RES
1330 051C 73 05                 JNC     R12                     ; FIND_SOURCE_DOWN
```

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                        ;-----  MEDIUM RES DOWN
051E D0 E2                      SAL     DL,1                    ; # COLUMNS * 2, SINCE 2 BYTES/CHAR
0520 D1 E7                      SAL     DI,1                    ; OFFSET *2 SINCE 2 BYTES/CHAR
0522 47                         INC     DI                      ; POINT TO LAST BYTE

                        ;-----  DETERMINE THE SOURCE ADDRESS IN THE BUFFER
0523                    R12:                                    ; FIND_SOURCE_DOWN
0523 06                         PUSH    ES                      ; BOTH SEGMENTS TO REGEN
0524 1F                         POP     DS
0525 2A ED                      SUB     CH,CH                   ; ZERO TO HIGH OF COUNT REGISTER
0527 81 C7 00F0                 ADD     DI,240                  ; POINT TO LAST ROW OF PIXELS
052B D0 E3                      SAL     BL,1                    ; MULTIPLY NUMBER OF LINES BY 4
052D D0 E3                      SAL     BL,1
052F 74 2B                      JZ      R16                     ; IF ZERO, THEN BLANK ENTIRE FIELD
0531 B0 50                      MOV     AL,80                   ; 80 BYTES/ROW
0533 F6 E3                      MUL     BL                      ; DETERMINE OFFSET TO SOURCE
0535 8B F7                      MOV     SI,DI                   ; SET UP SOURCE
0537 2B F0                      SUB     SI,AX                   ;  SUBTRACT THE OFFSET
0539 8A E6                      MOV     AH,DH                   ; NUMBER OF ROWS IN FIELD
053B 2A E3                      SUB     AH,BL                   ; DETERMINE NUMBER TO MOVE

                        ;-----  LOOP THROUGH, MOVING ONE ROW AT A TIME, BOTH EVEN AND ODD FIELDS
053D                    R13:                                    ; ROW_LOOP_DOWN
053D E8 0560 R                  CALL    R17                     ; MOVE ONE ROW
0540 81 EE 2050                 SUB     SI,2000H+80             ; MOVE TO NEXT ROW
0544 81 EF 2050                 SUB     DI,2000H+80
0548 FE CC                      DEC     AH                      ; NUMBER OF ROWS TO MOVE
054A 75 F1                      JNZ     R13                     ; CONTINUE TILL ALL MOVED

                        ;-----  FILL IN THE VACATED LINE(S)
054C                    R14:                                    ; CLEAR_ENTRY_DOWN
054C 8A C7                      MOV     AL,BH                   ; ATTRIBUTE TO FILL WITH
054E                    R15:                                    ; CLEAR_LOOP_DOWN
054E E8 0579 R                  CALL    R18                     ; CLEAR A ROW
0551 81 EF 2050                 SUB     DI,2000H+80             ; POINT TO NEXT LINE
0555 FE CB                      DEC     BL                      ; NUMBER OF LINES TO FILL
0557 75 F5                      JNZ     R15                     ; CLEAR_LOOP_DOWN

0559 E9 013D R                  JMP     VIDEO_RETURN            ; EVERYTHING DONE

055C                    R16:                                    ; BLANK_FIELD_DOWN
055C 8A DE                      MOV     BL,DH                   ; SET BLANK COUNT TO EVERYTHING IN FIELD
055E EB EC                      JMP     R14                     ; CLEAR THE FIELD
0560                    GRAPHICS_DOWN   ENDP

                        ;-----  ROUTINE TO MOVE ONE ROW OF INFORMATION

0560                    R17     PROC    NEAR
0560 8A CA                      MOV     CL,DL                   ; NUMBER OF BYTES IN THE ROW
0562 56                         PUSH    SI
0563 57                         PUSH    DI                      ; SAVE POINTERS
0564 F3/ A4                     REP     MOVSB                   ; MOVE THE EVEN FIELD
0566 5F                         POP     DI
0567 5E                         POP     SI
0568 81 C6 2000                 ADD     SI,2000H
056C 81 C7 2000                 ADD     DI,2000H                ; POINT TO THE ODD FIELD
0570 56                         PUSH    SI
0571 57                         PUSH    DI                      ; SAVE THE POINTERS
0572 8A CA                      MOV     CL,DL                   ; COUNT BACK
0574 F3/ A4                     REP     MOVSB                   ; MOVE THE ODD FIELD
0576 5F                         POP     DI
0577 5E                         POP     SI                      ; POINTERS BACK
0578 C3                         RET                             ; RETURN TO CALLER
0579                    R17     ENDP

                        ;-----  CLEAR A SINGLE ROW

0579                    R18     PROC    NEAR
0579 8A CA                      MOV     CL,DL                   ; NUMBER OF BYTES IN FIELD
057B 57                         PUSH    DI                      ; SAVE POINTER
057C F3/ AA                     REP     STOSB                   ; STORE THE NEW VALUE
057E 5F                         POP     DI                      ; POINTER BACK
057F 81 C7 2000                 ADD     DI,2000H                ; POINT TO ODD FIELD
0583 57                         PUSH    DI
0584 8A CA                      MOV     CL,DL
0586 F3/ AA                     REP     STOSB                   ; FILL THE ODD FIELD
0588 5F                         POP     DI
0589 C3                         RET                             ; RETURN TO CALLER
058A                    R18     ENDP
                        ;--------------------------------------------------
                        ; GRAPHICS WRITE
                        ;  THIS ROUTINE WRITES THE ASCII CHARACTER TO THE CURRENT
                        ;  POSITION ON THE SCREEN.
                        ; ENTRY --
                        ;  AL = CHARACTER TO WRITE
                        ;  BL = COLOR ATTRIBUTE TO BE USED FOR FOREGROUND COLOR
                        ;       IF BIT 7 IS SET, THE CHAR IS XOR'D INTO THE REGEN BUFFER
                        ;       (0 IS USED FOR THE BACKGROUND COLOR)
                        ;  CX = NUMBER OF CHARS TO WRITE
                        ;  DS = DATA SEGMENT
                        ;  ES = REGEN SEGMENT
                        ; EXIT --
                        ;  NOTHING IS RETURNED
                        ;
                        ; GRAPHICS READ
                        ;   THIS ROUTINE READS THE ASCII CHARACTER AT THE CURRENT CURSOR
                        ;   POSITION ON THE SCREEN BY MATCHING THE DOTS ON THE SCREEN TO THE
                        ;   CHARACTER GENERATOR CODE POINTS
                        ; ENTRY --
                        ;  NONE  (0 IS ASSUMED AS THE BACKGROUND COLOR)
                        ; EXIT --
                        ;  AL = CHARACTER READ AT THAT POSITION (0 RETURNED IF NONE FOUND)
                        ;
                        ; FOR BOTH ROUTINES, THE IMAGES USED TO FORM CHARS ARE CONTAINED IN ROM
                        ;  FOR THE 1ST 128 CHARS.  TO ACCESS CHARS IN THE SECOND HALF, THE USER
                        ;  MUST INITIALIZE THE VECTOR AT INTERRUPT 1FH (LOCATION 0007CH) TO
                        ;  POINT TO THE USER SUPPLIED TABLE OF GRAPHIC IMAGES (8X8 BOXES).
                        ;  FAILURE TO DO SO WILL CAUSE IN STRANGE RESULTS
                        ;--------------------------------------------------
                                ASSUME  DS:DATA,ES:DATA
058A                    GRAPHICS_WRITE  PROC    NEAR
058A B4 00                      MOV     AH,0                    ; ZERO TO HIGH OF CODE POINT
058C 50                         PUSH    AX                      ; SAVE CODE POINT VALUE
```

```
                        ;-----  DETERMINE POSITION IN REGEN BUFFER TO PUT CODE POINTS
058D E8 06E9 R                  CALL    S26                     ; FIND LOCATION IN REGEN BUFFER
0590 8B F8                      MOV     DI,AX                   ; REGEN POINTER IN DI

                        ;-----  DETERMINE REGION TO GET CODE POINTS FROM

0592 58                         POP     AX                      ; RECOVER CODE POINT
0593 3C 80                      CMP     AL,80H                  ; IS IT IN SECOND HALF
0595 73 06                      JAE     S1                      ; YES

                        ;-----  IMAGE IS IN FIRST HALF, CONTAINED IN ROM

0597 BE 0000 E                  MOV     SI,OFFSET CRT_CHAR_GEN  ; OFFSET OF IMAGES
059A 0E                         PUSH    CS                      ; SAVE SEGMENT ON STACK
059B EB 18                      JMP     SHORT S2                ; DETERMINE_MODE

                        ;-----  IMAGE IS IN SECOND HALF, IN USER MEMORY

059D                    S1:                                     ; EXTEND_CHAR
059D 2C 80                      SUB     AL,80H                  ; ZERO ORIGIN FOR SECOND HALF
059F 1E                         PUSH    DS                      ; SAVE DATA POINTER
05A0 2B F6                      SUB     SI,SI
05A2 8E DE                      MOV     DS,SI                   ; ESTABLISH VECTOR ADDRESSING
                                ASSUME  DS:ABS0
05A4 C5 36 007C R               LDS     SI,@EXT_PTR             ; GET THE OFFSET OF THE TABLE
05A8 8C DA                      MOV     DX,DS                   ; GET THE SEGMENT OF THE TABLE
                                ASSUME  DS:DATA
05AA 1F                         POP     DS                      ; RECOVER DATA SEGMENT
05AB 52                         PUSH    DX                      ; SAVE TABLE SEGMENT ON STACK
05AC 0B D6                      OR      DX,SI                   ; CHECK FOR VALID TABLE DEFINED
05AE 75 05                      JNZ     S2                      ; CONTINUE IF DS:SI NOT 0000:0000

05B0 58                         POP     AX                      ; ELSE SET (AX)= 0000 FOR "NULL"
05B1 BE 0000 E                  MOV     SI,OFFSET CRT_CHAR_GEN  ; POINT TO DEFAULT TABLE OFFSET
05B4 0E                         PUSH    CS                      ;  IN THE CODE SEGMENT

                        ;-----  DETERMINE GRAPHICS MODE IN OPERATION

05B5                    S2:                                     ;       DETERMINE_MODE
05B5 D1 E0                      SAL     AX,1                    ; MULTIPLY CODE POINT VALUE BY 8
05B7 D1 E0                      SAL     AX,1
05B9 D1 E0                      SAL     AX,1
05BB 03 F0                      ADD     SI,AX                   ; SI HAS OFFSET OF DESIRED CODES
05BD 80 3E 0049 R 06            CMP     @CRT_MODE,6
05C2 1F                         POP     DS                      ; RECOVER TABLE POINTER SEGMENT
05C3 72 2C                      JC      S7                      ; TEST FOR MEDIUM RESOLUTION MODE

                        ;-----  HIGH RESOLUTION MODE
05C5                    S3:                                     ; HIGH_CHAR
05C5 57                         PUSH    DI                      ; SAVE REGEN POINTER
05C6 56                         PUSH    SI                      ; SAVE CODE POINTER
05C7 B6 04                      MOV     DH,4                    ; NUMBER OF TIMES THROUGH LOOP
05C9                    S4:
05C9 AC                         LODSB                           ; GET BYTE FROM CODE POINTS
05CA F6 C3 80                   TEST    BL,80H                  ; SHOULD WE USE THE FUNCTION
05CD 75 16                      JNZ     S6                      ;  TO PUT CHAR IN
05CF AA                         STOSB                           ; STORE IN REGEN BUFFER
05D0 AC                         LODSB
05D1                    S5:
05D1 26: 88 85 1FFF             MOV     ES:[DI+2000H-1],AL      ; STORE IN SECOND HALF
05D6 83 C7 4F                   ADD     DI,79                   ; MOVE TO NEXT ROW IN REGEN
05D9 FE CE                      DEC     DH                      ; DONE WITH LOOP
05DB 75 EC                      JNZ     S4
05DD 5E                         POP     SI
05DE 5F                         POP     DI                      ; RECOVER REGEN POINTER
05DF 47                         INC     DI                      ; POINT TO NEXT CHAR POSITION
05E0 E2 E3                      LOOP    S3                      ; MORE CHARS TO WRITE
05E2 E9 013D R                  JMP     VIDEO_RETURN

05E5                    S6:
05E5 26: 32 05                  XOR     AL,ES:[DI]              ; EXCLUSIVE OR WITH CURRENT
05E8 AA                         STOSB                           ; STORE THE CODE POINT
05E9 AC                         LODSB                           ; AGAIN FOR ODD FIELD
05EA 26: 32 85 1FFF             XOR     AL,ES:[DI+2000H-1]
05EF EB E0                      JMP     S5                      ; BACK TO MAINSTREAM

                        ;-----  MEDIUM RESOLUTION WRITE
05F1                    S7:                                     ;  MED_RES_WRITE
05F1 8A D3                      MOV     DL,BL                   ; SAVE HIGH COLOR BIT
05F3 D1 E7                      SAL     DI,1                    ; OFFSET*2 SINCE 2 BYTES/CHAR
                                                                ; EXPAND BL TO FULL WORD OF COLOR
05F5 80 E3 03                   AND     BL,3                    ; ISOLATE THE COLOR BITS ( LOW 2 BITS )
05F8 B0 55                      MOV     AL,055H                 ; GET BIT CONVERSION MULTIPLIER
05FA F6 E3                      MUL     BL                      ; EXPAND 2 COLOR BITS TO 4 REPLICATIONS
05FC 8A D8                      MOV     BL,AL                   ; PLACE BACK IN WORK REGISTER
05FE 8A F8                      MOV     BH,AL                   ; EXPAND TO 8 REPLICATIONS OF COLOR BITS
0600                    S8:                                     ;  MED_CHAR
0600 57                         PUSH    DI                      ; SAVE REGEN POINTER
0601 56                         PUSH    SI                      ; SAVE THE CODE POINTER
0602 B6 04                      MOV     DH,4                    ; NUMBER OF LOOPS
0604                    S9:
0604 AC                         LODSB                           ; GET CODE POINT
0605 E8 06C0 R                  CALL    S21                     ; DOUBLE UP ALL THE BITS
0608 23 C3                      AND     AX,BX                   ; CONVERT TO FOREGROUND COLOR ( 0 BACK )
060A 86 E0                      XCHG    AH,AL                   ; SWAP HIGH/LOW BYTES FOR WORD MOVE
060C F6 C2 80                   TEST    DL,80H                  ; IS THIS XOR FUNCTION
060F 74 03                      JZ      S10                     ; NO, STORE IT IN AS IT IS
0611 26: 33 05                  XOR     AX,ES:[DI]              ; DO FUNCTION WITH LOW/HIGH
0614                    S10:
0614 26: 89 05                  MOV     ES:[DI],AX              ; STORE FIRST BYTE HIGH, SECOND LOW
0617 AC                         LODSB                           ; GET CODE POINT
0618 E8 06C0 R                  CALL    S21
061B 23 C3                      AND     AX,BX                   ; CONVERT TO COLOR
061D 86 E0                      XCHG    AH,AL                   ; SWAP HIGH/LOW BYTES FOR WORD MOVE
061F F6 C2 80                   TEST    DL,80H                  ; AGAIN, IS THIS XOR FUNCTION
0622 74 05                      JZ      S11                     ; NO, JUST STORE THE VALUES
0624 26: 33 85 2000             XOR     AX,ES:[DI+2000H]        ; FUNCTION WITH FIRST HALF LOW
0629                    S11:
0629 26: 89 85 2000             MOV     ES:[DI+2000H],AX        ; STORE SECOND PORTION HIGH
062E 83 C7 50                   ADD     DI,80                   ; POINT TO NEXT LOCATION
0631 FE CE                      DEC     DH
0633 75 CF                      JNZ     S9                      ; KEEP GOING
```

```
1559 0635 5E                    POP     SI                      ; RECOVER CODE POINTER
1560 0636 5F                    POP     DI                      ; RECOVER REGEN POINTER
1561 0637 47                    INC     DI                      ; POINT TO NEXT CHAR POSITION
1562 0638 47                    INC     DI
1563 0639 E2 C5                 LOOP    S8                      ; MORE TO WRITE
1564 063B E9 013D R             JMP     VIDEO_RETURN
1565 063E                   GRAPHICS_WRITE  ENDP
1566                        ;--------------------------------------------
1567                        ; GRAPHICS READ
1568                        ;--------------------------------------------
1569 063E                   GRAPHICS_READ   PROC    NEAR
1570 063E E8 06E9 R            CALL    S26                     ; CONVERTED TO OFFSET IN REGEN
1571 0641 8B F0                 MOV     SI,AX                   ; SAVE IN SI
1572 0643 83 EC 08              SUB     SP,8                    ; ALLOCATE SPACE FOR THE READ CODE POINT
1573 0646 8B EC                 MOV     BP,SP                   ; POINTER TO SAVE AREA
1574
1575                        ;-----  DETERMINE GRAPHICS MODES
1576
1577 0648 80 3E 0049 R 06       CMP     @CRT_MODE,6
1578 064D 06                    PUSH    ES
1579 064E 1F                    POP     DS                      ; POINT TO REGEN SEGMENT
1580 064F 72 19                 JC      S13                     ; MEDIUM RESOLUTION
1581
1582                        ;-----  HIGH RESOLUTION READ
1583
1584                        ;-----  GET VALUES FROM REGEN BUFFER AND CONVERT TO CODE POINT
1585 0651 B6 04                 MOV     DH,4                    ; NUMBER OF PASSES
1586 0653                   S12:
1587 0653 8A 04                 MOV     AL,[SI]                 ; GET FIRST BYTE
1588 0655 88 46 00              MOV     [BP],AL                 ; SAVE IN STORAGE AREA
1589 0658 45                    INC     BP                      ; NEXT LOCATION
1590 0659 8A 84 2000            MOV     AL,[SI+2000H]           ; GET LOWER REGION BYTE
1591 065D 88 46 00              MOV     [BP],AL                 ; ADJUST AND STORE
1592 0660 45                    INC     BP
1593 0661 83 C6 50              ADD     SI,80                   ; POINTER INTO REGEN
1594 0664 FE CE                 DEC     DH                      ; LOOP CONTROL
1595 0666 75 EB                 JNZ     S12                     ; DO IT SOME MORE
1596 0668 EB 16                 JMP     SHORT S15               ; GO MATCH THE SAVED CODE POINTS
1597
1598                        ;-----  MEDIUM RESOLUTION READ
1599 066A                   S13:                                ; MED_RES_READ
1600 066A D1 E6                 SAL     SI,1                    ; OFFSET*2 SINCE 2 BYTES/CHAR
1601 066C B6 04                 MOV     DH,4                    ; NUMBER OF PASSES
1602 066E                   S14:
1603 066E E8 06CF R             CALL    S23                     ; GET BYTES FROM REGEN INTO SINGLE SAVE
1604 0671 81 C6 1FFE            ADD     SI,2000H-2              ; GO TO LOWER REGION
1605 0675 E8 06CF R             CALL    S23                     ; GET THIS PAIR INTO SAVE
1606 0678 81 EE 1FB2            SUB     SI,2000H-80+2           ; ADJUST POINTER BACK INTO UPPER
1607 067C FE CE                 DEC     DH
1608 067E 75 EE                 JNZ     S14                     ; KEEP GOING UNTIL ALL 8 DONE
1609
1610                        ;-----  SAVE AREA HAS CHARACTER IN IT, MATCH IT
1611 0680                   S15:                                ; FIND_CHAR
1612 0680 BF 0000 E             MOV     DI,OFFSET CRT_CHAR_GEN  ; ESTABLISH ADDRESSING
1613 0683 0E                    PUSH    CS
1614 0684 07                    POP     ES                      ; CODE POINTS IN CS
1615 0685 83 ED 08              SUB     BP,8                    ; ADJUST POINTER TO START OF SAVE AREA
1616 0688 8B F5                 MOV     SI,BP
1617 068A B0 00                 MOV     AL,0                    ; CURRENT CODE POINT BEING MATCHED
1618 068C                   S16:
1619 068C 16                    PUSH    SS                      ; ESTABLISH ADDRESSING TO STACK
1620 068D 1F                    POP     DS                      ; FOR THE STRING COMPARE
1621 068E BA 0080               MOV     DX,128                  ; NUMBER TO TEST AGAINST
1622 0691                   S17:
1623 0691 56                    PUSH    SI                      ; SAVE SAVE AREA POINTER
1624 0692 57                    PUSH    DI                      ; SAVE CODE POINTER
1625 0693 B9 0004               MOV     CX,4                    ; NUMBER OF WORDS TO MATCH
1626 0696 F3/ A7                REPE    CMPSW                   ; COMPARE THE 8 BYTES AS WORDS
1627 0698 5F                    POP     DI                      ; RECOVER THE POINTERS
1628 0699 5E                    POP     SI
1629 069A 74 1E                 JZ      S18                     ; IF ZERO FLAG SET, THEN MATCH OCCURRED
1630 069C FE C0                 INC     AL                      ; NO MATCH, MOVE ON TO NEXT
1631 069E 83 C7 08              ADD     DI,8                    ; NEXT CODE POINT
1632 06A1 4A                    DEC     DX                      ; LOOP CONTROL
1633 06A2 75 ED                 JNZ     S17                     ; DO ALL OF THEM
1634
1635                        ;-----  CHAR NOT MATCHED, MIGHT BE IN USER SUPPLIED SECOND HALF
1636
1637 06A4 3C 00                 CMP     AL,0                    ;  AL<> 0 IF ONLY 1ST HALF SCANNED
1638 06A6 74 12                 JE      S18                     ;  IF = 0, THEN ALL HAS BEEN SCANNED
1639 06A8 2B C0                 SUB     AX,AX
1640 06AA 8E D8                 MOV     DS,AX                   ;  ESTABLISH ADDRESSING TO VECTOR
1641                            ASSUME  DS:ABS0
1642 06AC C4 3E 007C R          LES     DI,@EXT_PTR             ;  GET POINTER
1643 06B0 8C C0                 MOV     AX,ES                   ;  SEE IF THE POINTER REALLY EXISTS
1644 06B2 0B C7                 OR      AX,DI                   ; IF ALL 0, THEN DOESN'T EXIST
1645 06B4 74 04                 JZ      S18                     ; NO SENSE LOOKING
1646 06B6 B0 80                 MOV     AL,128                  ; ORIGIN FOR SECOND HALF
1647 06B8 EB D2                 JMP     S16                     ; GO BACK AND TRY FOR IT
1648                            ASSUME  DS:DATA
1649
1650                        ;-----  CHARACTER IS FOUND ( AL=0 IF NOT FOUND )
1651 06BA                   S18:
1652 06BA 83 C4 08              ADD     SP,8                    ; READJUST THE STACK, THROW AWAY SAVE
1653 06BD E9 013D R             JMP     VIDEO_RETURN            ; ALL DONE
1654 06C0                   GRAPHICS_READ   ENDP
1655                        ;--------------------------------------------
1656                        ; EXPAND_BYTE
1657                        ;  THIS ROUTINE TAKES THE BYTE IN AL AND DOUBLES ALL
1658                        ;  OF THE BITS, TURNING THE 8 BITS INTO 16 BITS.
1659                        ;  THE RESULT IS LEFT IN AX
1660                        ;--------------------------------------------
1661 06C0                   S21     PROC    NEAR
1662 06C0 51                    PUSH    CX                      ; SAVE REGISTER
1663 06C1 B9 0008               MOV     CX,8                    ; SHIFT COUNT REGISTER FOR ONE BYTE
1664 06C4                   S22:
1665 06C4 D0 C8                 ROR     AL,1                    ; SHIFT BITS, LOW BIT INTO CARRY FLAG
1666 06C6 D1 DD                 RCR     BP,1                    ; MOVE CARRY FLAG (LOW BIT) INTO RESULTS
1667 06C8 D1 FD                 SAR     BP,1                    ; SIGN EXTEND HIGH BIT (DOUBLE IT)
1668 06CA E2 F8                 LOOP    S22                     ; REPEAT FOR ALL 8 BITS
1669
1670 06CC 95                    XCHG    AX,BP                   ; MOVE RESULTS TO PARAMETER REGISTER
1671 06CD 59                    POP     CX                      ; RECOVER REGISTER
1672 06CE C3                    RET                             ; ALL DONE
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                        S21     ENDP
                        ;--------------------------------------------------
                        ; MED_READ_BYTE
                        ; THIS ROUTINE WILL TAKE 2 BYTES FROM THE REGEN BUFFER,
                        ;  COMPARE AGAINST THE CURRENT FOREGROUND COLOR, AND PLACE
                        ;  THE CORRESPONDING ON/OFF BIT PATTERN INTO THE CURRENT
                        ;  POSITION IN THE SAVE AREA
                        ; ENTRY --
                        ;  SI,DS = POINTER TO REGEN AREA OF INTEREST
                        ;  BX = EXPANDED FOREGROUND COLOR
                        ;  BP = POINTER TO SAVE AREA
                        ; EXIT --
                        ;  SI AND BP ARE INCREMENTED
                        ;--------------------------------------------------
1687 06CF               S23     PROC    NEAR
1688 06CF AD                    LODSW                   ; GET FIRST BYTE AND SECOND BYTES
1689 06D0 86 C4                 XCHG    AL,AH           ; SWAP FOR COMPARE
1690 06D2 B9 C000               MOV     CX,0C000H       ; 2 BIT MASK TO TEST THE ENTRIES
1691 06D5 B2 00                 MOV     DL,0            ; RESULT REGISTER
1692 06D7               S24:
1693 06D7 85 C1                 TEST    AX,CX           ; IS THIS SECTION BACKGROUND?
1694 06D9 74 01                 JZ      S25             ; IF ZERO, IT IS BACKGROUND (CARRY=0)
1695 06DB F9                    STC                     ; WASN'T, SO SET CARRY
1696 06DC               S25:
1697 06DC D0 D2                 RCL     DL,1            ; MOVE THAT BIT INTO THE RESULT
1698 06DE D1 E9                 SHR     CX,1
1699 06E0 D1 E9                 SHR     CX,1            ; MOVE THE MASK TO THE RIGHT BY 2 BITS
1700 06E2 73 F3                 JNC     S24             ; DO IT AGAIN IF MASK DIDN'T FALL OUT
1701 06E4 88 56 00              MOV     [BP],DL         ; STORE RESULT IN SAVE AREA
1702 06E7 45                    INC     BP              ; ADJUST POINTER
1703 06E8 C3                    RET                     ; ALL DONE
1704 06E9               S23     ENDP
                        ;--------------------------------------------
                        ; V4_POSITION
                        ;  THIS ROUTINE TAKES THE CURSOR POSITION CONTAINED IN
                        ;  THE MEMORY LOCATION, AND CONVERTS IT INTO AN OFFSET
                        ;  INTO THE REGEN BUFFER, ASSUMING ONE BYTE/CHAR.
                        ;  FOR MEDIUM RESOLUTION GRAPHICS, THE NUMBER MUST
                        ;  BE DOUBLED.
                        ; ENTRY -- NO REGISTERS,MEMORY LOCATION @CURSOR_POSN IS USED
                        ; EXIT--
                        ;  AX CONTAINS OFFSET INTO REGEN BUFFER
                        ;--------------------------------------
1716 06E9               S26     PROC    NEAR
1717 06E9 A1 0050 R             MOV     AX,@CURSOR_POSN ; GET CURRENT CURSOR
1718 06EC               GRAPH_POSN      LABEL   NEAR
1719 06EC 53                    PUSH    BX              ; SAVE REGISTER
1720 06ED 8B D8                 MOV     BX,AX           ; SAVE A COPY OF CURRENT CURSOR
1721 06EF A0 004A R             MOV     AL,BYTE PTR @CRT_COLS   ; GET BYTES PER COLUMN
1722 06F2 F6 E4                 MUL     AH              ; MULTIPLY BY ROWS
1723 06F4 D1 E0                 SHL     AX,1
1724 06F6 D1 E0                 SHL     AX,1            ; MULTIPLY * 4 SINCE 4 ROWS/BYTE
1725 06F8 2A FF                 SUB     BH,BH           ; ISOLATE COLUMN VALUE
1726 06FA 03 C3                 ADD     AX,BX           ; DETERMINE OFFSET
1727 06FC 5B                    POP     BX              ; RECOVER POINTER
1728 06FD C3                    RET                     ; ALL DONE
1729 06FE               S26     ENDP
                        ;--- WRITE_TTY ------------------------------------------------------------------------
                        ;                                                                                      :
                        ;   THIS INTERFACE PROVIDES A TELETYPE LIKE INTERFACE TO THE                           :
                        ;     VIDEO CARDS.  THE INPUT CHARACTER IS WRITTEN TO THE CURRENT                      :
                        ;     CURSOR POSITION, AND THE CURSOR IS MOVED TO THE NEXT POSITION.                   :
                        ;     IF THE CURSOR LEAVES THE LAST COLUMN OF THE FIELD, THE COLUMN                    :
                        ;     IS SET TO ZERO, AND THE ROW VALUE IS INCREMENTED.  IF THE ROW                    :
                        ;     ROW VALUE LEAVES THE FIELD, THE CURSOR IS PLACED ON THE LAST ROW,                :
                        ;     FIRST COLUMN, AND THE ENTIRE SCREEN IS SCROLLED UP ONE LINE.                     :
                        ;     WHEN THE SCREEN IS SCROLLED UP, THE ATTRIBUTE FOR FILLING THE                    :
                        ;     NEWLY BLANKED LINE IS READ FROM THE CURSOR POSITION ON THE PREVIOUS              :
                        ;     LINE BEFORE THE SCROLL, IN CHARACTER MODE.  IN GRAPHICS MODE,                    :
                        ;     THE 0 COLOR IS USED.                                                             :
                        ;   ENTRY --                                                                           :
                        ;     (AH) = CURRENT CRT MODE                                                          :
                        ;     (AL) = CHARACTER TO BE WRITTEN                                                   :
                        ;            NOTE THAT BACK SPACE, CARRIAGE RETURN, BELL AND LINE FEED ARE             :
                        ;            HANDLED AS COMMANDS RATHER THAN AS DISPLAY GRAPHICS CHARACTERS            :
                        ;     (BL) = FOREGROUND COLOR FOR CHAR WRITE IF CURRENTLY IN A GRAPHICS MODE            :
                        ;   EXIT --                                                                            :
                        ;     ALL REGISTERS SAVED THROUGH VIDEO_EXIT (INCLUDING (AX))                          :
                        ;--------------------------------------------------------------------------------------
                                ASSUME  DS:DATA
1753 06FE               WRITE_TTY       PROC    NEAR
1754 06FE 97                    XCHG    DI,AX           ; SAVE (AX) REGISTER IN (DI) FOR EXIT
1755 06FF B4 03                 MOV     AH,03H          ; READ CURSOR POSITION
1756 0701 8A 3E 0062 R          MOV     BH,@ACTIVE_PAGE ; GET CURRENT PAGE SETTING
1757 0705 CD 10                 INT     10H             ; READ THE CURRENT CURSOR POSITION
1758 0707 8B C7                 MOV     AX,DI           ; RECOVER CHARACTER FROM (DI) REGISTER
1759
1760                    ;-----  DX NOW HAS THE CURRENT CURSOR POSITION
1761
1762 0709 3C 0D                 CMP     AL,CR           ; IS IT CARRIAGE RETURN OR CONTROL
1763 070B 76 46                 JBE     U8              ; GO TO CONTROL CHECKS IF IT IS
1764
1765                    ;-----  WRITE THE CHAR TO THE SCREEN
1766 070D               U0:
1767 070D B4 0A                 MOV     AH,0AH          ; WRITE CHARACTER ONLY COMMAND
1768 070F B9 0001               MOV     CX,1            ; ONLY ONE CHARACTER
1769 0712 CD 10                 INT     10H             ; WRITE THE CHARACTER
1770
1771                    ;-----  POSITION THE CURSOR FOR NEXT CHAR
1772
1773 0714 FE C2                 INC     DL
1774 0716 3A 16 004A R          CMP     DL,BYTE PTR @CRT_COLS   ; TEST FOR COLUMN OVERFLOW
1775 071A 75 33                 JNZ     U7              ;  SET_CURSOR
1776 071C B2 00                 MOV     DL,0            ; COLUMN FOR CURSOR
1777 071E 80 FE 18              CMP     DH,25-1         ; CHECK FOR LAST ROW
1778 0721 75 2A                 JNZ     U6              ;  SET_CURSOR_INC
1779
1780                    ;-----  SCROLL REQUIRED
1781 0723               U1:
1782 0723 B4 02                 MOV     AH,02H
1783 0725 CD 10                 INT     10H             ; SET THE CURSOR
1784
1785                    ;-----  DETERMINE VALUE TO FILL WITH DURING SCROLL
1786
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0727 A0 0049 R                  MOV     AL,@CRT_MODE            ; GET THE CURRENT MODE
072A 3C 04                      CMP     AL,4
072C 72 06                      JC      U2                      ; READ-CURSOR
072E 3C 07                      CMP     AL,7
0730 B7 00                      MOV     BH,0                    ; FILL WITH BACKGROUND
0732 75 06                      JNE     U3                      ; SCROLL-UP
0734                    U2:                                     ; READ-CURSOR
0734 B4 08                      MOV     AH,08H                  ; GET READ CURSOR COMMAND
0736 CD 10                      INT     10H                     ; READ CHAR/ATTR AT CURRENT CURSOR
0738 8A FC                      MOV     BH,AH                   ; STORE IN BH
073A                    U3:                                     ; SCROLL-UP
073A B8 0601                    MOV     AX,0601H                ; SCROLL ONE LINE
073D 2B C9                      SUB     CX,CX                   ; UPPER LEFT CORNER
073F B6 18                      MOV     DH,25-1                 ; LOWER RIGHT ROW
0741 8A 16 004A R               MOV     DL,BYTE PTR @CRT_COLS   ; LOWER RIGHT COLUMN
0745 FE CA                      DEC     DL
0747                    U4:                                     ; VIDEO-CALL-RETURN
0747 CD 10                      INT     10H                     ; SCROLL UP THE SCREEN
0749                    U5:                                     ; TTY-RETURN
0749 97                         XCHG    AX,DI                   ; RESTORE THE ENTRY CHARACTER FROM (DI)
074A E9 013D R                  JMP     VIDEO_RETURN            ; RETURN TO CALLER

074D                    U6:                                     ; SET-CURSOR-INC
074D FE C6                      INC     DH                      ; NEXT ROW
074F                    U7:                                     ; SET-CURSOR
074F B4 02                      MOV     AH,02H
0751 EB F4                      JMP     U4                      ; ESTABLISH THE NEW CURSOR

                        ;-----  CHECK FOR CONTROL CHARACTERS
0753                    U8:
0753 74 13                      JE      U9                      ; WAS IT A CARRIAGE RETURN
0755 3C 0A                      CMP     AL,LF                   ; IS IT A LINE FEED
0757 74 13                      JE      U10                     ; GO TO LINE FEED
0759 3C 07                      CMP     AL,07H                  ; IS IT A BELL
075B 74 16                      JE      U11                     ; GO TO BELL
075D 3C 08                      CMP     AL,08H                  ; IS IT A BACKSPACE
075F 75 AC                      JNE     U0                      ; IF NOT A CONTROL, DISPLAY IT

                        ;-----  BACK SPACE FOUND

0761 0A D2                      OR      DL,DL                   ; IS IT ALREADY AT START OF LINE
0763 74 EA                      JE      U7                      ; SET_CURSOR
0765 4A                         DEC     DX                      ; NO -- JUST MOVE IT BACK
0766 EB E7                      JMP     U7                      ; SET_CURSOR

                        ;-----  CARRIAGE RETURN FOUND

0768                    U9:
0768 B2 00                      MOV     DL,0                    ; MOVE TO FIRST COLUMN
076A EB E3                      JMP     U7                      ; SET_CURSOR

                        ;-----  LINE FEED FOUND

076C                    U10:
076C 80 FE 18                   CMP     DH,25-1                 ; BOTTOM OF SCREEN
076F 75 DC                      JNE     U6                      ; YES, SCROLL THE SCREEN
0771 EB B0                      JMP     U1                      ; NO, JUST SET THE CURSOR

                        ;-----  BELL FOUND

0773                    U11:
0773 B9 0533                    MOV     CX,1331                 ; DIVISOR FOR 896 HZ TONE
0776 B3 1F                      MOV     BL,31                   ; SET COUNT FOR 31/64 SECOND FOR BEEP
0778 E8 0000 E                  CALL    BEEP                    ; SOUND THE POD BELL
077B EB CC                      JMP     U5                      ; TTY_RETURN
077D                    WRITE_TTY       ENDP
                        ;--------------------------------------------------------------------------
                        ; LIGHT PEN                                                              :
                        ;       THIS ROUTINE TESTS THE LIGHT PEN SWITCH AND THE LIGHT            :
                        ;       PEN TRIGGER. IF BOTH ARE SET, THE LOCATION OF THE LIGHT          :
                        ;       PEN IS DETERMINED. OTHERWISE, A RETURN WITH NO INFORMATION       :
                        ;       IS MADE.                                                         :
                        ; ON EXIT:                                                               :
                        ;       (AH) = 0 IF NO LIGHT PEN INFORMATION IS AVAILABLE                :
                        ;              BX,CX,DX ARE DESTROYED                                    :
                        ;       (AH) = 1 IF LIGHT PEN IS AVAILABLE                               :
                        ;              (DH,DL) = ROW,COLUMN OF CURRENT LIGHT PEN POSITION        :
                        ;              (CH) = RASTER POSITION                                    :
                        ;              (BX) = BEST GUESS AT PIXEL HORIZONTAL POSITION            :
                        ;--------------------------------------------------------------------------
                                ASSUME  DS:DATA
077D 03 03 05 05 03 03  V1      DB      3,3,5,5,3,3,3,4         ; SUBTRACT_TABLE
     03 04
                        ;-----  WAIT FOR LIGHT PEN TO BE DEPRESSED

0785                    READ_LPEN       PROC    NEAR
0785 B4 00                      MOV     AH,0                    ; SET NO LIGHT PEN RETURN CODE
0787 8B 16 0063 R               MOV     DX,@ADDR_6845           ; GET BASE ADDRESS OF 6845
078B 83 C2 06                   ADD     DX,6                    ; POINT TO STATUS REGISTER
078E EC                         IN      AL,DX                   ; GET STATUS REGISTER
078F A8 04                      TEST    AL,004H                 ; TEST LIGHT PEN SWITCH
0791 74 03                      JZ      V6_A                    ; GO IF YES
0793 E9 0816 R                  JMP     V6                      ; NOT SET, RETURN

                        ;-----  NOW TEST FOR LIGHT PEN TRIGGER

0796 A8 02              V6_A:   TEST    AL,2                    ; TEST LIGHT PEN TRIGGER
0798 75 03                      JNZ     V7A                     ; RETURN WITHOUT RESETTING TRIGGER
079A E9 0820 R                  JMP     V7

                        ;-----  TRIGGER HAS BEEN SET, READ THE VALUE IN

079D                    V7A:
079D B4 10                      MOV     AH,16                   ; LIGHT PEN REGISTERS ON 6845

                        ;-----  INPUT REGISTERS POINTED TO BY AH, AND CONVERT TO ROW COLUMN IN (DX)

079F 8B 16 0063 R               MOV     DX,@ADDR_6845           ; ADDRESS REGISTER FOR 6845
07A3 8A C4                      MOV     AL,AH                   ; REGISTER TO READ
07A5 EE                         OUT     DX,AL                   ; SET IT UP
07A6 90                         NOP                             ; I/O DELAY
07A7 42                         INC     DX                      ; DATA REGISTER
07A8 EC                         IN      AL,DX                   ; GET THE VALUE
07A9 8A E8                      MOV     CH,AL                   ; SAVE IN CX
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07AB 4A                         DEC     DX                      ; ADDRESS REGISTER
07AC FE C4                      INC     AH
07AE 8A C4                      MOV     AL,AH                   ; SECOND DATA REGISTER
07B0 EE                         OUT     DX,AL
07B1 42                         INC     DX                      ; POINT TO DATA REGISTER
07B2 90                         NOP                             ; I/O DELAY
07B3 EC                         IN      AL,DX                   ; GET SECOND DATA VALUE
07B4 8A E5                      MOV     AH,CH                   ; AX HAS INPUT VALUE

                        ;-----  AX HAS THE VALUE READ IN FROM THE 6845

07B6 8A 1E 0049 R               MOV     BL,@CRT_MODE
07BA 2A FF                      SUB     BH,BH                   ; MODE VALUE TO BX
07BC 2E: 8A 9F 077D R           MOV     BL,CS:V1[BX]            ; DETERMINE AMOUNT TO SUBTRACT
07C1 2B C3                      SUB     AX,BX                   ; TAKE IT AWAY
07C3 8B 1E 004E R               MOV     BX,@CRT_START
07C7 D1 EB                      SHR     BX,1
07C9 2B C3                      SUB     AX,BX                   ; CONVERT TO CORRECT PAGE ORIGIN
07CB 79 02                      JNS     V2                      ; IF POSITIVE, DETERMINE MODE
07CD 2B C0                      SUB     AX,AX                   ; <0 PLAYS AS 0

                        ;-----  DETERMINE MODE OF OPERATION

07CF                    V2:                                     ; DETERMINE_MODE
07CF B1 03                      MOV     CL,3                    ; SET #8 SHIFT COUNT
07D1 80 3E 0049 R 04            CMP     @CRT_MODE,4             ; DETERMINE IF GRAPHICS OR ALPHA
07D6 72 2A                      JB      V4                      ; ALPHA_PEN
07D8 80 3E 0049 R 07            CMP     @CRT_MODE,7
07DD 74 23                      JE      V4                      ; ALPHA_PEN

                        ;-----  GRAPHICS MODE

07DF B2 28                      MOV     DL,40                   ; DIVISOR FOR GRAPHICS
07E1 F6 F2                      DIV     DL                      ; DETERMINE ROW(AL) AND COLUMN(AH)
                                                                ;  AL RANGE 0-99, AH RANGE 0-39

                        ;-----  DETERMINE GRAPHIC ROW POSITION

07E3 8A E8                      MOV     CH,AL                   ; SAVE ROW VALUE IN CH
07E5 02 ED                      ADD     CH,CH                   ; *2 FOR EVEN/ODD FIELD
07E7 8A DC                      MOV     BL,AH                   ; COLUMN VALUE TO BX
07E9 2A FF                      SUB     BH,BH                   ; MULTIPLY BY 8 FOR MEDIUM RES
07EB 80 3E 0049 R 06            CMP     @CRT_MODE,6             ; DETERMINE MEDIUM OR HIGH RES
07F0 75 04                      JNE     V3                      ; NOT_HIGH_RES
07F2 B1 04                      MOV     CL,4                    ; SHIFT VALUE FOR HIGH RES
07F4 D0 E4                      SAL     AH,1                    ; COLUMN VALUE TIMES 2 FOR HIGH RES
07F6                    V3:                                     ; NOT_HIGH_RES
07F6 D3 E3                      SHL     BX,CL                   ; MULTIPLY *16 FOR HIGH RES

                        ;-----  DETERMINE ALPHA CHAR POSITION

07F8 8A D4                      MOV     DL,AH                   ; COLUMN VALUE FOR RETURN
07FA 8A F0                      MOV     DH,AL                   ; ROW VALUE
07FC D0 EE                      SHR     DH,1                    ; DIVIDE BY 4
07FE D0 EE                      SHR     DH,1                    ;    FOR VALUE IN 0-24 RANGE
0800 EB 12                      JMP     SHORT V5                ; LIGHT_PEN_RETURN_SET

                        ;-----  ALPHA MODE ON LIGHT PEN

0802                    V4:                                     ; ALPHA_PEN
0802 F6 36 004A R               DIV     BYTE PTR @CRT_COLS      ; DETERMINE ROW,COLUMN VALUE
0806 8A F0                      MOV     DH,AL                   ; ROWS TO DH
0808 8A D4                      MOV     DL,AH                   ; COLS TO DL
080A D2 E0                      SAL     AL,CL                   ; MULTIPLY ROWS * 8
080C 8A E8                      MOV     CH,AL                   ; GET RASTER VALUE TO RETURN REGISTER
080E 8A DC                      MOV     BL,AH                   ; COLUMN VALUE
0810 32 FF                      XOR     BH,BH                   ;  TO BX
0812 D3 E3                      SAL     BX,CL
0814                    V5:                                     ; LIGHT_PEN_RETURN_SET
0814 B4 01                      MOV     AH,1                    ; INDICATE EVERY THING SET
0816                    V6:                                     ; LIGHT_PEN_RETURN
0816 52                         PUSH    DX                      ; SAVE RETURN VALUE (IN CASE)
0817 8B 16 0063 R               MOV     DX,@ADDR_6845           ;  GET BASE ADDRESS
081B 83 C2 07                   ADD     DX,7                    ; POINT TO RESET PARM
081E EE                         OUT     DX,AL                   ; ADDRESS, NOT DATA, IS IMPORTANT
081F 5A                         POP     DX                      ; RECOVER VALUE
0820                    V7:                                     ; RETURN_NO_RESET
0820 5D                         POP     BP
0821 5F                         POP     DI
0822 5E                         POP     SI
0823 1F                         POP     DS                      ; DISCARD SAVED BX,CX,DX
0824 1F                         POP     DS
0825 1F                         POP     DS
0826 1F                         POP     DS
0827 07                         POP     ES
0828 CF                         IRET
0829                    READ_LPEN       ENDP
0829                    CODE    ENDS
                                END
```

```
                        PAGE 118,121
                        TITLE BIOS1 ---- 01/10/86  INTERRUPT 15H BIOS ROUTINES
                        .LIST
0000                    CODE    SEGMENT BYTE PUBLIC

                                PUBLIC  CASSETTE_IO_1

                                EXTRN   CONF_TBL:NEAR           ; SYSTEM/BIOS CONFIGURATION TABLE
                                EXTRN   DDS:NEAR                ; LOAD (DS) WITH DATA SEGMENT SELECTOR

                        ;--- INT 15 H ----------------------------------------------------------------
                        ;       INPUT - CASSETTE I/O FUNCTIONS                                      :
                        ;                                                                           :
                        ;           (AH) = 00H                                                      :
                        ;           (AH) = 01H                                                      :
                        ;           (AH) = 02H                                                      :
                        ;           (AH) = 03H                                                      :
                        ;           RETURNS FOR THESE FUNCTIONS ALWAYS (AH) = 86H, CY = 1)          :
                        ;           IF CASSETTE PORT NOT PRESENT                                    :
                        ;-------------------------------------------------------------------------- :
                        ;       INPUT - UNUSED FUNCTIONS                                            :
                        ;           (AH) = 04H THROUGH 7FH                                          :
                        ;           RETURNS FOR THESE FUNCTIONS ALWAYS (AH) = 86H, CY = 1)          :
                        ;                   (UNLESS INTERCEPTED BY SYSTEM HANDLERS)                 :
                        ;                   NOTE: THE KEYBOARD INTERRUPT HANDLER INTERRUPTS WITH AH=4FH :
                        ;-------------------------------------------------------------------------- :
                        ; EXTENSIONS                                                                 :
                        ;           (AH) = 80H    DEVICE OPEN (NULL)                                :
                        ;                           (BX) = DEVICE ID                                :
                        ;                           (CX) = PROCESS ID                               :
                        ;                                                                           :
                        ;           (AH) = 81H    DEVICE CLOSE (NULL)                               :
                        ;                           (BX) = DEVICE ID                                :
                        ;                           (CX) = PROCESS ID                               :
                        ;                                                                           :
                        ;           (AH) = 82H    PROGRAM TERMINATION (NULL)                        :
                        ;                           (BX) = DEVICE ID                                :
                        ;                                                                           :
                        ;           (AH) = 83H    EVENT WAIT (NULL)                                 :
                        ;                                                                           :
                        ;           (AH) = 84H    JOYSTICK SUPPORT                                  :
                        ;                           (DX) = 00H - READ THE CURRENT SWITCH SETTINGS    :
                        ;                                        RETURNS AL = SWITCH SETTINGS (BITS 7-4) :
                        ;                           (DX) = 01H - READ THE RESISTIVE INPUTS          :
                        ;                                        RETURNS AX = A(x) VALUE            :
                        ;                                                BX = A(y) VALUE            :
                        ;                                                CX = B(x) VALUE            :
                        ;                                                DX = B(y) VALUE            :
                        ;                                                                           :
                        ;           (AH) = 88H    EXTENDED MEMORY SIZE DETERMINE                    :
                        ;                                                                           :
                        ;           (AH) = 91H    INTERRUPT COMPLETE FLAG SET                       :
                        ;                           (AL)    TYPE CODE                               :
                        ;                           00H -> 7FH                                      :
                        ;                                   SERIALLY REUSABLE DEVICES               :
                        ;                                   OPERATING SYSTEM MUST SERIALIZE ACCESS  :
                        ;                           80H -> BFH                                      :
                        ;                                   REENTRANT DEVICES; ES:BX IS USED TO     :
                        ;                                   DISTINGUISH DIFFERENT CALLS (MULTIPLE I/O :
                        ;                                   CALLS ARE ALLOWED SIMULTANEOUSLY)       :
                        ;                           C0H -> FFH                                      :
                        ;                                   WAIT ONLY CALLS --  THERE IS NO         :
                        ;                                   COMPLEMENTARY 'POST' FOR THESE WAITS.   :
                        ;                                   THESE ARE TIMEOUT ONLY.  TIMES ARE      :
                        ;                                   FUNCTION NUMBER DEPENDENT.              :
                        ;                                                                           :
                        ;                           TYPE  DESCRIPTION           TIMEOUT             :
                        ;                                                                           :
                        ;                           00H = DISK                  YES                 :
                        ;                           01H = DISKETTE              YES                 :
                        ;                           02H = KEYBOARD              NO                  :
                        ;                           80H = NETWORK               NO                  :
                        ;                                 ES:BX --> NCB                             :
                        ;                           FDH = DISKETTE MOTOR START  YES                 :
                        ;                           FEH = PRINTER               YES                 :
                        ;                                                                           :
                        ;           (AH) = C0H    RETURN CONFIGURATION PARAMETERS POINTER           :
                        ;                           RETURNS                                         :
                        ;                            (AH) = 00H AND CY= 0 (IF PRESENT ELSE 86 AND CY= 1) :
                        ;                            (ES:BX) = PARAMETER TABLE ADDRESS POINTER      :
                        ;                                      WHERE:                               :
                        ;                                                                           :
                        ;                       DW   8              LENGTH OF FOLLOWING TABLE       :
                        ;                       DB   MODEL_BYTE     SYSTEM MODEL BYTE               :
                        ;                       DB   TYPE_BYTE      SYSTEM MODEL TYPE BYTE          :
                        ;                       DB   BIOS_LEVEL     BIOS REVISION LEVEL             :
                        ;                       DB   ?              10000000 = DMA CHANNEL 3 USE BY BIOS :
                        ;                                           01000000 = CASCADED INTERRUPT LEVEL 2 :
                        ;                                           00100000 = REAL TIME CLOCK AVAILABLE :
                        ;                                           00010000 = KEYBOARD SCAN CODE HOOK 1AH :
                        ;                       DB   0              RESERVED                        :
                        ;                       DB   0              RESERVED                        :
                        ;                       DB   0              RESERVED                        :
                        ;                       DB   0              RESERVED                        :
                        ;                                                                           :
                        ;-------------------------------------------------------------------------- :

                                ASSUME  CS:CODE

0000                    CASSETTE_IO_1   PROC    FAR
0000 FB                         STI                             ; ENABLE INTERRUPTS
0001 80 FC 80                   CMP     AH,080H                 ; CHECK FOR RANGE OF  00-7FH
0004 73 06                      JAE     C1_G                    ; SKIP AND HANDLE, ELSE RETURN ERROR

0006                    C1:                                     ;       ERROR
0006 B4 86                      MOV     AH,86H                  ; SET BAD COMMAND
0008 F9                         STC                             ; SET CARRY FLAG ON (CY=1)

0009                    C1_F:                                   ;       COMMON EXIT
0009 CA 0002                    RET     2                       ; FAR RETURN EXIT FROM ROUTINES

000C                    C1_G:                                   ;       CONTINUE CHECKING FOR FUNCTION
000C 80 FC C0                   CMP     AH,0C0H                 ; CHECK FOR CONFIGURATION PARAMETERS
000F 74 2E                      JE      CONF_PARMS
```

```
0011 80 EC 80                   SUB     AH,080H                 ; BASE ON 0
0014 74 25                      JZ      DEV_OPEN                ; DEVICE OPEN           (80H)
0016 FE CC                      DEC     AH
0018 74 21                      JZ      DEV_CLOSE               ; DEVICE CLOSE          (81H)
001A FE CC                      DEC     AH
001C 74 1D                      JZ      PROG_TERM               ; PROGRAM TERMINATION   (82H)
001E FE CC                      DEC     AH                      ;  IGNORE EVENT WAIT    (83H)
0020 FE CC                      DEC     AH
0022 74 27                      JZ      JOY_STICK               ; JOYSTICK BIOS         (84H)
0024 FE CC                      DEC     AH
0026 74 13                      JZ      SYS_REQ                 ; SYSTEM REQUEST KEY    (85H)
0028 FE CC                      DEC     AH                      ;  IGNORE WAIT          (86H)
002A FE CC                      DEC     AH                      ;  IGNORE BLOCK MOVE    (87H)
002C FE CC                      DEC     AH
002E 74 18                      JZ      EXT_MEMORY              ; EXTENDED MEMORY SIZE (88H)

0030 80 EC 08                   SUB     AH,8                    ; CHECK FOR FUNCTION    (90H)
0033 74 06                      JZ      DEVICE_BUSY
0035 FE CC                      DEC     AH                      ; CHECK FOR FUNCTION    (91H)
0037 74 05                      JZ      INT_COMPLETE            ; GO TO INTERRUPT COMPLETE RETURN
0039 EB CB                      JMP     C1                      ; EXIT IF NOT A VALID FUNCTION

                        DEV_OPEN:                               ; NULL HANDLERS
003B                    DEV_CLOSE:
003B                    PROG_TERM:
003B                    SYS_REQ:
003B                    DEVICE_BUSY:
003B F8                         CLC                             ; TURN CARRY OFF
003C EB CB                      JMP     C1_F                    ; RETURN WITH (AH= 00) AND CY=0

003E                    CASSETTE_IO_1   ENDP

                        ;--- INTERRUPT COMPLETE --------------------------
                        ;                                                 :
                        ;       THIS ROUTINE IS A TEMPORARY HANDLER       :
                        ;       FOR INTERRUPT COMPLETE                    :
                        ;                                                 :
                        ;       INPUT   - SEE PROLOGUE                    :
                        ;-------------------------------------------------

003E                    INT_COMPLETE    PROC    NEAR
003E CF                         IRET                            ; RETURN
003F                    INT_COMPLETE    ENDP

003F                    CONF_PARMS      PROC    NEAR            ;       FUNCTION (C0H)
003F 0E                         PUSH    CS                      ; GET CODE SEGMENT
0040 07                         POP     ES                      ; PLACE IN SELECTOR POINTER
0041 BB 0000 E                  MOV     BX,OFFSET CONF_TBL      ; GET OFFSET OF PARAMETER TABLE
0044 32 E4                      XOR     AH,AH                   ; CLEAR AH AND SET CARRY OFF
0046 EB C1                      JMP     C1_F                    ; EXIT THROUGH COMMON RETURN
0048                    CONF_PARMS      ENDP

                        ;--- INT 15 H -- ( FUNCTION 88 H - I/O MEMORY SIZE DETERMINE ) ----------------
                        ; EXT_MEMORY                                                                  :
                        ;       THIS ROUTINE RETURNS  THE AMOUNT OF MEMORY IN THE SYSTEM THAT IS       :
                        ;       LOCATED STARTING AT THE 1024K ADDRESSING RANGE, AS DETERMINED BY       :
                        ;       THE POST ROUTINES.                                                     :
                        ; INPUT                                                                        :
                        ;       AH = 88H                                                               :
                        ;                                                                              :
                        ; OUTPUT                                                                       :
                        ;       (AX) = 0                                                               :
                        ;                                                                              :
                        ;-------------------------------------------------------------------------------

0048                    EXT_MEMORY      PROC

0048 33 C0                      XOR     AX,AX                   ; SET EXTENDED MEMORY SIZE TO ZERO

004A CF                         IRET                            ; RETURN TO USER

004B                    EXT_MEMORY      ENDP
```

SECTION 5

```
                        PAGE
                        ;--- JOY_STICK ------------------------------------------------
                        ;       THIS ROUTINE WILL READ THE JOYSTICK PORT                 :
                        ;                                                               :
                        ;       INPUT                                                   :
                        ;       (DX)=0 READ THE CURRENT SWITCHES                        :
                        ;              RETURNS (AL)= SWITCH SETTINGS IN BITS 7-4        :
                        ;                                                               :
                        ;       (DX)=1  READ THE RESISTIVE INPUTS                       :
                        ;              RETURNS (AX)=A(x) VALUE                          :
                        ;                      (BX)=A(y) VALUE                          :
                        ;                      (CX)=B(x) VALUE                          :
                        ;                      (DX)=B(y) VALUE                          :
                        ;                                                               :
                        ;       CY FLAG ON IF NO ADAPTER CARD OR INVALID CALL           :
                        ;---------------------------------------------------------------

004B                    JOY_STICK       PROC    NEAR
004B FB                         STI                             ; INTERRUPTS BACK ON
004C 8B C2                      MOV     AX,DX                   ; GET SUB FUNCTION CODE
004E BA 0201                    MOV     DX,201H                 ; ADDRESS OF PORT
0051 0A C0                      OR      AL,AL
0053 74 09                      JZ      JOY_2                   ; READ SWITCHES
0055 FE C8                      DEC     AL
0057 74 0A                      JZ      JOY_3                   ; READ RESISTIVE INPUTS
0059 EB AB                      JMP     C1                      ; GO TO ERROR RETURN
005B                    JOY_1:
005B FB                         STI
005C EB AB                      JMP     C1_F                    ; GO TO COMMON RETURN

005E                    JOY_2:
005E EC                         IN      AL,DX
005F 24 F0                      AND     AL,0F0H                 ; STRIP UNWANTED BITS OFF
0061 EB F8                      JMP     JOY_1                   ; FINISHED

0063                    JOY_3:
0063 B3 01                      MOV     BL,1
0065 E8 0081 R                  CALL    TEST_CORD
0068 51                         PUSH    CX                      ; SAVE A(X) VALUE
0069 B3 02                      MOV     BL,2
006B E8 0081 R                  CALL    TEST_CORD
006E 51                         PUSH    CX                      ; SAVE A(Y) VALUE
006F B3 04                      MOV     BL,4
0071 E8 0081 R                  CALL    TEST_CORD
0074 51                         PUSH    CX                      ; SAVE B(X) VALUE
0075 B3 08                      MOV     BL,8
0077 E8 0081 R                  CALL    TEST_CORD
007A 8B D1                      MOV     DX,CX                   ; SAVE B(Y) VALUE
007C 59                         POP     CX                      ; GET B(X) VALUE
007D 5B                         POP     BX                      ; GET A(Y) VALUE
007E 58                         POP     AX                      ; GET A(X) VALUE
007F EB DA                      JMP     JOY_1                   ; FINISHED - RETURN

0081                    TEST_CORD       PROC    NEAR
0081 52                         PUSH    DX                      ; SAVE
0082 FA                         CLI                             ; BLOCK INTERRUPTS WHILE READING
0083 B0 00                      MOV     AL,0                    ; SET UP TO LATCH TIMER 0
0085 E6 43                      OUT     TIMER+3,AL
0087 EB 00                      JMP     $+2
0089 E4 40                      IN      AL,TIMER                ; READ LOW BYTE OF TIMER 0
008B EB 00                      JMP     $+2
008D 8A E0                      MOV     AH,AL
008F E4 40                      IN      AL,TIMER                ; READ HIGH BYTE OF TIMER 0
0091 86 E0                      XCHG    AH,AL                   ; REARRANGE TO HIGH,LOW
0093 50                         PUSH    AX                      ; SAVE
0094 B9 04FF                    MOV     CX,4FFH                 ; SET COUNT
0097 EE                         OUT     DX,AL                   ; FIRE TIMER
0098 EB 00                      JMP     $+2
009A                    TEST_CORD_1:
009A EC                         IN      AL,DX                   ; READ VALUES
009B 84 C3                      TEST    AL,BL                   ; HAS PULSE ENDED?
009D E0 FB                      LOOPNZ  TEST_CORD_1
009F 83 F9 00                   CMP     CX,0
00A2 59                         POP     CX                      ; ORIGINAL COUNT
00A3 75 04                      JNZ     SHORT TEST_CORD_2
00A5 2B C9                      SUB     CX,CX                   ; SET 0 COUNT FOR RETURN
00A7 EB 2D                      JMP     SHORT TEST_CORD_3       ; EXIT WITH COUNT = 0
00A9                    TEST_CORD_2:
00A9 B0 00                      MOV     AL,0                    ; SET UP TO LATCH TIMER 0
00AB E6 43                      OUT     TIMER+3,AL
00AD EB 00                      JMP     $+2
00AF E4 40                      IN      AL,TIMER                ; READ LOW BYTE OF TIMER 0
00B1 8A E0                      MOV     AH,AL
00B3 EB 00                      JMP     $+2
00B5 E4 40                      IN      AL,TIMER                ; READ HIGH BYTE OF TIMER 0
00B7 86 E0                      XCHG    AH,AL                   ; REARRANGE TO HIGH,LOW

00B9 3B C8                      CMP     CX,AX                   ; CHECK FOR COUNTER WRAP
00BB 73 0B                      JAE     TEST_CORD_4             ; GO IF NO
00BD 52                         PUSH    DX
00BE BA FFFF                    MOV     DX,-1

00C1 2B D0                      SUB     DX,AX                   ; ADJUST FOR WRAP
00C3 03 CA                      ADD     CX,DX
00C5 5A                         POP     DX
00C6 EB 02                      JMP     SHORT TEST_CORD_5

00C8                    TEST_CORD_4:
00C8 2B C8                      SUB     CX,AX
00CA                    TEST_CORD_5:
00CA 81 E1 1FF0                 AND     CX,1FF0H                ; ADJUST
00CE D1 E9                      SHR     CX,1
00D0 D1 E9                      SHR     CX,1
00D2 D1 E9                      SHR     CX,1
00D4 D1 E9                      SHR     CX,1

00D6                    TEST_CORD_3:
00D6 FB                         STI                             ; INTERRUPTS BACK ON
00D7 BA 0201                    MOV     DX,201H                 ; FLUSH OTHER INPUTS
00DA 51                         PUSH    CX
00DB 50                         PUSH    AX
00DC B9 04FF                    MOV     CX,4FFH                 ; COUNT
00DF                    TEST_CORD_6:
00DF EC                         IN      AL,DX
```

```
00E0 A8 0F                      TEST    AL,0FH
00E2 E0 FB                      LOOPNZ  TEST_CORD_6
                                
00E4 58                         POP     AX
00E5 59                         POP     CX
00E6 5A                         POP     DX                      ; SET COUNT
                                
00E7 C3                         RET                             ; RETURN
                                
00E8                    TEST_CORD       ENDP
00E8                    JOY_STICK       ENDP
                                
00E8                    CODE    ENDS
                                END
```

```
                        PAGE 118,121
                        TITLE POST ----- 01/10/86  SYSTEM POST AND BIOS PROCEDURES

                        PUBLIC  A1
                        PUBLIC  BEEP
                        PUBLIC  CONF_TBL
                        PUBLIC  CRT_CHAR_GEN
                        PUBLIC  DDS
                        PUBLIC  DISK_BASE
                        PUBLIC  M5
                        PUBLIC  M6
                        PUBLIC  M7
                        PUBLIC  MD_TBL1
                        PUBLIC  MD_TBL2
                        PUBLIC  MD_TBL3
                        PUBLIC  MD_TBL4
                        PUBLIC  MD_TBL5
                        PUBLIC  MD_TBL6
                        PUBLIC  P_O_R
                        PUBLIC  RESET
                        PUBLIC  VIDEO_PARMS
                        PUBLIC  WAITF

                        EXTRN   CASSETTE_IO_1:NEAR
                        EXTRN   DISKETTE_IO_1:NEAR
                        EXTRN   DISK_INT_1:NEAR
                        EXTRN   DSKETTE_SETUP:NEAR
                        EXTRN   KB_INT_1:NEAR
                        EXTRN   KEYBOARD_IO_1:NEAR
                        EXTRN   NEC_OUTPUT:NEAR
                        EXTRN   PRINTER_IO_1:NEAR
                        EXTRN   RESULTS:NEAR
                        EXTRN   RS232_IO_1:NEAR
                        EXTRN   SEEK:NEAR
                        EXTRN   VIDEO_IO_1:NEAR

                        EXTRN   SET_MODE:NEAR
                        EXTRN   SET_CTYPE:NEAR
                        EXTRN   SET_CPOS:NEAR
                        EXTRN   READ_CURSOR:NEAR
                        EXTRN   READ_LPEN:NEAR
                        EXTRN   ACT_DISP_PAGE:NEAR
                        EXTRN   SCROLL_UP:NEAR
                        EXTRN   SCROLL_DOWN:NEAR
                        EXTRN   READ_AC_CURRENT:NEAR
                        EXTRN   WRITE_AC_CURRENT:NEAR
                        EXTRN   WRITE_C_CURRENT:NEAR
                        EXTRN   SET_COLOR:NEAR
                        EXTRN   WRITE_DOT:NEAR
                        EXTRN   READ_DOT:NEAR
                        EXTRN   WRITE_TTY:NEAR
                        EXTRN   VIDEO_STATE:NEAR
                        .LIST
                        ;--------------------------------------------------------------------
                        ;       THE  BIOS ROUTINES ARE MEANT TO BE ACCESSED THROUGH      :
                        ;       SOFTWARE INTERRUPTS ONLY.  ANY ADDRESSES PRESENT IN      :
                        ;       THE LISTINGS  ARE INCLUDED  ONLY FOR  COMPLETENESS,      :
                        ;       NOT FOR  REFERENCE.   APPLICATIONS WHICH  REFERENCE      :
                        ;       ABSOLUTE   ADDRESSES   WITHIN   THE   CODE  SEGMENT      :
                        ;       VIOLATE THE STRUCTURE AND DESIGN OF BIOS.                :
                        ;--------------------------------------------------------------------
                        ;----------------------------------------
                        ;       ROM RESIDENT CODE                :
                        ;----------------------------------------
0000                    CODE    SEGMENT BYTE    PUBLIC

0000 1FFF [                     DB      01FFFH  DUP     (0CCH)  ; FILL UNUSED LOCATIONS WITH INTERRUPT 3
          CC
                ]

                        ;       ORG     0E000H
0000                            ORG     0
0000 36 32 58 30 38 35          DB      '62X0851 COPR. IBM 1986'        ; COPYRIGHT NOTICE
     31 20 43 4F 50 52
     2E 20 49 42 4D 20
     31 39 38 36

                        ;-----------------------------------------------
                        ;       INITIAL RELIABILITY TESTS -- PHASE 1    :
                        ;-----------------------------------------------

                                ASSUME  CS:CODE,SS:CODE,ES:ABS0,DS:DATA

0016 00D5 R             C1      DW      C11                     ; RETURN ADDRESS
0018 0181 R             C2      DW      C24                     ; RETURN ADDRESS FOR DUMMY STACK
001A 20 4B 42 20 4F 4B  F3B     DB      ' KB OK',CR             ; KB FOR MEMORY SIZE
     0D

                        ;-------------------------------------------------------------------
                        ;       LOAD A BLOCK OF TEST CODE THROUGH THE KEYBOARD PORT        :
                        ;       FOR MANUFACTURING TEST.                                   :
                        ;       THIS ROUTINE WILL LOAD A TEST (MAX LENGTH=FAFFH) THROUGH   :
                        ;       THE KEYBOARD PORT. CODE WILL BE LOADED AT LOCATION        :
                        ;       0000:0500. AFTER LOADING, CONTROL WILL BE TRANSFERED      :
                        ;       TO LOCATION 0000:0500. STACK WILL BE LOCATED JUST BELOW    :
                        ;       THE TEST CODE. THIS ROUTINE ASSUMES THAT THE FRIST 2      :
                        ;       BYTES TRANSFERED CONTAIN THE COUNT OF BYTES TO BE LOADED   :
                        ;       (BYTE 1=COUNT LOW, BYTE 2=COUNT HI.)                      :
                        ;-------------------------------------------------------------------

                        ;----- FIRST, GET THE COUNT

0021                    MFG_BOOT:
0021 E8 19F0 R                  CALL    SP_TEST                 ; GET COUNT LOW
0024 8A FB                      MOV     BH,BL                   ; SAVE IT
0026 E8 19F0 R                  CALL    SP_TEST                 ; GET COUNT HI
0029 8A EB                      MOV     CH,BL
002B 8A CF                      MOV     CL,BH                   ; CX NOW HAS COUNT
002D FC                         CLD                             ; SET DIR. FLAG TO INCRIMENT
002E FA                         CLI
002F BF 0500                    MOV     DI,0500H                ; SET TARGET OFFSET (DS=0000)
0032 B0 FD                      MOV     AL,0FDH                 ; UNMASK K/B INTERRUPT
0034 E6 21                      OUT     INTA01,AL
0036 B0 0A                      MOV     AL,0AH                  ; SEND READ INT. REQUEST REG. CMD
0038 E6 20                      OUT     INTA00,AL
003A BA 0061                    MOV     DX,PORT_B               ; SET UP PORT B ADDRESS
```

```
003D BB 4CCC                    MOV     BX,4CCCH                ; CONTROL BITS FOR PORT B
0040 B4 02                      MOV     AH,02H                  ; K/B REQUEST PENDING MASK
0042                    TST:
0042 8A C3                      MOV     AL,BL
0044 EE                         OUT     DX,AL                   ; TOGGLE K/B CLOCK
0045 8A C7                      MOV     AL,BH
0047 EE                         OUT     DX,AL
0048 4A                         DEC     DX                      ; POINT DX AT ADDR. 60 (KB DATA)
0049                    TST1:
0049 E4 20                      IN      AL,INTA00               ; GET IRR REG
004B 22 C4                      AND     AL,AH                   ; KB REQUEST PENDING?
004D 74 FA                      JZ      TST1                    ; LOOP TILL DATA PRESENT
004F EC                         IN      AL,DX                   ; GET DATA
0050 AA                         STOSB                           ; STORE IT
0051 42                         INC     DX                      ; POINT DX BACK AT PORT B (61)
0052 E2 EE                      LOOP    TST                     ; LOOP TILL ALL BYTES READ
0054 EA 0500 ---- R             JMP     @MFG_TEST_RTN           ; FAR JUMP TO CODE THAT WAS JUST
                                                                ; LOADED

                        ;--------------------------------------
                        ;       8088 PROCESSOR TEST             :
                        ; DESCRIPTION                           :
                        ;       VERIFY 8088 FLAGS, REGISTERS    :
                        ;       AND CONDITIONAL JUMPS           :
                        ;--------------------------------------

                                ASSUME  CS:CODE,DS:NOTHING,ES:NOTHING,SS:NOTHING
                        ;       ORG     0E05BH
                                ORG     0005BH
005B                    RESET:
005B                    START:
005B FA                          CLI                            ; DISABLE INTERRUPTS
005C B4 D5                       MOV    AH,0D5H                 ; SET SF, CF, ZF, AND AF FLAGS ON
005E 9E                          SAHF
005F 73 4A                       JNC    ERR01                   ; GO TO ERROR ROUTINE IF CF NOT SET
0061 75 48                       JNZ    ERR01                   ; GO TO ERROR ROUTINE IF ZF NOT SET
0063 7B 46                       JNP    ERR01                   ; GO TO ERROR ROUTINE IF PF NOT SET
0065 79 44                       JNS    ERR01                   ; GO TO ERROR ROUTINE IF SF NOT SET
0067 9F                          LAHF                           ; LOAD FLAG IMAGE TO AH
0068 B1 05                       MOV    CL,5                    ; LOAD COUNT REG WITH SHIFT COUNT
006A D2 EC                       SHR    AH,CL                   ; SHIFT AF INTO CARRY BIT POSITION
006C 73 3D                       JNC    ERR01                   ; GO TO ERROR ROUTINE IF AF NOT SET
006E B0 40                       MOV    AL,40H                  ; SET THE OF FLAG ON
0070 D0 E0                       SHL    AL,1                    ; SETUP FOR TESTING
0072 71 37                       JNO    ERR01                   ; GO TO ERROR ROUTINE IF OF NOT SET
0074 32 E4                       XOR    AH,AH                   ; SET AH = 0
0076 9E                          SAHF                           ; CLEAR SF, CF, ZF, AND PF
0077 76 32                       JBE    ERR01                   ; GO TO ERROR ROUTINE IF CF ON
                                                                ; GO TO ERROR ROUTINE IF ZF ON
0079 78 30                       JS     ERR01                   ; GO TO ERROR ROUTINE IF SF ON
007B 7A 2E                       JP     ERR01                   ; GO TO ERROR ROUTINE IF PF ON
007D 9F                          LAHF                           ; LOAD FLAG IMAGE TO AH
007E D2 EC                       SHR    AH,CL                   ; SHIFT 'AF' INTO CARRY BIT POSITION
0080 72 29                       JC     ERR01                   ; GO TO ERROR ROUTINE IF ON
0082 D0 E4                       SHL    AH,1                    ; CHECK THAT 'OF' IS CLEAR
0084 70 25                       JO     ERR01                   ; GO TO ERROR ROUTINE IF ON

                        ;----- READ/WRITE THE 8088 GENERAL AND SEGMENTATION REGISTERS
                        ;       WITH ALL ONE'S AND ZEROES'S.

0086 B8 FFFF                     MOV    AX,0FFFFH               ; SETUP ONE'S PATTERN IN AX
0089 F9                          STC
008A 8E D8              C8:      MOV    DS,AX                   ; WRITE PATTERN TO ALL REGS
008C 8C DB                       MOV    BX,DS
008E 8E C3                       MOV    ES,BX
0090 8C C1                       MOV    CX,ES
0092 8E D1                       MOV    SS,CX
0094 8C D2                       MOV    DX,SS
0096 8B E2                       MOV    SP,DX
0098 8B EC                       MOV    BP,SP
009A 8B F5                       MOV    SI,BP
009C 8B FE                       MOV    DI,SI
009E 73 07                       JNC    C9                      ; TSTIA
00A0 33 C7                       XOR    AX,DI                   ; PATTERN MAKE IT THRU ALL REGS
00A2 75 07                       JNZ    ERR01                   ; NO - GO TO ERR ROUTINE
00A4 F8                          CLC
00A5 EB E3                       JMP    C8
00A7                    C9:                                     ; TSTIA
00A7 0B C7                       OR     AX,DI                   ; ZERO PATTERN MAKE IT THRU?
00A9 74 01                       JZ     C10                     ; YES - GO TO NEXT TEST
500AB F4                ERR01:   HLT                             ; HALT SYSTEM

                        ;--------------------------------------
                        ;       ROS CHECKSUM TEST I             :
                        ; DESCRIPTION                           :
                        ;       A CHECKSUM IS DONE FOR THE 8K   :
                        ;       ROS MODULE CONTAINING POD AND   :
                        ;       BIOS.                           :
                        ;--------------------------------------

00AC                    C10:
                                                                ; ZERO IN AL ALREADY
00AC E6 A0                       OUT    0A0H,AL                 ; DISABLE NMI INTERRUPTS
00AE E6 83                       OUT    83H,AL                  ; INITIALZE DMA PAGE REG
00B0 BA 03D8                     MOV    DX,3D8H
00B3 EE                          OUT    DX,AL                   ; DISABLE COLOR VIDEO
00B4 FE C0                       INC    AL
00B6 B2 B8                       MOV    DL,0B8H
00B8 EE                          OUT    DX,AL                   ; DISABLE B/W VIDEO,EN HIGH RES
00B9 B0 89                       MOV    AL,89H                  ; SET 8255 FOR B,A=OUT, C=IN
00BB E6 63                       OUT    CMD_PORT,AL
00BD B0 A5                       MOV    AL,10100101B
                                                                ; ENABLE PARITY CHECKERS AND
00BF E6 61                       OUT    PORT_B,AL               ; PULL KB CLOCK LOW, TRI-STATE
                                                                ; KEYBOARD INPUTS,ENABLE HIGH
                                                                ; BANK OF SWITCHES->PORT C(0-3)
00C1 B0 01                       MOV    AL,01H                  ; <><><><><><><><><><><><>
00C3 E6 60                       OUT    PORT_A,AL               ; <><><>CHECKPOINT 1<><><>
00C5 8C C8                       MOV    AX,CS                   ; SETUP SS SEG REG
00C7 8E D0                       MOV    SS,AX
00C9 8E D8                       MOV    DS,AX                   ; SET UP DATA SEG TO POINT TO
                                                                ; ROM ADDRESS
00CB FC                          CLD                            ; SET DIRECTION FLAG TO INC.
                                 ASSUME SS:CODE
00CC BB 0000                     MOV    BX,00000H               ; SETUP STARTING ROS ADDR
00CF BC 0016 R                   MOV    SP,OFFSET C11           ; SETUP RETURN ADDRESS
00D2 E9 18BF R                   JMP    ROS_CHECKSUM
00D5 75 D4              C11:     JNE    ERR01                   ; HALT SYSTEM IF ERROR
```

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                        PAGE
                        ;--------------------------------------------------------
                        ;       8237 DMA INITIALIZATION CHANNEL REGISTER TEST    :
                        ; DESCRIPTION                                            :
                        ;       DISABLE THE 8237 DMA CONTROLLER.  VERIFY THAT    :
                        ;       TIMER 1 FUNCTIONS OK. WRITE/READ THE CURRENT     :
                        ;       ADDRESS AND WORD COUNT REGISTERS FOR ALL         :
                        ;       CHANNELS.  INITIALIZE AND START DMA FOR MEMORY   :
                        ;       REFRESH.                                         :
                        ;--------------------------------------------------------

                        ;----- DISABLE DMA CONTROLLER

00D7 B0 02                      MOV     AL,02H                  ; <><><><><><><><><><><>
00D9 E6 60                      OUT     PORT_A,AL               ; <><><>CHECKPOINT 2<><><>
00DB B0 04                      MOV     AL,04                   ; DISABLE DMA CONTROLLER
00DD E6 08                      OUT     DMA08,AL

                        ;----- VERIFY THAT TIMER 1 FUNCTIONS OK

00DF B0 54                      MOV     AL,54H                  ; SEL TIMER 1,LSB,MODE 2
00E1 E6 43                      OUT     TIMER+3,AL
00E3 8A C1                      MOV     AL,CL                   ; SET INITIAL TIMER CNT TO 0
00E5 E6 41                      OUT     TIMER+1,AL
00E7                    C12:                                    ; TIMER1_BITS_ON
00E7 B0 40                      MOV     AL,40H                  ; LATCH TIMER 1 COUNT
00E9 E6 43                      OUT     TIMER+3,AL
00EB 80 FB FF                   CMP     BL,0FFH                 ; YES - SEE IF ALL BITS GO OFF
00EE 74 07                      JE      C13                     ; TIMER1_BITS_OFF
00F0 E4 41                      IN      AL,TIMER+1              ; READ TIMER 1 COUNT
00F2 0A D8                      OR      BL,AL                   ; ALL BITS ON IN TIMER
00F4 E2 F1                      LOOP    C12                     ; TIMER1_BITS_ON
00F6 F4                         HLT                             ; TIMER 1 FAILURE, HALT SYS
00F7                    C13:                                    ; TIMER1_BITS_OFF
00F7 8A C3                      MOV     AL,BL                   ; SET TIMER 1 CNT
00F9 2B C9                      SUB     CX,CX
00FB E6 41                      OUT     TIMER+1,AL
00FD                    C14:                                    ; TIMER_LOOP
00FD B0 40                      MOV     AL,40H                  ; LATCH TIMER 1 COUNT
00FF E6 43                      OUT     TIMER+3,AL
0101 90                         NOP                             ; DELAY FOR TIMER
0102 90                         NOP
0103 E4 41                      IN      AL,TIMER+1              ; READ TIMER 1 COUNT
0105 22 D8                      AND     BL,AL
0107 74 03                      JZ      C15                     ; WRAP_DMA_REG
0109 E2 F2                      LOOP    C14                     ; TIMER_LOOP
010B F4                         HLT                             ; HALT SYSTEM

                        ;----- INITIALIZE TIMER 1 TO REFRESH MEMORY

010C B0 03              C15:    MOV     AL,03H                  ; <><><><><><><><><><><>
010E E6 60                      OUT     PORT_A,AL               ; <><><>CHECKPOINT 3<><><>
                                                                ; WRAP_DMA_REG
0110 E6 0D                      OUT     DMA+0DH,AL              ; SEND MASTER CLEAR TO DMA

                        ;----- WRAP DMA CHANNELS ADDRESS AND COUNT REGISTERS

0112 B0 FF                      MOV     AL,0FFH                 ; WRITE PATTERN FF TO ALL REGS
0114 8A D8              C16:    MOV     BL,AL                   ; SAVE PATTERN FOR COMPARE
0116 8A F8                      MOV     BH,AL
0118 B9 0008                    MOV     CX,8                    ; SETUP LOOP CNT
011B BA 0000                    MOV     DX,DMA                  ; SETUP I/O PORT ADDR OF REG
011E EE                 C17:    OUT     DX,AL                   ; WRITE PATTERN TO REG, LSB
011F 50                         PUSH    AX                      ; SATISIFY 8237 I/O TIMINGS
0120 EE                         OUT     DX,AL                   ; MSB OF 16 BIT REG
0121 B0 01                      MOV     AL,01H                  ; AL TO ANOTHER PAT BEFORE RD
0123 EC                         IN      AL,DX                   ; READ 16-BIT DMA CH REG, LSB
0124 8A E0                      MOV     AH,AL                   ; SAVE LSB OF 16-BIT REG
0126 EC                         IN      AL,DX                   ; READ MSB OF DMA CH REG
0127 3B D8                      CMP     BX,AX                   ; PATTERN READ AS WRITTEN?
0129 74 01                      JE      C18                     ; YES - CHECK NEXT REG
012B                    C17A:
012B F4                         HLT                             ; NO - HALT THE SYSTEM
012C                    C18:                                    ; NXT_DMA_CH
012C 42                         INC     DX                      ; SET I/O PORT TO NEXT CH REG
012D F9                         STC
012E E2 EE                      LOOP    C17                     ; WRITE PATTERN TO NEXT REG
0130 73 F9                      JNC     C17A                    ; IF CARRY NOT SET HALT SYSTEM
0132 FE C0                      INC     AL                      ; SET PATTERN TO 0
0134 74 DE                      JZ      C16                     ; WRITE TO CHANNEL REGS

                        ;----- INITIALIZE AND START DMA FOR MEMORY REFRESH.

0136 8E DB                      MOV     DS,BX                   ; SET UP ABS0 INTO DS AND ES
0138 8E C3                      MOV     ES,BX
                                ASSUME  DS:ABS0,ES:ABS0
013A B0 FF                      MOV     AL,0FFH                 ; SET CNT OF 64K FOR REFRESH
013C E6 01                      OUT     DMA+1,AL
013E 50                         PUSH    AX
013F E6 01                      OUT     DMA+1,AL
0141 B0 58                      MOV     AL,058H                 ; SET DMA MODE,CH 0,RD.,AUOTINT
0143 E6 0B                      OUT     DMA+0BH,AL              ; WRITE DMA MODE REG
0145 B0 00                      MOV     AL,0                    ; ENABLE DMA CONTROLLER
0147 8A E8                      MOV     CH,AL                   ; SET COUNT HIGH=00
0149 E6 08                      OUT     DMA+8,AL                ; SETUP DMA COMMAND REG
014B 50                         PUSH    AX
014C E6 0A                      OUT     DMA+10,AL               ; ENABLE DMA CH 0
014E B0 12                      MOV     AL,18                   ; START TIMER 1
0150 E6 41                      OUT     TIMER+1,AL
0152 B0 41                      MOV     AL,41H                  ; SET MODE FOR CHANNEL 1
0154 E6 0B                      OUT     DMA+0BH,AL
0156 50                         PUSH    AX
0157 E4 08                      IN      AL,DMA+08               ; GET DMA STATUS
0159 24 10                      AND     AL,00010000B            ; IS TIMER REQUEST THERE?
015B 74 01                      JZ      C18C                    ; (IT SHOULD'T BE)
015D F4                         HLT                             ; HALT SYS.(HOT TIMER 1 OUTPUT)
015E B0 42              C18C:   MOV     AL,42H                  ; SET MODE FOR CHANNEL 2
0160 E6 0B                      OUT     DMA+0BH,AL
0162 B0 43                      MOV     AL,43H                  ; SET MODE FOR CHANNEL 3
0164 E6 0B                      OUT     DMA+0BH,AL
```

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                        PAGE
                        ;--------------------------------------------
                        ;       BASE 64K READ/WRITE STORAGE TEST     :
                        ; DESCRIPTION                                :
                        ;       WRITE/READ/VERIFY DATA PATTERNS      :
                        ;       AA,55,FF,01, AND 00 TO 1ST 64K OF    :
                        ;       STORAGE. VERIFY STORAGE ADDRESSABILITY. :
                        ;--------------------------------------------

 0166 AD                        LODSW                           ; ALLOW RAM CHARGE TIME.
 0167 AD                        LODSW
 0168 AD                        LODSW
 0169 AD                        LODSW

                        ;----- DETERMINE MEMORY SIZE AND FILL MEMORY WITH DATA

 016A 8B 1E 0472 R              MOV     BX,DATA_WORD[@RESET_FLAG-DATA40] ; SAVE 'RESET_FLAG' IN BX
 016E 8B 2E 0496 R              MOV     BP,DATA_WORD[@KB_FLAG_3-DATA40] ; SAVE KEYBOARD TYPE
 0172 B9 8000                   MOV     CX,08000H               ; SET FOR 32K WORDS
 0175 81 FB 1234                CMP     BX,1234H                ; WARM START?
 0179 74 16                     JE      CLR_STG
 017B BC 0018 R                 MOV     SP,OFFSET C2
 017E E9 0CCF R                 JMP     STGTST_CNT
 0181 74 12             C24:    JE      HOW_BIG                 ; STORAGE OK, DETERMINE SIZE
 0183 8A D8                     MOV     BL,AL                   ; SAVE FAILING BIT PATTERN
 0185 B0 04                     MOV     AL,04H                  ; <><><><><><><><><><><><>
 0187 E6 60             C24A:   OUT     PORT_A,AL               ; <><><>CHECKPOINT 4<><><>
 0189 2B C9                     SUB     CX,CX                   ; BASE RAM FAILURE - HANG
 018B E2 FE             C24B:   LOOP    C24B                    ; FLIPPING BETWEEN 04 AND
 018D 86 D8                     XCHG    BL,AL                   ; FAILING BIT PATTERN
 018F EB F6                     JMP     C24A
 0191                   CLR_STG:
 0191 2B C0                     SUB     AX,AX                   ; MAKE AX=0000
 0193 F3/ AB                    REP     STOSW                   ; STORE 32K WORDS OF 0000
 0195                   HOW_BIG:
 0195 89 1E 0472 R              MOV     DATA_WORD[@RESET_FLAG-DATA40],BX        ; RESTORE RESET FLAG
 0199 83 FD 10                  CMP     BP,KBX                  ; IS THE KBX BIT THE ONLY ONE ON?
 019C 74 02                     JE      C24C                    ; IF NOT THEN THIS MUST BE A P.O.R.
 019E 2B ED                     SUB     BP,BP                   ; IF P.O.R. THEN INITIALIZE THIS TO ZERO
 01A0                   C24C:
 01A0 89 2E 0496 R              MOV     DATA_WORD[@KB_FLAG_3-DATA40],BP ; RESTORE RESET FLAG
 01A4 2B ED                     SUB     BP,BP                   ; BP IS USED LATER AS AN ERROR INDICATOR
 01A6 BA 0400                   MOV     DX,0400H                ; SET POINTER TO JUST>16KB
 01A9 BB 0010                   MOV     BX,16                   ; BASIC COUNT OF 16K
 01AC                   FILL_LOOP:
 01AC 8E C2                     MOV     ES,DX                   ; SET SEG. REG.
 01AE 2B FF                     SUB     DI,DI
 01B0 B8 AA55                   MOV     AX,0AA55H               ; TEST PATTERN
 01B3 8B C8                     MOV     CX,AX                   ; SAVE PATTERN
 01B5 26: 89 05                 MOV     ES:[DI],AX              ; SEND PATTERN TO MEM.
 01B8 B0 0F                     MOV     AL,0FH                  ; PUT SOMETHING IN AL
 01BA 26: 8B 05                 MOV     AX,ES:[DI]              ; GET PATTERN
 01BD 33 C1                     XOR     AX,CX                   ; COMPARE PATTERNS
 01BF 75 11                     JNZ     HOW_BIG_END             ; GO END IF NO COMPARE
 01C1 B9 2000                   MOV     CX,2000H                ; SET COUNT FOR 8K WORDS
 01C4 F3/ AB                    REP     STOSW                   ; FILL 8K WORDS
 01C6 81 C2 0400                ADD     DX,400H                 ; POINT TO NEXT 16KB BLOCK
 01CA 83 C3 10                  ADD     BX,16                   ; BUMP COUNT BY 16KB
 01CD 80 FE A0                  CMP     DH,0A0H                 ; TOP OF RAM AREA YET? (A0000)
 01D0 75 DA                     JNZ     FILL_LOOP
 01D2                   HOW_BIG_END:
 01D2 89 1E 0413 R              MOV     DATA_WORD[@MEMORY_SIZE-DATA40],BX       ; SAVE MEMORY SIZE

                        ;----- SETUP STACK SEG AND SP

 01D6 B8 0030                   MOV     AX,STACK_SS             ; GET STACK VALUE
 01D9 8E D0                     MOV     SS,AX                   ; SET THE STACK UP
 01DB BC 0100                   MOV     SP,TOS                  ; STACK IS READY TO GO
                        ;--------------------------------------------
                        ;  INITIALIZE THE 8259 INTERRUPT CONTROLLER CHIP  :
                        ;--------------------------------------------
 01DE B0 13             C25:    MOV     AL,13H                  ; ICW1 - EDGE, SNGL, ICW4
 01E0 E6 20                     OUT     INTA00,AL
 01E2 B0 08                     MOV     AL,8                    ; SETUP ICW2 - INT TYPE 8 (8-F)
 01E4 E6 21                     OUT     INTA01,AL
 01E6 B0 09                     MOV     AL,9                    ; SETUP ICW4 - BUFFRD,8086 MODE
 01E8 E6 21                     OUT     INTA01,AL
 01EA B0 FF                     MOV     AL,0FFH                 ; MASK ALL INTS. OFF
 01EC E6 21                     OUT     INTA01,AL               ; (VIDEO ROUTINE ENABLES INTS.)

                        ;----- SET UP THE INTERRUPT VECTORS TO TEMP INTERRUPT

 01EE 1E                        PUSH    DS
 01EF B9 0020                   MOV     CX,32                   ; FILL ALL 32 INTERRUPTS
 01F2 2B FF                     SUB     DI,DI                   ; FIRST INTERRUPT LOCATION
 01F4 8E C7                     MOV     ES,DI                   ; SET ES=0000 ALSO
 01F6 BB 1F23 R         D3:     MOV     AX,OFFSET D11           ; MOVE ADDR OF INTR PROC TO TBL
 01F9 AB                        STOSW
 01FA 8C C8                     MOV     AX,CS                   ; GET ADDR OF INTR PROC SEG
 01FC AB                        STOSW
 01FD E2 F7                     LOOP    D3                      ; VECTBL0

                        ;----- ESTABLISH BIOS SUBROUTINE CALL INTERRUPT VECTORS

 01FF BF 0040 R                 MOV     DI,OFFSET @VIDEO_INT    ; SETUP ADDR TO INTR AREA
 0202 0E                        PUSH    CS
 0203 1F                        POP     DS                      ; SETUP ADDR OF VECTOR TABLE
 0204 BE 1F03 R                 MOV     SI,OFFSET VECTOR_TABLE+16       ; START WITH VIDEO ENTRY
 0207 B9 0010                   MOV     CX,16
 020A A5                D3A:    MOVSW                           ; MOVE VECTOR TABLE TO RAM
 020B 47                        INC     DI                      ; SKIP SEGMENT POINTER
 020C 47                        INC     DI
 020D E2 FB                     LOOP    D3A
                        ;--------------------------------------------
                        ;       DETERMINE CONFIGURATION AND MFG. MODE  :
                        ;--------------------------------------------

 020F 1F                        POP     DS
 0210 1E                        PUSH    DS                      ; RECOVER DATA SEG
 0211 E4 62                     IN      AL,PORT_C               ; GET SWITCH INFO
 0213 24 0F                     AND     AL,0000T111B            ; ISOLATE SWITCHES
 0215 8A E0                     MOV     AH,AL                   ; SAVE
 0217 B0 AD                     MOV     AL,10101101B            ; ENABLE OTHER BANK OF SWS.
 0219 E6 61                     OUT     PORT_B,AL
```

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                        NOP
                        IN      AL,PORT_C
                        MOV     CL,4
                        ROL     AL,CL                   ; ROTATE TO HIGH NIBBLE
                        AND     AL,11110000B            ; ISOLATE
                        OR      AL,AH                   ; COMBINE WITH OTHER BANK
                        SUB     AH,AH
                        MOV     DATA_WORD[@EQUIP_FLAG-DATA40],AX        ; SAVE SWITCH INFO
                        MOV     AL,99H
                        OUT     CMD_PORT,AL
                        CALL    KBD_RESET               ; SEE IF MFG. JUMPER IN
                        CMP     BL,0EAH                 ; IS THIS THE EXTENDED KEYBOARD?
                        JNE     KBX1                    ; IF NOT THEN LEAVE THE FLAG ALONE
                        MOV     DATA_AREA[@KB_FLAG_3-DATA40],KBX  ; EXTENDED KEYBOARD
                        JMP     E6                      ; DONE WITH KEYBOARD HERE
                KBX1:
                        CMP     BL,0AAH                 ; KEYBOARD PRESENT?
                        JE      E6
                        CMP     BL,065H                 ; LOAD MFG. TEST REQUEST?
                        JNE     D3B
                        JMP     MFG_BOOT                ; GO TO BOOTSTRAP IF SO
                D3B:
                        OR      BL,BL                   ; MFG PLUG IN?
                        JNZ     E6                      ; NO
                        MOV     AL,38H
                        OUT     PORT_B,AL
                        NOP
                        NOP
                        IN      AL,PORT_A
                        AND     AL,0FFH                 ; WAS DATA LINE GROUNDED
                        JNZ     E6
                        INC     DATA_AREA[@MFG_TST-DATA40]      ; SET MANUFACTURING TEST FLAG

                ;--------------------------------------------------------
                ;       INITIALIZE AND START CRT CONTROLLER (6845)       :
                ;       TEST VIDEO READ/WRITE STORAGE.                   :
                ; DESCRIPTION                                            :
                ;       RESET THE VIDEO ENABLE SIGNAL.                   :
                ;       SELECT ALPHANUMERIC MODE, 40 * 25, B & W.        :
                ;       READ/WRITE DATA PATTERNS TO STG. CHECK STG       :
                ;       ADDRESSABILITY.                                  :
                ; ERROR = 1 LONG AND 2 SHORT BEEPS                       :
                ;--------------------------------------------------------
                E6:
                        MOV     AX,DATA_WORD[@EQUIP_FLAG-DATA40]        ; GET SENSE SWITCH INFO
                        PUSH    AX                      ; SAVE IT
                        MOV     AL,30H
                        MOV     DATA_WORD[@EQUIP_FLAG-DATA40],AX
                        SUB     AH,AH
                        INT     10H                     ; SEND INIT TO B/W CARD
                        MOV     AL,20H
                        MOV     DATA_WORD[@EQUIP_FLAG-DATA40],AX
                        SUB     AH,AH                   ; AND INIT COLOR CARD
                        INT     10H
                        POP     AX                      ; RECOVER REAL SWITCH INFO
                        MOV     DATA_WORD[@EQUIP_FLAG-DATA40],AX        ; RESTORE IT
                                                        ; AND CONTINUE
                        AND     AL,30H                  ; ISOLATE VIDEO SWS
                        JNZ     E7                      ; VIDEO SWS SET TO 0?
                        MOV     DI,OFFSET @VIDEO_INT    ; SET INT 10H TO DUMMY
                        MOV     WORD PTR [DI],OFFSET DUMMY_RETURN       ; RET IF NO VIDEO CARD
                        JMP     E18_1                   ; BYPASS VIDEO TEST
                E7:                                     ; TEST_VIDEO:
                        CMP     AL,30H                  ; B/W CARD ATTACHED?
                        JE      E8                      ; YES - SET MODE FOR B/W CARD
                        INC     AH                      ; SET COLOR MODE FOR COLOR CD
                        CMP     AL,20H                  ; 80X25 MODE SELECTED?
                        JNE     E8                      ; NO - SET MODE FOR 40X25
                        MOV     AH,3                    ; SET MODE FOR 80X25
                E8:     XCHG    AH,AL                   ; SET_MODE:
                        PUSH    AX                      ; SAVE VIDEO MODE ON STACK
                        SUB     AH,AH                   ; INITIALIZE TO ALPHANUMERIC MD
                        INT     10H                     ; CALL VIDEO_IO
                        POP     AX                      ; RESTORE VIDEO SENSE SWS IN AH
                        PUSH    AX                      ; RESAVE VALUE
                        MOV     BX,0B000H               ; BEG VIDEO RAM ADDR B/W CD
                        JMP     SHORT E8A

                ;----- UNNATURAL ACT FOR ADDRESS COMPATIBILITY

                ;       ORG     0E2C3H
                        ORG     002C3H
                NMI_INT:
                        JMP     NMI_INT_1

                E8A:
                        MOV     DX,3B8H                 ; MODE REG FOR B/W
                        MOV     CX,2048                 ; RAM WORD CNT FOR B/W CD
                        MOV     AL,1                    ; SET MODE FOR BW CARD
                        CMP     AH,30H                  ; B/W VIDEO CARD ATTACHED?
                        JE      E9                      ; YES - GO TEST VIDEO STG
                        MOV     BH,0B8H                 ; BEG VIDEO RAM ADDR COLOR CD
                        MOV     DX,3D8H                 ; MODE REG FOR COLOR CD
                        MOV     CH,20H                  ; RAM WORD CNT FOR COLOR CD
                        DEC     AL                      ; SET MODE TO 0 FOR COLOR CD
                E9:                                     ; TEST_VIDEO_STG:
                        OUT     DX,AL                   ; DISABLE VIDEO FOR COLOR CD
                        CMP     DATA_WORD[@RESET_FLAG-DATA40],1234H ; POD INIT BY KBD RESET?
                        MOV     ES,BX                   ; POINT ES TO VIDEO RAM STG
                        JE      E10                     ; YES - SKIP VIDEO RAM TEST
                        MOV     DS,BX                   ; POINT DS TO VIDEO RAM STG
                        ASSUME  DS:NOTHING,ES:NOTHING
                        CALL    STGTST_CNT              ; GO TEST VIDEO R/W STG
                        JNE     E17                     ; R/W STG FAILURE - BEEP SPK

                ;-----------------------------------------
                ;       SETUP VIDEO DATA ON SCREEN FOR VIDEO    :
                ;       LINE TEST.                              :
                ; DESCRIPTION                                   :
                ;       ENABLE VIDEO SIGNAL AND SET MODE.       :
                ;       DISPLAY A HORIZONTAL BAR ON SCREEN.     :
                ;-----------------------------------------
                E10:
                        POP     AX                      ; GET VIDEO SENSE SWS (AH)
                        PUSH    AX                      ; SAVE IT
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02F0 B4 00                      MOV     AH,0                    ; ENABLE VIDEO AND SET MODE
02F2 CD 10                      INT     10H                     ; VIDEO
02F4 B8 7020                    MOV     AX,7020H                ; WRT BLANKS IN REVERSE VIDEO

02F7 2B FF                      SUB     DI,DI                   ; SETUP STARTING LOC
02F9 B9 0028                    MOV     CX,40                   ; NO. OF BLANKS TO DISPLAY
02FC F3/ AB                     REP     STOSW                   ; WRITE VIDEO STORAGE
                        ;--------------------------------------------
                        ;       CRT INTERFACE LINES TEST        :
                        ; DESCRIPTION                           :
                        ;       SENSE ON/OFF TRANSITION OF THE  :
                        ;       VIDEO ENABLE AND HORIZONTAL     :
                        ;       SYNC LINES.                     :
                        ;--------------------------------------------
02FE 58                         POP     AX                      ; GET VIDEO SENSE SW INFO
02FF 50                         PUSH    AX                      ; SAVE IT
0300 80 FC 30                   CMP     AH,30H                  ; B/W CARD ATTACHED?
0303 BA 03BA                    MOV     DX,03BAH                ; SETUP ADDR OF BW STATUS PORT
0306 74 03                      JE      E11                     ; YES - GO TEST LINES
0308 BA 03DA                    MOV     DX,03DAH                ; COLOR CARD IS ATTACHED
030B                    E11:                                    ; LINE_TST:
030B B4 08                      MOV     AH,8
030D                    E12:                                    ; OFLOOP_CNT:
030D 2B C9                      SUB     CX,CX
030F                    E13:
030F EC                         IN      AL,DX                   ; READ CRT STATUS PORT
0310 22 C4                      AND     AL,AH                   ; CHECK VIDEO/HORZ LINE
0312 75 04                      JNZ     E14                     ; ITS ON - CHECK IF IT GOES OFF
0314 E2 F9                      LOOP    E13                     ; LOOP TILL ON OR TIMEOUT
0316 EB 09                      JMP     SHORT E17               ; GO PRINT ERROR MSG
0318                    E14:
0318 2B C9                      SUB     CX,CX
031A                    E15:
031A EC                         IN      AL,DX                   ; READ CRT STATUS PORT
031B 22 C4                      AND     AL,AH                   ; CHECK VIDEO/HORZ LINE
031D 74 11                      JZ      E16                     ; ITS ON - CHECK NEXT LINE
031F E2 F9                      LOOP    E15                     ; LOOP IF OFF TILL IT GOES ON
0321                    E17:                                    ; CRT_ERR:
0321 1F                         POP     DS
0322 1E                         PUSH    DS
0323 C6 06 0015 R 06            MOV     DS:@MFG_ERR_FLAG,06H    ; <><><>CRT ERR CHKPT. 06<><><>
0328 BA 0102                    MOV     DX,102H
032B E8 19A5 R                  CALL    ERR_BEEP                ; GO BEEP SPEAKER
032E EB 06                      JMP     SHORT E18
0330                    E16:                                    ; NXT_LINE:
0330 B1 03                      MOV     CL,3                    ; GET NEXT BIT TO CHECK
0332 D2 EC                      SHR     AH,CL
0334 75 D7                      JNZ     E12                     ; GO CHECK HORIZONTAL LINE
0336                    E18:                                    ; DISPLAY_CURSOR:
0336 58                         POP     AX                      ; GET VIDEO SENSE SWS (AH)
0337 B4 00                      MOV     AH,0                    ; SET MODE AND DISPLAY CURSOR
0339 CD 10                      INT     10H                     ; CALL VIDEO I/O PROCEDURE
033B                    E18_1:
033B BA C000                    MOV     DX,0C000H               ; SEE IF ADVANCED VIDEO CARD
033E                    E18A:
033E 8E DA                      MOV     DS,DX                   ; IS PRESENT
0340 2B DB                      SUB     BX,BX
0342 8B 07                      MOV     AX,[BX]                 ; GET FIRST 2 LOCATIONS
0344 53                         PUSH    BX
0345 5B                         POP     BX                      ; LET BUS SETTLE
0346 3D AA55                    CMP     AX,0AA55H               ; PRESENT?
0349 75 05                      JNZ     E18B                    ; NO? GO LOOK FOR OTHER MODULES
034B E8 1920 R                  CALL    ROM_CHECK               ; GO SCAN MODULE
034E EB 04                      JMP     SHORT E18C
0350                    E18B:
0350 81 C2 0080                 ADD     DX,0080H                ; POINT TO NEXT 2K BLOCK
0354                    E18C:
0354 81 FA C800                 CMP     DX,0C800H               ; TOP OF VIDEO ROM AREA YET?
0358 7C E4                      JL      E18A                    ; GO SCAN FOR ANOTHER MODULE
                        ;--------------------------------------------------------
                        ;       8259 INTERRUPT CONTROLLER TEST                  :
                        ; DESCRIPTION                                           :
                        ;       READ/WRITE THE INTERRUPT MASK REGISTER (IMR)    :
                        ;       WITH ALL ONES AND ZEROES. ENABLE SYSTEM         :
                        ;       INTERRUPTS.  MASK DEVICE INTERRUPTS OFF. CHECK  :
                        ;       FOR HOT INTERRUPTS (UNEXPECTED).                :
                        ;--------------------------------------------------------
                                ASSUME  DS:ABS0
035A 1F                 C21:    POP     DS

                        ;----- TEST THE IMR REGISTER

035B C6 06 0415 R 05    C21A:   MOV     DATA_AREA[@MFG_ERR_FLAG-DATA40],05H
                                                                ; <><><><><><><><><><><><>
                                                                ; <><><>CHECKPOINT 5<><><>
0360 B0 00                      MOV     AL,0                    ; SET IMR TO ZERO
0362 E6 21                      OUT     INTA01,AL
0364 E4 21                      IN      AL,INTA01               ; READ IMR
0366 0A C0                      OR      AL,AL                   ; IMR = 0?
0368 75 1B                      JNZ     D6                      ; GO TO ERR ROUTINE IF NOT 0
036A B0 FF                      MOV     AL,0FFH                 ; DISABLE DEVICE INTERRUPTS
036C E6 21                      OUT     INTA01,AL               ; WRITE TO IMR
036E E4 21                      IN      AL,INTA01               ; READ IMR
0370 04 01                      ADD     AL,1                    ; ALL IMR BIT ON?
0372 75 11                      JNZ     D6                      ; NO - GO TO ERR ROUTINE

                        ;----- CHECK FOR HOT INTERRUPTS

                        ;----- INTERRUPTS ARE MASKED OFF.  CHECK THAT NO INTERRUPTS OCCUR.

0374 A2 046B R                  MOV     DATA_AREA[@INTR_FLAG-DATA40],AL ; CLEAR INTERRUPT FLAG
0377 FB                         STI                             ; ENABLE EXTERNAL INTERRUPTS
0378 2B C9                      SUB     CX,CX                   ; WAIT 1 SEC FOR ANY INTRS THAT
037A                    D4:
037A E2 FE                      LOOP    D4                      ; MIGHT OCCUR
037C                    D5:
037C E2 FE                      LOOP    D5
037E 80 3E 046B R 00            CMP     DATA_AREA[@INTR_FLAG-DATA40],00H        ; ANY INTERRUPTS OCCUR?
0383 74 08                      JZ      D7                      ; NO - GO TO NEXT TEST
0385                    D6:
0385 BE 18CC R                  MOV     SI,OFFSET E0            ; DISPLAY 101 ERROR
0388 E8 1976 R                  CALL    E_MSG
038B FA                         CLI
038C F4                         HLT                             ; HALT THE SYSTEM
```

SECTION 5

```
                        PAGE
                        ;--------------------------------------------------------
                        ;       8253 TIMER CHECKOUT                             :
                        ; DESCRIPTION                                           :
                        ;       VERIFY THAT THE SYSTEM TIMER (0) DOESN'T COUNT  :
                        ;       TOO FAST OR TOO SLOW.                           :
                        ;--------------------------------------------------------
038D                    D7:
038D C6 06 0415 R 02            MOV     DATA_AREA[@MFG_ERR_FLAG-DATA40],02H
                                                        ; <><><><><><><><><><><><><><><>
                                                        ; <><><>TIMER CHECKPOINT (2)<><><>
0392 B0 FE                      MOV     AL,0FEH         ; MASK ALL INTRS EXCEPT LVL 0
0394 E6 21                      OUT     INTA01,AL       ; WRITE THE 8259 IMR
0396 B0 10                      MOV     AL,00010000B    ; SEL TIM 0, LSB, MODE 0, BINARY
0398 E6 43                      OUT     TIM_CTL,AL      ; WRITE TIMER CONTROL MODE REG
039A B9 0016                    MOV     CX,16H          ; SET PGM LOOP CNT
039D 8A C1                      MOV     AL,CL           ; SET TIMER 0 CNT REG
039F E6 40                      OUT     TIMER0,AL       ; WRITE TIMER 0 CNT REG
03A1                    D8:
03A1 F6 06 046B R 01            TEST    DATA_AREA[@INTR_FLAG-DATA40],01H
                                                        ; DID TIMER 0 INTERRUPT OCCUR?
03A6 75 04                      JNZ     D9              ; YES - CHECK TIMER OP FOR SLOW TIME
03A8 E2 F7                      LOOP    D8              ; WAIT FOR INTR FOR SPECIFIED TIME
03AA EB D9                      JMP     D6              ; TIMER 0 INTR DIDN'T OCCUR - ERR
03AC                    D9:
03AC B1 0C                      MOV     CL,12           ; SET PGM LOOP CNT
03AE B0 FF                      MOV     AL,0FFH         ; WRITE TIMER 0 CNT REG
03B0 E6 40                      OUT     TIMER0,AL
03B2 C6 06 046B R 00            MOV     DATA_AREA[@INTR_FLAG-DATA40],0  ; RESET INTR RECEIVED FLAG
03B7 B0 FE                      MOV     AL,0FEH         ; REENABLE TIMER 0 INTERRUTS
03B9 E6 21                      OUT     INTA01,AL
03BB                    D10:
03BB F6 06 046B R 01            TEST    DATA_AREA[@INTR_FLAG-DATA40],01H    ; TIMER 0 INTERRUPT OCCUR?
03C0 75 C3                      JNZ     D6              ; YES - TIMER CNTING TOO FAST, ERR
03C2 E2 F7                      LOOP    D10             ; WAIT FOR INTR FOR SPECIFIED TIME

                        ;----- SETUP TIMER 0 TO MODE 3

03C4 B0 FF                      MOV     AL,0FFH         ; DISABLE ALL DEVICE INTERRUPTS
03C6 E6 21                      OUT     INTA01,AL
03C8 B0 36                      MOV     AL,36H          ; SEL TIM 0,LSB,MSB,MODE 3
03CA E6 43                      OUT     TIMER+3,AL      ; WRITE TIMER MODE REG
03CC B0 00                      MOV     AL,0
03CE E6 40                      OUT     TIMER,AL        ; WRITE LSB TO TIMER 0 REG
03D0 E6 40                      OUT     TIMER,AL        ; WRITE MSB TO TIMER 0 REG
                        ;--------------------------------------------------------
                        ;       KEYBOARD TEST                                   :
                        ; DESCRIPTION                                           :
                        ;       RESET THE KEYBOARD AND CHECK THAT SCAN          :
                        ;       CODE 'AA' IS RETURNED TO THE CPU.               :
                        ;       CHECK FOR STUCK KEYS.                           :
                        ;--------------------------------------------------------
03D2                    TST12:
03D2 B0 99                      MOV     AL,99H          ; SET 8255 MODE A,C=IN B=OUT
03D4 E6 63                      OUT     CMD_PORT,AL
03D6 A0 0410 R                  MOV     AL,DATA_AREA[@EQUIP_FLAG-DATA40]
03D9 24 01                      AND     AL,01           ; TEST CHAMBER?
03DB 74 30                      JZ      F7              ; BYPASS IF SO
03DD 80 3E 0412 R 01            CMP     DATA_AREA[@MFG_TST-DATA40],1    ; MANUFACTURING TEST MODE?
03E2 74 29                      JE      F7              ; YES - SKIP KEYBOARD TEST
03E4 E8 19E3 R                  CALL    KBD_RESET       ; ISSUE RESET TO KEYBRD
03E7 E3 1E                      JCXZ    F6              ; PRINT ERR MSG IF NO INTERRUPT
03E9 B0 49                      MOV     AL,49H          ; ENABLE KEYBOARD
03EB E6 61                      OUT     PORT_B,AL
03ED 80 FB AA                   CMP     BL,0AAH         ; SCAN CODE AS EXPECTED?
03F0 75 15                      JNE     F6              ; NO - DISPLAY ERROR MSG

                        ;----- CHECK FOR STUCK KEYS

03F2 B0 C8                      MOV     AL,0C8H         ; CLR KBD, SET CLK LINE HIGH
03F4 E6 61                      OUT     PORT_B,AL
03F6 B0 48                      MOV     AL,48H          ; ENABLE KBD,CLK IN NEXT BYTE
03F8 E6 61                      OUT     PORT_B,AL
03FA 2B C9                      SUB     CX,CX
03FC                    F5:                             ; KBD_WAIT:
03FC E2 FE                      LOOP    F5              ; DELAY FOR A WHILE
03FE E4 60                      IN      AL,KB_DATA      ; CHECK FOR STUCK KEYS
0400 3C 00                      CMP     AL,0            ; SCAN CODE = 0?
0402 74 09                      JE      F7              ; YES - CONTINUE TESTING
0404 E8 1958 R                  CALL    XPC_BYTE        ; CONVERT AND PRINT
0407                    F6:
0407 BE 098A R                  MOV     SI,OFFSET F1    ; GET MSG ADDR
040A E8 1976 R                  CALL    E_MSG           ; PRINT MSG ON SCREEN
                        ;--------------------------------------------------------
                        ;       SETUP HARDWARE INT. VECTOR TABLE                :
                        ;--------------------------------------------------------
040D                    F7:
040D 1E                         PUSH    DS              ; SETUP_INT_TABLE:
040E 2B C0                      SUB     AX,AX
0410 8E C0                      MOV     ES,AX
0412 B9 0008                    MOV     CX,08           ; GET VECTOR CNT
0415 0E                         PUSH    CS              ; SETUP DS SEG REG
0416 1F                         POP     DS
0417 BE 1EF3 R                  MOV     SI,OFFSET VECTOR_TABLE
041A BF 0020 R                  MOV     DI,OFFSET @INT_PTR
041D                    F7A:
041D A5                         MOVSW
041E 47                         INC     DI              ; SKIP OVER SEGMENT
041F 47                         INC     DI
0420 E2 FB                      LOOP    F7A
0422 1F                         POP     DS

                        ;----- SET UP OTHER INTERRUPTS AS NECESSARY

0423 C7 06 0008 R 02C3 R        MOV     WORD PTR @NMI_PTR,OFFSET NMI_INT ; NMI INTERRUPT
0429 C7 06 0014 R 1F54 R        MOV     WORD PTR @INT5_PTR,OFFSET PRINT_SCREEN ; PRINT SCREEN
042F C7 06 0062 R F600          MOV     WORD PTR @BASIC_PTR+2,0F600H    ; SEGMENT FOR CASSETTE BASIC
0435 C7 06 007E R 0000          MOV     WORD PTR @EXT_PTR+2,0000        ;SEGMENT FOR VIDEO EXTENSION

                        ;----- SETUP TIMER 0 TO BLINK LED IF MANUFACTURING TEST MODE

043B 80 3E 0412 R 01            CMP     DATA_AREA[@MFG_TST-DATA40],01H  ; MFG. TEST MODE?
0440 75 0A                      JNZ     EXP_TO
0442 C7 06 0070 1909 R          MOV     WORD PTR DS:[1CH*4],OFFSET BLINK_INT ; SETUP TIMER TO BLINK LED
```

```
0448 B0 FE                      MOV     AL,0FEH                 ; ENABLE TIMER INTERRUPT
044A E6 21                      OUT     INTA01,AL
                        ;--------------------------------------------------------
                        ; EXPANSION I/O BOX TEST                               :
                        ;       CHECK TO SEE IF EXPANSION BOX PRESENT - IF INSTALLED,  :
                        ;       TEST DATA AND ADDRESS BUSES TO I/O BOX          :
                        ;  ERROR='1801'                                         :
                        ;--------------------------------------------------------

                        ;----- DETERMINE IF BOX IS PRESENT

044C                    EXP_IO:                                 ; (CARD WAS ENABLED EARLIER)
044C BA 0210                    MOV     DX,0210H                ; CONTROL PORT ADDRESS
044F B8 5555                    MOV     AX,5555H                ; SET DATA PATTERN
0452 EE                         OUT     DX,AL
0453 B0 01                      MOV     AL,01H                  ; MAKE AL DIFFERENT
0455 EC                         IN      AL,DX                   ; RECOVER DATA
0456 3A C4                      CMP     AL,AH                   ; REPLY?
0458 75 43                      JNE     E19                     ; NO RESPONSE, GO TO NEXT TEST
045A F7 D0                      NOT     AX                      ; MAKE DATA=AAAA
045C EE                         OUT     DX,AL
045D B0 01                      MOV     AL,01H
045F EC                         IN      AL,DX                   ; RECOVER DATA
0460 3A C4                      CMP     AL,AH
0462 75 39                      JNE     E19

                        ;----- CHECK ADDRESS BUS

0464                    EXP2:
0464 BB 0001                    MOV     BX,0001H
0467 BA 0215                    MOV     DX,0215H                ; LOAD HI ADDR. REG ADDRESS
046A B9 0010                    MOV     CX,0016                 ; GO ACROSS 16 BITS
046D                    EXP3:
046D 2E: 88 07                  MOV     CS:[BX],AL              ; WRITE ADDRESS F0000+BX
0470 90                         NOP
0471 EC                         IN      AL,DX                   ; READ ADDR. HIGH
0472 3A C7                      CMP     AL,BH
0474 75 21                      JNE     EXP_ERR                 ; GO ERROR IF MISCOMPARE
0476 42                         INC     DX                      ; DX=216H (ADDR. LOW REG)
0477 EC                         IN      AL,DX
0478 3A C3                      CMP     AL,BL                   ; COMPARE TO LOW ADDRESS
047A 75 1B                      JNE     EXP_ERR
047C 4A                         DEC     DX                      ; DX BACK TO 215H
047D D1 E3                      SHL     BX,1
047F E2 EC                      LOOP    EXP3                    ; LOOP TILL '1' WALKS ACROSS BX

                        ;----- CHECK DATA BUS

0481 B9 0008                    MOV     CX,0008                 ; DO 8 TIMES
0484 B0 01                      MOV     AL,01
0486 4A                         DEC     DX                      ; MAKE DX=214H (DATA BUS REG)
0487                    EXP4:
0487 8A E0                      MOV     AH,AL                   ; SAVE DATA BUS VALUE
0489 EE                         OUT     DX,AL                   ; SEND VALUE TO REG
048A B0 01                      MOV     AL,01H
048C EC                         IN      AL,DX                   ; RETRIVE VALUE FROM REG
048D 3A C4                      CMP     AL,AH                   ; = TO SAVED VALUE
048F 75 06                      JNE     SHORT EXP_ERR
0491 D0 E0                      SHL     AL,1                    ; FORM NEW DATA PATTERN
0493 E2 F2                      LOOP    EXP4                    ; LOOP TILL BIT WALKS ACROSS AL
0495 EB 06                      JMP     SHORT E19               ; GO ON TO NEXT TEST
0497                    EXP_ERR:
0497 BE 18DC R                  MOV     SI,OFFSET F3C
049A E8 1976 R                  CALL    E_MSG
                        ;--------------------------------------------------------
                        ;       ADDITIONAL READ/WRITE STORAGE TEST              :
                        ; DESCRIPTION                                           :
                        ;       WRITE/READ DATA PATTERNS TO ANY READ/WRITE      :
                        ;       STORAGE AFTER THE FIRST 64K.  STORAGE           :
                        ;       ADDRESSABILITY IS CHECKED.                      :
                        ;--------------------------------------------------------

                                ASSUME  DS:DATA
049D                    E19:
049D E8 1A12 R                  CALL    DDS
04A0 1E                         PUSH    DS
04A1                    E20:
04A1 81 3E 0072 R 1234          CMP     @RESET_FLAG,1234H       ; WARM START?
04A7 75 03                      JNE     E20A                    ; CONTINUE TEST IF NOT
04A9 E9 054A R                  JMP     ROM_SCAN                ; GO TO NEXT ROUTINE IF SO
04AC                    E20A:
04AC B8 0040                    MOV     AX,64                   ; STARTING AMT. OF MEMORY OK
04AF EB 28                      JMP     SHORT PRT_SIZ           ; POST MESSAGE
04B1                    E20B:
04B1 8B 1E 0013 R               MOV     BX,@MEMORY_SIZE         ; GET MEM. SIZE WORD
04B5 83 EB 40                   SUB     BX,64                   ; 1ST 64K ALREADY DONE
04B8 B1 04                      MOV     CL,4
04BA D3 EB                      SHR     BX,CL                   ; DIVIDE BY 16
04BC 8B CB                      MOV     CX,BX                   ; SAVE COUNT OF 16K BLOCKS
04BE BB 1000                    MOV     BX,1000H                ; SET PTR. TO RAM SEGMENT>64K
04C1                    E21:
04C1 8E DB                      MOV     DS,BX                   ; SET SEG. REG
04C3 8E C3                      MOV     ES,BX
04C5 81 C3 0400                 ADD     BX,0400H                ; POINT TO NEXT 16K
04C9 52                         PUSH    DX
04CA 51                         PUSH    CX                      ; SAVE WORK REGS
04CB 53                         PUSH    BX
04CC 50                         PUSH    AX
04CD B9 2000                    MOV     CX,02000H               ; SET COUNT FOR 8K WORDS
04D0 E8 0CCF R                  CALL    STGTST_CNT
04D3 75 4C                      JNZ     E21A                    ; GO PRINT ERROR
04D5 58                         POP     AX                      ; RECOVER TESTED MEM NUMBER
04D6 05 0010                    ADD     AX,16
04D9                    PRT_SIZ:
04D9 50                         PUSH    AX
04DA BB 000A                    MOV     BX,10                   ; SET UP FOR DECIMAL CONVERT
04DD B9 0003                    MOV     CX,3                    ; OF 3 NIBBLES
04E0                    DECIMAL_LOOP:
04E0 33 D2                      XOR     DX,DX
04E2 F7 F3                      DIV     BX                      ; DIVIDE BY 10
04E4 80 CA 30                   OR      DL,30H                  ; MAKE INTO ASCII
04E7 52                         PUSH    DX                      ; SAVE
04E8 E2 F6                      LOOP    DECIMAL_LOOP
04EA B9 0003                    MOV     CX,3
04ED                    PRT_DEC_LOOP:
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                                        POP     AX                      ; RECOVER A NUMBER
                                        CALL    PRT_HEX
                                        LOOP    PRT_DEC_LOOP
                                        MOV     CX,7
                                        MOV     SI,OFFSET F3B           ; PRINT ' KB OK'
                                KB_LOOP:
                                        MOV     AL,CS:[SI]
                                        INC     SI
                                        CALL    PRT_HEX
                                        LOOP    KB_LOOP
                                        POP     AX                      ; RECOVER WORK REGS
                                        CMP     AX,64                   ; FIRST PASS?
                                        JE      E20B
                                        POP     BX
                                        POP     CX
                                        POP     DX
                                        LOOP    E21                     ; LOOP TILL ALL MEM. CHECKED
                                        MOV     AL,10
                                        CALL    PRT_HEX                 ; LINE FEED

                                ;----- DMA TC0 SHOULD BE ON BY NOW - SEE IF IT IS

                                        IN      AL,DMA+08H
                                        AND     AL,00000001B            ; TC0 STATUS BIT ON?
                                        JNZ     ROM_SCAN                ; GO ON WITH NEXT TEST IF OK
                                        POP     DS
                                        MOV     @MFG_ERR_FLAG,03H       ; <><><><><><><><><><><><>
                                        JMP     D6                      ; POST 101 ERROR MSG AND HALT

                                ;----- PRINT FAILING ADDRESS AND XOR'ED PATTERN IF DATA COMPARE ERROR

                                E21A:   MOV     CH,AL                   ; SAVE FAILING BIT PATTERN
                                        MOV     AL,CR                   ; CARRAGE RETURN
                                        CALL    PRT_HEX
                                        MOV     AL,LF                   ; LINE FEED
                                        CALL    PRT_HEX
                                        POP     AX                      ; RECOVER AMT. OF GOOD MEM.
                                        ADD     SP,6                    ; BALANCE STACK
                                        MOV     DX,DS                   ; GET FAILING SEGMENT
                                        POP     DS
                                        PUSH    DS
                                        MOV     @MEMORY_SIZE,AX         ; LOAD MEM. SIZE WORD TO SHOW
                                                                        ; HOW MUCH MEM. WORKING
                                        MOV     @MFG_ERR_FLAG,DH        ; <><><><><><><><><><><><>
                                                                        ; <><>CHECKPOINTS 08->A0<><>
                                        CALL    PRT_SEG                 ; PRINT IT
                                        MOV     AL,CH                   ; GET FAILING BIT PATTERN
                                        CALL    XPC_BYTE                ; CONVERT AND PRINT CODE
                                        MOV     SI,OFFSET E1            ; SETUP ADDRESS OF ERROR MSG
                                        CALL    E_MSG                   ; PRINT ERROR MSG
                                ;--------------------------------------------------------
                                ; CHECK FOR OPTIONAL ROM FROM C8000->F0000 IN 2K BLOCKS  :
                                ;       (A VALID MODULE HAS '55AA' IN THE FIRST 2 LOCATIONS,    :
                                ;       LENGTH INDICATOR (LENGTH/512) IN THE 3D LOCATION AND    :
                                ;       TEST/INIT. CODE STARTING IN THE 4TH LOCATION.)          :
                                ;--------------------------------------------------------
                                ROM_SCAN:
                                        MOV     DX,0C800H               ; SET BEGINNING ADDRESS
                                ROM_SCAN_1:
                                        MOV     DS,DX
                                        SUB     BX,BX                   ; SET BX=0000
                                        MOV     AX,[BX]                 ; GET 1ST WORD FROM MODULE
                                        PUSH    BX
                                        POP     BX                      ; BUS SETTLING
                                        CMP     AX,0AA55H               ; = TO ID WORD?
                                        JNZ     NEXT_ROM                ; PROCEED TO NEXT ROM IF NOT
                                        CALL    ROM_CHECK               ; GO CHECK OUT MODULE
                                        JMP     ARE_WE_DONE             ; CHECK FOR END OF ROM SPACE
                                NEXT_ROM:
                                        ADD     DX,0080H                ; POINT TO NEXT 2K ADDRESS
                                ARE_WE_DONE:
                                        CMP     DX,0F000H               ; AT F0000 YET?
                                        JL      ROM_SCAN_1              ; GO CHECK ANOTHER ADD. IF NOT
                                ;--------------------------------------------------------
                                ;       DISKETTE ATTACHMENT TEST                        :
                                ; DESCRIPTION                                           :
                                ;       CHECK IF IPL DISKETTE DRIVE IS ATTACHED TO SYSTEM.  IF  :
                                ;       ATTACHED, VERIFY STATUS OF NEC FDC AFTER A RESET. ISSUE :
                                ;       A RECAL AND SEEK CMD TO FDC AND CHECK STATUS. COMPLETE  :
                                ;       SYSTEM INITIALIZATION THEN PASS CONTROL TO THE BOOT     :
                                ;       LOADER PROGRAM.                                 :
                                ;--------------------------------------------------------
                                F9:
                                        POP     DS
                                        MOV     AL,BYTE PTR @EQUIP_FLAG ; DISKETTE PRESENT?
                                        AND     AL,01H                  ; NO - BYPASS DISKETTE TEST
                                        JZ      F15
                                F10:                                    ; DISK_TEST:
                                        MOV     DX,3F1H                 ; I.D. PORT
                                        IN      AL,DX
                                        NOP
                                        MOV     BX,0FFFFH               ; BUS PRECHARGE
                                        AND     AL,0F8H                 ; KEEP I.D. BITS
                                        AND     @HF_CNTRL,11111110B     ; RESET DUAL BIT
                                        CMP     AL,CARD_ID
                                        JNE     NO_ID
                                        OR      @HF_CNTRL,1             ; SET DUAL BIT
                                NO_ID:
                                        IN      AL,INTA01
                                        AND     AL,0BFH                 ; ENABLE DISKETTE INTERRUPTS
                                        OUT     INTA01,AL
                                        MOV     AH,0                    ; RESET NEC FDC
                                        MOV     DL,AH                   ; SET FOR DRIVE 0
                                        INT     13H                     ; VERIFY STATUS AFTER RESET
                                        TEST    AH,0FFH                 ; STATUS OK?
                                        JNZ     F13                     ; NO - FDC FAILED

                                ;----- TURN DRIVE 0 MOTOR ON

                                        MOV     DX,03F2H                ; GET ADDR OF FDC CARD
                                        MOV     AL,1CH                  ; TURN MOTOR ON, EN DMA/INT
                                        OUT     DX,AL                   ; WRITE FDC CONTROL REG
                                        SUB     CX,CX
                                F11:                                    ; MOTOR_WAIT:
```

```
1022 05A3 E2 FE                         LOOP    F11                     ; WAIT FOR 1 SECOND
1023 05A5                       F12:                                    ; MOTOR_WAIT1:
1024 05A5 E2 FE                         LOOP    F12
1025 05A7 33 D2                         XOR     DX,DX                   ; SELECT DRIVE 0
1026 05A9 B5 22                         MOV     CH,34                   ; SELECT TRACK 34
1027 05AB 88 16 003E R                  MOV     @SEEK_STATUS,DL
1028 05AF E8 0000 E                     CALL    SEEK                    ; RECALIBRATE DISKETTE AND SEEK TO 34
1029 05B2 73 05                         JNC     F14                     ; OK--> GO TURN OF MOTOR
1030 05B4                       F13:                                    ; DISKETTE ERROR
1031 05B4 BE 0990 R                     MOV     SI,OFFSET F3            ; GET ADDR OF MSG
1032 05B7 EB 02                         JMP     SHORT F14A              ; DISPLAY MESSAGE AFTER DISKETTE SETUP
1033
1034                            ;----- TURN DRIVE 0 MOTOR OFF
1035
1036 05B9                       F14:                                    ; SEQUENCE END ENTRY IF NO ERROR
1037 05B9 33 F6                         XOR     SI,SI                   ; ZERO SI IF NO ERROR
1038 05BB                       F14A:                                   ; SEQUENCE END ENTRY IF ERROR
1039 05BB B0 0C                         MOV     AL,0CH                  ; TURN DRIVE 0 MOTOR OFF
1040 05BD BA 03F2                       MOV     DX,03F2H                ; FDC CTL ADDRESS
1041 05C0 EE                            OUT     DX,AL
1042
1043                            ;-----SETUP DISKETTE STATES
1044
1045 05C1 E8 0000 E                     CALL DSKETTE_SETUP              ; INITIALIZE DISKETTE PARMS
1046 05C4 72 04                         JC      F14B                    ; CY-->DISKETTE SETUP ERROR
1047 05C6 0B F6                         OR      SI,SI                   ; PREVIOUS DISKETTE ERROR
1048 05C8 74 06                         JZ      F15                     ; NZ-->DISKETTE ERROR BEFORE SETUP
1049 05CA                       F14B:
1050 05CA BE 0990 R                     MOV     SI,OFFSET F3            ; GET ADDR OF MSG
1051 05CD E8 1976 R                     CALL    E_MSG                   ; GO PRINT ERROR MSG
1052
1053                            ;----- SETUP PRINTER AND RS232 BASE ADDRESSES IF DEVICE ATTACHED
1054
1055 05D0                       F15:
1056 05D0 C6 06 006B R 00               MOV     @INTR_FLAG,00H          ; SET STRAY INTERRUPT FLAG = 00
1057 05D5 BE 001E R                     MOV     SI,OFFSET @KB_BUFFER    ; SETUP KEYBOARD PARAMETERS
1058 05D8 89 36 001A R                  MOV     @BUFFER_HEAD,SI
1059 05DC 89 36 001C R                  MOV     @BUFFER_TAIL,SI
1060 05E0 89 36 0080 R                  MOV     @BUFFER_START,SI
1061 05E4 83 C6 20                      ADD     SI,32                   ;DEFAULT BUFFER OF 32 BYTES
1062 05E7 89 36 0082 R                  MOV     @BUFFER_END,SI
1063 05EB BF 0078 R                     MOV     DI,OFFSET @PRINT_TIM_OUT ;SET DEFAULT PRINTER TIMEOUT
1064 05EE 1E                            PUSH    DS
1065 05EF 07                            POP     ES
1066 05F0 B8 1414                       MOV     AX,1414H                ; DEFAULT=20
1067 05F3 AB                            STOSW
1068 05F4 AB                            STOSW
1069 05F5 B8 0101                       MOV     AX,0101H                ;RS232 DEFAULT=01
1070 05F8 AB                            STOSW
1071 05F9 AB                            STOSW
1072 05FA E4 21                         IN      AL,INTA01
1073 05FC 24 FC                         AND     AL,0FCH                 ; ENABLE TIMER AND KB INTS
1074 05FE E6 21                         OUT     INTA01,AL
1075
1076 0600 83 FD 00                      CMP     BP,0000                 ; CHECK FOR BP= NON ZERO
1077                                                                    ; (ERROR HAPPENED)
1078 0603 74 18                         JE      F15A_0                  ; CONTINUE IF NO ERROR
1079 0605 BA 0002                       MOV     DX,2                    ; 2 SHORT BEEPS (ERROR)
1080 0608 E8 19A5 R                     CALL    ERR_BEEP
1081 060B BE 0769 R                     MOV     SI,OFFSET F3D           ; LOAD ERROR MSG
1082 060E E8 1997 R                     CALL    P_MSG
1083 0611                       ERR_WAIT:
1084 0611 B4 00                         MOV     AH,00
1085 0613 CD 16                         INT     16H                     ; WAIT FOR 'F1' KEY
1086 0615 80 FC 3B                      CMP     AH,3BH
1087 0618 75 F7                         JNE     ERR_WAIT
1088 061A EB 0E 90                      JMP     F15A                    ; BYPASS ERROR
1089 061D                       F15A_0:
1090 061D 80 3E 0012 R 01               CMP     @MFG_TST,1              ; MFG MODE
1091 0622 74 06                         JE      F15A                    ; BYPASS BEEP
1092 0624 BA 0001                       MOV     DX,1                    ; 1 SHORT BEEP (NO ERRORS)
1093 0627 E8 19A5 R                     CALL    ERR_BEEP
1094 062A A0 0010 R             F15A:   MOV     AL,BYTE PTR @EQUIP_FLAG ; GET SWITCHES
1095 062D 24 01                         AND     AL,00000001B            ; 'LOOP POST' SWITCH ON
1096 062F 75 03                         JNZ     F15B                    ; CONTINUE WITH BRING-UP
1097 0631 E9 005B R                     JMP     START
1098 0634 2A E4                 F15B:   SUB     AH,AH
1099 0636 A0 0049 R                     MOV     AL,@CRT_MODE
1100 0639 CD 10                         INT     10H                     ; CLEAR SCREEN
1101 063B                       F15C:
1102 063B BD 1970 R                     MOV     BP,OFFSET F4            ; PRT_SRC_TBL
1103 063E BE 0000                       MOV     SI,0
1104 0641                       F16:                                    ; PRT_BASE:
1105 0641 2E: 8B 56 00                  MOV     DX,CS:[BP]              ; GET PRINTER BASE ADDR
1106 0645 B0 AA                         MOV     AL,0AAH                 ; WRITE DATA TO PORT A
1107 0647 EE                            OUT     DX,AL
1108 0648 1E                            PUSH    DS                      ; BUS SETTLEING
1109 0649 EC                            IN      AL,DX                   ; READ PORT A
1110 064A 1F                            POP     DS
1111 064B 3C AA                         CMP     AL,0AAH                 ; DATA PATTERN SAME
1112 064D 75 05                         JNE     F17                     ; NO - CHECK NEXT PRT CD
1113 064F 89 54 08                      MOV     [@PRINTER_BASE-DATA40][SI],DX   ; YES - STORE PRT BASE ADDR
1114 0652 46                            INC     SI                      ; INCREMENT TO NEXT WORD
1115 0653 46                            INC     SI
1116 0654                       F17:
1117 0654 45                            INC     BP                      ; POINT TO NEXT BASE ADDR
1118 0655 45                            INC     BP
1119 0656 81 FD 1976 R                  CMP     BP,OFFSET F4E           ; ALL POSSIBLE ADDRS CHECKED?
1120 065A 75 E5                         JNE     F16                     ; PRT_BASE
1121 065C BB 0000                       MOV     BX,0                    ; POINTER TO RS232 TABLE
1122 065F BA 03FA                       MOV     DX,3FAH                 ; CHECK IF RS232 CD 1 ATTCH?
1123 0662 EC                            IN      AL,DX                   ; READ INTR ID REG
1124 0663 A8 F8                         TEST    AL,0F8H
1125 0665 75 06                         JNZ     F18
1126 0667 C7 07 03F8                    MOV     [@RS232_BASE-DATA40][BX],3F8H   ; SETUP RS232 CD #1 ADDR
1127 066B 43                            INC     BX
1128 066C 43                            INC     BX
1129 066D                       F18:
1130 066D BA 02FA                       MOV     DX,2FAH                 ; CHECK IF RS232 CD 2 ATTCH
1131 0670 EC                            IN      AL,DX                   ; READ INTERRUPT ID REG
1132 0671 A8 F8                         TEST    AL,0F8H
1133 0673 75 06                         JNZ     F19                     ; BASE_END
1134 0675 C7 07 02F8                    MOV     [@RS232_BASE-DATA40][BX],2F8H   ; SETUP RS232 CD #2
1135 0679 43                            INC     BX
```

```
                        INC     BX

                ;----- SET UP EQUIP FLAG TO INDICATE NUMBER OF PRINTERS AND RS232 CARDS

                F19:                                    ; BASE_END:
                        MOV     AX,SI                   ; SI HAS 2* NUMBER OF RS232
                        MOV     CL,3                    ; SHIFT COUNT
                        ROR     AL,CL                   ; ROTATE RIGHT 3 POSITIONS
                        OR      AL,BL                   ; OR IN THE PRINTER COUNT
                        MOV     BYTE PTR @EQUIP_FLAG+1,AL       ; STORE AS SECOND BYTE
                        MOV     DX,201H
                        IN      AL,DX
                        NOP
                        NOP
                        NOP
                        TEST    AL,0FH
                        JNZ     F20                     ; NO_GAME_CARD
                        OR      BYTE PTR @EQUIP_FLAG+1,16
                F20:                                    ; NO_GAME_CARD:

                ;----- ENABLE NMI INTERRUPTS

                        IN      AL,PORT_B               ; RESET CHECK ENABLES
                        OR      AL,30H
                        OUT     PORT_B,AL
                        AND     AL,0CFH
                        OUT     PORT_B,AL
                        MOV     AL,80H                  ; ENABLE NMI INTERRUPTS
                        OUT     0A0H,AL
                F21:                                    ; LOAD_BOOT_STRAP:
                        INT     19H                     ; GO TO THE BOOT LOADER

                ;--- INT 19 ------------------------------------------------
                ; BOOT STRAP LOADER                                         :
                ;       TRACK 0, SECTOR 1 IS READ INTO THE                  :
                ;       BOOT LOCATION (SEGMENT 0, OFFSET 7C00)              :
                ;       AND CONTROL IS TRANSFERRED THERE.                   :
                ;                                                           :
                ;       IF THERE IS A HARDWARE ERROR CONTROL IS             :
                ;       TRANSFERRED TO THE ROM BASIC ENTRY POINT.           :
                ;-----------------------------------------------------------
                        ASSUME  CS:CODE,DS:ABS0
                ;       ORG     0E6F2H
                        ORG     006F2H

                BOOT_STRAP      PROC    NEAR
                        STI                             ; ENABLE INTERRUPTS
                        SUB     AX,AX                   ; ESTABLISH ADDRESSING
                        MOV     DS,AX

                ;----- RESET THE DISK PARAMETER TABLE VECTOR

                        MOV     WORD PTR @DISK_POINTER,OFFSET DISK_BASE
                        MOV     WORD PTR @DISK_POINTER+2,CS

                ; -----  LOAD SYSTEM FROM DISKETTE -- CX HAS RETRY COUNT

                        MOV     CX,4                    ; SET RETRY COUNT
                H1:                                     ; IPL_SYSTEM
                        PUSH    CX                      ; SAVE RETRY COUNT
                        MOV     AH,0                    ; RESET THE DISKETTE SYSTEM
                        INT     13H                     ; DISKETTE_IO
                        JC      H2                      ; IF ERROR, TRY AGAIN
                        MOV     AX,201H                 ; READ IN THE SINGLE SECTOR
                        SUB     DX,DX                   ; TO THE BOOT LOCATION
                        MOV     ES,DX
                        MOV     BX,OFFSET @BOOT_LOCN
                                                        ; DRIVE 0, HEAD 0
                        MOV     CX,1                    ; SECTOR 1, TRACK 0
                        INT     13H                     ; DISKETTE_IO
                H2:
                        POP     CX                      ; RECOVER RETRY COUNT
                        JNC     H4                      ; CF SET BY UNSUCCESSFUL READ
                        LOOP    H1                      ; DO IT FOR RETRY TIMES


                ;----- UNABLE TO IPL FROM THE DISKETTE

                H3:
                        INT     18H                     ; GO TO RESIDENT BASIC

                ;----- IPL WAS SUCCESSFUL

                H4:
                        JMP     @BOOT_LOCN
                BOOT_STRAP      ENDP

                ;;-     ORG     0E729H
                        ORG     00729H
                A1      DW      1047                    ; 110 BAUD      ; TABLE OF VALUES
                        DW      768                     ; 150           ; FOR INITIALIZATION
                        DW      384                     ; 300
                        DW      192                     ; 600
                        DW      96                      ; 1200
                        DW      48                      ; 2400
                        DW      24                      ; 4800
                        DW      12                      ; 9600

                RS232_IO:
                        JMP     RS232_IO_1
                                                        ;       USE INT 15 H  AH= 0C0H
                CONF_TBL:                               ; CONFIGURATION TABLE FOR THIS SYSTEM
                        DW      CONF_E-CONF_TBL-2       ; LENGTH OF FOLLOWING TABLE
                        DB      MODEL_BYTE              ; SYSTEM MODEL BYTE
                        DB      SUB_MODEL_BYTE          ; SYSTEM SUB MODEL TYPE BYTE
                        DB      BIOS_LEVEL              ; BIOS REVISION LEVEL
                        DB      01010000B               ; 10000000 = DMA CHANNEL 3 USE BY BIOS
                                                        ; 01000000 = CASCADED INTERRUPT LEVEL 2
                                                        ; 00100000 = REAL TIME CLOCK AVAILABLE
                                                        ; 00010000 = KEYBOARD SCAN CODE HOOK 1AH
                        DB      0                       ; RESERVED
                        DB      0                       ; RESERVED
                        DB      0                       ; RESERVED
                        DB      0                       ; RESERVED
                CONF_E  EQU     $                       ; RESERVED FOR EXPANSION
```

```
                        ;--------------------------------------------------------------------------------
                        ;  PRINT ADDRESS AND ERROR MESSAGE FOR ROM CHECKSUM ERRORS                       :
                        ;--------------------------------------------------------------------------------
0746                    ROM_ERR PROC    NEAR
0746 52                         PUSH    DX                      ; SAVE POINTER
0747 50                         PUSH    AX
0748 8C DA                      MOV     DX,DS                   ; GET ADDRESS POINTER
074A 26: 88 36 0015 R           MOV     ES:@MFG_ERR_FLAG,DH     ; <><><><><><><><><><><><><><>
                                                                ; <><><>CHECKPOINTS C0->F4<><><>
074F 81 FA C800                 CMP     DX,0C800H               ; CRT CARD IN ERROR?
0753 7C 0C                      JL      ROM_ERR_BEEP            ; GIVE CRT CARD FAIL BEEP
0755 E8 0CBA R                  CALL    PRT_SEG                 ; PRINT SEGEMENT IN ERROR
0758 BE 18D7 R                  MOV     SI,OFFSET F3A           ; DISPLAY ERROR MSG
075B E8 1976 R                  CALL    E_MSG
075E                    ROM_ERR_END:
075E 58                         POP     AX
075F 5A                         POP     DX
0760 C3                         RET
0761                    ROM_ERR_BEEP:
0761 BA 0102                    MOV     DX,0102H                ; BEEP 1 LONG, 2 SHORT
0764 E8 19A5 R                  CALL    ERR_BEEP
0767 EB F5                      JMP     SHORT ROM_ERR_END
0769                    ROM_ERR ENDP
                        ;
0769 45 52 52 4F 52 2E  F3D     DB      'ERROR. (RESUME = "F1" KEY)',CR,LF      ; ERROR PROMPT
     20 28 52 45 53 55
     4D 45 20 3D 20 22
     46 31 22 20 4B 45
     59 29 0D 0A
                        ;       ORG     0E82EH
                        ;       ORG     0082EH
082E                    KEYBOARD_IO:
082E E9 0000 E                  JMP     KEYBOARD_IO_1
                        ;
                        ;       ORG     0E987H
                        ;       ORG     00987H
0987                    KB_INT:
0987 E9 0000 E                  JMP     KB_INT_1
                        ;
098A 20 33 30 31 0D 0A  F1      DB      ' 301',CR,LF            ; KEYBOARD ERROR
0990 36 30 31 0D 0A     F3      DB      '601',CR,LF             ; DISKETTE ERROR
                        ;
                        ;--- INT  1A H -- SYSTEM AND REAL TIME CLOCK SERVICES ----------------------------
                        ;                                                                               :
                        ;       THIS BIOS ROUTINE ALLOWS THE CLOCKS TO BE SET OR READ                   :
                        ;                                                                               :
                        ; PARAMETERS:                                                                   :
                        ;       (AH) = 00H  READ THE CURRENT CLOCK SETTING AND RETURN WITH,              :
                        ;                       (CX) = HIGH PORTION OF COUNT                            :
                        ;                       (DX) = LOW PORTION OF COUNT                             :
                        ;                       (AL) = 0 TIMER HAS NOT PASSED 24 HOURS SINCE LAST READ, :
                        ;                              1 IF ON ANOTHER DAY. (RESET TO ZERO AFTER READ)  :
                        ;                                                                               :
                        ;       (AH) = 01H  SET THE CURRENT CLOCK USING,                                :
                        ;                       (CX) = HIGH PORTION OF COUNT                            :
                        ;                       (DX) = LOW PORTION OF COUNT.                            :
                        ;                                                                               :
                        ;                   NOTE: COUNTS OCCUR AT THE RATE OF 1193180/65536 COUNTS/SECOND :
                        ;                                 (OR ABOUT 18.2 PER SECOND -- SEE EQUATES)     :
                        ;                                                                               :
                        ;       (AH) = 0AH  READ THE CURRENT COUNT OF DAYS AND RETURN WITH,             :
                        ;                       (CX) = COUNT OF ELAPSED DAYS                            :
                        ;                                                                               :
                        ;       (AH) = 0BH  SET THE CURRENT COUNT OF DAYS USING,                        :
                        ;                       (CX) = COUNT OF ELAPSED DAYS                            :
                        ;                                                                               :
                        ; NOTES: FOR ALL RETURNS CY= 0 FOR SUCCESSFUL OPERATION.                        :
                        ;        INTERRUPTS ARE DISABLED DURING DATA MODIFICATION.                      :
                        ;        AH & AL ARE RETURNED MODIFIED AND NOT DEFINED EXCEPT WHERE INDICATED.  :
                        ;-------------------------------------------------------------------------------
                                ASSUME  CS:CODE,DS:DATA
                        ;
0995                    TIME_OF_DAY_1   PROC    FAR
0995                    TIME_OF_DAY_11:
0995 FB                         STI                             ; INTERRUPTS BACK ON
0996 80 FC 0C                   CMP     AH,(RTC_TBE-RTC_TB)/2   ; CHECK IF COMMAND IN VALID RANGE
0999 F5                         CMC                             ; COMPLEMENT CARRY FOR ERROR EXIT
099A 72 17                      JC      TIME_9                  ; EXIT WITH CARRY = 1 IF NOT VALID
                        ;
099C 1E                         PUSH    DS                      ; SAVE USERS (DS) SEGMENT
099D E8 1A12 R                  CALL    DDS                     ; GET DATA SEGMENT SELECTOR
09A0 56                         PUSH    SI                      ; SAVE WORK REGISTER
09A1 8A C4                      MOV     AL,AH                   ; MOVE FUNCTION TO (AL) REGISTER
09A3 98                         CBW                             ; CONVERT FUNCTION TO BYTE OFFSET
09A4 03 C0                      ADD     AX,AX                   ; CONVERT FUNCTION TO WORD OFFSET (CY=0)
09A6 8B F0                      MOV     SI,AX                   ; PLACE INTO ADDRESSING REGISTER
09A8 FA                         CLI                             ; NO INTERRUPTS DURING TIME FUNCTIONS
09A9 2E: FF 94 09B6 R           CALL    CS:[SI]+OFFSET RTC_TB   ; VECTOR TO FUNCTION REQUESTED WITH CY=0
                                                                ;  RETURN WITH CARRY FLAG SET FOR RESULT
09AE FB                         STI                             ; INTERRUPTS BACK ON
09AF B4 00                      MOV     AH,0                    ; CLEAR (AH) TO ZERO
09B1 5E                         POP     SI                      ; RECOVER USERS REGISTER
09B2 1F                         POP     DS                      ; RECOVER USERS SEGMENT SELECTOR
09B3                    TIME_9:                                 ; RETURN WITH CY= 0 IF NO ERROR
09B3 CA 0002                    RET     2
                        ;                                               ROUTINE VECTOR TABLE (AH)=
09B6 09CE R             RTC_TB  DW      RTC_00                  ; 00H = READ CURRENT CLOCK COUNT
09B8 09DF R                     DW      RTC_10                  ; 01H = SET CLOCK COUNT
09BA 09ED R                     DW      RTC_NS                  ; 02H     INVALID
09BC 09ED R                     DW      RTC_NS                  ; 03H     INVALID
09BE 09ED R                     DW      RTC_NS                  ; 04H     INVALID
09C0 09ED R                     DW      RTC_NS                  ; 05H     INVALID
09C2 09ED R                     DW      RTC_NS                  ; 06H     INVALID
09C4 09ED R                     DW      RTC_NS                  ; 07H     INVALID
09C6 09ED R                     DW      RTC_NS                  ; 08H     INVALID
09C8 09ED R                     DW      RTC_NS                  ; 09H     INVALID
09CA 09EF R                     DW      RTC_A0                  ; 0AH = READ SYSTEM DAY COUNTER
09CC 09F4 R                     DW      RTC_B0                  ; 0BH = WRITE SYSTEM DAY COUNTER
= 09CE                  RTC_TBE EQU     $
                        ;
09CE                    TIME_OF_DAY_1   ENDP
                        ;
```

```
0C9E                    RTC_00  PROC    NEAR                    ;       READ TIME COUNT
0C9E A0 0070 R                  MOV     AL,@TIMER_OFL           ; GET THE OVERFLOW FLAG
0CD1 C6 06 0070 R 00            MOV     @TIMER_OFL,0            ; AND THEN RESET THE OVERFLOW FLAG
0CD6 8B 0E 006E R               MOV     CX,@TIMER_HIGH          ; GET COUNT OF TIME HIGH WORD
0CDA 8B 16 006C R               MOV     DX,@TIMER_LOW           ; GET COUNT OF TIME LOW WORD
0CDE C3                         RET                             ; RETURN WITH NO CARRY
                                                                ;
0CDF                    RTC_10:                                 ;       SET TIME COUNT
0CDF 89 16 006C R               MOV     @TIMER_LOW,DX           ; SET THE TIME COUNT LOW WORD
0CE3 89 0E 006E R               MOV     @TIMER_HIGH,CX          ; SET THE TIME COUNT HIGH WORD
0CE7 C6 06 0070 R 00            MOV     @TIMER_OFL,0            ; RESET OVERFLOW FLAG
0CEC C3                         RET                             ; RETURN WITH NO CARRY
                                                                ;
0CED                    RTC_NS:                                 ;       INVALID FUNCTION (NOT SUPPORTED)
0CED F9                         STC                             ; SET CARRY FLAG FOR ERROR (CY=1)
0CEE C3                         RET                             ; EXIT THROUGH COMMON RETURN
                                                                ;
0CEF                    RTC_A0:                                 ;       READ SYSTEM DAY COUNTER
0CEF 8B 0E 00CE R               MOV     CX,@DAY_COUNT           ; GET COUNT OF DAYS
0CF3 C3                         RET                             ; EXIT THROUGH COMMON RETURN WITH CY=0
                                                                ;
0CF4                    RTC_B0:                                 ;       SET SYSTEM DAY COUNTER
0CF4 89 0E 00CE R               MOV     @DAY_COUNT,CX           ; SET COUNT OF DAYS
0CF8 C3                         RET                             ; EXIT THROUGH COMMON RETURN WITH CY=0
                                                                ;
0CF9                    RTC_00  ENDP                            ;
                                                                ;
                        ;       ORG     0EC59H                  ;
0C59                            ORG     00C59H                  ;
0C59 E9 0000 E          DISKETTE_IO:    JMP     DISKETTE_IO_1   ;

                        ;--- BEEP ------------------------------------------------------------------------
                        ;       ROUTINE TO SOUND THE BEEPER USING TIMER 2 FOR TONE                      :
                        ; ENTRY:                                                                        :
                        ;       (BL) = DURATION COUNTER  ( 1 FOR 1/64 SECOND )                          :
                        ;       (CX) = FREQUENCY DIVISOR (1193180/FREQUENCY) (1331 FOR 886 HZ)          :
                        ; EXIT:                                                                         :
                        ;       (AX),(BL),(CX) MODIFIED.                                                :
                        ;-----------------------------------------------------------------------------

0C5C                    BEEP    PROC    NEAR                    ;       SETUP TIMER 2
0C5C 9C                         PUSHF                           ; SAVE INTERRUPT STATUS
0C5D FA                         CLI                             ; BLOCK INTERRUPTS DURING UPDATE
0C5E B0 B6                      MOV     AL,10110110B            ; SELECT TIMER 2,LSB,MSB,BINARY
0C60 E6 43                      OUT     TIMER+3,AL              ; WRITE THE TIMER MODE REGISTER
0C62 90                         NOP                             ; I/O DELAY
0C63 8A C1                      MOV     AL,CL                   ; DIVISOR FOR HZ (LOW)
0C65 E6 42                      OUT     TIMER+2,AL              ; WRITE TIMER 2 COUNT - LSB
0C67 90                         NOP                             ; I/O DELAY
0C68 8A C5                      MOV     AL,CH                   ; DIVISOR FOR HZ (HIGH)
0C6A E6 42                      OUT     TIMER+2,AL              ; WRITE TIMER 2 COUNT - MSB
0C6C E4 61                      IN      AL,PORT_B               ; GET CURRENT SETTING OF PORT
0C6E 8A E0                      MOV     AH,AL                   ; SAVE THAT SETTING
0C70 0C 03                      OR      AL,GATE2+SPK2           ; GATE TIMER 2 AND TURN SPEAKER ON
0C72 E6 61                      OUT     PORT_B,AL               ; AND RESTORE INTERRUPT STATUS
0C74 9D                         POPF
0C75                    G7:                                     ;       1/64 SECOND PER COUNT (BL)
0C75 B9 040B                    MOV     CX,1035                 ; DELAY COUNT FOR 1/64 OF A SECOND
0C78 E8 0CA0 R                  CALL    WAITF                   ; GO TO BEEP DELAY 1/64 COUNT
0C7B FE CB                      DEC     BL                      ; (BL) LENGTH COUNT EXPIRED?
0C7D 75 F6                      JNZ     G7                      ; NO - CONTINUE BEEPING SPEAKER
                                                                ;
0C7F 9C                         PUSHF                           ; SAVE INTERRUPT STATUS
0C80 FA                         CLI                             ; BLOCK INTERRUPTS DURING UPDATE
0C81 E4 61                      IN      AL,PORT_B               ; GET CURRENT PORT VALUE
0C83 0C FC                      OR      AL,NOT (GATE2+SPK2)     ; ISOLATE CURRENT SPEAKER BITS IN CASE
0C85 22 E0                      AND     AH,AL                   ;  SOMEONE TURNED THEM OFF DURING BEEP
0C87 8A C4                      MOV     AL,AH                   ; RECOVER VALUE OF PORT
0C89 24 FC                      AND     AL,NOT (GATE2+SPK2)     ; FORCE SPEAKER DATA OFF
0C8B E6 61                      OUT     PORT_B,AL               ; AND STOP SPEAKER TIMER
0C8D 9D                         POPF                            ; RESTORE INTERRUPT FLAG STATE
0C8E B9 040B                    MOV     CX,1035                 ; FORCE 1/64 SECOND DELAY (SHORT)
0C91 E8 0CA0 R                  CALL    WAITF                   ; MINIMUM DELAY BETWEEN ALL BEEPS
0C94 9C                         PUSHF                           ; SAVE INTERRUPT STATUS
0C95 FA                         CLI                             ; BLOCK INTERRUPTS DURING UPDATE
0C96 E4 61                      IN      AL,PORT_B               ; GET CURRENT PORT VALUE IN CASE
0C98 24 03                      AND     AL,GATE2+SPK2           ;  SOMEONE TURNED THEM ON
0C9A 0A C4                      OR      AL,AH                   ; RECOVER VALUE OF PORT_B
0C9C E6 61                      OUT     PORT_B,AL               ; RESTORE SPEAKER STATUS
0C9E 9D                         POPF                            ; RESTORE INTERRUPT FLAG STATE
0C9F C3                         RET
                                                                ;
0CA0                    BEEP    ENDP

                        ;--- WAITF -----------------------------------------------------------------------
                        ;       FIXED TIME WAIT ROUTINE (HARDWARE CONTROLLED - NOT PROCESSOR)           :
                        ;                                                                               :
                        ; ENTRY:                                                                        :
                        ;       (CX) = COUNT OF 15.085737 MICROSECOND INTERVALS TO WAIT                 :
                        ;              MEMORY REFRESH TIMER 1 OUTPUT AT THE DMA CHANNEL 0               :
                        ;              ADDRESS REGISTER USED AS REFERENCE.                              :
                        ; EXIT:                                                                         :
                        ;              AFTER (CX) TIME COUNT (PLUS OR MINUS 31 MICROSECONDS)            :
                        ;       (CX) = 0                                                                :
                        ;-----------------------------------------------------------------------------

0CA0                    WAITF   PROC    NEAR                    ;       DELAY FOR  (CX)*15.085737 US
0CA0 50                         PUSH    AX                      ; SAVE WORK REGISTER (AH)
0CA1 D1 E9                      SHR     CX,1                    ; DIVIDE 15us COUNT DOWN TO 30us COUNT
0CA3 E3 13                      JCXZ    WAITF9                  ; EXIT IF COUNT WAS ZERO OR ONE
                                                                ;
0CA5 E6 0C                      OUT     DMA+12,AL               ; CLEAR THE DMA BYTE POINTER FLIP/FLOP
0CA7                    WAITF1:
0CA7 9C                         PUSHF                           ; SAVE INTERRUPT STATE
0CA8 FA                         CLI                             ; BLOCK INTERRUPTS TILL NEXT CHANGE
0CA9                    WAITF3:                                 ;  WAIT FOR REFRESH ADDRESS CHANGE
0CA9 E4 00                      IN      AL,DMA                  ; READ CURRENT ADDRESS LOW BYTE
0CAB 24 FE                      AND     AL,11111110B            ; DISCARD LOW BIT (30us)
0CAD 3A E0                      CMP     AH,AL                   ; DID VALUE JUST CHANGE
0CAF 8A E0                      MOV     AH,AL                   ; SAVE NEW/OLD VALUE INCASE IT DID
0CB1 E4 00                      IN      AL,DMA                  ; READ HIGH BYTE (AND IGNORE)
0CB3 74 F4                      JE      WAITF3                  ; WAIT FOR A CHANGE IN ADDRESS BITS
                                                                ;
0CB5 9D                         POPF                            ; RESTORE INTERRUPTS
```

```
0CB6 E2 EF                      LOOP    WAITF1                  ; DECREMENT CYCLES COUNT TILL COUNT END
0CB8                    WAITF9:
0CB8 58                         POP     AX                      ; RESTORE (AH)
0CB9 C3                         RET                             ; RETURN  (CX)= 0

0CBA                    WAITF   ENDP


                        ;--------------------------------------------------------
                        ;       PRINT A SEGMENT VALUE TO LOOK LIKE A 20 BIT ADDRESS     :
                        ;       DX MUST CONTAIN SEGMENT VALUE TO BE PRINTED             :
                        ;--------------------------------------------------------
0CBA                    PRT_SEG PROC    NEAR
0CBA 8A C6                      MOV     AL,DH                   ;GET MSB
0CBC E8 1958 R                  CALL    XPC_BYTE
0CBF 8A C2                      MOV     AL,DL                   ;LSB
0CC1 E8 1958 R                  CALL    XPC_BYTE
0CC4 B0 30                      MOV     AL,'0'                  ; PRINT A '0 '
0CC6 E8 1969 R                  CALL    PRT_HEX
0CC9 B0 20                      MOV     AL,' '                  ;SPACE
0CCB E8 1969 R                  CALL    PRT_HEX
0CCE C3                         RET
0CCF                    PRT_SEG ENDP

                        ;--------------------------------------------------------
                        ; THIS SUBROUTINE PERFORMS A READ/WRITE STORAGE TEST ON A BLOCK :
                        ;       OF STORAGE.                                     :
                        ; ENTRY REQUIREMENTS:                                   :
                        ;       ES = ADDRESS OF STORAGE SEGMENT BEING TESTED    :
                        ;       DS = ADDRESS OF STORAGE SEGMENT BEING TESTED    :
                        ;       CX = WORD COUNT OF STORAGE BLOCK TO BE TESTED   :
                        ; EXIT PARAMETERS:                                      :
                        ;       ZERO FLAG = 0 IF STORAGE ERROR (DATA COMPARE OR PARITY  :
                        ;       CHECK.  AL=0 DENOTES A PARITY CHECK. ELSE AL=XOR'ED     :
                        ;       BIT PATTERN OF THE EXPECTED DATA PATTERN VS THE ACTUAL  :
                        ;       DATA READ.                                      :
                        ; AX,BX,CX,DX,DI, AND SI ARE ALL DESTROYED.             :
                        ;--------------------------------------------------------

0CCF                    STGTST_CNT      PROC    NEAR
0CCF 8B D9                      MOV     BX,CX                   ; SAVE WORD COUNT OF BLOCK TO TEST
0CD1 FC                         CLD                             ; SET DIR FLAG TO INCREMENT
0CD2 2B FF                      SUB     DI,DI                   ; SET DI=OFFSET 0 REL TO ES REG
0CD4 2B C0                      SUB     AX,AX                   ; SETUP FOR 0->FF PATTERN TEST
0CD6                    C2_1:
0CD6 88 05                      MOV     [DI],AL                 ; ON FIRST BYTE
0CD8 8A 05                      MOV     AL,[DI]
0CDA 32 C4                      XOR     AL,AH                   ; O.K.?
0CDC 75 79                      JNZ     C7                      ; GO ERROR IF NOT
0CDE FE C4                      INC     AH
0CE0 8A C4                      MOV     AL,AH
0CE2 75 F2                      JNZ     C2_1                    ; LOOP TILL WRAP THROUGH FF
0CE4 B8 55AA                    MOV     AX,055AAH               ; GET INITIAL DATA PATTERN TO WRITE
0CE7 8B D0                      MOV     DX,AX                   ; SET INITIAL COMPARE PATTERN.
0CE9 F3/ AB                     REP     STOSW                   ; FILL STORAGE LOCATIONS IN BLOCK
0CEB E4 61                      IN      AL,PORT_B
0CED 0C 30                      OR      AL,030H                 ; TOGGLE PARITY CHECK LATCHES
0CEF E6 61                      OUT     PORT_B,AL
0CF1 90                         NOP
0CF2 24 CF                      AND     AL,0CFH
0CF4 E6 61                      OUT     PORT_B,AL
                        ;
0CF6 4F                         DEC     DI                      ; POINT TO LAST WORD JUST WRITTEN
0CF7 4F                         DEC     DI
0CF8 FD                         STD                             ; SET DIR FLAG TO GO BACKWARDS
0CF9 8B F7                      MOV     SI,DI                   ; INITIALIZE DESTINATION POINTER
0CFB 8B CB                      MOV     CX,BX                   ; SETUP WORD COUNT FOR LOOP
0CFD                    C3:                                     ;       INNER TEST LOOP
0CFD AD                         LODSW                           ; READ OLD TEST WORD FROM STORAGE
0CFE 33 C2                      XOR     AX,DX                   ; DATA READ AS EXPECTED ?
0D00 75 57                      JNE     C7X                     ; NO - GO TO ERROR ROUTINE
0D02 B8 AA55                    MOV     AX,0AA55H               ; GET NEXT DATA PATTERN TO WRITE
0D05 AB                         STOSW                           ; WRITE INTO LOCATION JUST READ
0D06 E2 F5                      LOOP    C3                      ; DECREMENT WORD COUNT AND LOOP
                        ;
0D08 FC                         CLD                             ; SET DIR FLAG TO GO FORWARD
0D09 47                         INC     DI                      ; SET POINTER TO BEG LOCATION
0D0A 47                         INC     DI
0D0B 8B F7                      MOV     SI,DI                   ; INITIALIZE DESTINATION POINTER
0D0D 8B CB                      MOV     CX,BX                   ; SETUP WORD COUNT FOR LOOP
0D0F 8B D0                      MOV     DX,AX                   ; SETUP COMPARE PATTERN OF "0AA55H".
0D11                    C4:                                     ;       INNER TEST LOOP
0D11 AD                         LODSW                           ; READ OLD TEST WORD FROM STORAGE
0D12 33 C2                      XOR     AX,DX                   ; DATA READ AS EXPECTED ?
0D14 75 43                      JNE     C7X                     ; NO - GO TO ERROR ROUTINE
0D16 B8 FFFF                    MOV     AX,0FFFFH               ; GET NEXT DATA PATTERN TO WRITE
0D19 AB                         STOSW                           ; WRITE INTO LOCATION JUST READ
0D1A E2 F5                      LOOP    C4                      ; DECREMENT WORD COUNT AND LOOP
                        ;
0D1C 4F                         DEC     DI                      ; POINT TO LAST WORD JUST WRITTEN
0D1D 4F                         DEC     DI
0D1E FD                         STD                             ; SET DIR FLAG TO GO BACKWARDS
0D1F 8B F7                      MOV     SI,DI                   ; INITIALIZE DESTINATION POINTER
0D21 8B CB                      MOV     CX,BX                   ; SETUP WORD COUNT FOR LOOP
0D23 8B D0                      MOV     DX,AX                   ; SETUP COMPARE PATTERN "0FFFFH"
0D25                    C5:                                     ;       INNER TEST LOOP
0D25 AD                         LODSW                           ; READ OLD TEST WORD FROM STORAGE
0D26 33 C2                      XOR     AX,DX                   ; DATA READ AS EXPECTED ?
0D28 75 2F                      JNE     C7X                     ; NO - GO TO ERROR ROUTINE
0D2A B8 0101                    MOV     AX,00101H               ; GET NEXT DATA PATTERN TO WRITE
0D2D AB                         STOSW                           ; WRITE INTO LOCATION JUST READ
0D2E E2 F5                      LOOP    C5                      ; DECREMENT WORD COUNT AND LOOP
                        ;
0D30 FC                         CLD                             ; SET DIR FLAG TO GO FORWARD
0D31 47                         INC     DI                      ; SET POINTER TO BEG LOCATION
0D32 47                         INC     DI
0D33 8B F7                      MOV     SI,DI                   ; INITIALIZE DESTINATION POINTER
0D35 8B CB                      MOV     CX,BX                   ; SETUP WORD COUNT FOR LOOP
0D37 8B D0                      MOV     DX,AX                   ; SETUP COMPARE PATTERN "00101H".
0D39                    C6:                                     ;       INNER TEST LOOP
0D39 AD                         LODSW                           ; READ OLD TEST WORD FROM STORAGE
0D3A 33 C2                      XOR     AX,DX                   ; DATA READ AS EXPECTED ?
0D3C 75 1B                      JNE     C7X                     ; NO - GO TO ERROR ROUTINE
0D3E AB                         STOSW                           ; WRITE ZERO INTO LOCATION READ
0D3F E2 F8                      LOOP    C6                      ; DECREMENT WORD COUNT AND LOOP
```

SECTION 5

```
                        ;
0D41 4F                         DEC     DI                      ; POINT TO LAST WORD JUST WRITTEN
0D42 4F                         DEC     DI
0D43 FD                         STD                             ; SET DIR FLAG TO GO BACKWARDS
0D44 8B F7                      MOV     SI,DI                   ; INITIALIZE DESTINATION POINTER
0D46 8B CB                      MOV     CX,BX                   ; SETUP WORD COUNT FOR LOOP
0D48 8B D0                      MOV     DX,AX                   ; SETUP COMPARE PATTERN "00000H"
0D4A                    C6X:
0D4A AD                         LODSW                           ; VERIFY MEMORY IS ZERO.
0D4B 33 C2                      XOR     AX,DX                   ; DATA READ AS EXPECTED ?
0D4D 75 0A                      JNE     C7X                     ; NO - GO TO ERROR ROUTINE
0D4F E2 F9                      LOOP    C6X                     ; DECREMENT WORD COUNT AND LOOP
                        ;
0D51 E4 62                      IN      AL,PORT_C               ; DID A PARITY ERROR OCCUR ?
0D53 24 C0                      AND     AL,0C0H                 ; ZERO FLAG WILL BE OFF, IF PARITY ERROR
0D55 B0 00                      MOV     AL,0                    ; AL=0 DATA COMPARE OK
0D57                    C7:
0D57 FC                         CLD                             ; SET DIRECTION FLAG TO INC
0D58 C3                         RET
0D59                    C7X:
0D59 3C 00                      CMP     AL,0                    ; FIND BYTE THAT FAILED.
0D5B 75 FA                      JNZ     C7
0D5D 8A C4                      MOV     AL,AH
0D5F EB F6                      JMP     SHORT C7
0D61                    STGTST_CNT      ENDP
                        ;       ORG     0EF57H
                                ORG     00F57H
0F57 E9 0000 E          DISK_INT:       JMP     DISK_INT_1
                        ;       ORG     0EF79H
                                ORG     00F79H
                        ;---------------------------------------------------------------------------
                        ;       MEDIA/DRIVE PARAMETER TABLES                                        :
                        ;---------------------------------------------------------------------------
                        ;---------------------------------------------------------------------------
                        ;       40 TRACK LOW DATA RATE MEDIA IN 40 TRACK LOW DATA RATE DRIVE :
                        ;---------------------------------------------------------------------------
0F79                    MD_TBL1         LABEL BYTE
0F79 DF                         DB      11011111B       ; SRT=D, HD UNLOAD=0F - 1ST SPECIFY BYTE
0F7A 02                         DB      2               ; HD LOAD=1, MODE=DMA - 2ND SPECIFY BYTE
0F7B 25                         DB      MOTOR_WAIT      ; WAIT TIME AFTER OPERATION TILL MOTOR OFF
0F7C 02                         DB      2               ; 512 BYTES/SECTOR
0F7D 09                         DB      09              ; EOT ( LAST SECTOR ON TRACK)
0F7E 2A                         DB      02AH            ; GAP LENGTH
0F7F FF                         DB      0FFH            ; DTL
0F80 50                         DB      050H            ; GAP LENGTH FOR FORMAT
0F81 F6                         DB      0F6H            ; FILL BYTE FOR FORMAT
0F82 0F                         DB      15              ; HEAD SETTLE TIME (MILLISECONDS)
0F83 08                         DB      8               ; MOTOR START TIME (1/8 SECONDS)
0F84 27                         DB      39              ; MAX. TRACK NUMBER
0F85 80                         DB      RATE_250        ; DATA TRANSFER RATE
                        ;---------------------------------------------------------------------------
                        ;       40 TRACK LOW DATA RATE MEDIA IN 80 TRACK HI DATA RATE DRIVE  :
                        ;---------------------------------------------------------------------------
0F86                    MD_TBL2         LABEL BYTE
0F86 DF                         DB      11011111B       ; SRT=D, HD UNLOAD=0F - 1ST SPECIFY BYTE
0F87 02                         DB      2               ; HD LOAD=1, MODE=DMA - 2ND SPECIFY BYTE
0F88 25                         DB      MOTOR_WAIT      ; WAIT TIME AFTER OPERATION TILL MOTOR OFF
0F89 02                         DB      2               ; 512 BYTES/SECTOR
0F8A 09                         DB      09              ; EOT ( LAST SECTOR ON TRACK)
0F8B 2A                         DB      02AH            ; GAP LENGTH
0F8C FF                         DB      0FFH            ; DTL
0F8D 50                         DB      050H            ; GAP LENGTH FOR FORMAT
0F8E F6                         DB      0F6H            ; FILL BYTE FOR FORMAT
0F8F 0F                         DB      15              ; HEAD SETTLE TIME (MILLISECONDS)
0F90 08                         DB      8               ; MOTOR START TIME (1/8 SECONDS)
0F91 27                         DB      39              ; MAX. TRACK NUMBER
0F92 40                         DB      RATE_300        ; DATA TRANSFER RATE
                        ;---------------------------------------------------------------------------
                        ;       80 TRACK HI DATA RATE MEDIA IN 80 TRACK HI DATA RATE DRIVE   :
                        ;---------------------------------------------------------------------------
0F93                    MD_TBL3         LABEL BYTE
0F93 DF                         DB      11011111B       ; SRT=D, HD UNLOAD=0F - 1ST SPECIFY BYTE
0F94 02                         DB      2               ; HD LOAD=1, MODE=DMA - 2ND SPECIFY BYTE
0F95 25                         DB      MOTOR_WAIT      ; WAIT TIME AFTER OPERATION TILL MOTOR OFF
0F96 02                         DB      2               ; 512 BYTES/SECTOR
0F97 0F                         DB      15              ; EOT ( LAST SECTOR ON TRACK)
0F98 1B                         DB      01BH            ; GAP LENGTH
0F99 FF                         DB      0FFH            ; DTL
0F9A 54                         DB      054H            ; GAP LENGTH FOR FORMAT
0F9B F6                         DB      0F6H            ; FILL BYTE FOR FORMAT
0F9C 0F                         DB      15              ; HEAD SETTLE TIME (MILLISECONDS)
0F9D 08                         DB      8               ; MOTOR START TIME (1/8 SECONDS)
0F9E 4F                         DB      79              ; MAX. TRACK NUMBER
0F9F 00                         DB      RATE_500        ; DATA TRANSFER RATE
                        ;---------------------------------------------------------------------------
                        ;       80 TRACK LOW DATA RATE MEDIA IN 80 TRACK LOW DATA RATE DRIVE :
                        ;---------------------------------------------------------------------------
0FA0                    MD_TBL4         LABEL BYTE
0FA0 DF                         DB      11011111B       ; SRT=D, HD UNLOAD=0F - 1ST SPECIFY BYTE
0FA1 02                         DB      2               ; HD LOAD=1, MODE=DMA - 2ND SPECIFY BYTE
0FA2 25                         DB      MOTOR_WAIT      ; WAIT TIME AFTER OPERATION TILL MOTOR OFF
0FA3 02                         DB      2               ; 512 BYTES/SECTOR
0FA4 09                         DB      09              ; EOT ( LAST SECTOR ON TRACK)
0FA5 2A                         DB      02AH            ; GAP LENGTH
0FA6 FF                         DB      0FFH            ; DTL
0FA7 50                         DB      050H            ; GAP LENGTH FOR FORMAT
0FA8 F6                         DB      0F6H            ; FILL BYTE FOR FORMAT
0FA9 0F                         DB      15              ; HEAD SETTLE TIME (MILLISECONDS)
0FAA 08                         DB      8               ; MOTOR START TIME (1/8 SECONDS)
0FAB 4F                         DB      79              ; MAX. TRACK NUMBER
0FAC 80                         DB      RATE_250        ; DATA TRANSFER RATE
                        ;---------------------------------------------------------------------------
                        ;       80 TRACK LOW DATA RATE MEDIA IN 80 TRACK HI DATA RATE DRIVE  :
                        ;---------------------------------------------------------------------------
0FAD                    MD_TBL5         LABEL BYTE
0FAD DF                         DB      11011111B       ; SRT=D, HD UNLOAD=0F - 1ST SPECIFY BYTE
0FAE 02                         DB      2               ; HD LOAD=1, MODE=DMA - 2ND SPECIFY BYTE
0FAF 25                         DB      MOTOR_WAIT      ; WAIT TIME AFTER OPERATION TILL MOTOR OFF
0FB0 02                         DB      2               ; 512 BYTES/SECTOR
0FB1 09                         DB      09              ; EOT ( LAST SECTOR ON TRACK)
0FB2 2A                         DB      02AH            ; GAP LENGTH
0FB3 FF                         DB      0FFH            ; DTL
```

```
0FB4 50                         DB      050H            ; GAP LENGTH FOR FORMAT
0FB5 F6                         DB      0F6H            ; FILL BYTE FOR FORMAT
0FB6 0F                         DB      15              ; HEAD SETTLE TIME (MILLISECONDS)
0FB7 08                         DB      8               ; MOTOR START TIME (1/8 SECONDS)
0FB8 4F                         DB      79              ; MAX. TRACK NUMBER
0FB9 80                         DB      RATE_250        ; DATA TRANSFER RATE
                        ;--------------------------------------------------------------------
                        ;       80 TRACK HI DATA RATE MEDIA IN 80 TRACK HI DATA RATE DRIVE   :
                        ;--------------------------------------------------------------------
0FBA                    MD_TBL6         LABEL BYTE
0FBA AF                         DB      10101111B       ; SRT=A, HD UNLOAD=0F - 1ST SPECIFY BYTE
0FBB 02                         DB      2               ; HD LOAD=1, MODE=DMA - 2ND SPECIFY BYTE
0FBC 25                         DB      MOTOR_WAIT      ; WAIT TIME AFTER OPERATION TILL MOTOR OFF
0FBD 02                         DB      2               ; 512 BYTES/SECTOR
0FBE 12                         DB      18              ; EOT ( LAST SECTOR ON TRACK)
0FBF 1B                         DB      01BH            ; GAP LENGTH
0FC0 FF                         DB      0FFH            ; DTL
0FC1 6C                         DB      06CH            ; GAP LENGTH FOR FORMAT
0FC2 F6                         DB      0F6H            ; FILL BYTE FOR FORMAT
0FC3 0F                         DB      15              ; HEAD SETTLE TIME (MILLISECONDS)
0FC4 08                         DB      8               ; MOTOR START TIME (1/8 SECONDS)
0FC5 4F                         DB      79              ; MAX. TRACK NUMBER
0FC6 00                         DB      RATE_500        ; DATA TRANSFER RATE
                        ;--------------------------------------------------------------------
                        ; DISK_BASE                                                         :
                        ;       THIS IS THE SET OF PARAMETERS REQUIRED FOR DISKETTE OPERATION.  :
                        ;       THEY ARE POINTED AT BY THE DATA VARIABLE DISK_POINTER. TO      :
                        ;       MODIFY THE PARAMETERS, BUILD ANOTHER PARAMETER BLOCK AND POINT  :
                        ;       DISK_POINTER TO IT.                                            :
                        ;--------------------------------------------------------------------
                        ;       ORG     0EFC7H
                                ORG     00FC7H
0FC7                    DISK_BASE       LABEL   BYTE
0FC7 CF                         DB      11001111B       ; SRT=C, HD UNLOAD=0F - 1ST SPECIFY BYTE
0FC8 02                         DB      2               ; HD LOAD=1, MODE=DMA - 2ND SPECIFY BYTE
0FC9 25                         DB      MOTOR_WAIT      ; WAIT AFTER OPN TIL MOTOR OFF
0FCA 02                         DB      2               ; 512 BYTES/SECTOR
0FCB 08                         DB      8               ; EOT ( LAST SECTOR ON TRACK)
0FCC 2A                         DB      02AH            ; GAP LENGTH
0FCD FF                         DB      0FFH            ; DTL
0FCE 50                         DB      050H            ; GAP LENGTH FOR FORMAT
0FCF F6                         DB      0F6H            ; FILL BYTE FOR FORMAT
0FD0 19                         DB      25              ; HEAD SETTLE TIME (MILLISECONDS)
0FD1 04                         DB      4               ; MOTOR START TIME (1/8 SECONDS)

                        ;       ORG     0EFD2H
                                ORG     00FD2H
0FD2                    PRINTER_IO:
0FD2 E9 0000 E                  JMP     PRINTER_IO_1

                        ;       ORG     0F045H
                                ORG     01045H
1045 0000 E             M1      DW      OFFSET  SET_MODE        ;  TABLE OF ROUTINES WITHIN VIDEO I/O
1047 0000 E                     DW      OFFSET  SET_CTYPE
1049 0000 E                     DW      OFFSET  SET_CPOS
104B 0000 E                     DW      OFFSET  READ_CURSOR
104D 0000 E                     DW      OFFSET  READ_LPEN
104F 0000 E                     DW      OFFSET  ACT_DISP_PAGE
1051 0000 E                     DW      OFFSET  SCROLL_UP
1053 0000 E                     DW      OFFSET  SCROLL_DOWN
1055 0000 E                     DW      OFFSET  READ_AC_CURRENT
1057 0000 E                     DW      OFFSET  WRITE_AC_CURRENT
1059 0000 E                     DW      OFFSET  WRITE_C_CURRENT
105B 0000 E                     DW      OFFSET  SET_COLOR
105D 0000 E                     DW      OFFSET  WRITE_DOT
105F 0000 E                     DW      OFFSET  READ_DOT
1061 0000 E                     DW      OFFSET  WRITE_TTY
1063 0000 E                     DW      OFFSET  VIDEO_STATE
= 0020                  M1L     EQU     $-M1

                        ;       ORG     0F065H
                                ORG     01065H
1065                    VIDEO_IO:
1065 E9 0000 E                  JMP     VIDEO_IO_1

                        ;-----  VIDEO PARAMETERS --- INIT_TABLE

                        ;;-     ORG     0F0A4H
                                ORG     010A4H
10A4                    VIDEO_PARMS     LABEL   BYTE
10A4 38 28 2D 0A 1F 06          DB      38H,28H,2DH,0AH,1FH,6,19H       ; SET UP FOR 40X25
     19
10AB 1C 02 07 06 07             DB      1CH,2,7,6,7
10B0 00 00 00 00                DB      0,0,0,0
= 0010                  M4      EQU     $-VIDEO_PARMS

10B4 71 50 5A 0A 1F 06          DB      71H,50H,5AH,0AH,1FH,6,19H       ; SET UP FOR 80X25
     19
10BB 1C 02 07 06 07             DB      1CH,2,7,6,7
10C0 00 00 00 00                DB      0,0,0,0

10C4 38 28 2D 0A 7F 06          DB      38H,28H,2DH,0AH,7FH,6,64H       ; SET UP FOR GRAPHICS
     64
10CB 70 02 01 06 07             DB      70H,2,1,6,7
10D0 00 00 00 00                DB      0,0,0,0

10D4 61 50 52 0F 19 06          DB      61H,50H,52H,0FH,19H,6,19H       ; SET UP FOR 80X25 B&W CARD
     19
10DB 19 02 0D 0B 0C             DB      19H,2,0DH,0BH,0CH
10E0 00 00 00 00                DB      0,0,0,0

10E4 0800               M5      DW      2048                    ; TABLE OF REGEN LENGTHS
10E6 1000                       DW      4096                    ; 40X25
10E8 4000                       DW      16384                   ; 80X25
10EA 4000                       DW      16384                   ; GRAPHICS

                        ;-----  COLUMNS
10EC 28 28 50 50 28 28  M6      DB      40,40,80,80,40,40,80,80
     50 50
                        ;-----  C_REG_TAB
10F4 2C 28 2D 29 2A 2E  M7      DB      2CH,28H,2DH,29H,2AH,2EH,1EH,29H ; TABLE OF MODE SETS
     1E 29
```

SECTION 5

```
                        PAGE
                        ;--- INT 12 -----------------------------------------------------------------
                        ; MEMORY_SIZE_DET                                                          :
                        ;       THIS ROUTINE DETERMINES THE AMOUNT OF MEMORY IN THE SYSTEM         :
                        ;       AS REPRESENTED BY THE SWITCHES ON THE PLANAR.  NOTE THAT THE       :
                        ;       SYSTEM MAY NOT BE ABLE TO USE I/O MEMORY UNLESS THERE IS A FULL    :
                        ;       COMPLEMENT OF 64K BYTES ON THE PLANAR.                             :
                        ; INPUT                                                                    :
                        ;       NO REGISTERS                                                       :
                        ;       THE MEMORY_SIZE VARIABLE IS SET DURING POWER ON DIAGNOSTICS        :
                        ;        ACCORDING TO THE FOLLOWING HARDWARE ASSUMPTIONS:                  :
                        ;       PORT 60 BITS 3,2 = 00 - 256K BASE RAM                              :
                        ;                          01 - 512K BASE RAM                              :
                        ;                          10 - 576K BASE RAM                              :
                        ;                          11 - 640K BASE RAM                              :
                        ;       PORT 62 BITS 3-0 INDICATE AMOUNT OF I/O RAM IN 32K INCREMENTS      :
                        ;               E.G., 0000 - NO RAM IN I/O CHANNEL                         :
                        ;                     0010 - 64K RAM IN I/O CHANNEL, ETC.                  :
                        ; OUTPUT                                                                   :
                        ;       (AX) = NUMBER OF CONTIGUOUS 1K BLOCKS OF MEMORY                    :
                        ;-------------------------------------------------------------------------
                                ASSUME  CS:CODE,DS:DATA
                        ;       ORG     0F841H
                                ORG     01841H
1841                    MEMORY_SIZE_DET PROC    FAR
1841 FB                         STI                             ; INTERRUPTS BACK ON
1842 1E                         PUSH    DS                      ; SAVE SEGMENT
1843 E8 1A12 R                  CALL    DDS
1846 A1 0013 R                  MOV     AX,@MEMORY_SIZE         ; GET VALUE
1849 1F                         POP     DS                      ; RECOVER SEGMENT
184A CF                         IRET                            ; RETURN TO CALLER
184B                    MEMORY_SIZE_DET ENDP

                        ;--- INT 11 -----------------------------------------------------------------
                        ; EQUIPMENT DETERMINATION                                                  :
                        ;       THIS ROUTINE ATTEMPTS TO DETERMINE WHAT OPTIONAL                   :
                        ;       DEVICES ARE ATTACHED TO THE SYSTEM.                                :
                        ; INPUT                                                                    :
                        ;       NO REGISTERS                                                       :
                        ;       THE EQUIP_FLAG VARIABLE IS SET DURING THE POWER ON                 :
                        ;       DIAGNOSTICS USING THE FOLLOWING HARDWARE ASSUMPTIONS:              :
                        ;       PORT 60  = LOW ORDER BYTE OF EQUPMENT                              :
                        ;       PORT 3FA = INTERRUPT ID REGISTER OF 8250                           :
                        ;                  BITS 7-3 ARE ALWAYS 0                                   :
                        ;       PORT 378 = OUTPUT PORT OF PRINTER -- 8255 PORT THAT                :
                        ;                  CAN BE READ AS WELL AS WRITTEN                          :
                        ; OUTPUT                                                                   :
                        ;       (AX) IS SET, BIT SIGNIFICANT, TO INDICATE ATTACHED I/O             :
                        ;       BIT 15,14 = NUMBER OF PRINTERS ATTACHED                            :
                        ;       BIT 13 NOT USED                                                    :
                        ;       BIT 12 = GAME I/O ATTACHED                                         :
                        ;       BIT 11,10,9 = NUMBER OF RS232 CARDS ATTACHED                       :
                        ;       BIT 8 UNUSED                                                       :
                        ;       BIT 7,6 = NUMBER OF DISKETTE DRIVES                                :
                        ;                 00=1, 01=2, 10=3, 11=4 ONLY IF BIT 0 = 1                 :
                        ;       BIT 5,4 = INITIAL VIDEO MODE                                       :
                        ;                 00 - UNUSED                                              :
                        ;                 01 - 40X25 BW USING COLOR CARD                           :
                        ;                 10 - 80X25 BW USING COLOR CARD                           :
                        ;                 11 - 80X25 BW USING BW CARD                              :
                        ;       BIT 3,2 = PLANAR RAM SIZE (00=256K,01=512K,10=576K,11=640K)        :
                        ;       BIT 1 = MATH COPROCESSOR                                           :
                        ;       BIT 0 = IPL FROM DISKETTE -- THIS BIT INDICATES THAT               :
                        ;               THERE ARE DISKETTE DRIVES ON THE SYSTEM                    :
                        ;                                                                          :
                        ;       NO OTHER REGISTERS AFFECTED                                        :
                        ;-------------------------------------------------------------------------
                                ASSUME  CS:CODE,DS:DATA
                        ;       ORG     0F84DH
                                ORG     0184DH
184D                    EQUIPMENT       PROC    FAR
184D FB                         STI                             ; INTERRUPTS BACK ON
184E 1E                         PUSH    DS                      ; SAVE SEGMENT REGISTER
184F E8 1A12 R                  CALL    DDS
1852 A1 0010 R                  MOV     AX,@EQUIP_FLAG          ; GET THE CURRENT SETTINGS
1855 1F                         POP     DS                      ; RECOVER SEGMENT
1856 CF                         IRET                            ; RETURN TO CALLER
1857                    EQUIPMENT       ENDP

                        ;--- INT 15 -----------------------------------------------------------------
                        ;
                        ;       ORG     0F859H
                        ;       ORG     01859H
1859                    CASSETTE_IO:
1859 E9 0000 E                  JMP     CASSETTE_IO_1

                        ;--------------------------------------------------------------------------
                        ; NON-MASKABLE INTERRUPT ROUTINE:                                          :
                        ;       THIS ROUTINE WILL PRINT A "PARITY CHECK 1 OR 2" MESSAGE            :
                        ;       AND ATTEMPT TO FIND THE STORAGE LOCATION CONTAINING THE            :
                        ;       BAD PARITY.  IF FOUND, THE SEGMENT ADDRESS WILL BE                 :
                        ;       PRINTED.  IF NO PARITY ERROR CAN BE FOUND (INTERMITTANT            :
                        ;       READ PROBLEM) ?????<-WILL BE PRINTED WHERE THE ADDRESS             :
                        ;       WOULD NORMALLY GO.                                                 :
                        ;--------------------------------------------------------------------------
185C                    NMI_INT_1       PROC    NEAR
                                ASSUME  DS:DATA
185C 50                         PUSH    AX                      ; SAVE ORIG CONTENTS OF AX
185D E4 62                      IN      AL,PORT_C
185F A8 C0                      TEST    AL,0C0H                 ; PARITY CHECK?
1861 75 03                      JNZ     NMI_1
1863 EB 58 90                   JMP     D14                     ; NO, EXIT FROM ROUTINE
1866                    NMI_1:
1866 BA ---- R                  MOV     DX,DATA
1869 8E DA                      MOV     DS,DX
186B BE 18E2 R                  MOV     SI,OFFSET D1            ; ADDR OF ERROR MSG
186E A8 40                      TEST    AL,40H                  ; I/O PARITY CHECK
1870 75 03                      JNZ     D13                     ; DISPLAY ERROR MSG
1872 BE 18F2 R                  MOV     SI,OFFSET D2            ; MUST BE PLANAR
1875                    D13:
1875 B4 00                      MOV     AH,0                    ; INIT AND SET MODE FOR VIDEO
1877 A0 0049 R                  MOV     AL,@CRT_MODE
187A CD 10                      INT     10H                     ; CALL VIDEO_IO PROCEDURE
187C E8 1997 R                  CALL    P_MSG                   ; PRINT ERROR MSG
```

```
                        ;----- SEE IF LOCATION THAT CAUSED PARITY CHECK CAN BE FOUND
1892 2B D2                      SUB     DX,DX                   ; POINT DX AT START OF MEM
                        NMI_LOOP:
1894 8E DA                      MOV     DS,DX
1896 8E C2                      MOV     ES,DX
1898 B9 4000                    MOV     CX,4000H                ; SET FOR 16KB SCAN
189B 2B F6                      SUB     SI,SI                   ; SET SI TO BE REALTIVE TO
                                                                ; START OF ES
189D F3/ AC                     REP     LODSB                   ; READ 16KB OF MEMORY
189F E4 62                      IN      AL,PORT_C               ; SEE IF PARITY CHECK HAPPENED
18A1 24 C0                      AND     AL,11000000B
18A3 75 11                      JNZ     PRT_NMI                 ; GO PRINT ADDRESS IF IT DID
18A5 81 C2 0400                 ADD     DX,0400H                ; POINT TO NEXT 16K BLOCK
18A9 83 EB 10                   SUB     BX,16D
18AC 75 E6                      JNZ     NMI_LOOP
18AE BE 1902 R                  MOV     SI,OFFSET D2A)          ; PRINT ROW OF ????? IF PARITY
18B1 E8 1997 R                  CALL    P_MSG                   ; CHECK COULD NOT BE RE-CREATED
18B4 FA                         CLI
18B5 F4                         HLT                             ; HALT SYSTEM
                        PRT_NMI:
18B6 8C DA                      MOV     DX,DS
18B8 E8 0CBA R                  CALL    PRT_SEG                 ; PRINT SEGMENT VALUE
18BB FA                         CLI                             ; HALT SYSTEM
18BC F4                         HLT
                        D14:
18BD 58                         POP     AX                      ; RESTORE ORIG CONTENTS OF AX
18BE CF                         IRET
                        NMI_INT_1       ENDP

                        ;--------------------------------------
                        ;       ROS CHECKSUM SUBROUTINE         :
                        ;--------------------------------------
18BF                    ROS_CHECKSUM    PROC    NEAR            ; NEXT ROS MODULE
18BF B9 0000                    MOV     CX,0                    ; NUMBER OF BYTES TO ADD
18C2                    ROS_CHECKSUM_CNT:                       ; ENTRY FOR OPTIONAL ROS TEST
18C2 32 C0                      XOR     AL,AL
18C4                    C26:
18C4 02 07                      ADD     AL,DS:[BX]
18C6 43                         INC     BX                      ; POINT TO NEXT BYTE
18C7 E2 FB                      LOOP    C26                     ; ADD ALL BYTES IN ROS MODULE
18C9 0A C0                      OR      AL,AL                   ; SUM = 0?
18CB C3                         RET
18CC                    ROS_CHECKSUM    ENDP
                        ;--------------------------------------
                        ;       MESSAGE AREA FOR POST           :
                        ;--------------------------------------
18CC 31 30 31 0D 0A     E0      DB      '101',CR,LF             ; SYSTEM BOARD ERROR
18D1 20 32 30 31 0D 0A  E1      DB      ' 201',CR,LF            ; MEMORY ERROR
18D7 52 4F 4D 0D 0A     F3A     DB      'ROM',CR,LF             ; ROM CHECKSUM ERROR
18DC 31 38 30 31 0D 0A  F3C     DB      '1801',CR,LF            ; EXPANSION IO BOX ERROR
18E2 50 41 52 49 54 59  D1      DB      'PARITY CHECK 2',CR,LF
        20 43 48 45 43 4B
        20 32 0D 0A
18F2 50 41 52 49 54 59  D2      DB      'PARITY CHECK 1',CR,LF
        20 43 48 45 43 4B
        20 31 0D 0A
1902 3F 3F 3F 3F 3F 0D  D2A     DB      '?????',CR,LF
        0A

                        ;-----------------------------------------------------------------------
                        ;       BLINK LED PROCEDURE FOR MFG RUN-IN TESTS
                        ;         IF LED IS ON, TURN IT OFF. IF OFF, TURN ON.
                        ;-----------------------------------------------------------------------
                                ASSUME  DS:DATA
1909                    BLINK_INT       PROC    NEAR
1909 FB                         STI
190A 50                         PUSH    AX                      ; SAVE AX REG CONTENTS
190B E4 61                      IN      AL,PORT_B               ; READ CURRENT VAL OF PORT B
190D 8A E0                      MOV     AH,AL
190F F6 D0                      NOT     AL                      ; FLIP ALL BITS
1911 24 40                      AND     AL,01000000B            ; ISOLATE CONTROL BIT
1913 80 E4 BF                   AND     AH,10111111B            ; MASK OUT OF ORIGINAL VAL
1916 0A C4                      OR      AL,AH                   ; OR NEW CONTROL BIT IN
1918 E6 61                      OUT     PORT_B,AL
191A B0 20                      MOV     AL,EOI
191C E6 20                      OUT     INTA00,AL
191E 58                         POP     AX                      ; RESTORE AX REG
191F CF                         IRET
1920                    BLINK_INT       ENDP

                        ;-------------------------------------------------------
                        ; THIS ROUTINE CHECKSUMS OPTIONAL ROM MODULES AND      :
                        ; IF CHECKSUM IS OK, CALLS INIT/TEST CODE IN MODULE    :
                        ;-------------------------------------------------------
1920                    ROM_CHECK       PROC    NEAR
1920 B8 ---- R                  MOV     AX,DATA                 ; POINT ES TO DATA AREA
1923 8E C0                      MOV     ES,AX
1925 2A E4                      SUB     AH,AH                   ; ZERO OUT AH
1927 8A 47 02                   MOV     AL,[BX+2]               ; GET LENGTH INDICATOR
192A B1 09                      MOV     CL,09H                  ; MULTIPLY BY 512
192C D3 E0                      SHL     AX,CL
192E 8B C8                      MOV     CX,AX                   ; SET COUNT
1930 51                         PUSH    CX                      ; SAVE COUNT
1931 B9 0004                    MOV     CX,4                    ; ADJUST
1934 D3 E8                      SHR     AX,CL
1936 03 D0                      ADD     DX,AX                   ; SET POINTER TO NEXT MODULE
1938 59                         POP     CX                      ; RETRIVE COUNT
1939 E8 18C2 R                  CALL    ROS_CHECKSUM_CNT        ; DO CHECKSUM
193C 74 06                      JZ      ROM_CHECK_1
193E E8 0746 R                  CALL    ROM_ERR                 ; POST CHECKSUM ERROR
1941 EB 14 90                   JMP     ROM_CHECK_END           ; AND EXIT
1944                    ROM_CHECK_1:
1944 52                         PUSH    DX                      ; SAVE POINTER
```

```
1945 26: C7 06 0067 R 0003          MOV     ES:@IO_ROM_INIT,0003H   ; LOAD OFFSET
194C 26: 8C 1E 0069 R               MOV     ES:@IO_ROM_SEG,DS       ; LOAD SEGMENT
1951 26: FF 1E 0067 R               CALL    DWORD PTR ES:@IO_ROM_INIT       ; CALL INIT./TEST ROUTINE
1956 5A                             POP     DX
1957                        ROM_CHECK_END:
1957 C3                             RET                             ; RETURN TO CALLER
1958                        ROM_CHECK       ENDP

                            ;--------------------------------------------
                            ; CONVERT AND PRINT ASCII CODE              :
                            ;       AL MUST CONTAIN NUMBER TO BE CONVERTED. :
                            ;       AX AND BX DESTROYED.                :
                            ;--------------------------------------------
1958                        XPC_BYTE        PROC    NEAR
1958 50                             PUSH    AX                      ; SAVE FOR LOW NIBBLE DISPLAY
1959 B1 04                          MOV     CL,4                    ; SHIFT COUNT
195B D2 E8                          SHR     AL,CL                   ; NYBBLE SWAP
195D E8 1963 R                      CALL    XLAT_PR                 ; DO THE HIGH NIBBLE DISPLAY
1960 58                             POP     AX                      ; RECOVER THE NIBBLE
1961 24 0F                          AND     AL,0FH                  ; ISOLATE TO LOW NIbBLE
                                                                    ; FALL INTO LOW NIBBLE CONVERSION
1963                        XLAT_PR PROC    NEAR                    ;  CONVERT 00-0F TO ASCII CHARACTER
1963 04 90                          ADD     AL,090H                 ; ADD FIRST CONVERSION FACTOR
1965 27                             DAA                             ; ADJUST FOR NUMERIC AND ALPHA RANGE
1966 14 40                          ADC     AL,040H                 ; ADD CONVERSION AND ADJUST LOW NIBBLE
1968 27                             DAA                             ; ADJUST HIGH NIBBLE TO ASCHI RANGE
1969                        PRT_HEX PROC    NEAR
1969 B4 0E                          MOV     AH,14                   ; DISPLAY CHARACTER IN AL
196B B7 00                          MOV     BH,0
196D CD 10                          INT     10H                     ; CALL VIDEO_IO
196F C3                             RET
1970                        PRT_HEX ENDP
1970                        XLAT_PR ENDP
1970                        XPC_BYTE        ENDP

1970                        F4      LABEL   WORD                    ; PRINTER SOURCE TABLE
1970 03BC                           DW      3BCH
1972 0378                           DW      378H
1974 0278                           DW      278H
1976                        F4E     LABEL   WORD

                            ;--------------------------------------------------------
                            ; THIS SUBROUTINE WILL PRINT A MESSAGE ON THE DISPLAY   :
                            ;                                                       :
                            ; ENTRY REQUIREMENTS:                                   :
                            ;       SI = OFFSET(ADDRESS) OF MESSAGE BUFFER          :
                            ;       CX = MESSAGE BYTE COUNT                         :
                            ;       MAXIMUM MESSAGE LENGTH IS 36 CHARACTERS         :
                            ;--------------------------------------------------------
1976                        E_MSG   PROC    NEAR
1976 8B EE                          MOV     BP,SI                   ; SET BP NON-ZERO TO FLAG ERR
1978 E8 1997 R                      CALL    P_MSG                   ; PRINT MESSAGE
197B 1E                             PUSH    DS
197C E8 1A12 R                      CALL    DDS
197F A0 0010 R                      MOV     AL,BYTE PTR @EQUIP_FLAG ; LOOP/HALT ON ERROR
1982 24 01                          AND     AL,01H                  ; SWITCH ON?
1984 75 0F                          JNZ     G12                     ; NO - RETURN
1986                        MFG_HALT:
1986 FA                             CLI                             ; YES -  HALT SYSTEM
1987 B0 89                          MOV     AL,89H
1989 E6 63                          OUT     CMD_PORT,AL
198B B0 85                          MOV     AL,T0000101B            ; DISABLE KB
198D E6 61                          OUT     PORT_B,AL
198F A0 0015 R                      MOV     AL,@MFG_ERR_FLAG        ; RECOVER ERROR INDICATOR
1992 E6 60                          OUT     PORT_A,AL               ; SET INTO 8255 REG
1994 F4                             HLT                             ; HALT SYS
1995                        G12:
1995 1F                             POP     DS                      ; WRITE_MSG:
1996 C3                             RET
1997                        E_MSG   ENDP

1997                        P_MSG   PROC    NEAR
1997                        G12A:
1997 2E: 8A 04                      MOV     AL,CS:[SI]              ; PUT CHAR IN AL
199A 46                             INC     SI                      ; POINT TO NEXT CHAR
199B 50                             PUSH    AX                      ; SAVE PRINT CHAR
199C E8 1969 R                      CALL    PRT_HEX                 ; CALL VIDEO_IO
199F 58                             POP     AX                      ; RECOVER PRINT CHAR
19A0 3C 0A                          CMP     AL,10                   ; WAS IT LINE FEED?
19A2 75 F3                          JNE     G12A                            ; NO,KEEP PRINTING STRING
19A4 C3                             RET
19A5                        P_MSG   ENDP
                                    ASSUME  CS:CODE,DS:DATA
                            ;--------------------------------------------------------------------------
                            ;       THIS PROCEDURE WILL ISSUE LONG TONES (1-3/4 SECONDS) AND ONE OR  :
                            ;       MORE SHORT TONES (9/32 SECOND) TO INDICATE A FAILURE ON THE      :
                            ;       PLANAR BOARD, A BAD MEMORY MODULE, OR A PROBLEM WITH THE CRT.    :
                            ; ENTRY PARAMETERS:                                                      :
                            ;       DH = NUMBER OF LONG TONES TO BEEP.                               :
                            ;       DL = NUMBER OF SHORT TONES TO BEEP.                              :
                            ;--------------------------------------------------------------------------

19A5                        ERR_BEEP        PROC    NEAR
19A5 9C                             PUSHF                           ; SAVE FLAGS
19A6 FA                             CLI                             ; DISABLE SYSTEM INTERRUPTS
19A7 0A F6                          OR      DH,DH                   ; ANY LONG ONES TO BEEP
19A9 74 1E                          JZ      G3                      ; NO, DO THE SHORT ONES
19AB                        G1:                                     ;       LONG BEEPS
19AB B3 70                          MOV     BL,112                  ; COUNTER FOR LONG BEEPS (1-3/4 SECONDS)
19AD B9 0500                        MOV     CX,1280                 ; DIVISOR FOR 932 HZ
19B0 E8 0C5C R                      CALL    BEEP                    ; DO THE BEEP
19B3 B9 C233                        MOV     CX,49715                ; 2/3 SECOND DELAY AFTER LONG BEEP
19B6 E8 0CA0 R                      CALL    WAITF                   ; DELAY BETWEEN BEEPS
19B9 FE CE                          DEC     DH                      ; ANY MORE LONG BEEPS TO DO
19BB 75 EE                          JNZ     G1                      ; LOOP TILL DONE
19BD 1E                             PUSH    DS                      ; SAVE DS REGISTER CONTENTS
19BE E8 1A12 R                      CALL    DDS
19C1 80 3E 0012 R 01                CMP     @MFG_TST,01H            ; MANUFACTURING TEST MODE?
19C6 1F                             POP     DS                      ; RESTORE ORIGINAL CONTENTS OF (DS)
19C7 74 BD                          JE      MFG_HALT                ; YES - STOP BLINKING LED
19C9                        G3:                                     ;       SHORT BEEPS
19C9 B3 12                          MOV     BL,18                   ; COUNTER FOR A SHORT BEEP (9/32)
19CB B9 04B8                        MOV     CX,1208                 ; DIVISOR FOR 987 HZ
19CE E8 0C5C R                      CALL    BEEP                    ; DO THE SOUND
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19D1 B9 8178                    MOV     CX,33144                ; 1/2 SECOND DELAY AFTER SHORT BEEP
19D4 E8 0CA0 R                  CALL    WAITF                   ; DELAY BETWEEN BEEPS
19D7 FE CA                      DEC     DL                      ; DONE WITH SHORT BEEPS COUNT
19D9 75 EE                      JNZ     G3                      ; LOOP TILL DONE
19DB B9 8178                    MOV     CX,33144                ; 1/2 SECOND DELAY AFTER LAST BEEP
19DE E8 0CA0 R                  CALL    WAITF                   ; MAKE IT ONE SECOND DELAY BEFORE RETURN
19E1 9D                         POPF                            ; RESTORE FLAGS TO ORIGINAL SETTINGS
19E2 C3                         RET                             ; RETURN TO CALLER
19E3                    ERR_BEEP        ENDP

                        ;--------------------------------------------------------------------
                        ;       THIS PROCEDURE WILL SEND A SOFTWARE RESET TO THE KEYBOARD.   :
                        ;       SCAN CODE 'AA' SHOULD BE RETURNED TO THE CPU.               :
                        ;--------------------------------------------------------------------
19E3                    KBD_RESET       PROC    NEAR
                                ASSUME  DS:ABS0
19E3 B0 08                      MOV     AL,08H                  ; SET KBD CLK LINE LOW
19E5 E6 61                      OUT     PORT_B,AL               ; WRITE 8255 PORT B
19E7 B9 2956                    MOV     CX,10582                ; HOLD KBD CLK LOW FOR 20 MS
19EA                    G8:
19EA E2 FE                      LOOP    G8                      ; LOOP FOR 20 MS
19EC B0 C8                      MOV     AL,0C8H                 ; SET CLK, ENABLE LINES HIGH
19EE E6 61                      OUT     PORT_B,AL
19F0                    SP_TEST:                                ; ENTRY FOR MANUFACTURING TEST 2
19F0 B0 48                      MOV     AL,48H                  ; SET KBD CLK HIGH, ENABLE LOW
19F2 E6 61                      OUT     PORT_B,AL
19F4 B0 FD                      MOV     AL,0FDH                 ; ENABLE KEYBOARD INTERRUPTS
19F6 E6 21                      OUT     INTA01,AL               ; WRITE 8259 IMR
19F8 C6 06 046B R 00            MOV     DATA_AREA[@INTR_FLAG-DATA40],0  ; RESET INTERRUPT INDICATOR
19FD FB                         STI                             ; ENABLE INTERRUPTS
19FE 2B C9                      SUB     CX,CX                   ; SETUP INTERRUPT TIMEOUT CNT
1A00                    G9:
1A00 F6 06 046B R 02            TEST    DATA_AREA[@INTR_FLAG-DATA40],02H ; DID A KEYBOARD INTR OCCUR?
1A05 75 02                      JNZ     G10                     ; YES - READ SCAN CODE RETURNED
1A07 E2 F7                      LOOP    G9                      ; NO - LOOP TILL TIMEOUT
1A09                    G10:
1A09 E4 60                      IN      AL,PORT_A               ; READ KEYBOARD SCAN CODE
1A0B 8A D8                      MOV     BL,AL                   ; SAVE SCAN CODE JUST READ
1A0D B0 C8                      MOV     AL,0C8H                 ; CLEAR KEYBOARD
1A0F E6 61                      OUT     PORT_B,AL
1A11 C3                         RET                             ; RETURN TO CALLER
1A12                    KBD_RESET       ENDP

1A12                    DDS     PROC    NEAR                    ;       LOAD (DS) TO DATA AREA
1A12 2E: 8E 1E 1A18 R           MOV     DS,CS:DDSDATA           ; PUT SEGMENT VALUE OF DATA AREA INTO DS
1A17 C3                         RET                             ; RETURN TO USER WITH (DS)= DATA

1A18 ---- R             DDSDATA DW      DATA                    ; SEGMENT SELECTOR VALUE FOR DATA AREA

1A1A                    DDS     ENDP

                        ;-- HARDWARE INT  08 H -- ( IRQ LEVEL 0 ) ---------------------------------
                        ;                                                                       :
                        ;       THIS ROUTINE HANDLES THE TIMER INTERRUPT FROM FROM CHANNEL 0 OF  :
                        ;       THE 8254 TIMER.  INPUT FREQUENCY IS 1.19318 MHZ AND THE DIVISOR :
                        ;       IS 65536, RESULTING IN APPROXIMATELY 18.2 INTERRUPTS EVERY SECOND.:
                        ;                                                                       :
                        ;       THE INTERRUPT HANDLER MAINTAINS A COUNT (40:6C) OF INTERRUPTS SINCE :
                        ;       POWER ON TIME, WHICH MAY BE USED TO ESTABLISH TIME OF DAY.       :
                        ;       THE INTERRUPT HANDLER ALSO DECREMENTS THE MOTOR CONTROL COUNT (40:40) :
                        ;       OF THE DISKETTE, AND WHEN IT EXPIRES, WILL TURN OFF THE          :
                        ;       DISKETTE MOTOR(S), AND RESET THE MOTOR RUNNING FLAGS.            :
                        ;       THE INTERRUPT HANDLER WILL ALSO INVOKE A USER ROUTINE THROUGH    :
                        ;       INTERRUPT 1CH AT EVERY TIME TICK.  THE USER MUST CODE A          :
                        ;       ROUTINE AND PLACE THE CORRECT ADDRESS IN THE VECTOR TABLE.       :
                        ;-----------------------------------------------------------------------
                                ASSUME  CS:CODE,DS:DATA

1A1A                    TIMER_INT_1     PROC    NEAR
1A1A FB                         STI                             ; INTERRUPTS BACK ON
1A1B 1E                         PUSH    DS
1A1C 50                         PUSH    AX
1A1D 52                         PUSH    DX                      ; SAVE MACHINE STATE
1A1E B8 ---- R                  MOV     AX,DATA                 ; GET ADDRESS OF DATA SEGMENT
1A21 8E D8                      MOV     DS,AX                   ; ESTABLISH ADDRESSABILITY
1A23 FF 06 006C R               INC     @TIMER_LOW              ; INCREMENT TIME
1A27 75 04                      JNZ     T4                      ; GO TO TEST_DAY
1A29 FF 06 006E R               INC     @TIMER_HIGH             ; INCREMENT HIGH WORD OF TIME
1A2D                    T4:                                     ;       TEST_DAY
1A2D 83 3E 006E R 18            CMP     @TIMER_HIGH,018H        ; TEST FOR COUNT EQUALING 24 HOURS
1A32 75 19                      JNZ     T5                      ; GO TO DISKETTE_CTL
1A34 81 3E 006C R 00B0          CMP     @TIMER_LOW,0B0H
1A3A 75 11                      JNZ     T5                      ; GO TO DISKETTE_CTL

1A3C 2B C0                      SUB     AX,AX
1A3E A3 006E R                  MOV     @TIMER_HIGH,AX          ; CLEAR TIMER COUNT HIGH
1A41 A3 006C R                  MOV     @TIMER_LOW,AX           ;       LOW
1A44 C6 06 0070 R 01            MOV     @TIMER_OFL,1            ; SET TIMER ELAPSED 24 HOURS FLAG
1A49 FF 06 00CE R               INC     @DAY_COUNT              ; INCREMENT ELAPSED DAY COUNTER

                        ;-----  TEST FOR DISKETTE TIME OUT

1A4D                    T5:
1A4D FE 0E 0040 R               DEC     @MOTOR_COUNT            ; DECREMENT DISKETTE MOTOR CONTROL
1A51 75 0B                      JNZ     T6                      ; RETURN IF COUNT NOT OUT
1A53 80 26 003F R F0            AND     @MOTOR_STATUS,0F0H      ; TURN OFF MOTOR RUNNING BITS
1A58 B0 0C                      MOV     AL,0CH
1A5A BA 03F2                    MOV     DX,03F2H                ; FDC CTL PORT
1A5D EE                         OUT     DX,AL                   ; TURN OFF THE MOTOR

1A5E                    T6:                                     ;       TIMER TICK INTERRUPT
1A5E CD 1C                      INT     1CH                     ; TRANSFER CONTROL TO A USER ROUTINE

1A60 FA                         CLI                             ; DISABLE INTERRUPTS TILL STACK CLEARED
1A61 B0 20                      MOV     AL,EOI                  ; GET END OF INTERRUPT MASK
1A63 E6 20                      OUT     INTA00,AL               ; END OF INTERRUPT TO 8259 - 1
1A65 5A                         POP     DX                      ; RESTORE (DX)
1A66 58                         POP     AX
1A67 1F                         POP     DS                      ; RESET MACHINE STATE
1A68 CF                         IRET                            ;  RETURN FROM INTERRUPT

1A69                    TIMER_INT_1     ENDP
```

SECTION 5

```
                                PAGE
                                ;--------------------------------------------------------------------------------
                                ;       CHARACTER GENERATOR GRAPHICS FOR 320X200 AND 640X200 GRAPHICS   :
                                ;--------------------------------------------------------------------------------
                                ;       ORG     0FA6EH
                                        ORG     01A6EH
1A6E                    CRT_CHAR_GEN    LABEL   BYTE
1A6E 00 00 00 00 00 00 00       DB      000H,000H,000H,000H,000H,000H,000H,000H ; D_00    BLANK
     00 00
1A76 7E 81 A5 81 BD 99          DB      07EH,081H,0A5H,081H,0BDH,099H,081H,07EH ; D_01    SMILING FACE
     81 7E
1A7E 7E FF DB FF C3 E7          DB      07EH,0FFH,0DBH,0FFH,0C3H,0E7H,0FFH,07EH ; D_02    SMILING FACE N
     FF 7E
1A86 6C FE FE FE 7C 38          DB      06CH,0FEH,0FEH,0FEH,07CH,038H,010H,000H ; D_03    HEART
     10 00
1A8E 10 38 7C FE 7C 38          DB      010H,038H,07CH,0FEH,07CH,038H,010H,000H ; D_04    DIAMOND
     10 00
1A96 38 7C 38 FE FE 7C          DB      038H,07CH,038H,0FEH,0FEH,07CH,038H,07CH ; D_05    CLUB
     38 7C
1A9E 10 10 38 7C FE 7C          DB      010H,010H,038H,07CH,0FEH,07CH,038H,07CH ; D_06    SPADE
     38 7C
1AA6 00 00 18 3C 3C 18          DB      000H,000H,018H,03CH,03CH,018H,000H,000H ; D_07    BULLET
     00 00
1AAE FF FF E7 C3 C3 E7          DB      0FFH,0FFH,0E7H,0C3H,0C3H,0E7H,0FFH,0FFH ; D_08    BULLET NEG
     FF FF
1AB6 00 3C 66 42 42 66          DB      000H,03CH,066H,042H,042H,066H,03CH,000H ; D_09    CIRCLE
     3C 00
1ABE FF C3 99 BD BD 99          DB      0FFH,0C3H,099H,0BDH,0BDH,099H,0C3H,0FFH ; D_0A    CIRCLE NEG
     C3 FF
1AC6 0F 07 0F 7D CC CC          DB      00FH,007H,00FH,07DH,0CCH,0CCH,0CCH,078H ; D_0B    MALE
     CC 78
1ACE 3C 66 66 66 3C 18          DB      03CH,066H,066H,066H,03CH,018H,07EH,018H ; D_0C    FEMALE
     7E 18
1AD6 3F 33 3F 30 30 70          DB      03FH,033H,03FH,030H,030H,070H,0F0H,0E0H ; D_0D    EIGHTH NOTE
     F0 E0
1ADE 7F 63 7F 63 63 67          DB      07FH,063H,07FH,063H,063H,067H,0E6H,0C0H ; D_0E    TWO 1/16 NOTE
     E6 C0
1AE6 99 5A 3C E7 E7 3C          DB      099H,05AH,03CH,0E7H,0E7H,03CH,05AH,099H ; D_0F    SUN
     5A 99

1AEE 80 E0 F8 FE F8 E0          DB      080H,0E0H,0F8H,0FEH,0F8H,0E0H,080H,000H ; D_10    R ARROWHEAD
     80 00
1AF6 02 0E 3E FE 3E 0E          DB      002H,00EH,03EH,0FEH,03EH,00EH,002H,000H ; D_11    L ARROWHEAD
     02 00
1AFE 18 3C 7E 18 18 7E          DB      018H,03CH,07EH,018H,018H,07EH,03CH,018H ; D_12    ARROW 2 VERT
     3C 18
1B06 66 66 66 66 66 00          DB      066H,066H,066H,066H,066H,000H,066H,000H ; D_13    2 EXCLAMATIONS
     66 00
1B0E 7F DB DB 7B 1B 1B          DB      07FH,0DBH,0DBH,07BH,01BH,01BH,01BH,000H ; D_14    PARAGRAPH
     1B 00
1B16 3E 63 38 6C 6C 38          DB      03EH,063H,038H,06CH,06CH,038H,0CCH,078H ; D_15    SECTION
     CC 78
1B1E 00 00 00 00 7E 7E          DB      000H,000H,000H,000H,07EH,07EH,07EH,000H ; D_16    RECTANGLE
     7E 00
1B26 18 3C 7E 18 7E 3C          DB      018H,03CH,07EH,018H,07EH,03CH,018H,0FFH ; D_17    ARROW 2 VRT UP
     18 FF
1B2E 18 3C 7E 18 18 18          DB      018H,03CH,07EH,018H,018H,018H,018H,000H ; D_18    ARROW VRT UP
     18 00
1B36 18 18 18 18 7E 3C          DB      018H,018H,018H,018H,07EH,03CH,018H,000H ; D_19    ARROW VRT DOWN
     18 00
1B3E 00 18 0C FE 0C 18          DB      000H,018H,00CH,0FEH,00CH,018H,000H,000H ; D_1A    ARROW RIGHT
     00 00
1B46 00 30 60 FE 60 30          DB      000H,030H,060H,0FEH,060H,030H,000H,000H ; D_1B    ARROW LEFT
     00 00
1B4E 00 00 C0 C0 C0 FE          DB      000H,000H,0C0H,0C0H,0C0H,0FEH,000H,000H ; D_1C    NOT INVERTED
     00 00
1B56 00 24 66 FF 66 24          DB      000H,024H,066H,0FFH,066H,024H,000H,000H ; D_1D    ARROW 2 HORZ
     00 00
1B5E 00 18 3C 7E FF FF          DB      000H,018H,03CH,07EH,0FFH,0FFH,000H,000H ; D_1E    ARROWHEAD UP
     00 00
1B66 00 FF FF 7E 3C 18          DB      000H,0FFH,0FFH,07EH,03CH,018H,000H,000H ; D_1F    ARROWHEAD DOWN
     00 00

1B6E 00 00 00 00 00 00          DB      000H,000H,000H,000H,000H,000H,000H,000H ; D_20    SPACE
     00 00
1B76 30 78 78 30 30 00          DB      030H,078H,078H,030H,030H,000H,030H,000H ; D_21 !  EXCLAMATION
     30 00
1B7E 6C 6C 6C 00 00 00          DB      06CH,06CH,06CH,000H,000H,000H,000H,000H ; D_22 "  QUOTATION
     00 00
1B86 6C 6C FE 6C FE 6C          DB      06CH,06CH,0FEH,06CH,0FEH,06CH,06CH,000H ; D_23 #  LB.
     6C 00
1B8E 30 7C C0 78 0C F8          DB      030H,07CH,0C0H,078H,00CH,0F8H,030H,000H ; D_24 $  DOLLAR SIGN
     30 00
1B96 00 C6 CC 18 30 66          DB      000H,0C6H,0CCH,018H,030H,066H,0C6H,000H ; D_25 %  PERCENT
     C6 00
1B9E 38 6C 38 76 DC CC          DB      038H,06CH,038H,076H,0DCH,0CCH,076H,000H ; D_26 &  AMPERSAND
     76 00
1BA6 60 60 C0 00 00 00          DB      060H,060H,0C0H,000H,000H,000H,000H,000H ; D_27 '  APOSTROPHE
     00 00
1BAE 18 30 60 60 60 30          DB      018H,030H,060H,060H,060H,030H,018H,000H ; D_28 (  L. PARENTHESIS
     18 00
1BB6 60 30 18 18 18 30          DB      060H,030H,018H,018H,018H,030H,060H,000H ; D_29 )  R. PARENTHESIS
     60 00
1BBE 00 66 3C FF 3C 66          DB      000H,066H,03CH,0FFH,03CH,066H,000H,000H ; D_2A *  ASTERISK
     00 00
1BC6 00 30 30 FC 30 30          DB      000H,030H,030H,0FCH,030H,030H,000H,000H ; D_2B +  PLUS
     00 00
1BCE 00 00 00 00 00 30          DB      000H,000H,000H,000H,000H,030H,030H,060H ; D_2C ,  COMMA
     30 60
1BD6 00 00 00 FC 00 00          DB      000H,000H,000H,0FCH,000H,000H,000H,000H ; D_2D -  DASH
     00 00
1BDE 00 00 00 00 00 30          DB      000H,000H,000H,000H,000H,030H,030H,000H ; D_2E .  PERIOD
     30 00
1BE6 06 0C 18 30 60 C0          DB      006H,00CH,018H,030H,060H,0C0H,080H,000H ; D_2F /  SLASH
     80 00

1BEE 7C C6 CE DE F6 E6          DB      07CH,0C6H,0CEH,0DEH,0F6H,0E6H,07CH,000H ; D_30 0
     7C 00
1BF6 30 70 30 30 30 30          DB      030H,070H,030H,030H,030H,030H,0FCH,000H ; D_31 1
     FC 00
1BFE 78 CC 0C 38 60 CC          DB      078H,0CCH,00CH,038H,060H,0CCH,0FCH,000H ; D_32 2
     FC 00
1C06 78 CC 0C 38 0C CC          DB      078H,0CCH,00CH,038H,00CH,0CCH,078H,000H ; D_33 3
     78 00
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1C0E 1C 3C 6C CC FE 0C          DB      01CH,03CH,06CH,0CCH,0FEH,00CH,01EH,000H ; D_34 4
     1E 00
1C16 FC C0 F8 0C 0C CC          DB      0FCH,0C0H,0F8H,00CH,00CH,0CCH,078H,000H ; D_35 5
     78 00
1C1E 38 60 C0 F8 CC CC          DB      038H,060H,0C0H,0F8H,0CCH,0CCH,078H,000H ; D_36 6
     78 00
1C26 FC CC 0C 18 30 30          DB      0FCH,0CCH,00CH,018H,030H,030H,030H,000H ; D_37 7
     30 00
1C2E 78 CC CC 78 CC CC          DB      078H,0CCH,0CCH,078H,0CCH,0CCH,078H,000H ; D_38 8
     78 00
1C36 78 CC CC 7C 0C 18          DB      078H,0CCH,0CCH,07CH,00CH,018H,070H,000H ; D_39 9
     70 00
1C3E 00 30 30 00 00 30          DB      000H,030H,030H,000H,000H,030H,030H,000H ; D_3A :  COLON
     30 00
1C46 00 30 30 00 00 30          DB      000H,030H,030H,000H,000H,030H,030H,060H ; D_3B ;  SEMICOLON
     60 00
1C4E 18 30 60 C0 60 30          DB      018H,030H,060H,0C0H,060H,030H,018H,000H ; D_3C <  LESS THAN
     18 00
1C56 00 00 FC 00 00 FC          DB      000H,000H,0FCH,000H,000H,0FCH,000H,000H ; D_3D =  EQUAL
     00 00
1C5E 60 30 18 0C 18 30          DB      060H,030H,018H,00CH,018H,030H,060H,000H ; D_3E >  GREATER THAN
     60 00
1C66 78 CC 0C 18 30 00          DB      078H,0CCH,00CH,018H,030H,000H,030H,000H ; D_3F ?  QUESTION MARK
     30 00

1C6E 7C C6 DE DE DE C0          DB      07CH,0C6H,0DEH,0DEH,0DEH,0C0H,078H,000H ; D_40 @  AT
     78 00
1C76 30 78 CC CC FC CC          DB      030H,078H,0CCH,0CCH,0FCH,0CCH,0CCH,000H ; D_41 A
     CC 00
1C7E FC 66 66 7C 66 66          DB      0FCH,066H,066H,07CH,066H,066H,0FCH,000H ; D_42 B
     FC 00
1C86 3C 66 C0 C0 C0 66          DB      03CH,066H,0C0H,0C0H,0C0H,066H,03CH,000H ; D_43 C
     3C 00
1C8E F8 6C 66 66 66 6C          DB      0F8H,06CH,066H,066H,066H,06CH,0F8H,000H ; D_44 D
     F8 00
1C96 FE 62 68 78 68 62          DB      0FEH,062H,068H,078H,068H,062H,0FEH,000H ; D_45 E
     FE 00
1C9E FE 62 68 78 68 60          DB      0FEH,062H,068H,078H,068H,060H,0F0H,000H ; D_46 F
     F0 00
1CA6 3C 66 C0 C0 CE 66          DB      03CH,066H,0C0H,0C0H,0CEH,066H,03EH,000H ; D_47 G
     3E 00
1CAE CC CC CC FC CC CC          DB      0CCH,0CCH,0CCH,0FCH,0CCH,0CCH,0CCH,000H ; D_48 H
     CC 00
1CB6 78 30 30 30 30 30          DB      078H,030H,030H,030H,030H,030H,078H,000H ; D_49 I
     78 00
1CBE 1E 0C 0C CC CC             DB      01EH,00CH,00CH,00CH,0CCH,0CCH,078H,000H ; D_4A J
     78 00
1CC6 E6 66 6C 78 6C 66          DB      0E6H,066H,06CH,078H,06CH,066H,0E6H,000H ; D_4B K
     E6 00
1CCE F0 60 60 60 62 66          DB      0F0H,060H,060H,060H,062H,066H,0FEH,000H ; D_4C L
     FE 00
1CD6 C6 EE FE FE D6 C6          DB      0C6H,0EEH,0FEH,0FEH,0D6H,0C6H,0C6H,000H ; D_4D M
     C6 00
1CDE C6 E6 F6 DE CE C6          DB      0C6H,0E6H,0F6H,0DEH,0CEH,0C6H,0C6H,000H ; D_4E N
     C6 00
1CE6 38 6C C6 C6 C6 6C          DB      038H,06CH,0C6H,0C6H,0C6H,06CH,038H,000H ; D_4F O
     38 00

1CEE FC 66 66 7C 60 60          DB      0FCH,066H,066H,07CH,060H,060H,0F0H,000H ; D_50 P
     F0 00
1CF6 78 CC CC CC DC 78          DB      078H,0CCH,0CCH,0CCH,0DCH,078H,01CH,000H ; D_51 Q
     1C 00
1CFE FC 66 66 7C 6C 66          DB      0FCH,066H,066H,07CH,06CH,066H,0E6H,000H ; D_52 R
     E6 00
1D06 78 CC E0 70 1C CC          DB      078H,0CCH,0E0H,070H,01CH,0CCH,078H,000H ; D_53 S
     78 00
1D0E FC B4 30 30 30 30          DB      0FCH,0B4H,030H,030H,030H,030H,078H,000H ; D_54 T
     78 00
1D16 CC CC CC CC CC CC          DB      0CCH,0CCH,0CCH,0CCH,0CCH,0CCH,0FCH,000H ; D_55 U
     FC 00
1D1E CC CC CC CC CC 78          DB      0CCH,0CCH,0CCH,0CCH,0CCH,078H,030H,000H ; D_56 V
     30 00
1D26 C6 C6 C6 D6 FE EE          DB      0C6H,0C6H,0C6H,0D6H,0FEH,0EEH,0C6H,000H ; D_57 W
     C6 00
1D2E C6 C6 6C 38 38 6C          DB      0C6H,0C6H,06CH,038H,038H,06CH,0C6H,000H ; D_58 X
     C6 00
1D36 CC CC CC 78 30 30          DB      0CCH,0CCH,0CCH,078H,030H,030H,078H,000H ; D_59 Y
     78 00
1D3E FE C6 8C 18 32 66          DB      0FEH,0C6H,08CH,018H,032H,066H,0FEH,000H ; D_5A Z
     FE 00
1D46 78 60 60 60 60 60          DB      078H,060H,060H,060H,060H,060H,078H,000H ; D_5B [  LEFT BRACKET
     78 00
1D4E C0 60 30 18 0C 06          DB      0C0H,060H,030H,018H,00CH,006H,002H,000H ; D_5C \  BACKSLASH
     02 00
1D56 78 18 18 18 18 18          DB      078H,018H,018H,018H,018H,018H,078H,000H ; D_5D ]  RIGHT BRACKET
     78 00
1D5E 10 38 6C C6 00 00          DB      010H,038H,06CH,0C6H,000H,000H,000H,000H ; D_5E ^  CIRCUMFLEX
     00 00
1D66 00 00 00 00 00 00          DB      000H,000H,000H,000H,000H,000H,000H,0FFH ; D_5F _  UNDERSCORE
     00 FF

1D6E 30 30 18 00 00 00          DB      030H,030H,018H,000H,000H,000H,000H,000H ; D_60 `  APOSTROPHE REV
     00 00
1D76 00 00 78 0C 7C CC          DB      000H,000H,078H,00CH,07CH,0CCH,076H,000H ; D_61 a
     76 00
1D7E E0 60 60 7C 66 66          DB      0E0H,060H,060H,07CH,066H,066H,0DCH,000H ; D_62 b
     DC 00
1D86 00 00 78 CC C0 CC          DB      000H,000H,078H,0CCH,0C0H,0CCH,078H,000H ; D_63 c
     78 00
1D8E 1C 0C 0C 7C CC CC          DB      01CH,00CH,00CH,07CH,0CCH,0CCH,076H,000H ; D_64 d
     76 00
1D96 00 00 78 CC FC C0          DB      000H,000H,078H,0CCH,0FCH,0C0H,078H,000H ; D_65 e
     78 00
1D9E 38 6C 60 F0 60 60          DB      038H,06CH,060H,0F0H,060H,060H,0F0H,000H ; D_66 f
     F0 00
1DA6 00 00 76 CC CC 7C          DB      000H,000H,076H,0CCH,0CCH,07CH,00CH,0F8H ; D_67 g
     0C F8
1DAE E0 60 6C 76 66 66          DB      0E0H,060H,06CH,076H,066H,066H,0E6H,000H ; D_68 h
     E6 00
1DB6 30 00 70 30 30 30          DB      030H,000H,070H,030H,030H,030H,078H,000H ; D_69 i
     78 00
1DBE 0C 00 0C 0C 0C CC          DB      00CH,000H,00CH,00CH,00CH,0CCH,0CCH,078H ; D_6A j
     CC 78
1DC6 E0 60 66 6C 78 6C          DB      0E0H,060H,066H,06CH,078H,06CH,0E6H,000H ; D_6B k
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                E6 00
1DCE 70 30 30 30 30 30          DB      070H,030H,030H,030H,030H,030H,078H,000H ; D_6C l
                78 00
1DD6 00 00 CC FE FE D6          DB      000H,000H,0CCH,0FEH,0FEH,0D6H,0C6H,000H ; D_6D m
                C6 00
1DDE 00 00 F8 CC CC CC          DB      000H,000H,0F8H,0CCH,0CCH,0CCH,0CCH,000H ; D_6E n
                CC 00
1DE6 00 00 78 CC CC CC          DB      000H,000H,078H,0CCH,0CCH,0CCH,078H,000H ; D_6F o

1DEE 00 00 DC 66 66 7C          DB      000H,000H,0DCH,066H,066H,07CH,060H,0F0H ; D_70 p
                60 F0
1DF6 00 00 76 CC CC 7C          DB      000H,000H,076H,0CCH,0CCH,07CH,00CH,01EH ; D_71 q
                0C 1E
1DFE 00 00 DC 76 66 60          DB      000H,000H,0DCH,076H,066H,060H,0F0H,000H ; D_72 r
                F0 00
1E06 00 00 7C C0 78 0C          DB      000H,000H,07CH,0C0H,078H,00CH,0F8H,000H ; D_73 s
                F8 00
1E0E 10 30 7C 30 30 34          DB      010H,030H,07CH,030H,030H,034H,018H,000H ; D_74 t
                18 00
1E16 00 00 CC CC CC CC          DB      000H,000H,0CCH,0CCH,0CCH,0CCH,076H,000H ; D_75 u
                76 00
1E1E 00 00 CC CC CC 78          DB      000H,000H,0CCH,0CCH,0CCH,078H,030H,000H ; D_76 v
                30 00
1E26 00 00 C6 D6 FE FE          DB      000H,000H,0C6H,0D6H,0FEH,0FEH,06CH,000H ; D_77 w
                6C 00
1E2E 00 00 C6 6C 38 6C          DB      000H,000H,0C6H,06CH,038H,06CH,0C6H,000H ; D_78 x
                C6 00
1E36 00 00 CC CC CC 7C          DB      000H,000H,0CCH,0CCH,0CCH,07CH,00CH,0F8H ; D_79 y
                0C F8
1E3E 00 00 FC 98 30 64          DB      000H,000H,0FCH,098H,030H,064H,0FCH,000H ; D_7A z
                FC 00
1E46 1C 30 30 E0 30 30          DB      01CH,030H,030H,0E0H,030H,030H,01CH,000H ; D_7B {  LEFT BRACE
                1C 00
1E4E 18 18 18 00 18 18          DB      018H,018H,018H,000H,018H,018H,018H,000H ; D_7C |  BROKEN STROKE
                18 00
1E56 E0 30 30 1C 30 30          DB      0E0H,030H,030H,01CH,030H,030H,0E0H,000H ; D_7D }  RIGHT BRACE
                E0 00
1E5E 76 DC 00 00 00 00          DB      076H,0DCH,000H,000H,000H,000H,000H,000H ; D_7E ~  TILDE
                00 00
1E66 00 10 38 6C C6 C6          DB      000H,010H,038H,06CH,0C6H,0C6H,0FEH,000H ; D_7F    DELTA
                FE 00
```

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                        PAGE
                        ;--- INT 1A ------------------------------------------------
                        ; TIME_OF_DAY                                               :
                        ;  THIS ROUTINE ALLOWS THE CLOCK TO BE SET/READ            :
                        ;                                                          :
                        ; INPUT                                                    :
                        ;   (AH) = 0     READ THE CURRENT CLOCK SETTING           :
                        ;                RETURNS CX = HIGH PORTION OF COUNT       :
                        ;                        DX = LOW PORTION OF COUNT        :
                        ;                        AL = 0 IF TIMER HAS NOT PASSED   :
                        ;                         24 HOURS SINCE LAST READ        :
                        ;                           <>0 IF ON ANOTHER DAY         :
                        ;   (AH) = 1     SET THE CURRENT CLOCK                    :
                        ;        CX = HIGH PORTION OF COUNT                        :
                        ;        DX = LOW PORTION OF COUNT                         :
                        ; NOTE: COUNTS OCCUR AT THE RATE OF                        :
                        ;         1193180/65536 COUNTS/SEC                         :
                        ;        (OR ABOUT 18.2 PER SECOND -- SEE EQUATES BELOW)   :
                        ;----------------------------------------------------------
                                ASSUME  CS:CODE,DS:DATA
                        ;       ORG     0FE6EH
1E6E                            ORG     01E6EH
1E6E                    TIME_OF_DAY:
1E6E E9 0995 R                  JMP     TIME_OF_DAY_1!

                        ;       ORG     0FEA5H
1EA5                            ORG     01EA5H
1EA5                    TIMER_INT:
1EA5 E9 1A1A R                  JMP     TIMER_INT_1

                        ;----------------------------------------------------------
                        ; THESE ARE THE VECTORS WHICH ARE MOVED INTO               :
                        ; THE 808s INTERRUPT AREA DURING POWER ON.                 :
                        ; ONLY THE OFFSETS ARE DISPLAYED HERE, CODE                :
                        ; SEGMENT WILL BE ADDED FOR ALL OF THEM, EXCEPT            :
                        ; WHERE NOTED.                                            :
                        ;----------------------------------------------------------
                                ASSUME  CS:CODE
                        ;       ORG     0FEF3H
1EF3                            ORG     01EF3H
1EF3                    VECTOR_TABLE    LABEL   WORD            ; VECTOR TABLE VALUES FOR POST TESTS
1EF3 1EA5 R                     DW      OFFSET TIMER_INT        ; INT 08H - HARDWARE TIMER 0        IRQ  0
1EF5 0987 R                     DW      OFFSET KB_INT           ; INT 09H - KEYBOARD                IRQ  1
1EF7 1F23 R                     DW      OFFSET  DI1             ; INT 0AH                           IRQ  2
1EF9 1F23 R                     DW      OFFSET  DI1             ; INT 0BH -                         IRQ  3
1EFB 1F23 R                     DW      OFFSET  DI1             ; INT 0CH -                         IRQ  4
1EFD 1F23 R                     DW      OFFSET  DI1             ; INT 0DH -                         IRQ  5
1EFF 0F57 R                     DW      OFFSET DISK_INT         ; INT 0EH - DISKETTE                IRQ  6
1F01 1F23 R                     DW      OFFSET  DI1             ; INT 0FH -                         IRQ  7

                        ;-----  SOFTWARE INTERRUPTS  ( BIOS CALLS AND POINTERS )

1F03 1065 R                     DW      OFFSET VIDEO_IO         ; INT 10H -- VIDEO DISPLAY
1F05 184D R                     DW      OFFSET EQUIPMENT        ; INT 11H -- GET EQUIPMENT FLAG WORD
1F07 1841 R                     DW      OFFSET MEMORY_SIZE_DET  ; INT 12H -- GET REAL MODE MEMORY SIZE
1F09 0C59 R                     DW      OFFSET DISKETTE_IO      ; INT 13H -- DISKETTE
1F0B 0739 R                     DW      OFFSET RS232_IO         ; INT 14H -- COMMUNICATION ADAPTER
1F0D 1859 R                     DW      OFFSET CASSETTE_IO      ; INT 15H -- EXPANDED BIOS FUNCTION CALL
1F0F 082E R                     DW      OFFSET KEYBOARD_IO      ; INT 16H -- KEYBOARD INPUT
1F11 0FD2 R                     DW      OFFSET PRINTER_IO       ; INT 17H -- PRINTER OUTPUT
1F13 0000                       DW      00000H                  ; INT 18H -- 0F600H INSERTED FOR BASIC
1F15 06F2 R                     DW      OFFSET BOOT_STRAP       ; INT 19H -- BOOT FROM SYSTEM MEDIA
1F17 1E6E R                     DW      OFFSET TIME_OF_DAY      ; INT 1AH -- TIME OF DAY
1F19 1F49 R                     DW      OFFSET DUMMY_RETURN     ; INT 1BH -- KEYBOARD BREAK ADDRESS
1F1B 1F49 R                     DW      OFFSET DUMMY_RETURN     ; INT 1CH -- TIMER BREAK ADDRESS
1F1D 10A4 R                     DW      OFFSET VIDEO_PARMS      ; INT 1DH -- VIDEO PARAMETERS
1F1F 0FC7 R                     DW      OFFSET DISK_BASE        ; INT 1EH -- DISKETTE PARAMETERS
1F21 0000                       DW      00000H                  ; INT 1FH -- POINTER TO VIDEO EXTENSION

                        ;----------------------------------------------------------
                        ; TEMPORARY INTERRUPT SERVICE ROUTINE                      :
                        ;       1. THIS ROUTINE IS ALSO LEFT IN PLACE AFTER THE    :
                        ;       POWER ON DIAGNOSTICS TO SERVICE UNUSED             :
                        ;       INTERRUPT VECTORS. LOCATION 'INTR_FLAG' WILL       :
                        ;       CONTAIN EITHER: 1. LEVEL OF HARDWARE INT. THAT     :
                        ;       CAUSED CODE TO BE EXEC.                            :
                        ;       2. 'FF' FOR NON-HARDWARE INTERUPTS THAT WAS        :
                        ;       EXECUTED ACCIDENTLY.                               :
                        ;----------------------------------------------------------
1F23                    DI1     PROC    NEAR
                                ASSUME  DS:DATA
1F23 1E                         PUSH    DS
1F24 E8 1A12 R                  CALL    DDS
1F27 50                         PUSH    AX                      ; SAVE REG AX CONTENTS
1F28 B0 0B                      MOV     AL,0BH                  ; READ IN-SERVICE REG
1F2A E6 20                      OUT     INTA00,AL               ; (FIND OUT WHAT LEVEL BEING
1F2C 90                         NOP                             ; SERVICED)
1F2D E4 20                      IN      AL,INTA00               ; GET LEVEL
1F2F 8A E0                      MOV     AH,AL                   ; SAVE IT
1F31 0A C4                      OR      AL,AH                   ; 00? (NO HARDWARE ISR ACTIVE)
1F33 75 04                      JNZ     HW_INT
1F35 B4 FF                      MOV     AH,0FFH
1F37 EB 0A                      JMP     SHORT SET_INTR_FLAG     ; SET FLAG TO FF IF NON-HDWARE
1F39                    HW_INT:
1F39 E4 21                      IN      AL,INTA01               ; GET MASK VALUE
1F3B 0A C4                      OR      AL,AH                   ; MASK OFF LVL BEING SERVICED
1F3D E6 21                      OUT     INTA01,AL
1F3F B0 20                      MOV     AL,EOI
1F41 E6 20                      OUT     INTA00,AL
1F43                    SET_INTR_FLAG:
1F43 88 26 006B R               MOV     @INTR_FLAG,AH           ; SET FLAG
1F47 58                         POP     AX                      ; RESTORE REG AX CONTENTS
1F48 1F                         POP     DS
1F49                    DUMMY_RETURN:                           ; NEED IRET FOR VECTOR TABLE
1F49 CF                         IRET
1F4A                    DI1     ENDP

                        ;----------------------------------------------------------
                        ; DUMMY RETURN FOR ADDRESS COMPATIBILITY                   :
                        ;----------------------------------------------------------
                        ;       ORG     0FF53H
1F53                            ORG     01F53H
1F53 CF                         IRET
```

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                        PAGE
                        ;--- INT  05 H ----------------------------------------------------------------
                        ; PRINT_SCREEN                                                               :
                        ;       THIS LOGIC WILL BE INVOKED BY INTERRUPT 05H TO PRINT THE SCREEN.     :
                        ;       THE CURSOR POSITION AT THE TIME THIS ROUTINE IS INVOKED WILL BE      :
                        ;       SAVED AND RESTORED UPON COMPLETION.  THE ROUTINE IS INTENDED TO      :
                        ;       RUN WITH INTERRUPTS ENABLED.   IF A SUBSEQUENT PRINT SCREEN KEY      :
                        ;       IS DEPRESSED WHILE THIS ROUTINE IS PRINTING IT WILL BE IGNORED.      :
                        ;       THE BASE PRINTERS STATUS IS CHECKED FOR NOT BUSY AND NOT OUT OF      :
                        ;       PAPER.  AN INITIAL STATUS ERROR WILL ABEND THE PRINT REQUEST.        :
                        ;       ADDRESS  0050:0000  CONTAINS THE STATUS OF THE PRINT SCREEN:         :
                        ;                                                                            :
                        ;       50:0    = 0     PRINT SCREEN HAS NOT BEEN CALLED OR UPON RETURN      :
                        ;                       FROM A CALL THIS INDICATES A SUCCESSFUL OPERATION.   :
                        ;               = 1     PRINT SCREEN IS IN PROGRESS - IGNORE THIS REQUEST.   :
                        ;               = 255   ERROR ENCOUNTERED DURING PRINTING.                   :
                        ;--------------------------------------------------------------------------
                        ;       ORG     0FF54H
 1F54                   ;       ORG     01F54H
                        ;
 1F54                   PRINT_SCREEN_1  PROC    FAR
                                                                ; DELAY INTERRUPT ENABLE TILL FLAG SET
 1F54 1E                        PUSH    DS                      ; USE 0040:0100 FOR STATUS AREA STORAGE
 1F55 E8 1A12 R                 CALL    DDS                     ; GET STATUS_BYTE DATA SEGMENT
 1F58 80 3E 0100 R 01           CMP     @STATUS_BYTE,1          ; SEE IF PRINT ALREADY IN PROGRESS
 1F5D 74 7C                     JE      PRI90                   ; EXIT IF PRINT ALREADY IN PROGRESS
 1F5F C6 06 0100 R 01           MOV     @STATUS_BYTE,1          ; INDICATE PRINT NOW IN PROGRESS
 1F64 FB                        STI                             ; MUST RUN WITH INTERRUPTS ENABLED
 1F65 50                        PUSH    AX                      ; SAVE WORK REGISTERS
 1F66 53                        PUSH    BX
 1F67 51                        PUSH    CX
 1F68 52                        PUSH    DX
 1F69 B4 0F                     MOV     AH,0FH                  ; WILL REQUEST THE CURRENT SCREEN MODE
 1F6B CD 10                     INT     10H                     ;       (AL)= MODE
                                                                ;       (AH)= NUMBER COLUMNS/LINE
                                                                ;       (BH)= VISUAL PAGE
 1F6D 8A CC                     MOV     CL,AH                   ; WILL MAKE USE OF (CX) REGISTER TO
 1F6F 8A 2E 0084 R              MOV     CH,@ROWS                ;  CONTROL ROWS ON SCREEN & COLUMNS
 1F73 FE C5                     INC     CH                      ; ADJUST ROWS ON DISPLAY COUNT
                                                                ;       (CL)= NUMBER COLUMNS/LINE
                                                                ;       (CH)= NUMBER OF ROWS ON DISPLAY
                                ;---------------------------------------------------------
                                ;       AT THIS POINT WE KNOW THE COLUMNS/LINE COUNT IS IN (CL) :
                                ;       AND THE NUMBER OF ROWS ON THE DISPLAY IS IN (CH).       :
                                ;       THE PAGE IF APPLICABLE IS IN (BH).  THE STACK HAS       :
                                ;       (DS),(AX),(BX),(CX),(DX)  PUSHED.                       :
                                ;---------------------------------------------------------
 1F75 33 D2                     XOR     DX,DX                   ; FIRST PRINTER
 1F77 B4 02                     MOV     AH,02H                  ; SET PRINTER STATUS REQUEST COMMAND
 1F79 CD 17                     INT     17H                     ; REQUEST CURRENT PRINTER STATUS
 1F7B 80 F4 80                  XOR     AH,080H                 ; CHECK FOR PRINTER BUSY (NOT CONNECTED)
 1F7E F6 C4 A0                  TEST    AH,0A0H                 ;  OR   OUT OF PAPER
 1F81 75 4E                     JNZ     PRI70                   ; ERROR EXIT IF PRINTER STATUS ERROR

 1F83 E8 1FDD R                 CALL    CRLF                    ; CARRIAGE RETURN LINE FEED TO PRINTER
 1F86 51                        PUSH    CX                      ; SAVE SCREEN BOUNDS
 1F87 B4 03                     MOV     AH,03H                  ; NOW READ THE CURRENT CURSOR POSITION
 1F89 CD 10                     INT     10H                     ; AND RESTORE AT END OF ROUTINE
 1F8B 59                        POP     CX                      ; RECALL SCREEN BOUNDS
 1F8C 52                        PUSH    DX                      ; PRESERVE THE ORIGINAL POSITION
 1F8D 33 D2                     XOR     DX,DX                   ; INITIAL CURSOR (0,0) AND FIRST PRINTER
                                ;---------------------------------------------------------
                                ;       THIS LOOP IS TO READ EACH CURSOR POSITION FROM THE      :
                                ;       SCREEN AND PRINT IT.  (BH)= VISUAL PAGE  (CH)= ROWS     :
                                ;---------------------------------------------------------
 1F8F                   PRI10:
 1F8F B4 02                     MOV     AH,02H                  ; INDICATE CURSOR SET REQUEST
 1F91 CD 10                     INT     10H                     ; NEW CURSOR POSITION ESTABLISHED
 1F93 B4 08                     MOV     AH,08H                  ; INDICATE READ CHARACTER FROM DISPLAY
 1F95 CD 10                     INT     10H                     ; CHARACTER NOW IN (AL)
 1F97 0A C0                     OR      AL,AL                   ; SEE IF VALID CHAR
 1F99 75 02                     JNZ     PRI20                   ; JUMP IF VALID CHAR
 1F9B B0 20                     MOV     AL,' '                  ; ELSE MAKE IT A BLANK
 1F9D                   PRI20:
 1F9D 52                        PUSH    DX                      ; SAVE CURSOR POSITION
 1F9E 33 D2                     XOR     DX,DX                   ; INDICATE FIRST PRINTER (DX= 0)
 1FA0 32 E4                     XOR     AH,AH                   ; INDICATE PRINT CHARACTER IN (AL)
 1FA2 CD 17                     INT     17H                     ; PRINT THE CHARACTER
 1FA4 5A                        POP     DX                      ; RECALL CURSOR POSITION
 1FA5 F6 C4 29                  TEST    AH,29H                  ; TEST FOR PRINTER ERROR
 1FA8 75 22                     JNZ     PRI60                   ; EXIT IF ERROR DETECTED
 1FAA FE C2                     INC     DL                      ; ADVANCE TO NEXT COLUMN
 1FAC 3A CA                     CMP     CL,DL                   ; SEE IF AT END OF LINE
 1FAE 75 DF                     JNZ     PRI10                   ; IF NOT LOOP FOR NEXT COLUMN
 1FB0 32 D2                     XOR     DL,DL                   ; BACK TO COLUMN 0
 1FB2 8A E2                     MOV     AH,DL                   ; (AH)=0
 1FB4 52                        PUSH    DX                      ; SAVE NEW CURSOR POSITION
 1FB5 E8 1FDD R                 CALL    CRLF                    ; LINE FEED CARRIAGE RETURN
 1FB8 5A                        POP     DX                      ; RECALL CURSOR POSITION
 1FB9 FE C6                     INC     DH                      ; ADVANCE TO NEXT LINE
 1FBB 3A EE                     CMP     CH,DH                   ; FINISHED?
 1FBD 75 D0                     JNZ     PRI10                   ; IF NOT LOOP FOR NEXT LINE

 1FBF 5A                        POP     DX                      ; GET CURSOR POSITION
 1FC0 B4 02                     MOV     AH,02H                  ; INDICATE REQUEST CURSOR SET
 1FC2 CD 10                     INT     10H                     ; CURSOR POSITION RESTORED
 1FC4 FA                        CLI                             ; BLOCK INTERRUPTS TILL STACK CLEARED
 1FC5 C6 06 0100 R 00           MOV     @STATUS_BYTE,0          ; MOVE OK RESULTS FLAG TO STATUS_BYTE
 1FCA EB 0B                     JMP     SHORT PRI80             ; EXIT PRINTER ROUTINE
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                        PAGE
1FCC                    PR160:                                  ;       ERROR EXIT
1FCC 5A                         POP     DX                      ; GET CURSOR POSITION
1FCD B4 02                      MOV     AH,02H                  ; INDICATE REQUEST CURSOR SET
1FCF CD 10                      INT     10H                     ; CURSOR POSITION RESTORED
1FD1                    PR170:
1FD1 FA                         CLI                             ; BLOCK INTERRUPTS TILL STACK CLEARED
1FD2 C6 06 0100 R FF            MOV     @STATUS_BYTE,0FFH       ; SET ERROR FLAG
1FD7                    PR180:
1FD7 5A                         POP     DX                      ;       EXIT ROUTINE
1FD8 59                         POP     CX                      ; RESTORE ALL THE REGISTERS USED
1FD9 5B                         POP     BX
1FDA 58                         POP     AX
1FDB                    PR190:                                  ;       ROUTINE BUSY EXIT
1FDB 1F                         POP     DS
1FDC CF                         IRET                            ; RETURN WITH INITIAL INTERRUPT MASK
1FDD                    PRINT_SCREEN_I  ENDP

                        ;-----  CARRIAGE RETURN, LINE FEED SUBROUTINE

1FDD                    CRLF    PROC    NEAR
                                                                ;       SEND CR,LF TO FIRST PRINTER
1FDD 33 D2                      XOR     DX,DX                   ; ASSUME FIRST PRINTER (DX= 0)
1FDF B8 000D                    MOV     AX,CR                   ; GET THE PRINT CHARACTER COMMAND AND
1FE2 CD 17                      INT     17H                     ;   THE CARRIAGE RETURN CHARACTER
1FE4 B8 000A                    MOV     AX,LF                   ; NOW GET THE LINE FEED AND
1FE7 CD 17                      INT     17H                     ;   SEND IT TO THE BIOS PRINTER ROUTINE
1FE9 C3                         RET
1FEA                    CRLF    ENDP

                        ;--------------------------------
                        ;       POWER ON RESET VECTOR   :
                        ;--------------------------------
                        ;       ORG     0FFF0H
1FF0                            ORG     01FF0H

                        ;-----  POWER ON RESET
1FF0                    P_O_R   LABEL   FAR
1FF0 EA                         DB      0EAH
1FF1 E05B                       DW      0E05BH                  ; LOW WORD OF RESET
1FF3 F000                       DW      0F000H                  ; SEGMENT

1FF5 30 31 2F 31 30 2F          DB      '01/10/86'              ; RELEASE MARKER
     38 36

                        ;       ORG     0FFFEH
1FFE                            ORG     01FFEH
1FFE                    MODEL:
1FFE FB                         DB      MODEL_BYTE

1FFF                    CODE    ENDS
                                END
```

SECTION 5

Notes:

System BIOS Listing - 11/8/82

Quick Reference - 64/256K Board

SECTION 5

Notes:

```
LOC OBJECT            LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

                        1   $TITLE(BIOS FOR THE IBM PERSONAL COMPUTER XT)
                        2
                        3   ;--------------------------------------------------------------------
                        4   ;       THE  BIOS ROUTINES ARE MEANT TO BE ACCESSED THROUGH        :
                        5   ;       SOFTWARE INTERRUPTS ONLY.  ANY ADDRESSES PRESENT IN        :
                        6   ;       THE LISTINGS  ARE INCLUDED  ONLY FOR  COMPLETENESS,        :
                        7   ;       NOT FOR  REFERENCE.    APPLICATIONS WHICH  REFERENCE       :
                        8   ;       ABSOLUTE    ADDRESSES    WITHIN    THE    CODE  SEGMENT   :
                        9   ;       VIOLATE THE STRUCTURE AND DESIGN OF BIOS.                  :
                       10   ;--------------------------------------------------------------------
                       11
                       12   ;---------------------------------------
                       13   ;                EQUATES                :
                       14   ;---------------------------------------
0060                   15   PORT_A           EQU     60H            ; 8255 PORT A ADDR
0061                   16   PORT_B           EQU     61H            ; 8255 PORT B ADDR
0062                   17   PORT_C           EQU     62H            ; 8255 PORT C ADDR
0063                   18   CMD_PORT         EQU     63H
0020                   19   INTA00           EQU     20H            ; 8259 PORT
0021                   20   INTA01           EQU     21H            ; 8259 PORT
0020                   21   EOI              EQU     20H
0040                   22   TIMER            EQU     40H
0043                   23   TIM_CTL          EQU     43H            ; 8253 TIMER CONTROL PORT ADDR
0040                   24   TIMER0           EQU     40H            ; 8253 TIMER/CNTER 0 PORT ADDR
0001                   25   TMINT            EQU     01             ; TIMER 0 INTR RECVD MASK
0008                   26   DMA08            EQU     08             ; DMA STATUS REG PORT ADDR
0000                   27   DMA              EQU     00             ; DMA CH.0 ADDR. REG PORT ADDR
0540                   28   MAX_PERIOD       EQU     540H
0410                   29   MIN_PERIOD       EQU     410H
0060                   30   KBD_IN           EQU     60H            ; KEYBOARD DATA IN ADDR PORT
0002                   31   KBDINT           EQU     02             ; KEYBOARD INTR MASK
0060                   32   KB_DATA          EQU     60H            ; KEYBOARD SCAN CODE PORT
0061                   33   KB_CTL           EQU     61H            ; CONTROL BITS FOR KEYBOARD SENSE DATA
                       34
                       35   ;---------------------------------------
                       36   ;        8088 INTERRUPT LOCATIONS       :
                       37   ;---------------------------------------
                       38
----                   39   ABS0     SEGMENT AT 0
0000                   40   STG_LOC0         LABEL   BYTE
0008                   41            ORG     2*4
0008                   42   NMI_PTR          LABEL    WORD
0014                   43            ORG     5*4
0014                   44   INT5_PTR         LABEL   WORD
0020                   45            ORG     8*4
0020                   46   INT_ADDR         LABEL   WORD
0020                   47   INT_PTR          LABEL   DWORD
0040                   48            ORG     10H*4
0040                   49   VIDEO_INT        LABEL   WORD
0074                   50            ORG     1DH*4
0074                   51   PARM_PTR         LABEL   DWORD          ; POINTER TO VIDEO PARMS
0060                   52            ORG     18H*4
0060                   53   BASIC_PTR        LABEL   WORD           ; ENTRY POINT FOR CASSETTE BASIC
0078                   54            ORG     01EH*4                 ; INTERRUPT 1EH
0078                   55   DISK_POINTER     LABEL   DWORD
007C                   56            ORG     01FH*4                 ; LOCATION OF POINTER
007C                   57   EXT_PTR LABEL    DWORD                  ; POINTER TO EXTENSION
0400                   58            ORG     400H
0400                   59   DATA_AREA        LABEL   BYTE           ; ABSOLUTE LOCATION OF DATA SEGMENT
0400                   60   DATA_WORD        LABEL   WORD
0500                   61            ORG     0500H
0500                   62   MFG_TEST_RTN     LABEL   FAR
7C00                   63            ORG     7C00H
7C00                   64   BOOT_LOCN        LABEL   FAR
----                   65   ABS0     ENDS
                       66
                       67   ;---------------------------------------------
                       68   ; STACK -- USED DURING INITIALIZATION ONLY      :
                       69   ;---------------------------------------------
                       70
----                   71   STACK    SEGMENT AT 30H
0000 (128              72            DW      128 DUP(?)
     ????
     )
0100                   73   TOS      LABEL   WORD
----                   74   STACK    ENDS
                       75
                       76   ;---------------------------------------
                       77   ;       ROM BIOS DATA AREAS            :
                       78   ;---------------------------------------
                       79
----                   80   DATA     SEGMENT AT 40H
0000 (4                81   RS232_BASE       DW      4 DUP(?)       ; ADDRESSES OF RS232 ADAPTERS
     ????
     )
0008 (4                82   PRINTER_BASE     DW      4 DUP(?)       ; ADDRESSES OF PRINTERS
     ????
     )
0010 ????              83   EQUIP_FLAG       DW      ?              ; INSTALLED HARDWARE
0012 ??                84   MFG_TST          DB      ?              ; INITIALIZATION FLAG
0013 ????              85   MEMORY_SIZE      DW      ?              ; MEMORY SIZE IN K BYTES
0015 ??                86   MFG_ERR_FLAG     DB      ?              ; SCRATCHPAD FOR MANUFACTURING
0016 ??                87                    DB      ?              ; ERROR CODES
                       88
                       89   ;---------------------------------------
                       90   ;       KEYBOARD DATA AREAS            :
                       91   ;---------------------------------------
                       92
0017 ??                93   KB_FLAG          DB      ?
                       94
                       95   ;----- SHIFT FLAG EQUATES WITHIN KB_FLAG
                       96
0080                   97   INS_STATE        EQU     80H            ; INSERT STATE IS ACTIVE
0040                   98   CAPS_STATE       EQU     40H            ; CAPS LOCK STATE HAS BEEN TOGGLED
0020                   99   NUM_STATE        EQU     20H            ; NUM LOCK STATE HAS BEEN TOGGLED
0010                  100   SCROLL_STATE     EQU     10H            ; SCROLL LOCK STATE HAS BEEN TOGGLED
0008                  101   ALT_SHIFT        EQU     08H            ; ALTERNATE SHIFT KEY DEPRESSED
0004                  102   CTL_SHIFT        EQU     04H            ; CONTROL SHIFT KEY DEPRESSED
0002                  103   LEFT_SHIFT       EQU     02H            ; LEFT SHIFT KEY DEPRESSED
0001                  104   RIGHT_SHIFT      EQU     01H            ; RIGHT SHIFT KEY DEPRESSED
                      105
```

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LOC OBJECT          LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

0018 ??             106  KB_FLAG_1       DB      ?               ; SECOND BYTE OF KEYBOARD STATUS
                    107
  0080              108  INS_SHIFT       EQU     80H             ; INSERT KEY IS DEPRESSED
  0040              109  CAPS_SHIFT      EQU     40H             ; CAPS LOCK KEY IS DEPRESSED
  0020              110  NUM_SHIFT       EQU     20H             ; NUM LOCK KEY IS DEPRESSED
  0010              111  SCROLL_SHIFT    EQU     10H             ; SCROLL LOCK KEY IS DEPRESSED
  0008              112  HOLD_STATE      EQU     08H             ; SUSPEND KEY HAS BEEN TOGGLED
                    113
0019 ??             114  ALT_INPUT       DB      ?               ; STORAGE FOR ALTERNATE KEYPAD ENTRY
001A ????           115  BUFFER_HEAD     DW      ?               ; POINTER TO HEAD OF KEYBOARD BUFFER
001C ????           116  BUFFER_TAIL     DW      ?               ; POINTER TO TAIL OF KEYBOARD BUFFER
001E (16            117  KB_BUFFER       DW      16 DUP(?)       ; ROOM FOR 15 ENTRIES
     ????
     )
003E                118  KB_BUFFER_END   LABEL   WORD
                    119
                    120  ;------ HEAD = TAIL INDICATES THAT THE BUFFER IS EMPTY
                    121
  0045              122  NUM_KEY         EQU     69              ; SCAN CODE FOR NUMBER LOCK
  0046              123  SCROLL_KEY      EQU     70              ; SCROLL LOCK KEY
  0038              124  ALT_KEY         EQU     56              ; ALTERNATE SHIFT KEY SCAN CODE
  001D              125  CTL_KEY         EQU     29              ; SCAN CODE FOR CONTROL KEY
  003A              126  CAPS_KEY        EQU     58              ; SCAN CODE FOR SHIFT LOCK
  002A              127  LEFT_KEY        EQU     42              ; SCAN CODE FOR LEFT SHIFT
  0036              128  RIGHT_KEY       EQU     54              ; SCAN CODE FOR RIGHT SHIFT
  0052              129  INS_KEY         EQU     82              ; SCAN CODE FOR INSERT KEY
  0053              130  DEL_KEY         EQU     83              ; SCAN CODE FOR DELETE KEY
                    131
                    132  ;--------------------------------------
                    133  ;       DISKETTE DATA AREAS            :
                    134  ;--------------------------------------
003E ??             135  SEEK_STATUS     DB      ?               ; DRIVE RECALIBRATION STATUS
                    136                                          ; BIT 3-0 = DRIVE 3-0 NEEDS RECAL
                    137                                          ; BEFORE NEXT SEEK IF BIT IS = 0
                    138
  0080              139  INT_FLAG        EQU     080H            ; INTERRUPT OCCURRENCE FLAG
003F ??             140  MOTOR_STATUS    DB      ?               ; MOTOR STATUS
                    141                                          ; BIT 3-0 = DRIVE 3-0 IS CURRENTLY
                    142                                          ;   RUNNING
                    143                                          ; BIT 7 = CURRENT OPERATION IS A WRITE,
                    144                                          ;   REQUIRES DELAY
                    145
0040 ??             146  MOTOR_COUNT     DB      ?               ; TIME OUT COUNTER FOR DRIVE TURN OFF
  0025              147  MOTOR_WAIT      EQU     37              ; 2 SECS OF COUNTS FOR MOTOR TURN OFF
                    148
0041 ??             149  DISKETTE_STATUS DB      ?               ; RETURN CODE STATUS BYTE
  0080              150  TIME_OUT        EQU     80H             ; ATTACHMENT FAILED TO RESPOND
  0040              151  BAD_SEEK        EQU     40H             ; SEEK OPERATION FAILED
  0020              152  BAD_NEC         EQU     20H             ; NEC CONTROLLER HAS FAILED
  0010              153  BAD_CRC         EQU     10H             ; BAD CRC ON DISKETTE READ
  0009              154  DMA_BOUNDARY    EQU     09H             ; ATTEMPT TO DMA ACROSS 64K BOUNDARY
  0008              155  BAD_DMA         EQU     08H             ; DMA OVERRUN ON OPERATION
  0004              156  RECORD_NOT_FND  EQU     04H             ; REQUESTED SECTOR NOT FOUND
  0003              157  WRITE_PROTECT   EQU     03H             ; WRITE ATTEMPTED ON WRITE PROT DISK
  0002              158  BAD_ADDR_MARK   EQU     02H             ; ADDRESS MARK NOT FOUND
  0001              159  BAD_CMD         EQU     01H             ; BAD COMMAND PASSED TO DISKETTE I/O
                    160
0042 (7             161  NEC_STATUS      DB      7 DUP(?)        ; STATUS BYTES FROM NEC
     ??
     )

                    162
                    163  ;--------------------------------------
                    164  ;       VIDEO DISPLAY DATA AREA        :
                    165  ;--------------------------------------
0049 ??             166  CRT_MODE        DB      ?               ; CURRENT CRT MODE
004A ????           167  CRT_COLS        DW      ?               ; NUMBER OF COLUMNS ON SCREEN
004C ????           168  CRT_LEN         DW      ?               ; LENGTH OF REGEN IN BYTES
004E ????           169  CRT_START       DW      ?               ; STARTING ADDRESS IN REGEN BUFFER
0050 (8             170  CURSOR_POSN     DW      8 DUP(?)        ; CURSOR FOR EACH OF UP TO 8 PAGES
     ????
     )
0060 ????           171  CURSOR_MODE     DW      ?               ; CURRENT CURSOR MODE SETTING
0062 ??             172  ACTIVE_PAGE     DB      ?               ; CURRENT PAGE BEING DISPLAYED
0063 ????           173  ADDR_6845       DW      ?               ; BASE ADDRESS FOR ACTIVE DISPLAY CARD
0065 ??             174  CRT_MODE_SET    DB      ?               ; CURRENT SETTING OF THE 3X8 REGISTER
0066 ??             175  CRT_PALETTE     DB      ?               ; CURRENT PALETTE SETTING COLOR CARD
                    176
                    177  ;--------------------------------------
                    178  ;       POST DATA AREA                 :
                    179  ;--------------------------------------
0067 ????           180  IO_ROM_INIT     DW      ?               ; PNTR TO OPTIONAL I/O ROM INIT ROUTINE
0069 ????           181  IO_ROM_SEG      DW      ?               ; POINTER TO IO ROM SEGMENT
006B ??             182  INTR_FLAG       DB      ?               ; FLAG TO INDICATE AN INTERRUPT HAPPEND
                    183
                    184  ;--------------------------------------
                    185  ;       TIMER DATA AREA                :
                    186  ;--------------------------------------
006C ????           187  TIMER_LOW       DW      ?               ; LOW WORD OF TIMER COUNT
006E ????           188  TIMER_HIGH      DW      ?               ; HIGH WORD OF TIMER COUNT
0070 ??             189  TIMER_OFL       DB      ?               ; TIMER HAS ROLLED OVER SINCE LAST READ
                    190  ; COUNTS_SEC    EQU     18
                    191  ; COUNTS_MIN    EQU     1092
                    192  ; COUNTS_HOUR   EQU     65543
                    193  ; COUNTS_DAY    EQU     1573040 = 1800B0H
                    194
                    195  ;--------------------------------------
                    196  ;       SYSTEM DATA AREA               :
                    197  ;--------------------------------------
0071 ??             198  BIOS_BREAK      DB      ?               ; BIT 7=1 IF BREAK KEY HAS BEEN HIT
0072 ????           199  RESET_FLAG      DW      ?               ; WORD=1234H IF KEYBOARD RESET UNDERWAY
                    200  ;--------------------------------------
                    201  ;       FIXED DISK DATA AREAS          :
                    202  ;--------------------------------------
0074 ????           203                  DW      ?
0076 ????           204                  DW      ?
                    205  ;-----------------------------------------------------
                    206  ;       PRINTER AND RS232 TIME-OUT VARIABLES          :
                    207  ;-----------------------------------------------------
0078 (4             208  PRINT_TIM_OUT   DB      4 DUP(?)
     ??
     )
007C (4             209  RS232_TIM_OUT   DB      4 DUP(?)
     ??
     )
```

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 LOC OBJECT            LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

                       210  ;--------------------------------------
                       211  ;       ADDITIONAL KEYBOARD DATA AREA   :
                       212  ;--------------------------------------
0080 ????              213  BUFFER_START     DW      ?
0082 ????              214  BUFFER_END       DW      ?
----                   215  DATA    ENDS
                       216  ;--------------------------------------
                       217  ;       EXTRA DATA AREA                 :
                       218  ;--------------------------------------
----                   219  XXDATA  SEGMENT AT 50H
0000 ??                220  STATUS_BYTE      DB      ?
----                   221  XXDATA  ENDS
                       222  ;--------------------------------------
                       223  ;       VIDEO DISPLAY BUFFER            :
                       224  ;--------------------------------------
----                   225  VIDEO_RAM        SEGMENT AT 0B800H
0000                   226  REGEN    LABEL   BYTE
0000                   227  REGENW   LABEL   WORD
0000 (16384            228           DB      16384 DUP(?)
     ??
     )
----                   229  VIDEO_RAM        ENDS
                       230  ;--------------------------------------
                       231  ;       ROM RESIDENT CODE               :
                       232  ;--------------------------------------
----                   233  CODE    SEGMENT AT 0F000H
0000 (57344            234           DB      57344 DUP(?)            ; FILL LOWEST 56K
     ??
     )
                       235
E000 313530313531323132236           DB      '1501512 COPR. IBM 1982'        ; COPYRIGHT NOTICE
     20434F50522E20
     49424D20313938
     32
                       237
                       238
                       239  ;--------------------------------------------------
                       240  ;       INITIAL RELIABILITY TESTS -- PHASE 1    :
                       241  ;--------------------------------------------------
                       242
                       243           ASSUME    CS:CODE,SS:CODE,ES:ABS0,DS:DATA
                       244
                       245  ;--------------------------------------
                       246  ;       DATA DEFINITIONS                :
                       247  ;--------------------------------------
                       248
E016 D7E0              249  C1       DW      C11                     ; RETURN ADDRESS
E018 7EE1              250  C2       DW      C24                     ; RETURN ADDRESS FOR DUMMY STACK
                       251
E01A 204B42204F4B      252  F3B      DB      ' KB OK',13             ; KB FOR MEMORY SIZE
E020 0D
                       253
                       254  ;--------------------------------------------------------------------
                       255  ;       LOAD A BLOCK OF TEST CODE THROUGH THE KEYBOARD PORT          :
                       256  ;       FOR MANUFACTUING TEST.                                      :
                       257  ;       THIS ROUTINE WILL LOAD A TEST (MAX LENGTH=FAFFH) THROUGH     :
                       258  ;       THE KEYBOARD PORT. CODE WILL BE LOADED AT LOCATION          :
                       259  ;       0000:0500. AFTER LOADING, CONTROL WILL BE TRANSFERED        :
                       260  ;       TO LOCATION 0000:0500. STACK WILL BE LOCATED JUST BELOW     :
                       261  ;       THE TEST CODE. THIS ROUTINE ASSUMES THAT THE FRIST 2        :
                       262  ;       BYTES TRANSFERED CONTAIN THE COUNT OF BYTES TO BE LOADED    :
                       263  ;       (BYTE 1=COUNT LOW, BYTE 2=COUNT HI.)                        :
                       264  ;--------------------------------------------------------------------
                       265
                       266  ;----- FIRST, GET THE COUNT
                       267
E021                   268  MFG_BOOT:
E021 E8131A            269           CALL    SP_TEST                 ; GET COUNT LOW
E024 8AFB              270           MOV     BH,BL                   ; SAVE IT
E026 E80E1A            271           CALL    SP_TEST                 ; GET COUNT HI
E029 8AEB              272           MOV     CH,BL
E02B 8ACF              273           MOV     CL,BH                   ; CX NOW HAS COUNT
E02D FC                274           CLD                             ; SET DIR. FLAG TO INCRIMENT
E02E FA                275           CLI
E02F BF0005            276           MOV     DI,0500H                ; SET TARGET OFFSET (DS=0000)
E032 B0FD              277           MOV     AL,0FDH                 ; UNMASK K/B INTERRUPT
E034 E621              278           OUT     INTA01,AL
E036 B00A              279           MOV     AL,0AH                  ; SEND READ INT. REQUEST REG. CMD
E038 E620              280           OUT     INTA00,AL
E03A BA6100            281           MOV     DX,61H                  ; SET UP PORT B ADDRESS
E03D BBCC4C            282           MOV     BX,4CCCH                ; CONTROL BITS FOR PORT B
E040 B402              283           MOV     AH,02H                  ; K/B REQUEST PENDING MASK
E042                   284  TST:
E042 8AC3              285           MOV     AL,BL
E044 EE                286           OUT     DX,AL                   ; TOGGLE K/B CLOCK
E045 8AC7              287           MOV     AL,BH
E047 EE                288           OUT     DX,AL
E048 4A                289           DEC     DX                      ; POINT DX AT ADDR. 60 (KB DATA)
E049                   290  TST1:
E049 E420              291           IN      AL,INTA00               ; GET IRR REG
E04B 22C4              292           AND     AL,AH                   ; KB REQUEST PENDING?
E04D 74FA              293           JZ      TST1                    ; LOOP TILL DATA PRESENT
E04F EC                294           IN      AL,DX                   ; GET DATA
E050 AA                295           STOSB                           ; STORE IT
E051 42                296           INC     DX                      ; POINT DX BACK AT PORT B (61)
E052 E2EE              297           LOOP    TST                     ; LOOP TILL ALL BYTES READ
                       298
E054 EA00050000        299           JMP     MFG_TEST_RTN            ; FAR JUMP TO CODE THAT WAS JUST
                       300                                           ; LOADED
                       301
```

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LOC OBJECT          LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

                     302  ;--------------------------------------
                     303  ;       8088 PROCESSOR TEST            :
                     304  ; DESCRIPTION                          :
                     305  ;       VERIFY 8088 FLAGS, REGISTERS   :
                     306  ;       AND CONDITIONAL JUMPS          :
                     307  ;--------------------------------------
                     308          ASSUME  CS:CODE,DS:NOTHING,ES:NOTHING,SS:NOTHING
E05B                 309          ORG     0E05BH
E05B                 310  RESET   LABEL   FAR
E05B FA              311  START:   CLI                           ; DISABLE INTERRUPTS
E05C B4D5            312          MOV     AH,0D5H               ; SET SF, CF, ZF, AND AF FLAGS ON
E05E 9E              313          SAHF
E05F 734C            314          JNC     ERR01                 ; GO TO ERR ROUTINE IF CF NOT SET
E061 754A            315          JNZ     ERR01                 ; GO TO ERR ROUTINE IF ZF NOT SET
E063 7B48            316          JNP     ERR01                 ; GO TO ERR ROUTINE IF PF NOT SET
E065 7946            317          JNS     ERR01                 ; GO TO ERR ROUTINE IF SF NOT SET
E067 9F              318          LAHF                          ; LOAD FLAG IMAGE TO AH
E068 B105            319          MOV     CL,5                  ; LOAD CNT REG WITH SHIFT CNT
E06A D2EC            320          SHR     AH,CL                 ; SHIFT AF INTO CARRY BIT POS
E06C 733F            321          JNC     ERR01                 ; GO TO ERR ROUTINE IF AF NOT SET
E06E B040            322          MOV     AL,40H                ; SET THE OF FLAG ON
E070 D0E0            323          SHL     AL,1                  ; SETUP FOR TESTING
E072 7139            324          JNO     ERR01                 ; GO TO ERR ROUTINE IF OF NOT SET
E074 32E4            325          XOR     AH,AH                 ; SET AH = 0
E076 9E              326          SAHF                          ; CLEAR SF, CF, ZF, AND PF
E077 7634            327          JBE     ERR01                 ; GO TO ERR ROUTINE IF CF ON
                     328                                        ; GO TO ERR ROUTINE IF ZF ON
E079 7832            329          JS      ERR01                 ; GO TO ERR ROUTINE IF SF ON
E07B 7A30            330          JP      ERR01                 ; GO TO ERR ROUTINE IF PF ON
E07D 9F              331          LAHF                          ; LOAD FLAG IMAGE TO AH
E07E B105            332          MOV     CL,5                  ; LOAD CNT REG WITH SHIFT CNT
E080 D2EC            333          SHR     AH,CL                 ; SHIFT 'AF' INTO CARRY BIT POS
E082 7229            334          JC      ERR01                 ; GO TO ERR ROUTINE IF ON
E084 D0E4            335          SHL     AH,1                  ; CHECK THAT 'OF' IS CLEAR
E086 7025            336          JO      ERR01                 ; GO TO ERR ROUTINE IF ON
                     337
                     338  ;----- READ/WRITE THE 8088 GENERAL AND SEGMENTATION REGISTERS
                     339  ;       WITH ALL ONE'S AND ZEROES'S.
                     340
E088 B8FFFF          341          MOV     AX,0FFFFH             ; SETUP ONE'S PATTERN IN AX
E08B F9              342          STC
E08C 8ED8            343  C8:     MOV     DS,AX                 ; WRITE PATTERN TO ALL REGS
E08E 8CDB            344          MOV     BX,DS
E090 8EC3            345          MOV     ES,BX
E092 8CC1            346          MOV     CX,ES
E094 8ED1            347          MOV     SS,CX
E096 8CD2            348          MOV     DX,SS
F098 8BE2            349          MOV     SP,DX
E09A 8BEC            350          MOV     BP,SP
E09C 8BF5            351          MOV     SI,BP
E09E 8BFE            352          MOV     DI,SI
E0A0 7307            353          JNC     C9                    ; TSTIA
E0A2 33C7            354          XOR     AX,DI                 ; PATTERN MAKE IT THRU ALL REGS
E0A4 7507            355          JNZ     ERR01                 ; NO - GO TO ERR ROUTINE
E0A6 F8              356          CLC
E0A7 EBE3            357          JMP     C8
E0A9                 358  C9:                                   ; TSTIA
E0A9 0BC7            359          OR      AX,DI                 ; ZERO PATTERN MAKE IT THRU?
E0AB 7401            360          JZ      C10                   ; YES - GO TO NEXT TEST
E0AD F4              361  ERR01:  HLT                           ; HALT SYSTEM
                     362  ;--------------------------------------
                     363  ;       ROS CHECKSUM TEST I            :
                     364  ; DESCRIPTION                          :
                     365  ;       A CHECKSUM IS DONE FOR THE 8K  :
                     366  ;       ROS MODULE CONTAINING POD AND  :
                     367  ;       BIOS.                          :
                     368  ;--------------------------------------
E0AE                 369  C10:
                     370                                        ; ZERO IN AL ALREADY
E0AE E6A0            371          OUT     0A0H,AL               ; DISABLE NMI INTERRUPTS
E0B0 E683            372          OUT     83H,AL                ; INITIALZE DMA PAGE REG
E0B2 BAD803          373          MOV     DX,3D8H
E0B5 EE              374          OUT     DX,AL                 ; DISABLE COLOR VIDEO
E0B6 FEC0            375          INC     AL
E0B8 B2B8            376          MOV     DL,0B8H
E0BA EE              377          OUT     DX,AL                 ; DISABLE B/W VIDEO,EN HIGH RES
E0BB B089            378          MOV     AL,89H                ; SET 8255 FOR B,A=OUT, C=IN
E0BD E663            379          OUT     CMD_PORT,AL
E0BF B0A5            380          MOV     AL,T0100101B
                     381                                        ; ENABLE PARITY CHECKERS AND
E0C1 E661            382          OUT     PORT_B,AL             ; PULL KB CLOCK HI, TRI-STATE
                     383                                        ; KEYBOARD INPUTS,ENABLE HIGH
                     384                                        ; BANK OF SWITCHES->PORT C(0-3)
E0C3 B001            385          MOV     AL,01H                ; <><><><><><><><><><><><>
E0C5 E660            386          OUT     PORT_A,AL             ; <><><>CHECKPOINT 1<><><>
E0C7 8CC8            387          MOV     AX,CS                 ; SETUP SS SEG REG
E0C9 8ED0            388          MOV     SS,AX
E0CB 8ED8            389          MOV     DS,AX                 ; SET UP DATA SEG TO POINT TO
                     390                                        ; ROM ADDRESS
E0CD FC              391          CLD                           ; SET DIRECTION FLAG TO INC.
                     392          ASSUME  SS:CODE
E0CE BB00E0          393          MOV     BX,0E000H             ; SETUP STARTING ROS ADDR
E0D1 BC16E0          394          MOV     SP,OFFSET C1          ; SETUP RETURN ADDRESS
E0D4 E91B18          395          JMP     ROS_CHECKSUM
E0D7 75D4            396  C11:    JNE     ERR01                 ; HALT SYSTEM IF ERROR
                     397  ;--------------------------------------------------------
                     398  ;       8237 DMA INITIALIZATION CHANNEL REGISTER TEST   :
                     399  ; DESCRIPTION                                           :
                     400  ;       DISABLE THE 8237 DMA CONTROLLER.  VERIFY THAT   :
                     401  ;       TIMER 1 FUNCTIONS OK. WRITE/READ THE CURRENT    :
                     402  ;       ADDRESS AND WORD COUNT REGISTERS FOR ALL        :
                     403  ;       CHANNELS.  INITIALIZE AND START DMA FOR MEMORY  :
                     404  ;       REFRESH.                                        :
                     405  ;--------------------------------------------------------
                     406
                     407  ;----- DISABLE DMA CONTROLLER
                     408
E0D9 B002            409          MOV     AL,02H                ; <><><><><><><><><><><><>
E0DB E660            410          OUT     PORT_A,AL             ; <><><>CHECKPOINT 2<><><>
E0DD B004            411          MOV     AL,04                 ; DISABLE DMA CONTROLLER
E0DF E608            412          OUT     DMA08,AL
                     413
                     414  ;----- VERIFY THAT TIMER 1 FUNCTIONS OK
                     415
E0E1 B054            416          MOV     AL,54H                ; SEL TIMER 1,LSB,MODE 2
E0E3 E643            417          OUT     TIMER+3,AL
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 LOC OBJECT          LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

E0E5 8AC1             418          MOV     AL,CL                   ; SET INITIAL TIMER CNT TO 0
E0E7 E641             419          OUT     TIMER+1,AL
E0E9                  420  C12:                                    ; TIMER1_BITS_ON
E0E9 B040             421          MOV     AL,40H                  ; LATCH TIMER 1 COUNT
E0EB E643             422          OUT     TIMER+3,AL
E0ED 80FBFF           423          CMP     BL,0FFH                 ; YES - SEE IF ALL BITS GO OFF
E0F0 7407             424          JE      C13                     ; TIMER1_BITS_OFF
E0F2 E441             425          IN      AL,TIMER+1              ; READ TIMER 1 COUNT
E0F4 0AD8             426          OR      BL,AL                   ; ALL BITS ON IN TIMER
E0F6 E2F1             427          LOOP    C12                     ; TIMER1_BITS_ON
E0F8 F4               428          HLT                             ; TIMER 1 FAILURE, HALT SYS
E0F9                  429  C13:                                    ; TIMER1_BITS_OFF
E0F9 8AC3             430          MOV     AL,BL                   ; SET TIMER 1 CNT
E0FB 2BC9             431          SUB     CX,CX
E0FD E641             432          OUT     TIMER+1,AL
E0FF                  433  C14:                                    ; TIMER_LOOP
E0FF B040             434          MOV     AL,40H                  ; LATCH TIMER 1 COUNT
E101 E643             435          OUT     TIMER+3,AL
E103 90               436          NOP
E104 90               437          NOP                             ; DELAY FOR TIMER
E105 E441             438          IN      AL,TIMER+1              ; READ TIMER 1 COUNT
E107 22D8             439          AND     BL,AL
E109 7403             440          JZ      C15                     ; WRAP_DMA_REG
E10B E2F2             441          LOOP    C14                     ; TIMER_LOOP
E10D F4               442          HLT                             ; HALT SYSTEM
                      443
                      444  ;----- INITIALIZE TIMER 1 TO REFRESH MEMORY
                      445
E10E B003             446  C15:    MOV     AL,03H                  ; <><><><><><><><><><><><>
E110 E660             447          OUT     PORT_A,AL               ; <><><>CHECKPOINT 3<><><>
                      448                                          ; WRAP_DMA_REG
E112 E60D             449          OUT     DMA+0DH,AL              ; SEND MASTER CLEAR TO DMA
                      450
                      451  ;----- WRAP DMA CHANNELS ADDRESS AND COUNT REGISTERS
                      452
E114 B0FF             453          MOV     AL,0FFH                 ; WRITE PATTERN FF TO ALL REGS
E116 8AD8             454  C16:    MOV     BL,AL                   ; SAVE PATTERN FOR COMPARE
E118 8AF8             455          MOV     BH,AL
E11A B90800           456          MOV     CX,8                    ; SETUP LOOP CNT
E11D BA0000           457          MOV     DX,DMA                  ; SETUP I/O PORT ADDR OF REG
E120 EE               458  C17:    OUT     DX,AL                   ; WRITE PATTERN TO REG, LSB
E121 50               459          PUSH    AX                      ; SATISIFY 8237 I/O TIMINGS
E122 EE               460          OUT     DX,AL                   ; MSB OF 16 BIT REG
E123 B001             461          MOV     AL,01H                  ; AL TO ANOTHER PAT BEFORE RD
E125 EC               462          IN      AL,DX                   ; READ 16-BIT DMA CH REG, LSB
E126 8AE0             463          MOV     AH,AL                   ; SAVE LSB OF 16-BIT REG
E128 EC               464          IN      AL,DX                   ; READ MSB OF DMA CH REG
E129 3BD8             465          CMP     BX,AX                   ; PATTERN READ AS WRITTEN?
E12B 7401             466          JE      C18                     ; YES - CHECK NEXT REG
E12D F4               467          HLT                             ; NO - HALT THE SYSTEM
E12E                  468  C18:                                    ; NXT_DMA_CH
E12E 42               469          INC     DX                      ; SET I/O PORT TO NEXT CH REG
E12F E2EF             470          LOOP    C17                     ; WRITE PATTERN TO NEXT REG
E131 FEC0             471          INC     AL                      ; SET PATTERN TO 0
E133 74E1             472          JZ      C16                     ; WRITE TO CHANNEL REGS
                      473
                      474  ;----- INITIALIZE AND START DMA FOR MEMORY REFRESH.
                      475
E135 8EDB             476          MOV     DS,BX                   ; SET UP ABS0 INTO DS AND ES
E137 8EC3             477          MOV     ES,BX
                      478          ASSUME  DS:ABS0,ES:ABS0
E139 B0FF             479          MOV     AL,0FFH                 ; SET CNT OF 64K FOR REFRESH
E13B E601             480          OUT     DMA+1,AL
E13D 50               481          PUSH    AX
E13E E601             482          OUT     DMA+1,AL
E140 B058             483          MOV     AL,058H                 ; SET DMA MODE,CH 0,RD.,AUOTINT
E142 E60B             484          OUT     DMA+0BH,AL              ; WRITE DMA MODE REG
E144 B000             485          MOV     AL,0                    ; ENABLE DMA CONTROLLER
E146 8AE8             486          MOV     CH,AL                   ; SET COUNT HIGH=00
E148 E608             487          OUT     DMA+8,AL                ; SETUP DMA COMMAND REG
E14A 50               488          PUSH    AX
E14B E60A             489          OUT     DMA+10,AL               ; ENABLE DMA CH 0
E14D B012             490          MOV     AL,18                   ; START TIMER 1
E14F E641             491          OUT     TIMER+1,AL
E151 B041             492          MOV     AL,41H                  ; SET MODE FOR CHANNEL 1
E153 E60B             493          OUT     DMA+0BH,AL
E155 50               494          PUSH    AX
E156 E408             495          IN      AL,DMA+08               ; GET DMA STATUS
E158 2410             496          AND     AL,00010000B            ; IS TIMER REQUEST THERE?
E15A 7401             497          JZ      C18C                    ; (IT SHOULD'T BE)
E15C F4               498          HLT                             ; HALT SYS.(NOT TIMER 1 OUTPUT)
E15D B042             499  C18C:   MOV     AL,42H                  ; SET MODE FOR CHANNEL 2
E15F E60B             500          OUT     DMA+0BH,AL
E161 B043             501          MOV     AL,43H                  ; SET MODE FOR CHANNEL 3
E163 E60B             502          OUT     DMA+0BH,AL
                      503  ;--------------------------------------------
                      504  ;       BASE 16K READ/WRITE STORAGE TEST      :
                      505  ; DESCRIPTION                                 :
                      506  ;       WRITE/READ/VERIFY DATA PATTERNS       :
                      507  ;       AA,55,FF,01, AND 00 TO 1ST 32K OF     :
                      508  ;       STORAGE. VERIFY STORAGE ADDRESSABILITY. :
                      509  ;--------------------------------------------
                      510
                      511  ;----- DETERMINE MEMORY SIZE AND FILL MEMORY WITH DATA
                      512
E165 BA1302           513          MOV     DX,0213H                ; ENABLE I/O EXPANSION BOX
E168 B001             514          MOV     AL,01H
E16A EE               515          OUT     DX,AL
                      516
E16B 8B1E7204         517          MOV     BX,DATA_WORD[OFFSET RESET_FLAG] ; SAVE 'RESET_FLAG' IN BX
E16F B90020           518          MOV     CX,2000H                ; SET FOR 16K WORDS
E172 81FB3412         519          CMP     BX,1234H                ; WARM START?
E176 7416             520          JE      CLR_STG
E178 BC18E0           521          MOV     SP,OFFSET C2
E17B E9F104           522          JMP     STGTST_CNT
E17E 7412             523  C24:    JE      HOW_BIG                 ; STORAGE OK, DETERMINE SIZE
E180 8AD8             524          MOV     BL,AL                   ; SAVE FAILING BIT PATTERN
E182 B004             525          MOV     AL,04H                  ; <><><><><><><><><><><><>
E184 E660             526  C24A:   OUT     PORT_A,AL               ; <><><>CHECKPOINT 4<><><>
E186 2BC9             527          SUB     CX,CX                   ; BASE RAM FAILURE - HANG
E188 E2FE             528  C24B:   LOOP    C24B                    ; FLIPPING BETWEEN 04 AND
E18A 86D8             529          XCHG    BL,AL                   ; FAILING BIT PATTERN
E18C EBF6             530          JMP     C24A
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 LOC OBJECT            LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

E18E                    531  CLR_STG:
E18E 2BC0               532          SUB     AX,AX                   ; MAKE AX=0000
E190 F3                 533          REP     STOSW                   ; STORE 8K WORDS OF 0000
E191 AB
E192                    534  HOW_BIG:
E192 891E7204           535          MOV     DATA_WORD[OFFSET RESET_FLAG],BX ; RESTORE RESET FLAG
E196 BA0004             536          MOV     DX,0400H                ; SET POINTER TO JUST>16KB
E199 BB1000             537          MOV     BX,16                   ; BASIC COUNT OF 16K
E19C                    538  FILL_LOOP:
E19C 8EC2               539          MOV     ES,DX                   ; SET SEG. REG.
E19E 2BFF               540          SUB     DI,DI
E1A0 B855AA             541          MOV     AX,0AA55H               ; TEST PATTERN
E1A3 89C8               542          MOV     CX,AX                   ; SAVE PATTERN
E1A5 268905             543          MOV     ES:[DI],AX              ; SEND PATTERN TO MEM.
E1A8 B00F               544          MOV     AL,0FH                  ; PUT SOMETHING IN AL
E1AA 268B05             545          MOV     AX,ES:[DI]              ; GET PATTERN
E1AD 33C1               546          XOR     AX,CX                   ; COMPARE PATTERNS
E1AF 7511               547          JNZ     HOW_BIG_END             ; GO END IF NO COMPARE
E1B1 B90020             548          MOV     CX,2000H                ; SET COUNT FOR 8K WORDS
E1B4 F3                 549          REP     STOSW                   ; FILL 8K WORDS
E1B5 AB
E1B6 81C20004           550          ADD     DX,400H                 ; POINT TO NEXT 16KB BLOCK
E1BA 83C310             551          ADD     BX,16                   ; BUMP COUNT BY 16KB
E1BD 80FEA0             552          CMP     DH,0A0H                 ; TOP OF RAM AREA YET? (A0000)
E1C0 75DA               553          JNZ     FILL_LOOP
E1C2                    554  HOW_BIG_END:
E1C2 891E1304           555          MOV     DATA_WORD[OFFSET MEMORY_SIZE],BX        ; SAVE MEMORY SIZE
                        556
                        557  ;----- SETUP STACK SEG AND SP
                        558
E1C6 B83000             559          MOV     AX,STACK                ; GET STACK VALUE
E1C9 8ED0               560          MOV     SS,AX                   ; SET THE STACK UP
E1CB BC0001             561          MOV     SP,OFFSET TOS           ; STACK IS READY TO GO
                        562  ;--------------------------------------------------------
                        563  ;       INITIALIZE THE 8259 INTERRUPT CONTROLLER CHIP   :
                        564  ;--------------------------------------------------------
E1CE B013               565  C25:    MOV     AL,13H                  ; ICW1 - EDGE, SNGL, ICW4
E1D0 E620               566          OUT     INTA00,AL
E1D2 B008               567          MOV     AL,8                    ; SETUP ICW2 - INT TYPE 8 (8-F)
E1D4 E621               568          OUT     INTA01,AL
E1D6 B009               569          MOV     AL,9                    ; SETUP ICW4 - BUFFRD,8086 MODE
E1D8 E621               570          OUT     INTA01,AL
E1DA B0FF               571          MOV     AL,0FFH                 ; MASK ALL INTS. OFF
E1DC E621               572          OUT     INTA01,AL               ; (VIDEO ROUTINE ENABLES INTS.)
                        573
                        574  ;----- SET UP THE INTERRUPT VECTORS TO TEMP INTERRUPT
                        575
E1DE 1E                 576          PUSH    DS
E1DF B92000             577          MOV     CX,32                   ; FILL ALL 32 INTERRUPTS
E1E2 2BFF               578          SUB     DI,DI                   ; FIRST INTERRUPT LOCATION
E1E4 8EC7               579          MOV     ES,DI                   ; SET ES=0000 ALSO
E1E6 BB23FF             580  D3:     MOV     AX,OFFSET D11           ; MOVE ADDR OF INTR PROC TO TBL
E1E9 AB                 581          STOSW
E1EA 8CC8               582          MOV     AX,CS                   ; GET ADDR OF INTR PROC SEG
E1EC AB                 583          STOSW
E1ED E2F7               584          LOOP    D3                      ; VECTBL0
                        585
                        586  ;----- ESTABLISH BIOS SUBROUTINE CALL INTERRUPT VECTORS
                        587
E1EF BF4000             588          MOV     DI,OFFSET VIDEO_INT     ; SETUP ADDR TO INTR AREA
E1F2 0E                 589          PUSH    CS
E1F3 1F                 590          POP     DS                      ; SETUP ADDR OF VECTOR TABLE
E1F4 8CD8               591          MOV     AX,DS                   ; SET AX=SEGMENT
E1F6 BE03FF90           592          MOV     SI,OFFSET VECTOR_TABLE+16       ; START WITH VIDEO ENTRY
E1FA B91000             593          MOV     CX,16
E1FD A5                 594  D3A:    MOVSW                           ; MOVE VECTOR TABLE TO RAM
E1FE 47                 595          INC     DI                      ; SKIP SEGMENT POINTER
E1FF 47                 596          INC     DI
E200 E2FB               597          LOOP    D3A
                        598  ;--------------------------------------------
                        599  ;       DETERMINE CONFIGURATION AND MFG. MODE   :
                        600  ;--------------------------------------------
                        601
E202 1F                 602          POP     DS
E203 1E                 603          PUSH    DS                      ; RECOVER DATA SEG
E204 E462               604          IN      AL,PORT_C               ; GET SWITCH INFO
E206 240F               605          AND     AL,0000T111B            ; ISOLATE SWITCHES
E208 8AE0               606          MOV     AH,AL                   ; SAVE
E20A B0AD               607          MOV     AL,10101101B            ; ENABLE OTHER BANK OF SWS.
E20C E661               608          OUT     PORT_B,AL
E20E 90                 609          NOP
E20F E462               610          IN      AL,PORT_C
E211 B104               611          MOV     CL,4
E213 D2C0               612          ROL     AL,CL                   ; ROTATE TO HIGH NIBBLE
E215 24F0               613          AND     AL,11110000B            ; ISOLATE
E217 0AC4               614          OR      AL,AH                   ; COMBINE WITH OTHER BANK
E219 2AE4               615          SUB     AH,AH
E21B A31004             616          MOV     DATA_WORD[OFFSET EQUIP_FLAG],AX ; SAVE SWITCH INFO
E21E B099               617          MOV     AL,99H
E220 E663               618          OUT     CMD_PORT,AL
E222 E80518             619          CALL    KBD_RESET               ; SEE IF MFG. JUMPER IN
E225 80FBAA             620          CMP     BL,0AAH                 ; KEYBOARD PRESENT?
E228 7418               621          JE      E6
E22A 80FB65             622          CMP     BL,065H                 ; LOAD MFG. TEST REQUEST?
E22D 7503               623          JNE     D3B
E22F E9EFFD             624          JMP     MFG_BOOT                ; GO TO BOOTSTRAP IF SO
E232 B038               625  D3B:    MOV     AL,38H
E234 E661               626          OUT     PORT_B,AL
E236 90                 627          NOP
E237 90                 628          NOP
E238 E460               629          IN      AL,PORT_A
E23A 24FF               630          AND     AL,0FFH                 ; WAS DATA LINE GROUNDED
E23C 7504               631          JNZ     E6
E23E FE061204           632          INC     DATA_AREA[OFFSET MFG_TST]       ; SET MANUFACTURING TEST FLAG
                        633
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                        634  ;--------------------------------------------------------
                        635  ;       INITIALIZE AND START CRT CONTROLLER (6845)       :
                        636  ;       TEST VIDEO READ/WRITE STORAGE.                   :
                        637  ; DESCRIPTION                                           :
                        638  ;       RESET THE VIDEO ENABLE SIGNAL.                   :
                        639  ;       SELECT ALPHANUMERIC MODE, 40 * 25, B & W.        :
                        640  ;       READ/WRITE DATA PATTERNS TO STG. CHECK STG       :
                        641  ;       ADDRESSABILITY.                                  :
                        642  ; ERROR = 1 LONG AND 2 SHORT BEEPS                       :
                        643  ;--------------------------------------------------------
E242                    644  E6:
E242 A11004             645          MOV     AX,DATA_WORD[OFFSET EQUIP_FLAG] ; GET SENSE SWITCH INFO
E245 50                 646          PUSH    AX                              ; SAVE IT
E246 B030               647          MOV     AL,30H
E248 A31004             648          MOV     DATA_WORD[OFFSET EQUIP_FLAG],AX
E24B 2AE4               649          SUB     AH,AH
E24D CD10               650          INT     10H                             ; SEND INIT TO B/W CARD
E24F B020               651          MOV     AL,20H
E251 A31004             652          MOV     DATA_WORD[OFFSET EQUIP_FLAG],AX
E254 2AE4               653          SUB     AH,AH                           ; AND INIT COLOR CARD
E256 CD10               654          INT     10H
E258 58                 655          POP     AX                              ; RECOVER REAL SWITCH INFO
E259 A31004             656          MOV     DATA_WORD[OFFSET EQUIP_FLAG],AX ; RESTORE IT
                        657                                                  ; AND CONTINUE
E25C 2430               658          AND     AL,30H                          ; ISOLATE VIDEO SWS
E25E 750A               659          JNZ     E7                              ; VIDEO SWS SET TO 0?
E260 BF4000             660          MOV     DI,OFFSET VIDEO_INT             ; SET INT 10H TO DUMMY
E263 C7054BFF           661          MOV     [DI],OFFSET DUMMY_RETURN        ; RETURN IF NO VIDEO CARD
E267 E9A000             662          JMP     E18_1                           ; BYPASS VIDEO TEST
E26A                    663  E7:                                             ; TEST VIDEO:
E26A 3C30               664          CMP     AL,30H                          ; B/W CARD ATTACHED?
E26C 7408               665          JE      E8                              ; YES - SET MODE FOR B/W CARD
E26E FEC4               666          INC     AH                              ; SET COLOR MODE FOR COLOR CD
E270 3C20               667          CMP     AL,20H                          ; 80X25 MODE SELECTED?
E272 7502               668          JNE     E8                              ; NO - SET MODE FOR 40X25
E274 B403               669          MOV     AH,3                            ; SET MODE FOR 80X25
E276 86E0               670  E8:     XCHG    AH,AL                           ; SET MODE:
E278 50                 671          PUSH    AX                              ; SAVE VIDEO MODE ON STACK
E279 2AE4               672          SUB     AH,AH                           ; INITIALIZE TO ALPHANUMERIC MD
E27B CD10               673          INT     10H                             ; CALL VIDEO_IO
E27D 58                 674          POP     AX                              ; RESTORE VIDEO SENSE SWS IN AH
E27E 50                 675          PUSH    AX                              ; RESAVE VALUE
E27F BB00B0             676          MOV     BX,0B000H                       ; BEG VIDEO RAM ADDR B/W CD
E282 BA8803             677          MOV     DX,3B8H                         ; MODE REG FOR B/W
E285 B90008             678          MOV     CX,2048                         ; RAM WORD CNT FOR B/W CD
E288 B001               679          MOV     AL,1                            ; SET MODE FOR BW CARD
E28A 80FC30             680          CMP     AH,30H                          ; B/W VIDEO CARD ATTACHED?
E28D 7409               681          JE      E9                              ; YES - GO TEST VIDEO STG
E28F B7B8               682          MOV     BH,0B8H                         ; BEG VIDEO RAM ADDR COLOR CD
E291 BAD803             683          MOV     DX,3D8H                         ; MODE REG FOR COLOR CD
E294 B520               684          MOV     CH,20H                          ; RAM WORD CNT FOR COLOR CD
E296 FEC8               685          DEC     AL                              ; SET MODE TO 0 FOR COLOR CD
E298                    686  E9:                                             ; TEST_VIDEO_STG:
E298 EE                 687          OUT     DX,AL                           ; DISABLE VIDEO FOR COLOR CD
E299 813E72043412       688          CMP     DATA_WORD[OFFSET RESET_FLAG],1234H ; POD INIT BY KBD RESET?
E29F 8EC3               689          MOV     ES,BX                           ; POINT ES TO VIDEO RAM STG
E2A1 7407               690          JE      E10                             ; YES - SKIP VIDEO RAM TEST
E2A3 8EDB               691          MOV     DS,BX                           ; POINT DS TO VIDEO RAM STG
                        692          ASSUME  DS:NOTHING,ES:NOTHING
E2A5 E8C703             693          CALL    STGTST_CNT                      ; GO TEST VIDEO R/W STG
E2A8 7546               694          JNE     E17                             ; R/W STG FAILURE - BEEP SPK
                        695  ;--------------------------------------------------
                        696  ;       SETUP VIDEO DATA ON SCREEN FOR VIDEO      :
                        697  ;       LINE TEST.                                :
                        698  ; DESCRIPTION                                     :
                        699  ;       ENABLE VIDEO SIGNAL AND SET MODE.         :
                        700  ;       DISPLAY A HORIZONTAL BAR ON SCREEN.       :
                        701  ;--------------------------------------------------
E2AA                    702  E10:
E2AA 58                 703          POP     AX                              ; GET VIDEO SENSE SWS (AH)
E2AB 50                 704          PUSH    AX                              ; SAVE IT
E2AC B400               705          MOV     AH,0                            ; ENABLE VIDEO AND SET MODE
E2AE CD10               706          INT     10H                             ; VIDEO
E2B0 B82070             707          MOV     AX,7020H                        ; WRT BLANKS IN REVERSE VIDEO
                        708
                        709  ;----- UNNATURAL ACT FOR ADDRESS COMPATIBILITY
                        710
E2B3 EB11               711          JMP     SHORT E10A
E2C3                    712          ORG     0E2C3H
E2C3 E99915             713          JMP     NMI_INT
                        714
E2C6                    715  E10A:
E2C6 2BFF               716          SUB     DI,DI                           ; SETUP STARTING LOC
E2C8 B92800             717          MOV     CX,40                           ; NO. OF BLANKS TO DISPLAY
E2CB F3                 718          REP     STOSW                           ; WRITE VIDEO STORAGE
E2CC AB
                        719  ;--------------------------------------
                        720  ;       CRT INTERFACE LINES TEST       :
                        721  ; DESCRIPTION                          :
                        722  ;       SENSE ON/OFF TRANSITION OF THE  :
                        723  ;       VIDEO ENABLE AND HORIZONTAL     :
                        724  ;       SYNC LINES.                     :
                        725  ;--------------------------------------
E2CD 58                 726          POP     AX                              ; GET VIDEO SENSE SW INFO
E2CE 50                 727          PUSH    AX                              ; SAVE IT
E2CF 80FC30             728          CMP     AH,30H                          ; B/W CARD ATTACHED?
E2D2 BABA03             729          MOV     DX,03BAH                        ; SETUP ADDR OF BW STATUS PORT
E2D5 7403               730          JE      E11                             ; YES - GO TEST LINES
E2D7 BADA03             731          MOV     DX,03DAH                        ; COLOR CARD IS ATTACHED
E2DA                    732  E11:                                            ; LINE_TST:
E2DA B408               733          MOV     AH,8
E2DC                    734  E12:                                            ; OFLOOP_CNT:
E2DC 2BC9               735          SUB     CX,CX
E2DE                    736  E13:
E2DE EC                 737          IN      AL,DX                           ; READ CRT STATUS PORT
E2DF 22C4               738          AND     AL,AH                           ; CHECK VIDEO/HORZ LINE
E2E1 7504               739          JNZ     E14                             ; ITS ON - CHECK IF IT GOES OFF
E2E3 E2F9               740          LOOP    E13                             ; LOOP TILL ON OR TIMEOUT
E2E5 EB09               741          JMP     SHORT E17                       ; GO PRINT ERROR MSG
E2E7                    742  E14:
E2E7 2BC9               743          SUB     CX,CX
E2E9                    744  E15:
E2E9 EC                 745          IN      AL,DX                           ; READ CRT STATUS PORT
E2EA 22C4               746          AND     AL,AH                           ; CHECK VIDEO/HORZ LINE
E2EC 7411               747          JZ      E16                             ; ITS ON - CHECK NEXT LINE
E2EE E2F9               748          LOOP    E15                             ; LOOP IF OFF TILL IT GOES ON
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 LOC OBJECT          LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

E2F0                 749  E17:                                    ; CRT_ERR:
E2F0 1F              750          POP     DS
E2F1 1E              751          PUSH    DS
E2F2 C606150006      752          MOV     DS:MFG_ERR_FLAG,06H     ; <><><>CRT ERR CHKPT. 06<><><>
E2F7 BA0201          753          MOV     DX,102H
E2FA E8DB16          754          CALL    ERR_BEEP                ; GO BEEP SPEAKER
E2FD EB06            755          JMP     SHORT E18
E2FF                 756  E16:                                    ; NXT_LINE:
E2FF B103            757          MOV     CL,3                    ; GET NEXT BIT TO CHECK
E301 D2EC            758          SHR     AH,CL
E303 75D7            759          JNZ     E12                     ; GO CHECK HORIZONTAL LINE
E305                 760  E18:                                    ; DISPLAY CURSOR:
E305 58              761          POP     AX                      ; GET VIDEO SENSE SWS (AH)
E306 B400            762          MOV     AH,0                    ; SET MODE AND DISPLAY CURSOR
E308 CD10            763          INT     10H                     ; CALL VIDEO I/O PROCEDURE
E30A                 764  E18_1:
E30A BA00C0          765          MOV     DX,0C000H               ; SEE IF ADVANCED VIDEO CARD
E30D                 766  E18A:
E30D 8EDA            767          MOV     DS,DX                   ; IS PRESENT
E30F 2BDB            768          SUB     BX,BX
E311 8B07            769          MOV     AX,[BX]                 ; GET FIRST 2 LOCATIONS
E313 53              770          PUSH    BX
E314 5B              771          POP     BX                      ; LET BUS SETTLE
E315 3D55AA          772          CMP     AX,0AA55H               ; PRESENT?
E318 7505            773          JNZ     E18B                    ; NO? GO LOOK FOR OTHER MODULES
E31A E83616          774          CALL    ROM_CHECK               ; GO SCAN MODULE
E31D EB04            775          JMP     SHORT E18C
E31F                 776  E18B:
E31F 81C28000        777          ADD     DX,0080H                ; POINT TO NEXT 2K BLOCK
E323                 778  E18C:
E323 81FA00C8        779          CMP     DX,0C800H               ; TOP OF VIDEO ROM AREA YET?
E327 7CE4            780          JL      E18A                    ; GO SCAN FOR ANOTHER MODULE
                     781  ;--------------------------------------------------------
                     782  ;       8259 INTERRUPT CONTROLLER TEST                  :
                     783  ; DESCRIPTION                                           :
                     784  ;       READ/WRITE THE INTERRUPT MASK REGISTER (IMR)    :
                     785  ;       WITH ALL ONES AND ZEROES. ENABLE SYSTEM         :
                     786  ;       INTERRUPTS.  MASK DEVICE INTERRUPTS OFF. CHECK  :
                     787  ;       FOR HOT INTERRUPTS (UNEXPECTED).                :
                     788  ;--------------------------------------------------------
                     789          ASSUME  DS:ABS0
E329 1F              790  C21:    POP     DS
                     791
                     792  ;----- TEST THE IMR REGISTER
                     793
E32A C606150405      794  C21A:   MOV     DATA_AREA[OFFSET MFR_ERR_FLAG],05H
                     795                                          ; <><><><><><><><><><><><><><>
                     796                                          ; <><><>CHECKPOINT 5<><><>
E32F B000            797          MOV     AL,0                    ; SET IMR TO ZERO
E331 E621            798          OUT     INTA01,AL
E333 E421            799          IN      AL,INTA01               ; READ IMR
E335 0AC0            800          OR      AL,AL                   ; IMR = 0?
E337 751B            801          JNZ     D6                      ; GO TO ERR ROUTINE IF NOT 0
E339 B0FF            802          MOV     AL,0FFH                 ; DISABLE DEVICE INTERRUPTS
E33B E621            803          OUT     INTA01,AL               ; WRITE TO IMR
E33D E421            804          IN      AL,INTA01               ; READ IMR
E33F 0401            805          ADD     AL,1                    ; ALL IMR BIT ON?
E341 7511            806          JNZ     D6                      ; NO - GO TO ERR ROUTINE
                     807
                     808  ;----- CHECK FOR HOT INTERRUPTS
                     809
                     810  ;----- INTERRUPTS ARE MASKED OFF.  CHECK THAT NO INTERRUPTS OCCUR.
                     811
E343 A26B04          812          MOV     DATA_AREA[OFFSET INTR_FLAG],AL  ; CLEAR INTERRUPT FLAG
E346 FB              813          STI                             ; ENABLE EXTERNAL INTERRUPTS
E347 2BC9            814          SUB     CX,CX                   ; WAIT 1 SEC FOR ANY INTRS THAT
E349                 815  D4:
E349 E2FE            816          LOOP    D4                      ; MIGHT OCCUR
E34B                 817  D5:
E34B E2FE            818          LOOP    D5
E34D 803E6B0400      819          CMP     DATA_AREA[OFFSET INTR_FLAG],00H ; DID ANY INTERRUPTS OCCUR?
E352 7409            820          JZ      D7                      ; NO - GO TO NEXT TEST
E354                 821  D6:
E354 BEFFF890        822          MOV     SI,OFFSET E0            ; DISPLAY 101 ERROR
E358 E84E16          823          CALL    E_MSG
E35B FA              824          CLI
E35C F4              825          HLT                             ; HALT THE SYSTEM
                     826  ;--------------------------------------------------------
                     827  ;       8253 TIMER CHECKOUT                             :
                     828  ; DESCRIPTION                                           :
                     829  ;       VERIFY THAT THE SYSTEM TIMER (0) DOESN'T COUNT  :
                     830  ;       TOO FAST OR TOO SLOW.                           :
                     831  ;--------------------------------------------------------
E35D                 832  D7:
E35D C606150402      833          MOV     DATA_AREA[OFFSET MFR_ERR_FLAG],02H
                     834                                          ; <><><><><><><><><><><><><><>
                     835                                          ; <><><>TIMER CHECKPOINT (2)<><><>
E362 B0FE            836          MOV     AL,0FEH                 ; MASK ALL INTRS EXCEPT LVL 0
E364 E621            837          OUT     INTA01,AL               ; WRITE THE 8259 IMR
E366 B010            838          MOV     AL,00010000B            ; SEL TIM 0, LSB, MODE 0, BINARY
E368 E643            839          OUT     TIM_CTL,AL              ; WRITE TIMER CONTROL MODE REG
E36A B91600          840          MOV     CX,T6H                  ; SET PGM LOOP CNT
E36D 8AC1            841          MOV     AL,CL                   ; SET TIMER 0 CNT REG
E36F E640            842          OUT     TIMER0,AL               ; WRITE TIMER 0 CNT REG
E371                 843  D8:
E371 F6066B0401      844          TEST    DATA_AREA[OFFSET INTR_FLAG],01H
                     845                                          ; DID TIMER 0 INTERRUPT OCCUR?
E376 7504            846          JNZ     D9                      ; YES - CHECK TIMER OP FOR SLOW TIME
E378 E2F7            847          LOOP    D8                      ; WAIT FOR INTR FOR SPECIFIED TIME
E37A EBD8            848          JMP     D6                      ; TIMER 0 INTR DIDN'T OCCUR - ERR
E37C                 849  D9:
E37C B10C            850          MOV     CL,12                   ; SET PGM LOOP CNT
E37E B0FF            851          MOV     AL,0FFH                 ; WRITE TIMER 0 CNT REG
E380 E640            852          OUT     TIMER0,AL
E382 C6066B0400      853          MOV     DATA_AREA[OFFSET INTR_FLAG],0   ; RESET INTR RECEIVED FLAG
E387 B0FE            854          MOV     AL,0FEH                 ; REENABLE TIMER 0 INTERRUTS
E389 E621            855          OUT     INTA01,AL
E38B                 856  D10:
E38B F6066B0401      857          TEST    DATA_AREA[OFFSET INTR_FLAG],01H ; DID TIMER 0 INTERRUPT OCCUR?
E390 75C2            858          JNZ     D6                      ; YES - TIMER CNTING TOO FAST, ERR
E392 E2F7            859          LOOP    D10                     ; WAIT FOR INTR FOR SPECIFIED TIME
                     860
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                    861  ;----- SETUP TIMER 0 TO MODE 3
                    862
E394 B0FF           863          MOV     AL,0FFH                 ; DISABLE ALL DEVICE INTERRUPTS
E396 E621           864          OUT     INTA01,AL
E398 B036           865          MOV     AL,36H                  ; SEL TIM 0,LSB,MSB,MODE 3
E39A E643           866          OUT     TIMER+3,AL              ; WRITE TIMER MODE REG
E39C B000           867          MOV     AL,0
E39E E640           868          OUT     TIMER,AL                ; WRITE LSB TO TIMER 0 REG
E3A0 E640           869          OUT     TIMER,AL                ; WRITE MSB TO TIMER 0 REG
                    870  ;--------------------------------------------
                    871  ;       KEYBOARD TEST                       :
                    872  ; DESCRIPTION                               :
                    873  ;       RESET THE KEYBOARD AND CHECK THAT SCAN  :
                    874  ;       CODE 'AA' IS RETURNED TO THE CPU.       :
                    875  ;       CHECK FOR STUCK KEYS.                   :
                    876  ;--------------------------------------------
E3A2                877  TST12:
E3A2 B099           878          MOV     AL,99H                  ; SET 8255 MODE A,C=IN B=OUT
E3A4 E663           879          OUT     CMD_PORT,AL
E3A6 A01004         880          MOV     AL,DATA_AREA[OFFSET EQUIP_FLAG]
E3A9 2401           881          AND     AL,01                   ; TEST CHAMBER?
E3AB 7431           882          JZ      F7                      ; BYPASS IF SO
E3AD 803E120401     883          CMP     DATA_AREA[OFFSET MFG_TST],1     ; MANUFACTURING TEST MODE?
E3B2 742A           884          JE      F7                      ; YES - SKIP KEYBOARD TEST
E3B4 E87316         885          CALL    KBD_RESET               ; ISSUE RESET TO KEYBRD
E3B7 E31E           886          JCXZ    F6                      ; PRINT ERR MSG IF NO INTERRUPT
E3B9 B049           887          MOV     AL,49H                  ; ENABLE KEYBOARD
E3BB E661           888          OUT     PORT_B,AL
E3BD 80FBAA         889          CMP     BL,0AAH                 ; SCAN CODE AS EXPECTED?
E3C0 7515           890          JNE     F6                      ; NO - DISPLAY ERROR MSG
                    891
                    892  ;----- CHECK FOR STUCK KEYS
                    893
E3C2 B0C8           894          MOV     AL,0C8H                 ; CLR KBD, SET CLK LINE HIGH
E3C4 E661           895          OUT     PORT_B,AL
E3C6 B048           896          MOV     AL,48H                  ; ENABLE KBD,CLK IN NEXT BYTE
E3C8 E661           897          OUT     PORT_B,AL
E3CA 2BC9           898          SUB     CX,CX
E3CC                899  F5:                                     ; KBD_WAIT:
E3CC E2FE           900          LOOP    F5                      ; DELAY FOR A WHILE
E3CE E460           901          IN      AL,KBD_IN               ; CHECK FOR STUCK KEYS
E3D0 3C00           902          CMP     AL,0                    ; SCAN CODE = 0?
E3D2 740A           903          JE      F7                      ; YES - CONTINUE TESTING
E3D4 E8B415         904          CALL    XPC_BYTE                ; CONVERT AND PRINT
E3D7                905  F6:
E3D7 BE4CEC90       906          MOV     SI,OFFSET F1            ; GET MSG ADDR
E3DB E8CB15         907          CALL    E_MSG                   ; PRINT MSG ON SCREEN
                    908  ;--------------------------------------------------
                    909  ;       SETUP HARDWARE INT. VECTOR TABLE            :
                    910  ;--------------------------------------------------
E3DE                911  F7:
E3DE 1E             912          PUSH    DS                      ; SETUP_INT_TABLE:
E3DF 2BC0           913          SUB     AX,AX
E3E1 8EC0           914          MOV     ES,AX
E3E3 B90800         915          MOV     CX,08                   ; GET VECTOR CNT
E3E6 0E             916          PUSH    CS                      ; SETUP DS SEG REG
E3E7 1F             917          POP     DS
E3E8 BEF3FE90       918          MOV     SI,OFFSET VECTOR_TABLE
E3EC BF2000         919          MOV     DI,OFFSET INT_PTR
E3EF                920  F7A:
E3EF A5             921          MOVSW
E3F0 47             922          INC     DI                      ; SKIP OVER SEGMENT
E3F1 47             923          INC     DI
E3F2 E2FB           924          LOOP    F7A
E3F4 1F             925          POP     DS
                    926
                    927  ;----- SET UP OTHER INTERRUPTS AS NECESSARY
                    928
E3F5 C70608005FF8   929          MOV     NMI_PTR,OFFSET NMI_INT  ; NMI INTERRUPT
E3FB C706140054FF   930          MOV     INT5_PTR,OFFSET PRINT_SCREEN    ; PRINT SCREEN
E401 C706620000F6   931          MOV     BASIC_PTR+2,0F600H      ; SEGMENT FOR CASSETTE BASIC
                    932
                    933  ;----- SETUP TIMER 0 TO BLINK LED IF MANUFACTURING TEST MODE
                    934
E407 803E120401     935          CMP     DATA_AREA[OFFSET MFG_TST],01H   ; MFG. TEST MODE?
E40C 750A           936          JNZ     EXP_TO
E40E C70670003CF9   937          MOV     WORD PRT(1CH*4),OFFSET BLINK_INT; SETUP TIMER INTR TO BLINK LED
E414 B0FE           938          MOV     AL,0FEH                 ; ENABLE TIMER INTERRUPT
E416 E621           939          OUT     INTA01,AL
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                     940  ;--------------------------------------------------------
                     941  ; EXPANSION I/O BOX TEST                               :
                     942  ;       CHECK TO SEE IF EXPANSION BOX PRESENT - IF INSTALLED,  :
                     943  ;       TEST DATA AND ADDRESS BUSES TO I/O BOX          :
                     944  ;  ERROR='1801'                                        :
                     945  ;--------------------------------------------------------
                     946
                     947  ;----- DETERMINE IF BOX IS PRESENT
                     948
E418                 949  EXP_IO:                                ; (CARD WAS ENABLED EARLIER)
E418 BA1002          950          MOV     DX,0210H              ; CONTROL PORT ADDRESS
E41B B85555          951          MOV     AX,5555H              ; SET DATA PATTERN
E41E EE              952          OUT     DX,AL
E41F B001            953          MOV     AL,01H                ; MAKE AL DIFFERENT
E421 EC              954          IN      AL,DX                 ; RECOVER DATA
E422 3AC4            955          CMP     AL,AH                 ; REPLY?
E424 7544            956          JNE     E19                   ; NO RESPONSE, GO TO NEXT TEST
E426 F7D0            957          NOT     AX                    ; MAKE DATA=AAAA
E428 EE              958          OUT     DX,AL
E429 B001            959          MOV     AL,01H
E42B EC              960          IN      AL,DX                 ; RECOVER DATA
E42C 3AC4            961          CMP     AL,AH
E42E 753A            962          JNE     E19
                     963
                     964  ;----- CHECK ADDRESS BUS
                     965
E430                 966  EXP2:
E430 BB0100          967          MOV     BX,0001H
E433 BA1502          968          MOV     DX,0215H              ; LOAD HI ADDR. REG ADDRESS
E436 B91000          969          MOV     CX,0016               ; GO ACROSS 16 BITS
E439                 970  EXP3:
E439 2E8807          971          MOV     CS:[BX],AL            ; WRITE ADDRESS F0000+BX
E43C 90              972          NOP
E43D EC              973          IN      AL,DX                 ; READ ADDR. HIGH
E43E 3AC7            974          CMP     AL,BH
E440 7521            975          JNE     EXP_ERR               ; GO ERROR IF MISCOMPARE
E442 42              976          INC     DX                    ; DX=216H (ADDR. LOW REG)
E443 EC              977          IN      AL,DX
E444 3AC3            978          CMP     AL,BL                 ; COMPARE TO LOW ADDRESS
E446 751B            979          JNE     EXP_ERR
E448 4A              980          DEC     DX                    ; DX BACK TO 215H
E449 D1E3            981          SHL     BX,1
E44B E2EC            982          LOOP    EXP3                  ; LOOP TILL '1' WALKS ACROSS BX
                     983
                     984  ;----- CHECK DATA BUS
                     985
E44D B90800          986          MOV     CX,0008               ; DO 8 TIMES
E450 B001            987          MOV     AL,01
E452 4A              988          DEC     DX                    ; MAKE DX=214H (DATA BUS REG)
E453                 989  EXP4:
E453 8AE0            990          MOV     AH,AL                 ; SAVE DATA BUS VALUE
E455 EE              991          OUT     DX,AL                 ; SEND VALUE TO REG
E456 B001            992          MOV     AL,01H
E458 EC              993          IN      AL,DX                 ; RETRIVE VALUE FROM REG
E459 3AC4            994          CMP     AL,AH                 ; = TO SAVED VALUE
E45B 7506            995          JNE     SHORT EXP_ERR
E45D D0E0            996          SHL     AL,1                  ; FORM NEW DATA PATTERN
E45F E2F2            997          LOOP    EXP4                  ; LOOP TILL BIT WALKS ACROSS AL
E461 EB07            998          JMP     SHORT E19             ; GO ON TO NEXT TEST
E463                 999  EXP_ERR:
E463 BE0FF990       1000          MOV     SI,OFFSET F3C
E467 E83F15         1001          CALL    E_MSG
```

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                1002  ;--------------------------------------------------------
                1003  ;       ADDITIONAL READ/WRITE STORAGE TEST               :
                1004  ; DESCRIPTION                                            :
                1005  ;       WRITE/READ DATA PATTERNS TO ANY READ/WRITE       :
                1006  ;       STORAGE AFTER THE FIRST 32K.  STORAGE            :
                1007  ;       ADDRESSABILITY IS CHECKED.                       :
                1008  ;--------------------------------------------------------
                1009          ASSUME  DS:DATA
E46A            1010  E19:
E46A E8EC15     1011          CALL    DDS
E46D 1E         1012          PUSH    DS
E46E            1013  E20:
E46E 813E72003412 1014        CMP     RESET_FLAG,1234H        ; WARM START?
E474 7503       1015          JNE     E20A                    ; CONTINUE TEST IF NOT
E476 E99F00     1016          JMP     ROM_SCAN                ; GO TO NEXT ROUTINE IF SO
E479            1017  E20A:
E479 B81000     1018          MOV     AX,16                   ; STARTING AMT. OF MEMORY OK
E47C EB28       1019          JMP     SHORT PRT_SIZ           ; POST MESSAGE
E47E            1020  E20B:
E47E 8B1E1300   1021          MOV     BX,MEMORY_SIZE          ; GET MEM. SIZE WORD
E482 83EB10     1022          SUB     BX,16                   ; 1ST 16K ALREADY DONE
E485 B104       1023          MOV     CL,04H
E487 D3EB       1024          SHR     BX,CL                   ; DIVIDE BY 16
E489 8BCB       1025          MOV     CX,BX                   ; SAVE COUNT OF 16K BLOCKS
E48B BB0004     1026          MOV     BX,0400H                ; SET PTR. TO RAM SEGMENT>16K
E48E            1027  E21:
E48E 8EDB       1028          MOV     DS,BX                   ; SET SEG. REG
E490 8EC3       1029          MOV     ES,BX
E492 81C30004   1030          ADD     BX,0400H                ; POINT TO NEXT 16K
E496 52         1031          PUSH    DX
E497 51         1032          PUSH    CX                      ; SAVE WORK REGS
E498 53         1033          PUSH    BX
E499 50         1034          PUSH    AX
E49A B90020     1035          MOV     CX,2000H                ; SET COUNT FOR 8K WORDS
E49D E8CF01     1036          CALL    STGTST_CNT
E4A0 754C       1037          JNZ     E21A                    ; GO PRINT ERROR
E4A2 58         1038          POP     AX                      ; RECOVER TESTED MEM NUMBER
E4A3 051000     1039          ADD     AX,16
E4A6            1040  PRT_SIZ:
E4A6 50         1041          PUSH    AX
E4A7 BB0A00     1042          MOV     BX,10                   ; SET UP FOR DECIMAL CONVERT
E4AA B90300     1043          MOV     CX,3                    ; OF 3 NIBBLES
E4AD            1044  DECIMAL_LOOP:
E4AD 33D2       1045          XOR     DX,DX
E4AF F7F3       1046          DIV     BX                      ; DIVIDE BY 10
E4B1 80CA30     1047          OR      DL,30H                  ; MAKE INTO ASCII
E4B4 52         1048          PUSH    DX                      ; SAVE
E4B5 E2F6       1049          LOOP    DECIMAL_LOOP
E4B7 B90300     1050          MOV     CX,3
E4BA            1051  PRT_DEC_LOOP:
E4BA 58         1052          POP     AX                      ; RECOVER A NUMBER
E4BB E8DE14     1053          CALL    PRT_HEX
E4BE E2FA       1054          LOOP    PRT_DEC_LOOP
E4C0 B90700     1055          MOV     CX,7
E4C3 BE1AE0     1056          MOV     SI,OFFSET F3B           ; PRINT ' KB OK'
E4C6            1057  KB_LOOP:
E4C6 2E8A04     1058          MOV     AL,CS:[SI]
E4C9 46         1059          INC     SI
E4CA E8CF14     1060          CALL    PRT_HEX
E4CD E2F7       1061          LOOP    KB_LOOP
E4CF 58         1062          POP     AX                      ; RECOVER WORK REGS
E4D0 3D1000     1063          CMP     AX,16                   ; FIRST PASS?
E4D3 74A9       1064          JE      E20B
E4D5 5B         1065          POP     BX
E4D6 59         1066          POP     CX
E4D7 5A         1067          POP     DX
E4D8 E2B4       1068          LOOP    E21                     ; LOOP TILL ALL MEM. CHECKED
E4DA B00A       1069          MOV     AL,10
E4DC E8BD14     1070          CALL    PRT_HEX                 ; LINE FEED
                1071
                1072  ;----- DMA TC0 SHOULD BE ON BY NOW - SEE IF IT IS
                1073
E4DF E408       1074          IN      AL,DMA+08H
E4E1 2401       1075          AND     AL,00000001B            ; TC0 STATUS BIT ON?
E4E3 7533       1076          JNZ     ROM_SCAN                ; GO ON WITH NEXT TEST IF OK
E4E5 1F         1077          POP     DS
E4E6 C606150003 1078          MOV     MFG_ERR_FLAG,03H        ; <><><><><><><><><><><><><><>
E4EB E966FE     1079          JMP     D6                      ; POST 101 ERROR MSG AND HALT
                1080
                1081  ;----- PRINT FAILING ADDRESS AND XOR'ED PATTERN IF DATA COMPARE ERROR
                1082
E4EE 8AE8       1083  E21A:   MOV     CH,AL                   ; SAVE FAILING BIT PATTERN
E4F0 B00D       1084          MOV     AL,13                   ; CARRAGE RETURN
E4F2 E8A714     1085          CALL    PRT_HEX
E4F5 B00A       1086          MOV     AL,10
E4F7 E8A214     1087          CALL    PRT_HEX
E4FA 58         1088          POP     AX                      ; RECOVER AMT. OF GOOD MEM.
E4FB 83C406     1089          ADD     SP,6                    ; BALANCE STACK
E4FE 8CDA       1090          MOV     DX,DS                   ; GET FAILING SEGMENT
E500 1F         1091          POP     DS
E501 1E         1092          PUSH    DS
E502 A31300     1093          MOV     MEMORY_SIZE,AX          ; LOAD MEM. SIZE WORD TO SHOW
                1094                                          ; HOW MUCH MEM. WORKING
E505 88361500   1095          MOV     MFG_ERR_FLAG,DH         ; <><><><><><><><><><><><><><>
                1096                                          ; <><>CHECKPOINTS 08->A0<><>
E509 E8CE1A     1097          CALL    PRT_SEG                 ; PRINT IT
E50C 8AC5       1098          MOV     AL,CH                   ; GET FAILING BIT PATTERN
E50E E87A14     1099          CALL    XPC_BYTE                ; CONVERT AND PRINT CODE
E511 BE04F990   1100          MOV     SI,OFFSET E1            ; SETUP ADDRESS OF ERROR MSG
E515 E89114     1101          CALL    E_MSG                   ; PRINT ERROR MSG
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                    1102  ;--------------------------------------------------------
                    1103  ; CHECK FOR OPTIONAL ROM FROM C8000->F4000 IN 2K BLOCKS      :
                    1104  ;       (A VALID MODULE HAS '55AA' IN THE FIRST 2 LOCATIONS,  :
                    1105  ;       LENGTH INDICATOR (LENGTH/512) IN THE 3D LOCATION AND  :
                    1106  ;       TEST/INIT. CODE STARTING IN THE 4TH LOCATION.)        :
                    1107  ;--------------------------------------------------------
E518                1108  ROM_SCAN:
E518 BA00C8         1109          MOV     DX,0C800H               ; SET BEGINNING ADDRESS
E51B                1110  ROM_SCAN_1:
E51B 8EDA           1111          MOV     DS,DX
E51D 2BDB           1112          SUB     BX,BX                   ; SET BX=0000
E51F 8B07           1113          MOV     AX,[BX]                 ; GET 1ST WORD FROM MODULE
E521 53             1114          PUSH    BX
E522 5B             1115          POP     BX                      ; BUS SETTLING
E523 3D55AA         1116          CMP     AX,0AA55H               ; = TO ID WORD?
E526 7506           1117          JNZ     NEXT_ROM                ; PROCEED TO NEXT ROM IF NOT
E528 E82814         1118          CALL    ROM_CHECK               ; GO CHECK OUT MODULE
E52B EB0590         1119          JMP     ARE_WE_DONE             ; CHECK FOR END OF ROM SPACE
E52E                1120  NEXT_ROM:
E52E 81C28000       1121          ADD     DX,0080H                ; POINT TO NEXT 2K ADDRESS
E532                1122  ARE_WE_DONE:
E532 81FA00F6       1123          CMP     DX,0F600H               ; AT F6000 YET?
E536 7CE3           1124          JL      ROM_SCAN_1              ; GO CHECK ANOTHER ADD. IF NOT
E538 EB0190         1125          JMP     BASE_ROM_CHK            ; GO CHECK BASIC ROM
                    1126  ;--------------------------------------------------------------------------
                    1127  ; A CHECKSUM IS DONE FOR THE 4 ROS MODULES CONTAINING BASIC CODE          :
                    1128  ;--------------------------------------------------------------------------
E53B                1129  BASE_ROM_CHK:
E53B B404           1130          MOV     AH,4                    ; NO. OF ROS MODULES TO CHECK
E53D                1131  E4:
E53D 2BDB           1132          SUB     BX,BX                   ; SETUP STARTING ROS ADDR
E53F 8EDA           1133          MOV     DS,DX
                    1134                                          ; CHECK ROS
E541 E8AE13         1135          CALL    ROS_CHECKSUM
E544 7403           1136          JE      E5                      ; CONTINUE IF OK
E546 E88201         1137          CALL    ROM_ERR                 ; POST ERROR
E549                1138  E5:
E549 81C20002       1139          ADD     DX,0200H                ; POINT TO NEXT 8K MODULE
E54D FECC           1140          DEC     AH                      ; ANY MORE TO DO?
E54F 75EC           1141          JNZ     E4                      ; YES - CONTINUE
                    1142  ;--------------------------------------------------------
                    1143  ;       DISKETTE ATTACHMENT TEST                        :
                    1144  ; DESCRIPTION                                           :
                    1145  ;       CHECK IF IPL DISKETTE DRIVE IS ATTACHED TO SYSTEM.  IF  :
                    1146  ;       ATTACHED, VERIFY STATUS OF NEC FDC AFTER A RESET. ISSUE :
                    1147  ;       A RECAL AND SEEK CMD TO FDC AND CHECK STATUS. COMPLETE  :
                    1148  ;       SYSTEM INITIALIZATION THEN PASS CONTROL TO THE BOOT     :
                    1149  ;       LOADER PROGRAM.                                 :
                    1150  ;--------------------------------------------------------
E551                1151  F9:
E551 1F             1152          POP     DS
E552 A01000         1153          MOV     AL,BYTE PTR EQUIP_FLAG  ; DISKETTE PRESENT?
E555 2401           1154          AND     AL,01H                  ; NO - BYPASS DISKETTE TEST
E557 743E           1155          JZ      F15
E559                1156  F10:                                    ; DISK_TEST:
E559 E421           1157          IN      AL,INTA01
E55B 24BF           1158          AND     AL,0BFH                 ; ENABLE DISKETTE INTERRUPTS
E55D E621           1159          OUT     INTA01,AL
E55F B400           1160          MOV     AH,0                    ; RESET NEC FDC
E561 8AD4           1161          MOV     DL,AH                   ; SET FOR DRIVE 0
E563 CD13           1162          INT     13H                     ; VERIFY STATUS AFTER RESET
E565 F6C4FF         1163          TEST    AH,0FFH                 ; STATUS OK?
E568 7520           1164          JNZ     F13                     ; NO - FDC FAILED
                    1165
                    1166  ;----- TURN DRIVE 0 MOTOR ON
                    1167
E56A BAF203         1168          MOV     DX,03F2H                ; GET ADDR OF FDC CARD
E56D B01C           1169          MOV     AL,1CH                  ; TURN MOTOR ON, EN DMA/INT
E56F EE             1170          OUT     DX,AL                   ; WRITE FDC CONTROL REG
E570 2BC9           1171          SUB     CX,CX
E572                1172  F11:                                    ; MOTOR_WAIT:
E572 E2FE           1173          LOOP    F11                     ; WAIT FOR 1 SECOND
E574                1174  F12:                                    ; MOTOR_WAIT1:
E574 E2FE           1175          LOOP    F12
E576 33D2           1176          XOR     DX,DX                   ; SELECT DRIVE 0
E578 B501           1177          MOV     CH,1                    ; SELECT TRACK 1
E57A 88163E00       1178          MOV     SEEK_STATUS,DL
E57E E8FC08         1179          CALL    SEEK                    ; RECALIBRATE DISKETTE
E581 7207           1180          JC      F13                     ; GO TO ERR SUBROUTINE IF ERR
E583 B522           1181          MOV     CH,34                   ; SELECT TRACK 34
E585 E8F508         1182          CALL    SEEK                    ; SEEK TO TRACK 34
E588 7307           1183          JNC     F14                     ; OK, TURN MOTOR OFF
E58A                1184  F13:                                    ; DSK_ERR:
E58A BE52EC90       1185          MOV     SI,OFFSET F3            ; GET ADDR OF MSG
E58E E81814         1186          CALL    E_MSG                   ; GO PRINT ERROR MSG
                    1187
                    1188  ;----- TURN DRIVE 0 MOTOR OFF
                    1189
E591                1190  F14:                                    ; DR0_OFF:
E591 B00C           1191          MOV     AL,0CH                  ; TURN DRIVE 0 MOTOR OFF
E593 BAF203         1192          MOV     DX,03F2H                ; FDC CTL ADDRESS
E596 EE             1193          OUT     DX,AL
                    1194
                    1195  ;----- SETUP PRINTER AND RS232 BASE ADDRESSES IF DEVICE ATTACHED
                    1196
E597                1197  F15:
E597 C6066B0000     1198          MOV     INTR_FLAG,00H           ; SET STRAY INTERRUPT FLAG = 00
E59C BE1E00         1199          MOV     SI,OFFSET KB_BUFFER     ; SETUP KEYBOARD PARAMETERS
E59F 89361A00       1200          MOV     BUFFER_HEAD,SI
E5A3 89361C00       1201          MOV     BUFFER_TAIL,SI
E5A7 89368000       1202          MOV     BUFFER_START,SI
E5AB 83C620         1203          ADD     SI,32                   ;DEFAULT BUFFER OF 32 BYTES
E5AE 89368200       1204          MOV     BUFFER_END,SI
E5B2 BF7800         1205          MOV     DI,OFFSET PRINT_TIM_OUT ;SET DEFAULT PRINTER TIMEOUT
E5B5 1E             1206          PUSH    DS
E5B6 07             1207          POP     ES
E5B7 B81414         1208          MOV     AX,1414H                ; DEFAULT=20
E5BA AB             1209          STOSW
E5BB AB             1210          STOSW
E5BC B80101         1211          MOV     AX,0101H                ;RS232 DEFAULT=01
E5BF AB             1212          STOSW
E5C0 AB             1213          STOSW
E5C1 E421           1214          IN      AL,INTA01
E5C3 24FC           1215          AND     AL,0FCH                 ; ENABLE TIMER AND KB INTS
E5C5 E621           1216          OUT     INTA01,AL
```

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LOC OBJECT          LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

E5C7 83FD00         1217          CMP     BP,0000H                ; CHECK FOR BP= NON-ZERO
                    1218                                          ; (ERROR HAPPENED)
E5CA 7419           1219          JE      F15A_0                  ; CONTINUE IF NO ERROR
E5CC BA0200         1220          MOV     DX,2                    ; 2 SHORT BEEPS (ERROR)
E5CF E80614         1221          CALL    ERR_BEEP
E5D2 BE09E890       1222          MOV     SI,OFFSET F3D           ; LOAD ERROR MSG
E5D6 E8F113         1223          CALL    P_MSG
E5D9                1224    ERR_WAIT:
E5D9 B400           1225          MOV     AH,00
E5DB CD16           1226          INT     16H                     ; WAIT FOR 'F1' KEY
E5DD 80FC3B         1227          CMP     AH,3BH
E5E0 75F7           1228          JNE     ERR_WAIT
E5E2 EB0E90         1229          JMP     F15A                    ; BYPASS ERROR
E5E5                1230    F15A_0:
E5E5 803E120001     1231          CMP     MFG_TST,1               ; MFG MODE
E5EA 7406           1232          JE      F15A                    ; BYPASS BEEP
E5EC BA0100         1233          MOV     DX,1                    ; 1 SHORT BEEP (NO ERRORS)
E5EF E8E613         1234          CALL    ERR_BEEP
E5F2 A01000         1235    F15A: MOV     AL,BYTE PTR EQUIP_FLAG  ; GET SWITCHES
E5F5 2401           1236          AND     AL,00000001B            ; 'LOOP POST' SWITCH ON
E5F7 7503           1237          JNZ     F15B                    ; CONTINUE WITH BRING-UP
E5F9 E95FFA         1238          JMP     START
E5FC 2AE4           1239    F15B: SUB     AH,AH
E5FE A04900         1240          MOV     AL,CRT_MODE
E601 CD10           1241          INT     10H                     ; CLEAR SCREEN
E603                1242    F15C:
E603 BDA3F990       1243          MOV     BP,OFFSET F4            ; PRT_SRC_TBL
E607 BE0000         1244          MOV     SI,0
E60A                1245    F16:                                  ; PRT_BASE:
E60A 2E8B5600       1246          MOV     DX,CS:[BP]              ; GET PRINTER BASE ADDR
E60E B0AA           1247          MOV     AL,0AAH                 ; WRITE DATA TO PORT A
E610 EE             1248          OUT     DX,AL
E611 1E             1249          PUSH    DS                      ; BUS SETTLEING
E612 EC             1250          IN      AL,DX                   ; READ PORT A
E613 1F             1251          POP     DS
E614 3CAA           1252          CMP     AL,0AAH                 ; DATA PATTERN SAME
E616 7505           1253          JNE     F17                     ; NO - CHECK NEXT PRT CD
E618 895408         1254          MOV     PRINTER_BASE[SI],DX     ; YES - STORE PRT BASE ADDR
E61B 46             1255          INC     SI                      ; INCREMENT TO NEXT WORD
E61C 46             1256          INC     SI
E61D                1257    F17:
E61D 45             1258          INC     BP                      ; POINT TO NEXT BASE ADDR
E61E 45             1259          INC     BP
E61F 81FDA9F9       1260          CMP     BP,OFFSET F4E           ; ALL POSSIBLE ADDRS CHECKED?
E623 75E5           1261          JNE     F16                     ; PRT_BASE
E625 BB0000         1262          MOV     BX,0                    ; POINTER TO RS232 TABLE
E628 BAFA03         1263          MOV     DX,3FAH                 ; CHECK IF RS232 CD 1 ATTCH?
E62B EC             1264          IN      AL,DX                   ; READ INTR ID REG
E62C A8F8           1265          TEST    AL,0F8H
E62E 7506           1266          JNZ     F18
E630 C707F803       1267          MOV     RS232_BASE[BX],3F8H     ; SETUP RS232 CD #1 ADDR
E634 43             1268          INC     BX
E635 43             1269          INC     BX
E636                1270    F18:
E636 BAFA02         1271          MOV     DX,2FAH                 ; CHECK IF RS232 CD 2 ATTCH
E639 EC             1272          IN      AL,DX                   ; READ INTERRUPT ID REG
E63A A8F8           1273          TEST    AL,0F8H
E63C 7506           1274          JNZ     F19                     ; BASE_END
E63E C707F802       1275          MOV     RS232_BASE[BX],2F8H     ; SETUP RS232 CD #2
E642 43             1276          INC     BX
E643 43             1277          INC     BX
                    1278
                    1279    ;----- SET UP EQUIP FLAG TO INDICATE NUMBER OF PRINTERS AND RS232 CARDS
                    1280
E644                1281    F19:                                  ; BASE_END:
E644 8BC6           1282          MOV     AX,SI                   ; SI HAS 2* NUMBER OF RS232
E646 B103           1283          MOV     CL,3                    ; SHIFT COUNT
E648 D2C8           1284          ROR     AL,CL                   ; ROTATE RIGHT 3 POSITIONS
E64A 0AC3           1285          OR      AL,BL                   ; OR IN THE PRINTER COUNT
E64C A21100         1286          MOV     BYTE PTR EQUIP_FLAG+1,AL        ; STORE AS SECOND BYTE
E64F BA0102         1287          MOV     DX,201H
E652 EC             1288          IN      AL,DX
E653 90             1289          NOP
E654 90             1290          NOP
E655 90             1291          NOP
E656 A80F           1292          TEST    AL,0FH
E658 7505           1293          JNZ     F20                     ; NO_GAME_CARD
E65A 800E110010     1294          OR      BYTE PTR EQUIP_FLAG+1,16
E65F                1295    F20:                                  ; NO_GAME_CARD:
                    1296
                    1297    ;----- ENABLE NMI INTERRUPTS
                    1298
E65F E461           1299          IN      AL,PORT_B               ; RESET CHECK ENABLES
E661 0C30           1300          OR      AL,30H
E663 E661           1301          OUT     PORT_B,AL
E665 24CF           1302          AND     AL,0CFH
E667 E661           1303          OUT     PORT_B,AL
E669 B080           1304          MOV     AL,80H                  ; ENABLE NMI INTERRUPTS
E66B E6A0           1305          OUT     0A0H,AL
E66D                1306    F21:                                  ; LOAD_BOOT_STRAP:
E66D CD19           1307          INT     19H                     ; GO TO THE BOOT LOADER
                    1308
```

SECTION 5

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LOC OBJECT            LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

                      1309  ;--------------------------------------------------------------
                      1310  ; THIS SUBROUTINE PERFORMS A READ/WRITE STORAGE TEST ON A BLOCK :
                      1311  ;       OF STORAGE.                                            :
                      1312  ; ENTRY REQUIREMENTS:                                          :
                      1313  ;       ES = ADDRESS OF STORAGE SEGMENT BEING TESTED            :
                      1314  ;       DS = ADDRESS OF STORAGE SEGMENT BEING TESTED            :
                      1315  ;       CX = WORD COUNT OF STORAGE BLOCK TO BE TESTED           :
                      1316  ; EXIT PARAMETERS:                                             :
                      1317  ;       ZERO FLAG = 0 IF STORAGE ERROR (DATA COMPARE OR PARITY  :
                      1318  ;       CHECK.  AL=0 DENOTES A PARITY CHECK. ELSE AL=XOR'ED     :
                      1319  ;       BIT PATTERN OF THE EXPECTED DATA PATTERN VS THE ACTUAL  :
                      1320  ;       DATA READ.                                             :
                      1321  ; AX,BX,CX,DX,DI, AND SI ARE ALL DESTROYED.                    :
                      1322  ;--------------------------------------------------------------
                      1323
E66F                  1324  STGTST_CNT      PROC    NEAR
E66F FC               1325          CLD                             ; SET DIR FLAG TO INCREMENT
E670 2BFF             1326          SUB     DI,DI                   ; SET DI=OFFSET 0 REL TO ES REG
E672 2BC0             1327          SUB     AX,AX                   ; SETUP FOR 0->FF PATTERN TEST
E674                  1328  C2_1:
E674 8805             1329          MOV     [DI],AL                 ; ON FIRST BYTE
E676 8A05             1330          MOV     AL,[DI]
E678 32C4             1331          XOR     AL,AH                   ; O.K.?
E67A 754D             1332          JNZ     C7                      ; GO ERROR IF NOT
E67C FEC4             1333          INC     AH
E67E 8AC4             1334          MOV     AL,AH
E680 75F2             1335          JNZ     C2_1                    ; LOOP TILL WRAP THROUGH FF
E682 8BD9             1336          MOV     BX,CX                   ; SAVE WORD COUNT OF BLOCK TO TEST
E684 D1E3             1337          SHL     BX,1                    ; CONVERT TO A BYTE COUNT
E686 B8AAAA           1338          MOV     AX,0AAAAH               ; GET INITIAL DATA PATTERN TO WRITE
E689 BA55FF           1339          MOV     DX,0FF55H               ; SETUP OTHER DATA PATTERNS TO USE
E68C F3               1340          REP     STOSW                   ; FILL STORAGE LOCATIONS IN BLOCK
E68D AB
E68E E461             1341          IN      AL,PORT_B
E690 0C30             1342          OR      AL,00110000B            ; TOGGLE PARITY CHECK LATCHES
E692 E661             1343          OUT     PORT_B,AL
E694 90               1344          NOP
E695 24CF             1345          AND     AL,11001111B
E697 E661             1346          OUT     PORT_B,AL
E699                  1347  C3:
E699 4F               1348          DEC     DI                      ; POINT TO LAST BYTE JUST WRITTEN
E69A FD               1349          STD                             ; SET DIR FLAG TO GO BACKWARDS
E69B                  1350  C4:
E69B 8BF7             1351          MOV     SI,DI                   ; INITIALIZE DESTINATION POINTER
E69D 8BCB             1352          MOV     CX,BX                   ; SETUP BYTE COUNT FOR LOOP
E69F                  1353  C5:                                     ;       INNER TEST LOOP
E69F AC               1354          LODSB                           ; READ OLD TEST BYTE FROM STG [SI]+'
E6A0 32C4             1355          XOR     AL,AH                   ; DATA READ AS EXPECTED ?
E6A2 7525             1356          JNE     C7                      ; NO - GO TO ERROR ROUTINE
E6A4 8AC2             1357          MOV     AL,DL                   ; GET NEXT DATA PATTERN TO WRITE
E6A6 AA               1358          STOSB                           ; WRITE INTO LOC JUST READ [DI]+'
E6A7 E2F6             1359          LOOP    C5                      ; DECREMENT BYTE COUNT AND LOOP   CX
                      1360
E6A9 22E4             1361          AND     AH,AH                   ; ENDING ZERO PATTERN WRITTEN TO STG ?
E6AB 7416             1362          JZ      C6X                     ; YES - RETURN TO CALLER WITH AL=0
E6AD 8AE0             1363          MOV     AH,AL                   ; SETUP NEW VALUE FOR COMPARE
E6AF 86F2             1364          XCHG    DH,DL                   ; MOVE NEXT DATA PATTERN TO DL
E6B1 22E4             1365          AND     AH,AH                   ; READING ZERO PATTERN THIS PASS ?
E6B3 7504             1366          JNZ     C6                      ; CONTINUE TEST SEQUENCE TILL ZERO DATA
E6B5 8AD4             1367          MOV     DL,AH                   ; ELSE SET ZERO FOR END READ PATTERN
E6B7 EBE0             1368          JMP     C3                      ; AND MAKE FINAL BACKWARDS PASS
E6B9                  1369  C6:
E6B9 FC               1370          CLD                             ; SET DIR FLAG TO GO FORWARD
E6BA 47               1371          INC     DI                      ; SET POINTER TO BEG LOCATION
E6BB 74DE             1372          JZ      C4                      ; READ/WRITE FORWARD IN STG
E6BD 4F               1373          DEC     DI                      ; ADJUST POINTER
E6BE BA0100           1374          MOV     DX,00001H               ; SETUP 01 FOR PARITY BIT AND 00 FOR END
E6C1 EBD6             1375          JMP     C3                      ; READ/WRITE BACKWARD IN STG
E6C3                  1376  C6X:
E6C3 E462             1377          IN      AL,PORT_C               ; DID A PARITY ERROR OCCUR ?
E6C5 24C0             1378          AND     AL,0C0H                 ; ZERO FLAG WILL BE OFF PARITY ERROR
E6C7 B000             1379          MOV     AL,000H                 ; AL=0 DATA COMPARE OK
E6C9                  1380  C7:
E6C9 FC               1381          CLD                             ; SET DIRECTION FLAG TO INC
E6CA C3               1382          RET
                      1383  STGTST_CNT      ENDP
                      1384  ;--------------------------------------------------------------------------
                      1385  ;  PRINT ADDRESS AND ERROR MESSAGE FOR ROM CHECKSUM ERRORS                :
                      1386  ;--------------------------------------------------------------------------
E6CB                  1387  ROM_ERR PROC    NEAR
E6CB 52               1388          PUSH    DX                      ; SAVE POINTER
E6CC 50               1389          PUSH    AX
E6CD 8CDA             1390          MOV     DX,DS                   ; GET ADDRESS POINTER
E6CF 2688361500       1391          MOV     ES:MFG_ERR_FLAG,DH      ; <><><><><><><><><><><><><><><><>
                      1392                                          ; <><><>CHECKPOINTS C0->F4<><><>
E6D4 81FA00C8         1393          CMP     DX,0C800H               ; CRT CARD IN ERROR?
E6D8 7C0D             1394          JL      ROM_ERR_BEEP            ; GIVE CRT CARD FAIL BEEP
E6DA E8FD18           1395          CALL    PRT_SEG                 ; PRINT SEGEMENT IN ERROR
E6DD BE0AF990         1396          MOV     SI,OFFSET F3A           ; DISPLAY ERROR MSG
E6E1 E8C512           1397          CALL    E_MSG
E6E4                  1398  ROM_ERR_END:
E6E4 58               1399          POP     AX
E6E5 5A               1400          POP     DX
E6E6 C3               1401          RET
E6E7                  1402  ROM_ERR_BEEP:
E6E7 BA0201           1403          MOV     DX,0102H                ; BEEP 1 LONG, 2 SHORT
E6EA E8EB12           1404          CALL    ERR_BEEP
E6ED EBF5             1405          JMP     SHORT ROM_ERR_END
                      1406  ROM_ERR ENDP
                      1407
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LOC OBJECT            LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

                      1408  ;--- INT 19 ------------------------------------------------
                      1409  ; BOOT STRAP LOADER                                        :
                      1410  ;       TRACK 0, SECTOR 1 IS READ INTO THE                 :
                      1411  ;       BOOT LOCATION (SEGMENT 0, OFFSET 7C00)             :
                      1412  ;       AND CONTROL IS TRANSFERRED THERE.                  :
                      1413  ;                                                          :
                      1414  ;       IF THERE IS A HARDWARE ERROR CONTROL IS            :
                      1415  ;       TRANSFERRED TO THE ROM BASIC ENTRY POINT.          :
                      1416  ;------------------------------------------------------------
                      1417          ASSUME  CS:CODE,DS:ABS0
E6F2                  1418          ORG     0E6F2H
                      1419
E6F2                  1420  BOOT_STRAP      PROC    NEAR
E6F2 FB               1421          STI                             ; ENABLE INTERRUPTS
E6F3 2BC0             1422          SUB     AX,AX                   ; ESTABLISH ADDRESSING
E6F5 8ED8             1423          MOV     DS,AX
                      1424
                      1425  ;----- RESET THE DISK PARAMETER TABLE VECTOR
                      1426
E6F7 C7067800C7EF     1427          MOV     WORD PTR DISK_POINTER, OFFSET DISK_BASE
E6FD 8C0E7A00         1428          MOV     WORD PTR DISK_POINTER+2,CS
                      1429
                      1430  ;-----  LOAD SYSTEM FROM DISKETTE -- CX HAS RETRY COUNT
                      1431
E701 B90400           1432          MOV     CX,4                    ; SET RETRY COUNT
E704                  1433  H1:                                     ; IPL_SYSTEM
E704 51               1434          PUSH    CX                      ; SAVE RETRY COUNT
E705 B400             1435          MOV     AH,0                    ; RESET THE DISKETTE SYSTEM
E707 CD13             1436          INT     13H                     ; DISKETTE_IO
E709 720F             1437          JC      H2                      ; IF ERROR, TRY AGAIN
E70B B80102           1438          MOV     AX,201H                 ; READ IN THE SINGLE SECTOR
E70E 2BD2             1439          SUB     DX,DX                   ; TO THE BOOT LOCATION
E710 8EC2             1440          MOV     ES,DX
E712 BB007C           1441          MOV     BX,OFFSET BOOT_LOCN
                      1442                                          ; DRIVE 0, HEAD 0
E715 B90100           1443          MOV     CX,1                    ; SECTOR 1, TRACK 0
E718 CD13             1444          INT     13H                     ; DISKETTE_IO
E71A                  1445  H2:
E71A 59               1446          POP     CX                      ; RECOVER RETRY COUNT
E71B 7304             1447          JNC     H4                      ; CF SET BY UNSUCCESSFUL READ
E71D E2E5             1448          LOOP    H1                      ; DO IT FOR RETRY TIMES
                      1449
                      1450  ;----- UNABLE TO IPL FROM THE DISKETTE
                      1451
E71F                  1452  H3:
E71F CD18             1453          INT     18H                     ; GO TO RESIDENT BASIC
                      1454
                      1455  ;----- IPL WAS SUCCESSFUL
                      1456
E721                  1457  H4:
E721 EA007C0000       1458          JMP     BOOT_LOCN
                      1459  BOOT_STRAP      ENDP
                      1460
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LOC OBJECT          LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

                    1461  ;-----INT 14--------------------------------------------------------------
                    1462  ; RS232_IO                                                               :
                    1463  ;       THIS ROUTINE PROVIDES BYTE STREAM I/O TO THE COMMUNICATIONS       :
                    1464  ;       PORT ACCORDING TO THE PARAMETERS:                                 :
                    1465  ;       (AH)=0  INITIALIZE THE COMMUNICATIONS PORT                        :
                    1466  ;               (AL) HAS PARAMETERS FOR INITIALIZATION                    :
                    1467  ;                                                                         :
                    1468  ;       7       6       5       4       3       2       1       0         :
                    1469  ;       ----- BAUD RATE --      -PARITY--       STOPBIT   --WORD LENGTH-- :
                    1470  ;       000 - 110               X0 - NONE         0 - 1     10 - 7 BITS   :
                    1471  ;       001 - 150               01 - ODD          1 - 2     11 - 8 BITS   :
                    1472  ;       010 - 300               11 - EVEN                               :
                    1473  ;       011 - 600                                                       :
                    1474  ;       100 - 1200                                                      :
                    1475  ;       101 - 2400                                                      :
                    1476  ;       110 - 4800                                                      :
                    1477  ;       111 - 9600                                                      :
                    1478  ;                                                                       :
                    1479  ;       ON RETURN, CONDITIONS SET AS IN CALL TO COMMO STATUS (AH=3)      :
                    1480  ;       (AH)=1  SEND THE CHARACTER IN (AL) OVER THE COMMO LINE          :
                    1481  ;               (AL) REGISTER IS PRESERVED                              :
                    1482  ;               ON EXIT, BIT 7 OF AH IS SET IF THE ROUTINE WAS UNABLE   :
                    1483  ;                       TO TRANSMIT THE BYTE OF DATA OVER THE LINE.     :
                    1484  ;                       IF BIT 7 OF AH IS NOT SET, THE REMAINDER OF AH  :
                    1485  ;                       IS SET AS IN A STATUS REQUEST, REFLECTING THE   :
                    1486  ;                       CURRENT STATUS OF THE LINE.                     :
                    1487  ;       (AH)=2  RECEIVE A CHARACTER IN (AL) FROM COMMO LINE BEFORE      :
                    1488  ;                       RETURNING TO CALLER                             :
                    1489  ;               ON EXIT, AH HAS THE CURRENT LINE STATUS, AS SET BY THE   :
                    1490  ;                       THE STATUS ROUTINE, EXCEPT THAT THE ONLY BITS   :
                    1491  ;                       LEFT ON ARE THE ERROR BITS (7,4,3,2,1)          :
                    1492  ;                       IF AH HAS BIT 7 ON (TIME OUT) THE REMAINING     :
                    1493  ;                       BITS ARE NOT PREDICTABLE.                       :
                    1494  ;                       THUS, AH IS NON ZERO ONLY WHEN AN ERROR         :
                    1495  ;                       OCCURRED.                                       :
                    1496  ;       (AH)=3  RETURN THE COMMO PORT STATUS IN (AX)                    :
                    1497  ;               AH CONTAINS THE LINE STATUS                             :
                    1498  ;                       BIT 7 = TIME OUT                                :
                    1499  ;                       BIT 6 = TRANS SHIFT REGISTER EMPTY              :
                    1500  ;                       BIT 5 = TRAN HOLDING REGISTER EMPTY             :
                    1501  ;                       BIT 4 = BREAK DETECT                            :
                    1502  ;                       BIT 3 = FRAMING ERROR                           :
                    1503  ;                       BIT 2 = PARITY ERROR                            :
                    1504  ;                       BIT 1 = OVERRUN ERROR                           :
                    1505  ;                       BIT 0 = DATA READY                              :
                    1506  ;                       AL CONTAINS THE MODEM STATUS                    :
                    1507  ;                       BIT 7 = RECEIVED LINE SIGNAL DETECT             :
                    1508  ;                       BIT 6 = RING INDICATOR                          :
                    1509  ;                       BIT 5 = DATA SET READY                          :
                    1510  ;                       BIT 4 = CLEAR TO SEND                           :
                    1511  ;                       BIT 3 = DELTA RECEIVE LINE SIGNAL DETECT        :
                    1512  ;                       BIT 2 = TRAILING EDGE RING DETECTOR             :
                    1513  ;                       BIT 1 = DELTA DATA SET READY                    :
                    1514  ;                       BIT 0 = DELTA CLEAR TO SEND                     :
                    1515  ;                                                                       :
                    1516  ;       (DX) = PARAMETER INDICATING WHICH RS232 CARD (0,1 ALLOWED)       :
                    1517  ;                                                                       :
                    1518  ; DATA AREA RS232_BASE CONTAINS THE BASE ADDRESS OF THE 8250 ON THE     :
                    1519  ;       CARD LOCATION 400H CONTAINS UP TO 4 RS232 ADDRESSES POSSIBLE     :
                    1520  ;       DATA AREA LABEL RS232_TIM_OUT (BYTE) CONTAINS OUTER LOOP COUNT  :
                    1521  ;       VALUE FOR TIMEOUT (DEFAULT=1)                                   :
                    1522  ; OUTPUT                                                                :
                    1523  ;       AX MODIFIED ACCORDING TO PARMS OF CALL                          :
                    1524  ;       ALL OTHERS UNCHANGED                                            :
                    1525  ;-----------------------------------------------------------------------
                    1526          ASSUME  CS:CODE,DS:DATA
E729                1527          ORG     0E729H
E729                1528  A1      LABEL   WORD                    ; TABLE OF INIT VALUES
E729 1704           1529          DW      1047                    ; 110 BAUD
E72B 0003           1530          DW      768                     ; 150
E72D 8001           1531          DW      384                     ; 300
E72F C000           1532          DW      192                     ; 600
E731 6000           1533          DW      96                      ; 1200
E733 3000           1534          DW      48                      ; 2400
E735 1800           1535          DW      24                      ; 4800
E737 0C00           1536          DW      12                      ; 9600
                    1537
E739                1538  RS232_IO        PROC    FAR
                    1539
                    1540  ;----- VECTOR TO APPROPRIATE ROUTINE
                    1541
E739 FB             1542          STI                             ; INTERRUPTS BACK ON
E73A 1E             1543          PUSH    DS                      ; SAVE SEGMENT
E73B 52             1544          PUSH    DX
E73C 56             1545          PUSH    SI
E73D 57             1546          PUSH    DI
E73E 51             1547          PUSH    CX
E73F 53             1548          PUSH    BX
E740 8BF2           1549          MOV     SI,DX                   ; RS232 VALUE TO SI
E742 8BFA           1550          MOV     DI,DX
E744 D1E6           1551          SHL     SI,1                    ; WORD OFFSET
E746 E81013         1552          CALL    DDS
E7 49 8B14          1553          MOV     DX,RS232_BASE[SI]       ; GET BASE ADDRESS
E74B 0BD2           1554          OR      DX,DX                   ; TEST FOR 0 BASE ADDRESS
E74D 7413           1555          JZ      A3                      ; RETURN
E74F 0AE4           1556          OR      AH,AH                   ; TEST FOR (AH)=0
E751 7416           1557          JZ      A4                      ; COMMUN INIT
E753 FECC           1558          DEC     AH                      ; TEST FOR (AH)=1
E755 7445           1559          JZ      A5                      ; SEND AL
E757 FECC           1560          DEC     AH                      ; TEST FOR (AH)=2
E759 746A           1561          JZ      A12                     ; RECEIVE INTO AL
E75B                1562  A2:
E75B FECC           1563          DEC     AH                      ; TEST FOR (AH)=3
E75D 7503           1564          JNZ     A3
E75F E98300         1565          JMP     A18                     ; COMMUNICATION STATUS
E762                1566  A3:                                     ; RETURN FROM RS232
E762 5B             1567          POP     BX
E763 59             1568          POP     CX
E764 5F             1569          POP     DI
E765 5E             1570          POP     SI
E766 5A             1571          POP     DX
E767 1F             1572          POP     DS
E768 CF             1573          IRET                            ; RETURN TO CALLER, NO ACTION
                    1574
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LOC OBJECT          LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

                    1575  ;----- INITIALIZE THE COMMUNICATIONS PORT
                    1576
E769                1577  A4:
E769 8AE0           1578          MOV     AH,AL                   ; SAVE INIT PARMS IN AH
E76B 83C203         1579          ADD     DX,3                    ; POINT TO 8250 CONTROL REGISTER
E76E B080           1580          MOV     AL,80H
E770 EE             1581          OUT     DX,AL                   ; SET DLAB=1
                    1582
                    1583  ;----- DETERMINE BAUD RATE DIVISOR
                    1584
E771 8AD4           1585          MOV     DL,AH                   ; GET PARMS TO DL
E773 B104           1586          MOV     CL,4
E775 D2C2           1587          ROL     DL,CL
E777 81E20E00       1588          AND     DX,0EH                  ; ISOLATE THEM
E77B BF29E7         1589          MOV     DI,OFFSET A1            ; BASE OF TABLE
E77E 03FA           1590          ADD     DI,DX                   ; PUT INTO INDEX REGISTER
E780 8B14           1591          MOV     DX,RS232_BASE[SI]       ; POINT TO HIGH ORDER OF DIVISOR
E782 42             1592          INC     DX
E783 2E8A4501       1593          MOV     AL,CS:[DI]+1            ; GET HIGH ORDER OF DIVISOR
E787 EE             1594          OUT     DX,AL                   ; SET MS OF DIV TO 0
E788 4A             1595          DEC     DX
E789 2E8A05         1596          MOV     AL,SC:[DI]              ; GET LOW ORDER OF DIVISOR
E78C EE             1597          OUT     DX,AL                   ; SET LOW OF DIVISOR
E78D 83C203         1598          ADD     DX,3
E790 8AC4           1599          MOV     AL,AH                   ; GET PARMS BACK
E792 241F           1600          AND     AL,01FH                 ; STRIP OFF THE BAUD BITS
E794 EE             1601          OUT     DX,AL                   ; LINE CONTROL TO 8 BITS
E795 4A             1602          DEC     DX
E796 4A             1603          DEC     DX
E797 B000           1604          MOV     AL,0
E799 EE             1605          OUT     DX,AL                   ; INTERRUPT ENABLES ALL OFF
E79A EB49           1606          JMP     SHORT A18               ; COM_STATUS
                    1607
                    1608  ;----- SEND CHARACTER IN (AL) OVER COMMO LINE
                    1609
E79C                1610  A5:
E79C 50             1611          PUSH    AX                      ; SAVE CHAR TO SEND
E79D 83C204         1612          ADD     DX,4                    ; MODEM CONTROL REGISTER
E7A0 B003           1613          MOV     AL,3                    ; DTR AND RTS
E7A2 EE             1614          OUT     DX,AL                   ; DATA TERMINAL READY, REQUEST TO SEND
E7A3 42             1615          INC     DX                      ; MODEM STATUS REGISTER
E7A4 42             1616          INC     DX
E7A5 B730           1617          MOV     BH,30H                  ; DATA SET READY & CLEAR TO SEND
E7A7 E84800         1618          CALL    WAIT_FOR_STATUS         ; ARE BOTH TRUE
E7AA 7408           1619          JE      A9                      ; YES, READY TO TRANSMIT CHAR
E7AC                1620  A7:
E7AC 59             1621          POP     CX
E7AD 8AC1           1622          MOV     AL,CL                   ; RELOAD DATA BYTE
E7AF                1623  A8:
E7AF 80CC80         1624          OR      AH,80H                  ; INDICATE TIME OUT
E7B2 EBAE           1625          JMP     A3                      ; RETURN
E7B4                1626  A9:                                     ; CLEAR TO SEND
E7B4 4A             1627          DEC     DX                      ; LINE STATUS REGISTER
E7B5                1628  A10:                                    ; WAIT_SEND
E7B5 B720           1629          MOV     BH,20H                  ; IS TRANSMITTER READY
E7B7 E83800         1630          CALL    WAIT_FOR_STATUS         ; TEST FOR TRANSMITTER READY
E7BA 75F0           1631          JNZ     A7                      ; RETURN WITH TIME OUT SET
E7BC                1632  A11:                                    ; OUT_CHAR
E7BC 83EA05         1633          SUB     DX,5                    ; DATA PORT
E7BF 59             1634          POP     CX                      ; RECOVER IN CX TEMPORARILY
E7C0 8AC1           1635          MOV     AL,CL                   ; MOVE CHAR TO AL FOR OUT, STATUS IN AH
E7C2 EE             1636          OUT     DX,AL                   ; OUTPUT CHARACTER
E7C3 EB9D           1637          JMP     A3                      ; RETURN
                    1638
                    1639  ;----- RECEIVE CHARACTER FROM COMMO LINE
                    1640
E7C5                1641  A12:
E7C5 83C204         1642          ADD     DX,4                    ; MODEM CONTROL REGISTER
E7C8 B001           1643          MOV     AL,1                    ; DATA TERMINAL READY
E7CA EE             1644          OUT     DX,AL
E7CB 42             1645          INC     DX                      ; MODEM STATUS REGISTER
E7CC 42             1646          INC     DX
E7CD                1647  A13:                                    ; WAIT_DSR
E7CD B720           1648          MOV     BH,20H                  ; DATA_SET READY
E7CF E82000         1649          CALL    WAIT_FOR_STATUS         ; TEST FOR DSR
E7D2 75DB           1650          JNZ     A8                      ; RETURN WITH ERROR
E7D4                1651  A15:                                    ; WAIT DSR_END
E7D4 4A             1652          DEC     DX                      ; LINE_STATUS REGISTER
E7D5                1653  A16:                                    ; WAIT_RECV
E7D5 B701           1654          MOV     BH,1                    ; RECEIVE BUFFER FULL
E7D7 E81800         1655          CALL    WAIT_FOR_STATUS         ; TEST FOR REC. BUFF. FULL
E7DA 75D3           1656          JNZ     A8                      ; SET TIME OUT ERROR
E7DC                1657  A17:                                    ; GET_CHAR
E7DC 80E41E         1658          AND     AH,00011110B            ; TEST FOR ERR CONDITIONS ON RECV CHAR
E7DF 8B14           1659          MOV     DX,RS232_BASE[SI]       ; DATA PORT
E7E1 EC             1660          IN      AL,DX                   ; GET CHARACTER FROM LINE
E7E2 E97DFF         1661          JMP     A3                      ; RETURN
                    1662
                    1663  ;----- COMMO PORT STATUS ROUTINE
                    1664
E7E5                1665  A18:
E7E5 8B14           1666          MOV     DX,RS232_BASE[SI]
E7E7 83C205         1667          ADD     DX,5                    ; CONTROL PORT
E7EA EC             1668          IN      AL,DX                   ; GET LINE CONTROL STATUS
E7EB 8AE0           1669          MOV     AH,AL                   ; PUT IN AH FOR RETURN
E7ED 42             1670          INC     DX                      ; POINT TO MODEM STATUS REGISTER
E7EE EC             1671          IN      AL,DX                   ; GET MODEM CONTROL STATUS
E7EF E970FF         1672          JMP     A3                      ; RETURN
```

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LOC OBJECT            LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

                      1673  ;--------------------------------------
                      1674  ; WAIT FOR STATUS ROUTINE              :
                      1675  ;                                      :
                      1676  ; ENTRY:                               :
                      1677  ;       BH=STATUS BIT(S) TO LOOK FOR,  :
                      1678  ;       DX=ADDR. OF STATUS REG         :
                      1679  ; EXIT:                                :
                      1680  ;       ZERO FLAG ON  = STATUS FOUND   :
                      1681  ;       ZERO FLAG OFF = TIMEOUT.       :
                      1682  ;       AH=LAST STATUS READ            :
                      1683  ;--------------------------------------
E7F2                  1684  WAIT_FOR_STATUS PROC    NEAR
E7F2 8A5D7C           1685          MOV     BL,RS232_TIM_OUT[DI]    ; LOAD OUTER LOOP COUNT
E7F5                  1686  WFS0:
E7F5 2BC9             1687          SUB     CX,CX
E7F7                  1688  WFS1:
E7F7 EC               1689          IN      AL,DX                   ; GET STATUS
E7F8 8AE0             1690          MOV     AH,AL                   ; MOVE TO AH
E7FA 22C7             1691          AND     AL,BH                   ; ISOLATE BITS TO TEST
E7FC 3AC7             1692          CMP     AL,BH                   ; EXACTLY = TO MASK
E7FE 7408             1693          JE      WFS_END                 ; RETURN WITH ZERO FLAG ON
E800 E2F5             1694          LOOP    WFS1                    ; TRY AGAIN
E802 FECB             1695          DEC     BL
E804 75EF             1696          JNZ     WFS0
                      1697
E806 0AFF             1698          OR      BH,BH                   ; SET ZERO FLAG OFF
E808                  1699  WFS_END:
E808 C3               1700          RET
                      1701  WAIT_FOR_STATUS ENDP
                      1702  RS232_IO        ENDP
                      1703
E809 4552524F522E20   1704  F3D     DB      'ERROR. (RESUME = F1 KEY)',13,10        ; ERROR PROMPT
     28524553554D45
     203D2022463122
     204B455929
E823 0D
E824 0A
                      1705
```

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LOC OBJECT          LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

                    1706  ;---- INT 16 ------------------------------------------------------------
                    1707  ; KEYBOARD I/O                                                          :
                    1708  ;       THESE ROUTINES PROVIDE KEYBOARD SUPPORT                         :
                    1709  ; INPUT                                                                 :
                    1710  ;       (AH)=0  READ THE NEXT ASCII CHARACTER STRUCK FROM THE KEYBOARD  :
                    1711  ;               RETURN THE RESULT IN (AL), SCAN CODE IN (AH)            :
                    1712  ;       (AH)=1  SET THE Z FLAG TO INDICATE IF AN ASCII CHARACTER IS     :
                    1713  ;               AVAILABLE TO BE READ.                                   :
                    1714  ;               (ZF)=1 -- NO CODE AVAILABLE                             :
                    1715  ;               (ZF)=0 -- CODE IS AVAILABLE                             :
                    1716  ;               IF ZF = 0, THE NEXT CHARACTER IN THE BUFFER TO BE READ  :
                    1717  ;               IS IN AX, AND THE ENTRY REMAINS IN THE BUFFER           :
                    1718  ;       (AH)=2  RETURN THE CURRENT SHIFT STATUS IN AL REGISTER          :
                    1719  ;               THE BIT SETTINGS FOR THIS CODE ARE INDICATED IN THE     :
                    1720  ;               THE EQUATES FOR KB_FLAG                                 :
                    1721  ; OUTPUT                                                                :
                    1722  ;       AS NOTED ABOVE, ONLY AX AND FLAGS CHANGED                       :
                    1723  ;       ALL REGISTERS PRESERVED                                         :
                    1724  ;-----------------------------------------------------------------------
                    1725          ASSUME  CS:CODE,DS:DATA
E82E                1726          ORG     0E82EH
E82E                1727  KEYBOARD_IO     PROC    FAR
E82E FB             1728          STI                             ; INTERRUPTS BACK ON
E82F 1E             1729          PUSH    DS                      ; SAVE CURRENT DS
E830 53             1730          PUSH    BX                      ; SAVE BX TEMPORARILY
E831 E82512         1731          CALL    DDS
E834 0AE4           1732          OR      AH,AH                   ; AH=0
E836 740A           1733          JZ      K1                      ; ASCII_READ
E838 FECC           1734          DEC     AH                      ; AH=1
E83A 741E           1735          JZ      K2                      ; ASCII_STATUS
E83C FECC           1736          DEC     AH                      ; AH=2
E83E 742B           1737          JZ      K3                      ; SHIFT_STATUS
E840 EB2C           1738          JMP     SHORT INT10_END         ; EXIT
                    1739
                    1740  ;----- READ THE KEY TO FIGURE OUT WHAT TO DO
                    1741
E842                1742  K1:                                     ; ASCII READ
E842 FB             1743          STI                             ; INTERRUPTS BACK ON DURING LOOP
E843 90             1744          NOP                             ; ALLOW AN INTERRUPT TO OCCUR
E844 FA             1745          CLI                             ; INTERRUPTS BACK OFF
E845 8B1E1A00       1746          MOV     BX,BUFFER_HEAD          ; GET POINTER TO HEAD OF BUFFER
E849 3B1E1C00       1747          CMP     BX,BUFFER_TAIL          ; TEST END OF BUFFER
E84D 74F3           1748          JZ      K1                      ; LOOP UNTIL SOMETHING IN BUFFER
E84F 8B07           1749          MOV     AX,[BX]                 ; GET SCAN CODE AND ASCII CODE
E851 E81D00         1750          CALL    K4                      ; MOVE POINTER TO NEXT POSITION
E854 891E1A00       1751          MOV     BUFFER_HEAD,BX          ; STORE VALUE IN VARIABLE
E858 EB14           1752          JMP     SHORT INT10_END         ; RETURN
                    1753
                    1754  ;----- ASCII STATUS
                    1755
E85A                1756  K2:
E85A FA             1757          CLI                             ; INTERRUPTS OFF
E85B 8B1E1A00       1758          MOV     BX,BUFFER_HEAD          ; GET HEAD POINTER
E85F 3B1E1C00       1759          CMP     BX,BUFFER_TAIL          ; IF EQUAL (Z=1) THEN NOTHING THERE
E863 8B07           1760          MOV     AX,[BX]
E865 FB             1761          STI                             ; INTERRUPTS BACK ON
E866 5B             1762          POP     BX                      ; RECOVER REGISTER
E867 1F             1763          POP     DS                      ; RECOVER SEGMENT
E868 CA0200         1764          RET     2                       ; THROW AWAY FLAGS
                    1765
                    1766  ;----- SHIFT STATUS
                    1767
E86B                1768  K3:
E86B A01700         1769          MOV     AL,KB_FLAG              ; GET THE SHIFT STATUS FLAGS
E86E                1770  INT10_END:
E86E 5B             1771          POP     BX                      ; RECOVER REGISTER
E86F 1F             1772          POP     DS                      ; RECOVER REGISTERS
E870 CF             1773          IRET                            ; RETURN TO CALLER
                    1774  KEYBOARD_IO     ENDP
                    1775
                    1776  ;----- INCREMENT A BUFFER POINTER
                    1777
E871                1778  K4      PROC    NEAR
E871 43             1779          INC     BX                      ; MOVE TO NEXT WORD IN LIST
E872 43             1780          INC     BX
E873 3B1E8200       1781          CMP     BX,BUFFER_END           ; AT END OF BUFFER?
E877 7504           1782          JNE     K5                      ; NO, CONTINUE
E879 8B1E8000       1783          MOV     BX,BUFFER_START         ; YES, RESET TO BUFFER BEGINNING
E87D                1784  K5:
E87D C3             1785          RET
                    1786  K4      ENDP
                    1787
                    1788  ;----- TABLE OF SHIFT KEYS AND MASK VALUES
                    1789
E87E                1790  K6      LABEL   BYTE
E87E 52             1791          DB      INS_KEY                 ; INSERT KEY
E87F 3A             1792          DB      CAPS_KEY,NUM_KEY,SCROLL_KEY,ALT_KEY,CTL_KEY
E880 45
E881 46
E882 38
E883 1D
E884 2A             1793          DB      LEFT_KEY,RIGHT_KEY
E885 36
  0008              1794  K6L     EQU     $-K6
                    1795
                    1796  ;----- SHIFT_MASK_TABLE
                    1797
E886                1798  K7      LABEL   BYTE
E886 80             1799          DB      INS_SHIFT               ; INSERT MODE SHIFT
E887 40             1800          DB      CAPS_SHIFT,NUM_SHIFT,SCROLL_SHIFT,ALT_SHIFT,CTL_SHIFT
E888 20
E889 10
E88A 08
E88B 04
E88C 02             1801          DB      LEFT_SHIFT,RIGHT_SHIFT
E88D 01
                    1802
                    1803  ;----- SCAN CODE TABLES
                    1804
E88E 1B             1805  K8              DB      27,-1,0,-1,-1,-1,30,-1
E88F FF
E890 00
E891 FF
E892 FF
E893 FF
E894 1E
```

SECTION 5

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 LOC OBJECT              LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

E895 FF
E896 FF                  1806                    DB      -1,-1,-1,31,-1,127,-1,17
E897 FF
E898 FF
E899 1F
E89A FF
E89B 7F
E89C FF
E89D 11
E89E 17                  1807                    DB      23,5,18,20,25,21,9,15
E89F 05
E8A0 12
E8A1 14
E8A2 19
E8A3 15
E8A4 09
E8A5 0F
E8A6 10                  1808                    DB      16,27,29,10,-1,1,19
E8A7 1B
E8A8 1D
E8A9 0A
E8AA FF
E8AB 01
E8AC 13
E8AD 04                  1809                    DB      4,6,7,8,10,11,12,-1,-1
E8AE 06
E8AF 07
E8B0 08
E8B1 0A
E8B2 0B
E8B3 0C
E8B4 FF
E8B5 FF
E8B6 FF                  1810                    DB      -1,-1,28,26,24,3,22,2
E8B7 FF
E8B8 1C
E8B9 1A
E8BA 18
E8BB 03
E8BC 16
E8BD 02
E8BE 0E                  1811                    DB      14,13,-1,-1,-1,-1,-1,-1
E8BF 0D
E8C0 FF
E8C1 FF
E8C2 FF
E8C3 FF
E8C4 FF
E8C5 FF
E8C6 20                  1812                    DB      ' ',-1
E8C7 FF
                         1813  ;----- CTL TABLE SCAN
E8C8                     1814  K9        LABEL   BYTE
E8C8 5E                  1815                    DB      94,95,96,97,98,99,100,101
E8C9 5F
E8CA 60
E8CB 61
E8CC 62
E8CD 63
E8CE 64
E8CF 65
E8D0 66                  1816                    DB      102,103,-1,-1,119,-1,132,-1
E8D1 67
E8D2 FF
E8D3 FF
E8D4 77
E8D5 FF
E8D6 84
E8D7 FF
E8D8 73                  1817                    DB      115,-1,116,-1,117,-1,118,-1
E8D9 FF
E8DA 74
E8DB FF
E8DC 75
E8DD FF
E8DE 76
E8DF FF
E8E0 FF                  1818                    DB      -1
                         1819  ;----- LC TABLE
E8E1                     1820  K10       LABEL   BYTE
E8E1 1B                  1821                    DB      01BH,'1234567890-=',08H,09H
E8E2 31323334353637
     3839302D3D
E8EE 08
E8EF 09
E8F0 7177657274797
     696F705B5D       1822                    DB      'qwertyuiop[]',0DH,-1,'asdfghjkl;',027H
E8FC 0D
E8FD FF
E8FE 6173646667686A
     6B6C3B
E908 27
E909 60                  1823                    DB      60H,-1,5CH,'zxcvbnm,./',-1,'*',-1,' '
E90A FF
E90B 5C
E90C 7A7863766266E6D
     2C2E2F
E916 FF
E917 2A
E918 FF
E919 20
E91A FF                  1824                    DB      -1
                         1825  ;----- UC TABLE
E91B                     1826  K11       LABEL   BYTE
E91B 1B                  1827                    DB      27,'!@#&',37,05EH,'&*()_+',08H,0
E91C 21402324
E920 25
E921 5E
E922 262A28295F2B
E928 08
E929 00
E92A 515745525459555     1828                    DB      'QWERTYUIOP{}',0DH,-1,'ASDFGHJKL:"'
     494F507B7D
E936 0D
E937 FF
E938 4153444647484A
```

```
 LOC OBJECT            LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

     4B4C3A22
E943 7E                1829                  DB      07EH,-1,'|ZXCVBNM<>?',-1,0,-1,' ',-1
E944 FF
E945 7C5A584356424E
     4D3C3E3F
E950 FF
E951 00
E952 FF
E953 20
E954 FF
                       1830  ;----- UC TABLE SCAN
E955                   1831  K12     LABEL   BYTE
E955 54                1832                  DB      84,85,86,87,88,89,90
E956 55
E957 56
E958 57
E959 58
E95A 59
E95B 5A
E95C 5B                1833                  DB      91,92,93
E95D 5C
E95E 5D
                       1834  ;----- ALT TABLE SCAN
E95F                   1835  K13     LABEL   BYTE
E95F 68                1836                  DB      104,105,106,107,108
E960 69
E961 6A
E962 6B
E963 6C
E964 6D                1837                  DB      109,110,111,112,113
E965 6E
E966 6F
E967 70
E968 71
                       1838  ;----- NUM STATE TABLE
E969                   1839  K14     LABEL   BYTE
E969 3738392D343536    1840                  DB      '789-456+1230.'
     2B3132333032E
                       1841  ;----- BASE CASE TABLE
E976                   1842  K15     LABEL   BYTE
E976 47                1843                  DB      71,72,73,-1,75,-1,77
E977 48
E978 49
E979 FF
E97A 4B
E97B FF
E97C 4D
E97D FF                1844                  DB      -1,79,80,81,82,83
E97E 4F
E97F 50
E980 51
E981 52
E982 53
                       1845
                       1846  ;----- KEYBOARD INTERRUPT ROUTINE
                       1847
E987                   1848                  ORG     0E987H
E987                   1849  KB_INT  PROC    FAR
E987 FB                1850                  STI                             ; ALLOW FURTHER INTERRUPTS
E988 50                1851                  PUSH    AX
E989 53                1852                  PUSH    BX
E98A 51                1853                  PUSH    CX
E98B 52                1854                  PUSH    DX
E98C 56                1855                  PUSH    SI
E98D 57                1856                  PUSH    DI
E98E 1E                1857                  PUSH    DS
E98F 06                1858                  PUSH    ES
E990 FC                1859                  CLD                             ; FORWARD DIRECTION
E991 E8C510            1860                  CALL    DDS
E994 E460              1861                  IN      AL,KB_DATA              ; READ IN THE CHARACTER
E996 50                1862                  PUSH    AX                      ; SAVE IT
E997 E461              1863                  IN      AL,KB_CTL               ; GET THE CONTROL PORT
E999 8AE0              1864                  MOV     AH,AL                   ; SAVE VALUE
E99B 0C80              1865                  OR      AL,80H                  ; RESET BIT FOR KEYBOARD
E99D E661              1866                  OUT     KB_CTL,AL
E99F 86E0              1867                  XCHG    AH,AL                   ; GET BACK ORIGINAL CONTROL
E9A1 E661              1868                  OUT     KB_CTL,AL               ; KB HAS BEEN RESET
E9A3 58                1869                  POP     AX                      ; RECOVER SCAN CODE
E9A4 8AE0              1870                  MOV     AH,AL                   ; SAVE SCAN CODE IN AH ALSO
                       1871
                       1872  ;----- TEST FOR OVERRUN SCAN CODE FROM KEYBOARD
                       1873
E9A6 3CFF              1874                  CMP     AL,0FFH                 ; IS THIS AN OVERRUN CHAR
E9A8 7503              1875                  JNZ     K16                     ; NO, TEST FOR SHIFT KEY
E9AA E97A02            1876                  JMP     K62                     ; BUFFER_FULL_BEEP
                       1877
                       1878  ;----- TEST FOR SHIFT KEYS
                       1879
E9AD                   1880  K16:                                            ; TEST_SHIFT
E9AD 247F              1881                  AND     AL,07FH                 ; TURN OFF THE BREAK BIT
E9AF 0E                1882                  PUSH    CS
E9B0 07                1883                  POP     ES                      ; ESTABLISH ADDRESS OF SHIFT TABLE
E9B1 BF7EE8            1884                  MOV     DI,OFFSET K6            ; SHIFT KEY TABLE
E9B4 B90800            1885                  MOV     CX,K6L                  ; LENGTH
E9B7 F2                1886                  REPNE   SCASB                   ; LOOK THROUGH THE TABLE FOR A MATCH
E9B8 AE
E9B9 8AC4              1887                  MOV     AL,AH                   ; RECOVER SCAN CODE
E9BB 7403              1888                  JE      K17                     ; JUMP IF MATCH FOUND
E9BD E98500            1889                  JMP     K25                     ; IF NO MATCH, THEN SHIFT NOT FOUND
                       1890
                       1891  ;----- SHIFT KEY FOUND
                       1892
E9C0 81EF7FE8          1893  K17:    SUB     DI,OFFSET K6+1          ; ADJUST PTR TO SCAN CODE MTCH
E9C4 2E8AA586E8        1894          MOV     AH,CS:K7[DI]            ; GET MASK INTO AH
E9C9 A880              1895          TEST    AL,80H                  ; TEST FOR BREAK KEY
E9CB 7551              1896          JNZ     K23                     ; BREAK_SHIFT_FOUND
                       1897
                       1898  ;----- SHIFT MAKE FOUND, DETERMINE SET OR TOGGLE
                       1899
E9CD 80FC10            1900          CMP     AH,SCROLL_SHIFT
E9D0 7307              1901          JAE     K18                     ; IF SCROLL SHIFT OR ABOVE, TOGGLE KEY
                       1902
                       1903  ;----- PLAIN SHIFT KEY, SET SHIFT ON
                       1904
E9D2 08261700          1905          OR      KB_FLAG,AH              ; TURN ON SHIFT BIT
E9D6 E98000            1906          JMP     K26                     ; INTERRUPT_RETURN
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LOC OBJECT            LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

                      1907
                      1908  ;----- TOGGLED SHIFT KEY, TEST FOR 1ST MAKE OR NOT
                      1909
E9D9                  1910  K18:                                  ; SHIFT-TOGGLE
E9D9 F606170004       1911          TEST    KB_FLAG, CTL_SHIFT      ; CHECK CTL SHIFT STATE
E9DE 7565             1912          JNZ     K25                     ; JUMP IF CTL STATE
E9E0 3C52             1913          CMP     AL, INS_KEY             ; CHECK FOR INSERT KEY
E9E2 7522             1914          JNZ     K22                     ; JUMP IF NOT INSERT KEY
E9E4 F606170008       1915          TEST    KB_FLAG, ALT_SHIFT      ; CHECK FOR ALTERNATE SHIFT
E9E9 755A             1916          JNZ     K25                     ; JUMP IF ALTERNATE SHIFT
E9EB F606170020       1917  K19:    TEST    KB_FLAG, NUM_STATE      ; CHECK FOR BASE STATE
E9F0 750D             1918          JNZ     K27                     ; JUMP IF NUM LOCK IS ON
E9F2 F606170003       1919          TEST    KB_FLAG, LEFT_SHIFT+ RIGHT_SHIFT
E9F7 740D             1920          JZ      K22                     ; JUMP IF BASE STATE
                      1921
E9F9                  1922  K20:                                  ; NUMERIC ZERO, NOT INSERT KEY
E9F9 B83052           1923          MOV     AX, 5230H               ; PUT OUT AN ASCII ZERO
E9FC E9D601           1924          JMP     K57                     ; BUFFER_FILL
E9FF                  1925  K21:                                  ; MIGHT BE NUMERIC
E9FF F606170003       1926          TEST    KB_FLAG, LEFT_SHIFT+ RIGHT_SHIFT
EA04 74F3             1927          JZ      K20                     ; JUMP NUMERIC, NOT INSERT
                      1928
EA06                  1929  K22:                                  ; SHIFT TOGGLE KEY HIT; PROCESS IT
EA06 84261800         1930          TEST    AH,KB_FLAG_1            ; IS KEY ALREADY DEPRESSED
EA0A 754D             1931          JNZ     K26                     ; JUMP IF KEY ALREADY DEPRESSED
EA0C 08261800         1932          OR      KB_FLAG_1,AH            ; INDICATE THAT THE KEY IS DEPRESSED
EA10 30261700         1933          XOR     KB_FLAG,AH              ; TOGGLE THE SHIFT STATE
EA14 3C52             1934          CMP     AL,INS_KEY              ; TEST FOR 1ST MAKE OF INSERT KEY
EA16 7541             1935          JNE     K26                     ; JUMP IF NOT INSERT KEY
EA18 B80052           1936          MOV     AX,INS_KEY*256          ; SET SCAN CODE INTO AH, 0 INTO AL
EA1B E9B701           1937          JMP     K57                     ; PUT INTO OUTPUT BUFFER
                      1938
                      1939  ;----- BREAK SHIFT FOUND
                      1940
EA1E                  1941  K23:                                  ; BREAK-SHIFT-FOUND
EA1E 80FC10           1942          CMP     AH,SCROLL_SHIFT         ; IS THIS A TOGGLE KEY
EA21 731A             1943          JAE     K24                     ; YES, HANDLE BREAK TOGGLE
EA23 F6D4             1944          NOT     AH                      ; INVERT MASK
EA25 20261700         1945          AND     KB_FLAG,AH              ; TURN OFF SHIFT BIT
EA29 3CB8             1946          CMP     AL,ALT_KEY+80H          ; IS THIS ALTERNATE SHIFT RELEASE
EA2B 752C             1947          JNE     K26                     ; INTERRUPT_RETURN
                      1948
                      1949  ;----- ALTERNATE SHIFT KEY RELEASED, GET THE VALUE INTO BUFFER
                      1950
EA2D A01900           1951          MOV     AL,ALT_INPUT
EA30 B400             1952          MOV     AH,0                    ; SCAN CODE OF 0
EA32 88261900         1953          MOV     ALT_INPUT,AH            ; ZERO OUT THE FIELD
EA36 3C00             1954          CMP     AL,0                    ; WAS THE INPUT=0
EA38 741F             1955          JE      K26                     ; INTERRUPT_RETURN
EA3A E9A101           1956          JMP     K58                     ; IT WASN'T, SO PUT IN BUFFER
EA3D                  1957  K24:                                  ; BREAK-TOGGLE
EA3D F6D4             1958          NOT     AH                      ; INVERT MASK
EA3F 20261800         1959          AND     KB_FLAG_1,AH            ; INDICATE NO LONGER DEPRESSED
EA43 EB14             1960          JMP     SHORT K26               ; INTERRUPT_RETURN
                      1961
                      1962  ;----- TEST FOR HOLD STATE
                      1963
EA45                  1964  K25:                                  ; NO-SHIFT-FOUND
EA45 3C80             1965          CMP     AL,80H                  ; TEST FOR BREAK KEY
EA47 7310             1966          JAE     K26                     ; NOTHING FOR BREAK CHARS FROM HERE ON
EA49 F606180008       1967          TEST    KB_FLAG_1,HOLD_STATE    ; ARE WE IN HOLD STATE
EA4E 7417             1968          JZ      K28                     ; BRANCH AROUND TEST IF NOT
EA50 3C45             1969          CMP     AL,NUM_KEY
EA52 7405             1970          JE      K26                     ; CAN'T END HOLD ON NUM_LOCK
EA54 80261800F7       1971          AND     KB_FLAG_1,NOT HOLD_STATE        ; TURN OFF THE HOLD STATE BIT
EA59                  1972  K26:                                  ; INTERRUPT-RETURN
EA59 FA               1973          CLI                             ; TURN OFF INTERRUPTS
EA5A B020             1974          MOV     AL,EOI                  ; END OF INTERRUPT COMMAND
EA5C E620             1975          OUT     020H,AL                 ; SEND COMMAND TO INT CONTROL PORT
EA5E                  1976  K27:                                  ; INTERRUPT-RETURN-NO-EOI
EA5E 07               1977          POP     ES
EA5F 1F               1978          POP     DS
EA60 5F               1979          POP     DI
EA61 5E               1980          POP     SI
EA62 5A               1981          POP     DX
EA63 59               1982          POP     CX
EA64 5B               1983          POP     BX
EA65 58               1984          POP     AX                      ; RESTORE STATE
EA66 CF               1985          IRET                            ; RETURN, INTERRUPTS BACK ON
                      1986                                          ;  WITH FLAG CHANGE
                      1987
                      1988  ;----- NOT IN   HOLD STATE, TEST FOR SPECIAL CHARS
                      1989
EA67                  1990  K28:                                  ; NO-HOLD-STATE
EA67 F606170008       1991          TEST    KB_FLAG,ALT_SHIFT       ; ARE WE IN ALTERNATE SHIFT
EA6C 7503             1992          JNZ     K29                     ; JUMP IF ALTERNATE SHIFT
EA6E E99100           1993          JMP     K38                     ; JUMP IF NOT ALTERNATE
                      1994
                      1995  ;----- TEST FOR RESET KEY SEQUENCE (CTL ALT DEL)
                      1996
EA71                  1997  K29:                                  ; TEST-RESET
EA71 F606170004       1998          TEST    KB_FLAG,CTL_SHIFT       ; ARE WE IN CONTROL SHIFT ALSO
EA76 7433             1999          JZ      K31                     ; NO_RESET
EA78 3C53             2000          CMP     AL,DEL_KEY              ; SHIFT STATE IS THERE, TEST KEY
EA7A 752F             2001          JNE     K31                     ; NO_RESET
                      2002
                      2003  ;----- CTL-ALT-DEL HAS BEEN FOUND, DO I/O CLEANUP
                      2004
EA7C C706720034 12    2005          MOV     RESET_FLAG, 1234H       ; SET FLAG FOR RESET FUNCTION
EA82 EA5BE000F0       2006          JMP     RESET                   ; JUMP TO POWER ON DIAGNOSTICS
                      2007
                      2008  ;----- ALT-INPUT-TABLE
EA87                  2009  K30     LABEL   BYTE
EA87 52               2010          DB      82,79,80,81,75,76,77
EA88 4F
EA89 50
EA8A 51
EA8B 4B
EA8C 4C
EA8D 4D
EA8E 47               2011          DB      71,72,73                ; 10 NUMBERS ON KEYPAD
EA8F 48
EA90 49
                      2012  ;----- SUPER-SHIFT-TABLE
EA91 10               2013          DB      16,17,18,19,20,21,22,23 ; A-Z TYPEWRITER CHARS
EA92 11
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EA93 12
EA94 13
EA95 14
EA96 15
EA97 16
EA98 17
EA99 18             2014          DB      24,25,30,31,32,33,34,35
EA9A 19
EA9B 1E
EA9C 1F
EA9D 20
EA9E 21
EA9F 22
EAA0 23
EAA1 24             2015          DB      36,37,38,44,45,46,47,48
EAA2 25
EAA3 26
EAA4 2C
EAA5 2D
EAA6 2E
EAA7 2F
EAA8 30
EAA9 31             2016          DB      49,50
EAAA 32
                    2017
                    2018  ;----- IN ALTERNATE SHIFT, RESET NOT FOUND
                    2019
EAAB                2020  K31:                                    ; NO-RESET
EAAB 3C39           2021          CMP     AL,57                   ; TEST FOR SPACE KEY
EAAD 7505           2022          JNE     K32                     ; NOT THERE
EAAF B020           2023          MOV     AL,' '                  ; SET SPACE CHAR
EAB1 E92101         2024          JMP     K57                     ; BUFFER_FILL
                    2025
                    2026  ;----- LOOK FOR KEY PAD ENTRY
                    2027
EAB4                2028  K32:                                    ; ALT-KEY-PAD
EAB4 BF87EA         2029          MOV     DI,OFFSET K30           ; ALT-INPUT-TABLE
EAB7 B90A00         2030          MOV     CX,10                   ; LOOK FOR ENTRY USING KEYPAD
EABA F2             2031          REPNE   SCASB                   ; LOOK FOR MATCH
EABB AE
EABC 7512           2032          JNE     K33                     ; NO_ALT_KEYPAD
EABE 81EF88EA       2033          SUB     DI,OFFSET K30+1         ; DI NOW HAS ENTRY VALUE
EAC2 A01900         2034          MOV     AL,ALT_INPUT            ; GET THE CURRENT BYTE
EAC5 B40A           2035          MOV     AH,10                   ; MULTIPLY BY 10
EAC7 F6E4           2036          MUL     AH
EAC9 03C7           2037          ADD     AX,DI                   ; ADD IN THE LATEST ENTRY
EACB A21900         2038          MOV     ALT_INPUT,AL            ; STORE IT AWAY
EACE EB89           2039          JMP     K26                     ; THROW AWAY THAT KEYSTROKE
                    2040
                    2041  ;----- LOOK FOR SUPERSHIFT ENTRY
                    2042
EAD0                2043  K33:                                    ; NO-ALT-KEYPAD
EAD0 C606190000     2044          MOV     ALT_INPUT,0             ; ZERO ANY PREVIOUS ENTRY INTO INPUT
EAD5 B91A00         2045          MOV     CX,26                   ; DI,ES ALREADY POINTING
EAD8 F2             2046          REPNE   SCASB                   ; LOOK FOR MATCH IN ALPHABET
EAD9 AE
EADA 7505           2047          JNE     K34                     ; NOT FOUND, FUNCTION KEY OR OTHER
EADC B000           2048          MOV     AL,0                    ; ASCII CODE OF ZERO
EADE E9F400         2049          JMP     K57                     ; PUT IT IN THE BUFFER
                    2050
                    2051  ;----- LOOK FOR TOP ROW OF ALTERNATE SHIFT
                    2052
EAE1                2053  K34:                                    ; ALT-TOP-ROW
EAE1 3C02           2054          CMP     AL,2                    ; KEY WITH '1' ON IT
EAE3 720C           2055          JB      K35                     ; NOT ONE OF INTERESTING KEYS
EAE5 3C0E           2056          CMP     AL,14                   ; IS IT IN THE REGION
EAE7 7308           2057          JAE     K35                     ; ALT-FUNCTION
EAE9 80C476         2058          ADD     AH,118                  ; CONVERT PSUEDO SCAN CODE TO RANGE
EAEC B000           2059          MOV     AL,0                    ; INDICATE AS SUCH
EAEE E9E400         2060          JMP     K57                     ; BUFFER_FILL
                    2061
                    2062  ;----- TRANSLATE ALTERNATE SHIFT PSEUDO SCAN CODES
                    2063
EAF1                2064  K35:                                    ; ALT-FUNCTION
EAF1 3C3B           2065          CMP     AL,59                   ; TEST FOR IN TABLE
EAF3 7303           2066          JAE     K37                     ; ALT-CONTINUE
EAF5                2067  K36:                                    ; CLOSE-RETURN
EAF5 E961FF         2068          JMP     K26                     ; IGNORE THE KEY
EAF8                2069  K37:                                    ; ALT-CONTINUE
EAF8 3C47           2070          CMP     AL,71                   ; IN KEYPAD REGION
EAFA 73F9           2071          JAE     K36                     ; IF SO, IGNORE
EAFC BB5FE9         2072          MOV     BX,OFFSET K13           ; ALT SHIFT PSEUDO SCAN TABLE
EAFF E91B01         2073          JMP     K63                     ; TRANSLATE THAT
                    2074
                    2075  ;----- NOT IN ALTERNATE SHIFT
                    2076
EB02                2077  K38:                                    ; NOT-ALT-SHIFT
EB02 F606170004     2078          TEST    KB_FLAG,CTL_SHIFT       ; ARE WE IN CONTROL SHIFT
EB07 7458           2079          JZ      K44                     ; NOT-CTL-SHIFT
                    2080
                    2081  ;----- CONTROL SHIFT, TEST SPECIAL CHARACTERS
                    2082  ;----- TEST FOR BREAK AND PAUSE KEYS
                    2083
EB09 3C46           2084          CMP     AL,SCROLL_KEY           ; TEST FOR BREAK
EB0B 7518           2085          JNE     K39                     ; NO-BREAK
EB0D 8B1E8000       2086          MOV     BX,BUFFER_START         ; RESET BUFFER TO EMPTY
EB11 891E1A00       2087          MOV     BUFFER_HEAD,BX
EB15 891E1C00       2088          MOV     BUFFER_TAIL,BX
EB19 C606710080     2089          MOV     BIOS_BREAK,80H          ; TURN ON BIOS_BREAK BIT
EB1E CD1B           2090          INT     1BH                     ; BREAK INTERRUPT VECTOR
EB20 2BC0           2091          SUB     AX,AX                   ; PUT OUT DUMMY CHARACTER
EB22 E9B000         2092          JMP     K57                     ; BUFFER_FILL
EB25                2093  K39:                                    ; NO-BREAK
EB25 3C45           2094          CMP     AL,NUM_KEY              ; LOOK FOR PAUSE KEY
EB27 7521           2095          JNE     K41                     ; NO-PAUSE
EB29 800E180008     2096          OR      KB_FLAG_1,HOLD_STATE    ; TURN ON THE HOLD FLAG
EB2E B020           2097          MOV     AL,EOI                  ; END OF INTERRUPT TO CONTROL PORT
EB30 E620           2098          OUT     020H,AL                 ; ALLOW FURTHER KEYSTROKE INTS
                    2099
                    2100  ;----- DURING PAUSE INTERVAL, TURN CRT BACK ON
                    2101
EB32 803E490007     2102          CMP     CRT_MODE,7              ; IS THIS BLACK AND WHITE CARD
EB37 7407           2103          JE      K40                     ; YES, NOTHING TO DO
EB39 BAD803         2104          MOV     DX,03D8H                ; PORT FOR COLOR CARD
EB3C A06500         2105          MOV     AL,CRT_MODE_SET         ; GET THE VALUE OF THE CURRENT MODE
EB3F EE             2106          OUT     DX,AL                   ; SET THE CRT MODE, SO THAT CRT IS ON
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EB40                2107  K40:                                    ; PAUSE-LOOP
EB40 F606180008     2108          TEST    KB_FLAG_1,HOLD_STATE
EB45 75F9           2109          JNZ     K40                     ; LOOP UNTIL FLAG TURNED OFF
EB47 E914FF         2110          JMP     K27                     ; INTERRUPT_RETURN_NO_EOI
EB4A                2111  K41:                                    ; NO-PAUSE
                    2112
                    2113  ;----- TEST SPECIAL CASE KEY 55
                    2114
EB4A 3C37           2115          CMP     AL,55
EB4C 7506           2116          JNE     K42                     ; NOT-KEY-55
EB4E B80072         2117          MOV     AX,114*256              ; START/STOP PRINTING SWITCH
EB51 E98100         2118          JMP     K57                     ; BUFFER_FILL
                    2119
                    2120  ;----- SET UP TO TRANSLATE CONTROL SHIFT
                    2121
EB54                2122  K42:                                    ; NOT-KEY-55
EB54 BB8EE8         2123          MOV     BX,OFFSET K8            ; SET UP TO TRANSLATE CTL
EB57 3C3B           2124          CMP     AL,59                   ; IS IT IN TABLE
                    2125                                          ; CTL-TABLE-TRANSLATE
EB59 7276           2126          JB      K56                     ; YES, GO TRANSLATE CHAR
EB5B                2127  K43:                                    ; CTL-TABLE-TRANSLATE
EB5B BBC8E8         2128          MOV     BX,OFFSET K9            ; CTL TABLE SCAN
EB5E E9BC00         2129          JMP     K63                     ; TRANSLATE_SCAN
                    2130
                    2131  ;----- NOT IN CONTROL SHIFT
                    2132
EB61                2133  K44:                                    ; NOT-CTL-SHIFT
EB61 3C47           2134          CMP     AL,71                   ; TEST FOR KEYPAD REGION
EB63 732C           2135          JAE     K48                     ; HANDLE KEYPAD REGION
EB65 F606170003     2136          TEST    KB_FLAG,LEFT_SHIFT+RIGHT_SHIFT
EB6A 745A           2137          JZ      K54                     ; TEST FOR SHIFT STATE
                    2138
                    2139  ;----- UPPER CASE, HANDLE SPECIAL CASES
                    2140
EB6C 3C0F           2141          CMP     AL,15                   ; BACK TAB KEY
EB6E 7505           2142          JNE     K45                     ; NOT-BACK-TAB
EB70 B8000F         2143          MOV     AX,15*256               ; SET PSEUDO SCAN CODE
EB73 EB60           2144          JMP     SHORT K57               ; BUFFER_FILL
EB75                2145  K45:                                    ; NOT-BACK-TAB
EB75 3C37           2146          CMP     AL,55                   ; PRINT SCREEN KEY
EB77 7509           2147          JNE     K46                     ; NOT-PRINT-SCREEN
                    2148
                    2149  ;----- ISSUE INTERRUPT TO INDICATE PRINT SCREEN FUNCTION
                    2150
EB79 B020           2151          MOV     AL,EOI
EB7B E620           2152          OUT     020H,AL                 ;  SO FURTHER THINGS CAN HAPPEN
EB7D CD05           2153          INT     5H                      ; ISSUE PRINT SCREEN INTERRUPT
EB7F E9DCFE         2154          JMP     K27                     ; GO BACK WITHOUT EOI OCCURRING
EB82                2155  K46:                                    ; NOT-PRINT-SCREEN
EB82 3C3B           2156          CMP     AL,59                   ; FUNCTION KEYS
EB84 7206           2157          JB      K47                     ; NOT-UPPER-FUNCTION
EB86 BB55E9         2158          MOV     BX,OFFSET K12           ; UPPER CASE PSEUDO SCAN CODES
EB89 E99100         2159          JMP     K63                     ; TRANSLATE_SCAN
EB8C                2160  K47:                                    ; NOT-UPPER-FUNCTION
EB8C BB1BE9         2161          MOV     BX,OFFSET K11           ; POINT TO UPPER CASE TABLE
EB8F EB40           2162          JMP     SHORT K56               ; OK, TRANSLATE THE CHAR
                    2163
                    2164  ;----- KEYPAD KEYS, MUST TEST NUM LOCK FOR DETERMINATION
                    2165
EB91                2166  K48:                                    ; KEYPAD-REGION
EB91 F606170020     2167          TEST    KB_FLAG,NUM_STATE       ; ARE WE IN NUM_LOCK
EB96 7520           2168          JNZ     K52                     ; TEST FOR SURE
EB98 F606170003     2169          TEST    KB_FLAG,LEFT_SHIFT+RIGHT_SHIFT  ; ARE WE IN SHIFT STATE
EB9D 7520           2170          JNZ     K53                     ; IF SHIFTED, REALLY NUM STATE
                    2171
                    2172  ;----- BASE CASE FOR KEYPAD
                    2173
EB9F                2174  K49:                                    ; BASE-CASE
EB9F 3C4A           2175          CMP     AL,74                   ; SPECIAL CASE FOR A COUPLE OF KEYS
EBA1 740B           2176          JE      K50                     ; MINUS
EBA3 3C4E           2177          CMP     AL,78
EBA5 740C           2178          JE      K51
EBA7 2C47           2179          SUB     AL,71                   ; CONVERT ORIGIN
EBA9 BB76E9         2180          MOV     BX,OFFSET K15           ; BASE CASE TABLE
EBAC EBT1           2181          JMP     SHORT K64               ; CONVERT TO PSEUDO SCAN
EBAE                2182  K50:
EBAE B82D4A         2183          MOV     AX,74*256+'-'           ; MINUS
EBB1 EB22           2184          JMP     SHORT K57               ; BUFFER_FILL
EBB3                2185  K51:
EBB3 B82B4E         2186          MOV     AX,78*256+'+'           ; PLUS
EBB6 EB1D           2187          JMP     SHORT K57               ; BUFFER_FILL
                    2188
                    2189  ;----- MIGHT BE NUM LOCK, TEST SHIFT STATUS
                    2190
EBB8                2191  K52:                                    ; ALMOST-NUM-STATE
EBB8 F606170003     2192          TEST    KB_FLAG,LEFT_SHIFT+RIGHT_SHIFT
EBBD 75E0           2193          JNZ     K49                     ; SHIFTED TEMP OUT OF NUM STATE
EBBF                2194  K53:                                    ; REALLY_NUM_STATE
EBBF 2C46           2195          SUB     AL,70                   ; CONVERT ORIGIN
EBC1 BB69E9         2196          MOV     BX,OFFSET K14           ; NUM STATE TABLE
EBC4 EB0B           2197          JMP     SHORT K56               ; TRANSLATE_CHAR
                    2198
                    2199  ;----- PLAIN OLD LOWER CASE
                    2200
EBC6                2201  K54:                                    ; NOT-SHIFT
EBC6 3C3B           2202          CMP     AL,59                   ; TEST FOR FUNCTION KEYS
EBC8 7204           2203          JB      K55                     ; NOT-LOWER-FUNCTION
EBCA B000           2204          MOV     AL,0                    ; SCAN CODE IN AH ALREADY
EBCC EB07           2205          JMP     SHORT K57               ; BUFFER_FILL
EBCE                2206  K55:                                    ; NOT-LOWER-FUNCTION
EBCE BBE1E8         2207          MOV     BX,OFFSET K10           ; LC TABLE
                    2208
                    2209  ;----- TRANSLATE THE CHARACTER
                    2210
EBD1                2211  K56:                                    ; TRANSLATE-CHAR
EBD1 FEC8           2212          DEC     AL                      ; CONVERT ORIGIN
EBD3 2ED7           2213          XLAT    CS:K11                  ; CONVERT THE SCAN CODE TO ASCII
                    2214
                    2215  ;----- PUT CHARACTER INTO BUFFER
                    2216
EBD5                2217  K57:                                    ; BUFFER-FILL
EBD5 3CFF           2218          CMP     AL,-1                   ; IS THIS AN IGNORE CHAR
EBD7 741F           2219          JE      K59                     ; YES, DO NOTHING WITH IT
EBD9 80FCFF         2220          CMP     AH,-1                   ; LOOK FOR -1 PSEUDO SCAN
EBDC 741A           2221          JE      K59                     ; NEAR_INTERRUPT_RETURN
                    2222
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LOC OBJECT            LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

                      2223  ;----- HANDLE THE CAPS LOCK PROBLEM
                      2224
EBDE                  2225  K58:                                    ; BUFFER-FILL-NOTEST
EBDE F606170040       2226          TEST    KB_FLAG,CAPS_STATE      ; ARE WE IN CAPS LOCK STATE
EBE3 7420             2227          JZ      K61                     ; SKIP IF NOT
                      2228
                      2229  ;----- IN CAPS LOCK STATE
                      2230
EBE5 F606170003       2231          TEST    KB_FLAG,LEFT_SHIFT+RIGHT_SHIFT  ; TEST FOR SHIFT STATE
EBEA 740F             2232          JZ      K60                     ; IF NOT SHIFT, CONVERT LOWER TO UPPER
                      2233
                      2234  ;----- CONVERT ANY UPPER CASE TO LOWER CASE
                      2235
EBEC 3C41             2236          CMP     AL,'A'                  ; FIND OUT IF ALPHABETIC
EBEE 7215             2237          JB      K61                     ; NOT_CAPS_STATE
EBF0 3C5A             2238          CMP     AL,'Z'
EBF2 7711             2239          JA      K61                     ; NOT_CAPS_STATE
EBF4 0420             2240          ADD     AL,'a'-'A'              ; CONVERT TO LOWER CASE
EBF6 EB0D             2241          JMP     SHORT K61               ; NOT_CAPS_STATE
EBF8                  2242  K59:                                    ; NEAR-INTERRUPT-RETURN
EBF8 E95EFE           2243          JMP     K26                     ; INTERRUPT_RETURN
                      2244
                      2245  ;----- CONVERT ANY LOWER CASE TO UPPER CASE
                      2246
EBFB                  2247  K60:                                    ; LOWER-TO-UPPER
EBFB 3C61             2248          CMP     AL,'a'                  ; FIND OUT IF ALPHABETIC
EBFD 7206             2249          JB      K61                     ; NOT_CAPS_STATE
EBFF 3C7A             2250          CMP     AL,'z'
EC01 7702             2251          JA      K61                     ; NOT_CAPS_STATE
EC03 2C20             2252          SUB     AL,'a'-'A'              ; CONVERT TO UPPER CASE
EC05                  2253  K61:                                    ; NOT-CAPS-STATE
EC05 8B1E1C00         2254          MOV     BX,BUFFER_TAIL          ; GET THE END POINTER TO THE BUFFER
EC09 8BF3             2255          MOV     SI,BX                   ; SAVE THE VALUE
EC0B E863FC           2256          CALL    K4                      ; ADVANCE THE TAIL
EC0E 3B1E1A00         2257          CMP     BX,BUFFER_HEAD          ; HAS THE BUFFER WRAPPED AROUND
EC12 7413             2258          JE      K62                     ; BUFFER_FULL_BEEP
EC14 8904             2259          MOV     [SI],AX                 ; STORE THE VALUE
EC16 891E1C00         2260          MOV     BUFFER_TAIL,BX          ; MOVE THE POINTER UP
EC1A E93CFE           2261          JMP     K26                     ; INTERRUPT_RETURN
                      2262
                      2263  ;----- TRANSLATE SCAN FOR PSEUDO SCAN CODES
                      2264
EC1D                  2265  K63:                                    ; TRANSLATE-SCAN
EC1D 2C3B             2266          SUB     AL,59                   ; CONVERT ORIGIN TO FUNCTION KEYS
EC1F                  2267  K64:                                    ; TRANSLATE-SCAN-ORGD
EC1F 2ED7             2268          XLAT    CS:K9                   ; CTL TABLE SCAN
EC21 8AE0             2269          MOV     AH,AL                   ; PUT VALUE INTO AH
EC23 B000             2270          MOV     AL,0                    ; ZERO ASCII CODE
EC25 EBAE             2271          JMP     K57                     ; PUT IT INTO THE BUFFER
                      2272
                      2273  KB_INT  ENDP
                      2274
                      2275  ;----- BUFFER IS FULL, SOUND THE BEEPER
                      2276
EC27                  2277  K62:                                    ; BUFFER-FULL-BEEP
EC27 B020             2278          MOV     AL,EOI                  ; END OF INTERRUPT COMMAND
EC29 E620             2279          OUT     20H,AL                  ; SEND COMMAND TO INT CONTROL PORT
EC2B BB8000           2280          MOV     BX,080H                 ; NUMBER OF CYCLES FOR 1/12 SECOND TONE
EC2E E461             2281          IN      AL,KB_CTL               ; GET CONTROL INFORMATION
EC30 50               2282          PUSH    AX                      ; SAVE
EC31                  2283  K65:                                    ; BEEP-CYCLE
EC31 24FC             2284          AND     AL,0FCH                 ; TURN OFF TIMER GATE AND SPEAKER DATA
EC33 E661             2285          OUT     KB_CTL,AL               ; OUTPUT TO CONTROL
EC35 B94800           2286          MOV     CX,48H                  ; HALF CYCLE TIME FOR TONE
EC38                  2287  K66:
EC38 E2FE             2288          LOOP    K66                     ; SPEAKER OFF
EC3A 0C02             2289          OR      AL,2                    ; TURN ON SPEAKER BIT
EC3C E661             2290          OUT     KB_CTL,AL               ; OUTPUT TO CONTROL
EC3E B94800           2291          MOV     CX,48H                  ; SET UP COUNT
EC41                  2292  K67:
EC41 E2FE             2293          LOOP    K67                     ; ANOTHER HALF CYCLE
EC43 4B               2294          DEC     BX                      ; TOTAL TIME COUNT
EC44 75EB             2295          JNZ     K65                     ; DO ANOTHER CYCLE
EC46 58               2296          POP     AX                      ; RECOVER CONTROL
EC47 E661             2297          OUT     KB_CTL,AL               ; OUTPUT THE CONTROL
EC49 E912FE           2298          JMP     K27
                      2299
EC4C 20333031         2300  F1      DB      ' 301',13,10            ; KEYBOARD ERROR
EC50 0D
EC51 0A
EC52 363031           2301  F3      DB      '601',13,10             ; DISKETTE ERROR
EC55 0D
EC56 0A
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                        2302
                        2303  ;-- INT 13 ------------------------------------------------------------------
                        2304  ; DISKETTE I/O                                                              :
                        2305  ;       THIS INTERFACE PROVIDES ACCESS TO THE 5 1/4 DISKETTE DRIVES          :
                        2306  ; INPUT                                                                     :
                        2307  ;       (AH)=0  RESET DISKETTE SYSTEM                                       :
                        2308  ;               HARD RESET TO NEC, PREPARE COMMAND, RECAL REQUIRED           :
                        2309  ;               ON ALL DRIVES                                               :
                        2310  ;       (AH)=1  READ THE STATUS OF THE SYSTEM INTO (AL)                     :
                        2311  ;               DISKETTE_STATUS FROM LAST OPERATION IS USED                  :
                        2312  ;                                                                           :
                        2313  ; REGISTERS FOR READ/WRITE/VERIFY/FORMAT                                    :
                        2314  ;       (DL) - DRIVE NUMBER (0-3 ALLOWED, VALUE CHECKED)                    :
                        2315  ;       (DH) - HEAD NUMBER (0-1 ALLOWED, NOT VALUE CHECKED)                 :
                        2316  ;       (CH) - TRACK NUMBER (0-39, NOT VALUE CHECKED)                       :
                        2317  ;       (CL) - SECTOR NUMBER (1-8, NOT VALUE CHECKED,                       :
                        2318  ;                                   NOT USED FOR FORMAT)                    :
                        2319  ;       (AL) - NUMBER OF SECTORS ( MAX = 8, NOT VALUE CHECKED, NOT USED     :
                        2320  ;                                           FOR FORMAT)                     :
                        2321  ;       (ES:BX) - ADDRESS OF BUFFER ( NOT REQUIRED FOR VERIFY)              :
                        2322  ;                                                                           :
                        2323  ;       (AH)=2  READ THE DESIRED SECTORS INTO MEMORY                        :
                        2324  ;       (AH)=3  WRITE THE DESIRED SECTORS FROM MEMORY                       :
                        2325  ;       (AH)=4  VERIFY THE DESIRED SECTORS                                  :
                        2326  ;       (AH)=5  FORMAT THE DESIRED TRACK                                    :
                        2327  ;               FOR THE FORMAT OPERATION, THE BUFFER POINTER (ES,BX)         :
                        2328  ;               MUST POINT TO THE COLLECTION OF DESIRED ADDRESS FIELDS       :
                        2329  ;               FOR THE TRACK.  EACH FIELD IS COMPOSED OF 4 BYTES,           :
                        2330  ;               (C,H,R,N), WHERE C = TRACK NUMBER, H=HEAD NUMBER,            :
                        2331  ;               R = SECTOR NUMBER, N= NUMBER OF BYTES PER SECTOR             :
                        2332  ;               (00=128, 01=256, 02=512, 03=1024).  THERE MUST BE ONE       :
                        2333  ;               ENTRY FOR EVERY SECTOR ON THE TRACK.  THIS INFORMATION       :
                        2334  ;               IS USED TO FIND THE REQUESTED SECTOR DURING READ/WRITE       :
                        2335  ;               ACCESS.                                                     :
                        2336  ;                                                                           :
                        2337  ; DATA VARIABLE -- DISK_POINTER                                             :
                        2338  ;       DOUBLE WORD POINTER TO THE CURRENT SET OF DISKETTE PARAMETERS        :
                        2339  ; OUTPUT                                                                    :
                        2340  ;       AH = STATUS OF OPERATION                                            :
                        2341  ;               STATUS BITS ARE DEFINED IN THE EQUATES FOR                  :
                        2342  ;               DISKETTE_STATUS VARIABLE IN THE DATA SEGMENT OF THIS        :
                        2343  ;               MODULE.                                                     :
                        2344  ;       CY = 0  SUCCESSFUL OPERATION (AH=0 ON RETURN)                       :
                        2345  ;       CY = 1  FAILED OPERATION (AH HAS ERROR REASON)                      :
                        2346  ;       FOR READ/WRITE/VERIFY                                               :
                        2347  ;               DS,BX,DX,CH,CL PRESERVED                                    :
                        2348  ;               AL = NUMBER OF SECTORS ACTUALLY READ                        :
                        2349  ;               ***** AL MAY NOT BE CORRECT IF TIME OUT ERROR OCCURS         :
                        2350  ;       NOTE:   IF AN ERROR IS REPORTED BY THE DISKETTE CODE, THE           :
                        2351  ;               APPROPRIATE ACTION IS TO RESET THE DISKETTE, THEN RETRY      :
                        2352  ;               THE OPERATION. ON READ ACCESSES, NO MOTOR START DELAY        :
                        2353  ;               IS TAKEN, SO THAT THREE RETRIES ARE REQUIRED ON READS        :
                        2354  ;               TO ENSURE THAT THE PROBLEM IS NOT DUE TO MOTOR               :
                        2355  ;               START-UP.                                                   :
                        2356  ;--------------------------------------------------------------------------
                        2357          ASSUME  CS:CODE,DS:DATA,ES:DATA
EC59                    2358          ORG     0EC59H
EC59                    2359  DISKETTE_IO     PROC    FAR
EC59 FB                 2360          STI                             ; INTERRUPTS BACK ON
EC5A 53                 2361          PUSH    BX                      ; SAVE ADDRESS
EC5B 51                 2362          PUSH    CX
EC5C 1E                 2363          PUSH    DS                      ; SAVE SEGMENT REGISTER VALUE
EC5D 56                 2364          PUSH    SI                      ; SAVE ALL REGISTERS DURING OPERATION
EC5E 57                 2365          PUSH    DI
EC5F 55                 2366          PUSH    BP
EC60 52                 2367          PUSH    DX
EC61 8BEC               2368          MOV     BP,SP                   ; SET UP POINTER TO HEAD PARM
EC63 E8F30D             2369          CALL    DDS
EC66 E81C00             2370          CALL    J1                      ; CALL THE REST TO ENSURE DS RESTORED
EC69 BB0400             2371          MOV     BX,4                    ; GET THE MOTOR WAIT PARAMETER
EC6C E8FD01             2372          CALL    GET_PARM
EC6F 88264000           2373          MOV     MOTOR_COUNT,AH          ; SET THE TIMER COUNT FOR THE MOTOR
EC73 8A264100           2374          MOV     AH,DISKETTE_STATUS      ; GET STATUS OF OPERATION
EC77 80FC01             2375          CMP     AH,1                    ; SET THE CARRY FLAG TO INDICATE
EC7A F5                 2376          CMC                             ;  SUCCESS OR FAILURE
EC7B 5A                 2377          POP     DX                      ; RESTORE ALL REGISTERS
EC7C 5D                 2378          POP     BP
EC7D 5F                 2379          POP     DI
EC7E 5E                 2380          POP     SI
EC7F 1F                 2381          POP     DS
EC80 59                 2382          POP     CX
EC81 5B                 2383          POP     BX                      ; RECOVER ADDRESS
EC82 CA0200             2384          RET     2                       ; THROW AWAY SAVED FLAGS
                        2385  DISKETTE_IO     ENDP
                        2386
EC85                    2387  J1      PROC    NEAR
EC85 8AF0               2388          MOV     DH,AL                   ; SAVE # SECTORS IN DH
EC87 80263F007F         2389          AND     MOTOR_STATUS,07FH       ; INDICATE A READ OPERATION
EC8C 0AE4               2390          OR      AH,AH                   ; AH=0
EC8E 7427               2391          JZ      DISK_RESET
EC90 FECC               2392          DEC     AH                      ; AH=1
EC92 7473               2393          JZ      DISK_STATUS
EC94 C606410000         2394          MOV     DISKETTE_STATUS,0       ; RESET THE STATUS INDICATOR
EC99 80FA04             2395          CMP     DL,4                    ; TEST FOR DRIVE IN 0-3 RANGE
EC9C 7313               2396          JAE     J3                      ; ERROR IF ABOVE
EC9E FECC               2397          DEC     AH                      ; AH=2
ECA0 7469               2398          JZ      DISK_READ
ECA2 FECC               2399          DEC     AH                      ; AH=3
ECA4 7503               2400          JNZ     J2                      ; TEST_DISK_VERF
ECA6 E99500             2401          JMP     DISK_WRITE
ECA9                    2402  J2:                                     ; TEST_DISK_VERF
ECA9 FECC               2403          DEC     AH                      ; AH=4
ECAB 7467               2404          JZ      DISK_VERF
ECAD FECC               2405          DEC     AH                      ; AH=5
ECAF 7467               2406          JZ      DISK_FORMAT
ECB1                    2407  J3:                                     ; BAD_COMMAND
ECB1 C606410001         2408          MOV     DISKETTE_STATUS,BAD_CMD ; ERROR CODE, NO SECTORS TRANSFERRED
ECB6 C3                 2409          RET                             ; UNDEFINED OPERATION
                        2410  J1      ENDP
                        2411
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LOC OBJECT          LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

                    2412  ;----- RESET THE DISKETTE SYSTEM
                    2413
ECB7                2414  DISK_RESET      PROC    NEAR
ECB7 BAF203         2415          MOV     DX,03F2H                ; ADAPTER CONTROL PORT
ECBA FA             2416          CLI                             ; NO INTERRUPTS
ECBB A03F00         2417          MOV     AL,MOTOR_STATUS         ; WHICH MOTOR IS ON
ECBE B104           2418          MOV     CL,4                    ; SHIFT COUNT
ECC0 D2E0           2419          SAL     AL,CL                   ; MOVE MOTOR VALUE TO HIGH NYBBLE
ECC2 A820           2420          TEST    AL, 20H                 ; SELECT CORRESPONDING DRIVE
ECC4 7506           2421          JNZ     J5                      ; JUMP IF MOTOR ONE IS ON
ECC6 A840           2422          TEST    AL, 40H
ECC8 7506           2423          JNZ     J4                      ; JUMP IF MOTOR TWO IS ON
ECCA A880           2424          TEST    AL, 80H
ECCC 7406           2425          JZ      J6                      ; JUMP IF MOTOR ZERO IS ON
ECCE FEC0           2426          INC     AL
ECD0                2427  J4:
ECD0 FEC0           2428          INC     AL
ECD2                2429  J5:
ECD2 FEC0           2430          INC     AL
ECD4                2431  J6:
ECD4 0C08           2432          OR      AL,8                    ; TURN ON INTERRUPT ENABLE
ECD6 EE             2433          OUT     DX,AL                   ; RESET THE ADAPTER
ECD7 C6063E0000     2434          MOV     SEEK_STATUS,0           ; SET RECAL REQUIRED ON ALL DRIVES
ECDC C606410000     2435          MOV     DISKETTE_STATUS,0       ; SET OK STATUS FOR DISKETTE
ECE1 0C04           2436          OR      AL,4                    ; TURN OFF RESET
ECE3 EE             2437          OUT     DX,AL                   ; TURN OFF THE RESET
ECE4 FB             2438          STI                             ; REENABLE THE INTERRUPTS
ECE5 E82A02         2439          CALL    CHK_STAT_2              ; DO SENSE INTERRUPT STATUS
                    2440                                          ;  FOLLOWING RESET
ECE8 A04200         2441          MOV     AL,NEC_STATUS           ; IGNORE ERROR RETURN AND DO OWN TEST
ECEB 3CC0           2442          CMP     AL,0C0H                 ; TEST FOR DRIVE READY TRANSITION
ECED 7406           2443          JZ      J7                      ; EVERYTHING OK
ECEF 800E410020     2444          OR      DISKETTE_STATUS,BAD_NEC ; SET ERROR CODE
ECF4 C3             2445          RET
                    2446
                    2447  ;----- SEND SPECIFY COMMAND TO NEC
                    2448
ECF5                2449  J7:                                     ; DRIVE_READY
ECF5 B403           2450          MOV     AH,03H                  ; SPECIFY COMMAND
ECF7 E84701         2451          CALL    NEC_OUTPUT              ; OUTPUT THE COMMAND
ECFA BB0100         2452          MOV     BX,1                    ; FIRST BYTE PARM IN BLOCK
ECFD E86C01         2453          CALL    GET_PARM                ;  TO THE NEC CONTROLLER
ED00 BB0300         2454          MOV     BX,3                    ; SECOND BYTE PARM IN BLOCK
ED03 E86601         2455          CALL    GET_PARM                ;  TO THE NEC CONTROLLER
ED06                2456  J8:                                     ; RESET_RET
ED06 C3             2457          RET                             ; RETURN TO CALLER
                    2458  DISK_RESET      ENDP
                    2459
                    2460  ;----- DISKETTE STATUS ROUTINE
                    2461
ED07                2462  DISK_STATUS     PROC    NEAR
ED07 A04100         2463          MOV     AL,DISKETTE_STATUS
ED0A C3             2464          RET
                    2465  DISK_STATUS     ENDP
                    2466
                    2467  ;----- DISKETTE READ
                    2468
ED0B                2469  DISK_READ       PROC    NEAR
ED0B B046           2470          MOV     AL,046H                 ; READ COMMAND FOR DMA
ED0D                2471  J9:                                     ; DISK_READ_CONT
ED0D E8B801         2472          CALL    DMA_SETUP               ; SET UP THE DMA
ED10 B4E6           2473          MOV     AH,0E6H                 ; SET UP RD COMMAND FOR NEC CONTROLLER
ED12 EB36           2474          JMP     SHORT RW_OPN            ; GO DO THE OPERATION
                    2475  DISK_READ       ENDP
                    2476
                    2477  ;----- DISKETTE VERIFY
                    2478
ED14                2479  DISK_VERF       PROC    NEAR
ED14 B042           2480          MOV     AL,042H                 ; VERIFY COMMAND FOR DMA
ED16 EBF5           2481          JMP     J9                      ; DO AS IF DISK READ
                    2482  DISK_VERF       ENDP
                    2483
                    2484  ;----- DISKETTE FORMAT
                    2485
ED18                2486  DISK_FORMAT     PROC    NEAR
ED18 800E3F0080     2487          OR      MOTOR_STATUS,80H        ; INDICATE WRITE OPERATION
ED1D B04A           2488          MOV     AL,04AH                 ; WILL WRITE TO THE DISKETTE
ED1F E8A601         2489          CALL    DMA_SETUP               ; SET UP THE DMA
ED22 B44D           2490          MOV     AH,04DH                 ; ESTABLISH THE FORMAT COMMAND
ED24 EB24           2491          JMP     SHORT RW_OPN            ; DO THE OPERATION
ED26                2492  J10:                                    ; CONTINUATION OF RW_OPN FOR FMT
ED26 BB0700         2493          MOV     BX,7                    ; GET THE
ED29 E84001         2494          CALL    GET_PARM                ;  BYTES/SECTOR VALUE TO NEC
ED2C BB0900         2495          MOV     BX,9                    ; GET THE
ED2F E83A01         2496          CALL    GET_PARM                ;  SECTORS/TRACK VALUE TO NEC
ED32 BB0F00         2497          MOV     BX,15                   ; GET THE
ED35 E83401         2498          CALL    GET_PARM                ;  GAP LENGTH VALUE TO NEC
ED38 BB1100         2499          MOV     BX,17                   ; GET THE FILLER BYTE
ED3B E9AB00         2500          JMP     J16                     ;  TO THE CONTROLLER
                    2501  DISK_FORMAT     ENDP
                    2502
                    2503  ;----- DISKETTE WRITE ROUTINE
                    2504
ED3E                2505  DISK_WRITE      PROC    NEAR
ED3E 800E3F0080     2506          OR      MOTOR_STATUS,80H        ; INDICATE WRITE OPERATION
ED43 B04A           2507          MOV     AL,04AH                 ; DMA WRITE COMMAND
ED45 E88001         2508          CALL    DMA_SETUP
ED48 B4C5           2509          MOV     AH,0C5H                 ; NEC COMMAND TO WRITE TO DISKETTE
                    2510  DISK_WRITE      ENDP
                    2511
                    2512  ;----- ALLOW WRITE ROUTINE TO FALL INTO RW_OPN
                    2513
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SECTION 5

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LOC OBJECT          LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

                    2514  ;--------------------------------------------------------------------
                    2515  ; RW_OPN                                                           :
                    2516  ;       THIS ROUTINE PERFORMS THE READ/WRITE/VERIFY OPERATION       :
                    2517  ;--------------------------------------------------------------------
ED4A                2518  RW_OPN  PROC    NEAR
ED4A 7308           2519          JNC     J11                     ; TEST FOR DMA ERROR
ED4C C606410009     2520          MOV     DISKETTE_STATUS,DMA_BOUNDARY    ; SET ERROR
ED51 B000           2521          MOV     AL,0                    ; NO SECTORS TRANSFERRED
ED53 C3             2522          RET                             ; RETURN TO MAIN ROUTINE
ED54                2523  J11:                                    ; DO_RW_OPN
ED54 50             2524          PUSH    AX                      ; SAVE THE COMMAND
                    2525
                    2526  ;----- TURN ON THE MOTOR AND SELECT THE DRIVE
                    2527
ED55 51             2528          PUSH    CX                      ; SAVE THE T/S PARMS
ED56 8ACA           2529          MOV     CL,DL                   ; GET DRIVE NUMBER AS SHIFT COUNT
ED58 B001           2530          MOV     AL,1                    ; MASK FOR DETERMINING MOTOR BIT
ED5A D2E0           2531          SAL     AL,CL                   ; SHIFT THE MASK BIT
ED5C FA             2532          CLI                             ; NO INTERRUPTS WHILE DETERMINING
                    2533                                          ;  MOTOR STATUS
ED5D C6064000FF     2534          MOV     MOTOR_COUNT,0FFH        ; SET LARGE COUNT DURING OPERATION
ED62 84063F00       2535          TEST    AL,MOTOR_STATUS         ; TEST THAT MOTOR FOR OPERATING
ED66 7531           2536          JNZ     J14                     ; IF RUNNING, SKIP THE WAIT
ED68 80263F00F0     2537          AND     MOTOR_STATUS,0F0H       ; TURN OFF ALL MOTOR BITS
ED6D 08063F00       2538          OR      MOTOR_STATUS,AL         ; TURN ON THE CURRENT MOTOR
ED71 FB             2539          STI                             ; INTERRUPTS BACK ON
ED72 B010           2540          MOV     AL,10H                  ; MASK BIT
ED74 D2E0           2541          SAL     AL,CL                   ; DEVELOP BIT MASK FOR MOTOR ENABLE
ED76 0AC2           2542          OR      AL,DL                   ; GET DRIVE SELECT BITS IN
ED78 0C0C           2543          OR      AL,0CH                  ; NO RESET, ENABLE DMA/INT
ED7A 52             2544          PUSH    DX                      ; SAVE REG
ED7B BAF203         2545          MOV     DX,03F2H                ; CONTROL PORT ADDRESS
ED7E EE             2546          OUT     DX,AL
ED7F 5A             2547          POP     DX                      ; RECOVER REGISTERS
                    2548
                    2549  ;----- WAIT FOR MOTOR IF WRITE OPERATION
                    2550
ED80 F6063F0080     2551          TEST    MOTOR_STATUS,80H        ; IS THIS A WRITE
ED85 7412           2552          JZ      J14                     ; NO, CONTINUE WITHOUT WAIT
ED87 BB1400         2553          MOV     BX,20                   ; GET THE MOTOR WAIT
ED8A E8DF00         2554          CALL    GET_PARM                ;  PARAMETER
ED8D 0AE4           2555          OR      AH,AH                   ; TEST FOR NO WAIT
ED8F                2556  J12:                                    ; TEST_WAIT_TIME
ED8F 7408           2557          JZ      J14                     ; EXIT WITH TIME EXPIRED
ED91 2BC9           2558          SUB     CX,CX                   ; SET UP 1/8 SECOND LOOP TIME
ED93                2559  J13:
ED93 E2FE           2560          LOOP    J13                     ; WAIT FOR THE REQUIRED TIME
ED95 FECC           2561          DEC     AH                      ; DECREMENT TIME VALUE
ED97 EBF6           2562          JMP     J12                     ; ARE WE DONE YET
ED99                2563  J14:                                    ; MOTOR_RUNNING
ED99 FB             2564          STI                             ; INTERRUPTS BACK ON FOR BYPASS WAIT
ED9A 59             2565          POP     CX
                    2566
                    2567  ;----- DO THE SEEK OPERATION
                    2568
ED9B E8DF00         2569          CALL    SEEK                    ; MOVE TO CORRECT TRACK
ED9E 58             2570          POP     AX                      ; RECOVER COMMAND
ED9F 8AFC           2571          MOV     BH,AH                   ; SAVE COMMAND IN BH
EDA1 B600           2572          MOV     DH,0                    ; SET NO SECTORS READ IN CASE OF ERROR
EDA3 724B           2573          JC      J17                     ; IF ERROR, THEN EXIT AFTER MOTOR OFF
EDA5 BEF0ED90       2574          MOV     SI,OFFSET J17           ; DUMMY RETURN ON STACK FOR NEC_OUTPUT
EDA9 56             2575          PUSH    SI                      ;  SO THAT IT WILL RETURN TO MOTOR OFF
                    2576                                          ;  LOCATION
                    2577
                    2578  ;----- SEND OUT THE PARAMETERS TO THE CONTROLLER
                    2579
EDAA E89400         2580          CALL    NEC_OUTPUT              ; OUTPUT THE OPERATION COMMAND
EDAD 8A6601         2581          MOV     AH,[BP+1]               ; GET THE CURRENT HEAD NUMBER
EDB0 D0E4           2582          SAL     AH,1                    ; MOVE IT TO BIT 2
EDB2 D0E4           2583          SAL     AH,1
EDB4 80E404         2584          AND     AH,4                    ; ISOLATE THAT BIT
EDB7 0AE2           2585          OR      AH,DL                   ; OR IN THE DRIVE NUMBER
EDB9 E88500         2586          CALL    NEC_OUTPUT
                    2587
                    2588  ;----- TEST FOR FORMAT COMMAND
                    2589
EDBC 80FF4D         2590          CMP     BH,04DH                 ; IS THIS A FORMAT OPERATION
EDBF 7503           2591          JNE     J15                     ; NO, CONTINUE WITH R/W/V
EDC1 E962FF         2592          JMP     J10                     ; IF SO, HANDLE SPECIAL
EDC4                2593  J15:
EDC4 8AE5           2594          MOV     AH,CH                   ; CYLINDER NUMBER
EDC6 E87800         2595          CALL    NEC_OUTPUT
EDC9 8A6601         2596          MOV     AH,[BP+1]               ; HEAD NUMBER FROM STACK
EDCC E87200         2597          CALL    NEC_OUTPUT
EDCF 8AE1           2598          MOV     AH,CL                   ; SECTOR NUMBER
EDD1 E86D00         2599          CALL    NEC_OUTPUT
EDD4 BB0700         2600          MOV     BX,7                    ; BYTES/SECTOR PARM FROM BLOCK
EDD7 E89200         2601          CALL    GET_PARM                ;  TO THE NEC
EDDA BB0900         2602          MOV     BX,9                    ; EOT PARM FROM BLOCK
EDDD E88C00         2603          CALL    GET_PARM                ;  TO THE NEC
EDE0 BB0B00         2604          MOV     BX,11                   ; GAP LENGTH PARM FROM BLOCK
EDE3 E88600         2605          CALL    GET_PARM                ;  TO THE NEC
EDE6 BB0D00         2606          MOV     BX,13                   ; DTL PARM FROM BLOCK
EDE9                2607  J16:                                    ; RW_OPN_FINISH
EDE9 E88000         2608          CALL    GET_PARM                ;  TO THE NEC
EDEC 5E             2609          POP     SI                      ; CAN NOW DISCARD THAT DUMMY
                    2610                                          ;  RETURN ADDRESS
                    2611
                    2612  ;----- LET THE OPERATION HAPPEN
                    2613
EDED E84301         2614          CALL    WAIT_INT                ; WAIT FOR THE INTERRUPT
EDF0                2615  J17:                                    ; MOTOR_OFF
EDF0 7245           2616          JC      J21                     ; LOOK FOR ERROR
EDF2 E87401         2617          CALL    RESULTS                 ; GET THE NEC STATUS
EDF5 723F           2618          JC      J20                     ; LOOK FOR ERROR
                    2619
                    2620  ;----- CHECK THE RESULTS RETURNED BY THE CONTROLLER
                    2621
EDF7 FC             2622          CLD                             ; SET THE CORRECT DIRECTION
EDF8 BE4200         2623          MOV     SI,OFFSET NEC_STATUS    ; POINT TO STATUS FIELD
EDFB AC             2624          LODS    NEC_STATUS              ; GET ST0
EDFC 24C0           2625          AND     AL,0C0H                 ; TEST FOR NORMAL TERMINATION
EDFE 743B           2626          JZ      J22                     ; OPN_OK
EE00 3C40           2627          CMP     AL,040H                 ; TEST FOR ABNORMAL TERMINATION
EE02 7529           2628          JNZ     J18                     ; NOT ABNORMAL, BAD NEC
                    2629
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LOC OBJECT          LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

                    2630  ;----- ABNORMAL TERMINATION, FIND OUT WHY
                    2631
EE04 AC             2632          LODS    NEC_STATUS              ; GET STI
EE05 D0E0           2633          SAL     AL,1                    ; TEST FOR EOT FOUND
EE07 B404           2634          MOV     AH,RECORD_NOT_FND
EE09 7224           2635          JC      J19                     ; RW_FAIL
EE0B D0E0           2636          SAL     AL,1
EE0D D0E0           2637          SAL     AL,1                    ; TEST FOR CRC ERROR
EE0F B410           2638          MOV     AH,BAD_CRC
EE11 721C           2639          JC      J19                     ; RW_FAIL
EE13 D0E0           2640          SAL     AL,1                    ; TEST FOR DMA OVERRUN
EE15 B408           2641          MOV     AH,BAD_DMA
EE17 7216           2642          JC      J19                     ; RW_FAIL
EE19 D0E0           2643          SAL     AL,1
EE1B D0E0           2644          SAL     AL,1                    ; TEST FOR RECORD NOT FOUND
EE1D B404           2645          MOV     AH,RECORD_NOT_FND
EE1F 720E           2646          JC      J19                     ; RW_FAIL
EE21 D0E0           2647          SAL     AL,1
EE23 B403           2648          MOV     AH,WRITE_PROTECT        ; TEST FOR WRITE_PROTECT
EE25 7208           2649          JC      J19                     ; RW_FAIL
EE27 D0E0           2650          SAL     AL,1                    ; TEST MISSING ADDRESS MARK
EE29 B402           2651          MOV     AH,BAD_ADDR_MARK
EE2B 7202           2652          JC      J19                     ; RW_FAIL
                    2653
                    2654  ;----- NEC MUST HAVE FAILED
                    2655
EE2D                2656  J18:                                    ; RW-NEC-FAIL
EE2D B420           2657          MOV     AH,BAD_NEC
EE2F                2658  J19:                                    ; RW-FAIL
EE2F 08264100       2659          OR      DISKETTE_STATUS,AH
EE33 E87801         2660          CALL    NUM_TRANS               ; HOW MANY WERE REALLY TRANSFERRED
EE36                2661  J20:                                    ; RW_ERR
EE36 C3             2662          RET                             ; RETURN TO CALLER
EE37                2663  J21:                                    ; RW_ERR_RES
EE37 E82F01         2664          CALL    RESULTS                 ; FLUSH THE RESULTS BUFFER
EE3A C3             2665          RET
                    2666
                    2667  ;----- OPERATION WAS SUCCESSFUL
                    2668
EE3B                2669  J22:                                    ; OPN_OK
EE3B E87001         2670          CALL    NUM_TRANS               ; HOW MANY GOT MOVED
EE3E 32E4           2671          XOR     AH,AH                   ; NO ERRORS
EE40 C3             2672          RET
                    2673  RW_OPN  ENDP
                    2674  ;--------------------------------------------------------------------------
                    2675  ; NEC_OUTPUT                                                            :
                    2676  ;       THIS ROUTINE SENDS A BYTE TO THE NEC CONTROLLER AFTER TESTING    :
                    2677  ;       FOR CORRECT DIRECTION AND CONTROLLER READY THIS ROUTINE WILL     :
                    2678  ;       TIME OUT IF THE BYTE IS NOT ACCEPTED WITHIN A REASONABLE        :
                    2679  ;       AMOUNT OF TIME, SETTING THE DISKETTE STATUS ON COMPLETION.      :
                    2680  ; INPUT                                                                 :
                    2681  ;       (AH)    BYTE TO BE OUTPUT                                       :
                    2682  ; OUTPUT                                                                :
                    2683  ;       CY = 0  SUCCESS                                                 :
                    2684  ;       CY = 1  FAILURE -- DISKETTE STATUS UPDATED                      :
                    2685  ;               IF A FAILURE HAS OCCURRED, THE RETURN IS MADE ONE LEVEL  :
                    2686  ;               HIGHER THAN THE CALLER OF NEC_OUTPUT.                    :
                    2687  ;               THIS REMOVES THE REQUIREMENT OF TESTING AFTER EVERY      :
                    2688  ;               CALL OF NEC_OUTPUT.                                     :
                    2689  ;       (AL) DESTROYED                                                  :
                    2690  ;--------------------------------------------------------------------------
EE41                2691  NEC_OUTPUT      PROC    NEAR
EE41 52             2692          PUSH    DX                      ; SAVE REGISTERS
EE42 51             2693          PUSH    CX
EE43 BAF403         2694          MOV     DX,03F4H                ; STATUS PORT
EE46 33C9           2695          XOR     CX,CX                   ; COUNT FOR TIME OUT
EE48                2696  J23:
EE48 EC             2697          IN      AL,DX                   ; GET STATUS
EE49 A840           2698          TEST    AL,040H                 ; TEST DIRECTION BIT
EE4B 740C           2699          JZ      J25                     ; DIRECTION OK
EE4D E2F9           2700          LOOP    J23
EE4F                2701  J24:                                    ; TIME_ERROR
EE4F 800E410080     2702          OR      DISKETTE_STATUS,TIME_OUT
EE54 59             2703          POP     CX
EE55 5A             2704          POP     DX                      ; SET ERROR CODE AND RESTORE REGS
EE56 58             2705          POP     AX                      ; DISCARD THE RETURN ADDRESS
EE57 F9             2706          STC                             ; INDICATE ERROR TO CALLER
EE58 C3             2707          RET
EE59                2708  J25:
EE59 33C9           2709          XOR     CX,CX                   ; RESET THE COUNT
EE5B                2710  J26:
EE5B EC             2711          IN      AL,DX                   ; GET THE STATUS
EE5C A880           2712          TEST    AL,080H                 ; IS IT READY
EE5E 7504           2713          JNZ     J27                     ; YES, GO OUTPUT
EE60 E2F9           2714          LOOP    J26                     ; COUNT DOWN AND TRY AGAIN
EE62 EBEB           2715          JMP     J24                     ; ERROR CONDITION
EE64                2716  J27:                                    ; OUTPUT
EE64 8AC4           2717          MOV     AL,AH                   ; GET BYTE TO OUTPUT
EE66 B2F5           2718          MOV     DL,0F5H                 ; DATA PORT (3F5)
EE68 EE             2719          OUT     DX,AL                   ; OUTPUT THE BYTE
EE69 59             2720          POP     CX                      ; RECOVER REGISTERS
EE6A 5A             2721          POP     DX
EE6B C3             2722          RET                             ; CY = 0 FROM TEST INSTRUCTION
                    2723  NEC_OUTPUT      ENDP
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LOC OBJECT            LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

                      2724  ;--------------------------------------------------------------------------------
                      2725  ; GET_PARM                                                                      :
                      2726  ;       THIS ROUTINE FETCHES THE INDEXED POINTER FROM THE DISK_BASE             :
                      2727  ;       BLOCK POINTED AT BY THE DATA VARIABLE DISK_POINTER. A BYTE FROM :
                      2728  ;       THAT TABLE IS THEN MOVED INTO AH, THE INDEX OF THAT BYTE BEING  :
                      2729  ;       THE PARM IN BX                                                          :
                      2730  ; ENTRY --                                                                      :
                      2731  ;   BX = INDEX OF BYTE TO BE FETCHED * 2                                       :
                      2732  ;        IF THE LOW BIT OF BX IS ON, THE BYTE IS IMMEDIATELY OUTPUT      :
                      2733  ;        TO THE NEC CONTROLLER                                                  :
                      2734  ; EXIT --                                                                       :
                      2735  ;   AH = THAT BYTE FROM BLOCK                                                   :
                      2736  ;--------------------------------------------------------------------------------
EE6C                  2737  GET_PARM        PROC    NEAR
EE6C 1E               2738          PUSH    DS                              ; SAVE SEGMENT
EE6D 2BC0             2739          SUB     AX,AX                           ; ZERO TO AX
EE6F 8ED8             2740          MOV     DS,AX
                      2741          ASSUME  DS:ABS0
EE71 C5367800         2742          LDS     SI,DISK_POINTER                 ; POINT TO BLOCK
EE75 D1EB             2743          SHR     BX,1                            ; DIVIDE BX BY 2, AND SET FLAG
                      2744                                                  ; FOR EXIT
EE77 8A20             2745          MOV     AH,[SI+BX]                      ; GET THE WORD
EE79 1F               2746          POP     DS                              ; RESTORE SEGMENT
                      2747          ASSUME  DS:DATA
EE7A 72C5             2748          JC      NEC_OUTPUT                      ; IF FLAG SET, OUTPUT TO CONTROLLER
EE7C C3               2749          RET                                     ; RETURN TO CALLER
                      2750  GET_PARM        ENDP
                      2751  ;--------------------------------------------------------------------------------
                      2752  ; SEEK                                                                          :
                      2753  ;       THIS ROUTINE WILL MOVE THE HEAD ON THE NAMED DRIVE TO THE               :
                      2754  ;       NAMED TRACK.  IF THE DRIVE HAS NOT BEEN ACCESSED SINCE THE      :
                      2755  ;       DRIVE RESET COMMAND WAS ISSUED, THE DRIVE WILL BE RECALIBRATED. :
                      2756  ; INPUT                                                                         :
                      2757  ;       (DL) = DRIVE TO SEEK ON                                                 :
                      2758  ;       (CH) = TRACK TO SEEK TO                                                 :
                      2759  ; OUTPUT                                                                        :
                      2760  ;       CY = 0 SUCCESS                                                          :
                      2761  ;       CY = 1 FAILURE -- DISKETTE_STATUS SET ACCORDINGLY               :
                      2762  ;       (AX) DESTROYED                                                          :
                      2763  ;--------------------------------------------------------------------------------
EE7D                  2764  SEEK    PROC    NEAR
EE7D B001             2765          MOV     AL,1
EE7F 51               2766          PUSH    CX                              ; SAVE INPUT VALUES
EE80 8ACA             2767          MOV     CL,DL                           ; GET DRIVE VALUE INTO CL
EE82 D2C0             2768          ROL     AL,CL                           ; SHIFT IT BY THE DRIVE VALUE
EE84 59               2769          POP     CX                              ; RECOVER TRACK VALUE
EE85 840463E00        2770          TEST    AL,SEEK_STATUS                  ; TEST FOR RECAL REQUIRED
EE89 7513             2771          JNZ     J28                             ; NO_RECAL
EE8B 080463E00        2772          OR      SEEK_STATUS,AL                  ; TURN ON THE NO RECAL BIT IN FLAG
EE8F B407             2773          MOV     AH,07H                          ; RECALIBRATE COMMAND
EE91 E8ADFF           2774          CALL    NEC_OUTPUT
EE94 8AE2             2775          MOV     AH,DL
EE96 E8A8FF           2776          CALL    NEC_OUTPUT                      ; OUTPUT THE DRIVE NUMBER
EE99 E87600           2777          CALL    CHK_STAT_2                      ; GET THE INTERUPT AND SENSE INT STATUS
EE9C 7229             2778          JC      J32                             ; SEEK_ERROR
                      2779
                      2780  ;----- DRIVE IS IN SYNCH WITH CONTROLLER, SEEK TO TRACK
                      2781
EE9E                  2782  J28:
EE9E B40F             2783          MOV     AH,0FH                          ; SEEK COMMAND TO NEC
EEA0 E89EFF           2784          CALL    NEC_OUTPUT
EEA3 8AE2             2785          MOV     AH,DL                           ; DRIVE NUMBER
EEA5 E899FF           2786          CALL    NEC_OUTPUT
EEA8 8AE5             2787          MOV     AH,CH                           ; TRACK NUMBER
EEAA E894FF           2788          CALL    NEC_OUTPUT
EEAD E86200           2789          CALL    CHK_STAT_2                      ; GET ENDING INTERRUPT AND
                      2790                                                  ;  SENSE STATUS
                      2791
                      2792  ;----- WAIT FOR HEAD SETTLE
                      2793
EEB0 9C               2794          PUSHF                                   ; SAVE STATUS FLAGS
EEB1 BB1200           2795          MOV     BX,18                           ; GET HEAD SETTLE PARAMETER
EEB4 E8B5FF           2796          CALL    GET_PARM
EEB7 51               2797          PUSH    CX                              ; SAVE REGISTER
EEB8                  2798  J29:                                            ; HEAD_SETTLE
EEB8 B92602           2799          MOV     CX,550                          ; 1 MS LOOP
EEBB 0AE4             2800          OR      AH,AH                           ; TEST FOR TIME EXPIRED
EEBD 7406             2801          JZ      J31
EEBF                  2802  J30:
EEBF E2FE             2803          LOOP    J30                             ; DELAY FOR 1 MS
EEC1 FECC             2804          DEC     AH                              ; DECREMENT THE COUNT
EEC3 EBF3             2805          JMP     J29                             ; DO IT SOME MORE
EEC5                  2806  J31:
EEC5 59               2807          POP     CX                              ; RECOVER STATE
EEC6 9D               2808          POPF
EEC7                  2809  J32:                                            ; SEEK_ERROR
EEC7 C3               2810          RET                                     ; RETURN TO CALLER
                      2811  SEEK    ENDP
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LOC OBJECT            LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

                      2812  ;--------------------------------------------------------------------------------
                      2813  ; DMA_SETUP                                                                    :
                      2814  ;       THIS ROUTINE SETS UP THE DMA FOR READ/WRITE/VERIFY OPERATIONS.          :
                      2815  ; INPUT                                                                        :
                      2816  ;       (AL) = MODE BYTE FOR THE DMA                                           :
                      2817  ;       (ES:BX) - ADDRESS TO READ/WRITE THE DATA                               :
                      2818  ; OUTPUT                                                                       :
                      2819  ;       (AX) DESTROYED                                                         :
                      2820  ;--------------------------------------------------------------------------------
EEC8                  2821  DMA_SETUP       PROC    NEAR
EEC8 51               2822          PUSH    CX                      ; SAVE THE REGISTER
EEC9 FA               2823          CLI                             ; NO MORE INTERRUPTS
EECA E60C             2824          OUT     DMA+12,AL               ; SET THE FIRST/LAST F/F
EECC 50               2825          PUSH    AX
EECD 58               2826          POP     AX
EECE E60B             2827          OUT     DMA+11,AL               ; OUTPUT THE MODE BYTE
EED0 8CC0             2828          MOV     AX,ES                   ; GET THE ES VALUE
EED2 B104             2829          MOV     CL,4                    ; SHIFT COUNT
EED4 D3C0             2830          ROL     AX,CL                   ; ROTATE LEFT
EED6 8AE8             2831          MOV     CH,AL                   ; GET HIGHEST NYBLE OF ES TO CH
EED8 24F0             2832          AND     AL,0F0H                 ; ZERO THE LOW NYBBLE FROM SEGMENT
EEDA 03C3             2833          ADD     AX,BX                   ; TEST FOR CARRY FROM ADDITION
EEDC 7302             2834          JNC     J33
EEDE FEC5             2835          INC     CH                      ; CARRY MEANS HIGH 4 BITS MUST BE INC
EEE0                  2836  J33:
EEE0 50               2837          PUSH    AX                      ; SAVE START ADDRESS
EEE1 E604             2838          OUT     DMA+4,AL                ; OUTPUT LOW ADDRESS
EEE3 8AC4             2839          MOV     AL,AH
EEE5 E604             2840          OUT     DMA+4,AL                ; OUTPUT HIGH ADDRESS
EEE7 8AC5             2841          MOV     AL,CH                   ; GET HIGH 4 BITS
EEE9 240F             2842          AND     AL,0FH
EEEB E681             2843          OUT     081H,AL                 ; OUTPUT THE HIGH 4 BITS TO
                      2844                                          ;  THE PAGE REGISTER
                      2845
                      2846  ;----- DETERMINE COUNT
                      2847
EEED 8AE6             2848          MOV     AH,DH                   ; NUMBER OF SECTORS
EEEF 2AC0             2849          SUB     AL,AL                   ;  TIMES 256 INTO AX
EEF1 D1E8             2850          SHR     AX,1                    ; SECTORS * 128 INTO AX
EEF3 50               2851          PUSH    AX
EEF4 BB0600           2852          MOV     BX,6                    ; GET THE BYTES/SECTOR PARM
EEF7 E872FF           2853          CALL    GET_PARM
EEFA 8ACC             2854          MOV     CL,AH                   ; USE AS SHIFT COUNT (0=128, 1=256 ETC)
EEFC 58               2855          POP     AX
EEFD D3E0             2856          SHL     AX,CL                   ; MULTIPLY BY CORRECT AMOUNT
EEFF 48               2857          DEC     AX                      ; -1 FOR DMA VALUE
EF00 50               2858          PUSH    AX                      ; SAVE COUNT VALUE
EF01 E605             2859          OUT     DMA+5,AL                ; LOW BYTE OF COUNT
EF03 8AC4             2860          MOV     AL,AH
EF05 E605             2861          OUT     DMA+5,AL                ; HIGH BYTE OF COUNT
EF07 FB               2862          STI                             ; INTERRUPTS BACK ON
EF08 59               2863          POP     CX                      ; RECOVER COUNT VALUE
EF09 58               2864          POP     AX                      ; RECOVER ADDRESS VALUE
EF0A 03C1             2865          ADD     AX,CX                   ; ADD, TEST FOR 64K OVERFLOW
EF0C 59               2866          POP     CX                      ; RECOVER REGISTER
EF0D B002             2867          MOV     AL,2                    ; MODE FOR 8237
EF0F E60A             2868          OUT     DMA+10,AL               ; INITIALIZE THE DISKETTE CHANNEL
EF11 C3               2869          RET                             ; RETURN TO CALLER,
                      2870                                          ;  CFL SET BY ABOVE IF ERROR
                      2871  DMA_SETUP       ENDP
                      2872  ;--------------------------------------------------------------------------------
                      2873  ; CHK_STAT_2                                                                   :
                      2874  ;       THIS ROUTINE HANDLES THE INTERRUPT RECEIVED AFTER A                     :
                      2875  ;       RECALIBRATE, SEEK, OR RESET TO THE ADAPTER.                             :
                      2876  ;       THE INTERRUPT IS WAITED FOR, THE INTERRUPT STATUS SENSED,               :
                      2877  ;       AND THE RESULT RETURNED TO THE CALLER.                                  :
                      2878  ; INPUT                                                                        :
                      2879  ;       NONE                                                                   :
                      2880  ; OUTPUT                                                                       :
                      2881  ;       CY = 0 SUCCESS                                                         :
                      2882  ;       CY = 1 FAILURE -- ERROR IS IN DISKETTE_STATUS                          :
                      2883  ;       (AX) DESTROYED                                                         :
                      2884  ;--------------------------------------------------------------------------------
EF12                  2885  CHK_STAT_2      PROC    NEAR
EF12 E81E00           2886          CALL    WAIT_INT                ; WAIT FOR THE INTERRUPT
EF15 7214             2887          JC      J34                     ; IF ERROR, RETURN IT
EF17 B408             2888          MOV     AH,08H                  ; SENSE INTERRUPT STATUS COMMAND
EF19 E825FF           2889          CALL    NEC_OUTPUT
EF1C E84A00           2890          CALL    RESULTS                 ; READ IN THE RESULTS
EF1F 720A             2891          JC      J34                     ; CHK2_RETURN
EF21 A04200           2892          MOV     AL,NEC_STATUS           ; GET THE FIRST STATUS BYTE
EF24 2460             2893          AND     AL,060H                 ; ISOLATE THE BITS
EF26 3C60             2894          CMP     AL,060H                 ; TEST FOR CORRECT VALUE
EF28 7402             2895          JZ      J35                     ; IF ERROR, GO MARK IT
EF2A F8               2896          CLC                             ; GOOD RETURN
EF2B                  2897  J34:
EF2B C3               2898          RET                             ; RETURN TO CALLER
EF2C                  2899  J35:                                    ; CHK2_ERROR
EF2C 800E410040       2900          OR      DISKETTE_STATUS,BAD_SEEK
EF31 F9               2901          STC                             ; ERROR RETURN CODE
EF32 C3               2902          RET
                      2903  CHK_STAT_2      ENDP
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LOC OBJECT            LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

                      2904  ;--------------------------------------------------------------------------
                      2905  ; WAIT_INT                                                               :
                      2906  ;       THIS ROUTINE WAITS FOR AN INTERRUPT TO OCCUR. A TIME OUT         :
                      2907  ;       ROUTINE TAKES PLACE DURING THE WAIT, SO THAT AN ERROR MAY BE     :
                      2908  ;       RETURNED IF THE DRIVE IS NOT READY.                              :
                      2909  ; INPUT                                                                  :
                      2910  ;       NONE                                                             :
                      2911  ; OUTPUT                                                                 :
                      2912  ;       CY = 0 SUCCESS                                                   :
                      2913  ;       CY = 1 FAILURE -- DISKETTE_STATUS IS SET ACCORDINGLY             :
                      2914  ;       (AX) DESTROYED                                                   :
                      2915  ;--------------------------------------------------------------------------
EF33                  2916  WAIT_INT        PROC    NEAR
EF33 FB               2917          STI                             ; TURN ON INTERRUPTS, JUST IN CASE
EF34 53               2918          PUSH    BX
EF35 51               2919          PUSH    CX                      ; SAVE REGISTERS
EF36 B302             2920          MOV     BL,2                    ; CLEAR THE COUNTERS
EF38 33C9             2921          XOR     CX,CX                   ; FOR 2 SECOND WAIT
EF3A                  2922  J36:
EF3A F6063E0080       2923          TEST    SEEK_STATUS,INT_FLAG    ; TEST FOR INTERRUPT OCCURRING
EF3F 750C             2924          JNZ     J37
EF41 E2F7             2925          LOOP    J36                     ; COUNT DOWN WHILE WAITING
EF43 FECB             2926          DEC     BL                      ; SECOND LEVEL COUNTER
EF45 75F3             2927          JNZ     J36
EF47 800E410080       2928          OR      DISKETTE_STATUS,TIME_OUT        ; NOTHING HAPPENED
EF4C F9               2929          STC                             ; ERROR RETURN
EF4D                  2930  J37:
EF4D 9C               2931          PUSHF                           ; SAVE CURRENT CARRY
EF4E 80263E007F       2932          AND     SEEK_STATUS,NOT INT_FLAG        ; TURN OFF INTERRUPT FLAG
EF53 9D               2933          POPF                            ; RECOVER CARRY
EF54 59               2934          POP     CX
EF55 5B               2935          POP     BX                      ; RECOVER REGISTERS
EF56 C3               2936          RET                             ; GOOD RETURN CODE COMES
                      2937                                          ;  FROM TEST INST
                      2938  WAIT_INT        ENDP
                      2939  ;--------------------------------------------------------
                      2940  ; DISK_INT                                              :
                      2941  ;       THIS ROUTINE HANDLES THE DISKETTE INTERRUPT      :
                      2942  ;INPUT                                                  :
                      2943  ;       NONE                                            :
                      2944  ; OUTPUT                                                :
                      2945  ;       THE INTERRUPT FLAG IS SET IS SEEK_STATUS        :
                      2946  ;--------------------------------------------------------
EF57                  2947          ORG     0EF57H
EF57                  2948  DISK_INT        PROC    FAR
EF57 FB               2949          STI                             ; RE ENABLE INTERRUPTS
EF58 1E               2950          PUSH    DS
EF59 50               2951          PUSH    AX
EF5A E8FC0A           2952          CALL    DDS
EF5D 800E3E0080       2953          OR      SEEK_STATUS,INT_FLAG
EF62 B020             2954          MOV     AL,20H                  ; END OF INTERRUPT MARKER
EF64 E620             2955          OUT     20H,AL                  ; INTERRUPT CONTROL PORT
EF66 58               2956          POP     AX
EF67 1F               2957          POP     DS                      ; RECOVER SYSTEM
EF68 CF               2958          IRET                            ; RETURN FROM INTERRUPT
                      2959  DISK_INT        ENDP
                      2960  ;--------------------------------------------------------------------------
                      2961  ; RESULTS                                                                :
                      2962  ;       THIS ROUTINE WILL READ ANYTHING THAT THE NEC CONTROLLER HAS       :
                      2963  ;       TO SAY FOLLOWING AN INTERRUPT.                                   :
                      2964  ; INPUT                                                                  :
                      2965  ;       NONE                                                             :
                      2966  ; OUTPUT                                                                 :
                      2967  ;       CY = 0  SUCCESSFUL TRANSFER                                      :
                      2968  ;       CY = 1  FAILURE -- TIME OUT IN WAITING FOR STATUS                :
                      2969  ;       NEC_STATUS AREA HAS STATUS BYTE LOADED INTO IT                   :
                      2970  ;       (AH) DESTROYED                                                   :
                      2971  ;--------------------------------------------------------------------------
EF69                  2972  RESULTS PROC    NEAR
EF69 FC               2973          CLD
EF6A BF4200           2974          MOV     DI,OFFSET NEC_STATUS    ; POINTER TO DATA AREA
EF6D 51               2975          PUSH    CX                      ; SAVE COUNTER
EF6E 52               2976          PUSH    DX
EF6F 53               2977          PUSH    BX
EF70 B307             2978          MOV     BL,7                    ; MAX STATUS BYTES
                      2979
                      2980  ;----- WAIT FOR REQUEST FOR MASTER
                      2981
EF72                  2982  J38:                                    ; INPUT_LOOP
EF72 33C9             2983          XOR     CX,CX                   ; COUNTER
EF74 BAF403           2984          MOV     DX,03F4H                ; STATUS PORT
EF77                  2985  J39:                                    ; WAIT FOR MASTER
EF77 EC               2986          IN      AL,DX                   ; GET STATUS
EF78 A880             2987          TEST    AL,080H                 ; MASTER READY
EF7A 750C             2988          JNZ     J40A                    ; TEST_DIR
EF7C E2F9             2989          LOOP    J39                     ; WAIT_MASTER
EF7E 800E410080       2990          OR      DISKETTE_STATUS,TIME_OUT
EF83                  2991  J40:                                    ; RESULTS_ERROR
EF83 F9               2992          STC                             ; SET ERROR RETURN
EF84 5B               2993          POP     BX
EF85 5A               2994          POP     DX
EF86 59               2995          POP     CX
EF87 C3               2996          RET
                      2997
                      2998  ;----- TEST THE DIRECTION BIT
                      2999
EF88                  3000  J40A:
EF88 EC               3001          IN      AL,DX                   ; GET STATUS REG AGAIN
EF89 A840             3002          TEST    AL,040H                 ; TEST DIRECTION BIT
EF8B 7507             3003          JNZ     J42                     ; OK TO READ STATUS
EF8D                  3004  J41:                                    ; NEC_FAIL
EF8D 800E410020       3005          OR      DISKETTE_STATUS,BAD_NEC
EF92 EBEF             3006          JMP     J40                     ; RESULTS_ERROR
                      3007
                      3008  ;----- READ IN THE STATUS
                      3009
EF94                  3010  J42:                                    ; INPUT_STAT
EF94 42               3011          INC     DX                      ; POINT AT DATA PORT
EF95 EC               3012          IN      AL,DX                   ; GET THE DATA
EF96 8805             3013          MOV     [DI],AL                 ; STORE THE BYTE
EF98 47               3014          INC     DI                      ; INCREMENT THE POINTER
EF99 B90A00           3015          MOV     CX,10                   ; LOOP TO KILL TIME FOR NEC
EF9C E2FE             3016  J43:    LOOP    J43
EF9E 4A               3017          DEC     DX                      ; POINT AT STATUS PORT
EF9F EC               3018          IN      AL,DX                   ; GET STATUS
EFA0 A810             3019          TEST    AL,010H                 ; TEST FOR NEC STILL BUSY
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 LOC OBJECT          LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

EFA2 7406            3020          JZ      J44                     ; RESULTS DONE
EFA4 FECB            3021          DEC     BL                      ; DECREMENT THE STATUS COUNTER
EFA6 75CA            3022          JNZ     J38                     ; GO BACK FOR MORE
EFA8 EBE3            3023          JMP     J41                     ; CHIP HAS FAILED
                     3024
                     3025  ;----- RESULT OPERATION IS DONE
                     3026
EFAA                 3027  J44:
EFAA 5B              3028          POP     BX
EFAB 5A              3029          POP     DX
EFAC 59              3030          POP     CX                      ; RECOVER REGISTERS
EFAD C3              3031          RET                             ; GOOD RETURN CODE FROM TEST INST
                     3032  ;--------------------------------------------------------------------
                     3033  ; NUM_TRANS                                                        :
                     3034  ;       THIS ROUTINE CALCULATES THE NUMBER OF SECTORS THAT       :
                     3035  ;       WERE ACTUALLY TRANSFERRED TO/FROM THE DISKETTE           :
                     3036  ; INPUT                                                          :
                     3037  ;       (CH) = CYLINDER OF OPERATION                             :
                     3038  ;       (CL) = START SECTOR OF OPERATION                         :
                     3039  ; OUTPUT                                                         :
                     3040  ;       (AL) = NUMBER ACTUALLY TRANSFERRED                       :
                     3041  ;       NO OTHER REGISTERS MODIFIED                              :
                     3042  ;--------------------------------------------------------------------
EFAE                 3043  NUM_TRANS       PROC    NEAR
EFAE A04500          3044          MOV     AL,NEC_STATUS+3         ; GET CYLINDER ENDED UP ON
EFB1 3AC5            3045          CMP     AL,CH                   ; SAME AS WE STARTED
EFB3 A04700          3046          MOV     AL,NEC_STATUS+5         ; GET ENDING SECTOR
EFB6 740A            3047          JZ      J45                     ; IF ON SAME CYL, THEN NO ADJUST
EFB8 BB0800          3048          MOV     BX,8
EFBB E8AEFE          3049          CALL    GET_PARM                ; GET EOT VALUE
EFBE 8AC4            3050          MOV     AL,AH                   ;  INTO AL
EFC0 FEC0            3051          INC     AL                      ; USE EOT+1 FOR CALCULATION
EFC2                 3052  J45:
EFC2 2AC1            3053          SUB     AL,CL                   ; SUBTRACT START FROM END
EFC4 C3              3054          RET
                     3055  NUM_TRANS       ENDP
                     3056  RESULTS ENDP
                     3057  ;--------------------------------------------------------------------
                     3058  ; DISK_BASE                                                       :
                     3059  ;       THIS IS THE SET OF PARAMETERS REQUIRED FOR DISKETTE OPERATION.  :
                     3060  ;       THEY ARE POINTED AT BY THE DATA VARIABLE DISK_POINTER. TO       :
                     3061  ;       MODIFY THE PARAMETERS, BUILD ANOTHER PARAMETER BLOCK AND POINT  :
                     3062  ;       DISK_POINTER TO IT.                                            :
                     3063  ;--------------------------------------------------------------------
EFC7                 3064          ORG     0EFC7H
EFC7                 3065  DISK_BASE       LABEL   BYTE
EFC7 CF              3066          DB      11001111B       ; SRT=C, HD UNLOAD=0F - 1ST SPECIFY BYTE
EFC8 02              3067          DB      2               ; HD LOAD=1, MODE=DMA - 2ND SPECIFY BYTE
EFC9 25              3068          DB      MOTOR_WAIT      ; WAIT AFTER OPN TIL MOTOR OFF
EFCA 02              3069          DB      2               ; 512 BYTES/SECTOR
EFCB 08              3070          DB      8               ; EOT ( LAST SECTOR ON TRACK)
EFCC 2A              3071          DB      02AH            ; GAP LENGTH
EFCD FF              3072          DB      0FFH            ; DTL
EFCE 50              3073          DB      050H            ; GAP LENGTH FOR FORMAT
EFCF F6              3074          DB      0F6H            ; FILL BYTE FOR FORMAT
EFD0 19              3075          DB      25              ; HEAD SETTLE TIME (MILLISECONDS)
EFD1 04              3076          DB      4               ; MOTOR START TIME (1/8 SECONDS)
                     3077
```

SECTION 5

```
LOC OBJECT          LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

                    3078  ;--- INT 17 ------------------------------------------------------------
                    3079  ; PRINTER_IO                                                          :
                    3080  ;       THIS ROUTINE PROVIDES COMMUNICATION WITH THE PRINTER           :
                    3081  ; INPUT                                                               :
                    3082  ;       (AH)=0  PRINT THE CHARACTER IN (AL)                           :
                    3083  ;               ON RETURN, AH=1 IF CHARACTER COULD NOT BE PRINTED      :
                    3084  ;               (TIME OUT). OTHER BITS SET AS ON NORMAL STATUS CALL    :
                    3085  ;       (AH)=1  INITIALIZE THE PRINTER PORT                           :
                    3086  ;               RETURNS WITH (AH) SET WITH PRINTER STATUS              :
                    3087  ;       (AH)=2  READ THE PRINTER STATUS INTO (AH)                     :
                    3088  ;               7       6       5       4       3       2-1   0       :
                    3089  ;               |       |       |       |       |       |     |_TIME OUT :
                    3090  ;               |       |       |       |       |       |_ UNUSED       :
                    3091  ;               |       |       |       |       |__ 1 = I/O ERROR       :
                    3092  ;               |       |       |       |_ 1 = SELECTED                 :
                    3093  ;               |       |       |_ 1 = OUT OF PAPER                     :
                    3094  ;               |       |_ 1 = ACKNOWLEDGE                              :
                    3095  ;               |_ 1 = NOT BUSY                                       :
                    3096  ;                                                                     :
                    3097  ;       (DX) = PRINTER TO BE USED (0,1,2) CORRESPONDING TO ACTUAL      :
                    3098  ;               VALUES IN PRINTER_BASE AREA                           :
                    3099  ;                                                                     :
                    3100  ; DATA AREA PRINTER_BASE CONTAINS THE BASE ADDRESS OF THE PRINTER     :
                    3101  ; CARD(S) AVAILABLE (LOCATED AT BEGINNING OF DATA SEGMENT,            :
                    3102  ; 408H ABSOLUTE, 3 WORDS)                                            :
                    3103  ;                                                                     :
                    3104  ; DATA AREA PRINT_TIM_OUT (BYTE) MAY BE CHANGED TO CAUSE DIFFERENT   :
                    3105  ; TIME-OUT WAITS. DEFAULT=20                                         :
                    3106  ;                                                                     :
                    3107  ; REGISTERS     AH IS MODIFIED                                        :
                    3108  ;               ALL OTHERS UNCHANGED                                  :
                    3109  ;-------------------------------------------------------------------
                    3110          ASSUME  CS:CODE,DS:DATA
EFD2                3111          ORG     0EFD2H
EFD2                3112  PRINTER_IO      PROC    FAR
EFD2 FB             3113          STI                             ; INTERRUPTS BACK ON
EFD3 1E             3114          PUSH    DS                      ; SAVE SEGMENT
EFD4 52             3115          PUSH    DX
EFD5 56             3116          PUSH    SI
EFD6 51             3117          PUSH    CX
EFD7 53             3118          PUSH    BX
EFD8 E87E0A         3119          CALL    DDS
EFDB 8BF2           3120          MOV     SI,DX                   ; GET PRINTER PARM
EFDD 8A5C78         3121          MOV     BL,PRINT_TIM_OUT[SI]    ; LOAD TIME-OUT PARM
EFE0 D1E6           3122          SHL     SI,1                    ; WORD OFFSET INTO TABLE
EFE2 8B5408         3123          MOV     DX,PRINTER_BASE[SI]     ; GET BASE ADDRESS FOR PRINTER CARD
EFE5 0BD2           3124          OR      DX,DX                   ; TEST DX FOR ZERO,
                    3125                                          ;  INDICATING NO PRINTER
EFE7 740C           3126          JZ      B1                      ; RETURN
EFE9 0AE4           3127          OR      AH,AH                   ; TEST FOR (AH)=0
EFEB 740E           3128          JZ      B2                      ; PRINT_AL
EFED FECC           3129          DEC     AH                      ; TEST FOR (AH)=1
EFEF 743F           3130          JZ      B8                      ; INIT_PRT
EFF1 FECC           3131          DEC     AH                      ; TEST FOR (AH)=2
EFF3 7428           3132          JZ      B5                      ; PRINTER STATUS
EFF5                3133  B1:                                     ; RETURN
EFF5 5B             3134          POP     BX
EFF6 59             3135          POP     CX
EFF7 5E             3136          POP     SI                      ; RECOVER REGISTERS
EFF8 5A             3137          POP     DX                      ; RECOVER REGISTERS
EFF9 1F             3138          POP     DS
EFFA CF             3139          IRET
                    3140
                    3141  ;------ PRINT THE CHARACTER IN (AL)
                    3142
EFFB                3143  B2:
EFFB 50             3144          PUSH    AX                      ; SAVE VALUE TO PRINT
EFFC EE             3145          OUT     DX,AL                   ; OUTPUT CHAR TO PORT
EFFD 42             3146          INC     DX                      ; POINT TO STATUS PORT
EFFE                3147  B3:
EFFE 2BC9           3148          SUB     CX,CX                   ; WAIT_BUSY
F000                3149  B3_1:
F000 EC             3150          IN      AL,DX                   ; GET STATUS
F001 8AE0           3151          MOV     AH,AL                   ; STATUS TO AH ALSO
F003 A880           3152          TEST    AL,80H                  ; IS THE PRINTER CURRENTLY BUSY
F005 750E           3153          JNZ     B4                      ; OUT_STROBE
F007 E2F7           3154          LOOP    B3_1                    ; TRY AGAIN
F009 FECB           3155          DEC     BL                      ; DROP LOOP COUNT
F00B 75F1           3156          JNZ     B3                      ; GO TILL TIMEOUT ENDS
F00D 80CC01         3157          OR      AH,1                    ; SET ERROR FLAG
F010 80E4F9         3158          AND     AH,0F9H                 ; TURN OFF THE OTHER BITS
F013 EB13           3159          JMP     SHORT B7                ; RETURN WITH ERROR FLAG SET
F015                3160  B4:                                     ; OUT_STROBE
F015 B00D           3161          MOV     AL,0DH                  ; SET THE STROBE HIGH
F017 42             3162          INC     DX                      ; STROBE IS BIT 0 OF PORT C OF 8255
F018 EE             3163          OUT     DX,AL
F019 B00C           3164          MOV     AL,0CH                  ; SET THE STROBE LOW
F01B EE             3165          OUT     DX,AL
F01C 58             3166          POP     AX                      ; RECOVER THE OUTPUT CHAR
                    3167
                    3168  ;------ PRINTER STATUS
                    3169
F01D                3170  B5:
F01D 50             3171          PUSH    AX                      ; SAVE AL REG
F01E                3172  B6:
F01E 8B5408         3173          MOV     DX,PRINTER_BASE[SI]
F021 42             3174          INC     DX
F022 EC             3175          IN      AL,DX                   ; GET PRINTER STATUS
F023 8AE0           3176          MOV     AH,AL
F025 80E4F8         3177          AND     AH,0F8H                 ; TURN OFF UNUSED BITS
F028                3178  B7:                                     ; STATUS_SET
F028 5A             3179          POP     DX                      ; RECOVER AL REG
F029 8AC2           3180          MOV     AL,DL                   ; GET CHARACTER INTO AL
F02B 80F448         3181          XOR     AH,48H                  ; FLIP A COUPLE OF BITS
F02E EBC5           3182          JMP     B1                      ; RETURN FROM ROUTINE
```

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                    3183
                    3184  ;------ INITIALIZE THE PRINTER PORT
                    3185
F030                3186  B8:
F030 50             3187          PUSH    AX                      ; SAVE AL
F031 42             3188          INC     DX                      ; POINT TO OUTPUT PORT
F032 42             3189          INC     DX
F033 B008           3190          MOV     AL,8                    ; SET INIT LINE LOW
F035 EE             3191          OUT     DX,AL
F036 B8E803         3192          MOV     AX,1000
F039                3193  B9:                                     ; INIT_LOOP
F039 48             3194          DEC     AX                      ; LOOP FOR RESET TO TAKE
F03A 75FD           3195          JNZ     B9                      ; INIT_LOOP
F03C B00C           3196          MOV     AL,0CH                  ; NO INTERRUPTS, NON AUTO LF,
                    3197                                          ;  INIT HIGH
F03E EE             3198          OUT     DX,AL
F03F EBDD           3199          JMP     B6                      ; PRT_STATUS_1
                    3200  PRINTER_IO    ENDP
                    3201
```

```
3202
3203 ;--- INT 10 ----------------------------------------------------------------
3204 ; VIDEO_IO                                                                 :
3205 ;       THESE ROUTINES PROVIDE THE CRT INTERFACE                           :
3206 ;       THE FOLLOWING FUNCTIONS ARE PROVIDED:                              :
3207 ;       (AH)=0  SET MODE (AL) CONTAINS MODE VALUE                          :
3208 ;               (AL)=0 40X25 BW (POWER ON DEFAULT)                         :
3209 ;               (AL)=1 40X25 COLOR                                         :
3210 ;               (AL)=2  80X25 BW                                           :
3211 ;               (AL)=3  80X25 COLOR                                        :
3212 ;               GRAPHICS MODES                                             :
3213 ;               (AL)=4  320X200 COLOR                                      :
3214 ;               (AL)=5  320X200 BW                                         :
3215 ;               (AL)=6  640X200 BW                                         :
3216 ;               CRT MODE=7 80X25 B&W CARD (USED INTERNAL TO VIDEO ONLY)    :
3217 ;               *** NOTE BW MODES OPERATE SAME AS COLOR MODES, BUT          :
3218 ;                       COLOR BURST IS NOT ENABLED                         :
3219 ;       (AH)=1  SET CURSOR TYPE                                            :
3220 ;               (CH) =  BITS 4-0 = START LINE FOR CURSOR                   :
3221 ;                       ** HARDWARE WILL ALWAYS CAUSE BLIN                 :
3222 ;                       ** SETTING BIT 5 OR 6 WILL CAUSE ERRATIC           :
3223 ;                          BLINKING OR NO CURSOR AT ALL                    :
3224 ;               (CL) =  BITS 4-0 = END LINE FOR CURSOR                     :
3225 ;       (AH)=2  SET CURSOR POSITION                                        :
3226 ;               (DH,DL) = ROW,COLUMN  (0,0) IS UPPER LEFT                  :
3227 ;               (BH) = PAGE NUMBER (MUST BE 0 FOR GRAPHICS MODES)          :
3228 ;       (AH)=3  READ CURSOR POSITION                                       :
3229 ;               (BH) = PAGE NUMBER (MUST BE 0 FOR GRAPHICS MODES)          :
3230 ;               ON EXIT (DH,DL) = ROW,COLUMN OF CURRENT CURSOR             :
3231 ;                       (CH,CL) = CURSOR MODE CURRENTLY SET                :
3232 ;       (AH)=4  READ LIGHT PEN POSITION                                    :
3233 ;               ON EXIT:                                                   :
3234 ;               (AH) = 0 -- LIGHT PEN SWITCH NOT DOWN/NOT TRIGGERED        :
3235 ;               (AH) = 1 -- VALID LIGHT PEN VALUE IN REGISTERS             :
3236 ;                       (DH,DL) = ROW,COLUMN OF CHARACTER LP POSN          :
3237 ;                       (CH) = RASTER LINE (0-199)                         :
3238 ;                       (BX) = PIXEL COLUMN (0-319,639)                    :
3239 ;       (AH)=5  SELECT ACTIVE DISPLAY PAGE (VALID ONLY FOR ALPHA MODES)    :
3240 ;               (AL)=NEW PAGE VAL (0-7 FOR MODES 0&1, 0-3 FOR MODES 2&3)   :
3241 ;       (AH)=6  SCROLL ACTIVE PAGE UP                                      :
3242 ;               (AL) = NUMBER OF LINES, INPUT LINES BLANKED AT BOTTOM      :
3243 ;                      OF WINDOW                                           :
3244 ;                       AL = 0 MEANS BLANK ENTIRE WINDOW                   :
3245 ;               (CH,CL) = ROW,COLUMN OF UPPER LEFT CORNER OF SCROLL        :
3246 ;               (DH,DL) = ROW,COLUMN OF LOWER RIGHT CORNER OF SCROLL       :
3247 ;               (BH) = ATTRIBUTE TO BE USED ON BLANK LINE                  :
3248 ;       (AH)=7  SCROLL ACTIVE PAGE DOWN                                    :
3249 ;               (AL) = NUMBER OF LINES, INPUT LINES BLANKED AT TOP         :
3250 ;                      OF WINDOW                                           :
3251 ;                       AL = 0 MEANS BLANK ENTIRE WINDOW                   :
3252 ;               (CH,CL) = ROW,COLUMN OF UPPER LEFT CORNER OF SCROLL        :
3253 ;               (DH,DL) = ROW,COLUMN OF LOWER RIGHT CORNER OF SCROLL       :
3254 ;               (BH) = ATTRIBUTE TO BE USED ON BLANK LINE                  :
3255 ;                                                                          :
3256 ;       CHARACTER HANDLING ROUTINES                                        :
3257 ;                                                                          :
3258 ;       (AH) = 8 READ ATTRIBUTE/CHARACTER AT CURRENT CURSOR POSITION       :
3259 ;               (BH) = DISPLAY PAGE (VALID FOR ALPHA MODES ONLY)           :
3260 ;               ON EXIT:                                                   :
3261 ;               (AL) = CHAR READ                                           :
3262 ;               (AH) = ATTRIBUTE OF CHARACTER READ (ALPHA MODES ONLY)      :
3263 ;       (AH) = 9 WRITE ATTRIBUTE/CHARACTER AT CURRENT CURSOR POSITION      :
3264 ;               (BH) = DISPLAY PAGE (VALID FOR ALPHA MODES ONLY)           :
3265 ;               (CX) = COUNT OF CHARACTERS TO WRITE                        :
3266 ;               (AL) = CHAR TO WRITE                                       :
3267 ;               (BL) = ATTRIBUTE OF CHARACTER (ALPHA)/COLOR OF CHAR        :
3268 ;                      (GRAPHICS)                                          :
3269 ;                       SEE NOTE ON WRITE DOT FOR BIT 7 OF BL = 1.         :
3270 ;       (AH)= 10 WRITE CHARACTER ONLY AT CURRENT CURSOR POSITION           :
3271 ;               (BH) = DISPLAY PAGE (VALID FOR ALPHA MODES ONLY)           :
3272 ;               (CX) = COUNT OF CHARACTERS TO WRITE                        :
3273 ;               (AL) = CHAR TO WRITE                                       :
3274 ;       FOR READ/WRITE CHARACTER INTERFACE WHILE IN GRAPHICS MODE, THE      :
3275 ;               CHARACTERS ARE FORMED FROM A CHARACTER GENERATOR IMAGE      :
3276 ;               MAINTAINED IN THE SYSTEM ROM.  ONLY THE 1ST 128 CHARS      :
3277 ;               ARE CONTAINED THERE.  TO READ/WRITE THE SECOND 128         :
3278 ;               CHARS, THE USER MUST INITIALIZE THE POINTER AT             :
3279 ;               INTERRUPT 1FH (LOCATION 0007CH) TO POINT TO THE 1K BYTE    :
3280 ;               TABLE CONTAINING THE CODE POINTS FOR THE SECOND            :
3281 ;               128 CHARS (128-255).                                       :
3282 ;       FOR WRITE CHARACTER INTERFACE IN GRAPHICS MODE, THE REPLICATION     :
3283 ;               FACTOR CONTAINED IN (CX) ON ENTRY WILL PRODUCE VALID       :
3284 ;               RESULTS ONLY FOR CHARACTERS CONTAINED ON THE SAME ROW.     :
3285 ;               CONTINUATION TO SUCCEEDING LINES WILL NOT PRODUCE           :
3286 ;               CORRECTLY.                                                 :
3287 ;                                                                          :
3288 ;       GRAPHICS INTERFACE                                                 :
3289 ;       (AH) = 11 SET COLOR PALETTE                                        :
3290 ;               (BH) = PALETTE COLOR ID BEING SET (0-127)                  :
3291 ;               (BL) = COLOR VALUE TO BE USED WITH THAT COLOR ID           :
3292 ;                  NOTE: FOR THE CURRENT COLOR CARD, THIS ENTRY POINT      :
3293 ;                        HAS MEANING ONLY FOR 320X200 GRAPHICS.            :
3294 ;                       COLOR ID = 0 SELECTS THE BACKGROUND COLOR (0-15)   :
3295 ;                       COLOR ID = 1 SELECTS THE PALETTE TO BE USED:       :
3296 ;                               0 = GREEN(1)/RED(2)/YELLOW(3)              :
3297 ;                               1 = CYAN(1)/MAGENTA(2)/WHITE(3)            :
3298 ;                       IN 40X25 OR 80X25 ALPHA MODES, THE VALUE SET       :
3299 ;                               FOR PALETTE COLOR 0 INDICATES THE          :
3300 ;                               BORDER COLOR TO BE USED (VALUES 0-31,      :
3301 ;                               WHERE 16-31 SELECT THE HIGH INTENSITY      :
3302 ;                               BACKGROUND SET.                            :
3303 ;       (AH) = 12 WRITE DOT                                                :
3304 ;               (DX) = ROW NUMBER                                          :
3305 ;               (CX) = COLUMN NUMBER                                       :
3306 ;               (AL) = COLOR VALUE                                         :
3307 ;                       IF BIT 7 OF AL = 1, THEN THE COLOR VALUE IS        :
3308 ;                       EXCLUSIVE OR'D WITH THE CURRENT CONTENTS OF        :
3309 ;                       THE DOT                                            :
3310 ;       (AH) = 13 READ DOT                                                 :
3311 ;               (DX) = ROW NUMBER                                          :
3312 ;               (CX) = COLUMN NUMBER                                       :
3313 ;               (AL) RETURNS THE DOT READ                                  :
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                    3314  ;
                    3315  ; ASCII TELETYPE ROUTINE FOR OUTPUT                                          :
                    3316  ;                                                                            :
                    3317  ;       (AH) = 14 WRITE TELETYPE TO ACTIVE PAGE                              :
                    3318  ;               (AL) = CHAR TO WRITE                                         :
                    3319  ;               (BL) = FOREGROUND COLOR IN GRAPHICS MODE                      :
                    3320  ;               NOTE -- SCREEN WIDTH IS CONTROLLED BY PREVIOUS MODE SET       :
                    3321  ;                                                                            :
                    3322  ;       (AH) = 15 CURRENT VIDEO STATE                                        :
                    3323  ;               RETURNS THE CURRENT VIDEO STATE                              :
                    3324  ;               (AL) = MODE CURRENTLY SET ( SEE AH=0 FOR EXPLANATION)        :
                    3325  ;               (AH) = NUMBER OF CHARACTER COLUMNS ON SCREEN                  :
                    3326  ;               (BH) = CURRENT ACTIVE DISPLAY PAGE                            :
                    3327  ;                                                                            :
                    3328  ;       CS,SS,DS,ES,BX,CX,DX PRESERVED DURING CALL                           :
                    3329  ;       ALL OTHERS DESTROYED                                                 :
                    3330  ;-----------------------------------------------------------------------------
                    3331          ASSUME  CS:CODE,DS:DATA,ES:VIDEO_RAM
F045                3332          ORG     0F045H
F045                3333  M1      LABEL   WORD                    ; TABLE OF ROUTINES WITHIN VIDEO I/O
F045 FCF0           3334          DW      OFFSET  SET_MODE
F047 CDF1           3335          DW      OFFSET  SET_CTYPE
F049 EEF1           3336          DW      OFFSET  SET_CPOS
F04B 39F2           3337          DW      OFFSET  READ_CURSOR
F04D 9CF7           3338          DW      OFFSET  READ_LPEN
F04F 17F2           3339          DW      OFFSET  ACT_DISP_PAGE
F051 96F2           3340          DW      OFFSET  SCROLL_UP
F053 38F3           3341          DW      OFFSET  SCROLL_DOWN
F055 74F3           3342          DW      OFFSET  READ_AC_CURRENT
F057 B9F3           3343          DW      OFFSET  WRITE_AC_CURRENT
F059 ECF3           3344          DW      OFFSET  WRITE_C_CURRENT
F05B 4EF2           3345          DW      OFFSET  SET_COLOR
F05D 2FF4           3346          DW      OFFSET  WRITE_DOT
F05F 1EF4           3347          DW      OFFSET  READ_DOT
F061 18F7           3348          DW      OFFSET  WRITE_TTY
F063 74F2           3349          DW      OFFSET  VIDEO_STATE
  0020              3350  M1L     EQU     $-M1
                    3351
F065                3352          ORG     0F065H
F065                3353  VIDEO_IO        PROC    NEAR
F065 FB             3354          STI                             ; INTERRUPTS BACK ON
F066 FC             3355          CLD                             ; SET DIRECTION FORWARD
F067 06             3356          PUSH    ES
F068 1E             3357          PUSH    DS                      ; SAVE SEGMENT REGISTERS
F069 52             3358          PUSH    DX
F06A 51             3359          PUSH    CX
F06B 53             3360          PUSH    BX
F06C 56             3361          PUSH    SI
F06D 57             3362          PUSH    DI
F06E 50             3363          PUSH    AX                      ; SAVE AX VALUE
F06F 8AC4           3364          MOV     AL,AH                   ; GET INTO LOW BYTE
F071 32E4           3365          XOR     AH,AH                   ; ZERO TO HIGH BYTE
F073 D1E0           3366          SAL     AX,1                    ; *2 FOR TABLE LOOKUP
F075 8BF0           3367          MOV     SI,AX                   ; PUT INTO SI FOR BRANCH
F077 3D2000         3368          CMP     AX,M1L                  ; TEST FOR WITHIN RANGE
F07A 7204           3369          JB      M2                      ; BRANCH AROUND BRANCH
F07C 58             3370          POP     AX                      ; THROW AWAY THE PARAMETER
F07D E94501         3371          JMP     VIDEO_RETURN            ; DO NOTHING IF NOT IN RANGE
F080                3372  M2:
F080 E8D609         3373          CALL    DDS
F083 B800B8         3374          MOV     AX,0B800H               ; SEGMENT FOR COLOR CARD
F086 8B3E1000       3375          MOV     DI,EQUIP_FLAG           ; GET EQUIPMENT SETTING
F08A 81E73000       3376          AND     DI,30H                  ; ISOLATE CRT SWITCHES
F08E 83FF30         3377          CMP     DI,30H                  ; IS SETTING FOR BW CARD?
F091 7502           3378          JNE     M3
F093 B4B0           3379          MOV     AH,0B0H                 ; SEGMENT FOR BW CARD
F095                3380  M3:
F095 8EC0           3381          MOV     ES,AX                   ; SET UP TO POINT AT VIDEO RAM AREAS
F097 58             3382          POP     AX                      ; RECOVER VALUE
F098 8A264900       3383          MOV     AH,CRT_MODE             ; GET CURRENT MODE INTO AH
F09C 2EFFA445F0     3384          JMP     WORD PRT CS:[SI+OFFSET M1]
                    3385  VIDEO_IO        ENDP
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                        3386  ;--------------------------------------------------------
                        3387  ; SET_MODE                                              :
                        3388  ;       THIS ROUTINE INITIALIZES THE ATTACHMENT TO      :
                        3389  ;       THE SELECTED MODE.  THE SCREEN IS BLANKED.      :
                        3390  ; INPUT                                                 :
                        3391  ;       (AL) = MODE SELECTED (RANGE 0-9)                :
                        3392  ; OUTPUT                                                :
                        3393  ;       NONE                                            :
                        3394  ;--------------------------------------------------------
                        3395
                        3396  ;----- TABLES FOR USE IN SETTING OF MODE
                        3397
F0A4                    3398          ORG     0F0A4H
F0A4                    3399  VIDEO_PARMS     LABEL   BYTE
                        3400  ;-----  INIT_TABLE
F0A4 38                 3401          DB      38H,28H,2DH,0AH,1FH,6,19H       ; SET UP FOR 40X25
F0A5 28
F0A6 2D
F0A7 0A
F0A8 1F
F0A9 06
F0AA 19
F0AB 1C                 3402          DB      1CH,2,7,6,7
F0AC 02
F0AD 07
F0AE 06
F0AF 07
F0B0 00                 3403          DB      0,0,0,0
F0B1 00
F0B2 00
F0B3 00
  0010                  3404  M4      EQU     $-VIDEO_PARMS
                        3405
F0B4 71                 3406          DB      71H,50H,5AH,0AH,1FH,6,19H       ; SET UP FOR 80X25
F0B5 50
F0B6 5A
F0B7 0A
F0B8 1F
F0B9 06
F0BA 19
F0BB 1C                 3407          DB      1CH,2,7,6,7
F0BC 02
F0BD 07
F0BE 06
F0BF 07
F0C0 00                 3408          DB      0,0,0,0
F0C1 00
F0C2 00
F0C3 00
                        3409
F0C4 38                 3410          DB      38H,28H,2DH,0AH,7FH,6,64H       ; SET UP FOR GRAPHICS
F0C5 28
F0C6 2D
F0C7 0A
F0C8 7F
F0C9 06
F0CA 64
F0CB 70                 3411          DB      70H,2,1,6,7
F0CC 02
F0CD 01
F0CE 06
F0CF 07
F0D0 00                 3412          DB      0,0,0,0
F0D1 00
F0D2 00
F0D3 00
                        3413
F0D4 61                 3414          DB      61H,50H,52H,0FH,19H,6,19H       ; SET UP FOR 80X25 B&W CARD
F0D5 50
F0D6 52
F0D7 0F
F0D8 19
F0D9 06
F0DA 19
F0DB 19                 3415          DB      19H,2,0DH,0BH,0CH
F0DC 02
F0DD 0D
F0DE 0B
F0DF 0C
F0E0 00                 3416          DB      0,0,0,0
F0E1 00
F0E2 00
F0E3 00
                        3417
F0E4                    3418  M5      LABEL   WORD                    ; TABLE OF REGEN LENGTHS
F0E4 0008               3419          DW      2048                    ; 40X25
F0E6 0010               3420          DW      4096                    ; 80X25
F0E8 0040               3421          DW      16384                   ; GRAPHICS
F0EA 0040               3422          DW      16384
                        3423
                        3424  ;-----  COLUMNS
                        3425
F0EC                    3426  M6      LABEL   BYTE
F0EC 28                 3427          DB      40,40,80,80,40,40,80,80
F0ED 28
F0EE 50
F0EF 50
F0F0 28
F0F1 28
F0F2 50
F0F3 50
                        3428
                        3429  ;-----  C_REG_TAB
                        3430
F0F4                    3431  M7      LABEL   BYTE                    ; TABLE OF MODE SETS
F0F4 2C                 3432          DB      2CH,28H,2DH,29H,2AH,2EH,1EH,29H
F0F5 28
F0F6 2D
F0F7 29
F0F8 2A
F0F9 2E
F0FA 1E
F0FB 29
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                        3433
F0FC                    3434  SET_MODE        PROC    NEAR
F0FC BAD403             3435                  MOV     DX,03D4H                ; ADDRESS OF COLOR CARD
F0FF B300               3436                  MOV     BL,0                    ; MODE SET FOR COLOR CARD
F101 83FF30             3437                  CMP     DI,30H                  ; IS BW CARD INSTALLED
F104 7506               3438                  JNE     M8                      ; OK WITH COLOR
F106 B007               3439                  MOV     AL,7                    ; INDICATE BW CARD MODE
F108 B2B4               3440                  MOV     DL,0B4H                 ; ADDRESS OF BW CARD (3B4)
F10A FEC3               3441                  INC     BL                      ; MODE SET FOR BW CARD
F10C                    3442  M8:
F10C 8AE0               3443                  MOV     AH,AL                   ; SAVE MODE IN AH
F10E A24900             3444                  MOV     CRT_MODE,AL             ; SAVE IN GLOBAL VARIABLE
F111 89166300           3445                  MOV     ADDR_6845,DX            ; SAVE ADDRESS OF BASE
F115 1E                 3446                  PUSH    DS                      ; SAVE POINTER TO DATA SEGMENT
F116 50                 3447                  PUSH    AX                      ; SAVE MODE
F117 52                 3448                  PUSH    DX                      ; SAVE OUTPUT PORT VALUE
F118 83C204             3449                  ADD     DX,4                    ; POINT TO CONTROL REGISTER
F11B 8AC3               3450                  MOV     AL,BL                   ; GET MODE SET FOR CARD
F11D EE                 3451                  OUT     DX,AL                   ; RESET VIDEO
F11E 5A                 3452                  POP     DX                      ; BACK TO BASE REGISTER
F11F 2BC0               3453                  SUB     AX,AX                   ; SET UP FOR ABS0 SEGMENT
F121 8ED8               3454                  MOV     DS,AX                   ; ESTABLISH VECTOR TABLE ADDRESSING
                        3455                  ASSUME  DS:ABS0
F123 C51E7400           3456                  LDS     BX,PARM_PTR             ; GET POINTER TO VIDEO PARMS
F127 58                 3457                  POP     AX                      ; RECOVER PARMS
                        3458                  ASSUME  DS:CODE
F128 B91000             3459                  MOV     CX,M4                   ; LENGTH OF EACH ROW OF TABLE
F12B 80FC02             3460                  CMP     AH,2                    ; DETERMINE WHICH ONE TO USE
F12E 7210               3461                  JC      M9                      ; MODE IS 0 OR 1
F130 03D9               3462                  ADD     BX,CX                   ; MOVE TO NEXT ROW OF INIT TABLE
F132 80FC04             3463                  CMP     AH,4
F135 7209               3464                  JC      M9                      ; MODE IS 2 OR 3
F137 03D9               3465                  ADD     BX,CX                   ; MOVE TO GRAPHICS ROW OF INIT_TABLE
F139 80FC07             3466                  CMP     AH,7
F13C 7202               3467                  JC      M9                      ; MODE IS 4,5, OR 6
F13E 03D9               3468                  ADD     BX,CX                   ; MOVE TO BW CARD ROW OF INIT_TABLE
                        3469
                        3470  ;----- BX POINTS TO CORRECT ROW OF INITIALIZATION TABLE
                        3471
F140                    3472  M9:                                             ; OUT_INIT
F140 50                 3473                  PUSH    AX                      ; SAVE MODE IN AH
F141 32E4               3474                  XOR     AH,AH                   ; AH WILL SERVE AS REGISTER
                        3475                                                  ;  NUMBER DURING LOOP
                        3476
                        3477  ;----- LOOP THROUGH TABLE, OUTPUTTTING REG ADDRESS, THEN VALUE FROM TABLE
                        3478
F143                    3479  M10:                                            ; INIT LOOP
F143 8AC4               3480                  MOV     AL,AH                   ; GET 6845 REGISTER NUMBER
F145 EE                 3481                  OUT     DX,AL
F146 42                 3482                  INC     DX                      ; POINT TO DATA PORT
F147 FEC4               3483                  INC     AH                      ; NEXT REGISTER VALUE
F149 8A07               3484                  MOV     AL,[BX]                 ; GET TABLE VALUE
F14B EE                 3485                  OUT     DX,AL                   ; OUT TO CHIP
F14C 43                 3486                  INC     BX                      ; NEXT IN TABLE
F14D 4A                 3487                  DEC     DX                      ; BACK TO POINTER REGISTER
F14E E2F3               3488                  LOOP    M10                     ; DO THE WHOLE TABLE
F150 58                 3489                  POP     AX                      ; GET MODE BACK
F151 1F                 3490                  POP     DS                      ; RECOVER SEGMENT VALUE
                        3491                  ASSUME  DS:DATA
                        3492
                        3493  ;----- FILL REGEN AREA WITH BLANK
                        3494
F152 33FF               3495                  XOR     DI,DI                   ; SET UP POINTER FOR REGEN
F154 893E4E00           3496                  MOV     CRT_START,DI            ; START ADDRESS SAVED IN GLOBAL
F158 C606620000         3497                  MOV     ACTIVE_PAGE,0           ; SET PAGE VALUE
F15D B90020             3498                  MOV     CX,8192                 ; NUMBER OF WORDS IN COLOR CARD
F160 80FC04             3499                  CMP     AH,4                    ; TEST FOR GRAPHICS
F163 720B               3500                  JC      M12                     ; NO_GRAPHICS_INIT
F165 80FC07             3501                  CMP     AH,7                    ; TEST FOR BW CARD
F168 7404               3502                  JE      M11                     ; BW_CARD_INIT
F16A 33C0               3503                  XOR     AX,AX                   ; FILL FOR GRAPHICS MODE
F16C EB05               3504                  JMP     SHORT M13               ; CLEAR_BUFFER
F16E                    3505  M11:                                            ; BW_CARD_INIT
F16E B508               3506                  MOV     CH,08H                  ; BUFFER SIZE ON BW CARD
F170                    3507  M12:                                            ; NO_GRAPHICS_INIT
F170 B82007             3508                  MOV     AX,' '+7*256            ; FILL CHAR FOR ALPHA
F173                    3509  M13:                                            ; CLEAR_BUFFER
F173 F3                 3510                  REP     STOSW                   ; FILL THE REGEN BUFFER WITH BLANKS
F174 AB
                        3511
                        3512  ;----- ENABLE VIDEO AND CORRECT PORT SETTING
                        3513
F175 C70660000706       3514                  MOV     CURSOR_MODE,607H        ; SET CURRENT CURSOR MODE
F17B A04900             3515                  MOV     AL,CRT_MODE             ; GET THE MODE
F17E 32E4               3516                  XOR     AH,AH                   ;  INTO AX REGISTER
F180 8BF0               3517                  MOV     SI,AX                   ; TABLE POINTER, INDEXED BY MODE
F182 8B166300           3518                  MOV     DX,ADDR_6845            ; PREPARE TO OUTPUT TO
                        3519                                                  ;  VIDEO ENABLE PORT
F186 83C204             3520                  ADD     DX,4
F189 2E8A84F4F0         3521                  MOV     AL,CS:[SI+OFFSET M7]
F18E EE                 3522                  OUT     DX,AL                   ; SET VIDEO ENABLE PORT
F18F A26500             3523                  MOV     CRT_MODE_SET,AL         ; SAVE THAT VALUE
                        3524
                        3525  ;----- DETERMINE NUMBER OF COLUMNS, BOTH FOR ENTIRE DISPLAY
                        3526  ;----- AND THE NUMBER TO BE USED FOR TTY INTERFACE
                        3527
F192 2E8A84ECF0         3528                  MOV     AL,CS:[SI+OFFSET M6]
F197 32E4               3529                  XOR     AH,AH
F199 A34A00             3530                  MOV     CRT_COLS,AX             ; NUMBER OF COLUMNS IN THIS SCREEN
                        3531
                        3532  ;----- SET CURSOR POSITIONS
                        3533
F19C 81E60E00           3534                  AND     SI,0EH                  ; WORD OFFSET INTO CLEAR LENGTH TABLE
F1A0 2E8B8CE4F0         3535                  MOV     CX,CS:[SI+OFFSET M5]    ; LENGTH TO CLEAR
F1A5 890E4C00           3536                  MOV     CRT_LEN,CX              ; SAVE LENGTH OF CRT -- NOT USED FOR BW
F1A9 B90800             3537                  MOV     CX,8                    ; CLEAR ALL CURSOR POSITIONS
F1AC BF5000             3538                  MOV     DI,OFFSET CURSOR_POSN
F1AF 1E                 3539                  PUSH    DS                      ; ESTABLISH SEGMENT
F1B0 07                 3540                  POP     ES                      ;  ADDRESSING
F1B1 33C0               3541                  XOR     AX,AX
F1B3 F3                 3542                  REP     STOSW                   ; FILL WITH ZEROES
F1B4 AB
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                      3543
                      3544  ;----- SET UP OVERSCAN REGISTER
                      3545
F1B5 42               3546          INC     DX                      ; SET OVERSCAN PORT TO A DEFAULT
F1B6 B030             3547          MOV     AL,30H                  ; VALUE OF 30H FOR ALL MODES
                      3548                                          ;  EXCEPT 640X200
F1B8 803E490006       3549          CMP     CRT_MODE,6              ; SEE IF THE MODE IS 640X200 BW
F1BD 7502             3550          JNZ     M14                     ; IF IT ISNT 640X200, THEN GOTO REGULAR
F1BF B03F             3551          MOV     AL,3FH                  ; IF IT IS 640X200, THEN PUT IN 3FH
F1C1                  3552  M14:
F1C1 EE               3553          OUT     DX,AL                   ; OUTPUT THE CORRECT VALUE TO 3D9 PORT
F1C2 A26600           3554          MOV     CRT_PALETTE,AL          ; SAVE THE VALUE FOR FUTURE USE
                      3555
                      3556  ;----- NORMAL RETURN FROM ALL VIDEO RETURNS
                      3557
F1C5                  3558  VIDEO_RETURN:
F1C5 5F               3559          POP     DI
F1C6 5E               3560          POP     SI
F1C7 5B               3561          POP     BX
F1C8                  3562  M15:                                    ; VIDEO_RETURN_C
F1C8 59               3563          POP     CX
F1C9 5A               3564          POP     DX
F1CA 1F               3565          POP     DS
F1CB 07               3566          POP     ES                      ; RECOVER SEGMENTS
F1CC CF               3567          IRET                            ; ALL DONE
                      3568  SET_MODE        ENDP
                      3569  ;--------------------------------------------------------------
                      3570  ; SET_CTYPE                                                   :
                      3571  ;       THIS ROUTINE SETS THE CURSOR VALUE                    :
                      3572  ; INPUT                                                       :
                      3573  ;       (CX) HAS CURSOR VALUE CH-START LINE, CL-STOP LINE      :
                      3574  ; OUTPUT                                                      :
                      3575  ;       NONE                                                  :
                      3576  ;--------------------------------------------------------------
F1CD                  3577  SET_CTYPE       PROC    NEAR
F1CD B40A             3578          MOV     AH,10                   ; 6845 REGISTER FOR CURSOR SET
F1CF 890E6000         3579          MOV     CURSOR_MODE,CX          ; SAVE IN DATA AREA
F1D3 E80200           3580          CALL    M16                     ; OUTPUT CX REG
F1D6 EBED             3581          JMP     VIDEO_RETURN
                      3582
                      3583  ;----- THIS ROUTINE OUTPUTS THE CX REGISTER TO THE 6845 REGS NAMED IN AH
                      3584
F1D8                  3585  M16:
F1D8 8B166300         3586          MOV     DX,ADDR_6845            ; ADDRESS REGISTER
F1DC 8AC4             3587          MOV     AL,AH                   ; GET VALUE
F1DE EE               3588          OUT     DX,AL                   ; REGISTER SET
F1DF 42               3589          INC     DX                      ; DATA REGISTER
F1E0 8AC5             3590          MOV     AL,CH                   ; DATA
F1E2 EE               3591          OUT     DX,AL
F1E3 4A               3592          DEC     DX
F1E4 8AC4             3593          MOV     AL,AH
F1E6 FEC0             3594          INC     AL                      ; POINT TO OTHER DATA REGISTER
F1E8 EE               3595          OUT     DX,AL                   ; SET FOR SECOND REGISTER
F1E9 42               3596          INC     DX
F1EA 8AC1             3597          MOV     AL,CL                   ; SECOND DATA VALUE
F1EC EE               3598          OUT     DX,AL
F1ED C3               3599          RET                             ; ALL DONE
                      3600  SET_CTYPE       ENDP
                      3601  ;-----------------------------------------------
                      3602  ; SET_CPOS                                    :
                      3603  ;       THIS ROUTINE SETS THE CURRENT CURSOR   :
                      3604  ;       POSITION TO THE NEW X-Y VALUES PASSED  :
                      3605  ; INPUT                                       :
                      3606  ;       DX - ROW,COLUMN OF NEW CURSOR         :
                      3607  ;       BH - DISPLAY PAGE OF CURSOR           :
                      3608  ; OUTPUT                                      :
                      3609  ;       CURSOR IS SET AT 6845 IF DISPLAY PAGE :
                      3610  ;       IS CURRENT DISPLAY                    :
                      3611  ;-----------------------------------------------
F1EE                  3612  SET_CPOS        PROC    NEAR
F1EE 8ACF             3613          MOV     CL,BH
F1F0 32ED             3614          XOR     CH,CH                   ; ESTABLISH LOOP COUNT
F1F2 D1E1             3615          SAL     CX,1                    ; WORD OFFSET
F1F4 8BF1             3616          MOV     SI,CX                   ; USE INDEX REGISTER
F1F6 895450           3617          MOV     [SI+OFFSET CURSOR_POSN],DX      ; SAVE THE POINTER
F1F9 383E6200         3618          CMP     ACTIVE_PAGE,BH
F1FD 7505             3619          JNZ     M17                     ; SET_CPOS_RETURN
F1FF 8BC2             3620          MOV     AX,DX                   ; GET ROW/COLUMN TO AX
F201 E80200           3621          CALL    M18                     ; CURSOR SET
F204                  3622  M17:                                    ; SET_CPOS_RETURN
F204 EBBF             3623          JMP     VIDEO_RETURN
                      3624  SET_CPOS        ENDP
                      3625
                      3626  ;----- SET CURSOR POSITION, AX HAS ROW/COLUMN FOR CURSOR
                      3627
F206                  3628  M18     PROC    NEAR
F206 E87C00           3629          CALL    POSITION                ; DETERMINE LOCATION IN REGEN BUFFER
F209 8BC8             3630          MOV     CX,AX
F20B 030E4E00         3631          ADD     CX,CRT_START            ; ADD IN THE START ADDR FOR THIS PAGE
F20F D1F9             3632          SAR     CX,1                    ; DIVIDE BY 2 FOR CHAR ONLY COUNT
F211 B40E             3633          MOV     AH,14                   ; REGISTER NUMBER FOR CURSOR
F213 E8C2FF           3634          CALL    M16                     ; OUTPUT THE VALUE TO THE 6845
F216 C3               3635          RET
                      3636  M18     ENDP
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                        3637 ;--------------------------------------------------------------
                        3638 ; ACT_DISP_PAGE                                               :
                        3639 ;       THIS ROUTINE SETS THE ACTIVE DISPLAY PAGE, ALLOWING THE :
                        3640 ;       FULL USE OF THE RAM SET ASIDE FOR THE VIDEO ATTACHMENT  :
                        3641 ; INPUT                                                        :
                        3642 ;       AL HAS THE NEW ACTIVE DISPLAY PAGE                     :
                        3643 ; OUTPUT                                                       :
                        3644 ;       THE 6845 IS RESET TO DISPLAY THAT PAGE                 :
                        3645 ;--------------------------------------------------------------
F217                    3646 ACT_DISP_PAGE   PROC    NEAR
F217 A26200             3647         MOV     ACTIVE_PAGE,AL          ; SAVE ACTIVE PAGE VALUE
F21A 8B0E4C00           3648         MOV     CX,CRT_LEN              ; GET SAVED LENGTH OF REGEN BUFFER
F21E 98                 3649         CBW                             ; CONVERT AL TO WORD
F21F 50                 3650         PUSH    AX                      ; SAVE PAGE VALUE
F220 F7E1               3651         MUL     CX                      ; DISPLAY PAGE TIMES REGEN LENGTH
F222 A34E00             3652         MOV     CRT_START,AX            ; SAVE START ADDRESS FOR
                        3653                                         ;  LATER REQUIREMENTS
F225 8BC8               3654         MOV     CX,AX                   ; START ADDRESS TO CX
F227 D1F9               3655         SAR     CX,1                    ; DIVIDE BY 2 FOR 6845 HANDLING
F229 B40C               3656         MOV     AH,12                   ; 6845 REGISTER FOR START ADDRESS
F22B E8AAFF             3657         CALL    M16
F22E 5B                 3658         POP     BX                      ; RECOVER PAGE VALUE
F22F D1E3               3659         SAL     BX,1                    ; *2 FOR WORD OFFSET
F231 8B4750             3660         MOV     AX,[BX + OFFSET CURSOR_POSN]    ; GET CURSOR FOR THIS PAGE
F234 E8CFFF             3661         CALL    M18                     ; SET THE CURSOR POSITION
F237 EB8C               3662         JMP     SHORT VIDEO_RETURN
                        3663 ACT_DISP_PAGE   ENDP
                        3664 ;--------------------------------------------------------------
                        3665 ; READ_CURSOR                                                  :
                        3666 ;       THIS ROUTINE READS THE CURRENT CURSOR VALUE FROM THE    :
                        3667 ;       6845, FORMATS IT, AND SENDS IT BACK TO THE CALLER       :
                        3668 ; INPUT                                                        :
                        3669 ;       BH - PAGE OF CURSOR                                    :
                        3670 ; OUTPUT                                                       :
                        3671 ;       DX - ROW, COLUMN OF THE CURRENT CURSOR POSITION        :
                        3672 ;       CX - CURRENT CURSOR MODE                               :
                        3673 ;--------------------------------------------------------------
F239                    3674 READ_CURSOR     PROC    NEAR
F239 8ADF               3675         MOV     BL,BH
F23B 32FF               3676         XOR     BH,BH
F23D D1E3               3677         SAL     BX,1                    ; WORD OFFSET
F23F 8B5750             3678         MOV     DX,[BX+OFFSET CURSOR_POSN]
F242 8B0E6000           3679         MOV     CX,CURSOR_MODE
F246 5F                 3680         POP     DI
F247 5E                 3681         POP     SI
F248 5B                 3682         POP     BX
F249 58                 3683         POP     AX                      ; DISCARD SAVED CX AND DX
F24A 58                 3684         POP     AX
F24B 1F                 3685         POP     DS
F24C 07                 3686         POP     ES
F24D CF                 3687         IRET
                        3688 READ_CURSOR     ENDP
                        3689 ;--------------------------------------------------------------------------
                        3690 ; SET COLOR                                                              :
                        3691 ;       THIS ROUTINE WILL ESTABLISH THE BACKGROUND COLOR, THE OVERSCAN   :
                        3692 ;       COLOR, AND THE FOREGROUND COLOR SET FOR MEDIUM RESOLUTION        :
                        3693 ;       GRAPHICS                                                        :
                        3694 ; INPUT                                                                 :
                        3695 ;       (BH) HAS COLOR ID                                               :
                        3696 ;               IF BH=0, THE BACKGROUND COLOR VALUE IS SET               :
                        3697 ;                       FROM THE LOW BITS OF BL (0-31)                  :
                        3698 ;               IF BH=1, THE PALETTE SELECTION IS MADE                   :
                        3699 ;                       BASED ON THE LOW BIT OF BL:                     :
                        3700 ;                               0=GREEN, RED, YELLOW FOR COLORS 1,2,3   :
                        3701 ;                               1=BLUE, CYAN, MAGENTA FOR COLORS 1,2,3  :
                        3702 ;       (BL) HAS THE COLOR VALUE TO BE USED                             :
                        3703 ; OUTPUT                                                                 :
                        3704 ;       THE COLOR SELECTION IS UPDATED                                  :
                        3705 ;--------------------------------------------------------------------------
F24E                    3706 SET_COLOR       PROC    NEAR
F24E 8B166300           3707         MOV     DX,ADDR_6845            ; I/O PORT FOR PALETTE
F252 83C205             3708         ADD     DX,5                    ; OVERSCAN PORT
F255 A06600             3709         MOV     AL,CRT_PALETTE          ; GET THE CURRENT PALETTE VALUE
F258 0AFF               3710         OR      BH,BH                   ; IS THIS COLOR 0?
F25A 750E               3711         JNZ     M20                     ; OUTPUT COLOR 1
                        3712
                        3713 ;----- HANDLE COLOR 0 BY SETTING THE BACKGROUND COLOR
                        3714
F25C 24E0               3715         AND     AL,0E0H                 ; TURN OFF LOW 5 BITS OF CURRENT
F25E 80E31F             3716         AND     BL,01FH                 ; TURN OFF HIGH 3 BITS OF INPUT VALUE
F261 0AC3               3717         OR      AL,BL                   ; PUT VALUE INTO REGISTER
F263                    3718 M19:                                    ; OUTPUT THE PALETTE
F263 EE                 3719         OUT     DX,AL                   ; OUTPUT COLOR SELECTION TO 3D9 PORT
F264 A26600             3720         MOV     CRT_PALETTE,AL          ; SAVE THE COLOR VALUE
F267 E95BFF             3721         JMP     VIDEO_RETURN
                        3722
                        3723 ;----- HANDLE COLOR 1 BY SELECTING THE PALETTE TO BE USED
                        3724
F26A                    3725 M20:
F26A 24DF               3726         AND     AL,0DFH                 ; TURN OFF PALETTE SELECT BIT
F26C D0EB               3727         SHR     BL,1                    ; TEST THE LOW ORDER BIT OF BL
F26E 73F3               3728         JNC     M19                     ; ALREADY DONE
F270 0C20               3729         OR      AL,20H                  ; TURN ON PALETTE SELECT BIT
F272 EBEF               3730         JMP     M19                     ; GO DO IT
                        3731 SET_COLOR       ENDP
                        3732 ;-----------------------------------------------
                        3733 ; VIDEO_STATE                                   :
                        3734 ;  RETURNS THE CURRENT VIDEO STATE IN AX        :
                        3735 ;  AH = NUMBER OF COLUMNS ON THE SCREEN         :
                        3736 ;  AL = CURRENT VIDEO MODE                      :
                        3737 ;  BH = CURRENT ACTIVE PAGE                     :
                        3738 ;-----------------------------------------------
F274                    3739 VIDEO_STATE     PROC    NEAR
F274 8A264A00           3740         MOV     AH,BYTE PTR CRT_COLS    ; GET NUMBER OF COLUMNS
F278 A04900             3741         MOV     AL,CRT_MODE             ; CURRENT MODE
F27B 8A3E6200           3742         MOV     BH,ACTIVE_PAGE          ; GET CURRENT ACTIVE PAGE
F27F 5F                 3743         POP     DI                      ; RECOVER REGISTERS
F280 5E                 3744         POP     SI
F281 59                 3745         POP     CX                      ; DISCARD SAVED BX
F282 E943FF             3746         JMP     M15                     ; RETURN TO CALLER
                        3747 VIDEO_STATE     ENDP
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                    3748  ;--------------------------------------------------------
                    3749  ; POSITION                                             :
                    3750  ;       THIS SERVICE ROUTINE CALCULATES THE REGEN       :
                    3751  ;       BUFFER ADDRESS OF A CHARACTER IN THE ALPHA MODE  :
                    3752  ; INPUT                                                 :
                    3753  ;       AX = ROW, COLUMN POSITION                       :
                    3754  ; OUTPUT                                                :
                    3755  ;       AX = OFFSET OF CHAR POSITION IN REGEN BUFFER    :
                    3756  ;--------------------------------------------------------
F285                3757  POSITION        PROC    NEAR
F285 53             3758          PUSH    BX                      ; SAVE REGISTER
F286 8BD8           3759          MOV     BX,AX
F288 8AC4           3760          MOV     AL,AH                   ; ROWS TO AL
F28A F66264A00      3761          MUL     BYTE PTR CRT_COLS       ; DETERMINE BYTES TO ROW
F28E 32FF           3762          XOR     BH,BH
F290 03C3           3763          ADD     AX,BX                   ; ADD IN COLUMN VALUE
F292 D1E0           3764          SAL     AX,1                    ; * 2 FOR ATTRIBUTE BYTES
F294 5B             3765          POP     BX
F295 C3             3766          RET
                    3767  POSITION        ENDP
                    3768  ;--------------------------------------------------------
                    3769  ; SCROLL UP                                            :
                    3770  ;       THIS ROUTINE MOVES A BLOCK OF CHARACTERS UP     :
                    3771  ;       ON THE SCREEN                                   :
                    3772  ; INPUT                                                 :
                    3773  ;       (AH) = CURRENT CRT MODE                         :
                    3774  ;       (AL) = NUMBER OF ROWS TO SCROLL                 :
                    3775  ;       (CX) = ROW/COLUMN OF UPPER LEFT CORNER          :
                    3776  ;       (DX) = ROW/COLUMN OF LOWER RIGHT CORNER         :
                    3777  ;       (BH) = ATTRIBUTE TO BE USED ON BLANKED LINE     :
                    3778  ;       (DS) = DATA SEGMENT                             :
                    3779  ;       (ES) = REGEN BUFFER SEGMENT                     :
                    3780  ; OUTPUT                                                :
                    3781  ;       NONE -- THE REGEN BUFFER IS MODIFIED            :
                    3782  ;--------------------------------------------------------
                    3783          ASSUME  CS:CODE,DS:DATA,ES:DATA
F296                3784  SCROLL_UP       PROC    NEAR
F296 8AD8           3785          MOV     BL,AL                   ; SAVE LINE COUNT IN BL
F298 80FC04         3786          CMP     AH,4                    ; TEST FOR GRAPHICS MODE
F29B 7208           3787          JC      N1                      ; HANDLE SEPARATELY
F29D 80FC07         3788          CMP     AH,7                    ; TEST FOR BW CARD
F2A0 7403           3789          JE      N1
F2A2 E9F001         3790          JMP     GRAPHICS_UP
F2A5                3791  N1:                                     ; UP_CONTINUE
F2A5 53             3792          PUSH    BX                      ; SAVE FILL ATTRIBUTE IN BH
F2A6 8BC1           3793          MOV     AX,CX                   ; UPPER LEFT POSITION
F2A8 E83700         3794          CALL    SCROLL_POSITION         ; DO SETUP FOR SCROLL
F2AB 7431           3795          JZ      N7                      ; BLANK_FIELD
F2AD 03F0           3796          ADD     SI,AX                   ; FROM ADDRESS
F2AF 8AE6           3797          MOV     AH,DH                   ; # ROWS IN BLOCK
F2B1 2AE3           3798          SUB     AH,BL                   ; # ROWS TO BE MOVED
F2B3                3799  N2:                                     ; ROW_LOOP
F2B3 E87200         3800          CALL    N10                     ; MOVE ONE ROW
F2B6 03F5           3801          ADD     SI,BP
F2B8 03FD           3802          ADD     DI,BP                   ; POINT TO NEXT LINE IN BLOCK
F2BA FECC           3803          DEC     AH                      ; COUNT OF LINES TO MOVE
F2BC 75F5           3804          JNZ     N2                      ; ROW_LOOP
F2BE                3805  N3:                                     ; CLEAR_ENTRY
F2BE 58             3806          POP     AX                      ; RECOVER ATTRIBUTE IN AH
F2BF B020           3807          MOV     AL,' '                  ; FILL WITH BLANKS
F2C1                3808  N4:                                     ; CLEAR_LOOP
F2C1 E86D00         3809          CALL    N11                     ; CLEAR THE ROW
F2C4 03FD           3810          ADD     DI,BP                   ; POINT TO NEXT LINE
F2C6 FECB           3811          DEC     BL                      ; COUNTER OF LINES TO SCROLL
F2C8 75F7           3812          JNZ     N4                      ; CLEAR_LOOP
F2CA                3813  N5:                                     ; SCROLL_END
F2CA E88C07         3814          CALL    DDS
F2CD 803E490007     3815          CMP     CRT_MODE,7              ; IS THIS THE BLACK AND WHITE CARD
F2D2 7407           3816          JE      N6                      ; IF SO, SKIP THE MODE RESET
F2D4 A06500         3817          MOV     AL,CRT_MODE_SET         ; GET THE VALUE OF THE MODE SET
F2D7 BAD803         3818          MOV     DX,03D8H                ; ALWAYS SET COLOR CARD PORT
F2DA EE             3819          OUT     DX,AL
F2DB                3820  N6:                                     ; VIDEO_RET_HERE
F2DB E9E7FE         3821          JMP     VIDEO_RETURN
F2DE                3822  N7:                                     ; BLANK_FIELD
F2DE 8ADE           3823          MOV     BL,DH                   ; GET ROW COUNT
F2E0 EBDC           3824          JMP     N3                      ; GO CLEAR THAT AREA
                    3825  SCROLL_UP       ENDP
                    3826
                    3827  ;----- HANDLE COMMON SCROLL SET UP HERE
                    3828
F2E2                3829  SCROLL_POSITION PROC    NEAR
F2E2 803E490002     3830          CMP     CRT_MODE,2              ; TEST FOR SPECIAL CASE HERE
F2E7 7218           3831          JB      N9                      ; HAVE TO HANDLE 80X25 SEPARATELY
F2E9 803E490003     3832          CMP     CRT_MODE,3
F2EE 7711           3833          JA      N9
                    3834
                    3835  ;----- 80X25 COLOR CARD SCROLL
                    3836
F2F0 52             3837          PUSH    DX
F2F1 BADA03         3838          MOV     DX,3DAH                 ; GUARANTEED TO BE COLOR CARD HERE
F2F4 50             3839          PUSH    AX
F2F5                3840  N8:                                     ; WAIT_DISP_ENABLE
F2F5 EC             3841          IN      AL,DX                   ; GET PORT
F2F6 A808           3842          TEST    AL,8                    ; WAIT FOR VERTICAL RETRACE
F2F8 74FB           3843          JZ      N8                      ; WAIT_DISP_ENABLE
F2FA B025           3844          MOV     AL,25H
F2FC B2D8           3845          MOV     DL,0D8H                 ; DX=3D8
F2FE EE             3846          OUT     DX,AL                   ; TURN OFF VIDEO
F2FF 58             3847          POP     AX                      ; DURING VERTICAL RETRACE
F300 5A             3848          POP     DX
F301                3849  N9:
F301 E881FF         3850          CALL    POSITION                ; CONVERT TO REGEN POINTER
F304 03064E00       3851          ADD     AX,CRT_START            ; OFFSET OF ACTIVE PAGE
F308 8BF8           3852          MOV     DI,AX                   ; TO ADDRESS FOR SCROLL
F30A 8BF0           3853          MOV     SI,AX                   ; FROM ADDRESS FOR SCROLL
F30C 2BD1           3854          SUB     DX,CX                   ; DX = # ROWS, #COLS IN BLOCK
F30E FEC6           3855          INC     DH
F310 FEC2           3856          INC     DL                      ; INCREMENT FOR 0 ORIGIN
F312 32ED           3857          XOR     CH,CH                   ; SET HIGH BYTE OF COUNT TO ZERO
F314 8B2E4A00       3858          MOV     BP,CRT_COLS             ; GET NUMBER OF COLUMNS IN DISPLAY
F318 03ED           3859          ADD     BP,BP                   ; TIMES 2 FOR ATTRIBUTE BYTE
F31A 8AC3           3860          MOV     AL,BL                   ; GET LINE COUNT
F31C F66264A00      3861          MUL     BYTE PTR CRT_COLS       ; DETERMINE OFFSET TO FROM ADDRESS
F320 03C0           3862          ADD     AX,AX                   ; *2 FOR ATTRIBUTE BYTE
F322 06             3863          PUSH    ES                      ; ESTABLISH ADDRESSING TO REGEN BUFFER
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F323 1F              3864          POP     DS                      ;  FOR BOTH POINTERS
F324 80FB00          3865          CMP     BL,0                    ; 0 SCROLL MEANS BLANK FIELD
F327 C3              3866          RET                             ; RETURN WITH FLAGS SET
                     3867  SCROLL_POSITION ENDP
                     3868
                     3869  ;----- MOVE_ROW
                     3870
F328                 3871  N10     PROC    NEAR
F328 8ACA            3872          MOV     CL,DL                   ; GET # OF COLS TO MOVE
F32A 56              3873          PUSH    SI
F32B 57              3874          PUSH    DI                      ; SAVE START ADDRESS
F32C F3              3875          REP     MOVSW                   ; MOVE THAT LINE ON SCREEN
F32D A5
F32E 5F              3876          POP     DI
F32F 5E              3877          POP     SI                      ; RECOVER ADDRESSES
F330 C3              3878          RET
                     3879  N10     ENDP
                     3880
                     3881  ;----- CLEAR_ROW
                     3882
F331                 3883  N11     PROC    NEAR
F331 8ACA            3884          MOV     CL,DL                   ; GET # COLUMNS TO CLEAR
F333 57              3885          PUSH    DI
F334 F3              3886          REP     STOSW                   ; STORE THE FILL CHARACTER
F335 AB
F336 5F              3887          POP     DI
F337 C3              3888          RET
                     3889  N11     ENDP
                     3890  ;--------------------------------------------------------
                     3891  ; SCROLL_DOWN                                          :
                     3892  ;       THIS ROUTINE MOVES THE CHARACTERS WITHIN A      :
                     3893  ;       DEFINED BLOCK DOWN ON THE SCREEN, FILLING THE   :
                     3894  ;       TOP LINES WITH A DEFINED CHARACTER              :
                     3895  ; INPUT                                                :
                     3896  ;       (AH) = CURRENT CRT MODE                         :
                     3897  ;       (AL) = NUMBER OF LINES TO SCROLL                :
                     3898  ;       (CX) = UPPER LEFT CORNER OF REGION              :
                     3899  ;       (DX) = LOWER RIGHT CORNER OF REGION             :
                     3900  ;       (BH) = FILL CHARACTER                           :
                     3901  ;       (DS) = DATA SEGMENT                             :
                     3902  ;       (ES) = REGEN SEGMENT                            :
                     3903  ; OUTPUT                                               :
                     3904  ;       NONE -- SCREEN IS SCROLLED                      :
                     3905  ;--------------------------------------------------------
F338                 3906  SCROLL_DOWN     PROC    NEAR
F338 FD              3907          STD                             ; DIRECTION FOR SCROLL DOWN
F339 8AD8            3908          MOV     BL,AL                   ; LINE COUNT TO BL
F33B 80FC04          3909          CMP     AH,4                    ; TEST FOR GRAPHICS
F33E 7208            3910          JC      N12
F340 80FC07          3911          CMP     AH,7                    ; TEST FOR BW CARD
F343 7403            3912          JE      N12
F345 E9A601          3913          JMP     GRAPHICS_DOWN
F348                 3914  N12:                                    ; CONTINUE_DOWN
F348 53              3915          PUSH    BX                      ; SAVE ATTRIBUTE IN BH
F349 8BC2            3916          MOV     AX,DX                   ; LOWER RIGHT CORNER
F34B E894FF          3917          CALL    SCROLL_POSITION         ; GET REGEN LOCATION
F34E 7420            3918          JZ      N16
F350 2BF0            3919          SUB     SI,AX                   ; SI IS FROM ADDRESS
F352 8AE6            3920          MOV     AH,DH                   ; GET TOTAL # ROWS
F354 2AE3            3921          SUB     AH,BL                   ; COUNT TO MOVE IN SCROLL
F356                 3922  N13:
F356 E8CFFF          3923          CALL    N10                     ; MOVE ONE ROW
F359 2BF5            3924          SUB     SI,BP
F35B 2BFD            3925          SUB     DI,BP
F35D FECC            3926          DEC     AH
F35F 75F5            3927          JNZ     N13
F361                 3928  N14:
F361 58              3929          POP     AX                      ; RECOVER ATTRIBUTE IN AH
F362 B020            3930          MOV     AL,' '
F364                 3931  N15:
F364 E8CAFF          3932          CALL    N11                     ; CLEAR ONE ROW
F367 2BFD            3933          SUB     DI,BP                   ; GO TO NEXT ROW
F369 FECB            3934          DEC     BL
F36B 75F7            3935          JNZ     N15
F36D E95AFF          3936          JMP     N5                      ; SCROLL_END
F370                 3937  N16:
F370 8ADE            3938          MOV     BL,DH
F372 EBED            3939          JMP     N14
                     3940  SCROLL_DOWN     ENDP
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LOC OBJECT            LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

                      3941  ;--------------------------------------------------------
                      3942  ; READ_AC_CURRENT                                      :
                      3943  ;       THIS ROUTINE READS THE ATTRIBUTE AND CHARACTER  :
                      3944  ;       AT THE CURRENT CURSOR POSITION AND RETURNS THEM :
                      3945  ;       TO THE CALLER                                  :
                      3946  ;INPUT                                                 :
                      3947  ;       (AH) = CURRENT CRT MODE                        :
                      3948  ;       (BH) = DISPLAY PAGE ( ALPHA MODES ONLY )       :
                      3949  ;       (DS) = DATA SEGMENT                            :
                      3950  ;       (ES) = REGEN SEGMENT                           :
                      3951  ;OUTPUT                                                :
                      3952  ;       (AL) = CHAR READ                               :
                      3953  ;       (AH) = ATTRIBUTE READ                          :
                      3954  ;--------------------------------------------------------
                      3955          ASSUME  CS:CODE,DS:DATA,ES:DATA
F374                  3956  READ_AC_CURRENT PROC    NEAR
F374 80FC04           3957          CMP     AH,4                    ; IS THIS GRAPHICS
F377 7208             3958          JC      P1
F379 80FC07           3959          CMP     AH,7                    ; IS THIS BW CARD
F37C 7403             3960          JE      P1
F37E E9A802           3961          JMP     GRAPHICS_READ
F381                  3962  P1:                                     ; READ_AC_CONTINUE
F381 E81A00           3963          CALL    FIND_POSITION
F384 8BF3             3964          MOV     SI,BX                   ; ESTABLISH ADDRESSING IN SI
                      3965
                      3966  ;----- WAIT FOR HORIZONTAL RETRACE
                      3967
F386 8B166300         3968          MOV     DX,ADDR_6845            ; GET BASE ADDRESS
F38A 83C206           3969          ADD     DX,6                    ; POINT AT STATUS PORT
F38D 06               3970          PUSH    ES
F38E 1F               3971          POP     DS                      ; GET SEGMENT FOR QUICK ACCESS
F38F                  3972  P2:                                     ; WAIT FOR RETRACE LOW
F38F EC               3973          IN      AL,DX                   ; GET STATUS
F390 A801             3974          TEST    AL,1                    ; IS HORZ RETRACE LOW
F392 75FB             3975          JNZ     P2                      ; WAIT UNTIL IT IS
F394 FA               3976          CLI                             ; NO MORE INTERRUPTS
F395                  3977  P3:                                     ; WAIT FOR RETRACE HIGH
F395 EC               3978          IN      AL,DX                   ; GET STATUS
F396 A801             3979          TEST    AL,1                    ; IS IT HIGH
F398 74FB             3980          JZ      P3                      ; WAIT UNTIL IT IS
F39A AD               3981          LODSW                           ; GET THE CHAR/ATTR
F39B E927FE           3982          JMP     VIDEO_RETURN
                      3983  READ_AC_CURRENT ENDP
                      3984
F39E                  3985  FIND_POSITION   PROC    NEAR
F39E 8ACF             3986          MOV     CL,BH                   ; DISPLAY PAGE TO CX
F3A0 32ED             3987          XOR     CH,CH
F3A2 8BF1             3988          MOV     SI,CX                   ; MOVE TO SI FOR INDEX
F3A4 D1E6             3989          SAL     SI,1                    ; * 2 FOR WORD OFFSET
F3A6 8B4450           3990          MOV     AX,[SI+OFFSET CURSOR_POSN]      ; GET ROW/COLUMN OF THAT PAGE
F3A9 33DB             3991          XOR     BX,BX                   ; SET START ADDRESS TO ZERO
F3AB E306             3992          JCXZ    P5                      ; NO_PAGE
F3AD                  3993  P4:                                     ; PAGE_LOOP
F3AD 031E4C00         3994          ADD     BX,CRT_LEN              ; LENGTH OF BUFFER
F3B1 E2FA             3995          LOOP    P4
F3B3                  3996  P5:                                     ; NO_PAGE
F3B3 E8CFFE           3997          CALL    POSITION                ; DETERMINE LOCATION IN REGEN
F3B6 03D8             3998          ADD     BX,AX                   ; ADD TO START OF REGEN
F3B8 C3               3999          RET
                      4000  FIND_POSITION   ENDP
                      4001  ;--------------------------------------------------------
                      4002  ; WRITE_AC_CURRENT                                     :
                      4003  ;       THIS ROUTINE WRITES THE ATTRIBUTE               :
                      4004  ;       AND CHARACTER AT THE CURRENT CURSOR             :
                      4005  ;       POSITION                                       :
                      4006  ; INPUT                                                :
                      4007  ;       (AH) = CURRENT CRT MODE                        :
                      4008  ;       (BH) = DISPLAY PAGE                            :
                      4009  ;       (CX) = COUNT OF CHARACTERS TO WRITE            :
                      4010  ;       (AL) = CHAR TO WRITE                           :
                      4011  ;       (BL) = ATTRIBUTE OF CHAR TO WRITE              :
                      4012  ;       (DS) = DATA SEGMENT                            :
                      4013  ;       (ES) = REGEN SEGMENT                           :
                      4014  ; OUTPUT                                               :
                      4015  ;       NONE                                           :
                      4016  ;--------------------------------------------------------
F3B9                  4017  WRITE_AC_CURRENT        PROC    NEAR
F3B9 80FC04           4018          CMP     AH,4                    ; IS THIS GRAPHICS
F3BC 7208             4019          JC      P6
F3BE 80FC07           4020          CMP     AH,7                    ; IS THIS BW CARD
F3C1 7403             4021          JE      P6
F3C3 E9B201           4022          JMP     GRAPHICS_WRITE
F3C6                  4023  P6:                                     ; WRITE_AC_CONTINUE
F3C6 8AE3             4024          MOV     AH,BL                   ; GET ATTRIBUTE TO AH
F3C8 50               4025          PUSH    AX                      ; SAVE ON STACK
F3C9 51               4026          PUSH    CX                      ; SAVE WRITE COUNT
F3CA E8D1FF           4027          CALL    FIND_POSITION
F3CD 8BFB             4028          MOV     DI,BX                   ; ADDRESS TO DI REGISTER
F3CF 59               4029          POP     CX                      ; WRITE COUNT
F3D0 5B               4030          POP     BX                      ; CHARACTER IN BX REG
F3D1                  4031  P7:                                     ; WRITE_LOOP
                      4032
                      4033  ;----- WAIT FOR HORIZONTAL RETRACE
                      4034
F3D1 8B166300         4035          MOV     DX,ADDR_6845            ; GET BASE ADDRESS
F3D5 83C206           4036          ADD     DX,6                    ; POINT AT STATUS PORT
F3D8                  4037  P8:
F3D8 EC               4038          IN      AL,DX                   ; GET STATUS
F3D9 A801             4039          TEST    AL,1                    ; IS IT LOW
F3DB 75FB             4040          JNZ     P8                      ; WAIT UNTIL IT IS
F3DD FA               4041          CLI                             ; NO MORE INTERRUPTS
F3DE                  4042  P9:
F3DE EC               4043          IN      AL,DX                   ; GET STATUS
F3DF A801             4044          TEST    AL,1                    ; IS IT HIGH
F3E1 74FB             4045          JZ      P9                      ; WAIT UNTIL IT IS
F3E3 8BC3             4046          MOV     AX,BX                   ; RECOVER THE CHAR/ATTR
F3E5 AB               4047          STOSW                           ; PUT THE CHAR/ATTR
F3E6 FB               4048          STI                             ; INTERRUPTS BACK ON
F3E7 E2E8             4049          LOOP    P7                      ;  AS MANY TIMES AS REQUESTED
F3E9 E9D9FD           4050          JMP     VIDEO_RETURN
                      4051  WRITE_AC_CURRENT        ENDP
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LOC OBJECT          LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

                    4052  ;--------------------------------------------
                    4053  ; WRITE_C_CURRENT                          :
                    4054  ;       THIS ROUTINE WRITES THE CHARACTER AT  :
                    4055  ;       THE CURRENT CURSOR POSITION, ATTRIBUTE :
                    4056  ;       UNCHANGED                          :
                    4057  ; INPUT                                    :
                    4058  ;       (AH) = CURRENT CRT MODE            :
                    4059  ;       (BH) = DISPLAY PAGE                :
                    4060  ;       (CX) = COUNT OF CHARACTERS TO WRITE :
                    4061  ;       (AL) = CHAR TO WRITE               :
                    4062  ;       (DS) = DATA SEGMENT                :
                    4063  ;       (ES) = REGEN SEGMENT               :
                    4064  ; OUTPUT                                   :
                    4065  ;       NONE                               :
                    4066  ;--------------------------------------------
F3EC                4067  WRITE_C_CURRENT PROC    NEAR
F3EC 80FC04         4068          CMP     AH,4                    ; IS THIS GRAPHICS
F3EF 7208           4069          JC      P10
F3F1 80FC07         4070          CMP     AH,7                    ; IS THIS BW CARD
F3F4 7403           4071          JE      P10
F3F6 E97F01         4072          JMP     GRAPHICS_WRITE
F3F9                4073  P10:
F3F9 50             4074          PUSH    AX                      ; SAVE ON STACK
F3FA 51             4075          PUSH    CX                      ; SAVE WRITE COUNT
F3FB E8A0FF         4076          CALL    FIND_POSITION
F3FE 8BFB           4077          MOV     DI,BX                   ; ADDRESS TO DI
F400 59             4078          POP     CX                      ; WRITE COUNT
F401 5B             4079          POP     BX                      ; BL HAS CHAR TO WRITE
F402                4080  P11:                                    ; WRITE_LOOP
                    4081
                    4082  ;----- WAIT FOR HORIZONTAL RETRACE
                    4083
F402 8B166300       4084          MOV     DX,ADDR_6845            ; GET BASE ADDRESS
F406 83C206         4085          ADD     DX,6                    ; POINT AT STATUS PORT
F409                4086  P12:
F409 EC             4087          IN      AL,DX                   ; GET STATUS
F40A A801           4088          TEST    AL,1                    ; IS IT LOW
F40C 75FB           4089          JNZ     P12                     ; WAIT UNTIL IT IS
F40E FA             4090          CLI                             ; NO MORE INTERRUPTS
F40F                4091  P13:
F40F EC             4092          IN      AL,DX                   ; GET STATUS
F410 A801           4093          TEST    AL,1                    ; IS IT HIGH
F412 74FB           4094          JZ      P13                     ; WAIT UNTIL IT IS
F414 8AC3           4095          MOV     AL,BL                   ; RECOVER CHAR
F416 AA             4096          STOSB                           ; PUT THE CHAR/ATTR
F417 FB             4097          STI                             ; INTERRUPTS BACK ON
F418 47             4098          INC     DI                      ; BUMP POINTER PAST ATTRIBUTE
F419 E2E7           4099          LOOP    P11                     ;  AS MANY TIMES AS REQUESTED
F41B E9A7FD         4100          JMP     VIDEO_RETURN
                    4101  WRITE_C_CURRENT ENDP
                    4102  ;--------------------------------------------------------------
                    4103  ; READ DOT  -- WRITE DOT                                     :
                    4104  ;       THESE ROUTINES WILL WRITE A DOT, OR READ THE DOT AT   :
                    4105  ;       THE INDICATED LOCATION                               :
                    4106  ; ENTRY --                                                   :
                    4107  ;   DX = ROW (0-199)     (THE ACTUAL VALUE DEPENDS ON THE MODE) :
                    4108  ;   CX = COLUMN ( 0-639) ( THE VALUES ARE NOT RANGE CHECKED ) :
                    4109  ;   AL = DOT VALUE TO WRITE (1,2 OR 4 BITS DEPENDING ON MODE, :
                    4110  ;       REQ'D FOR WRITE DOT ONLY, RIGHT JUSTIFIED)           :
                    4111  ;       BIT 7 OF AL=1 INDICATES XOR THE VALUE INTO THE LOCATION :
                    4112  ;   DS = DATA SEGMENT                                        :
                    4113  ;   ES = REGEN SEGMENT                                       :
                    4114  ;                                                            :
                    4115  ; EXIT                                                       :
                    4116  ;       AL = DOT VALUE READ, RIGHT JUSTIFIED, READ ONLY      :
                    4117  ;--------------------------------------------------------------
                    4118          ASSUME  CS:CODE,DS:DATA,ES:DATA
F41E                4119  READ_DOT        PROC    NEAR
F41E E83100         4120          CALL    R3                      ; DETERMINE BYTE POSITION OF DOT
F421 268A04         4121          MOV     AL,ES:[SI]              ; GET THE BYTE
F424 22C4           4122          AND     AL,AH                   ; MASK OFF THE OTHER BITS IN THE BYTE
F426 D2E0           4123          SHL     AL,CL                   ; LEFT JUSTIFY THE VALUE
F428 8ACE           4124          MOV     CL,DH                   ; GET NUMBER OF BITS IN RESULT
F42A D2C0           4125          ROL     AL,CL                   ; RIGHT JUSTIFY THE RESULT
F42C E996FD         4126          JMP     VIDEO_RETURN            ; RETURN FROM VIDEO IO
                    4127  READ_DOT        ENDP
                    4128
F42F                4129  WRITE_DOT       PROC    NEAR
F42F 50             4130          PUSH    AX                      ; SAVE DOT VALUE
F430 50             4131          PUSH    AX                      ;  TWICE
F431 E81E00         4132          CALL    R3                      ; DETERMINE BYTE POSITION OF THE DOT
F434 D2E8           4133          SHR     AL,CL                   ; SHIFT TO SET UP THE BITS FOR OUTPUT
F436 22C4           4134          AND     AL,AH                   ; STRIP OFF THE OTHER BITS
F438 268A0C         4135          MOV     CL,ES:[SI]              ; GET THE CURRENT BYTE
F43B 5B             4136          POP     BX                      ; RECOVER XOR FLAG
F43C F6C380         4137          TEST    BL,80H                  ; IS IT ON
F43F 750D           4138          JNZ     R2                      ; YES, XOR THE DOT
F441 F6D4           4139          NOT     AH                      ; SET THE MASK TO REMOVE THE
F443 22CC           4140          AND     CL,AH                   ;  INDICATED BITS
F445 0AC1           4141          OR      AL,CL                   ; OR IN THE NEW VALUE OF THOSE BITS
                    4142  R1:                                     ; FINISH_DOT
F447 268804         4143          MOV     ES:[SI],AL              ; RESTORE THE BYTE IN MEMORY
F44A 58             4144          POP     AX
F44B E977FD         4145          JMP     VIDEO_RETURN            ; RETURN FROM VIDEO IO
F44E                4146  R2:                                     ; XOR_DOT
F44E 32C1           4147          XOR     AL,CL                   ; EXCLUSIVE OR THE DOTS
F450 EBF5           4148          JMP     R1                      ; FINISH UP THE WRITING
                    4149  WRITE_DOT       ENDP
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                    4150  ;--------------------------------------------------------
                    4151  ; THIS SUBROUTINE DETERMINES THE REGEN BYTE LOCATION    :
                    4152  ; OF THE INDICATED ROW COLUMN VALUE IN GRAPHICS MODE.   :
                    4153  ; ENTRY --                                              :
                    4154  ;  DX = ROW VALUE (0-199)                              :
                    4155  ;  CX = COLUMN VALUE (0-639)                           :
                    4156  ; EXIT --                                              :
                    4157  ;  SI = OFFSET INTO REGEN BUFFER FOR BYTE OF INTEREST  :
                    4158  ;  AH = MASK TO STRIP OFF THE BITS OF INTEREST         :
                    4159  ;  CL = BITS TO SHIFT TO RIGHT JUSTIFY THE MASK IN AH  :
                    4160  ;  DH = # BITS IN RESULT                               :
                    4161  ;--------------------------------------------------------
F452                4162  R3      PROC    NEAR
F452 53             4163          PUSH    BX                      ; SAVE BX DURING OPERATION
F453 50             4164          PUSH    AX                      ; WILL SAVE AL DURING OPERATION
                    4165
                    4166  ;----- DETERMINE 1ST BYTE IN IDICATED ROW BY MULTIPLYING ROW VALUE BY 40
                    4167  ;-----  ( LOW BIT OF ROW DETERMINES EVEN/ODD, 80 BYTES/ROW
                    4168
F454 B028           4169          MOV     AL,40
F456 52             4170          PUSH    DX                      ; SAVE ROW VALUE
F457 80E2FE         4171          AND     DL,0FEH                 ; STRIP OFF ODD/EVEN BIT
F45A F6E2           4172          MUL     DL                      ; AX HAS ADDRESS OF 1ST BYTE
                    4173                                          ;  OF INDICATED ROW
F45C 5A             4174          POP     DX                      ; RECOVER IT
F45D F6C201         4175          TEST    DL,1                    ; TEST FOR EVEN/ODD
F460 7403           4176          JZ      R4                      ; JUMP IF EVEN ROW
F462 050020         4177          ADD     AX,2000H                ; OFFSET TO LOCATION OF ODD ROWS
F465                4178  R4:                                     ; EVEN_ROW
F465 8BF0           4179          MOV     SI,AX                   ; MOVE POINTER TO SI
F467 58             4180          POP     AX                      ; RECOVER AL VALUE
F468 8BD1           4181          MOV     DX,CX                   ; COLUMN VALUE TO DX
                    4182
                    4183  ;----- DETERMINE GRAPHICS MODE CURRENTLY IN EFFECT
                    4184
                    4185  ;--------------------------------------------------------
                    4186  ; SET UP THE REGISTERS ACCORDING TO THE MODE            :
                    4187  ;  CH = MASK FOR LOW OF COLUMN ADDRESS ( 7/3 FOR HIGH/MED RES)  :
                    4188  ;  CL = # OF ADDRESS BITS IN COLUMN VALUE ( 3/2 FOR H/M)  :
                    4189  ;  BL = MASK TO SELECT BITS FROM POINTED BYTE (80H/C0H FOR H/M) :
                    4190  ;  BH = NUMBER OF VALID BITS IN POINTED BYTE ( 1/2 FOR H/M)  :
                    4191  ;--------------------------------------------------------
F46A BBC002         4193          MOV     BX,2C0H
F46D B90203         4194          MOV     CX,302H                 ; SET PARMS FOR MED RES
F470 803E490006     4195          CMP     CRT_MODE,6
F475 7206           4196          JC      R5                      ; HANDLE IF MED ARES
F477 BB8001         4197          MOV     BX,180H
F47A B90307         4198          MOV     CX,703H                 ; SET PARMS FOR HIGH RES
                    4199
                    4200  ;----- DETERMINE BIT OFFSET IN BYTE FROM COLUMN MASK
                    4201
F47D                4202  R5:
F47D 22EA           4203          AND     CH,DL                   ; ADDRESS OF PEL WITHIN BYTE TO CH
                    4204
                    4205  ;----- DETERMINE BYTE OFFSET FOR THIS LOCATION IN COLUMN
                    4206
F47F D3EA           4207          SHR     DX,CL                   ; SHIFT BY CORRECT AMOUNT
F481 03F2           4208          ADD     SI,DX                   ; INCREMENT THE POINTER
F483 8AF7           4209          MOV     DH,BH                   ; GET THE # OF BITS IN RESULT TO DH
                    4210
                    4211  ;----- MULTIPLY BH (VALID BITS IN BYTE) BY CH (BIT OFFSET)
                    4212
F485 2AC9           4213          SUB     CL,CL                   ; ZERO INTO STORAGE LOCATION
F487                4214  R6:
F487 D0C8           4215          ROR     AL,1                    ; LEFT JUSTIFY THE VALUE
                    4216                                          ;  IN AL (FOR WRITE)
F489 02CD           4217          ADD     CL,CH                   ; ADD IN THE BIT OFFSET VALUE
F48B FECF           4218          DEC     BH                      ; LOOP CONTROL
F48D 75F8           4219          JNZ     R6                      ; ON EXIT, CL HAS SHIFT COUNT
                    4220                                          ;  TO RESTORE BITS
F48F 8AE3           4221          MOV     AH,BL                   ; GET MASK TO AH
F491 D2EC           4222          SHR     AH,CL                   ; MOVE THE MASK TO CORRECT LOCATION
F493 5B             4223          POP     BX                      ; RECOVER REG
F494 C3             4224          RET                             ; RETURN WITH EVERYTHING SET UP
                    4225  R3      ENDP
                    4226  ;--------------------------------------------------------
                    4227  ; SCROLL UP                                             :
                    4228  ;       THIS ROUTINE SCROLLS UP THE INFORMATION ON THE CRT  :
                    4229  ; ENTRY                                                 :
                    4230  ;       CH,CL = UPPER LEFT CORNER OF REGION TO SCROLL   :
                    4231  ;       DH,DL = LOWER RIGHT CORNER OF REGION TO SCROLL  :
                    4232  ;         BOTH OF THE ABOVE ARE IN CHARACTER POSITIONS   :
                    4233  ;       BH = FILL VALUE FOR BLANKED LINES               :
                    4234  ;       AL = # LINES TO SCROLL (AL=0 MEANS BLANK THE ENTIRE  :
                    4235  ;            FIELD)                                     :
                    4236  ;       DS = DATA SEGMENT                               :
                    4237  ;       ES = REGEN SEGMENT                              :
                    4238  ; EXIT                                                  :
                    4239  ;       NOTHING, THE SCREEN IS SCROLLED                 :
                    4240  ;--------------------------------------------------------
F495                4241  GRAPHICS_UP     PROC    NEAR
F495 8AD8           4242          MOV     BL,AL                   ; SAVE LINE COUNT IN BL
F497 8BC1           4243          MOV     AX,CX                   ; GET UPPER LEFT POSITION INTO AX REG
                    4244
                    4245  ;----- USE CHARACTER SUBROUTINE FOR POSITIONING
                    4246  ;-----  ADDRESS RETURNED IS MULTIPLIED BY 2 FROM CORRECT VALUE
                    4247
F499 E86902         4248          CALL    GRAPH_POSN
F49C 8BF8           4249          MOV     DI,AX                   ; SAVE RESULT AS DESTINATION ADDRESS
                    4250
                    4251  ;----- DETERMINE SIZE OF WINDOW
                    4252
F49E 2BD1           4253          SUB     DX,CX
F4A0 81C20101       4254          ADD     DX,101H                 ; ADJUST VALUES
F4A4 D0E6           4255          SAL     DH,1                    ; MULTIPLY # ROWS BY 4
                    4256                                          ;  SINCE 8 VERT DOTS/CHAR
F4A6 D0E6           4257          SAL     DH,1                    ;  AND EVEN/ODD ROWS
                    4258
                    4259  ;----- DETERMINE CRT MODE
                    4260
F4A8 803E490006     4261          CMP     CRT_MODE,6              ; TEST FOR MEDIUM RES
F4AD 7304           4262          JNC     R7                      ; FIND_SOURCE
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                    4263
                    4264  ;----- MEDIUM RES UP
                    4265
F4AF D0E2           4266          SAL     DL,1                    ; # COLUMNS * 2, SINCE 2 BYTES/CHAR
F4B1 D1E7           4267          SAL     DI,1                    ; OFFSET *2 SINCE 2 BYTES/CHAR
                    4268
                    4269  ;----- DETERMINE THE SOURCE ADDRESS IN THE BUFFER
                    4270
F4B3                4271  R7:                                     ; FIND_SOURCE
F4B3 06             4272          PUSH    ES                      ; GET SEGMENTS BOTH POINTING TO REGEN
F4B4 1F             4273          POP     DS
F4B5 2AED           4274          SUB     CH,CH                   ; ZERO TO HIGH OF COUNT REG
F4B7 D0E3           4275          SAL     BL,1                    ; MULTIPLY NUMBER OF LINES BY 4
F4B9 D0E3           4276          SAL     BL,1
F4BB 742D           4277          JZ      R11                     ; IF ZERO, THEN BLANK ENTIRE FIELD
F4BD 8AC3           4278          MOV     AL,BL                   ; GET NUMBER OF LINES IN AL
F4BF B450           4279          MOV     AH,80                   ; 80 BYTES/ROW
F4C1 F6E4           4280          MUL     AH                      ; DETERMINE OFFSET TO SOURCE
F4C3 8BF7           4281          MOV     SI,DI                   ; SET UP SOURCE
F4C5 03F0           4282          ADD     SI,AX                   ;  ADD IN OFFSET TO IT
F4C7 8AE6           4283          MOV     AH,DH                   ; NUMBER OF ROWS IN FIELD
F4C9 2AE3           4284          SUB     AH,BL                   ; DETERMINE NUMBER TO MOVE
                    4285
                    4286  ;----- LOOP THROUGH, MOVING ONE ROW AT A TIME, BOTH EVEN AND ODD FIELDS
                    4287
F4CB                4288  R8:                                     ; ROW_LOOP
F4CB E88000         4289          CALL    R17                     ; MOVE ONE ROW
F4CE 81EEB01F       4290          SUB     SI,2000H-80             ; MOVE TO NEXT ROW
F4D2 81EFB01F       4291          SUB     DI,2000H-80
F4D6 FECC           4292          DEC     AH                      ; NUMBER OF ROWS TO MOVE
F4D8 75F1           4293          JNZ     R8                      ; CONTINUE TILL ALL MOVED
                    4294
                    4295  ;----- FILL IN THE VACATED LINE(S)
                    4296
F4DA                4297  R9:                                     ; CLEAR_ENTRY
F4DA 8AC7           4298          MOV     AL,BH                   ; ATTRIBUTE TO FILL WITH
F4DC                4299  R10:
F4DC E88800         4300          CALL    R18                     ; CLEAR THAT ROW
F4DF 81EFB01F       4301          SUB     DI,2000H-80             ; POINT TO NEXT LINE
F4E3 FECB           4302          DEC     BL                      ; NUMBER OF LINES TO FILL
F4E5 75F5           4303          JNZ     R10                     ; CLEAR_LOOP
F4E7 E9DBFC         4304          JMP     VIDEO_RETURN            ; EVERYTHING DONE
F4EA                4305  R11:                                    ; BLANK FIELD
F4EA 8ADE           4306          MOV     BL,DH                   ; SET BLANK COUNT TO
                    4307                                          ;  EVERYTHING IN FIELD
F4EC EBEC           4308          JMP     R9                      ; CLEAR THE FIELD
                    4309  GRAPHICS_UP     ENDP
                    4310  ;--------------------------------------------------------------
                    4311  ; SCROLL_DOWN                                                 :
                    4312  ;       THIS ROUTINE SCROLLS DOWN THE INFORMATION ON THE CRT   :
                    4313  ; ENTRY                                                       :
                    4314  ;       CH,CL = UPPER LEFT CORNER OF REGION TO SCROLL         :
                    4315  ;       DH,DL = LOWER RIGHT CORNER OF REGION TO SCROLL        :
                    4316  ;        BOTH OF THE ABOVE ARE IN CHARACTER POSITIONS          :
                    4317  ;       BH = FILL VALUE FOR BLANKED LINES                     :
                    4318  ;       AL = # LINES TO SCROLL (AL=0 MEANS BLANK THE ENTIRE    :
                    4319  ;            FIELD)                                           :
                    4320  ;       DS = DATA SEGMENT                                     :
                    4321  ;       ES = REGEN SEGMENT                                    :
                    4322  ; EXIT                                                        :
                    4323  ;       NOTHING, THE SCREEN IS SCROLLED                       :
                    4324  ;--------------------------------------------------------------
F4EE                4325  GRAPHICS_DOWN   PROC    NEAR
F4EE FD             4326          STD                             ; SET DIRECTION
F4EF 8AD8           4327          MOV     BL,AL                   ; SAVE LINE COUNT IN BL
F4F1 8BC2           4328          MOV     AX,DX                   ; GET LOWER RIGHT POSITION INTO AX REG
                    4329
                    4330  ;----- USE CHARACTER SUBROUTINE FOR POSITIONING
                    4331  ;----- ADDRESS RETURNED IS MULTIPLIED BY 2 FROM CORRECT VALUE
                    4332
F4F3 E80F02         4333          CALL    GRAPH_POSN
F4F6 8BF8           4334          MOV     DI,AX                   ; SAVE RESULT AS DESTINATION ADDRESS
                    4335
                    4336  ;----- DETERMINE SIZE OF WINDOW
                    4337
F4F8 2BD1           4338          SUB     DX,CX
F4FA 81C20101       4339          ADD     DX,101H                 ; ADJUST VALUES
F4FE D0E6           4340          SAL     DH,1                    ; MULTIPLY # ROWS BY 4
                    4341                                          ;  SINCE 8 VERT DOTS/CHAR
F500 D0E6           4342          SAL     DH,1                    ;  AND EVEN/ODD ROWS
                    4343
                    4344  ;----- DETERMINE CRT MODE
                    4345
F502 803E490006     4346          CMP     CRT_MODE,6              ; TEST FOR MEDIUM RES
F507 7305           4347          JNC     R12                     ; FIND_SOURCE_DOWN
                    4348
                    4349  ;----- MEDIUM RES DOWN
                    4350
F509 D0E2           4351          SAL     DL,1                    ; # COLUMNS * 2, SINCE
                    4352                                          ;  2 BYTES/CHAR (OFFSET OK)
F50B D1E7           4353          SAL     DI,1                    ; OFFSET *2 SINCE 2 BYTES/CHAR
F50D 47             4354          INC     DI                      ; POINT TO LAST BYTE
                    4355
                    4356  ;----- DETERMINE THE SOURCE ADDRESS IN THE BUFFER
                    4357
F50E                4358  R12:                                    ; FIND_SOURCE_DOWN
F50E 06             4359          PUSH    ES                      ; BOTH SEGMENTS TO REGEN
F50F 1F             4360          POP     DS
F510 2AED           4361          SUB     CH,CH                   ; ZERO TO HIGH OF COUNT REG
F512 81C7F000       4362          ADD     DI,240                  ; POINT TO LAST ROW OF PIXELS
F516 D0E3           4363          SAL     BL,1                    ; MULTIPLY NUMBER OF LINES BY 4
F518 D0E3           4364          SAL     BL,1
F51A 742E           4365          JZ      R16                     ; IF ZERO, THEN BLANK ENTIRE FIELD
F51C 8AC3           4366          MOV     AL,BL                   ; GET NUMBER OF LINES IN AL
F51E B450           4367          MOV     AH,80                   ; 80 BYTES/ROW
F520 F6E4           4368          MUL     AH                      ; DETERMINE OFFSET TO SOURCE
F522 8BF7           4369          MOV     SI,DI                   ; SET UP SOURCE
F524 2BF0           4370          SUB     SI,AX                   ;  SUBTRACT THE OFFSET
F526 8AE6           4371          MOV     AH,DH                   ; NUMBER OF ROWS IN FIELD
F528 2AE3           4372          SUB     AH,BL                   ; DETERMINE NUMBER TO MOVE
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                     4373
                     4374 ;----- LOOP THROUGH, MOVING ONE ROW AT A TIME, BOTH EVEN AND ODD FIELDS
                     4375
F52A                 4376 R13:                                    ; ROW_LOOP_DOWN
F52A E82100          4377         CALL    R17                     ; MOVE ONE ROW
F52D 81EE5020        4378         SUB     SI,2000H+80             ; MOVE TO NEXT ROW
F531 81EF5020        4379         SUB     DI,2000H+80
F535 FECC            4380         DEC     AH                      ; NUMBER OF ROWS TO MOVE
F537 75F1            4381         JNZ     R13                     ; CONTINUE TILL ALL MOVED
                     4382
                     4383 ;----- FILL IN THE VACATED LINE(S)
                     4384
F539                 4385 R14:                                    ; CLEAR_ENTRY_DOWN
F539 8AC7            4386         MOV     AL,BH                   ; ATTRIBUTE TO FILL WITH
F53B                 4387 R15:                                    ; CLEAR_LOOP_DOWN
F53B E82900          4388         CALL    R18                     ; CLEAR A ROW
F53E 81EF5020        4389         SUB     DI,2000H+80             ; POINT TO NEXT LINE
F542 FECB            4390         DEC     BL                      ; NUMBER OF LINES TO FILL
F544 75F5            4391         JNZ     R15                     ; CLEAR_LOOP_DOWN
F546 FC              4392         CLD                             ; RESET THE DIRECTION FLAG
F547 E97BFC          4393         JMP     VIDEO_RETURN            ; EVERYTHING DONE
F54A                 4394 R16:                                    ; BLANK_FIELD_DOWN
F54A 8ADE            4395         MOV     BL,DH                   ; SET BLANK COUNT TO EVERYTHING
                     4396                                         ;   IN FIELD
F54C EBEB            4397         JMP     R14                     ; CLEAR THE FIELD
                     4398 GRAPHICS_DOWN   ENDP
                     4399
                     4400 ;----- ROUTINE TO MOVE ONE ROW OF INFORMATION
                     4401
F54E                 4402 R17     PROC    NEAR
F54E 8ACA            4403         MOV     CL,DL                   ; NUMBER OF BYTES IN THE ROW
F550 56              4404         PUSH    SI
F551 57              4405         PUSH    DI                      ; SAVE POINTERS
F552 F3              4406         REP     MOVSB                   ; MOVE THE EVEN FIELD
F553 A4
F554 5F              4407         POP     DI
F555 5E              4408         POP     SI
F556 81C60020        4409         ADD     SI,2000H
F55A 81C70020        4410         ADD     DI,2000H                ; POINT TO THE ODD FIELD
F55E 56              4411         PUSH    SI
F55F 57              4412         PUSH    DI                      ; SAVE THE POINTERS
F560 8ACA            4413         MOV     CL,DL                   ; COUNT BACK
F562 F3              4414         REP     MOVSB                   ; MOVE THE ODD FIELD
F563 A4
F564 5F              4415         POP     DI
F565 5E              4416         POP     SI                      ; POINTERS BACK
F566 C3              4417         RET                             ; RETURN TO CALLER
                     4418 R17     ENDP
                     4419
                     4420 ;----- CLEAR A SINGLE ROW
                     4421
F567                 4422 R18     PROC    NEAR
F567 8ACA            4423         MOV     CL,DL                   ; NUMBER OF BYTES IN FIELD
F569 57              4424         PUSH    DI                      ; SAVE POINTER
F56A F3              4425         REP     STOSB                   ; STORE THE NEW VALUE
F56B AA
F56C 5F              4426         POP     DI                      ; POINTER BACK
F56D 81C70020        4427         ADD     DI,2000H                ; POINT TO ODD FIELD
F571 57              4428         PUSH    DI
F572 8ACA            4429         MOV     CL,DL
F574 F3              4430         REP     STOSB                   ; FILL THE ODD FILELD
F575 AA
F576 5F              4431         POP     DI
F577 C3              4432         RET                             ; RETURN TO CALLER
                     4433 R18     ENDP
                     4434 ;--------------------------------------------------------------
                     4435 ; GRAPHICS WRITE                                              :
                     4436 ;       THIS ROUTINE WRITES THE ASCII CHARACTER TO THE         :
                     4437 ;       CURRENT POSITION ON THE SCREEN.                       :
                     4438 ; ENTRY                                                       :
                     4439 ;       AL = CHARACTER TO WRITE                               :
                     4440 ;       BL = COLOR ATTRIBUTE TO BE USED FOR FOREGROUND COLOR  :
                     4441 ;          IF BIT 7 IS SET, THE CHAR IS XOR'D INTO THE REGEN   :
                     4442 ;          BUFFER (0 IS USED FOR THE BACKGROUND COLOR)         :
                     4443 ;       CX = NUMBER OF CHARS TO WRITE                         :
                     4444 ;       DS = DATA SEGMENT                                     :
                     4445 ;       ES = REGEN SEGMENT                                    :
                     4446 ; EXIT                                                        :
                     4447 ;       NOTHING IS RETURNED                                   :
                     4448 ;                                                             :
                     4449 ; GRAPHICS READ                                               :
                     4450 ;       THIS ROUTINE READS THE ASCII CHARACTER AT THE CURRENT  :
                     4451 ;       CURSOR POSITION ON THE SCREEN BY MATCHING THE DOTS ON  :
                     4452 ;       THE SCREEN TO THE CHARACTER GENERATOR CODE POINTS      :
                     4453 ; ENTRY                                                       :
                     4454 ;       NONE  ( 0 IS ASSUMED AS THE BACKGROUND COLOR          :
                     4455 ; EXIT                                                        :
                     4456 ;       AL = CHARACTER READ AT THAT POSITION (0 RETURNED IF    :
                     4457 ;            NONE FOUND)                                      :
                     4458 ;                                                             :
                     4459 ; FOR BOTH ROUTINES, THE IMAGES USED TO FORM CHARS ARE        :
                     4460 ;  CONTAINED IN ROM FOR THE 1ST 128 CHARS.  TO ACCESS CHARS   :
                     4461 ;  IN THE SECOND HALF, THE USER MUST INITIALIZE THE VECTOR AT  :
                     4462 ;  INTERRUPT 1FH (LOCATION 0007CH) TO POINT TO THE USER       :
                     4463 ;  SUPPLIED TABLE OF GRAPHIC IMAGES (8X8 BOXES).              :
                     4464 ;  FAILURE TO DO SO WILL CAUSE IN STRANGE RESULTS            :
                     4465 ;--------------------------------------------------------------
                     4466         ASSUME  CS:CODE,DS:DATA,ES:DATA
F578                 4467 GRAPHICS_WRITE  PROC    NEAR
F578 B400            4468         MOV     AH,0                    ; ZERO TO HIGH OF CODE POINT
F57A 50              4469         PUSH    AX                      ; SAVE CODE POINT VALUE
                     4470
                     4471 ;----- DETERMINE POSITION IN REGEN BUFFER TO PUT CODE POINTS
                     4472
F57B E88401          4473         CALL    S26                     ; FIND LOCATION IN REGEN BUFFER
F57E 8BF8            4474         MOV     DI,AX                   ; REGEN POINTER IN DI
                     4475
                     4476 ;----- DETERMINE REGION TO GET CODE POINTS FROM
                     4477
F580 58              4478         POP     AX                      ; RECOVER CODE POINT
F581 3C80            4479         CMP     AL,80H                  ; IS IT IN SECOND HALF
F583 7306            4480         JAE     S1                      ; YES
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                    4481
                    4482  ;----- IMAGE IS IN FIRST HALF, CONTAINED IN ROM
                    4483
F585 BE6EFA         4484          MOV     SI,0FA6EH               ; CRT_CHAR_GEN (OFFSET OF IMAGES)
F588 0E             4485          PUSH    CS                      ; SAVE SEGMENT ON STACK
F589 EB0F           4486          JMP     SHORT S2                ; DETERMINE_MODE
                    4487
                    4488  ;----- IMAGE IS IN SECOND HALF, IN USER RAM
                    4489
F58B                4490  S1:                                     ; EXTEND_CHAR
F58B 2C80           4491          SUB     AL,80H                  ; ZERO ORIGIN FOR SECOND HALF
F58D 1E             4492          PUSH    DS                      ; SAVE DATA POINTER
F58E 2BF6           4493          SUB     SI,SI
F590 8EDE           4494          MOV     DS,SI                   ; ESTABLISH VECTOR ADDRESSING
                    4495          ASSUME  DS:ABS0
F592 C5367C00       4496          LDS     SI,EXT_PTR              ; GET THE OFFSET OF THE TABLE
F596 8CDA           4497          MOV     DX,DS                   ; GET THE SEGMENT OF THE TABLE
                    4498          ASSUME  DS:DATA
F598 1F             4499          POP     DS                      ; RECOVER DATA SEGMENT
F599 52             4500          PUSH    DX                      ; SAVE TABLE SEGMENT ON STACK
                    4501
                    4502  ;----- DETERMINE GRAPHICS MODE IN OPERATION
                    4503
F59A                4504  S2:                                     ; DETERMINE_MODE
F59A D1E0           4505          SAL     AX,1                    ; MULTIPLY CODE POINT
F59C D1E0           4506          SAL     AX,1                    ;  VALUE BY 8
F59E D1E0           4507          SAL     AX,1
F5A0 03F0           4508          ADD     SI,AX                   ; SI HAS OFFSET OF DESIRED CODES
F5A2 803E490006     4509          CMP     CRT_MODE,6
F5A7 1F             4510          POP     DS                      ; RECOVER TABLE POINTER SEGMENT
F5A8 722C           4511          JC      S7                      ; TEST FOR MEDIUM RESOLUTION MODE
                    4512
                    4513  ;----- HIGH RESOLUTION MODE
                    4514
F5AA                4515  S3:                                     ; HIGH_CHAR
F5AA 57             4516          PUSH    DI                      ; SAVE REGEN POINTER
F5AB 56             4517          PUSH    SI                      ; SAVE CODE POINTER
F5AC B604           4518          MOV     DH,4                    ; NUMBER OF TIMES THROUGH LOOP
F5AE                4519  S4:
F5AE AC             4520          LODSB                           ; GET BYTE FROM CODE POINTS
F5AF F6C380         4521          TEST    BL,80H                  ; SHOULD WE USE THE FUNCTION
F5B2 7516           4522          JNZ     S6                      ;  TO PUT CHAR IN

F5B4 AA             4523          STOSB                           ; STORE IN REGEN BUFFER
F5B5 AC             4524          LODSB
F5B6                4525  S5:
F5B6 268885FF1F     4526          MOV     ES:[DI+2000H-1],AL      ; STORE IN SECOND HALF
F5BB 83C74F         4527          ADD     DI,79                   ; MOVE TO NEXT ROW IN REGEN
F5BE FECE           4528          DEC     DH                      ; DONE WITH LOOP
F5C0 75EC           4529          JNZ     S4
F5C2 5E             4530          POP     SI
F5C3 5F             4531          POP     DI                      ; RECOVER REGEN POINTER
F5C4 47             4532          INC     DI                      ; POINT TO NEXT CHAR POSITION
F5C5 E2E3           4533          LOOP    S3                      ; MORE CHARS TO WRITE
F5C7 E9FBFB         4534          JMP     VIDEO_RETURN
F5CA                4535  S6:
F5CA 263205         4536          XOR     AL,ES:[DI]              ; EXCLUSIVE OR WITH CURRENT
F5CD AA             4537          STOSB                           ; STORE THE CODE POINT
F5CE AC             4538          LODSB                           ; AGAIN FOR ODD FIELD
F5CF 263285FF1F     4539          XOR     AL,ES:[DI+2000H-1]
F5D4 EBE0           4540          JMP     S5                      ; BACK TO MAINSTREAM
                    4541
                    4542  ;----- MEDIUM RESOLUTION WRITE
                    4543
F5D6                4544  S7:                                     ; MED_RES_WRITE
F5D6 8AD3           4545          MOV     DL,BL                   ; SAVE HIGH COLOR BIT
F5D8 D1E7           4546          SAL     DI,1                    ; OFFSET*2 SINCE 2 BYTES/CHAR
F5DA E8D100         4547          CALL    S19                     ; EXPAND BL TO FULL WORD OF COLOR
F5DD                4548  S8:                                     ; MED_CHAR
F5DD 57             4549          PUSH    DI                      ; SAVE REGEN POINTER
F5DE 56             4550          PUSH    SI                      ; SAVE THE CODE POINTER
F5DF B604           4551          MOV     DH,4                    ; NUMBER OF LOOPS
F5E1                4552  S9:
F5E1 AC             4553          LODSB                           ; GET CODE POINT
F5E2 E8DE00         4554          CALL    S21                     ; DOUBLE UP ALL THE BITS
F5E5 23C3           4555          AND     AX,BX                   ; CONVERT THEM TO FOREGROUND
                    4556                                          ;  COLOR ( 0 BACK )
F5E7 F6C280         4557          TEST    DL,80H                  ; IS THIS XOR FUNCTION
F5EA 7407           4558          JZ      S10                     ; NO, STORE IT IN AS IT IS
F5EC 263225         4559          XOR     AH,ES:[DI]              ; DO FUNCTION WITH HALF
F5EF 26324501       4560          XOR     AL,ES:[DI+1]            ; AND WITH OTHER HALF
F5F3                4561  S10:
F5F3 268825         4562          MOV     ES:[DI],AH              ; STORE FIRST BYTE
F5F6 26884501       4563          MOV     ES:[DI+1],AL            ; STORE SECOND BYTE
F5FA AC             4564          LODSB                           ; GET CODE POINT
F5FB E8C500         4565          CALL    S21
F5FE 23C3           4566          AND     AX,BX                   ; CONVERT TO COLOR
F600 F6C280         4567          TEST    DL,80H                  ; AGAIN, IS THIS XOR FUNCTION
F603 740A           4568          JZ      S11                     ; NO, JUST STORE THE VALUES
F605 2632A50020     4569          XOR     AH,ES:[DI+2000H]        ; FUNCTION WITH FIRST HALF
F60A 2632850120     4570          XOR     AL,ES:[DI+2001H]        ; AND WITH SECOND HALF
F60F                4571  S11:
F60F 2688A50020     4572          MOV     ES:[DI+2000H ,AH]
F614 2688850120     4573          MOV     ES:[DI+2000H+1],AL      ; STORE IN SECOND PORTION OF BUFFER
F619 83C702         4574          ADD     DI,80                   ; POINT TO NEXT LOCATION
F61C FECE           4575          DEC     DH
F61E 75C1           4576          JNZ     S9                      ; KEEP GOING
F620 5E             4577          POP     SI                      ; RECOVER CODE PONTER
F621 5F             4578          POP     DI                      ; RECOVER REGEN POINTER
F622 47             4579          INC     DI                      ; POINT TO NEXT CHAR POSITION
F623 47             4580          INC     DI
F624 E2B7           4581          LOOP    S8                      ; MORE TO WRITE
F626 E99CFB         4582          JMP     VIDEO_RETURN
                    4583  GRAPHICS_WRITE  ENDP
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                        4584  ;--------------------------
                        4585  ; GRAPHICS READ          :
                        4586  ;--------------------------
F629                    4587  GRAPHICS_READ   PROC    NEAR
F629 E8D600             4588          CALL    S26                     ; CONVERTED TO OFFSET IN REGEN
F62C 8BF0               4589          MOV     SI,AX                   ; SAVE IN SI
F62E 83EC08             4590          SUB     SP,8                    ; ALLOCATE SPACE TO SAVE THE
                        4591                                          ;  READ CODE POINT
F631 8BEC               4592          MOV     BP,SP                   ; POINTER TO SAVE AREA
                        4593
                        4594  ;----- DETERMINE GRAPHICS MODES
                        4595
F633 803E490006         4596          CMP     CRT_MODE,6
F638 06                 4597          PUSH    ES
F639 1F                 4598          POP     DS                      ; POINT TO REGEN SEGMENT
F63A 721A               4599          JC      S13                     ; MEDIUM RESOLUTION
                        4600
                        4601  ;----- HIGH RESOLUTION READ
                        4602
                        4603  ;----- GET VALUES FROM REGEN BUFFER AND CONVERT TO CODE POINT
                        4604
F63C B604               4605          MOV     DH,4                    ; NUMBER OF PASSES
F63E                    4606  S12:
F63E                    4607          MOV     AL,[SI]                 ; GET FIRST BYTE
F640 884600             4608          MOV     [BP],AL                 ; SAVE IN STORAGE AREA
F643 45                 4609          INC     BP                      ; NEXT LOCATION
F644 8A840020           4610          MOV     AL,[SI+2000H]           ; GET LOWER REGION BYTE
F648 884600             4611          MOV     [BP],AL                 ; ADJUST AND STORE
F64B 45                 4612          INC     BP
F64C 83C650             4613          ADD     SI,80                   ; POINTER INTO REGEN
F64F FECE               4614          DEC     DH                      ; LOOP CONTROL
F651 75EB               4615          JNZ     S12                     ; DO IT SOME MORE
F653 EB1790             4616          JMP     S15                     ; GO MATCH THE SAVED CODE POINTS
                        4617
                        4618  ;----- MEDIUM RESOLUTION READ
                        4619
F656                    4620  S13:                                    ; MED_RES_READ
F656 D1E6               4621          SAL     SI,1                    ; OFFSET*2 SINCE 2 BYTES/CHAR
F658 B604               4622          MOV     DH,4                    ; NUMBER OF PASSES
F65A                    4623  S14:
F65A E88800             4624          CALL    S23                     ; GET PAIR BYTES FROM REGEN
                        4625                                          ;  INTO SINGLE SAVE
F65D 81C60020           4626          ADD     SI,2000H                ; GO TO LOWER REGION
F661 E88100             4627          CALL    S23                     ; GET THIS PAIR INTO SAVE
F664 81EEB01F           4628          SUB     SI,2000H-80             ; ADJUST POINTER BACK INTO UPPER
F668 FECE               4629          DEC     DH
F66A 75EE               4630          JNZ     S14                     ; KEEP GOING UNTIL ALL 8 DONE
                        4631
                        4632  ;----- SAVE AREA HAS CHARACTER IN IT, MATCH IT
                        4633
F66C                    4634  S15:                                    ; FIND_CHAR
F66C BF6EFA90           4635          MOV     DI,OFFSET CRT_CHAR_GEN  ; ESTABLISH ADDRESSING
F670 0E                 4636          PUSH    CS
F671 07                 4637          POP     ES                      ; CODE POINTS IN CS
F672 83ED08             4638          SUB     BP,8                    ; ADJUST POINTER TO BEGINNING
                        4639                                          ;  OF SAVE AREA
F675 8BF5               4640          MOV     SI,BP
F677 FC                 4641          CLD                             ; ENSURE DIRECTION
F678 B000               4642          MOV     AL,0                    ; CURRENT CODE POINT BEING MATCHED
F67A                    4643  S16:
F67A 16                 4644          PUSH    SS                      ; ESTABLISH ADDRESSING TO STACK
F67B 1F                 4645          POP     DS                      ; FOR THE STRING COMPARE
F67C BA8000             4646          MOV     DX,128                  ; NUMBER TO TEST AGAINST
F67F                    4647  S17:
F67F 56                 4648          PUSH    SI                      ; SAVE SAVE AREA POINTER
F680 57                 4649          PUSH    DI                      ; SAVE CODE POINTER
F681 B90800             4650          MOV     CX,8                    ; NUMBER OF BYTES TO MATCH
F684 F3                 4651          REPE    CMPSB                   ; COMPARE THE 8 BYTES
F685 A6
F686 5F                 4652          POP     DI                      ; RECOVER THE POINTERS
F687 5E                 4653          POP     SI
F688 741E               4654          JZ      S18                     ; IF ZERO FLAG SET, THEN MATCH OCCURRED
F68A FEC0               4655          INC     AL                      ; NO MATCH, MOVE ON TO NEXT
F68C 83C708             4656          ADD     DI,8                    ; NEXT CODE POINT
F68F 4A                 4657          DEC     DX                      ; LOOP CONTROL
F690 75ED               4658          JNZ     S17                     ; DO ALL OF THEM
                        4659
                        4660  ;----- CHAR NOT MATCHED, MIGHT BE IN USER SUPPLIED SECOND HALF
                        4661
F692 3C00               4662          CMP     AL,0                    ; AL <> 0 IF ONLY 1ST HALF SCANNED
F694 7412               4663          JE      S18                     ; IF = 0, THEN ALL HAS BEEN SCANNED
F696 2BC0               4664          SUB     AX,AX
F698 8ED8               4665          MOV     DS,AX                   ; ESTABLISH ADDRESSING TO VECTOR
                        4666          ASSUME  DS:ABS0
F69A C43E7C00           4667          LES     DI,EXT_PTR              ; GET POINTER
F69E 8CC0               4668          MOV     AX,ES                   ; SEE IF THE POINTER REALLY EXISTS
F6A0 0BC7               4669          OR      AX,DI                   ; IF ALL 0, THEN DOESN'T EXIST
F6A2 7404               4670          JZ      S18                     ; NO SENSE LOOKING
F6A4 B080               4671          MOV     AL,128                  ; ORIGIN FOR SECOND HALF
F6A6 EBD2               4672          JMP     S16                     ; GO BACK AND TRY FOR IT
                        4673          ASSUME  DS:DATA
                        4674
                        4675  ;----- CHARACTER IS FOUND ( AL=0 IF NOT FOUND )
                        4676
F6A8                    4677  S18:
F6A8 83C408             4678          ADD     SP,8                    ; READJUST THE STACK, THROW AWAY SAVE
F6AB E917FB             4679          JMP     VIDEO_RETURN            ; ALL DONE
                        4680  GRAPHICS_READ   ENDP
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                    4681  ;--------------------------------------------------------
                    4682  ; EXPAND_MED_COLOR                                      :
                    4683  ;       THIS ROUTINE EXPANDS THE LOW 2 BITS IN BL TO     :
                    4684  ;       FILL THE ENTIRE BX REGISTER                      :
                    4685  ; ENTRY                                                  :
                    4686  ;       BL = COLOR TO BE USED ( LOW 2 BITS )             :
                    4687  ; EXIT                                                   :
                    4688  ;       BX = COLOR TO BE USED ( 8 REPLICATIONS OF THE    :
                    4689  ;       2 COLOR BITS )                                   :
                    4690  ;--------------------------------------------------------
F6AE                4691  S19     PROC    NEAR
F6AE 80E303         4692          AND     BL,3                    ; ISOLATE THE COLOR BITS
F6B1 8AC3           4693          MOV     AL,BL                   ; COPY TO AL
F6B3 51             4694          PUSH    CX                      ; SAVE REGISTER
F6B4 B90300         4695          MOV     CX,3                    ; NUMBER OF TIMES TO DO THIS
F6B7                4696  S20:
F6B7 D0E0           4697          SAL     AL,1
F6B9 D0E0           4698          SAL     AL,1                    ; LEFT SHIFT BY 2
F6BB 0AD8           4699          OR      BL,AL                   ; ANOTHER COLOR VERSION INTO BL
F6BD E2F8           4700          LOOP    S20                     ; FILL ALL OF BL
F6BF 8AFB           4701          MOV     BH,BL                   ; FILL UPPER PORTION
F6C1 59             4702          POP     CX                      ; REGISTER BACK
F6C2 C3             4703          RET                             ; ALL DONE
                    4704  S19     ENDP
                    4705  ;--------------------------------------------------------
                    4706  ; EXPAND_BYTE                                           :
                    4707  ;       THIS ROUTINE TAKES THE BYTE IN AL AND DOUBLES     :
                    4708  ;       ALL OF THE BITS, TURNING THE 8 BITS INTO         :
                    4709  ;       16 BITS. THE RESULT IS LEFT IN AX                :
                    4710  ;--------------------------------------------------------
F6C3                4711  S21     PROC    NEAR
F6C3 52             4712          PUSH    DX                      ; SAVE REGISTERS
F6C4 51             4713          PUSH    CX
F6C5 53             4714          PUSH    BX
F6C6 2BD2           4715          SUB     DX,DX                   ; RESULT REGISTER
F6C8 B90100         4716          MOV     CX,1                    ; MASK REGISTER
F6CB                4717  S22:
F6CB 8BD8           4718          MOV     BX,AX                   ; BASE INTO TEMP
F6CD 23D9           4719          AND     BX,CX                   ; USE MASK TO EXTRACT A BIT
F6CF 0BD3           4720          OR      DX,BX                   ; PUT INTO RESULT REGISTER
F6D1 D1E0           4721          SHL     AX,1
F6D3 D1E1           4722          SHL     CX,1                    ; SHIFT BASE AND MASK BY 1

F6D5 8BD8           4723          MOV     BX,AX                   ; BASE TO TEMP
F6D7 23D9           4724          AND     BX,CX                   ; EXTRACT THE SAME BIT
F6D9 0BD3           4725          OR      DX,BX                   ; PUT INTO RESULT
F6DB D1E1           4726          SHL     CX,1                    ; SHIFT ONLY MASK NOW,
                    4727                                          ;  MOVING TO NEXT BASE
F6DD 73EC           4728          JNC     S22                     ; USE MASK BIT COMING OUT TO TERMINATE
F6DF 8BC2           4729          MOV     AX,DX                   ; RESULT TO PARM REGISTER
F6E1 5B             4730          POP     BX
F6E2 59             4731          POP     CX                      ; RECOVER REGISTERS
F6E3 5A             4732          POP     DX
F6E4 C3             4733          RET                             ; ALL DONE
                    4734  S21     ENDP
                    4735  ;--------------------------------------------------------
                    4736  ; MED_READ_BYTE                                         :
                    4737  ;       THIS ROUTINE WILL TAKE 2 BYTES FROM THE REGEN    :
                    4738  ;       BUFFER, COMPARE AGAINST THE CURRENT FOREGROUND    :
                    4739  ;       COLOR, AND PLACE THE CORRESPONDING ON/OFF BIT     :
                    4740  ;       PATTERN INTO THE CURRENT POSITION IN THE SAVE     :
                    4741  ;       AREA                                             :
                    4742  ; ENTRY                                                  :
                    4743  ;       SI,DS = POINTER TO REGEN AREA OF INTEREST        :
                    4744  ;       BX = EXPANDED FOREGROUND COLOR                   :
                    4745  ;       BP = POINTER TO SAVE AREA                        :
                    4746  ; EXIT                                                   :
                    4747  ;       BP IS INCREMENT AFTER SAVE                       :
                    4748  ;--------------------------------------------------------
F6E5                4749  S23     PROC    NEAR
F6E5 8A24           4750          MOV     AH,[SI]                 ; GET FIRST BYTE
F6E7 8A4401         4751          MOV     AL,[SI+1]               ; GET SECOND BYTE
F6EA B900C0         4752          MOV     CX,0C000H               ; 2 BIT MASK TO TEST THE ENTRIES
F6ED B200           4753          MOV     DL,0                    ; RESULT REGISTER
F6EF                4754  S24:
F6EF 85C1           4755          TEST    AX,CX                   ; IS THIS SECTION BACKGROUND?
F6F1 F8             4756          CLC                             ; CLEAR CARRY IN HOPES THAT IT IS
F6F2 7401           4757          JZ      S25                     ; IF ZERO, IT IS BACKGROUND
F6F4 F9             4758          STC                             ; WASN'T, SO SET CARRY
F6F5 D0D2           4759  S25:    RCL     DL,1                    ; MOVE THAT BIT INTO THE RESULT
F6F7 D1E9           4760          SHR     CX,1
F6F9 D1E9           4761          SHR     CX,1                    ; MOVE THE MASK TO THE RIGHT BY 2 BITS
F6FB 73F2           4762          JNC     S24                     ; DO IT AGAIN IF MASK DIDN'T FALL OUT
F6FD 885600         4763          MOV     [BP],DL                 ; STORE RESULT IN SAVE AREA
F700 45             4764          INC     BP                      ; ADJUST POINTER
F701 C3             4765          RET                             ; ALL DONE
                    4766  S23     ENDP
                    4767  ;--------------------------------------------------------
                    4768  ; V4_POSITION                                           :
                    4769  ;       THIS ROUTINE TAKES THE CURSOR POSITION           :
                    4770  ;       CONTAINED IN THE MEMORY LOCATION, AND            :
                    4771  ;       CONVERTS IT INTO AN OFFSET INTO THE              :
                    4772  ;       REGEN BUFFER, ASSUMING ONE BYTE/CHAR.            :
                    4773  ;       FOR MEDIUM RESOLUTION GRAPHICS,                  :
                    4774  ;       THE NUMBER MUST BE DOUBLED.                      :
                    4775  ; ENTRY                                                  :
                    4776  ;       NO REGISTERS, MEMORY LOCATION                    :
                    4777  ;       CURSOR_POSN IS USED                              :
                    4778  ; EXIT                                                   :
                    4779  ;       AX CONTAINS OFFSET INTO REGEN BUFFER             :
                    4780  ;--------------------------------------------------------
F702                4781  S26     PROC    NEAR
F702 A15000         4782          MOV     AX,CURSOR_POSN          ; GET CURRENT CURSOR
F705                4783  GRAPH_POSN LABEL  NEAR
F705 53             4784          PUSH    BX                      ; SAVE REGISTER
F706 8BD8           4785          MOV     BX,AX                   ; SAVE A COPY OF CURRENT CURSOR
F708 8AC4           4786          MOV     AL,AH                   ; GET ROWS TO AL
F70A F66400         4787          MUL     BYTE PTR CRT_COLS       ; MULTIPLY BY BYTES/COLUMN
F70E D1E0           4788          SHL     AX,1                    ; MULTIPLY * 4 SINCE 4 ROWS/BYTE
F710 D1E0           4789          SHL     AX,1
F712 2AFF           4790          SUB     BH,BH                   ; ISOLATE COLUMN VALUE
F714 03C3           4791          ADD     AX,BX                   ; DETERMINE OFFSET
F716 5B             4792          POP     BX                      ; RECOVER POINTER
F717 C3             4793          RET                             ; ALL DONE
                    4794  S26     ENDP
```

SECTION 5

```
                        4795  ;--------------------------------------------------------------------------------
                        4796  ; WRITE_TTY                                                                    :
                        4797  ;       THIS INTERFACE PROVIDES A TELETYPE LIKE INTERFACE TO THE VIDEO          :
                        4798  ;       CARD. THE INPUT CHARACTER IS WRITTEN TO THE CURRENT CURSOR              :
                        4799  ;       POSITION, AND THE CURSOR IS MOVED TO THE NEXT POSITION. IF THE          :
                        4800  ;       CURSOR LEAVES THE LAST COLUMN OF THE FIELD, THE COLUMN IS SET           :
                        4801  ;       TO ZERO, AND THE ROW VALUE IS INCREMENTED. IF THE ROW VALUE             :
                        4802  ;       LEAVES THE FIELD, THE CURSOR IS PLACED ON THE LAST ROW, FIRST           :
                        4803  ;       COLUMN, AND THE ENTIRE SCREEN IS SCROLLED UP ONE LINE. WHEN             :
                        4804  ;       THE SCREEN IS SCROLLED UP, THE ATTRIBUTE FOR FILLING THE NEWLY          :
                        4805  ;       BLANKED LINE IS READ FROM THE CURSOR POSITION ON THE PREVIOUS           :
                        4806  ;       LINE BEFORE THE SCROLL, IN CHARACTER MODE. IN GRAPHICS MODE,            :
                        4807  ;       THE 0 COLOR IS USED.                                                   :
                        4808  ; ENTRY                                                                        :
                        4809  ;       (AH) = CURRENT CRT MODE                                                :
                        4810  ;       (AL) = CHARACTER TO BE WRITTEN                                         :
                        4811  ;        NOTE THAT BACK SPACE, CAR RET, BELL AND LINE FEED ARE HANDLED         :
                        4812  ;        AS COMMANDS RATHER THAN AS DISPLAYABLE GRAPHICS                       :
                        4813  ;       (BL) = FOREGROUND COLOR FOR CHAR WRITE IF CURRENTLY IN A                :
                        4814  ;        GRAPHICS MODE                                                         :
                        4815  ; EXIT                                                                         :
                        4816  ;       ALL REGISTERS SAVED                                                    :
                        4817  ;--------------------------------------------------------------------------------
                        4818          ASSUME  CS:CODE,DS:DATA
F718                    4819  WRITE_TTY PROC    NEAR
F718 50                 4820          PUSH    AX                      ; SAVE REGISTERS
F719 50                 4821          PUSH    AX                      ; SAVE CHAR TO WRITE
F71A B403               4822          MOV     AH,3
F71C 8A3E6200           4823          MOV     BH,ACTIVE_PAGE          ; GET THE CURRENT ACTIVE PAGE
F720 CD10               4824          INT     10H                     ; READ THE CURRENT CURSOR POSITION
F722 58                 4825          POP     AX                      ; RECOVER CHAR
                        4826
                        4827  ;----- DX NOW HAS THE CURRENT CURSOR POSITION
                        4828
F723 3C08               4829          CMP     AL,8                    ; IS IT A BACKSPACE
F725 7452               4830          JE      U8                      ; BACK_SPACE
F727 3C0D               4831          CMP     AL,0DH                  ; IS IT CARRIAGE RETURN
F729 7457               4832          JE      U9                      ; CAR_RET
F72B 3C0A               4833          CMP     AL,0AH                  ; IS IT A LINE FEED
F72D 7457               4834          JE      U10                     ; LINE_FEED
F72F 3C07               4835          CMP     AL,07H                  ; IS IT A BELL
F731 745A               4836          JE      U11                     ; BELL
                        4837
                        4838  ;----- WRITE THE CHAR TO THE SCREEN
                        4839
                        4840
F733 B40A               4841          MOV     AH,10                   ; WRITE CHAR ONLY
F735 B90100             4842          MOV     CX,1                    ; ONLY ONE CHAR
F738 CD10               4843          INT     10H                     ; WRITE THE CHAR
                        4844
                        4845  ;----- POSITION THE CURSOR FOR NEXT CHAR
                        4846
F73A FEC2               4847          INC     DL
F73C 3A164A00           4848          CMP     DL,BYTE PTR CRT_COLS    ; TEST FOR COLUMN OVERFLOW
F740 7533               4849          JNZ     U7                      ; SET_CURSOR
F742 B200               4850          MOV     DL,0                    ; COLUMN FOR CURSOR
F744 80FE18             4851          CMP     DH,24
F747 752A               4852          JNZ     U6                      ; SET_CURSOR_INC
                        4853
                        4854  ;----- SCROLL REQUIRED
                        4855
F749                    4856  U1:
F749 B402               4857          MOV     AH,2
F74B CD10               4858          INT     10H                     ; SET THE CURSOR
                        4859
                        4860  ;----- DETERMINE VALUE TO FILL WITH DURING SCROLL
                        4861
F74D A04900             4862          MOV     AL,CRT_MODE             ; GET THE CURRENT MODE
F750 3C04               4863          CMP     AL,4
F752 7206               4864          JC      U2                      ; READ-CURSOR
F754 3C07               4865          CMP     AL,7
F756 B700               4866          MOV     BH,0                    ; FILL WITH BACKGROUND
F758 7506               4867          JNE     U3                      ; SCROLL-UP
F75A                    4868  U2:                                     ; READ-CURSOR
F75A B408               4869          MOV     AH,8
F75C CD10               4870          INT     10H                     ; READ CHAR/ATTR AT CURRENT CURSOR
F75E 8AFC               4871          MOV     BH,AH                   ; STORE IN BH
F760                    4872  U3:                                     ; SCROLL-UP
F760 B80106             4873          MOV     AX,601H                 ; SCROLL ONE LINE
F763 2BC9               4874          SUB     CX,CX                   ; UPPER LEFT CORNER
F765 B618               4875          MOV     DH,24                   ; LOWER RIGHT ROW
F767 8A164A00           4876          MOV     DL,BYTE PTR CRT_COLS    ; LOWER RIGHT COLUMN
F76B FECA               4877          DEC     DL
F76D                    4878  U4:                                     ; VIDEO-CALL-RETURN
F76D CD10               4879          INT     10H                     ; SCROLL UP THE SCREEN
F76F                    4880  U5:                                     ; TTY-RETURN
F76F 58                 4881          POP     AX                      ; RESTORE THE CHARACTER
F770 E952FA             4882          JMP     VIDEO_RETURN            ; RETURN TO CALLER
F773                    4883  U6:                                     ; SET-CURSOR-INC
F773 FEC6               4884          INC     DH                      ; NEXT ROW
F775                    4885  U7:                                     ; SET-CURSOR
F775 B402               4886          MOV     AH,2
F777 EBF4               4887          JMP     U4                      ; ESTABLISH THE NEW CURSOR
                        4888
                        4889  ;----- BACK SPACE FOUND
                        4890
F779                    4891  U8:
F779 80FA00             4892          CMP     DL,0                    ; ALREADY AT END OF LINE
F77C 74F7               4893          JE      U7                      ; SET_CURSOR
F77E FECA               4894          DEC     DL                      ; NO -- JUST MOVE IT BACK
F780 EBF3               4895          JMP     U7                      ; SET_CURSOR
                        4896
                        4897  ;----- CARRIAGE RETURN FOUND
                        4898
F782                    4899  U9:
F782 B200               4900          MOV     DL,0                    ; MOVE TO FIRST COLUMN
F784 EBEF               4901          JMP     U7                      ; SET_CURSOR
                        4902
                        4903  ;----- LINE FEED FOUND
                        4904
F786                    4905  U10:
F786 80FE18             4906          CMP     DH,24                   ; BOTTOM OF SCREEN
F789 75E8               4907          JNE     U6                      ; YES, SCROLL THE SCREEN
F78B EBBC               4908          JMP     U1                      ; NO, JUST SET THE CURSOR
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                    4909
                    4910  ;----- BELL FOUND
                    4911
F78D                4912  U11:
F78D B302           4913          MOV     BL,2                    ; SET UP COUNT FOR BEEP
F78F E87602         4914          CALL    BEEP                    ; SOUND THE POD BELL
F792 EBDB           4915          JMP     U5                      ; TTY_RETURN
                    4916  WRITE_TTY     ENDP
                    4917  ;--------------------------------------------------------
                    4918  ; LIGHT PEN                                            :
                    4919  ;       THIS ROUTINE TESTS THE LIGHT PEN SWITCH AND THE LIGHT   :
                    4920  ;       PEN TRIGGER. IF BOTH ARE SET, THE LOCATION OF THE LIGHT :
                    4921  ;       PEN IS DETERMINED. OTHERWISE, A RETURN WITH NO          :
                    4922  ;       INFORMATION IS MADE.                                    :
                    4923  ; ON EXIT                                                      :
                    4924  ;       (AH) = 0 IF NO LIGHT PEN INFORMATION IS AVAILABLE       :
                    4925  ;                BX,CX,DX ARE DESTROYED                         :
                    4926  ;       (AH) = 1 IF LIGHT PEN IS AVAILABLE                      :
                    4927  ;                (DH,DL) = ROW,COLUMN OF CURRENT LIGHT PEN      :
                    4928  ;                          POSITION                             :
                    4929  ;                (CH) = RASTER POSITION                        :
                    4930  ;                (BX) = BEST GUESS AT PIXEL HORIZONTAL POSITION :
                    4931  ;--------------------------------------------------------
                    4932          ASSUME  CS:CODE,DS:DATA
                    4933  ;----- SUBTRACT_TABLE
F794                4934  V1      LABEL   BYTE
F794 03             4935          DB      3,3,5,5,3,3,3,4 ;
F795 03
F796 05
F797 05
F798 03
F799 03
F79A 03
F79B 04
F79C                4936  READ_LPEN       PROC    NEAR
                    4937
                    4938  ;----- WAIT FOR LIGHT PEN TO BE DEPRESSED
                    4939
F79C B400           4940          MOV     AH,0                    ; SET NO LIGHT PEN RETURN CODE
F79E 8B166300       4941          MOV     DX,ADDR_6845            ; GET BASE ADDRESS OF 6845
F7A2 83C206         4942          ADD     DX,6                    ; POINT TO STATUS REGISTER
F7A5 EC             4943          IN      AL,DX                   ; GET STATUS REGISTER
F7A6 A804           4944          TEST    AL,4                    ; TEST LIGHT PEN SWITCH
F7A8 757E           4945          JNZ     V6                      ; NOT SET, RETURN
                    4946
                    4947  ;----- NOW TEST FOR LIGHT PEN TRIGGER
                    4948
F7AA A802           4949          TEST    AL,2                    ; TEST LIGHT PEN TRIGGER
F7AC 7503           4950          JNZ     V7A                     ; RETURN WITHOUT RESETTING TRIGGER
F7AE E98100         4951          JMP     V7
                    4952
                    4953  ;----- TRIGGER HAS BEEN SET, READ THE VALUE IN
                    4954
F7B1                4955  V7A:
F7B1 B410           4956          MOV     AH,16                   ; LIGHT PEN REGISTERS ON 6845
                    4957
                    4958  ;----- INPUT REGS POINTED TO BY AH, AND CONVERT TO ROW COLUMN IN DX
                    4959
F7B3 8B166300       4960          MOV     DX,ADDR_6845            ; ADDRESS REGISTER FOR 6845
F7B7 8AC4           4961          MOV     AL,AH                   ; REGISTER TO READ
F7B9 EE             4962          OUT     DX,AL                   ; SET IT UP
F7BA 42             4963          INC     DX                      ; DATA REGISTER
F7BB EC             4964          IN      AL,DX                   ; GET THE VALUE
F7BC 8AE8           4965          MOV     CH,AL                   ; SAVE IN CX
F7BE 4A             4966          DEC     DX                      ; ADDRESS REGISTER
F7BF FEC4           4967          INC     AH
F7C1 8AC4           4968          MOV     AL,AH                   ; SECOND DATA REGISTER
F7C3 EE             4969          OUT     DX,AL
F7C4 42             4970          INC     DX                      ; POINT TO DATA REGISTER
F7C5 EC             4971          IN      AL,DX                   ; GET SECOND DATA VALUE
F7C6 8AE5           4972          MOV     AH,CH                   ; AX HAS INPUT VALUE
                    4973
                    4974  ;----- AX HAS THE VALUE READ IN FROM THE 6845
                    4975
F7C8 8A1E4900       4976          MOV     BL,CRT_MODE
F7CC 2AFF           4977          SUB     BH,BH                   ; MODE VALUE TO BX
F7CE 2E8A9F94F7     4978          MOV     BL,CS:V1[BX]            ; DETERMINE AMOUNT TO SUBTRACT
F7D3 2BC3           4979          SUB     AX,BX                   ; TAKE IT AWAY
F7D5 8B1E4E00       4980          MOV     BX,CRT_START
F7D9 D1EB           4981          SHR     BX,1
F7DB 2BC3           4982          SUB     AX,BX
F7DD 7902           4983          JNS     V2                      ; IF POSITIVE, DETERMINE MODE
F7DF 2BC0           4984          SUB     AX,AX                   ; <0 PLAYS AS 0
                    4985
                    4986  ;----- DETERMINE MODE OF OPERATION
                    4987
F7E1                4988  V2:                                     ; DETERMINE_MODE
F7E1 B103           4989          MOV     CL,3                    ; SET *8 SHIFT COUNT
F7E3 803E490004     4990          CMP     CRT_MODE,4              ; DETERMINE IF GRAPHICS OR ALPHA
F7E8 722A           4991          JB      V4                      ; ALPHA_PEN
F7EA 803E490007     4992          CMP     CRT_MODE,7
F7EF 7423           4993          JE      V4                      ; ALPHA_PEN
                    4994
                    4995  ;----- GRAPHICS MODE
                    4996
F7F1 B228           4997          MOV     DL,40                   ; DIVISOR FOR GRAPHICS
F7F3 F6F2           4998          DIV     DL                      ; DETERMINE ROW(AL) AND COLUMN(AH)
                    4999                                          ;  AL RANGE 0-99, AH RANGE 0-39
                    5000
                    5001  ;----- DETERMINE GRAPHIC ROW POSITION
                    5002
F7F5 8AE8           5003          MOV     CH,AL                   ; SAVE ROW VALUE IN CH
F7F7 02ED           5004          ADD     CH,CH                   ; *2 FOR EVEN/ODD FIELD
F7F9 8ADC           5005          MOV     BL,AH                   ; COLUMN VALUE TO BX
F7FB 2AFF           5006          SUB     BH,BH                   ; MULTIPLY BY 8 FOR MEDIUM RES
F7FD 803E490006     5007          CMP     CRT_MODE,6              ; DETERMINE MEDIUM OR HIGH RES
F802 7504           5008          JNE     V3                      ; NOT_HIGH_RES
F804 B104           5009          MOV     CL,4                    ; SHIFT VALUE FOR HIGH RES
F806 D0E4           5010          SAL     AH,1                    ; COLUMN VALUE TIMES 2 FOR HIGH RES
F808                5011  V3:                                     ; NOT_HIGH_RES
F808 D3E3           5012          SHL     BX,CL                   ; MULTIPLY *16 FOR HIGH RES
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                    5013
                    5014  ;----- DETERMINE ALPHA CHAR POSITION
                    5015
F80A 8AD4           5016          MOV     DL,AH                   ; COLUMN VALUE FOR RETURN
F80C 8AF0           5017          MOV     DH,AL                   ; ROW VALUE
F80E D0EE           5018          SHR     DH,1                    ; DIVIDE BY 4
F810 D0EE           5019          SHR     DH,1                    ;  FOR VALUE IN 0-24 RANGE
F812 EB12           5020          JMP     SHORT V5                ; LIGHT_PEN_RETURN_SET
                    5021
                    5022  ;----- ALPHA MODE ON LIGHT PEN
                    5023
F814                5024  V4:                                     ; ALPHA_PEN
F814 F6364A00       5025          DIV     BYTE PTR CRT_COLS       ; DETERMINE ROW,COLUMN VALUE
F818 8AF0           5026          MOV     DH,AL                   ; ROWS TO DH
F81A 8AD4           5027          MOV     DL,AH                   ; COLS TO DL
F81C D2E0           5028          SAL     AL,CL                   ; MULTIPLY ROWS * 8
F81E 8AE8           5029          MOV     CH,AL                   ; GET RASTER VALUE TO RETURN REG
F820 8ADC           5030          MOV     BL,AH                   ; COLUMN VALUE
F822 32FF           5031          XOR     BH,BH                   ;  TO BX
F824 D3E3           5032          SAL     BX,CL
F826                5033  V5:                                     ; LIGHT_PEN_RETURN_SET
F826 B401           5034          MOV     AH,1                    ; INDICATE EVERTHING SET
F828                5035  V6:                                     ; LIGHT_PEN_RETURN
F828 52             5036          PUSH    DX                      ; SAVE RETURN VALUE (IN CASE)
F829 8B166300       5037          MOV     DX,ADDR_6845            ; GET BASE ADDRESS
F82D 83C207         5038          ADD     DX,7                    ; POINT TO RESET PARM
F830 EE             5039          OUT     DX,AL                   ; ADDRESS, NOT DATA, IS IMPORTANT
F831 5A             5040          POP     DX                      ; RECOVER VALUE
F832                5041  V7:                                     ; RETURN_NO_RESET
F832 5F             5042          POP     DI
F833 5E             5043          POP     SI
F834 1F             5044          POP     DS                      ; DISCARD SAVED BX,CX,DX
F835 1F             5045          POP     DS
F836 1F             5046          POP     DS
F837 1F             5047          POP     DS
F838 07             5048          POP     ES
F839 CF             5049          IRET
                    5050  READ_LPEN       ENDP
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                    5051
                    5052  ;--- INT 12 -----------------------------------------------------------------
                    5053  ; MEMORY_SIZE_DET                                                           :
                    5054  ;       THIS ROUTINE DETERMINES THE AMOUNT OF MEMORY IN THE SYSTEM           :
                    5055  ;       AS REPRESENTED BY THE SWITCHES ON THE PLANAR.  NOTE THAT THE         :
                    5056  ;       SYSTEM MAY NOT BE ABLE TO USE I/O MEMORY UNLESS THERE IS A FULL      :
                    5057  ;       COMPLEMENT OF 64K BYTES ON THE PLANAR.                               :
                    5058  ; INPUT                                                                     :
                    5059  ;       NO REGISTERS                                                        :
                    5060  ;       THE MEMORY_SIZE VARIABLE IS SET DURING POWER ON DIAGNOSTICS         :
                    5061  ;        ACCORDING TO THE FOLLOWING HARDWARE ASSUMPTIONS:                    :
                    5062  ;       PORT 60 BITS 3,2 = 00 - 16K BASE RAM                                :
                    5063  ;                          01 - 32K BASE RAM                                :
                    5064  ;                          10 - 48K BASE RAM                                :
                    5065  ;                          11 - 64K BASE RAM                                :
                    5066  ;       PORT 62 BITS 3-0 INDICATE AMOUNT OF I/O RAM IN 32K INCREMENTS       :
                    5067  ;               E.G., 0000 - NO RAM IN I/O CHANNEL                          :
                    5068  ;                     0010 - 64K RAM IN I/O CHANNEL, ETC.                   :
                    5069  ; OUTPUT                                                                    :
                    5070  ;       (AX) = NUMBER OF CONTIGUOUS 1K BLOCKS OF MEMORY                     :
                    5071  ;---------------------------------------------------------------------------
                    5072          ASSUME  CS:CODE,DS:DATA
F841                5073          ORG     0F841H
F841                5074  MEMORY_SIZE_DET PROC    FAR
F841 FB             5075          STI                             ; INTERRUPTS BACK ON
F842 1E             5076          PUSH    DS                      ; SAVE SEGMENT
F843 E81302         5077          CALL    DDS
F846 A11300         5078          MOV     AX,MEMORY_SIZE          ; GET VALUE
F849 1F             5079          POP     DS                      ; RECOVER SEGMENT
F84A CF             5080          IRET                            ; RETURN TO CALLER
                    5081  MEMORY_SIZE_DET  ENDP
                    5082
                    5083  ;--- INT 11 -----------------------------------------------------
                    5084  ; EQUIPMENT DETERMINATION                                          :
                    5085  ;       THIS ROUTINE ATTEMPTS TO DETERMINE WHAT OPTIONAL            :
                    5086  ;       DEVICES ARE ATTACHED TO THE SYSTEM.                         :
                    5087  ; INPUT                                                           :
                    5088  ;       NO REGISTERS                                            :
                    5089  ;       THE EQUIP_FLAG VARIABLE IS SET DURING THE POWER ON      :
                    5090  ;       DIAGNOSTICS USING THE FOLLOWING HARDWARE ASSUMPTIONS:   :
                    5091  ;       PORT 60 = LOW ORDER BYTE OF EQUPMENT                    :
                    5092  ;       PORT 3FA = INTERRUPT ID REGISTER OF 8250                :
                    5093  ;               BITS 7-3 ARE ALWAYS 0                           :
                    5094  ;       PORT 378 = OUTPUT PORT OF PRINTER -- 8255 PORT THAT     :
                    5095  ;               CAN BE READ AS WELL AS WRITTEN                  :
                    5096  ; OUTPUT                                                          :
                    5097  ;       (AX) IS SET, BIT SIGNIFICANT, TO INDICATE ATTACHED I/O  :
                    5098  ;       BIT 15,14 = NUMBER OF PRINTERS ATTACHED                 :
                    5099  ;       BIT 13 NOT USED                                         :
                    5100  ;       BIT 12 = GAME I/O ATTACHED                              :
                    5101  ;       BIT 11,10,9 = NUMBER OF RS232 CARDS ATTACHED            :
                    5102  ;       BIT 8 UNUSED                                            :
                    5103  ;       BIT 7,6 = NUMBER OF DISKETTE DRIVES                     :
                    5104  ;               00=1, 01=2, 10=3, 11=4 ONLY IF BIT 0 = 1        :
                    5105  ;       BIT 5,4 = INITIAL VIDEO MODE                            :
                    5106  ;                 00 - UNUSED                                   :
                    5107  ;                 01 - 40X25 BW USING COLOR CARD                :
                    5108  ;                 10 - 80X25 BW USING COLOR CARD                :
                    5109  ;                 11 - 80X25 BW USING BW CARD                   :
                    5110  ;       BIT 3,2 = PLANAR RAM SIZE (00=16K,01=32K,10=48K,11=64K) :
                    5111  ;       BIT 1 NOT USED                                          :
                    5112  ;       BIT 0 = IPL FROM DISKETTE -- THIS BIT INDICATES THAT    :
                    5113  ;               THERE ARE DISKETTE DRIVES ON THE SYSTEM          :
                    5114  ;                                                               :
                    5115  ;       NO OTHER REGISTERS AFFECTED                             :
                    5116  ;-----------------------------------------------------------------
                    5117          ASSUME  CS:CODE,DS:DATA
F84D                5118          ORG     0F84DH
F84D                5119  EQUIPMENT       PROC    FAR
F84D FB             5120          STI                             ; INTERRUPTS BACK ON
F84E 1E             5121          PUSH    DS                      ; SAVE SEGMENT REGISTER
F84F E80702         5122          CALL    DDS
F852 A11000         5123          MOV     AX,EQUIP_FLAG           ; GET THE CURRENT SETTINGS
F855 1F             5124          POP     DS                      ; RECOVER SEGMENT
F856 CF             5125          IRET                            ; RETURN TO CALLER
                    5126  EQUIPMENT       ENDP
                    5127
                    5128  ;--- INT 15 -----------------------------------------------------------------
                    5129  ;    DUMMY CASSETTE IO ROUTINE-RETURNS 'INVALID CMD' IF THE ROUTINE IS      :
                    5130  ;    IS EVER CALLED BY ACCIDENT (AH=86H, CARRY FLAG=1)                      :
                    5131  ;-----------------------------------------------------------------------------
F859                5132          ORG     0F859H
F859                5133  CASSETTE_IO     PROC    FAR
F859 F9             5134          STC                             ; CARRY INDICATOR=1
F85A B486           5135          MOV     AH,86H
F85C CA0200         5136          RET     2
                    5137  CASSETTE_IO     ENDP
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LOC OBJECT          LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

                    5138
                    5139  ;--------------------------------------------------------------
                    5140  ; NON-MASKABLE INTERRUPT ROUTINE:                            :
                    5141  ;       THIS ROUTINE WILL PRINT A PARITY CHECK 1 OR 2 MESSAGE  :
                    5142  ;       AND ATTEMPT TO FIND THE STORAGE LOCATION CONTAINING THE :
                    5143  ;       BAD PARITY.  IF FOUND, THE SEGMENT ADDRESS WILL BE     :
                    5144  ;       PRINTED.  IF NO PARITY ERROR CAN BE FOUND (INTERMITTANT :
                    5145  ;       READ PROBLEM) ????<-WILL BE PRINTED WHERE THE ADDRESS  :
                    5146  ;       WOULD NORMALLY GO.                                     :
                    5147  ;       IF ADDRESS IN ERROR IS IN THE I/O EXPANSION BOX, THE    :
                    5148  ;       ADDRESS WILL BE FOLLOWED BY A '(E)', IF IN SYSTEM UNIT, :
                    5149  ;       A '(S)' WILL FOLLOW THE ADDRESS                        :
                    5150  ;--------------------------------------------------------------
F85F                5151  NMI_INT PROC    NEAR
                    5152          ASSUME  DS:DATA
F85F 50             5153          PUSH    AX                      ; SAVE ORIG CONTENTS OF AX
F860 E462           5154          IN      AL,PORT_C
F862 A8C0           5155          TEST    AL,0C0H                 ; PARITY CHECK?
F864 7503           5156          JNZ     NMI_1
F866 E98700         5157          JMP     D14                     ; NO, EXIT FROM ROUTINE
F869                5158  NMI_1:
F869 BA4000         5159          MOV     DX,DATA
F86C 8EDA           5160          MOV     DS,DX
F86E BE15F990       5161          MOV     SI,OFFSET D1            ; ADDR OF ERROR MSG
F872 A840           5162          TEST    AL,40H                  ; I/O PARITY CHECK
F874 7504           5163          JNZ     D13                     ; DISPLAY ERROR MSG
F876 BE25F990       5164          MOV     SI,OFFSET D2            ; MUST BE PLANAR
F87A                5165  D13:
F87A B400           5166          MOV     AH,0                    ; INIT AND SET MODE FOR VIDEO
F87C A04900         5167          MOV     AL,CRT_MODE
F87F CD10           5168          INT     10H                     ; CALL VIDEO_IO PROCEDURE
F881 E84601         5169          CALL    P_MSG                   ; PRINT ERROR MSG
                    5170
                    5171  ;----- SEE IF LOCATION THAT CAUSED PARITY CHECK CAN BE FOUND
                    5172
F884 B000           5173          MOV     AL,00H                  ; DISABLE TRAP
F886 E6A0           5174          OUT     0A0H,AL
F888 E461           5175          IN      AL,PORT_B
F88A 0C30           5176          OR      AL,00110000B            ; TOGGLE PARITY CHECK ENABLES
F88C E661           5177          OUT     PORT_B,AL
F88E 24CF           5178          AND     AL,11001111B
F890 E661           5179          OUT     PORT_B,AL
F892 8B1E1300       5180          MOV     BX,MEMORY_SIZE          ; GET MEMORY SIZE WORD
F896 FC             5181          CLD                             ; SET DIR FLAG TO INCRIMENT
F897 2BD2           5182          SUB     DX,DX                   ; POINT DX AT START OF MEM
F899                5183  NMI_LOOP:
F899 8EDA           5184          MOV     DS,DX
F89B 8EC2           5185          MOV     ES,DX
F89D B90040         5186          MOV     CX,4000H                ; SET FOR 16KB SCAN
F8A0 2BF6           5187          SUB     SI,SI                   ; SET SI TO BE REALTIVE TO
                    5188                                          ; START OF ES
F8A2 F3             5189          REP     LODSB                   ; READ 16KB OF MEMORY
F8A3 AC
F8A4 E462           5190          IN      AL,PORT_C               ; SEE IF PARITY CHECK HAPPENED
F8A6 24C0           5191          AND     AL,11000000B
F8A8 7512           5192          JNZ     PRT_NMI                 ; GO PRINT ADDRESS IF IT DID
F8AA 81C20004       5193          ADD     DX,0400H                ; POINT TO NEXT 16K BLOCK
F8AE 83EB10         5194          SUB     BX,16D
F8B1 75E6           5195          JNZ     NMI_LOOP
F8B3 BE35F990       5196          MOV     SI,OFFSET D2A           ; PRINT ROW OF ????? IF PARITY
F8B7 E81001         5197          CALL    P_MSG                   ; CHECK COULD NOT BE RE-CREATED
F8BA FA             5198          CLI
F8BB F4             5199          HLT                             ; HALT SYSTEM
F8BC                5200  PRT_NMI:
F8BC 8CDA           5201          MOV     DX,DS
F8BE E81907         5202          CALL    PRT_SEG                 ; PRINT SEGMENT VALUE
F8C1 BA1302         5203          MOV     DX,0213H
F8C4 B000           5204          MOV     AL,00                   ; DISABLE EXPANSION BOX
F8C6 EE             5205          OUT     DX,AL                   ; (CAN'T WRITE TO MEM)
F8C7 B028           5206          MOV     AL,'('
F8C9 E8D000         5207          CALL    PRT_HEX
F8CC B85AA5         5208          MOV     AX,0A55AH
F8CF 8BC8           5209          MOV     CX,AX
F8D1 2BDB           5210          SUB     BX,BX
F8D3 8907           5211          MOV     [BX],AX                 ; WRITE A WORD TO SEGMENT THAT
F8D5 90             5212          NOP
F8D6 90             5213          NOP
F8D7 8B07           5214          MOV     AX,[BX]                 ; HAD THE ERROR
F8D9 3BC1           5215          CMP     AX,CX                   ; IS IT THERE?
F8DB 7407           5216          JE      SYS_BOX_ERR             ; YES- MUST BE SYS UNIT
F8DD B045           5217          MOV     AL,'E'                  ; NO-MUST BE IN EXP. BOX
F8DF E8BA00         5218          CALL    PRT_HEX
F8E2 EB05           5219          JMP     SHORT HLT_NMI
F8E4                5220  SYS_BOX_ERR:
F8E4 B053           5221          MOV     AL,'S'
F8E6 E8B300         5222          CALL    PRT_HEX
F8E9                5223  HLT_NMI:
F8E9 B029           5224          MOV     AL,')'
F8EB E8AE00         5225          CALL    PRT_HEX
F8EE FA             5226          CLI                             ; HALT SYSTEM
F8EF F4             5227          HLT
F8F0                5228  D14:
F8F0 58             5229          POP     AX                      ; RESTORE ORIG CONTENTS OF AX
F8F1 CF             5230          IRET
                    5231  NMI_INT ENDP
                    5232
                    5233  ;--------------------------------------
                    5234  ;       ROS CHECKSUM SUBROUTINE        :
                    5235  ;--------------------------------------
F8F2                5236  ROS_CHECKSUM    PROC    NEAR            ; NEXT ROS MODULE
F8F2 B90020         5237          MOV     CX,8192                 ; NUMBER OF BYTES TO ADD
F8F5                5238  ROS_CHECKSUM_CNT:                       ; ENTRY FOR OPTIONAL ROS TEST
F8F5 32C0           5239          XOR     AL,AL
F8F7                5240  C26:
F8F7 0207           5241          ADD     AL,DS:[BX]
F8F9 43             5242          INC     BX                      ; POINT TO NEXT BYTE
F8FA E2FB           5243          LOOP    C26                     ; ADD ALL BYTES IN ROS MODULE
F8FC 0AC0           5244          OR      AL,AL                   ; SUM = 0?
F8FE C3             5245          RET
                    5246  ROS_CHECKSUM    ENDP
```

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                      5247  ;--------------------------------------
                      5248  ;       MESSAGE AREA FOR POST          :
                      5249  ;--------------------------------------
F8FF 313031           5250  E0      DB      '101',13,10             ; SYSTEM BOARD ERROR
F902 0D
F903 0A
F904 20323031         5251  E1      DB      ' 201',13,10            ; MEMORY ERROR
F908 0D
F909 0A
F90A 524F4D           5252  F3A     DB      'ROM',13,10             ; ROM CHECKSUM ERROR
F90D 0D
F90E 0A
F90F 31383031         5253  F3C     DB      '1801',13,10            ; EXPANSION IO BOX ERROR
F913 0D
F914 0A
F915 50415249545920   5254  D1      DB      'PARITY CHECK 2',13,10
     434845434B2032
F923 0D
F924 0A
F925 50415249545920   5255  D2      DB      'PARITY CHECK 1',13,10
     434845434B2031
F933 0D
F934 0A
F935 3F3F3F3F3F       5256  D2A     DB      '?????',13,10
F93A 0D
F93B 0A

                      5257
                      5258  ;-------------------------------------------------------------------------
                      5259  ;       BLINK LED PROCEDURE FOR MFG RUN-IN TESTS
                      5260  ;        IF LED IS ON, TURN IT OFF. IF OFF, TURN ON.
                      5261  ;-------------------------------------------------------------------------
                      5262          ASSUME  DS:DATA
F93C                  5263  BLINK_INT       PROC    NEAR
F93C FB               5264          STI
F93D 50               5265          PUSH    AX                      ; SAVE AX REG CONTENTS
F93E E461             5266          IN      AL,PORT_B               ; READ CURRENT VAL OF PORT B
F940 8AE0             5267          MOV     AH,AL
F942 F6D0             5268          NOT     AL                      ; FLIP ALL BITS
F944 2440             5269          AND     AL,01000000B            ; ISOLATE CONTROL BIT
F946 80E4BF           5270          AND     AH,10111111B            ; MASK OUT OF ORIGINAL VAL
F949 0AC4             5271          OR      AL,AH                   ; OR NEW CONTROL BIT IN
F94B E661             5272          OUT     PORT_B,AL
F94D B020             5273          MOV     AL,EOI
F94F E620             5274          OUT     INTA00,AL
F951 58               5275          POP     AX                      ; RESTORE AX REG
F952 CF               5276          IRET
                      5277  BLINK_INT       ENDP
                      5278
                      5279  ;-----------------------------------------------------
                      5280  ; THIS ROUTINE CHECKSUMS OPTIONAL ROM MODULES AND     :
                      5281  ; IF CHECKSUM IS OK, CALLS INIT/TEST CODE IN MODULE   :
                      5282  ;-----------------------------------------------------
F953                  5283  ROM_CHECK       PROC    NEAR
F953 B84000           5284          MOV     AX,DATA                 ; POINT ES TO DATA AREA
F956 8EC0             5285          MOV     ES,AX
F958 2AE4             5286          SUB     AH,AH                   ; ZERO OUT AH
F95A 8A4702           5287          MOV     AL,[BX+2]               ; GET LENGTH INDICATOR
F95D B109             5288          MOV     CL,09H                  ; MULTIPLY BY 512
F95F D3E0             5289          SHL     AX,CL
F961 8BC8             5290          MOV     CX,AX                   ; SET COUNT
F963 51               5291          PUSH    CX                      ; SAVE COUNT
F964 B90400           5292          MOV     CX,4                    ; ADJUST
F967 D3E8             5293          SHR     AX,CL
F969 03D0             5294          ADD     DX,AX                   ; SET POINTER TO NEXT MODULE
F96B 59               5295          POP     CX                      ; RETRIVE COUNT
F96C E886FF           5296          CALL    ROS_CHECKSUM_CNT        ; DO CHECKSUM
F96F 7406             5297          JZ      ROM_CHECK_1
F971 E857ED           5298          CALL    ROM_ERR                 ; POST CHECKSUM ERROR
F974 EB1490           5299          JMP     ROM_CHECK_END           ; AND EXIT
F977                  5300  ROM_CHECK_1:
F977 52               5301          PUSH    DX                      ; SAVE POINTER
F978 26C70667000300   5302          MOV     ES:IO_ROM_INIT,0003H    ; LOAD OFFSET
F97F 268C1E6900       5303          MOV     ES:IO_ROM_SEG,DS        ; LOAD SEGMENT
F984 26FF1E6700       5304          CALL    DWORD PTR ES:IO_ROM_INIT        ; CALL INIT./TEST ROUTINE
F989 5A               5305          POP     DX
F98A                  5306  ROM_CHECK_END:
F98A C3               5307          RET                             ; RETURN TO CALLER
                      5308  ROM_CHECK       ENDP
                      5309
                      5310  ;-------------------------------------------------
                      5311  ; CONVERT AND PRINT ASCII CODE                  :
                      5312  ;       AL MUST CONTAIN NUMBER TO BE CONVERTED. :
                      5313  ;       AX AND BX DESTROYED.                    :
                      5314  ;-------------------------------------------------
F98B                  5315  XPC_BYTE        PROC    NEAR
F98B 50               5316          PUSH    AX                      ; SAVE FOR LOW NIBBLE DISPLAY
F98C B104             5317          MOV     CL,4                    ; SHIFT COUNT
F98E D2E8             5318          SHR     AL,CL                   ; NYBBLE SWAP
F990 E80300           5319          CALL    XLAT_PR                 ; DO THE HIGH NIBBLE DISPLAY
F993 58               5320          POP     AX                      ; RECOVER THE NIBBLE
F994 240F             5321          AND     AL,0FH                  ; ISOLATE TO LOW NIBBLE
                      5322                                          ; FALL INTO LOW NIBBLE CONVERSION
F996                  5323  XLAT_PR PROC    NEAR                    ;  CONVERT 00-0F TO ASCII CHARACTER
F996 0490             5324          ADD     AL,090H                 ; ADD FIRST CONVERSION FACTOR
F998 27               5325          DAA                             ; ADJUST FOR NUMERIC AND ALPHA RANGE
F999 1440             5326          ADC     AL,040H                 ; ADD CONVERSION AND ADJUST LOW NIBBLE
F99B 27               5327          DAA                             ; ADJUST HIGH NIBBLE TO ASCHI RANGE
F99C                  5328  PRT_HEX PROC    NEAR
F99C B40E             5329          MOV     AH,14                   ; DISPLAY CHARACTER IN AL
F99E B700             5330          MOV     BH,0
F9A0 CD10             5331          INT     10H                     ; CALL VIDEO_IO
F9A2 C3               5332          RET
                      5333  PRT_HEX ENDP
                      5334  XLAT_PR ENDP
                      5335  XPC_BYTE        ENDP
                      5336
F9A3                  5337  F4      LABEL   WORD                    ; PRINTER SOURCE TABLE
F9A3 BC03             5338          DW      3BCH
F9A5 7803             5339          DW      378H
F9A7 7802             5340          DW      278H
F9A9                  5341  F4E     LABEL   WORD
                      5342
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                        5343 ;--------------------------------------------------------
                        5344 ; THIS SUBROUTINE WILL PRINT A MESSAGE ON THE DISPLAY   :
                        5345 ;                                                       :
                        5346 ; ENTRY REQUIREMENTS:                                   :
                        5347 ;       SI = OFFSET(ADDRESS) OF MESSAGE BUFFER          :
                        5348 ;       CX = MESSAGE BYTE COUNT                         :
                        5349 ;       MAXIMUM MESSAGE LENGTH IS 36 CHARACTERS         :
                        5350 ;--------------------------------------------------------
F9A9                    5351 E_MSG   PROC    NEAR
F9A9 8BEE               5352         MOV     BP,SI                   ; SET BP NON-ZERO TO FLAG ERR
F9AB E81C00             5353         CALL    P_MSG                   ; PRINT MESSAGE
F9AE 1E                 5354         PUSH    DS
F9AF E8A700             5355         CALL    DDS
F9B2 A01000             5356         MOV     AL,BYTE PTR EQUIP_FLAG  ; LOOP/HALT ON ERROR
F9B5 2401               5357         AND     AL,01H                  ; SWITCH ON?
F9B7 750F               5358         JNZ     G12                     ; NO - RETURN
F9B9                    5359 MFG_HALT:
F9B9 FA                 5360         CLI                             ; YES -  HALT SYSTEM
F9BA B089               5361         MOV     AL,89H
F9BC E663               5362         OUT     CMD_PORT,AL
F9BE B085               5363         MOV     AL,10000101B            ; DISABLE KB
F9C0 E661               5364         OUT     PORT_B,AL
F9C2 A01500             5365         MOV     AL,MFG_ERR_FLAG         ; RECOVER ERROR INDICATOR
F9C5 E660               5366         OUT     PORT_A,AL               ; SET INTO 8255 REG
F9C7 F4                 5367         HLT                             ; HALT SYS
F9C8                    5368 G12:
F9C8 1F                 5369         POP     DS                      ; WRITE_MSG:
F9C9 C3                 5370         RET
                        5371 E_MSG   ENDP
                        5372
F9CA                    5373 P_MSG   PROC    NEAR
F9CA                    5374 G12A:
F9CA 2E8A04             5375         MOV     AL,CS:[SI]              ; PUT CHAR IN AL
F9CD 46                 5376         INC     SI                      ; POINT TO NEXT CHAR
F9CE 50                 5377         PUSH    AX                      ; SAVE PRINT CHAR
F9CF E8CAFF             5378         CALL    PRT_HEX                 ; CALL VIDEO_IO
F9D2 58                 5379         POP     AX                      ; RECOVER PRINT CHAR
F9D3 3C0A               5380         CMP     AL,10                   ; WAS IT LINE FEED?
F9D5 75F3               5381         JNE     G12A                            ; NO,KEEP PRINTING STRING
F9D7 C3                 5382         RET
                        5383 P_MSG   ENDP
                        5384
                        5385 ;--------------------------------------------
                        5386 ;  INITIAL RELIABILITY TEST -- SUBROUTINES     :
                        5387 ;--------------------------------------------
                        5388         ASSUME  CS:CODE,DS:DATA
                        5389 ;--------------------------------------------
                        5390 ;       SUBROUTINES FOR POWER ON DIAGNOSTICS    :
                        5391 ;-------------------------------------------------------------------------
                        5392 ;       THIS PROCEDURE WILL ISSUE ONE LONG TONE (3 SECS) AND ONE OR      :
                        5393 ;       MORE SHORT TONES (1 SEC) TO INDICATE A FAILURE ON THE PLANAR     :
                        5394 ;       BOARD, A BAD RAM MODULE, OR A PROBLEM WITH THE CRT.              :
                        5395 ; ENTRY PARAMETERS:                                                      :
                        5396 ;       DH = NUMBER OF LONG TONES TO BEEP                               :
                        5397 ;       DL = NUMBER OF SHORT TONES TO BEEP.                             :
                        5398 ;-------------------------------------------------------------------------
F9D8                    5399 ERR_BEEP  PROC  NEAR
F9D8 9C                 5400         PUSHF                           ; SAVE FLAGS
F9D9 FA                 5401         CLI                             ; DISABLE SYSTEM INTERRUPTS
F9DA 1E                 5402         PUSH    DS                      ; SAVE DS REG CONTENTS
F9DB E87B00             5403         CALL    DDS
F9DE 0AF6               5404         OR      DH,DH                   ; ANY LONG ONES TO BEEP
F9E0 7414               5405         JZ      G3                      ; NO, DO THE SHORT ONES
F9E2                    5406 G1:                                     ; LONG_BEEP:
F9E2 B306               5407         MOV     BL,6                    ; COUNTER FOR BEEPS
F9E4 E82100             5408         CALL    BEEP                    ; DO THE BEEP
F9E7                    5409 G2:
F9E7 E2FE               5410         LOOP    G2                      ; DELAY BETWEEN BEEPS
F9E9 FECE               5411         DEC     DH                      ; ANY MORE TO DO
F9EB 75F5               5412         JNZ     G1                      ; DO IT
F9ED 803E120001         5413         CMP     MFG_TST,1               ; MFG TEST MODE?
F9F2 7502               5414         JNE     G3                      ; YES - CONTINUE BEEPING SPEAKER
F9F4 EBC3               5415         JMP     MFG_HALT                ; STOP BLINKING LED
F9F6                    5416 G3:                                     ; SHORT_BEEP:
F9F6 B301               5417         MOV     BL,1                    ; COUNTER FOR A SHORT BEEP
F9F8 E80D00             5418         CALL    BEEP                    ; DO THE SOUND
F9FB                    5419 G4:
F9FB E2FE               5420         LOOP    G4                      ; DELAY BETWEEN BEEPS
F9FD FECA               5421         DEC     DL                      ; DONE WITH SHORTS
F9FF 75F5               5422         JNZ     G3                      ; DO SOME MORE
FA01                    5423 G5:
FA01 E2FE               5424         LOOP    G5                      ; LONG DELAY BEFORE RETURN
FA03                    5425 G6:
FA03 E2FE               5426         LOOP    G6
FA05 1F                 5427         POP     DS                      ; RESTORE ORIG CONTENTS OF DS
FA06 9D                 5428         POPF                            ; RESTORE FLAGS TO ORIG SETTINGS
FA07 C3                 5429         RET                             ; RETURN TO CALLER
                        5430 ERR_BEEP  ENDP
                        5431
                        5432 ;----- ROUTINE TO SOUND BEEPER
                        5433
FA08                    5434 BEEP    PROC    NEAR
FA08 B0B6               5435         MOV     AL,10110110B            ; SEL TIM 2,LSB,MSB,BINARY
FA0A E643               5436         OUT     TIMER+3,AL              ; WRITE THE TIMER MODE REG
FA0C B85305             5437         MOV     AX,533H                 ; DIVISOR FOR 1000 HZ
FA0F E642               5438         OUT     TIMER+2,AL              ; WRITE TIMER 2 CNT - LSB
FA11 8AC4               5439         MOV     AL,AH
FA13 E642               5440         OUT     TIMER+2,AL              ; WRITE TIMER 2 CNT - MSB
FA15 E461               5441         IN      AL,PORT_B               ; GET CURRENT SETTING OF PORT
FA17 8AE0               5442         MOV     AH,AL                   ; SAVE THAT SETTINGH
FA19 0C03               5443         OR      AL,03                   ; TURN SPEAKER ON
FA1B E661               5444         OUT     PORT_B,AL
FA1D 2BC9               5445         SUB     CX,CX                   ; SET CNT TO WAIT 500 MS
FA1F                    5446 G7:
FA1F E2FE               5447         LOOP    G7                      ; DELAY BEFORE TURNING OFF
FA21 FECB               5448         DEC     BL                      ; DELAY CNT EXPIRED?
FA23 75FA               5449         JNZ     G7                      ; NO - CONTINUE BEEPING SPK
FA25 8AC4               5450         MOV     AL,AH                   ; RECOVER VALUE OF PORT
FA27 E661               5451         OUT     PORT_B,AL
FA29 C3                 5452         RET                             ; RETURN TO CALLER
                        5453 BEEP    ENDP
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                    5454
                    5455  ;--------------------------------------------------------------------------------
                    5456  ;       THIS PROCEDURE WILL SEND A SOFTWARE RESET TO THE KEYBOARD.              :
                    5457  ;       SCAN CODE 'AA' SHOULD BE RETURNED TO THE CPU.                          :
                    5458  ;--------------------------------------------------------------------------------
FA2A                5459  KBD_RESET       PROC    NEAR
                    5460                  ASSUME  DS:ABS0
FA2A B008           5461                  MOV     AL,08H                  ; SET KBD CLK LINE LOW
FA2C E661           5462                  OUT     PORT_B,AL               ; WRITE 8255 PORT B
FA2E B95629         5463                  MOV     CX,10582                ; HOLD KBD CLK LOW FOR 20 MS
FA31                5464  G8:
FA31 E2FE           5465                  LOOP    G8                      ; LOOP FOR 20 MS
FA33 B0C8           5466                  MOV     AL,0C8H                 ; SET CLK, ENABLE LINES HIGH
FA35 E661           5467                  OUT     PORT_B,AL
FA37                5468  SP_TEST:                                      ; ENTRY FOR MANUFACTURING TEST 2
FA37 B048           5469                  MOV     AL,48H                  ; SET KBD CLK HIGH, ENABLE LOW
FA39 E661           5470                  OUT     PORT_B,AL
FA3B B0FD           5471                  MOV     AL,0FDH                 ; ENABLE KEYBOARD INTERRUPTS
FA3D E621           5472                  OUT     INTA01,AL               ; WRITE 8259 IMR
FA3F C6066B0400     5473                  MOV     DATA_AREA[OFFSET INTR_FLAG],0 ; RESET INTERRUPT INDICATOR
FA44 FB             5474                  STI                             ; ENABLE INTERRUPTS
FA45 2BC9           5475                  SUB     CX,CX                   ; SETUP INTERRUPT TIMEOUT CNT
FA47                5476  G9:
FA47 F6066B0402     5477                  TEST    DATA_AREA[OFFSET INT R_FLAG],02H ; DID A KEYBOARD INTR OCCUR?
FA4C 7502           5478                  JNZ     G10                     ; YES - READ SCAN CODE RETURNED
FA4E E2F7           5479                  LOOP    G9                      ; NO - LOOP TILL TIMEOUT
FA50                5480  G10:
FA50 E460           5481                  IN      AL,PORT_A               ; READ KEYBOARD SCAN CODE
FA52 8AD8           5482                  MOV     BL,AL                   ; SAVE SCAN CODE JUST READ
FA54 B0C8           5483                  MOV     AL,0C8H                 ; CLEAR KEYBOARD
FA56 E661           5484                  OUT     PORT_B,AL
FA58 C3             5485                  RET                             ; RETURN TO CALLER
                    5486  KBD_RESET       ENDP
                    5487
FA59                5488  DDS     PROC    NEAR
FA59 50             5489                  PUSH    AX                      ; SAVE AX
FA5A B84000         5490                  MOV     AX,DATA
FA5D 8ED8           5491                  MOV     DS,AX                   ; SET SEGMENT
FA5F 58             5492                  POP     AX                      ; RESTORE AX
FA60 C3             5493                  RET
                    5494  DDS     ENDP
                    5495
                    5496  ;--------------------------------------------------------------------------------
                    5497  ;       CHARACTER GENERATOR GRAPHICS FOR 320X200 AND 640X200 GRAPHICS          :
                    5498  ;--------------------------------------------------------------------------------
FA6E                5499                  ORG     0FA6EH
FA6E                5500  CRT_CHAR_GEN    LABEL   BYTE
FA6E 0000000000000000 5501                  DB      000H,000H,000H,000H,000H,000H,000H,000H ; D_00
FA76 7E81A581BD9981 7E 5502                 DB      07EH,081H,0A5H,081H,0BDH,099H,081H,07EH ; D_01
FA7E 7EFFDBFFC3E7FF7E 5503                  DB      07EH,0FFH,0DBH,0FFH,0C3H,0E7H,0FFH,07EH ; D_02
FA86 6CFEFEFE7C381000 5504                  DB      06CH,0FEH,0FEH,0FEH,07CH,038H,010H,000H ; D_03
FA8E 10387CFE7C381000 5505                  DB      010H,038H,07CH,0FEH,07CH,038H,010H,000H ; D_04
FA96 387C38FEFE7C387C 5506                  DB      038H,07CH,038H,0FEH,0FEH,07CH,038H,07CH ; D_05
FA9E 1010387CFE7C387C 5507                  DB      010H,010H,038H,07CH,0FEH,07CH,038H,07CH ; D_06
FAA6 0000183C3C180000 5508                  DB      000H,000H,018H,03CH,03CH,018H,000H,000H ; D_07
FAAE FFFFE7C3C3E7FFFF 5509                  DB      0FFH,0FFH,0E7H,0C3H,0C3H,0E7H,0FFH,0FFH ; D_08
FAB6 003C66424263C00 5510                   DB      000H,03CH,066H,042H,042H,066H,03CH,000H ; D_09
FABE FFC399BDBD99C3FF 5511                  DB      0FFH,0C3H,099H,0BDH,0BDH,099H,0C3H,0FFH ; D_0A
FAC6 0F070F7DCCCCCC78 5512                  DB      00FH,007H,00FH,07DH,0CCH,0CCH,0CCH,078H ; D_0B
FACE 3C6666663C187E18 5513                  DB      03CH,066H,066H,066H,03CH,018H,07EH,018H ; D_0C
FAD6 3F333F303070F0E0 5514                  DB      03FH,033H,03FH,030H,030H,070H,0F0H,0E0H ; D_0D
FADE 7F637F6363676E6C0 5515                 DB      07FH,063H,07FH,063H,063H,067H,0E6H,0C0H ; D_0E
FAE6 995A3CE7E73C5A99 5516                  DB      099H,05AH,03CH,0E7H,0E7H,03CH,05AH,099H ; D_0F
FAEE 80E0F8FEF8E08000 5517                  DB      080H,0E0H,0F8H,0FEH,0F8H,0E0H,080H,000H ; D_10
FAF6 020E3EFE3E0E0200 5518                  DB      002H,00EH,03EH,0FEH,03EH,00EH,002H,000H ; D_11
FAFE 183C7E18187E3C18 5519                  DB      018H,03CH,07EH,018H,018H,07EH,03CH,018H ; D_12
FB06 6666666666006600 5520                  DB      066H,066H,066H,066H,066H,000H,066H,000H ; D_13
FB0E 7FDBDB7B1B1B1B00 5521                  DB      07FH,0DBH,0DBH,07BH,01BH,01BH,01BH,000H ; D_14
FB16 3E63386C6C38CC78 5522                  DB      03EH,063H,038H,06CH,06CH,038H,0CCH,078H ; D_15
FB1E 000000007E7E7E00 5523                  DB      000H,000H,000H,000H,07EH,07EH,07EH,000H ; D_16
FB26 183C7E187E3C18FF 5524                  DB      018H,03CH,07EH,018H,07EH,03CH,018H,0FFH ; D_17
FB2E 183C7E1818181800 5525                  DB      018H,03CH,07EH,018H,018H,018H,018H,000H ; D_18
FB36 181818187E3C1800 5526                  DB      018H,018H,018H,018H,07EH,03CH,018H,000H ; D_19
FB3E 00180CFE0C180000 5527                  DB      000H,018H,00CH,0FEH,00CH,018H,000H,000H ; D_1A
FB46 003060FE60300000 5528                  DB      000H,030H,060H,0FEH,060H,030H,000H,000H ; D_1B
FB4E 0000C0C0C0FE0000 5529                  DB      000H,000H,0C0H,0C0H,0C0H,0FEH,000H,000H ; D_1C
FB56 002466FF66240000 5530                  DB      000H,024H,066H,0FFH,066H,024H,000H,000H ; D_1D
FB5E 00183C7EFFFF0000 5531                  DB      000H,018H,03CH,07EH,0FFH,0FFH,000H,000H ; D_1E
FB66 00FFFF7E3C180000 5532                  DB      000H,0FFH,0FFH,07EH,03CH,018H,000H,000H ; D_1F
FB6E 0000000000000000 5533                  DB      000H,000H,000H,000H,000H,000H,000H,000H ; SP D_20
FB76 3078783030003000 5534                  DB      030H,078H,078H,030H,030H,000H,030H,000H ; ! D_21
FB7E 6C6C6C0000000000 5535                  DB      06CH,06CH,06CH,000H,000H,000H,000H,000H ; " D_22
FB86 6C6CFE6CFE6C6C00 5536                  DB      06CH,06CH,0FEH,06CH,0FEH,06CH,06CH,000H ; # D_23
FB8E 307CC0780CF83000 5537                  DB      030H,07CH,0C0H,078H,00CH,0F8H,030H,000H ; $ D_24
FB96 00C6CC183066C600 5538                  DB      000H,0C6H,0CCH,018H,030H,066H,0C6H,000H ; PER CENT D_25
FB9E 386C3876DCCC7600 5539                  DB      038H,06CH,038H,076H,0DCH,0CCH,076H,000H ; & D_26
FBA6 6060C000000000 5540                    DB      060H,060H,0C0H,000H,000H,000H,000H,000H ; ' D_27
FBAE 1830606060301800 5541                  DB      018H,030H,060H,060H,060H,030H,018H,000H ; ( D_28
FBB6 6030181818306000 5542                  DB      060H,030H,018H,018H,018H,030H,060H,000H ; ) D_29
FBBE 00663CFF3C660000 5543                  DB      000H,066H,03CH,0FFH,03CH,066H,000H,000H ; * D_2A
FBC6 003030FC30300000 5544                  DB      000H,030H,030H,0FCH,030H,030H,000H,000H ; + D_2B
FBCE 0000000003030360 5545                  DB      000H,000H,000H,000H,000H,030H,030H,060H ; , D_2C
FBD6 000000FC00000000 5546                  DB      000H,000H,000H,0FCH,000H,000H,000H,000H ; - D_2D
FBDE 0000000003030000 5547                  DB      000H,000H,000H,000H,000H,030H,030H,000H ; . D_2E
FBE6 060C183060C08000 5548                  DB      006H,00CH,018H,030H,060H,0C0H,080H,000H ; / D_2F
FBEE 7CC6CEDEF6E67C00 5549                  DB      07CH,0C6H,0CEH,0DEH,0F6H,0E6H,07CH,000H ; 0 D_30
FBF6 3070303030303FC00 5550                 DB      030H,070H,030H,030H,030H,030H,0FCH,000H ; 1 D_31
FBFE 78CC0C3860CCFC00 5551                  DB      078H,0CCH,00CH,038H,060H,0CCH,0FCH,000H ; 2 D_32
FC06 78CC0C380CCC7800 5552                  DB      078H,0CCH,00CH,038H,00CH,0CCH,078H,000H ; 3 D_33
FC0E 1C3C6CCCFE0C1E00 5553                  DB      01CH,03CH,06CH,0CCH,0FEH,00CH,01EH,000H ; 4 D_34
FC16 FCC0F80C0CCC7800 5554                  DB      0FCH,0C0H,0F8H,00CH,00CH,0CCH,078H,000H ; 5 D_35
FC1E 3860C0F8CCCC7800 5555                  DB      038H,060H,0C0H,0F8H,0CCH,0CCH,078H,000H ; 6 D_36
FC26 FCCC0C1830303000 5556                  DB      0FCH,0CCH,00CH,018H,030H,030H,030H,000H ; 7 D_37
FC2E 78CCCC78CCCC7800 5557                  DB      078H,0CCH,0CCH,078H,0CCH,0CCH,078H,000H ; 8 D_38
FC36 78CCCC7C0C187000 5558                  DB      078H,0CCH,0CCH,07CH,00CH,018H,070H,000H ; 9 D_39
FC3E 0030300000303000 5559                  DB      000H,030H,030H,000H,000H,030H,030H,000H ; : D_3A
FC46 0030300000303060 5560                  DB      000H,030H,030H,000H,000H,030H,030H,060H ; ; D_3B
FC4E 183060C060301800 5561                  DB      018H,030H,060H,0C0H,060H,030H,018H,000H ; < D_3C
FC56 0000FC0000FC0000 5562                  DB      000H,000H,0FCH,000H,000H,0FCH,000H,000H ; = D_3D
FC5E 6030180C18306000 5563                  DB      060H,030H,018H,00CH,018H,030H,060H,000H ; > D_3E
FC66 78CC0C1830003000 5564                  DB      078H,0CCH,00CH,018H,030H,000H,030H,000H ; ? D_3F
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 LOC OBJECT          LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

FC6E 7CC6DEDEDEC07800  5565          DB      07CH,0C6H,0DEH,0DEH,0DEH,0C0H,078H,000H ; @ D_40
FC76 3078CCCCFCCCCC00  5566          DB      030H,078H,0CCH,0CCH,0FCH,0CCH,0CCH,000H ; A D_41
FC7E FC6666766666FC00  5567          DB      0FCH,066H,066H,07CH,066H,066H,0FCH,000H ; B D_42
FC86 3C66C0C0C0663C00  5568          DB      03CH,066H,0C0H,0C0H,0C0H,066H,03CH,000H ; C D_43
FC8E F86C6666666CF800  5569          DB      0F8H,06CH,066H,066H,066H,06CH,0F8H,000H ; D D_44
FC96 FE6268786862FE00  5570          DB      0FEH,062H,068H,078H,068H,062H,0FEH,000H ; E D_45
FC9E FE6268786860F000  5571          DB      0FEH,062H,068H,078H,068H,060H,0F0H,000H ; F D_46
FCA6 3C66C0C0CE663E00  5572          DB      03CH,066H,0C0H,0C0H,0CEH,066H,03EH,000H ; G D_47
FCAE CCCCCCFCCCCCCC00  5573          DB      0CCH,0CCH,0CCH,0FCH,0CCH,0CCH,0CCH,000H ; H D_48
FCB6 7830303030307800  5574          DB      078H,030H,030H,030H,030H,030H,078H,000H ; I D_49
FCBE 1E0C0C0CCCCC7800  5575          DB      01EH,00CH,00CH,00CH,0CCH,0CCH,078H,000H ; J D_4A
FCC6 E6666C786C66E600  5576          DB      0E6H,066H,06CH,078H,06CH,066H,0E6H,000H ; K D_4B
FCCE F06060606266FE00  5577          DB      0F0H,060H,060H,060H,062H,066H,0FEH,000H ; L D_4C
FCD6 C6EEFEFED6C6C600  5578          DB      0C6H,0EEH,0FEH,0FEH,0D6H,0C6H,0C6H,000H ; M D_4D
FCDE C6E6F6DECEC6C600  5579          DB      0C6H,0E6H,0F6H,0DEH,0CEH,0C6H,0C6H,000H ; N D_4E
FCE6 386CC6C6C66C3800  5580          DB      038H,06CH,0C6H,0C6H,0C6H,06CH,038H,000H ; O D_4F
FCEE FC66667C6060F000  5581          DB      0FCH,066H,066H,07CH,060H,060H,0F0H,000H ; P D_50
FCF6 78CCCCCCDC781C00  5582          DB      078H,0CCH,0CCH,0CCH,0DCH,078H,01CH,000H ; Q D_51
FCFE FC66667C6C66E600  5583          DB      0FCH,066H,066H,07CH,06CH,066H,0E6H,000H ; R D_52
FD06 78CCE0701CCC7800  5584          DB      078H,0CCH,0E0H,070H,01CH,0CCH,078H,000H ; S D_53
FD0E FCB4303030307800  5585          DB      0FCH,0B4H,030H,030H,030H,030H,078H,000H ; T D_54
FD16 CCCCCCCCCCCCFC00  5586          DB      0CCH,0CCH,0CCH,0CCH,0CCH,0CCH,0FCH,000H ; U D_55
FD1E CCCCCCCCCC783000  5587          DB      0CCH,0CCH,0CCH,0CCH,0CCH,078H,030H,000H ; V D_56
FD26 C6C6C6D6FEEEC600  5588          DB      0C6H,0C6H,0C6H,0D6H,0FEH,0EEH,0C6H,000H ; W D_57
FD2E C6C66C38386CC600  5589          DB      0C6H,0C6H,06CH,038H,038H,06CH,0C6H,000H ; X D_58
FD36 CCCCCC7830307800  5590          DB      0CCH,0CCH,0CCH,078H,030H,030H,078H,000H ; Y D_59
FD3E FEC68C183266FE00  5591          DB      0FEH,0C6H,08CH,018H,032H,066H,0FEH,000H ; Z D_5A
FD46 7860606060607800  5592          DB      078H,060H,060H,060H,060H,060H,078H,000H ; [ D_5B
FD4E C06030180C060200  5593          DB      0C0H,060H,030H,018H,00CH,006H,002H,000H ; BACKSLASH D_5C
FD56 7818181818187800  5594          DB      078H,018H,018H,018H,018H,018H,078H,000H ; ] D_5D
FD5E 10386CC600000000  5595          DB      010H,038H,06CH,0C6H,000H,000H,000H,000H ; CIRCUMFLEX D_5E
FD66 00000000000000FF  5596          DB      000H,000H,000H,000H,000H,000H,000H,0FFH ; _ D_5F
FD6E 3030180000000000  5597          DB      030H,030H,018H,000H,000H,000H,000H,000H ; ` D_60
FD76 0000780C7CCC7600  5598          DB      000H,000H,078H,00CH,07CH,0CCH,076H,000H ; LOWER CASE A D_61
FD7E E06060785666DC00  5599          DB      0E0H,060H,060H,07CH,066H,066H,0DCH,000H ; L.C. B D_62
FD86 000078CCC0CC7800  5600          DB      000H,000H,078H,0CCH,0C0H,0CCH,078H,000H ; L.C. C D_63
FD8E 1C0C0C7CCCCC7600  5601          DB      01CH,00CH,00CH,07CH,0CCH,0CCH,076H,000H ; L.C. D D_64
FD96 000078CCFCC07800  5602          DB      000H,000H,078H,0CCH,0FCH,0C0H,078H,000H ; L.C. E D_65
FD9E 386C60F0606F0000  5603          DB      038H,06CH,060H,0F0H,060H,060H,0F0H,000H ; L.C. F D_66
FDA6 000076CCCC7C0CF8  5604          DB      000H,000H,076H,0CCH,0CCH,07CH,00CH,0F8H ; L.C. G D_67
FDAE E06066766666E600  5605          DB      0E0H,060H,06CH,076H,066H,066H,0E6H,000H ; L.C. H D_68
FDB6 3000703030307800  5606          DB      030H,000H,070H,030H,030H,030H,078H,000H ; L.C. I D_69
FDBE 0C000C0C0CCCCC78  5607          DB      00CH,000H,00CH,00CH,00CH,0CCH,0CCH,078H ; L.C. J D_6A
FDC6 E060666C786CE600  5608          DB      0E0H,060H,066H,06CH,078H,06CH,0E6H,000H ; L.C. K D_6B
FDCE 7030303030307800  5609          DB      070H,030H,030H,030H,030H,030H,078H,000H ; L.C. L D_6C
FDD6 0000CCFEFED6C600  5610          DB      000H,000H,0CCH,0FEH,0FEH,0D6H,0C6H,000H ; L.C. M D_6D
FDDE 0000F8CCCCCCCC00  5611          DB      000H,000H,0F8H,0CCH,0CCH,0CCH,0CCH,000H ; L.C. N D_6E
FDE6 000078CCCCCC7800  5612          DB      000H,000H,078H,0CCH,0CCH,0CCH,078H,000H ; L.C. O D_6F
FDEE 0000DC66667C60F0  5613          DB      000H,000H,0DCH,066H,066H,07CH,060H,0F0H ; L.C. P D_70
FDF6 000076CCCC7C0C1E  5614          DB      000H,000H,076H,0CCH,0CCH,07CH,00CH,01EH ; L.C. Q D_71
FDFE 0000DC766660F000  5615          DB      000H,000H,0DCH,076H,066H,060H,0F0H,000H ; L.C. R D_72
FE06 00007CC0780CF800  5616          DB      000H,000H,07CH,0C0H,078H,00CH,0F8H,000H ; L.C. S D_73
FE0E 10307C3030341800  5617          DB      010H,030H,07CH,030H,030H,034H,018H,000H ; L.C. T D_74
FE16 0000CCCCCCCC7600  5618          DB      000H,000H,0CCH,0CCH,0CCH,0CCH,076H,000H ; L.C. U D_75
FE1E 0000CCCCCCC783000  5619          DB      000H,000H,0CCH,0CCH,0CCH,078H,030H,000H ; L.C. V D_76
FE26 0000C6D6FEFE6C00  5620          DB      000H,000H,0C6H,0D6H,0FEH,0FEH,06CH,000H ; L.C. W D_77
FE2E 0000C66C386CC600  5621          DB      000H,000H,0C6H,06CH,038H,06CH,0C6H,000H ; L.C. X D_78
FE36 0000CCCCCC7C0CF8  5622          DB      000H,000H,0CCH,0CCH,0CCH,07CH,00CH,0F8H ; L.C. Y D_79
FE3E 0000FC983064FC00  5623          DB      000H,000H,0FCH,098H,030H,064H,0FCH,000H ; L.C. Z D_7A
FE46 1C3030E030301C00  5624          DB      01CH,030H,030H,0E0H,030H,030H,01CH,000H ; { D_7B
FE4E 1818180018181800  5625          DB      018H,018H,018H,000H,018H,018H,018H,000H ; | D_7C
FE56 E030301C3030E000  5626          DB      0E0H,030H,030H,01CH,030H,030H,0E0H,000H ; } D_7D
FE5E 76DC000000000000  5627          DB      076H,0DCH,000H,000H,000H,000H,000H,000H ; TILDE D_7E
FE66 0010386CC6C6FE00  5628          DB      000H,010H,038H,06CH,0C6H,0C6H,0FEH,000H ; DELTA D_7F
                       5629
                       5630  ;--- INT 1A ----------------------------------------------
                       5631  ; TIME_OF_DAY                                            :
                       5632  ;  THIS ROUTINE ALLOWS THE CLOCK TO BE SET/READ         :
                       5633  ;                                                        :
                       5634  ; INPUT                                                 :
                       5635  ;   (AH) = 0    READ THE CURRENT CLOCK SETTING          :
                       5636  ;               RETURNS CX = HIGH PORTION OF COUNT       :
                       5637  ;                        DX = LOW PORTION OF COUNT       :
                       5638  ;                        AL = 0 IF TIMER HAS NOT PASSED  :
                       5639  ;                             24 HOURS SINCE LAST READ   :
                       5640  ;                             <>0 IF ON ANOTHER DAY      :
                       5641  ;   (AH) = 1    SET THE CURRENT CLOCK                    :
                       5642  ;       CX = HIGH PORTION OF COUNT                       :
                       5643  ;       DX = LOW PORTION OF COUNT                        :
                       5644  ; NOTE: COUNTS OCCUR AT THE RATE OF                     :
                       5645  ;        1193180/65536 COUNTS/SEC                        :
                       5646  ;     . (OR ABOUT 18.2 PER SECOND -- SEE EQUATES BELOW) :
                       5647  ;-----------------------------------------------------
                       5648          ASSUME  CS:CODE,DS:DATA
FE6E                   5649          ORG     0FE6EH
FE6E                   5650  TIME_OF_DAY     PROC    FAR
FE6E FB                5651          STI                             ; INTERRUPTS BACK ON
FE6F 1E                5652          PUSH    DS                      ; SAVE SEGMENT
FE70 E8E6FB            5653          CALL    DDS
FE73 0AE4              5654          OR      AH,AH                   ; AH=0
FE75 7407              5655          JZ      T2                      ; READ_TIME
FE77 FECC              5656          DEC     AH                      ; AH=1
FE79 7416              5657          JZ      T3                      ; SET_TIME
FE7B                   5658  T1:                                     ; TOD_RETURN
FE7B FB                5659          STI                             ; INTERRUPTS BACK ON
FE7C 1F                5660          POP     DS                      ; RECOVER SEGMENT
FE7D CF                5661          IRET                            ; RETURN TO CALLER
FE7E                   5662  T2:                                     ; READ_TIME
FE7E FA                5663          CLI                             ; NO TIMER INTERRUPTS WHILE READING
FE7F A07000            5664          MOV     AL,TIMER_OFL
FE82 C6067000000       5665          MOV     TIMER_OFL,0             ; GET OVERFLOW, AND RESET THE FLAG
FE87 8B0E6E00          5666          MOV     CX,TIMER_HIGH
FE8B 8B166C00          5667          MOV     DX,TIMER_LOW
FE8F EBEA              5668          JMP     T1
FE91                   5669  T3:                                     ; TOD_RETURN
FE91 FA                5670          CLI                             ; SET_TIME
FE92 89166C00          5671          MOV     TIMER_LOW,DX            ; NO INTERRUPTS WHILE WRITING
FE96 890E6E00          5672          MOV     TIMER_HIGH,CX           ; SET THE TIME
FE9A C606700000        5673          MOV     TIMER_OFL,0             ; RESET OVERFLOW
FE9F EBDA              5674          JMP     T1                      ; TOD_RETURN
                       5675  TIME_OF_DAY     ENDP
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LOC OBJECT          LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

                    5676
                    5677  ;--------------------------------------------------------
                    5678  ; THIS ROUTINE HANDLES THE TIMER INTERRUPT FROM         :
                    5679  ;  CHANNEL 0 OF THE 8253 TIMER.  INPUT FREQUENCY       :
                    5680  ;  IS 1.19318 MHZ AND THE DIVISOR IS 65536, RESULTING   :
                    5681  ;  IN APPROX. 18.2 INTERRUPTS EVERY SECOND.            :
                    5682  ;                                                       :
                    5683  ; THE INTERRUPT HANDLER MAINTAINS A COUNT OF INTERRUPTS :
                    5684  ;  SINCE POWER ON TIME, WHICH MAY BE USED TO ESTABLISH  :
                    5685  ;  TIME OF DAY.                                         :
                    5686  ; THE INTERRUPT HANDLER ALSO DECREMENTS THE MOTOR       :
                    5687  ;  CONTROL COUNT OF THE DISKETTE, AND WHEN IT EXPIRES,  :
                    5688  ;  WILL TURN OFF THE DISKETTE MOTOR, AND RESET THE      :
                    5689  ;  MOTOR RUNNING FLAGS.                                :
                    5690  ; THE INTERRUPT HANDLER WILL ALSO INVOKE A USER ROUTINE :
                    5691  ;  THROUGH INTERRUPT ICH AT EVERY TIME TICK.  THE USER  :
                    5692  ;  MUST CODE A ROUTINE AND PLACE THE CORRECT ADDRESS IN :
                    5693  ;  THE VECTOR TABLE.                                    :
                    5694  ;--------------------------------------------------------
FEA5                5695          ORG     0FEA5H
FEA5                5696  TIMER_INT       PROC    FAR
FEA5 FB             5697          STI                             ; INTERRUPTS BACK ON
FEA6 1E             5698          PUSH    DS
FEA7 50             5699          PUSH    AX
FEA8 52             5700          PUSH    DX                      ; SAVE MACHINE STATE
FEA9 E8ADFB         5701          CALL    DDS
FEAC FF066C00       5702          INC     TIMER_LOW               ; INCREMENT TIME
FEB0 7504           5703          JNZ     T4                      ; TEST_DAY
FEB2 FF066E00       5704          INC     TIMER_HIGH              ; INCREMENT HIGH WORD OF TIME
FEB6                5705  T4:                                     ; TEST_DAY
FEB6 833E6E0018     5706          CMP     TIMER_HIGH,018H         ; TEST FOR COUNT EQUALING 24 HOURS
FEBB 7515           5707          JNZ     T5                      ; DISKETTE_CTL
FEBD 813E6C00B000   5708          CMP     TIMER_LOW,0B0H
FEC3 750D           5709          JNZ     T5                      ; DISKETTE_CTL
                    5710
                    5711  ;------ TIMER HAS GONE 24 HOURS
                    5712
FEC5 2BC0           5713          SUB     AX,AX
FEC7 A36E00         5714          MOV     TIMER_HIGH,AX
FECA A36C00         5715          MOV     TIMER_LOW,AX
FECD C606700001     5716          MOV     TIMER_OFL,1
                    5717
                    5718  ;------ TEST FOR DISKETTE TIME OUT
                    5719
FED2                5720  T5:                                     ; DISKETTE_CTL
FED2 FE0E4000       5721          DEC     MOTOR_COUNT
FED6 750B           5722          JNZ     T6                      ; RETURN IF COUNT NOT OUT
FED8 80263F00F0     5723          AND     MOTOR_STATUS,0F0H       ; TURN OFF MOTOR RUNNING BITS
FEDD B00C           5724          MOV     AL,0CH
FEDF BAF203         5725          MOV     DX,03F2H                ; FDC CTL PORT
FEE2 EE             5726          OUT     DX,AL                   ; TURN OFF THE MOTOR
FEE3                5727  T6:                                     ; TIMER_RET:
FEE3 CD1C           5728          INT     1CH                     ; TRANSFER CONTROL TO A USER ROUTINE
FEE5 B020           5729          MOV     AL,EOI
FEE7 E620           5730          OUT     020H,AL                 ; END OF INTERRUPT TO 8259
FEE9 5A             5731          POP     DX
FEEA 58             5732          POP     AX
FEEB 1F             5733          POP     DS                      ; RESET MACHINE STATE
FEEC CF             5734          IRET                            ; RETURN FROM INTERRUPT
                    5735  TIMER_INT       ENDP
                    5736
```

```
LOC OBJECT          LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

                    5737  ;--------------------------------------------------
                    5738  ; THESE ARE THE VECTORS WHICH ARE MOVED INTO     :
                    5739  ; THE 8086 INTERRUPT AREA DURING POWER ON.       :
                    5740  ; ONLY THE OFFSETS ARE DISPLAYED HERE, CODE      :
                    5741  ; SEGMENT WILL BE ADDED FOR ALL OF THEM, EXCEPT  :
                    5742  ; WHERE NOTED.                                   :
                    5743  ;--------------------------------------------------
                    5744          ASSUME  CS:CODE
FEF3                5745          ORG     0FEF3H
FEF3                5746  VECTOR_TABLE    LABEL   WORD             ; VECTOR TABLE FOR MOVE TO INTERRUPTS
FEF3 A5FE           5747          DW      OFFSET TIMER_INT        ; INTERRUPT 8
FEF5 87E9           5748          DW      OFFSET  KB_INT          ; INTERRUPT 9
FEF7 23FF           5749          DW      OFFSET  DIT             ; INTERRUPT A
FEF9 23FF           5750          DW      OFFSET  DI1             ; INTERRUPT B
FEFB 23FF           5751          DW      OFFSET  DI1             ; INTERRUPT C
FEFD 23FF           5752          DW      OFFSET  DI1             ; INTERRUPT D
FEFF 57EF           5753          DW      OFFSET DISK_INT         ; INTERRUPT E
FF01 23FF           5754          DW      OFFSET  DI1             ; INTERRUPT F
FF03 65F0           5755          DW      OFFSET VIDEO_IO         ; INTERRUPT 10H
FF05 4DF8           5756          DW      OFFSET EQUIPMENT        ; INTERRUPT 11H
FF07 41F8           5757          DW      OFFSET MEMORY_SIZE_DET  ; INTERRUPT 12H
FF09 59EC           5758          DW      OFFSET DISKETTE_IO      ; INTERRUPT 13H
FF0B 39E7           5759          DW      OFFSET RS232_IO         ; INTERRUPT 14H
FF0D 59F8           5760          DW      CASSETTE_IO             ; INTERRUPT 15H(FORMER CASSETTE IO)
FF0F 2EE8           5761          DW      OFFSET KEYBOARD_IO      ; INTERRUPT 16H
FF11 D2EF           5762          DW      OFFSET PRINTER_IO       ; INTERRUPT 17H
                    5763
FF13 0000           5764          DW      00000H                  ; INTERRUPT 18H
                    5765  ;       DW      0F600H                  ;  MUST BE INSERTED INTO TABLE LATER
                    5766
FF15 F2E6           5767          DW      OFFSET BOOT_STRAP       ; INTERRUPT 19H
FF17 6EFE           5768          DW      TIME_OF_DAY             ; INTERRUPT 1AH -- TIME OF DAY
FF19 48FF           5769          DW      DUMMY_RETURN            ; INTERRUPT 1BH -- KEYBOARD BREAK ADDR
FF1B 4BFF           5770          DW      DUMMY_RETURN            ; INTERRUPT 1C -- TIMER BREAK ADDR
FF1D A4F0           5771          DW      VIDEO_PARMS             ; INTERRUPT 1D -- VIDEO PARAMETERS
FF1F C7EF           5772          DW      OFFSET DISK_BASE        ; INTERRUPT 1E -- DISK PARMS
FF21 0000           5773          DW      0                       ; INTERRUPT 1F -- POINTER TO VIDEO EXT
                    5774
                    5775  ;--------------------------------------------------------
                    5776  ; TEMPORARY INTERRUPT SERVICE ROUTINE                   :
                    5777  ;       1. THIS ROUTINE IS ALSO LEFT IN PLACE AFTER THE :
                    5778  ;       POWER ON DIAGNOSTICS TO SERVICE UNUSED          :
                    5779  ;       INTERRUPT VECTORS. LOCATION 'INTR_FLAG' WILL    :
                    5780  ;       CONTAIN EITHER: 1. LEVEL OF HARDWARE INT. THAT  :
                    5781  ;       CAUSED CODE TO BE EXEC.                         :
                    5782  ;       2. 'FF' FOR NON-HARDWARE INTERUPTS THAT WAS     :
                    5783  ;       EXECUTED ACCIDENTLY.                            :
                    5784  ;--------------------------------------------------------
FF23                5785  DI1     PROC    NEAR
                    5786          ASSUME  DS:DATA
FF23 1E             5787          PUSH    DS
FF24 52             5788          PUSH    DX
FF25 50             5789          PUSH    AX                      ; SAVE REG AX CONTENTS
FF26 E830FB         5790          CALL    DDS
FF29 B00B           5791          MOV     AL,0BH                  ; READ IN-SERVICE REG
FF2B E620           5792          OUT     INTA00,AL               ; (FIND OUT WHAT LEVEL BEING
FF2D 90             5793          NOP                             ; SERVICED)
FF2E E420           5794          IN      AL,INTA00               ; GET LEVEL
FF30 8AE0           5795          MOV     AH,AL                   ; SAVE IT
FF32 0AC4           5796          OR      AL,AH                   ; 00? (NO HARDWARE ISR ACTIVE)
FF34 7504           5797          JNZ     HW_INT
FF36 B4FF           5798          MOV     AH,0FFH
FF38 EB0A           5799          JMP     SHORT SET_INTR_FLAG     ; SET FLAG TO FF IF NON-HDWARE
FF3A                5800  HW_INT:
FF3A E421           5801          IN      AL,INTA01               ; GET MASK VALUE
FF3C 0AC4           5802          OR      AL,AH                   ; MASK OFF LVL BEING SERVICED
FF3E E621           5803          OUT     INTA01,AL
FF40 B020           5804          MOV     AL,EOI
FF42 E620           5805          OUT     INTA00,AL
FF44                5806  SET_INTR_FLAG:
FF44 88266B00       5807          MOV     INTR_FLAG,AH            ; SET FLAG
FF48 58             5808          POP     AX                      ; RESTORE REG AX CONTENTS
FF49 5A             5809          POP     DX
FF4A 1F             5810          POP     DS
FF4B                5811  DUMMY_RETURN:                           ; NEED IRET FOR VECTOR TABLE
FF4B CF             5812          IRET
                    5813  DI1     ENDP
                    5814
                    5815  ;--------------------------------------------------
                    5816  ; DUMMY RETURN FOR ADDRESS COMPATIBILITY         :
                    5817  ;--------------------------------------------------
FF53                5818          ORG     0FF53H
FF53 CF             5819          IRET
                    5820
```

```
                        ;-- INT 5 ------------------------------------------------------------
                        ;       THIS LOGIC WILL BE INVOKED BY INTERRUPT 05H TO PRINT THE        :
                        ;       SCREEN. THE CURSOR POSITION AT THE TIME THIS ROUTINE IS INVOKED :
                        ;       WILL BE SAVED AND RESTORED UPON COMPLETION. THE ROUTINE IS      :
                        ;       INTENDED TO RUN WITH INTERRUPTS ENABLED. IF A SUBSEQUENT       :
                        ;       'PRINT SCREEN' KEY IS DEPRESSED DURING THE TIME THIS ROUTINE   :
                        ;       IS PRINTING IT WILL BE IGNORED.                                :
                        ;       ADDRESS 50:0 CONTAINS THE STATUS OF THE PRINT SCREEN:          :
                        ;                                                                      :
                        ;       50:0    =0      EITHER PRINT SCREEN HAS NOT BEEN CALLED        :
                        ;                       OR UPON RETURN FROM A CALL THIS INDICATES      :
                        ;                       A SUCCESSFUL OPERATION.                        :
                        ;               =1      PRINT SCREEN IS IN PROGRESS                    :
                        ;               =255    ERROR ENCOUNTERED DURING PRINTING              :
                        ;----------------------------------------------------------------------
                                ASSUME  CS:CODE,DS:XXDATA
FF54                            ORG     0FF54H
FF54                    PRINT_SCREEN    PROC    FAR
FF54 FB                         STI                             ; MUST RUN WITH INTERRUPTS ENABLED
FF55 1E                         PUSH    DS                      ; MUST USE 50:0 FOR DATA AREA STORAGE
FF56 50                         PUSH    AX
FF57 53                         PUSH    BX
FF58 51                         PUSH    CX                      ; WILL USE THIS LATER FOR CURSOR LIMITS
FF59 52                         PUSH    DX                      ; WILL HOLD CURRENT CURSOR POSITION
FF5A B85000                     MOV     AX,XXDATA               ; HEX 50
FF5D 8ED8                       MOV     DS,AX
FF5F 803E000001                 CMP     STATUS_BYTE,1           ; SEE IF PRINT ALREADY IN PROGRESS
FF64 745F                       JZ      EXIT                    ; JUMP IF PRINT ALREADY IN PROGRESS
FF66 C606000001                 MOV     STATUS_BYTE,1           ; INDICATE PRINT NOW IN PROGRESS
FF6B B40F                       MOV     AH,15                   ; WILL REQUEST THE CURRENT SCREEN MODE
FF6D CD10                       INT     10H                     ;       [AL]=MODE
                                                                ;       [AH]=NUMBER COLUMNS/LINE
                                                                ;       [BH]=VISUAL PAGE
                        ;-----------------------------------------------------------
                        ;       AT THIS POINT WE KNOW THE COLUMNS/LINE ARE IN   :
                        ;       [AX] AND THE PAGE IF APPLICABLE IS IN[BH]. THE STACK    :
                        ;       HAS DS,AX,BX,CX,DX PUSHED. [A] HAS VIDEO MODE           :
                        ;-----------------------------------------------------------
FF6F 8ACC                       MOV     CL,AH                   ; WILL MAKE USE OF [CX] REGISTER TO
FF71 B519                       MOV     CH,25                   ; CONTROL ROW & COLUMNS
FF73 E85500                     CALL    CRLF                    ; CARRIAGE RETURN LINE FEED ROUTINE
FF76 51                         PUSH    CX                      ; SAVE SCREEN BOUNDS
FF77 B403                       MOV     AH,3                    ; WILL NOW READ THE CURSOR.
FF79 CD10                       INT     10H                     ; AND PRESERVE THE POSITION
FF7B 59                         POP     CX                      ; RECALL SCREEN BOUNDS
FF7C 52                         PUSH    DX                      ; RECALL [BH]=VISUAL PAGE
FF7D 33D2                       XOR     DX,DX                   ; WILL SET CURSOR POSITION TO [0,0]
                        ;-----------------------------------------------------------
                        ;       THE LOOP FROM PRI10 TO THE INSTRUCTION PRIOR TO PRI20   :
                        ;       IS THE LOOP TO READ EACH CURSOR POSITION FROM THE       :
                        ;       SCREEN AND PRINT.                                       :
                        ;-----------------------------------------------------------
FF7F                    PRI10:
FF7F B402                       MOV     AH,2                    ; TO INDICATE CURSOR SET REQUEST
FF81 CD10                       INT     10H                     ; NEW CURSOR POSITION ESTABLISHED
FF83 B408                       MOV     AH,8                    ; TO INDICATE READ CHARACTER
FF85 CD10                       INT     10H                     ; CHARACTER NOW IN [AL]
FF87 0AC0                       OR      AL,AL                   ; SEE IF VALID CHAR
FF89 7502                       JNZ     PRI15                   ; JUMP IF VALID CHAR
FF8B B020                       MOV     AL,' '                  ; MAKE A BLANK
FF8D                    PRI15:
FF8D 52                         PUSH    DX                      ; SAVE CURSOR POSITION
FF8E 33D2                       XOR     DX,DX                   ; INDICATE PRINTER 1
FF90 32E4                       XOR     AH,AH                   ; TO INDICATE PRINT CHAR IN [AL]
FF92 CD17                       INT     17H                     ; PRINT THE CHARACTER
FF94 5A                         POP     DX                      ; RECALL CURSOR POSITION
FF95 F6C425                     TEST    AH, 25H                 ; TEST FOR PRINTER ERROR
FF98 7521                       JNZ     ERR10                   ; JUMP IF ERROR DETECTED
FF9A FEC2                       INC     DL                      ; ADVANCE TO NEXT COLUMN
FF9C 3ACA                       CMP     CL,DL                   ; SEE IF AT END OF LINE
FF9E 75DF                       JNZ     PRI10                   ; IF NOT PROCEED
FFA0 32D2                       XOR     DL,DL                   ; BACK TO COLUMN 0
FFA2 8AE2                       MOV     AH,DL                   ; [AH]=0
FFA4 52                         PUSH    DX                      ; SAVE NEW CURSOR POSITION
FFA5 E82300                     CALL    CRLF                    ; LINE FEED CARRIAGE RETURN
FFA8 5A                         POP     DX                      ; RECALL CURSOR POSITION
FFA9 FEC6                       INC     DH                      ; ADVANCE TO NEXT LINE
FFAB 3AEE                       CMP     CH,DH                   ; FINISHED?
FFAD 75D0                       JNZ     PRI10                   ; IF NOT CONTINUE
FFAF                    PRI20:
FFAF 5A                         POP     DX                      ; RECALL CURSOR POSITION
FFB0 B402                       MOV     AH,2                    ; TO INDICATE CURSOR SET REQUEST
FFB2 CD10                       INT     10H                     ; CURSOR POSITION RESTORED
FFB4 C606000000                 MOV     STATUS_BYTE,0           ; INDICATE FINISHED
FFB9 EB0A                       JMP     SHORT EXIT              ; EXIT THE ROUTINE
FFBB                    ERR10:
FFBB 5A                         POP     DX                      ; GET CURSOR POSITION
FFBC B402                       MOV     AH,2                    ; TO REQUEST CURSOR SET
FFBE CD10                       INT     10H                     ; CURSOR POSITION RESTORED
FFC0                    ERR20:
FFC0 C6060000FF                 MOV     STATUS_BYTE,0FFH        ; INDICATE ERROR
FFC5                    EXIT:
FFC5 5A                         POP     DX                      ; RESTORE ALL THE REGISTERS USED
FFC6 59                         POP     CX
FFC7 5B                         POP     BX
FFC8 58                         POP     AX
FFC9 1F                         POP     DS
FFCA CF                         IRET
                        PRINT_SCREEN    ENDP

                        ;------ CARRIAGE RETURN, LINE FEED SUBROUTINE

FFCB                    CRLF    PROC    NEAR
FFCB 33D2                       XOR     DX,DX                   ; PRINTER 0
FFCD 32E4                       XOR     AH,AH                   ; WILL NOW SEND INITIAL LF,CR
                                                                ;  TO PRINTER
FFCF B00A                       MOV     AL,12Q                  ; LF
FFD1 CD17                       INT     17H                     ; SEND THE LINE FEED
FFD3 32E4                       XOR     AH,AH                   ; NOW FOR THE CR
FFD5 B00D                       MOV     AL,15Q                  ; CR
FFD7 CD17                       INT     17H                     ; SEND THE CARRIAGE RETURN
FFD9 C3                         RET
                        CRLF    ENDP
```

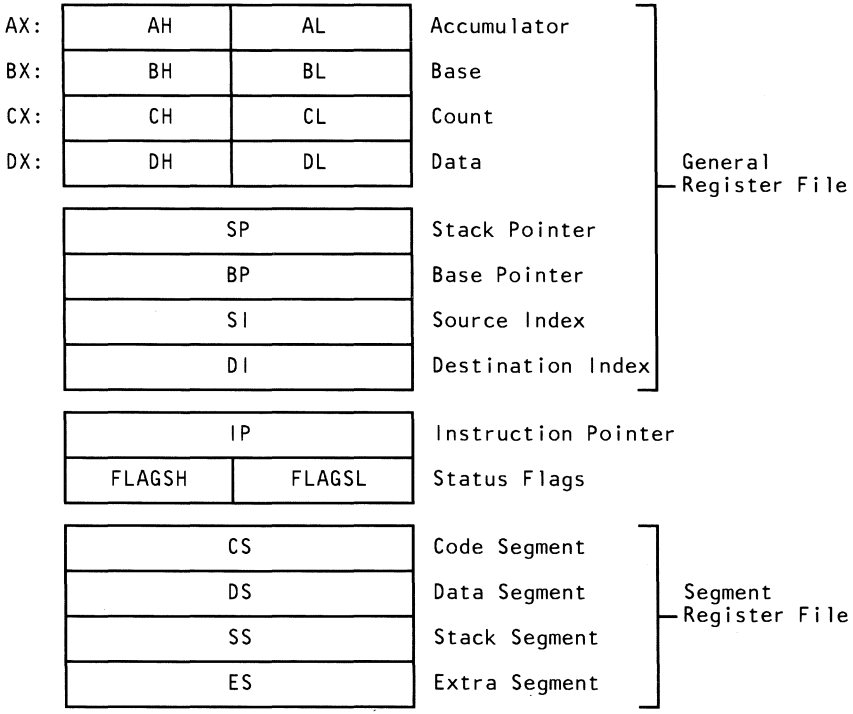
```
 LOC OBJECT            LINE  SOURCE (BIOS FOR THE IBM PERSONAL COMPUTER XT) 11/08/82

                       5934
                       5935  ;--------------------------------------------------------------
                       5936  ;       PRINT A SEGMENT VALUE TO LOOK LIKE A 20 BIT ADDRESS     :
                       5937  ;       DX MUST CONTAIN SEGMENT VALUE TO BE PRINTED              :
                       5938  ;--------------------------------------------------------------
FFDA                   5939  PRT_SEG PROC    NEAR
FFDA 8AC6              5940          MOV     AL,DH                   ;GET MSB
FFDC E8ACF9            5941          CALL    XPC_BYTE
FFDF 8AC2              5942          MOV     AL,DL                   ;LSB
FFE1 E8A7F9            5943          CALL    XPC_BYTE
FFE4 B030              5944          MOV     AL,'0'                  ; PRINT A '0 '
FFE6 E8B3F9            5945          CALL    PRT_HEX
FFE9 B020              5946          MOV     AL,' '                  ;SPACE
FFEB E8AEF9            5947          CALL    PRT_HEX
FFEE C3                5948          RET
                       5949  PRT_SEG ENDP
                       5950
----                   5951  CODE    ENDS
                       5952
                       5953  ;--------------------------------
                       5954  ;       POWER ON RESET VECTOR   :
                       5955  ;--------------------------------
----                   5956  VECTOR  SEGMENT AT 0FFFFH
                       5957
                       5958  ;----- POWER ON RESET
                       5959
0000 EA5BE000F0        5960          JMP     RESET
                       5961
0005 31312F30382F38    5962          DB      '11/08/82'              ; RELEASE MARKER
     32
----                   5963  VECTOR  ENDS
                       5964          END
```

SECTION 6. INSTRUCTION SET

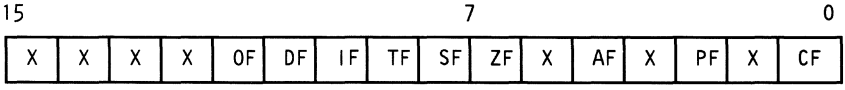
Notes:

8088 Register Model

Notes:
if d = 1 then "to"; if d = 0 then "from"
if w = 1 then word instruction; if w = 0 then byte instruction
if s:w = 01 then 16 bits of immediate data from the operand
if s:w = 11 then an immediate data byte is signed extended to form the 16-bit operand
if v = 0 the "count" = 1; if v = 1 the "count" is in (CL) or (CX)
x = don't care
z is used for string primitives for comparison with ZF FLAG
AL = 8-bit accumulator
AX = 16-bit accumulator
CX = Count register
DS = Data segment
ES = Extra segment
Above/below refers to unsigned value
Greater = more positive;
Less = less positive (more negative) signed values



Instructions which reference the flag register file as a 16-bit object, use the symbol FLAGS to represent the file:



X = Don't Care

```
AF: Auxiliary Carry - BCD
CF: Carry Flag
PF: Parity Flag
SF: Sign Flag
ZF: Zero Flag                    ─ 8080 Flags

DF: Direction Flag
IF: Interrupt Enable Flag
OF: Overflow Flag (CF + SF)      ─ 8088 Flags
TF: Trap-Single Step Flag
```

Operand Summary

reg Field Bit Assignments

16-Bit [w = 1]	8-Bit [w = 0]	Segment
000 AX	000 AL	00 ES
001 CX	001 CL	01 CS
010 DX	010 DL	10 SS
011 BX	011 BL	11 DS
100 SP	100 AH	
101 BP	101 CH	
110 SI	110 DH	
111 DI	111 BH	

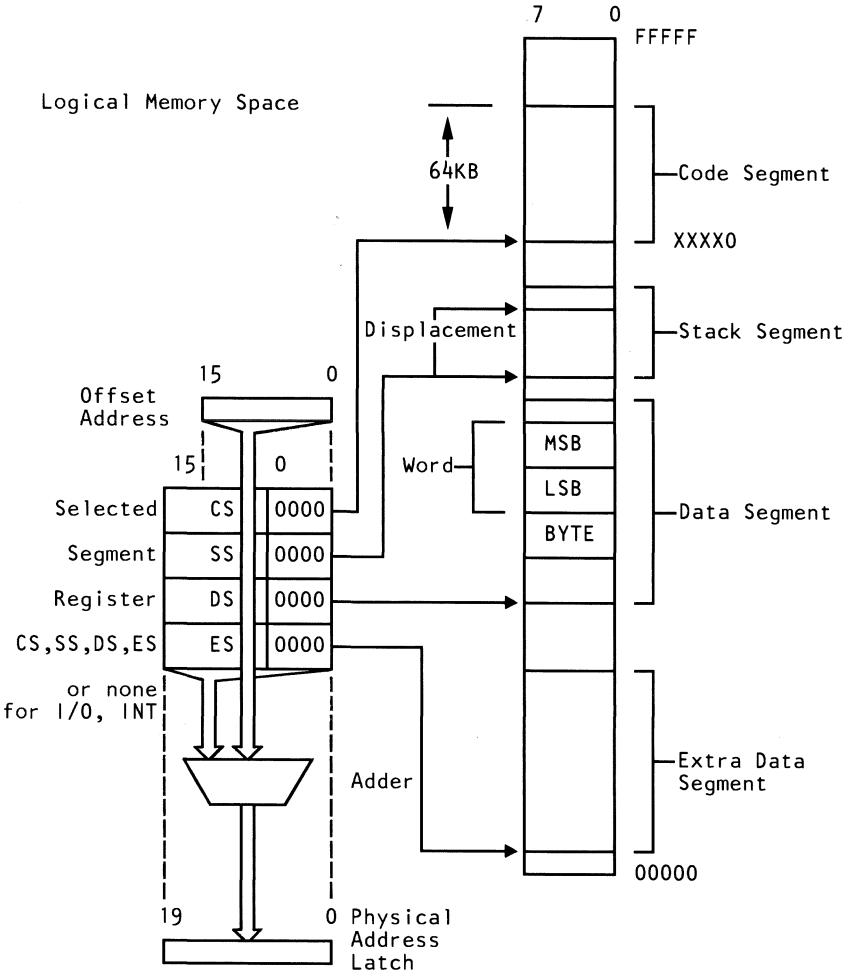
Second Instruction Byte Summary

mod	xxx	r/m

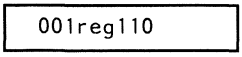
mod	Displacement
00	DISP = 0*, disp-low and disp-high are absent
01	DISP = disp-low sign-extended to 16-bits, disp-high is absent
10	DISP = disp-high: disp-low
11	r/m is treated as a "reg" field

DISP follows 2nd byte of instruction (before data if required)
*except if mod=00 and r/m-110 then EA=disp-high: disp-low.

Memory Segmentation Model



Segment Override Prefix



Use of Segment Override

Operand Register	Default	With Override Prefix
IP (Code Address)	CS	Never
SP (Stack Address)	SS	Never
BP (Stack Address or Stack Marker)	SS	BP + DS or ES, or CS
SI or DI (not including strings)	DS	ES, SS, or CS
SI (Implicit Source Address for strings)	DS	ES, SS, or CS
DI (Implicit Destination Address for strings)	ES	Never

8088 Instruction Set

Data Transfer

MOV = Move

Register/Memory to/from Register

100010dw	mod reg r/m

Immediate to Register/Memory

1100011w	mod 000 r/m	data	data if w = 1

Immediate to Register

1011wreg	data	data if w = 1

Memory to Accumulator

1010000w	addr-low	addr-high

Accumulator to Memory

1010001w	addr-low	addr-high

Register/Memory to Segment Register

10001110	mod 0 reg r/m

Segment Register to Register/Memory

10001100	mod 0 reg r/m

PUSH = Push

Register/Memory

11111111	mod 110 r/m

Register

01010 reg

Segment Register

000 reg 110

POP = Pop

Register/Memory

10001111	mod 000 r/m

Register

01011reg

Segment Register

000 reg 111

XCHG = Exchange

Register/Memory with Register

1000011w	mod reg r/m

Register with Accumulator

10010reg

IN = Input to AL/AX from

Fixed Port

1110010w	port

Variable Port

1110110w

OUT = Output from AL/AX to

Fixed Port

1110011w	port

Variable Port (DX)

1110110w

XLAT = Translate Byte to AL

11010111

LEA = Load EA to Register

10001101	mod reg r/m

LDS = Load Pointer to DS

11000101	mod reg r/m

LES = Load Pointer to ES

11000100	mod reg r/m

LAHF = Load AH with Flags

10011111

SAHF = Store AH with Flags

10011110

PUSHF = Push Flags

10011100

POPF = Pop Flags

10011101

Arithmetic

ADD = Add

Register/Memory with Register to Either

000000dw	mod reg r/m

Immediate to Register Memory

100000sw	mod 000 r/m	data	data if s:w = 01

Immediate to Accumulator

0000010w	data	data if w = 1

ADC = Add with Carry

Register/Memory with Register to Either

000100dw	mod reg r/m

Immediate to Register/Memory

100000sw	mod 010 r/m	data	data if s:w = 01

Immediate to Accumulator

0001010w	data	data if w = 1

INC = Increment

Register/Memory

1111111w	mod 000 r/m

Register

01000reg

AAA = ASCII Adjust for Add

00110111

DAA = Decimal Adjust for Add

00100111

SUB = Subtract

Register/Memory and Register to Either

001010dw	mod reg r/m

Immediate from Register/Memory

100000sw	mod 101 r/m	data	data if s:w = 01

Immediate from Accumulator

0010110w	data	data if w = 1

SBB = Subtract with Borrow

Register/Memory and Register to Either

000110dw	mod reg r/m

Immediate from Register/Memory

100000sw	mod 011 r/m	data	data if s:w = 01

Immediate to Accumulator

0001110w	data	data if w = 1

DEC = Decrement

Register/Memory

1111111w	mod 001 r/m

Register

01001reg

NEG = Change Sign

1111011w	mod 011 r/m

CMP = Compare

Register/Memory and Register

001110dw	mod reg r/m

Immediate with Register/Memory

100000sw	mod 111 r/m	data	data if s:w = 01

Immediate with Accumulator

0011110w	data	data if w = 1

AAS = ASCII Adjust for Subtract

00111111

DAS = Decimal Adjust for Subtract

00101111

MUL = Multiply (Unsigned)

1111011w	mod 100 r/m

IMUL = Integer Multiply (Signed)

1111011w	mod 101 r/m

AAM = ASCII Adjust for Multiply

11010100	00001010

DIV = Divide (Unsigned)

1111011w	mod 110 r/m

IDIV = Integer Divide (Signed)

1111011w	mod 111 r/m

AAD = ASCII Adjust for Divide

11010101	00001010

CBW = Convert Byte to Word

10011000

CWD = Convert Word to Double Word

10011001

Logic

Shift/Rotate Instructions

NOT = Invert Register/Memory

1111011w	mod 010 r/m

SHL/SAL = Shift Logical/Arithmetic Left

110100vw	mod 100 r/m

SHR = Shift Logical Right

110100vw	mod 101 r/m

SAR = Shift Arithmetic Right

110100vw	mod 111 r/m

ROL = Rotate Left

110100vw	mod 000 r/m

ROR = Rotate Right

110100vw	mod 001 r/m

RCL = Rotate through Carry Left

110100vw	mod 010 r/m

RCR = Rotate through Carry Right

110100vw	mod 011 r/m

AND = And

Register/Memory and Register to Either

001000dw	mod reg r/m

Immmediate to Register/Memory

1000000w	mod 100 r/m	data	data if w = 1

Immediate to Accumulator

0010010w	data	data if w = 1

TEST = AND Function to Flags; No Result

Register/Memory and Register

1000010w	mod reg r/m

Immediate Data and Register/Memory

1111011w	mod 000 r/m	data	data if w = 1

Immediate Data and Accumulator

1010100w	data	data if w = 1

OR = Or

Register/Memory and Register to Either

000010dw	mod reg r/m

Immediate to Register/Memory

1000000w	mod 001 r/m	data	data if w = 1

Immediate to Accumulator

0000110w	data	data if w = 1

XOR = Exclusive OR

Register/Memory and Register to Either

001100dw	mod reg r/m

Immediate to Register/Memory

1000000w	mod 110 r/m	data	data if w = 1

Immediate to Accumulator

0011010w	data	data if w = 1

String Manipulation

REP = Repeat

1111001z

MOVS = Move String

1010010w

CMPS = Compare String

1010011w

SCAS = Scan String

1010111w

LODS = Load String

1010110w

STOS = Store String

1010101w

Control Transfer

CALL = Call

Direct within Segment

11101000	disp-low	disp-high

Indirect within Segment

11111111	mod 010 r/m

Direct Intersegment

10011010	offset-low	offset-high
	seg-low	seg-high

Indirect Intersegment

11111111	mod 011 r/m

JMP = Unconditional Jump

Direct within Segment-Short

11101011	disp

Indirect within Segment

11111111	mod 100 r/m

Direct Intersegment

11101010	offset-low	offset-high
	seg-low	seg-high

Indirect Intersegment

11111111	mod 101 r/m

RET = Return from Call

Within Segment

11000011

Within Segment Adding Immediate to SP

11000010	data-low	data-high

Intersegment

11001011

Intersegment Adding Immediate to SP

11000010	data-low	data-high

JE/JZ = Jump on Equal/Zero

01110100	disp

JL/JNGE = Jump on Less/Not Greater, or Equal

01111100	disp

JLE/JNG = Jump on Less, or Equal/Not Greater

01111110	disp

JB/JNAE = Jump on Below/Not Above, or Equal

01110010	disp

JBE/JNA = Jump on Below, or Equal/Not Above

01110110	disp

JP/JPE = Jump on Parity/Parity Even

01111010	disp

JO = Jump on Overflow

01110000	disp

JS = Jump on Sign

01111000	disp

JNE/JNZ = Jump on Not Equal/Not Zero

01110101	disp

JNL/JGE = Jump on Not Less/Greater, or Equal

01111101	disp

JNLE/JG = Jump on Not Less, or Equal/Greater

01111111	disp

JNB/JAE = Jump on Not Below/Above, or Equal

01110011	disp

JNBE/JA = Jump on Not Below, or Equal/Above

01110111	disp

JNP/JPO = Jump on Not Parity/Parity Odd

01111011	disp

JNO = Jump on Not Overflow

01110001	disp

JNS = Jump on Not Sign

01111001	disp

LOOP = Loop CX Times

11100010	disp

LOOPZ/LOOPE = Loop while Zero/Equal

11100001	disp

LOOPNZ/LOOPNE = Loop while Not Zero/Not Equal

11100000	disp

JCXZ = Jump on CX Zero

11100011	disp

8088 Instruction Set Matrix

HI \ LO	0	1	2	3	4	5	6	7
0	ADD b,b,r/m	ADD w,f,r/m	ADD b,t,r/m	ADD w,t,r/m	ADD b,ia	ADD w,ia	PUSH ES	POP ES
1	ADC b,f,r/m	ADC w,f,r/m	ADC b,t,r/m	ADC w,t,r/m	ADC b,i	ADC w,i	PUSH SS	POP SS
2	AND b,f,r/m	AND w,f,r/m	AND b,t,r/m	AND w,t,r/m	AND b,i	AND w,i	DEG =ES	DAA
3	XOR b,f,r/m	XOR w,f,r/m	XOR b,t,r/m	XOR w,t,r/m	XOR b,i	XOR w,i	SEG =S+	AAA
4	INC AX	INC CX	INC DX	INC BX	INC SP	INC BP	INC SI	INC DI
5	PUSH AX	PUSH CX	PUSH DX	PUSH BX	PUSH SP	PUSH BP	PUSH SI	PUSH DI
6								
7	JO	JNO	JB/ JNAE	JNB/ JAE	JE/ JZ	JNE/ JNZ	JBE/ JNA	JNBE/ JA
8	Immed b,r/m	Immed w,r/m	Immed b,r/m	Immed is,r/m	TEST b,r/m	TEST w,r/m	XCHG b,r/m	XCHG w,r/m
9	NOP	XCHG CX	XCHG DX	XCHG BX	XCHG SP	XCHG BP	XCHG SI	XCHG DI
A	MOV m AL	MOV m AL	MOV AL m	MOV AL m	MOVS b	MOVS w	CMPS b	CMPS w
B	MOV i AL	MOV i CL	MOV i DL	MOV i BL	MOV i AH	MOV i CH	MOV i DH	MOV i BH
C			RET (I+SP)	RET	LES	LDS	MOV b,i,r/m	MOV w,i,r/m
D	Shift b	Shift w	Shift b,v	Shift w,v	AAM	AAD		XLAT
E	LOOPNZ/ LOOPNE	LOOPZ/ POOPE	LOOP	JCXZ	IN b	IN w	OUT b	OUT w
F	LOCK		REP	REP z	HLT	CMC	Grp 1 b,r/m	Grp 1 w,r/m

b = byte operation
d = direct
f = from CPU reg
i = immediate
ia = immed. to accum.
id = direct
is = immed. byte, sign ext.
l = long ie. intersegment
m = memory
r/m = EA is second byte
si = short intersegment
t = to CPU reg
v = variable
w = word operation
z = zero
sr = segment register

HI \ LO	8	9	A	B	C	D	E	F
0	OR b,f,r/m	 w,f,r/m	OR b,t,r/m	OR w,t,r/m	OR b,i	OR w,i	PUSH CS	
1	SBB b,f,r/m	SBB w,f,r/m	SBB b,t,r/m	SBB w,t,r/m	SBB b,i	SBB w,i	PUSH DS	POP DS
2	SUB b,f,r/m	SUB w,f,r/m	SUB b,t,r/m	SUB w,t,r/m	SUB b,i	SUB w,i	SEG= CS	DAS
3	CMP b,f,r/m	CMP w,f,r/m	CMP b,t,r/m	CMP w,t,r/m	CMP b,i	CMP w,i	SEG= CS	AAS
4	DEC AX	DEC CX	DEC DX	DEC BX	DEC SP	DEC BP	DEC SI	DEC DI
5	POP AX	POP CX	POP DX	POP BX	POP SP	POP BP	POP SI	POP DI
6								
7	JS	JNS	JP/ JPE	JNP/ JPO	JL/ JNGE	JNL/ JGE	JLE/ JNG	JNLE/ JG
8	MOV b,f,r/m	MOV w,f,r/m	MOV b,t,r/m	MOV w,t,r/m	MOV sr,t,r/m	LEA	MOV sr,f,r/m	POP r/m
9	CBW	CWD CX	CALL l,d	WAIT BX	PUSHF SP	POPF BP	SAHF SI	LAHF DI
A	TEST b,i	TEST w,i	STOS b	STOS w	LODS b	LODS w	SCAS b	SCAS w
B	MOV i AX	MOV i CX	MOV i DX	MOV i BX	MOV i SP	MOV i BP	MOV i SI	MOV i DI
C			RET l,(l+SP)	RET l	INT Type 3	INT (Any)	INTO	IRET
D	ESC 0	ESC 1	ESC 2	ESC 3	ESC 4	ESC 5	ESC 6	ESC 7
E	CALL d	JMP d	JMP l,d	JMP si,d	IN v,b	IN v,w	OUT v,b	OUT v,w
F	CLC	STC	CLI	STI	CLD	STD	Grp 2 b,r/m	Grp 3 w,r/m

where:

mod r/m	000	001	010	011	100	101	110	111
Immed	ADD	OR	ADC	SBB	AND	SUB	XOR	CMP
Shift	ROL	ROR	RCL	RCR	SHL/SAL	SHR	--	SAR
Grp 1	TEST	--	NOT	NEG	MUL	IMUL	DIV	DIV
Grp 2	INC	DEC	CALL id	CALL l,id	JMP id	JMP l,id	PUSH	--

8088 Conditional Transfer Operations

Instruction	Condition	Interpretation
JE or JZ	ZF = 1	"equal" or "zero"
JL or JNGE	(SF xor OF) =1	"less" or "not greater or equal"
JLE or JNG	((SF xor OF) or ZF) = 1	"less or equal" or "not greater"
JB or JNAE or JC	CF = 1	"below" or "not above or equal"
JBE or JNA	(CF or ZF) = 1	"below or equal" or "not above"
JP or JPE	PF = 1	"parity" or "parity even"
JO	OF = 1	"overflow"
JS	SF = 1	"sign"
JNE or JNZ	ZF = 0	"not equal" or "not zero"
JNL or JGE	(SF xor OF) = 0	"not less" or "greater or equal"
JNLE or JG	((SF xor OF) or ZF) = 0	"not less or equal" or "greater"
JNB or JAE or JNC	CF = 0	"not below" or "above or equal"
JNBE or JA	(CF or ZF) = 0	"not below or equal" or "above"
JNP or JPO	PF = 0	"not parity" or "parity odd"
JNO	OF = 0	"not overflow"
JNS	SF = 0	"not sign"

"Above" and "below" refer to the relation between two unsigned values, while "greater" and "less" refer to the relation between two signed values.

INT = Interrupt

Type Specified

11001101	Type

Type 3

11001100

INTO = Interrupt on Overflow

11001110

IRET = Interrupt Return

11001111

Processor Control

CLC = Clear Carry

11111000

STC = Set Carry

11111001

CMC = Complement Carry

11110101

NOP = No Operation

10010000

CLD = Clear Direction

11111100

STD = Set Direction

11111101

CLI = Clear Interrupt

11111010

STI = Set Interrupt

11111011

HLT = Halt

11110100

WAIT = Wait

10011011

LOCK = Bus lock prefix

11110000

ESC = Escape (to 8087)

11011xxx	mod xxx r/m

8087 Coprocessor Instruction Set

The following is an instruction set summary for the 8087 coprocessor. In the following, the bit pattern for escape is 11011.

MF = Memory format	r/m	Operand Address
00 - 32-bit Real	000	(BX) + (SI) + DISP
01 - 32-bit Integer	001	(BX) + (DI) + DISP
10 - 64-bit Real	010	(BP) + (SI) + DISP
11 - 64-bit Integer	011	(BP) + (DI) + DISP
	100	(SI) + DISP
	101	(DI) + DISP
	110	(BP) + DISP*
	100	(BX) + DISP

DISP follows 2nd byte of instruction (before data if required)
*except if mod=00 and r/m-110 then EA=disp-high: disp-low.

Data Transfer

FLD = Load

Integer/Real Memory to ST(0)

escape MF 1	mod 000 r/m	disp-low	disp-high

Long Integer Memory to ST(0)

escape 111	mod 101 r/m	disp-low	disp-high

Temporary Real Memory to ST(0)

escape 011	mod 101 r/m	disp-low	disp-high

BCD Memory to ST(0)

escape 111	mod 100 r/m	disp-low	disp-high

ST(i) to ST(0)

escape 001	11000ST(i)

FST = Store

ST(0) to Integer/Real Memory

escape MF 1	mod 010 r/m	disp-low	disp-high

ST(0) to ST(i)

escape 101	11010 ST(i)

FSTP = Store and Pop

ST(0) to Integer/Real Memory

escape MF 1	mod 011 r/m	disp-low	disp-high

ST(0) to Long Integer Memory

escape 111	mod 111 r/m	disp-low	disp-high

ST(0) to Temporary Real Memory

escape 011	mod 111 r/m	disp-low	disp-high

ST(0) to BCD Memory

escape 111	mod 110 r/m	disp-low	disp-high

ST(0) to ST(i)

escape 101	11011 ST(i)

FXCH = Exchange ST(i) and ST(0)

escape 001	11001 ST(i)

Comparison

FCOM = Compare

Integer/Real Memory to ST(0)

escape MF 0	mod 010 r/m	disp-low	disp-high

ST(i) to ST(0)

escape 000	11010 ST(i)

FCOMP = Compare and Pop

Integer/Real Memory to ST(0)

escape MF 0	mod 011 r/m	disp-low	disp-high

ST(i) to ST(0)

escape 000	11010 ST(i)

FCOMPP = Compare ST(i) to ST(0) and Pop Twice

escape 110	11011001

FTST = Test ST(0)

escape 001	11100100

FXAM = Examine ST(0)

escape 001	11100101

Arithmetic

FADD = Addition

Integer/Real Memory with ST(0)

escape MF 0	mod 000 r/m	disp-low	disp-high

ST(i) and ST(0)

escape dP0	11000 ST(i)

FSUB = Subtraction

Integer/Real Memory with ST(0)

escape MF 0	mod 10R r/m	disp-low	disp-high

ST(i) and ST(0)

escape dP0	1110R r/m

FMUL = Multiplication

Integer/Real Memory with ST(0)

escape MF 0	mod 001 r/m	disp-low	disp-high

ST(i) and ST(0)

escape dP0	11001 r/m

FDIV = Division

Integer/Real Memory with ST(0)

escape MF 0	mod 11R r/m	disp-low	disp-high

ST(i) and ST(0)

escape dP0	1111R r/m

FSQRT = Square Root of ST(0)

escape 001	11111010

FSCALE = Scale ST(0) by ST(1)

escape 001	11111101

FPREM = Partial Remainder of ST(0) ÷ ST(1)

escape 001	11111000

FRNDINT = Round ST(0) to Integer

escape 001	11111100

FXTRACT = Extract Components of ST(0)

escape 001	11110100

FABS = Absolute Value of ST(0)

escape 001	11100001

FCHS = Change Sign of ST(0)

escape 001	11100000

Transcendental

FPTAN = Partial Tangent of ST(0)

escape 001	11110010

FPATAN = Partial Arctangent of ST(0) ÷ ST(1)

escape 001	11110011

F2XM1 = $2^{ST(0)}$ -1

escape 001	11110000

FYL2X = ST(1) x Log_2 [ST(0)]

escape 001	11110001

FYL2XP1 = ST(1) x Log_2 [ST(0) + 1]

escape 001	11111001

Constants

FLDZ = Load + 0.0 into ST(0)

escape 001	11101110

FLD1 = Load + 1.0 into ST(0)

escape 001	11101000

FLDP1 = Load π into ST(0)

escape 001	11101011

FLDL2T = Load Log_2 10 into ST(0)

escape 001	11101001

FLDLG2 = Load Log_{10} 2 into ST(0)

escape 001	11101100

FLDLN2 = Load Log_e 2 into ST(0)

escape 001	11101101

Processor Control

FINIT = Initialize NDP

escape 011	11100011

FENI = Enable Interrupts

escape 011	11100000

FDISI = Disable Interrupts

escape 011	11100001

FLDCW = Load Control Word

escape 001	mod101 r/m	disp-low	disp-high

FSTCW = Store Control Word

escape 001	mod111 r/m	disp-low	disp-high

FSTSW = Store Status Word

escape 101	mod111 r/m	disp-low	disp-high

FCLEX = Clear Exceptions

escape 011	11100010

FSTENV = Store Environment

escape 001	mod110 r/m	disp-low	disp-high

FLDENV = Load Environment

escape 001	mod100 r/m	disp-low	disp-high

FSAVE = Save State

escape 101	mod110 r/m	disp-low	disp-high

FRSTOR = Restore State

escape 101	mod100 r/m	disp-low	disp-high

FINCSTP = Increment Stack Pointer

escape 001	11110111

FDECSTP = Decrement Stack Pointer

escape 001	11110110

FFREE = Free ST(i)

escape 001	11000ST(i)

FNOP = No Operation

escape 001	11010000

FWAIT = CPU Wait for NDP

10011011

Notes:

ST(0) = Current Stack top

ST(i) = i^{th} register below Stack top

d = Destination

0—Destination is ST(0)
1—Destination is ST(i)

P = POP

0—No Pop
1—Pop ST(0)

R = Reverse

0—Destination (op) Source
1—Source (op) Destination

For **FSQRT:** $-0 \leq ST(0) \leq +\infty$

For **FSCALE:** $-2^{15} \leq ST(1) < +2^{15}$ and ST(1) interger

For **F2XM1:** $0 \leq ST(0) \leq 2^{-1}$

For **FYL2X:** $0 < St(0) < \infty \; -\infty < ST(1) < +\infty$

For **FYL2XP1:** $0 < |ST(0)| < (2-\sqrt{2})/2 \; -\infty < ST(1) < \infty$

For **FPTAN:** $0 \leq ST(0) < \pi/4$

For **FPATAN:** $0 \leq ST(0) < ST(1) < +\infty$

Notes:

SECTION 7. CHARACTERS, KEYSTROKES, AND COLORS

Notes:

Character Codes

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
00	0	Blank (Null)	Ctrl 2		Black	Black	Non-Display
01	1	☺	Ctrl A		Black	Blue	Underline
02	2	☻	Ctrl B		Black	Green	Normal
03	3	♥	Ctrl C		Black	Cyan	Normal
04	4	♦	Ctrl D		Black	Red	Normal
05	5	♣	Ctrl E		Black	Magenta	Normal
06	6	♠	Ctrl F		Black	Brown	Normal
07	7	•	Ctrl G		Black	Light Grey	Normal
08	8	◘	Ctrl H, Backspace, Shift Backspace		Black	Dark Grey	Non-Display
09	9	○	Ctrl I		Black	Light Blue	High Intensity Underline
0A	10	◙	Ctrl J, Ctrl ↵		Black	Light Green	High Intensity
0B	11	♂	Ctrl K		Black	Light Cyan	High Intensity
0C	12	♀	Ctrl L		Black	Light Red	High Intensity
0D	13	♪	Ctrl M, ↵, Shift ↵		Black	Light Magenta	High Intensity
0E	14	♫	Ctrl N		Black	Yellow	High Intensity
0F	15	☼	Ctrl O		Black	White	High Intensity
10	16	►	Ctrl P		Blue	Black	Normal
11	17	◄	Ctrl Q		Blue	Blue	Underline
12	18	↕	Ctrl R		Blue	Green	Normal
13	19	‼	Ctrl S		Blue	Cyan	Normal
14	20	¶	Ctrl T		Blue	Red	Normal
15	21	§	Ctrl U		Blue	Magenta	Normal
16	22	▬	Ctrl V		Blue	Brown	Normal
17	23	↨	Ctrl W		Blue	Light Grey	Normal

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	Adapter
18	24	↑	Ctrl X		Blue	Dark Grey	High Intensity
19	25	↓	Ctrl Y		Blue	Light Blue	High Intensity Underline
1A	26	→	Ctrl Z		Blue	Light Green	High Intensity
1B	27	←	Ctrl [, Esc, Shift Esc, Crtl Esc		Blue	Light Cyan	High Intensity
1C	28	∟	Ctrl \		Blue	Light Red	High Intensity
1D	29	↔	Ctrl]		Blue	Light Magenta	High Intensity
1E	30	▲	Ctrl 6		Blue	Yellow	High Intensity
1F	31	▼	Ctrl —		Blue	White	High Intensity
20	32	Blank Space	Space Bar, Shift, Space, Ctrl Space, Alt Space		Green	Black	Normal
21	33	!	!	Shift	Green	Blue	Underline
22	34	"	"	Shift	Green	Green	Normal
23	35	#	#	Shift	Green	Cyan	Normal
24	36	$	$	Shift	Green	Red	Normal
25	37	%	%	Shift	Green	Magenta	Normal
26	38	&	&	Shift	Green	Brown	Normal
27	39	'	'		Green	Light Grey	Normal
28	40	(	(	Shift	Green	Dark Grey	High Intensity
29	41	)	)	Shift	Green	Light Blue	High Intensity Underline
2A	42	*	*	Note 1	Green	Light Green	High Intensity
2B	43	+	+	Shift	Green	Light Cyan	High Intensity
2C	44	,	,		Green	Light Red	High Intensity
2D	45	-	-		Green	Light Magenta	High Intensity
2E	46	.	.	Note 2	Green	Yellow	High Intensity

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
2F	47	/	/		Green	White	High Intensity
30	48	0	0	Note 3	Cyan	Black	Normal
31	49	1	1	Note 3	Cyan	Blue	Underline
32	50	2	2	Note 3	Cyan	Green	Normal
33	51	3	3	Note 3	Cyan	Cyan	Normal
34	52	4	4	Note 3	Cyan	Red	Normal
35	53	5	5	Note 3	Cyan	Magenta	Normal
36	54	6	6	Note 3	Cyan	Brown	Normal
37	55	7	7	Note 3	Cyan	Light Grey	Normal
38	56	8	8	Note 3	Cyan	Dark Grey	High Intensity
39	57	9	9	Note 3	Cyan	Light Blue	High Intensity Underline
3A	58	:	:	Shift	Cyan	Light Green	High Intensity
3B	59	;	;		Cyan	Light Cyan	High Intensity
3C	60	<	<	Shift	Cyan	Light Red	High Intensity
3D	61	=	=		Cyan	Light Magenta	High Intensity
3E	62	>	>	Shift	Cyan	Yellow	High Intensity
3F	63	?	?	Shift	Cyan	White	High Intensity
40	64	@	@	Shift	Red	Black	Normal
41	65	A	A	Note 4	Red	Blue	Underline
42	66	B	B	Note 4	Red	Green	Normal
43	67	C	C	Note 4	Red	Cyan	Normal
44	68	D	D	Note 4	Red	Red	Normal
45	69	E	E	Note 4	Red	Magenta	Normal
46	70	F	F	Note 4	Red	Brown	Normal
47	71	G	G	Note 4	Red	Light Grey	Normal
48	72	H	H	Note 4	Red	Dark Grey	High Intensity
49	73	I	I	Note 4	Red	Light Blue	High Intensity Underline
4A	74	J	J	Note 4	Red	Light Green	High Intensity

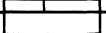
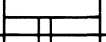
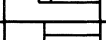
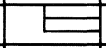
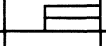
Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
4B	75	K	K	Note 4	Red	Light Cyan	High Intensity
4C	76	L	L	Note 4	Red	Light Red	High Intensity
4D	77	M	M	Note 4	Red	Light Magenta	High Intensity
4E	78	N	N	Note 4	Red	Yellow	High Intensity
4F	79	O	O	Note 4	Red	White	High Intensity
50	80	P	P	Note 4	Magenta	Black	Normal
51	81	Q	Q	Note 4	Magenta	Blue	Underline
52	82	R	R	Note 4	Magenta	Green	Normal
53	83	S	S	Note 4	Magenta	Cyan	Normal
54	84	T	T	Note 4	Magenta	Red	Normal
55	85	U	U	Note 4	Magenta	Magenta	Normal
56	86	V	V	Note 4	Magenta	Brown	Normal
57	87	W	W	Note 4	Magenta	Light Grey	Normal
58	88	X	X	Note 4	Magenta	Dark Grey	High Intensity
59	89	Y	Y	Note 4	Magenta	Light Blue	High Intensity Underline
5A	90	Z	Z	Note 4	Magenta	Light Green	High Intensity
5B	91	[	[		Magenta	Light Cyan	High Intensity
5C	92	\	\		Magenta	Light Red	High Intensity
5D	93	]	]		Magenta	Light Magenta	High Intensity
5E	94	^	^	Shift	Magenta	Yellow	High Intensity
5F	95	—	—	Shift	Magenta	White	High Intensity
60	96	'	'		Brown	Black	Normal
61	97	a	a	Note 5	Brown	Blue	Underline
62	98	b	b	Note 5	Brown	Green	Normal
63	99	c	c	Note 5	Brown	Cyan	Normal
64	100	d	d	Note 5	Brown	Red	Normal
65	101	e	e	Note 5	Brown	Magenta	Normal
66	102	f	f	Note 5	Brown	Brown	Normal

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
67	103	g	g	Note 5	Brown	Light Grey	Normal
68	104	h	h	Note 5	Brown	Dark Grey	High Intensity
69	105	i	i	Note 5	Brown	Light Blue	High Intensity Underline
6A	106	j	j	Note 5	Brown	Light Green	High Intensity
6B	107	k	k	Note 5	Brown	Light Cyan	High Intensity
6C	108	l	l	Note 5	Brown	Light Red	High Intensity
6D	109	m	m	Note 5	Brown	Light Magenta	High Intensity
6E	110	n	n	Note 5	Brown	Yellow	High Intensity
6F	111	o	o	Note 5	Brown	White	High Intensity
70	112	p	p	Note 5	Light Grey	Black	Reverse Video
71	113	q	q	Note 5	Light Grey	Blue	Underline
72	114	r	r	Note 5	Light Grey	Green	Normal
73	115	s	s	Note 5	Light Grey	Cyan	Normal
74	116	t	t	Note 5	Light Grey	Red	Normal
75	117	u	u	Note 5	Light Grey	Magenta	Normal
76	118	v	v	Note 5	Light Grey	Brown	Normal
77	119	w	w	Note 5	Light Grey	Light Grey	Normal
78	120	x	x	Note 5	Light Grey	Dark Grey	Reverse Video
79	121	y	y	Note 5	Light Grey	Light Blue	High Intensity Underline
7A	122	z	z	Note 5	Light Grey	Light Green	High Intensity
7B	123	{	{	Shift	Light Grey	Light Cyan	High Intensity
7C	124	|	|	Shift	Light Grey	Light Red	High Intensity
7D	125	}	}	Shift	Light Grey	Light Magenta	High Intensity
7E	126	~	~	Shift	Light Grey	Yellow	High Intensity
7F	127	△	Ctrl ←		Light Grey	White	High Intensity

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
* * * * 80 to FF Hex are Flashing in both Color & IBM Monochrome * * * *							
80	128	Ç	Alt 128	Note 6	Black	Black	Non-Display
81	129	ü	Alt 129	Note 6	Black	Blue	Underline
82	130	é	Alt 130	Note 6	Black	Green	Normal
83	131	â	Alt 131	Note 6	Black	Cyan	Normal
84	132	ä	Alt 132	Note 6	Black	Red	Normal
85	133	à	Alt 133	Note 6	Black	Magenta	Normal
86	134	å	Alt 134	Note 6	Black	Brown	Normal
87	135	ç	Alt 135	Note 6	Black	Light Grey	Normal
88	136	ê	Alt 136	Note 6	Black	Dark Grey	Non-Display
89	137	ë	Alt 137	Note 6	Black	Light Blue	High Intensity Underline
8A	138	è	Alt 138	Note 6	Black	Light Green	High Intensity
8B	139	ï	Alt 139	Note 6	Black	Light Cyan	High Intensity
8C	140	î	Alt 140	Note 6	Black	Light Red	High Intensity
8D	141	ì	Alt 141	Note 6	Black	Light Magenta	High Intensity
8E	142	Ä	Alt 142	Note 6	Black	Yellow	High Intensity
8F	143	Å	Alt 143	Note 6	Black	White	High Intensity
90	144	É	Alt 144	Note 6	Blue	Black	Normal
91	145	æ	Alt 145	Note 6	Blue	Blue	Underline
92	146	Æ	Alt 146	Note 6	Blue	Green	Normal
93	147	ô	Alt 147	Note 6	Blue	Cyan	Normal
94	148	ö	Alt 148	Note 6	Blue	Red	Normal
95	149	ò	Alt 149	Note 6	Blue	Magenta	Normal
96	150	û	Alt 150	Note 6	Blue	Brown	Normal
97	151	ù	Alt 151	Note 6	Blue	Light Grey	Normal
98	152	ÿ	Alt 152	Note 6	Blue	Dark Grey	High Intensity
99	153	Ö	Alt 153	Note 6	Blue	Light Blue	High Intensity Underline
9A	154	Ü	Alt 154	Note 6	Blue	Light Green	High Intensity

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
9B	155	¢	Alt 155	Note 6	Blue	Light Cyan	High Intensity
9C	156	£	Alt 156	Note 6	Blue	Light Red	High Intensity
9D	157	¥	Alt 157	Note 6	Blue	Light Magenta	High Intensity
9E	158	Pt	Alt 158	Note 6	Blue	Yellow	High Intensity
9F	159	*f*	Alt 159	Note 6	Blue	White	High Intensity
A0	160	á	Alt 160	Note 6	Green	Black	Normal
A1	161	í	Alt 161	Note 6	Green	Blue	Underline
A2	162	ó	Alt 162	Note 6	Green	Green	Normal
A3	163	ú	Alt 163	Note 6	Green	Cyan	Normal
A4	164	ñ	Alt 164	Note 6	Green	Red	Normal
A5	165	Ñ	Alt 165	Note 6	Green	Magenta	Normal
A6	166	a	Alt 166	Note 6	Green	Brown	Normal
A7	167	o	Alt 167	Note 6	Green	Light Grey	Normal
A8	168	¿	Alt 168	Note 6	Green	Dark Grey	High Intensity
A9	169	⌐	Alt 169	Note 6	Green	Light Blue	High Intensity Underline
AA	170	¬	Alt 170	Note 6	Green	Light Green	High Intensity
AB	171	½	Alt 171	Note 6	Green	Light Cyan	High Intensity
AC	172	¼	Alt 172	Note 6	Green	Light Red	High Intensity
AD	173	i	Alt 173	Note 6	Green	Light Magenta	High Intensity
AE	174	<<	Alt 174	Note 6	Green	Yellow	High Intensity
AF	175	>>	Alt 175	Note 6	Green	White	High Intensity
B0	176	⁙	Alt 176	Note 6	Cyan	Black	Normal
B1	177	▒	Alt 177	Note 6	Cyan	Blue	Underline
B2	178	▓	Alt 178	Note 6	Cyan	Green	Normal
B3	179	│	Alt 179	Note 6	Cyan	Cyan	Normal
B4	180	┤	Alt 180	Note 6	Cyan	Red	Normal
B5	181	╡	Alt 181	Note 6	Cyan	Magenta	Normal
B6	182	╢	Alt 182	Note 6	Cyan	Brown	Normal

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
B7	183		Alt 183	Note 6	Cyan	Light Grey	Normal
B8	184		Alt 184	Note 6	Cyan	Dark Grey	High Intensity
B9	185		Alt 185	Note 6	Cyan	Light Blue	High Intensity Underline
BA	186		Alt 186	Note 6	Cyan	Light Green	High Intensity
BB	187		Alt 187	Note 6	Cyan	Light Cyan	High Intensity
BC	188		Alt 188	Note 6	Cyan	Light Red	High Intensity
BD	189		Alt 189	Note 6	Cyan	Light Magenta	High Intensity
BE	190		Alt 190	Note 6	Cyan	Yellow	High Intensity
BF	191		Alt 191	Note 6	Cyan	White	High Intensity
C0	192		Alt 192	Note 6	Red	Black	Normal
C1	193		Alt 193	Note 6	Red	Blue	Underline
C2	194		Alt 194	Note 6	Red	Green	Normal
C3	195		Alt 195	Note 6	Red	Cyan	Normal
C4	196		Alt 196	Note 6	Red	Red	Normal
C5	197		Alt 197	Note 6	Red	Magenta	Normal
C6	198		Alt 198	Note 6	Red	Brown	Normal
C7	199		Alt 199	Note 6	Red	Light Grey	Normal
C8	200		Alt 200	Note 6	Red	Dark Grey	High Intensity
C9	201		Alt 201	Note 6	Red	Light Blue	High Intensity Underline
CA	202		Alt 202	Note 6	Red	Light Green	High Intensity
CB	203		Alt 203	Note 6	Red	Light Cyan	High Intensity
CC	204		Alt 204	Note 6	Red	Light Red	High Intensity
CD	205		Alt 205	Note 6	Red	Light Magenta	High Intensity
CE	206		Alt 206	Note 6	Red	Yellow	High Intensity
CF	207		Alt 207	Note 6	Red	White	High Intensity
D0	208		Alt 208	Note 6	Magenta	Black	Normal

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
D1	209		Alt 209	Note 6	Magenta	Blue	Underline
D2	210		Alt 210	Note 6	Magenta	Green	Normal
D3	211		Alt 211	Note 6	Magenta	Cyan	Normal
D4	212		Alt 212	Note 6	Magenta	Red	Normal
D5	213		Alt 213	Note 6	Magenta	Magenta	Normal
D6	214		Alt 214	Note 6	Magenta	Brown	Normal
D7	215		Alt 215	Note 6	Magenta	Light Grey	Normal
D8	216		Alt 216	Note 6	Magenta	Dark Grey	High Intensity
D9	217		Alt 217	Note 6	Magenta	Light Blue	High Intensity Underline
DA	218		Alt 218	Note 6	Magenta	Light Green	High Intensity
DB	219		Alt 219	Note 6	Magenta	Light Cyan	High Intensity
DC	220		Alt 220	Note 6	Magenta	Light Red	High Intensity
DD	221		Alt 221	Note 6	Magenta	Light Magenta	High Intensity
DE	222		Alt 222	Note 6	Magenta	Yellow	High Intensity
DF	223		Alt 223	Note 6	Magenta	White	High Intensity
E0	224	α	Alt 224	Note 6	Brown	Black	Normal
E1	225	β	Alt 225	Note 6	Brown	Blue	Underline
E2	226	Γ	Alt 226	Note 6	Brown	Green	Normal
E3	227	π	Alt 227	Note 6	Brown	Cyan	Normal
E4	228	Σ	Alt 228	Note 6	Brown	Red	Normal
E5	229	σ	Alt 229	Note 6	Brown	Magenta	Normal
E6	230	μ	Alt 230	Note 6	Brown	Brown	Normal
E7	231	τ	Alt 231	Note 6	Brown	Light Grey	Normal
E8	232	Φ	Alt 232	Note 6	Brown	Dark Grey	High Intensity
E9	233	θ	Alt 233	Note 6	Brown	Light Blue	High Intensity Underline
EA	234	Ω	Alt 234	Note 6	Brown	Light Green	High Intensity
EB	235	δ	Alt 235	Note 6	Brown	Light Cyan	High Intensity

Value		As Characters			As Text Attributes		
					Color/Graphics Monitor Adapter		IBM Monochrome Display Adapter
Hex	Dec	Symbol	Keystrokes	Modes	Background	Foreground	
EC	236	∞	Alt 236	Note 6	Brown	Light Red	High Intensity
ED	237	φ	Alt 237	Note 6	Brown	Light Magenta	High Intensity
EE	238	∈	Alt 238	Note 6	Brown	Yellow	High Intensity
EF	239	∩	Alt 239	Note 6	Brown	White	High Intensity
F0	240	≡	Alt 240	Note 6	Light Grey	Black	Reverse Video
F1	241	±	Alt 241	Note 6	Light Grey	Blue	Underline
F2	242	≥	Alt 242	Note 6	Light Grey	Green	Normal
F3	243	≤	Alt 243	Note 6	Light Grey	Cyan	Normal
F4	244	⌠	Alt 244	Note 6	Light Grey	Red	Normal
F5	245	⌡	Alt 245	Note 6	Light Grey	Magenta	Normal
F6	246	÷	Alt 246	Note 6	Light Grey	Brown	Normal
F7	247	≈	Alt 247	Note 6	Light Grey	Light Grey	Normal
F8	248	○	Alt 248	Note 6	Light Grey	Dark Grey	Reverse Video
F9	249	●	Alt 249	Note 6	Light Grey	Light Blue	High Intensity Underline
FA	250	•	Alt 250	Note 6	Light Grey	Light Green	High Intensity
FB	251	√	Alt 251	Note 6	Light Grey	Light Cyan	High Intensity
FC	252	^{n}	Alt 252	Note 6	Light Grey	Light Red	High Intensity
FD	253	^{2}	Alt 253	Note 6	Light Grey	Light Magenta	High Intensity
FE	254	■	Alt 254	Note 6	Light Grey	Yellow	High Intensity
FF	255	**BLANK**	Alt 255	Note 6	Light Grey	White	High Intensity

Notes:

1. Asterisk (*) can be typed using two methods: press the (PrtSc/*) key or, in the shift mode, press the 8 key.

2. Period (.) can be typed using two methods: press the . key or, in the shift or Num Lock mode, press the Del key.

3. Numeric characters 0-9 can be typed using two methods: press the numeric keys on the top row of the keyboard or, in the shift or Num Lock mode, press the numeric keys in the keypad portion of the keyboard.

4. Uppercase alphabetic characters (A-Z) can be typed in two modes: the shift mode or the Caps Lock mode.

5. Lowercase alphabetic characters (a-z) can be typed in two modes: in the normal mode or in Caps Lock and shift mode combined.

6. The three digits after the Alt key must be typed from the numeric keypad. Character codes 001-255 may be entered in this fashion (with Caps Lock activated, character codes 97-122 will display uppercase).

Quick Reference

DECIMAL VALUE	➡	0	16	32	48	64	80	96	112
⬇	HEXA-DECIMAL VALUE	0	1	2	3	4	5	6	7
0	0	BLANK (NULL)	►	BLANK (SPACE)	0	@	P	‘	p
1	1	☺	◄	!	1	A	Q	a	q
2	2	☻	↕	"	2	B	R	b	r
3	3	♥	!!	#	3	C	S	c	s
4	4	♦	¶	$	4	D	T	d	t
5	5	♣	§	%	5	E	U	e	u
6	6	♠	▬	&	6	F	V	f	v
7	7	•	↨	’	7	G	W	g	w
8	8	◘	↑	(	8	H	X	h	x
9	9	○	↓	)	9	I	Y	i	y
10	A	◙	→	*	:	J	Z	j	z
11	B	♂	←	+	;	K	[	k	{
12	C	♀	∟	,	<	L	\	l	¦
13	D	♪	↔	—	=	M	]	m	}
14	E	♫	▲	.	>	N	^	n	~
15	F	☼	▼	/	?	O	_	o	△

DECIMAL VALUE ➡		128	144	160	176	192	208	224	240
⬇	HEXA-DECIMAL VALUE	8	9	A	B	C	D	E	F
0	0	Ç	É	á	⣿	└	╨	∝	≡
1	1	ü	æ	í	⣿	┴	╤	β	±
2	2	é	Æ	ó	⣿	┬	╥	Γ	≥
3	3	â	ô	ú	⣿	├	╙	π	≤
4	4	ä	ö	ñ	⣿	─	╘	Σ	⌠
5	5	à	ò	Ñ	⣿	┼	╒	σ	⌡
6	6	å	û	ª	⣿	╞	╓	µ	÷
7	7	ç	ù	º	⣿	╟	╫	τ	≈
8	8	ê	ÿ	¿	⣿	╚	╪	Φ	°
9	9	ë	Ö	⌐	⣿	╔	┘	Θ	∙
10	A	è	Ü	¬	⣿	╩	┌	Ω	·
11	B	ï	¢	½	⣿	╦	■	δ	√
12	C	î	£	¼	⣿	╠	▄	∞	n
13	D	ì	¥	¡	⣿	═	▌	φ	2
14	E	Ä	₧	«	⣿	╬	▐	∈	■
15	F	Å	ƒ	»	⣿	╧	▀	∩	BLANK 'FF'

Notes:

Glossary

This glossary includes terms and definitions from the *IBM Vocabulary for Data Processing, Telecommunications, and Office Systems,* GC20-1699.

μ. Prefix micro; 0.000 001.

μs. Microsecond; 0.000 001 second.

A. Ampere.

ac. Alternating current.

accumulator. A register in which the result of an operation is formed.

active high. Designates a signal that has to go high to produce an effect. Synonymous with positive true.

active low. Designates a signal that has to go low to produce an effect. Synonymous with negative true.

adapter. An auxiliary device or unit used to extend the operation of another system.

address bus. One or more conductors used to carry the binary-coded address from the processor throughout the rest of the system.

algorithm. A finite set of well-defined rules for the solution of a problem in a finite number of steps.

all points addressable (APA). A mode in which all points of a displayable image can be controlled by the user.

alphameric. Synonym for alphanumeric.

alphanumeric (A/N). Pertaining to a character set that contains letters, digits, and usually other characters, such as punctuation marks. Synonymous with alphameric.

alternating current (ac). A current that periodically reverses its direction of flow.

American National Standard Code for Information Interchange (ASCII). The standard code, using a coded character set consisting of 7-bit coded characters (8 bits including parity check), used for information exchange between data processing systems, data communication systems, and associated equipment. The ASCII set consists of control characters and graphic characters.

ampere (A). The basic unit of electric current.

A/N. Alphanumeric

analog. (1) Pertaining to data in the form of continuously variable physical quantities. (2) Contrast with digital.

AND. A logic operator having the property that if P is a statement, Q is a statement, R is a statement,..., then the AND of P, Q, R,...is true if all statements are true, false if any statement is false.

AND gate. A logic gate in which the output is 1 only if all inputs are 1.

AND operation. The boolean operation whose result has the boolean value 1, if and only if, each operand has the boolean value 1. Synonymous with conjunction.

APA. All points addressable.

ASCII. American National Standard Code for Information Interchange.

assemble. To translate a program expressed in an assembler language into a computer language.

assembler. A computer program used to assemble.

assembler language. A computer-oriented language whose instructions are usually in one-to-one correspondence with computer instructions.

asynchronous transmission. (1) Transmission in which the time of occurrence of the start of each character, or block of characters, is arbitrary; once started, the time of occurrence of each signal representing a bit within a character, or block, has the same relationship to significant instants of a fixed time frame. (2) Transmission in which each information character is individually transmitted (usually timed by the use of start elements and stop elements).

audio frequencies. Frequencies that can be heard by the human ear (approximately 15 hertz to 20,000 hertz).

auxiliary storage. (1) A storage device that is not main storage. (2) Data storage other than main storage; for example, storage on magnetic disk. (3) Contrast with main storage.

BASIC. Beginner's all-purpose symbolic instruction code.

basic input/output system (BIOS). The feature of the IBM Personal Computer that provides the level control of the major I/O devices, and relieves the programmer from concern about hardware device characteristics.

baud. (1) A unit of signaling speed equal to the number of discrete conditions or signal events per second. For example, one baud equals one bit per second in a train of binary signals, one-half dot cycle per second in Morse code, and one 3-bit value per second in a train of signals each of which can assume one of eight different states. (2) In asynchronous transmission, the unit of modulation rate corresponding to one unit of interval per second; that is, if the duration of the unit interval is 20 milliseconds, the modulation rate is 50 baud.

BCC. Block-check character.

beginner's all-purpose symbolic instruction code (BASIC). A programming language with a small repertoire of commands and a simple syntax, primarily designed for numeric applications.

binary. (1) Pertaining to a selection, choice, or condition that has two possible values or states. (2) Pertaining to a fixed radix numeration system having a radix of 2.

binary digit. (1) In binary notation, either of the characters 0 or 1. (2) Synonymous with bit.

binary notation. Any notation that uses two different characters, usually the binary digits 0 and 1.

binary synchronous communications (BSC). A uniform procedure, using a standardized set of control characters and control character sequences for synchronous transmission of binary–coded data between stations.

BIOS. Basic input/output system.

bit. Synonym for binary digit

bits per second (bps). A unit of measurement representing the number of discrete binary digits transmitted by a device in one second.

block. (1) A string of records, a string of words, or a character string formed for technical or logic reasons to be treated as an entity. (2) A set of things, such as words, characters, or digits, treated as a unit.

block-check character (BCC). In cyclic redundancy checking, a character that is transmitted by the sender after each message block and is compared with a block-check character computed by the receiver to determine if the transmission was successful.

boolean operation. (1) Any operation in which each of the operands and the result take one of two values. (2) An operation that follows the rules of boolean algebra.

bootstrap. A technique or device designed to bring itself into a desired state by means of its own action; for example, a machine routine whose first few instructions are sufficient to bring the rest of itself into the computer from an input device.

bps. Bits per second.

BSC. Binary synchronous communications.

buffer. (1) An area of storage that is temporarily reserved for use in performing an input/output operation, into which data is read or from which data is written. Synonymous with I/O area. (2) A portion of storage for temporarily holding input or output data.

bus. One or more conductors used for transmitting signals or power.

byte. (1) A sequence of eight adjacent binary digits that are operated upon as a unit. (2) A binary character operated upon as a unit. (3) The representation of a character.

C. Celsius.

capacitor. An electronic circuit component that stores an electric charge.

Cartesian coordinates. A system of coordinates for locating a point on a plane by its distance from each of two intersecting lines, or in space by its distance from each of three mutually perpendicular planes.

CAS. Column address strobe.

cathode ray tube (CRT). A vacuum tube in which a stream of electrons is projected onto a fluorescent screen producing a luminous spot. The location of the spot can be controlled.

cathode ray tube display (CRT display). (1) A CRT used for displaying data. For example, the electron beam can be controlled to form alphanumeric data by use of a dot matrix.
(2) Synonymous with monitor.

CCITT. International Telegraph and Telephone Consultative Committee.

Celsius (C). A temperature scale. Contrast with Fahrenheit (F).

central processing unit (CPU). Term for processing unit.

channel. A path along which signals can be sent; for example, data channel, output channel.

character generator. (1) In computer graphics, a functional unit that converts the coded representation of a graphic character into the shape of the character for display. (2) In word processing, the means within equipment for generating visual characters or symbols from coded data.

character set. (1) A finite set of different characters upon which agreement has been reached and that is considered complete for some purpose. (2) A set of unique representations called characters. (3) A defined collection of characters.

characters per second (cps). A standard unit of measurement for the speed at which a printer prints.

check key. A group of characters, derived from and appended to a data item, that can be used to detect errors in the data item during processing.

clipping. In computer graphics, removing parts of a display image that lie outside a window.

closed circuit. A continuous unbroken circuit; that is, one in which current can flow. Contrast with open circuit.

CMOS. Complementary metal oxide semiconductor.

code. (1) A set of unambiguous rules specifying the manner in which data may be represented in a discrete form. Synonymous with coding scheme. (2) A set of items, such as abbreviations, representing the members of another set. (3) To represent data or a computer program in a symbolic form that can be accepted by a data processor. (4) Loosely, one or more computer programs, or part of a computer program.

coding scheme. Synonym for code.

collector. An element in a transistor toward which current flows.

color cone. An arrangement of the visible colors on the surface of a double-ended cone where lightness varies along the axis of

the cone, and hue varies around the circumference. Lightness includes both the intensity and saturation of color.

column address strobe (CAS). A signal that latches the column addresses in a memory chip.

compile. (1) To translate a computer program expressed in a problem-oriented language into a computer-oriented language. (2) To prepare a machine-language program from a computer program written in another programming language by making use of the overall logic structure of the program, or generating more than one computer instruction for each symbolic statement, or both, as well as performing the function of an assembler.

complement. A number that can be derived from a specified number by subtracting it from a second specified number.

complementary metal oxide semiconductor (CMOS). A logic circuit family that uses very little power. It works with a wide range of power supply voltages.

computer. A functional unit that can perform substantial computation, including numerous arithmetic operations or logic operations, without human intervention during a run.

computer instruction code. A code used to represent the instructions in an instruction set. Synonymous with machine code.

computer program. A sequence of instructions suitable for processing by a computer.

computer word. A word stored in one computer location and capable of being treated as a unit.

configuration. (1) The arrangement of a computer system or network as defined by the nature, number, and the chief characteristics of its functional units. More specifically, the term configuration may refer to a hardware configuration or a software configuration. (2) The devices and programs that make up a system, subsystem, or network.

conjunction. Synonym for AND operation.

contiguous. Touching or joining at the edge or boundary; adjacent.

control character. A character whose occurrence in a particular context initiates, modifies, or stops a control operation.

control operation. An action that affects the recording, processing, transmission, or interpretation of data; for example, starting or stopping a process, carriage return, font change, rewind, and end of transmission.

control storage. A portion of storage that contains microcode.

coordinate space. In computer graphics, a system of Cartesian coordinates in which an object is defined.

cps. Characters per second.

CPU. Central processing unit.

CRC. Cyclic redundancy check.

CRT. Cathode ray tube.

CRT display. Cathode ray tube display.

CTS. Clear to send. Associated with modem control.

cursor. (1) In computer graphics, a movable marker that is used to indicate position on a display. (2) A displayed symbol that acts as a marker to help the user locate a point in text, in a system command, or in storage. (3) A movable spot of light on the screen of a display device, usually indicating where the next character is to be entered, replaced, or deleted.

cyclic redundancy check (CRC). (1) A redundancy check in which the check key is generated by a cyclic algorithm. (2) A system of error checking performed at both the sending and receiving station after a block-check character has been accumulated.

cylinder. (1) The set of all tracks with the same nominal distance from the axis about which the disk rotates. (2) The

tracks of a disk storage device that can be accessed without repositioning the access mechanism.

daisy-chained cable. A type of cable that has two or more connectors attached in series.

data. (1) A representation of facts, concepts, or instructions in a formalized manner suitable for communication, interpretation, or processing by human or automatic means. (2) Any representations, such as characters or analog quantities, to which meaning is, or might be assigned.

data base. A collection of data that can be immediately accessed and operated upon by a data processing system for a specific purpose.

data processing system. A system that performs input, processing, storage, output, and control functions to accomplish a sequence of operations on data.

data transmission. Synonym for transmission.

dB. Decibel.

dBa. Adjusted decibels.

dc. Direct current.

debounce. (1) An electronic means of overcoming the make/break bounce of switches to obtain one smooth change of signal level. (2) The elimination of undesired signal variations caused by mechanically generated signals from contacts.

decibel. (1) A unit that expresses the ratio of two power levels on a logarithmic scale. (2) A unit for measuring relative power.

decoupling capacitor. A capacitor that provides a low impedance path to ground to prevent common coupling between circuits.

Deutsche Industrie Norm (DIN). (1) German Industrial Norm. (2) The committee that sets German dimension standards.

digit. (1) A graphic character that represents an integer; for example, one of the characters 0 to 9. (2) A symbol that

represents one of the non-negative integers smaller than the radix. For example, in decimal notation, a digit is one of the characters 0 to 9.

digital. (1) Pertaining to data in the form of digits. (2) Contrast with analog.

DIN. Deutsche Industrie Norm.

DIN connector. One of the connectors specified by the DIN committee.

DIP. Dual in-line package.

DIP switch. One of a set of small switches mounted in a dual in-line package.

direct current (dc). A current that always flows in one direction.

direct memory access (DMA). A method of transferring data between main storage and I/O devices that does not require processor intervention.

disable. To stop the operation of a circuit or device.

disabled. Pertaining to a state of a processing unit that prevents the occurrence of certain types of interruptions. Synonymous with masked.

disk. Loosely, a magnetic disk.

diskette. A thin, flexible magnetic disk and a semirigid protective jacket, in which the disk is permanently enclosed. Synonymous with flexible disk.

diskette drive. A device for storing data on and retrieving data from a diskette.

display. (1) A visual presentation of data. (2) A device for visual presentation of information on any temporary character imaging device. (3) To present data visually. (4) See cathode ray tube display.

display attribute. In computer graphics, a particular property that is assigned to all or part of a display; for example, low intensity, green color, blinking status.

display element. In computer graphics, a basic graphic element that can be used to construct a display image; for example, a dot, a line segment, a character.

display group. In computer graphics, a collection of display elements that can be manipulated as a unit and that can be further combined to form larger groups.

display image. In computer graphics, a collection of display elements or display groups that are represented together at any one time in a display space.

display space. In computer graphics, that portion of a display surface available for a display image. The display space may be all or part of a display surface.

display surface. In computer graphics, that medium on which display images may appear; for example, the entire screen of a cathode ray tube.

DMA. Direct memory access.

dot matrix. (1) In computer graphics, a two-dimensional pattern of dots used for constructing a display image. This type of matrix can be used to represent characters by dots. (2) In word processing, a pattern of dots used to form characters. This term normally refers to a small section of a set of addressable points; for example, a representation of characters by dots.

dot printer. Synonym for matrix printer.

dot-matrix character generator. In computer graphics, a character generator that generates character images composed of dots.

drawing primitive. A group of commands that draw defined geometric shapes.

DSR. Data set ready. Associated with modem control.

DTR. In the IBM Personal Computer, data terminal ready. Associated with modem control.

dual in-line package (DIP). A widely used container for an integrated circuit. DIPs have pins in two parallel rows. The pins are spaced 1/10 inch apart. See also DIP switch.

duplex. (1) In data communication, pertaining to a simultaneous two-way independent transmission in both directions. (2) Contrast with half-duplex.

duty cycle. In the operation of a device, the ratio of on time to idle time. Duty cycle is expressed as a decimal or percentage.

dynamic memory. RAM using transistors and capacitors as the memory elements. This memory requires a refresh (recharge) cycle every few milliseconds. Contrast with static memory.

EBCDIC. Extended binary-coded decimal interchange code.

ECC. Error checking and correction.

edge connector. A terminal block with a number of contacts attached to the edge of a printed-circuit board to facilitate plugging into a foundation circuit.

EIA. Electronic Industries Association.

electromagnet. Any device that exhibits magnetism only while an electric current flows through it.

enable. To initiate the operation of a circuit or device.

end of block (EOB). A code that marks the end of a block of data.

end of file (EOF). An internal label, immediately following the last record of a file, signaling the end of that file. It may include control totals for comparison with counts accumulated during processing.

end-of-text (ETX). A transmission control character used to terminate text.

end-of-transmission (EOT). A transmission control character used to indicate the conclusion of a transmission, which may have included one or more texts and any associated message headings.

end-of-transmission-block (ETB). A transmission control character used to indicate the end of a transmission block of data when data is divided into such blocks for transmission purposes.

EOB. End of block.

EOF. End of file.

EOT. End-of-transmission.

EPROM. Erasable programmable read-only memory.

erasable programmable read-only memory (EPROM). A PROM in which the user can erase old information and enter new information.

error checking and correction (ECC). The detection and correction of all single-bit errors, plus the detection of double-bit and some multiple-bit errors.

ESC. The escape character.

escape character (ESC). A code extension character used, in some cases, with one or more succeeding characters to indicate by some convention or agreement that the coded representations following the character or the group of characters are to be interpreted according to a different code or according to a different coded character set.

ETB. End-of-transmission-block.

ETX. End-of-text.

extended binary-coded decimal interchange code (EBCDIC). A set of 256 characters, each represented by eight bits.

F. Fahrenheit.

Fahrenheit (F). A temperature scale. Contrast with Celsius (C).

falling edge. Synonym for negative-going edge.

FCC. Federal Communications Commission.

fetch. To locate and load a quantity of data from storage.

FF. The form feed character.

field. (1) In a record, a specified area used for a particular category of data. (2) In a data base, the smallest unit of data that can be referred to.

field-programmable logic sequencer (FPLS). An integrated circuit containing a programmable, read-only memory that responds to external inputs and feedback of its own outputs.

FIFO (first-in-first out). A queuing technique in which the next item to be retrieved is the item that has been in the queue for the longest time.

fixed disk drive. In the IBM Personal Computer, a unit consisting of nonremovable magnetic disks, and a device for storing data on and retrieving data from the disks.

flag. (1) Any of various types of indicators used for identification. (2) A character that signals the occurrence of some condition, such as the end of a word. (3) Deprecated term for mark.

flexible disk. Synonym for diskette.

flip-flop. A circuit or device containing active elements, capable of assuming either one of two stable states at a given time.

font. A family or assortment of characters of a given size and style; for example, 10 point Press Roman medium.

foreground. (1) In multiprogramming, the environment in which high-priority programs are executed. (2) On a color display screen, the characters as opposed to the background.

form feed. (1) Paper movement used to bring an assigned part of a form to the printing position. (2) In word processing, a

function that advances the typing position to the same character position on a predetermined line of the next form or page.

form feed character. A control character that causes the print or display position to move to the next predetermined first line on the next form, the next page, or the equivalent.

format. The arrangement or layout of data on a data medium.

FPLS. Field-programmable logic sequencer.

frame. (1) In SDLC, the vehicle for every command, every response, and all information that is transmitted using SDLC procedures. Each frame begins and ends with a flag. (2) In data transmission, the sequence of contiguous bits bracketed by and including beginning and ending flag sequences.

g. Gram.

G. (1) Prefix giga; 1,000,000,000. (2) When referring to computer storage capacity, 1,073,741,824. (1,073,741,824 = 2 to the 30th power.)

gate. (1) A combinational logic circuit having one output channel and one or more input channels, such that the output channel state is completely determined by the input channel states. (2) A signal that enables the passage of other signals through a circuit.

Gb. 1,073,741,824 bytes.

general-purpose register. A register, usually explicitly addressable within a set of registers, that can be used for different purposes; for example, as an accumulator, as an index register, or as a special handler of data.

giga (G). Prefix 1,000,000,000.

gram (g). A unit of weight (equivalent to 0.035 ounces).

graphic. A symbol produced by a process such as handwriting, drawing, or printing.

graphic character. A character, other than a control character, that is normally represented by a graphic.

half-duplex. (1) In data communication, pertaining to an alternate, one way at a time, independent transmission. (2) Contrast with duplex.

hardware. (1) Physical equipment used in data processing, as opposed to programs, procedures, rules, and associated documentation. (2) Contrast with software.

head. A device that reads, writes, or erases data on a storage medium; for example, a small electromagnet used to read, write, or erase data on a magnetic disk.

hertz (Hz). A unit of frequency equal to one cycle per second.

hex. Common abbreviation for hexadecimal. Also, hexidecimal can be noted as X' '.

hexadecimal. (1) Pertaining to a selection, choice, or condition that has 16 possible different values or states. These values or states are usually symbolized by the ten digits 0 through 9 and the six letters A through F. (2) Pertaining to a fixed radix numeration system having a radix of 16.

high impedance state. A state in which the output of a device is effectively isolated from the circuit.

highlighting. In computer graphics, emphasizing a given display group by changing its attributes relative to other display groups in the same display field.

high-order position. The leftmost position in a string of characters. See also most-significant digit.

hither plane. In computer graphics, a plane that is perpendicular to the line joining the viewing reference point and the view point and that lies between these two points. Any part of an object between the hither plane and the view point is not seen. See also yon plane.

housekeeping. Operations or routines that do not contribute directly to the solution of the problem but do contribute directly to the operation of the computer.

Hz. Hertz

image. A fully processed unit of operational data that is ready to be transmitted to a remote unit; when loaded into control storage in the remote unit, the image determines the operations of the unit.

immediate instruction. An instruction that contains within itself an operand for the operation specified, rather than an address of the operand.

index register. A register whose contents may be used to modify an operand address during the execution of computer instructions.

indicator. (1) A device that may be set into a prescribed state, usually according to the result of a previous process or on the occurrence of a specified condition in the equipment, and that usually gives a visual or other indication of the existence of the prescribed state, and that may in some cases be used to determine the selection among alternative processes; for example, an overflow indicator. (2) An item of data that may be interrogated to determine whether a particular condition has been satisfied in the execution of a computer program; for example, a switch indicator, an overflow indicator.

inhibited. (1) Pertaining to a state of a processing unit in which certain types of interruptions are not allowed to occur. (2) Pertaining to the state in which a transmission control unit or an audio response unit cannot accept incoming calls on a line.

initialize. To set counters, switches, addresses, or contents of storage to 0 or other starting values at the beginning of, or at prescribed points in, the operation of a computer routine.

input/output (I/O). (1) Pertaining to a device or to a channel that may be involved in an input process, and, at a different time, in an output process. In the English language, "input/output" may be used in place of such terms as "input/output data," "input/output signal," and "input/output terminals," when such usage is clear in a given context. (2) Pertaining to a device

whose parts can be performing an input process and an output process at the same time. (3) Pertaining to either input or output, or both.

instruction. In a programming language, a meaningful expression that specifies one operation and identifies its operands, if any.

instruction set. The set of instructions of a computer, of a programming language, or of the programming languages in a programming system.

intensity. In computer graphics, the amount of light emitted at a display point

interface. A device that alters or converts actual electrical signals between distinct devices, programs, or systems.

interleave. To arrange parts of one sequence of things or events so that they alternate with parts of one or more other sequences of the same nature and so that each sequence retains its identity.

interrupt. (1) A suspension of a process, such as the execution of a computer program, caused by an event external to that process, and performed in such a way that the process can be resumed. (2) In a data transmission, to take an action at a receiving station that causes the transmitting station to terminate a transmission. (3) Synonymous with interruption.

I/O. Input/output.

I/O area. Synonym for buffer.

irrecoverable error. An error that makes recovery impossible without the use of recovery techniques external to the computer program or run.

joystick. In computer graphics, a lever that can pivot in all directions and that is used as a locator device.

k. Prefix kilo; 1000.

K. When referring to storage capacity, 1024. (1024 = 2 to the 10th power.)

KB. 1024 bytes.

key lock. A device that deactivates the keyboard and locks the cover on for security.

kg. Kilogram; 1000 grams.

kHz. Kilohertz; 1000 hertz.

kilo (k). Prefix 1000

kilogram (kg). 1000 grams.

kilohertz (kHz). 1000 hertz

latch. (1) A simple logic-circuit storage element. (2) A feedback loop in sequential digital circuits used to maintain a state.

least-significant digit. The rightmost digit. See also low-order position.

LED. Light-emitting diode.

light-emitting diode (LED). A semiconductor device that gives off visible or infrared light when activated.

load. In programming, to enter data into storage or working registers.

look-up table (LUT). (1) A technique for mapping one set of values into a larger set of values. (2) In computer graphics, a table that assigns a color value (red, green, blue intensities) to a color index.

low power Schottky TTL. A version (LS series) of TTL giving a good compromise between low power and high speed. See also transistor-transistor logic and Schottky TTL.

low-order position. The rightmost position in a string of characters. See also least-significant digit.

luminance. The luminous intensity per unit projected area of a given surface viewed from a given direction.

LUT. Look-up table.

m. (1) Prefix milli; 0.001. (2) Meter.

M. (1) Prefix mega; 1,000,000. (2) When referring to computer storage capacity, 1,048,576. (1,048,576 = 2 to the 20th power.)

mA. Milliampere; 0.001 ampere.

machine code. The machine language used for entering text and program instructions onto the recording medium or into storage and which is subsequently used for processing and printout.

machine language. (1) A language that is used directly by a machine. (2) Deprecated term for computer instruction code.

magnetic disk. (1) A flat circular plate with a magnetizable surface layer on which data can be stored by magnetic recording. (2) See also diskette.

main storage. (1) Program-addressable storage from which instructions and other data can be loaded directly into registers for subsequent execution or processing. (2) Contrast with auxiliary storage.

mark. A symbol or symbols that indicate the beginning or the end of a field, of a word, of an item of data, or of a set of data such as a file, a record, or a block.

mask. (1) A pattern of characters that is used to control the retention or elimination of portions of another pattern of characters. (2) To use a pattern of characters to control the retention or elimination of portions of another pattern of characters.

masked. Synonym for disabled.

matrix. (1) A rectangular array of elements, arranged in rows and columns, that may be manipulated according to the rules of matrix algebra. (2) In computers, a logic network in the form of an array of input leads and output leads with logic elements connected at some of their intersections.

matrix printer. A printer in which each character is represented by a pattern of dots; for example, a stylus printer, a wire printer. Synonymous with dot printer.

MB. 1,048,576 bytes.

mega (M). Prefix 1,000,000.

megahertz (MHz). 1,000,000 hertz.

memory. Term for main storage.

meter (m). A unit of length (equivalent to 39.37 inches).

MFM. Modified frequency modulation.

MHz. Megahertz; 1,000,000 hertz.

micro (μ). Prefix 0.000,001.

microcode. (1) One or more microinstructions. (2) A code, representing the instructions of an instruction set, implemented in a part of storage that is not program-addressable.

microinstruction. (1) An instruction of microcode. (2) A basic or elementary machine instruction.

microprocessor. An integrated circuit that accepts coded instructions for execution; the instructions may be entered, integrated, or stored internally.

microsecond (μs). 0.000,001 second.

milli (m). Prefix 0.001.

milliampere (mA). 0.001 ampere.

millisecond (ms). 0.001 second.

mnemonic. A symbol chosen to assist the human memory; for example, an abbreviation such as "mpy" for "multiply."

mode. (1) A method of operation; for example, the binary mode, the interpretive mode, the alphanumeric mode. (2) The most frequent value in the statistical sense.

modeling transformation. Operations on the coordinates of an object (usually matrix multiplications) that cause the object to be rotated about any axis, translated (moved without rotating), and/or scaled (changed in size along any or all dimensions). See also viewing transformation.

modem (modulator-demodulator). A device that converts serial (bit by bit) digital signals from a business machine (or data communication equipment) to analog signals that are suitable for transmission in a telephone network. The inverse function is also performed by the modem on reception of analog signals.

modified frequency modulation (MFM). The process of varying the amplitude and frequency of the 'write' signal. MFM pertains to the number of bytes of storage that can be stored on the recording media. The number of bytes is twice the number contained in the same unit area of recording media at single density.

modulation. The process by which some characteristic of one wave (usually high frequency) is varied in accordance with another wave or signal (usually low frequency). This technique is used in modems to make business-machine signals compatible with communication facilities.

modulation rate. The reciprocal of the measure of the shortest nominal time interval between successive significant instants of the modulated signal. If this measure is expressed in seconds, the modulation rate is expressed in baud.

module. (1) A program unit that is discrete and identifiable with respect to compiling, combining with other units, and loading. (2) A packaged functional hardware unit designed for use with other components.

modulo check. A calculation performed on values entered into a system. This calculation is designed to detect errors.

modulo-N check. A check in which an operand is divided by a number N (the modulus) to generate a remainder (check digit)

that is retained with the operand. For example, in a modulo-7 check, the remainder will be 0, 1, 2, 3, 4, 5, or 6. The operand is later checked by again dividing it by the modulus; if the remainder is not equal to the check digit, an error is indicated.

modulus. In a modulo-N check, the number by which the operand is divided.

monitor. Synonym for cathode ray tube display (CRT display).

most-significant digit. The leftmost (non-zero) digit. See also high-order position.

ms. Millisecond; 0.001 second.

multiplexer. A device capable of interleaving the events of two or more activities, or capable of distributing the events of an interleaved sequence to the respective activities.

multiprogramming. (1) Pertaining to the concurrent execution of two or more computer programs by a computer. (2) A mode of operation that provides for the interleaved execution of two or more computer programs by a single processor.

n. Prefix nano; 0.000,000,001.

NAND. A logic operator having the property that if P is a statement, Q is a statement, R is a statement,..., then the NAND of P, Q ,R,... is true if at least one statement is false, false if all statements are true.

NAND gate. A gate in which the output is 0 only if all inputs are 1.

nano (n). Prefix 0.000,000,001.

nanosecond (ns). 0.000,000,001 second.

negative true. Synonym for active low.

negative-going edge. The edge of a pulse or signal changing in a negative direction. Synonymous with falling edge.

non-return-to-zero change-on-ones recording (NRZI). A transmission encoding method in which the data terminal equipment changes the signal to the opposite state to send a binary 1 and leaves it in the same state to send a binary 0.

non-return-to-zero (inverted) recording (NRZI). Deprecated term for non-return-to-zero change-on-ones recording.

NOR. A logic operator having the property that if P is a statement, Q is a statement, R is a statement,..., then the NOR of P, Q, R,... is true if all statements are false, false if at least one statement is true.

NOR gate. A gate in which the output is 0 only if at least one input is 1.

NOT. A logical operator having the property that if P is a statement, then the NOT of P is true if P is false, false if P is true.

NRZI. Non-return-to-zero change-on-ones recording.

ns. Nanosecond; 0.000,000,001 second.

NUL. The null character.

null character (NUL). A control character that is used to accomplish media-fill or time-fill, and that may be inserted into or removed from, a sequence of characters without affecting the meaning of the sequence; however, the control of the equipment or the format may be affected by this character.

odd-even check. Synonym for parity check.

offline. Pertaining to the operation of a functional unit without the continual control of a computer.

one-shot. A circuit that delivers one output pulse of desired duration for each input (trigger) pulse.

open circuit. (1) A discontinuous circuit; that is, one that is broken at one or more points and, consequently, cannot conduct current. Contrast with closed circuit. (2) Pertaining to a no-load condition; for example, the open-circuit voltage of a power supply.

open collector. A switching transistor without an internal connection between its collector and the voltage supply. A connection from the collector to the voltage supply is made through an external (pull-up) resistor.

operand. (1) An entity to which an operation is applied. (2) That which is operated upon. An operand is usually identified by an address part of an instruction.

operating system. Software that controls the execution of programs; an operating system may provide services such as resource allocation, scheduling, input/output control, and data management.

OR. A logic operator having the property that if P is a statement, Q is a statement, R is a statement,..., then the OR of P, Q, R,...is true if at least one statement is true, false if all statements are false.

OR gate. A gate in which the output is 1 only if at least one input is 1.

output. Pertaining to a device, process, or channel involved in an output process, or to the data or states involved in an output process.

output process. (1) The process that consists of the delivery of data from a data processing system, or from any part of it. (2) The return of information from a data processing system to an end user, including the translation of data from a machine language to a language that the end user can understand.

overcurrent. A current of higher than specified strength.

overflow indicator. (1) An indicator that signifies when the last line on a page has been printed or passed. (2) An indicator that is set on if the result of an arithmetic operation exceeds the capacity of the accumulator.

overrun. Loss of data because a receiving device is unable to accept data at the rate it is transmitted.

overvoltage. A voltage of higher than specified value.

parallel. (1) Pertaining to the concurrent or simultaneous operation of two or more devices, or to the concurrent performance of two or more activities. (2) Pertaining to the concurrent or simultaneous occurrence of two or more related activities in multiple devices or channels. (3) Pertaining to the simultaneity of two or more processes. (4) Pertaining to the simultaneous processing of the individual parts of a whole, such as the bits of a character and the characters of a word, using separate facilities for the various parts. (5) Contrast with serial.

parameter. (1) A variable that is given a constant value for a specified application and that may denote the application. (2) A name in a procedure that is used to refer to an argument passed to that procedure.

parity bit. A binary digit appended to a group of binary digits to make the sum of all the digits either always odd (odd parity) or always even (even parity).

parity check. (1) A redundancy check that uses a parity bit. (2) Synonymous with odd-even check.

PEL. Picture element.

personal computer. A small home or business computer that has a processor and keyboard and that can be connected to a television or some other monitor. An optional printer is usually available.

phototransistor. A transistor whose switching action is controlled by light shining on it.

picture element (PEL). The smallest displayable unit on a display.

polling. (1) Interrogation of devices for purposes such as to avoid contention, to determine operational status, or to determine readiness to send or receive data. (2) The process whereby stations are invited, one at a time, to transmit.

port. An access point for data entry or exit.

positive true. Synonym for active high.

positive-going edge. The edge of a pulse or signal changing in a positive direction. Synonymous with rising edge.

potentiometer. A variable resistor with three terminals, one at each end and one on a slider (wiper).

power supply. A device that produces the power needed to operate electronic equipment.

printed circuit. A pattern of conductors (corresponding to the wiring of an electronic circuit) formed on a board of insulating material.

printed-circuit board. A usually copper-clad plastic board used to make a printed circuit.

priority. A rank assigned to a task that determines its precedence in receiving system resources.

processing program. A program that performs such functions as compiling, assembling, or translating for a particular programming language.

processing unit. A functional unit that consists of one or more processors and all or part of internal storage.

processor. (1) In a computer, a functional unit that interprets and executes instructions. (2) A functional unit, a part of another unit such as a terminal or a processing unit, that interprets and executes instructions. (3) Deprecated term for processing program. (4) See microprocessor.

program. (1) A series of actions designed to achieve a certain result. (2) A series of instructions telling the computer how to handle a problem or task. (3) To design, write, and test computer programs.

programmable read-only memory (PROM). A read-only memory that can be programmed by the user.

programming language. (1) An artificial language established for expressing computer programs. (2) A set of characters and rules with meanings assigned prior to their use, for writing computer programs.

programming system. One or more programming languages and the necessary software for using these languages with particular automatic data-processing equipment.

PROM. Programmable read-only memory.

propagation delay. (1) The time necessary for a signal to travel from one point on a circuit to another. (2) The time delay between a signal change at an input and the corresponding change at an output.

protocol. (1) A specification for the format and relative timing of information exchanged between communicating parties. (2) The set of rules governing the operation of functional units of a communication system that must be followed if communication is to be achieved.

pulse. A variation in the value of a quantity, short in relation to the time schedule of interest, the final value being the same as the initial value.

radio frequency (RF). An ac frequency that is higher than the highest audio frequency. So called because of the application to radio communication.

radix. (1) In a radix numeration system, the positive integer by which the weight of the digit place is multiplied to obtain the weight of the digit place with the next higher weight; for example, in the decimal numeration system the radix of each digit place is 10. (2) Another term for base.

radix numeration system. A positional representation system in which the ratio of the weight of any one digit place to the weight of the digit place with the next lower weight is a positive integer (the radix). The permissible values of the character in any digit place range from 0 to one less than the radix.

RAM. Random access memory. Read/write memory.

random access memory (RAM). Read/write memory.

RAS. In the IBM Personal Computer, row address strobe.

raster. In computer graphics, a predetermined pattern of lines that provides uniform coverage of a display space.

read. To acquire or interpret data from a storage device, from a data medium, or from another source.

read-only memory (ROM). A storage device whose contents cannot be modified. The memory is retained when power is removed.

read/write memory. A storage device whose contents can be modified. Also called RAM.

recoverable error. An error condition that allows continued execution of a program.

red-green-blue-intensity (RGBI). The description of a direct-drive color monitor that accepts input signals of red, green, blue, and intensity.

redundancy check. A check that depends on extra characters attached to data for the detection of errors. See cyclic redundancy check.

register. (1) A storage device, having a specified storage capacity such as a bit, a byte, or a computer word, and usually intended for a special purpose. (2) A storage device in which specific data is stored.

retry. To resend the current block of data (from the last EOB or ETB) a prescribed number of times, or until it is entered correctly or accepted.

reverse video. A form of highlighting a character, field, or cursor by reversing the color of the character, field, or cursor with its background; for example, changing a red character on a black background to a black character on a red background.

RF. Radio frequency.

RF modulator. The device used to convert the composite video signal to the antenna level input of a home TV.

RGBI. Red-green-blue-intensity.

rising edge. Synonym for positive-going edge.

ROM. Read-only memory.

ROM/BIOS. The ROM resident basic input/output system, which provides the level control of the major I/O devices in the computer system.

row address strobe (RAS). A signal that latches the row address in a memory chip.

RS-232C. A standard by the EIA for communication between computers and external equipment.

RTS. Request to send. Associated with modem control.

run. A single continuous performance of a computer program or routine.

saturation. In computer graphics, the purity of a particular hue. A color is said to be saturated when at least one primary color (red, blue, or green) is completely absent.

scaling. In computer graphics, enlarging or reducing all or part of a display image by multiplying the coordinates of the image by a constant value.

schematic. The representation, usually in a drawing or diagram form, of a logical or physical structure.

Schottky TTL. A version (S series) of TTL with faster switching speed, but requiring more power. See also transistor-transistor logic and low power Schottky TTL.

SDL. Shielded Data Link

SDLC. Synchronous Data Link Control.

sector. That part of a track or band on a magnetic drum, a magnetic disk, or a disk pack that can be accessed by the magnetic heads in the course of a predetermined rotational displacement of the particular device.

SERDES. Serializer/deserializer.

serial. (1) Pertaining to the sequential performance of two or more activities in a single device. In English, the modifiers serial and parallel usually refer to devices, as opposed to sequential and consecutive, which refer to processes. (2) Pertaining to the sequential or consecutive occurrence of two or more related activities in a single device or channel. (3) Pertaining to the sequential processing of the individual parts of a whole, such as the bits of a character or the characters of a word, using the same facilities for successive parts. (4) Contrast with parallel.

serializer/deserializer (SERDES). A device that serializes output from, and deserializes input to, a business machine.

setup. (1) In a computer that consists of an assembly of individual computing units, the arrangement of interconnections between the units, and the adjustments needed for the computer to operate. (2) The preparation of a computing system to perform a job or job step. Setup is usually performed by an operator and often involves performing routine functions, such as mounting tape reels. (3) The preparation of the system for normal operation.

short circuit. A low-resistance path through which current flows, rather than through a component or circuit.

signal. A variation of a physical quantity, used to convey data.

sink. A device or circuit into which current drains.

software. (1) Computer programs, procedures, and rules concerned with the operation of a data processing system. (2) Contrast with hardware.

source. The origin of a signal or electrical energy.

square wave. An alternating or pulsating current or voltage whose waveshape is square.

square wave generator. A signal generator delivering an output signal having a square waveform.

SS. Start-stop.

start bit. (1) A signal to a receiving mechanism to get ready to receive data or perform a function. (2) In a start-stop system, a signal preceding a character or block that prepares the receiving device for the reception of the code elements.

start-of-text (STX). A transmission control character that precedes a text and may be used to terminate the message heading.

start-stop system. A data transmission system in which each character is preceded by a start bit and is followed by a stop bit.

start-stop (SS) transmission. (1) Asynchronous transmission such that a group of signals representing a character is preceded by a start bit and followed by a stop bit. (2) Asynchronous transmission in which a group of bits is preceded by a start bit that prepares the receiving mechanism for the reception and registration of a character and is followed by at least one stop bit that enables the receiving mechanism to come to an idle condition pending the reception of the next character.

static memory. RAM using flip-flops as the memory elements. Data is retained as long as power is applied to the flip-flops. Contrast with dynamic memory.

stop bit. (1) A signal to a receiving mechanism to wait for the next signal. (2) In a start-stop system, a signal following a character or block that prepares the receiving device for the reception of a subsequent character or block.

storage. (1) A storage device. (2) A device, or part of a device, that can retain data. (3) The retention of data in a storage device. (4) The placement of data into a storage device.

strobe. An instrument that emits adjustable-rate flashes of light. Used to measure the speed of rotating or vibrating objects.

STX. Start-of-text.

symbol. (1) A conventional representation of a concept. (2) A representation of something by reason of relationship, association, or convention.

synchronization. The process of adjusting the corresponding significant instants of two signals to obtain the desired phase relationship between these instants.

Synchronous Data Link Control (SDLC). A protocol for management of data transfer over a data link.

synchronous transmission. (1) Data transmission in which the time of occurrence of each signal representing a bit is related to a fixed time frame. (2) Data transmission in which the sending and receiving devices are operating continuously at substantially the same frequency and are maintained, by means of correction, in a desired phase relationship.

syntax. (1) The relationship among characters or groups of characters, independent of their meanings or the manner of their interpretation and use. (2) The structure of expressions in a language. (3) The rules governing the structure of a language. (4) The relationships among symbols.

text. In ASCII and data communication, a sequence of characters treated as an entity if preceded and terminated by one STX and one ETX transmission control character, respectively.

time-out. (1) A parameter related to an enforced event designed to occur at the conclusion of a predetermined elapsed time. A time-out condition can be cancelled by the receipt of an appropriate time-out cancellation signal. (2) A time interval allotted for certain operations to occur; for example, response to polling or addressing before system operation is interrupted and must be restarted.

track. (1) The path or one of the set of paths, parallel to the reference edge on a data medium, associated with a single reading or writing component as the data medium moves past the component. (2) The portion of a moving data medium such as a drum, or disk, that is accessible to a given reading head position.

transistor-transistor logic (TTL). A popular logic circuit family that uses multiple-emitter transistors.

translate. To transform data from one language to another.

transmission. (1) The sending of data from one place for reception elsewhere. (2) In ASCII and data communication, a series of characters including headings and text. (3) The dispatching of a signal, message, or other form of intelligence by wire, radio, telephone, or other means. (4) One or more blocks or messages. For BSC and start-stop devices, a transmission is terminated by an EOT character. (5) Synonymous with data transmission.

TTL. Transistor-transistor logic.

typematic key. A keyboard key that repeats its function when held pressed.

V. Volt.

vector. In computer graphics, a directed line segment.

video. Computer data or graphics displayed on a cathode ray tube, monitor, or display.

view point. In computer graphics, the origin from which angles and scales are used to map virtual space into display space.

viewing reference point. In computer graphics, a point in the modeling coordinate space that is a defined distance from the view point.

viewing transformation. Operations on the coordinates of an object (usually matrix multiplications) that cause the view of the object to be rotated about any axis, translated (moved without rotating), and/or scaled (changed in size along any or all dimensions). Viewing transformation differs from modeling transformation in that perspective is considered. See also modeling transformation.

viewplane. The visible plane of a CRT display screen that completely contains a defined window.

viewport. In computer graphics, a predefined part of the CRT display space.

volt. The basic practical unit of electric pressure. The potential that causes electrons to flow through a circuit.

W. Watt.

watt. The practical unit of electric power.

window. (1) A predefined part of the virtual space. (2) The visible area of a viewplane.

word. (1) A character string or a bit string considered as an entity. (2) See computer word.

write. To make a permanent or transient recording of data in a storage device or on a data medium.

write precompensation. The varying of the timing of the head current from the outer tracks to the inner tracks of the diskette to keep a constant 'write' signal.

yon plane. In computer graphics, a plane that is perpendicular to the line joining the viewing reference point and the view point, and that lies beyond the viewing reference point. Any part of an object beyond the yon plane is not seen. See also hither plane.

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Printed in Great Britain by Ben Johnson & Co. Ltd., York.