Personal Computer Hardware Reference Library

IBM Fixed Disk Adapter

6361503

Contents

Description

The Fixed Disk Adapter attaches to one or two fixed disk drive units through an internal, daisy-chained, flat cable (data/control cable). Each system supports a maximum of one Fixed Disk Adapter and two fixed disk drives.

The adapter is buffered on the I/O bus and uses the system board's direct memory access (DMA) for record data transfers. An interrupt level also is used to indicate operation completion and status conditions that require microprocessor attention.

The Fixed Disk Adapter provides automatic 11-bit burst error detection and correction in the form of 32-bit error checking and correction (ECC).

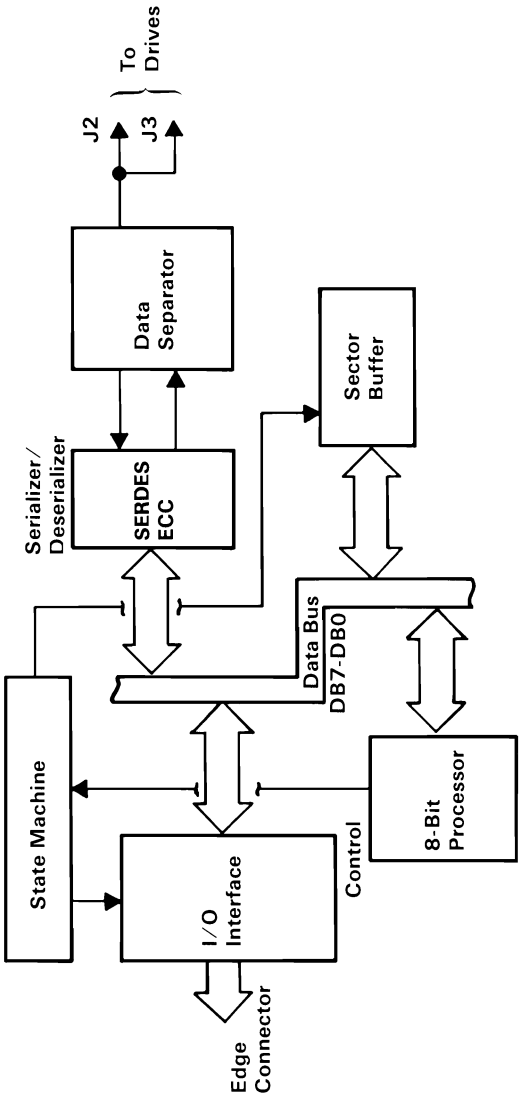
The device level control for the Fixed Disk Adapter is contained on a ROM module on the adapter. A listing of this device level control can be found in "BIOS Listing" of this section.

> **Warning:** The last cylinder on the fixed disk drive is reserved for diagnostic use. The diagnostic write test will destroy any data on this cylinder.

Fixed Disk Controller

The disk controller has two registers that may be accessed by the system unit's microprocessor: a status register and a data register. The 8-bit status register contains the status information of the disk controller, and can be accessed at any time. The 8-bit data register (actually consisting of several registers in a stack with only one register presented to the data bus) stores data, commands, and parameters, and provides the disk controller's status information. Data bytes are read from, or written to the data register in order to program or obtain the results after a particular command. The status register is a read-only register that is used to help the transfer of data between the system unit's microprocessor and the disk controller. The controller-select pulse is generated by writing to port address hex 322.

The following is a block diagram of the IBM Fixed Disk Adapter.



Fixed Disk Adapter Block Diagram

Programming Considerations

Status Register

At the end of all commands from the system board, the disk controller sends a completion status byte to the system board. This byte informs the system unit's microprocessor if an error occurred during the execution of the command. The following shows the format of this byte.

Bit	7	6	5	4	3	2	1	0
	0	0	d	0	0	0	e	0

Bits 0, 1, 2, 3, 4, 6, 7 These bits are set to zero.

Bit 1 When set, this bit shows an error has occurred during command execution.

Bit 5 This bit shows the logical unit number of the drive.

If the interrupts are enabled, the controller sends an interrupt when it is ready to transfer the status byte. Busy from the disk controller is unasserted when the byte is transferred to complete the command.

Sense Bytes

If the status register receives an error (bit 1 set), the disk controller requests four bytes of sense data. The format for the four bytes is as follows:

Bits	7	6	5	4	3	2	1	0
Byte 0	Address Valid	0	Error Type		Error Code			
Byte 1	0	0	d	Head Number				
Byte 2	Cylinder High			Sector Number				
Byte 3	Cylinder Low							

Remarks
d = drive

Byte 0 Bits 0, 1, 2, 3 Error code.

Byte 0 Bits 4, 5 Error type.

Byte 0 Bit 6 Set to 0 (spare)

Byte 0 Bit 7 The address-valid bit. Set only when the previous command required a disk address, in which case it is returned as a 1; otherwise, it is 0.

Disk Controller Error Tables

The following disk controller error tables list the error types and error codes found in byte 0:

	Error Type		Error Code				
Bits	5	4	3	2	1	0	Description
	0	0	0	0	0	0	The controller did not detect any error during the execution of the previous operation.
	0	0	0	0	0	1	The controller did not detect an index signal from the drive.
	0	0	0	0	1	0	The controller did not get a seek-complete signal from the drive after a seek operation (for all non-buffered step seeks).
	0	0	0	0	1	1	The controller detected a write fault from the drive during the last operation.
	0	0	0	1	0	0	After the controller selected the drive, the drive did not respond with a ready signal.
	0	0	0	1	0	1	Not used.
	0	0	0	1	1	0	After stepping the maximum number of cylinders, the controller did not receive the track 00 signal from the drive.
	0	0	0	1	1	1	Not used.
	0	0	1	0	0	0	The drive is still seeking. This status is reported by the Test Drive Ready command for an overlap seek condition when the drive has not completed the seek. No time-out is measured by the controller for the seek to complete.

	Error Type		Error Code				
Bits	**5**	**4**	**3**	**2**	**1**	**0**	**Description**
	0	**1**	**0**	**0**	**0**	**0**	ID Read Error: The controller detected an ECC error in the target ID field on the disk.
	0	1	0	0	0	1	Data Error: The controller detected an uncorrectable ECC error in the target sector during a read operation.
	0	1	0	0	1	0	Address Mark: The controller did not detect the target address mark (AM) on the disk.
	0	1	0	0	1	1	Not used.
	0	1	0	1	0	0	Sector Not Found: The controller found the correct cylinder and head, but not the target sector.
	0	1	0	1	0	1	Seek Error: The cylinder or head address (either or both) did not compare with the expected target address as a result of a seek.
	0	1	0	1	1	0	Not used.
	0	1	0	1	1	1	Not used.
	0	1	1	0	0	0	Correctable Data Error: The controller detected a correctable ECC error in the target field.
	0	1	1	0	0	1	Bad Track: The controller detected a bad track flag during the last operation. No retries are attempted on this error.

	Error Type		Error Code				
Bits	**5**	**4**	**3**	**2**	**1**	**0**	**Description**
	1	0	0	0	0	0	Invalid Command: The controller has received an invalid command from the system unit.
	1	0	0	0	0	1	Illegal Disk Address. The controller detected an address that is beyond the maximum range.

	Error Type		Error Code				
Bits	5	4	3	2	1	0	Description
	1	1	0	0	0	0	RAM Error: The controller detected a data error during the RAM sector-buffer diagnostic test.
	1	1	0	0	0	1	Program Memory Checksum Error: During this internal diagnostic test, the controller detected a program-memory checksum error.
	1	1	0	0	1	0	ECC Polynominal Error: During the controller's internal diagnostic tests, the hardware ECC generator failed its test.

Data Register

The system unit's microprocessor specifies the operation by sending the 6-byte device control block (DCB) to the controller. The figure below shows the composition of the DCB, and defines the bytes that make up the DCB.

Bit	7	6	5	4	3	2	1	0
Byte 0	Command Class			Opcode				
Byte 1	0	0	d	Head Number				
Byte 2	Cylinder High			Sector Number				
Byte 3	Cylinder Low							
Byte 4	Interleave or Block Count							
Byte 5	Control Field							

Byte 0 Bits 7, 6, and 5 identify the class of the command. Bits 4 through 0 contain the Opcode command.

Byte 1 Bit 5 identifies the drive number. Bits 4 through 0 contain the disk head number to be selected. Bits 6 and 7 are not used.

Byte 2 Bits 6 and 7 contain the two most significant bits of the cylinder number. Bits 0 through 5 contain the sector number.

Byte 3 Bits 0 through 7 are the eight least-significant bits of the cylinder number.

Byte 4 Bits 0 through 7 specify the interleave or block count.

Byte 5 Bits 0 through 7 contain the control field.

Control Byte

Byte 5 is the control field of the DCB and allows the user to select options for several types of disk drives. The format of this byte is as follows:

Bits	7	6	5	4	3	2	1	0
	r	a	0	0	0	s	s	s

Remarks

r = retries
s = step option
a = retry option on data ECC error

Bit 7 Disables the four retries by the controller on all disk-access commands. Set this bit only during the evaluation of the performance of a disk drive.

Bit 6 If set to 0 during read commands, a reread is attempted when an ECC error occurs. If no error occurs during reread, the command will finish without an error status. If this bit is set to 1, no reread is attempted.

Bits 5, 4, 3 Set to 0.

Bits 2, 1, 0 These bits define the type of drive and select the step option. See the following figure.

Bits 2, 1, 0	
0 0 0	This drive is not specified and defaults to 3 milliseconds per step
0 0 1	N/A
0 1 0	N/A
0 1 1	N/A
1 0 0	200 microseconds per step.
1 0 1	70 microseconds per step (specified by BIOS).
1 1 0	3 milliseconds per step.
1 1 1	3 milliseconds per step.

Command Summary

Command	Data Control Block	Remarks
Test Drive Ready (Class 0, Opcode 00)	Bit 7 6 5 4 3 2 1 0 Byte 0 0 0 0 0 0 0 0 0 Byte 1 0 0 d x x x x x	d = drive (0 or 1) x = don't care Bytes 2, 3, 4, 5 = don't care
Recalibrate (Class 0, Opcode 01)	Bit 7 6 5 4 3 2 1 0 Byte 0 0 0 0 0 0 0 0 1 Byte 1 0 0 d x x x x x Byte 5 r 0 0 0 0 s s s	d = drive (0 or 1) x = don't care r = retries s = Step Option Bytes 2, 3, 4 = don't care ch = cylinder high
Reserved (Class 0, Opcode 02)		This Opcode is not used.
Request Sense Status (Class 0, Opcode 03)	Bit 7 6 5 4 3 2 1 0 Byte 0 0 0 0 0 0 0 1 1 Byte 1 0 0 d x x x x x	d = drive (0 or 1) x = don't care Bytes 2, 3, 4, 5 = don't care
Format Drive (Class 0, Opcode 04)	Bit 7 6 5 4 3 2 1 0 Byte 0 0 0 0 0 0 1 0 0 Byte 1 0 0 d Head Number Byte 2 ch 0 0 0 0 0 0 Byte 3 Cylinder Low Byte 4 0 0 0 Interleave Byte 5 r 0 0 0 0 s s s	d = drive (0 or 1) r = retries s = step option ch = cylinder high Interleave 1 to 16 for 512-byte sectors.
Ready Verify (Class 0, Opcode 05)	Bit 7 6 5 4 3 2 1 0 Byte 0 0 0 0 0 0 1 0 1 Byte 1 0 0 d Head Number Byte 2 ch Sector Number Byte 3 Cylinder Low Byte 4 Block Count Byte 5 r a 0 0 0 s s s	d = drive (0 or 1) r = retries s = step option a = retry option on data ECC ch = cylinder high

Command	Data Control Block	Remarks
Format Track (Class 0, Opcode 06)	Bit 7 6 5 4 3 2 1 0 Byte 0 0 0 0 0 0 1 1 0 Byte 1 0 0 d Head Number Byte 2 ch 0 0 0 0 0 0 Byte 3 Cylinder Low Byte 4 0 0 0 Interleave Byte 5 r 0 0 0 0 s s s	d = drive (0 or 1) r = retries s = step option ch = cylinder high Interleave 1 to 16 for 512-byte sectors.
Format Bad Track (Class 0, Opcode 07)	Bit 7 6 5 4 3 2 1 0 Byte 0 0 0 0 0 0 1 1 1 Byte 1 0 0 d Head Number Byte 2 ch 0 0 0 0 0 0 Byte 3 Cylinder Low Byte 4 0 0 0 Interleave Byte 5 r 0 0 0 0 s s s	d = drive (0 or 1) r = retries s = step option ch = cylinder high Interleave 1 to 16 for 512-byte sectors.
Read (Class 0, Opcode 08)	Bit 7 6 5 4 3 2 1 0 Byte 0 0 0 0 0 1 0 0 0 Byte 1 0 0 d Head Number Byte 2 ch Sector Number Byte 3 Cylinder Low Byte 5 r a 0 0 0 s s s	d = drive (0 or 1) r = retries a = retry option on data ECC error s = step option ch = cylinder high
Reserved (Class 0, Opcode 09)		This Opcode is not used.
Write (Class 0, Opcode 0A)	Bit 7 6 5 4 3 2 1 0 Byte 0 0 0 0 0 1 0 1 0 Byte 1 0 0 d Head Number Byte 2 ch Sector Number Byte 3 Cylinder Low Byte 4 Block Count Byte 5 r 0 0 0 0 s s s	d = drive (0 or 1) r = retries s = step option ch = cylinder high
Seek (Class 0, Opcode 0B)	Bit 7 6 5 4 3 2 1 0 Byte 0 0 0 0 0 1 0 1 1 Byte 1 0 0 d Head Number Byte 2 ch 0 0 0 0 0 0 Byte 3 Cylinder Low Byte 4 x x x x x x x x Byte 5 r 0 0 0 0 s s s	d = drive (0 or 1) r = retries s = step option x = don't care ch = cylinder high

Command	Data Control Block	Remarks
Initialize Drive Characteristics* (Class 0, Opcode 0C)	Bit 7 6 5 4 3 2 1 0 Byte 0 0 0 0 0 1 1 0 0	Bytes 1, 2, 3, 4, 5, = don't care
Read ECC Burst Error Length (Class 0, Opcode 0D)	Bit 7 6 5 4 3 2 1 0 Byte 0 0 0 0 0 1 1 0 1	Bytes 1, 2, 3, 4, 5, = don't care
Read Data from Sector Buffer (Class 0, Opcode 0E)	Bit 7 6 5 4 3 2 1 0 Byte 0 0 0 0 0 1 1 1 0	Bytes 1, 2, 3, 4, 5, = don't care
Write Data to Sector Buffer (Class 0, Opcode 0F)	Bit 7 6 5 4 3 2 1 0 Byte 0 0 0 0 0 1 1 1 1	Bytes 1, 2, 3, 4, 5, = don't care
RAM Diagnostic (Class 7, Opcode 00)	Bit 7 6 5 4 3 2 1 0 Byte 0 1 1 1 0 0 0 0 0	Bytes 1, 2, 3, 4, 5, = don't care
Reserved (Class 7, Opcode 01)		This Opcode is not used.
Reserved (Class 7, Opcode 02)		This Opcode is not used.

*Initialize Drive Characteristics: The DBC must be followed by eight additional bytes.

Maximum number of cylinders	(2 bytes)
Maximum number of heads	(1 byte)
Start reduced write current cylinder	(2 bytes)
Start write precompensation cylinder	(2 bytes)
Maximum ECC data burst length	(1 byte)

Drive Diagnostic (Class 7, Opcode 03)

Bit	7	6	5	4	3	2	1	0
Byte 0	1	1	1	0	0	0	1	1
Byte 1	0	0	d	x	x	x	x	x
Byte 2	x	x	x	x	x	x	x	x
Byte 3	x	x	x	x	x	x	x	x
Byte 4	x	x	x	x	x	x	x	x
Byte 5	r	0	0	0	0	s	s	s

d = drive (0 or 1)
s = step option
r = retries
x = don't care

Controller Internal Diagnostics (Class 7, Opcode 04)

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

Bytes 1, 2, 3, 4, 5, = don't care

Read Long* (Class 7, Opcode 05)

Bit	7	6	5	4	3	2	1	0
Byte 0	1	1	1	0	0	1	0	1
Byte 1	0	0	d	Head Number				
Byte 2	ch			Sector Number				
Byte 3	Cylinder Low							
Byte 4	Block Count							
Byte 5	r	0	0	0	0	s	s	s

d = drive (0 or 1)
s = step option
r = retries
ch = cylinder high

Write Long (Class 7, Opcode 06)**

Bit	7	6	5	4	3	2	1	0
Byte 0	1	1	1	0	0	1	1	0
Byte 1	0	0	d	Head Number				
Byte 2	ch			Sector Number				
Byte 3	Cylinder Low							
Byte 4	Block Count							
Byte 5	r	0	0	0	0	s	s	s

d = drive (0 or 1)
s = step option
r = retries
ch = cylinder high

*Returns 512 bytes plus 4 bytes of ECC data per sector.

**Requires 512 bytes plus 4 bytes of ECC data per sector.

Programming Summary

The two least-significant bits of the address bus are sent to the system board's I/O port decoder, which has two sections. One section is enabled by the I/O read signal (-IOR) and the other by the I/O write signal (-IOW). The result is a total of four read/write ports assigned to the disk controller board.

The address enable signal (AEN) is asserted by the system board when DMA is controlling data transfer. When AEN is asserted, the I/O port decoder is disabled.

The following figure is a table of the read/write ports.

R/W	Port Address	Function
Read	320	Read data (from controller to system unit).
Write	320	Write data (from system unit to controller).
Read	321	Read controller hardware status.
Write	321	Controller reset.
Read	322	Reserved.
Write	322	Generate controller-select pulse.
Read	323	Not used.
Write	323	Write pattern to DMA and interrupt mask register.

Interface

The following lines are used by the disk controller:

A0-A19 Positive true 20-bit address. The least-significant 10 bits contain the I/O address within the range of hex 320 to hex 323 when an I/O read or write is executed by the system unit. The full 20 bits are decoded to address the read-only memory (ROM) between the addresses of hex C8000 and C9FFF.

DO-D7 Positive 8-bit data bus over which data and status information is passed between the system board and the controller.

-IOR Negative true signal that is asserted when the system board reads status or data from the controller under either programmed I/O or DMA control.

-IOW Negative true signal that is asserted when the system board sends a command or data to the controller under either programmed I/O or DMA control.

AEN Positive true signal that is asserted when the DMA in the system board is generating the I/O Read (-IOR) or I/O Write (-IOW) signals and has control of the address and data buses.

RESET Positive true signal that forces the disk controller to its initial power-up condition.

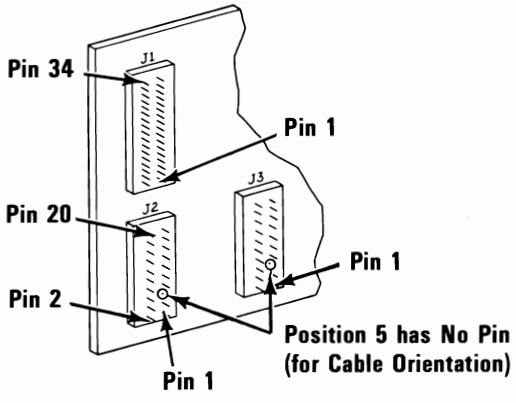
IRQ 5 Positive true interrupt-request signal that is asserted by the controller when enabled to interrupt the system board on the return ending status byte from the controller.

DRQ 3 Positive true DMA-request signal that is asserted by the controller when data is available for transfer to or from the controller under DMA control. This signal remains active until the system board's DMA channel activates the DMA-acknowledge signal (-DACK 3) in response.

-DACK 3 This signal is true when negative, and is generated by the system board DMA channel in response to a DMA request (DRQ 3).

Specifications

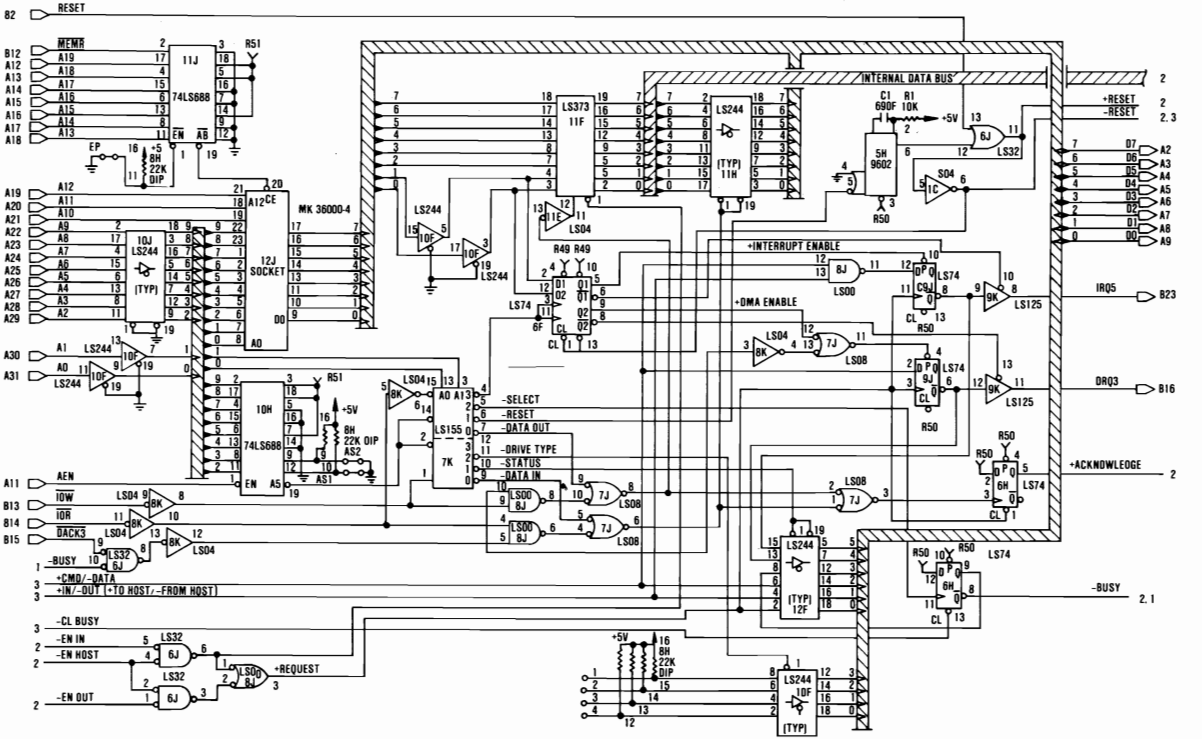
The Fixed Disk Adapter connector and interface specifications follow.



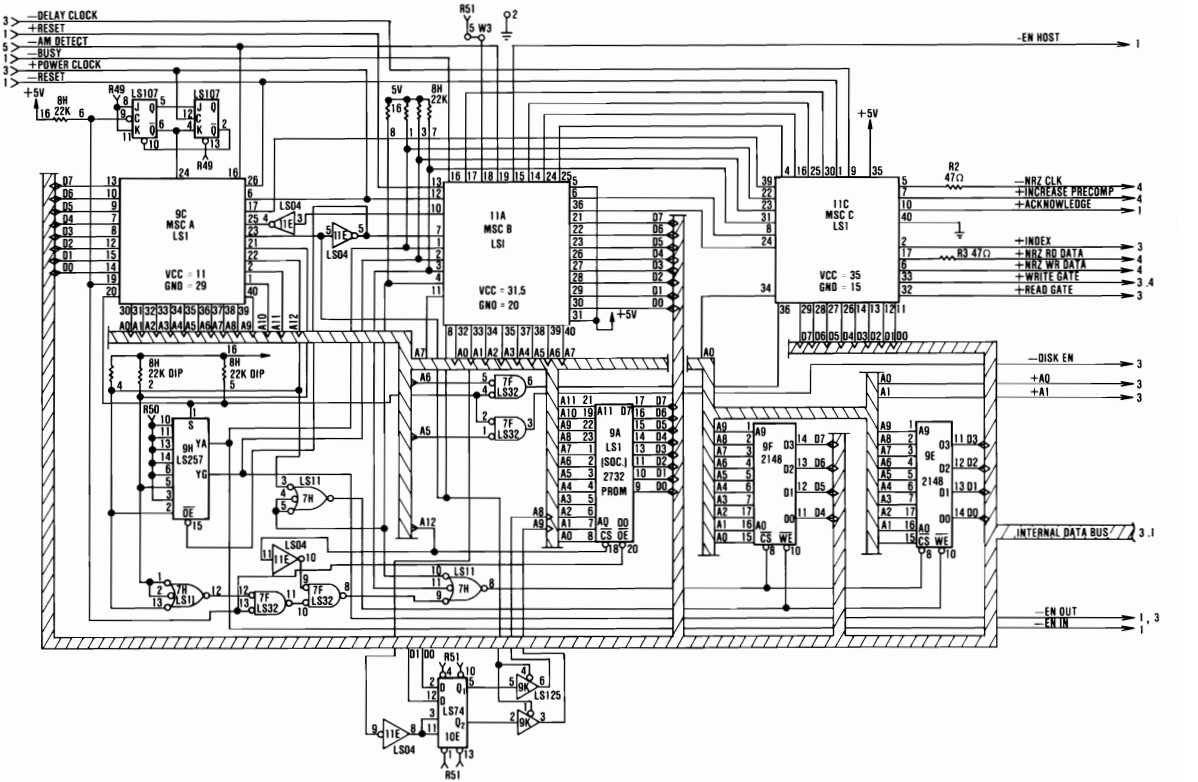
	Signal	Pin Number	
Disk Drive Connector J1	Ground-Odd Numbers	1-33	Disk Adapter Connector J1
	Reserved	4,16,30,32	
	← – Reduced Write Current	2	
	← – Write Gate	6	
	← – Seek Complete	8	
	→ – Track 00	10	
	→ – Write Fault	12	
	← – Head Select 2^0	14	
	← – Head Select 2^1	18	
	← – Index	20	
	→ – Ready	22	
	← – Step	24	
	← – Drive Select 1	26	
	← – Drive Select 2	28	
	← – Direction In	34	

	Signal	Pin Number	
Disk Drive Connector J2 or J3	Ground	2,4,6,8,12,16,20	Disk Adapter Connector J2 or J3
	→ Drive Select	1	
	Reserved	3,7	
	Spare	9,10,5 (No Pin)	
	Ground	11	
	← MFM Wire Data	13	
	← – MTM Write Data	14	
	Ground	15	
	→ MFM Read Data	17	
	→ – MFM Read Data	18	
	Ground	19	

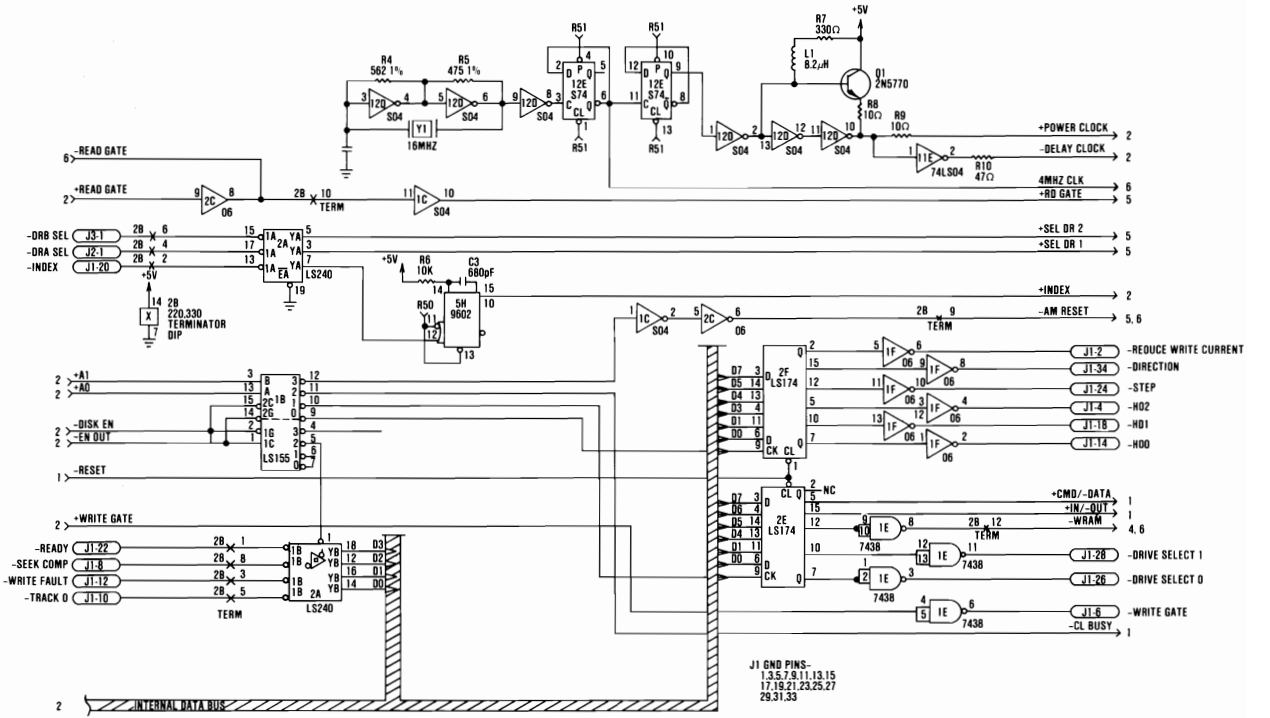
Fixed Disk Adapter Interface Specifications



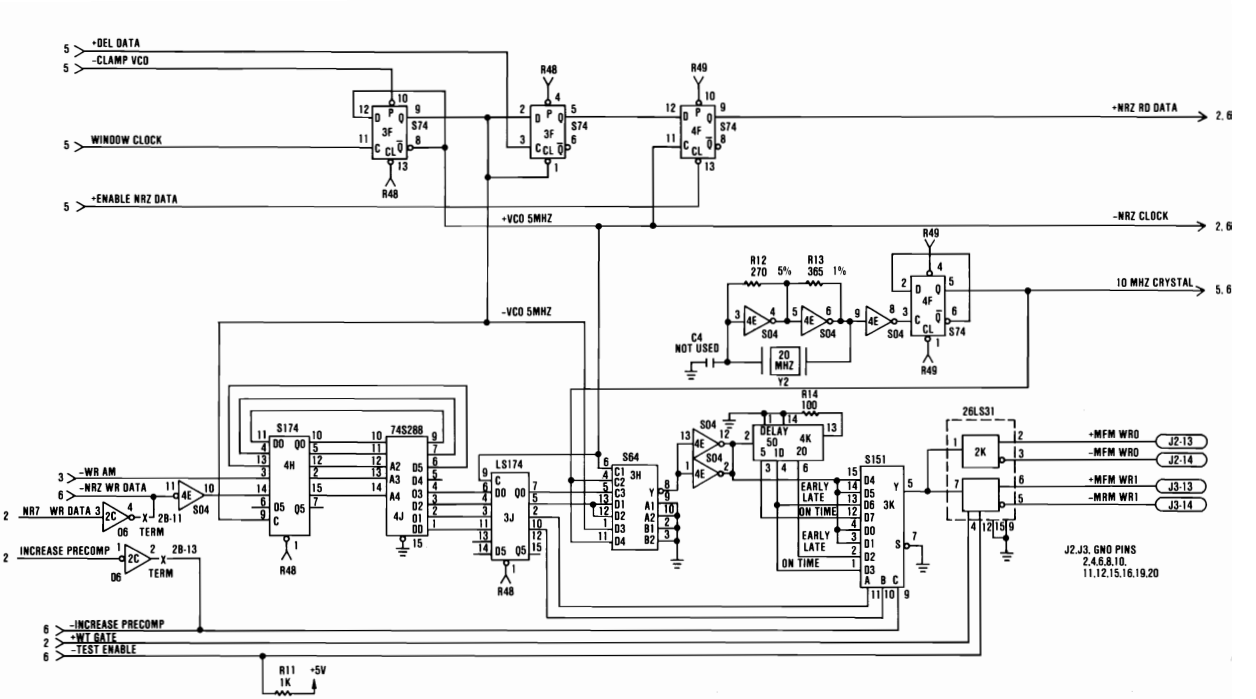
Fixed Disk Adapter (Sheet 1 of 6)



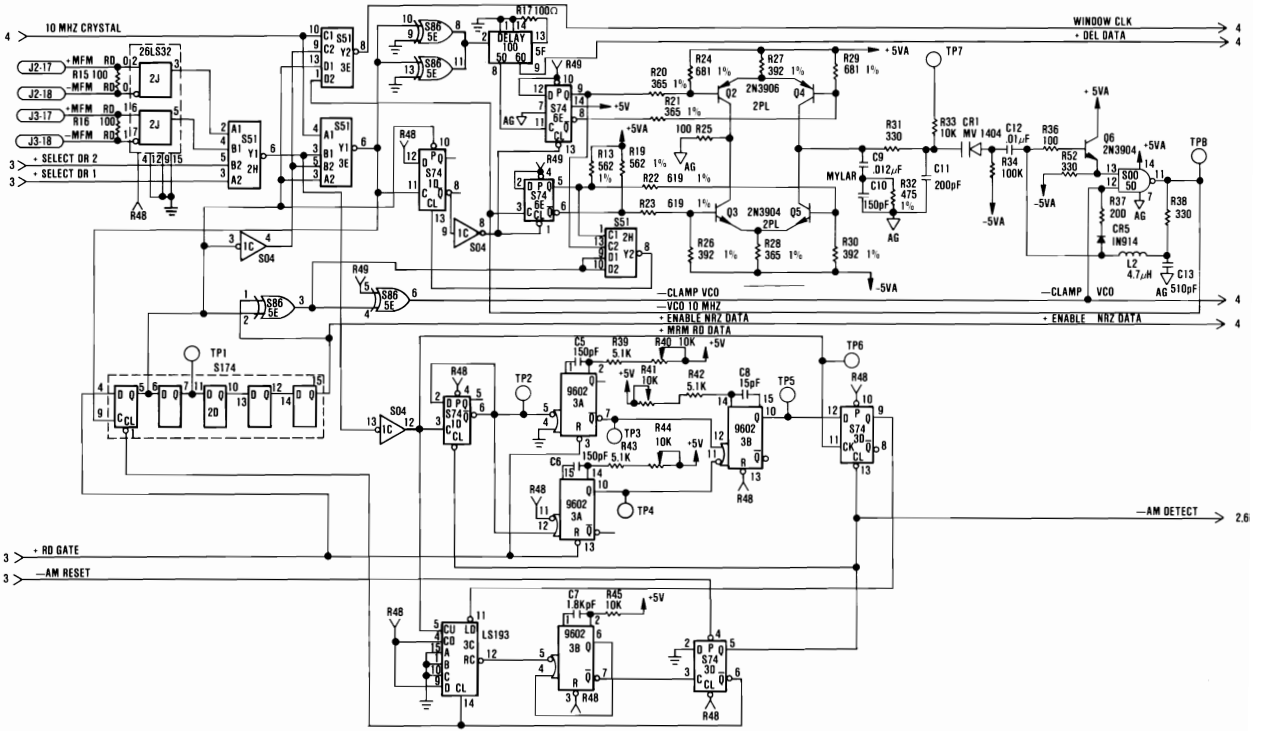
Fixed Disk Adapter (Sheet 2 of 6)



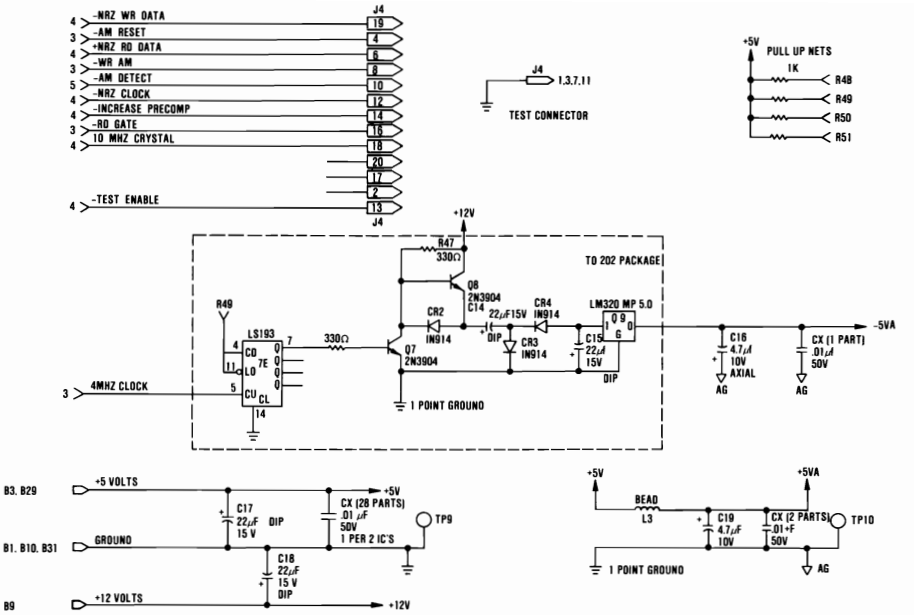
Fixed Disk Adapter (Sheet 3 of 6)



Fixed Disk Adapter (Sheet 4 of 6)



Fixed Disk Adapter (Sheet 5 of 6)



NOTES:
UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTORS 1/4 W, 5%, CARBON FILTER.
2. ALL CAPS +10V OR GREATER +10%.
3. NO MORE THAN 15 LOADS PER PULLUP NET.

Fixed Disk Adapter (Sheet 6 of 6)

BIOS Listing

The BIOS Listing for the IBM Fixed Disk Adapter follows.

```
LOC OBJ                 LINE    SOURCE

                          1     $TITLE(FIXED DISK BIOS FOR IBM DISK CONTROLLER)
                          2
                          3     ;-- INT 13 ------------------------------------------------------
                          4     ;                                                               :
                          5     ; FIXED DISK I/O INTERFACE                                      :
                          6     ;                                                               :
                          7     ;       THIS INTERFACE PROVIDES ACCESS TO 5 1/4" FIXED DISKS     :
                          8     ;       THROUGH THE IBM FIXED DISK CONTROLLER.                  :
                          9     ;                                                               :
                         10     ;---------------------------------------------------------------
                         11
                         12     ;---------------------------------------------------------------
                         13     ;       THE  BIOS ROUTINES ARE MEANT TO BE ACCESSED THROUGH     :
                         14     ;       SOFTWARE INTERRUPTS ONLY.  ANY ADDRESSES PRESENT IN     :
                         15     ;       THE LISTINGS  ARE INCLUDED  ONLY FOR  COMPLETENESS,     :
                         16     ;       NOT FOR  REFERENCE.   APPLICATIONS WHICH  REFERENCE     :
                         17     ;       ABSOLUTE   ADDRESSES   WITHIN   THE   CODE  SEGMENT     :
                         18     ;       VIOLATE THE STRUCTURE AND DESIGN OF BIOS.               :
                         19     ;---------------------------------------------------------------
                         20     ;
                         21     ; INPUT    (AH = HEX VALUE)
                         22     ;
                         23     ;       (AH)=00 RESET DISK (DL = 80H,81H) / DISKETTE
                         24     ;       (AH)=01 READ THE STATUS OF THE LAST DISK OPERATION INTO (AL)
                         25     ;               NOTE: DL < 80H - DISKETTE
                         26     ;                     DL > 80H - DISK
                         27     ;       (AH)=02 READ THE DESIRED SECTORS INTO MEMORY
                         28     ;       (AH)=03 WRITE THE DESIRED SECTORS FROM MEMORY
                         29     ;       (AH)=04 VERIFY THE DESIRED SECTORS
                         30     ;       (AH)=05 FORMAT THE DESIRED TRACK
                         31     ;       (AH)=06 FORMAT THE DESIRED TRACK AND SET BAD SECTOR FLAGS
                         32     ;       (AH)=07 FORMAT THE DRIVE STARTING AT THE DESIRED TRACK
                         33     ;       (AH)=08 RETURN THE CURRENT DRIVE PARAMETERS
                         34     ;
                         35     ;       (AH)=09 INITIALIZE DRIVE PAIR CHARACTERISTICS
                         36     ;               INTERRUPT 41 POINTS TO DATA BLOCK
                         37     ;       (AH)=0A READ LONG
                         38     ;       (AH)=0B WRITE LONG
                         39     ;       NOTE: READ AND WRITE LONG ENCOMPASS 512 + 4 BYTES ECC
                         40     ;       (AH)=0C SEEK
                         41     ;       (AH)=0D ALTERNATE DISK RESET (SEE DL)
                         42     ;       (AH)=0E READ SECTOR BUFFER
                         43     ;       (AH)=0F WRITE SECTOR BUFFER,
                         44     ;               (RECOMMENDED PRACTICE BEFORE FORMATTING)
                         45     ;       (AH)=10 TEST DRIVE READY
                         46     ;       (AH)=11 RECALIBRATE
                         47     ;       (AH)=12 CONTROLLER RAM DIAGNOSTIC
                         48     ;       (AH)=13 DRIVE DIAGNOSTIC
                         49     ;       (AH)=14 CONTROLLER INTERNAL DIAGNOSTIC
                         50     ;
                         51     ;               REGISTERS USED FOR FIXED DISK OPERATIONS
                         52     ;
                         53     ;               (DL)    -  DRIVE NUMBER      (80H-87H FOR DISK, VALUE CHECKED)
                         54     ;               (DH)    -  HEAD NUMBER       (0-7 ALLOWED, NOT VALUE CHECKED)
                         55     ;               (CH)    -  CYLINDER NUMBER   (0-1023, NOT VALUE CHECKED)(SEE CL)
                         56     ;               (CL)    -  SECTOR NUMBER     (1-17, NOT VALUE CHECKED)
                         57     ;
                         58     ;                          NOTE: HIGH 2 BITS OF CYLINDER NUMBER ARE PLACED
                         59     ;                                IN THE HIGH 2 BITS OF THE CL REGISTER
                         60     ;                                (10 BITS TOTAL)
                         61     ;               (AL)    -  NUMBER OF SECTORS (MAXIMUM POSSIBLE RANGE 1-80H,
                         62     ;                                             FOR READ/WRITE LONG 1-79H)
                         63     ;                          (INTERLEAVE VALUE FOR FORMAT 1-16D)
                         64     ;               (ES:BX) -  ADDRESS OF BUFFER FOR READS AND WRITES,
                         65     ;                          (NOT REQUIRED FOR VERIFY)
                         66     ;
                         67     ; OUTPUT
                         68     ;       AH = STATUS OF CURRENT OPERATION
                         69     ;            STATUS BITS ARE DEFINED IN THE EQUATES BELOW
                         70     ;       CY = 0  SUCCESSFUL OPERATION (AH=0 ON RETURN)
                         71     ;       CY = 1  FAILED OPERATION (AH HAS ERROR REASON)
                         72     ;
                         73     ;       NOTE:   ERROR 11H  INDICATES THAT THE DATA READ HAD A RECOVERABLE
                         74     ;               ERROR WHICH WAS CORRECTED BY THE ECC ALGORITHM.  THE DATA
                         75     ;               IS PROBABLY GOOD,   HOWEVER THE BIOS ROUTINE INDICATES AN
                         76     ;               ERROR TO ALLOW THE CONTROLLING PROGRAM A CHANCE TO DECIDE
                         77     ;               FOR  ITSELF.  THE  ERROR  MAY  NOT  RECUR  IF THE DATA IS
```

```
LOC OBJ                 LINE    SOURCE

                         78     ;               REWRITTEN. (AL) CONTAINS THE BURST LENGTH.
                         79     ;
                         80     ;       IF DRIVE PARAMETERS WERE REQUESTED,
                         81     ;
                         82     ;       DL = NUMBER OF CONSECUTIVE ACKNOWLEDGING DRIVES ATTACHED (0-2)
                         83     ;               (CONTROLLER CARD ZERO TALLY ONLY)
                         84     ;       DH = MAXIMUM USEABLE VALUE FOR HEAD NUMBER
                         85     ;       CH = MAXIMUM USEABLE VALUE FOR CYLINDER NUMBER
                         86     ;       CL = MAXIMUM USEABLE VALUE FOR SECTOR NUMBER
                         87     ;            AND CYLINDER NUMBER HIGH BITS
                         88     ;
                         89     ;       REGISTERS WILL BE PRESERVED EXCEPT WHEN THEY ARE USED TO RETURN
                         90     ;       INFORMATION.
                         91     ;
                         92     ;       NOTE: IF AN ERROR IS REPORTED BY THE DISK CODE, THE APPROPRIATE
                         93     ;               ACTION IS TO RESET THE DISK, THEN RETRY THE OPERATION.
                         94     ;
                         95     ;--------------------------------------------------------------------------
                         96
00FF                     97     SENSE_FAIL      EQU     0FFH            ; SENSE OPERATION FAILED
00BB                     98     UNDEF_ERR       EQU     0BBH            ; UNDEFINED ERROR OCCURRED
0080                     99     TIME_OUT        EQU     80H             ; ATTACHMENT FAILED TO RESPOND
0040                    100     BAD_SEEK        EQU     40H             ; SEEK OPERATION FAILED
0020                    101     BAD_CNTLR       EQU     20H             ; CONTROLLER HAS FAILED
0011                    102     DATA_CORRECTED  EQU     11H             ; ECC CORRECTED DATA ERROR
0010                    103     BAD_ECC         EQU     10H             ; BAD ECC ON DISK READ
000B                    104     BAD_TRACK       EQU     0BH             ; BAD TRACK FLAG DETECTED
0009                    105     DMA_BOUNDARY    EQU     09H             ; ATTEMPT TO DMA ACROSS 64K BOUNDARY
0007                    106     INIT_FAIL       EQU     07H             ; DRIVE PaRAMETER ACTIVITY FAILED
0005                    107     BAD_RESET       EQU     05H             ; RESET FAILED
0004                    108     RECORD_NOT_FND  EQU     04H             ; REQUESTED SECTOR NOT FOUND
0002                    109     BAD_ADDR_MARK   EQU     02H             ; ADDRESS MARK NOT FOUND
0001                    110     BAD_CMD         EQU     01H             ; BAD COMMAND PASSED TO DISK I/O
                        111
                        112     ;---------------------------------------
                        113     ;       INTERRUPT AND STATUS AREAS      :
                        114     ;---------------------------------------
                        115
----                    116     DUMMY   SEGMENT AT 0
0034                    117             ORG     0DH*4                   ; FIXED DISK INTERRUPT VECTOR
0034                    118     HDISK_INT       LABEL   DWORD
004C                    119             ORG     13H*4                   ; DISK INTERRUPT VECTOR
004C                    120     ORG_VECTOR      LABEL   DWORD
0064                    121             ORG     19H*4                   ; BOOTSTRAP INTERRUPT VECTOR
0064                    122     BOOT_VEC        LABEL   DWORD
0078                    123             ORG     1EH*4                   ; DISKETTE PARAMETERS
0078                    124     DISKETTE_PARM   LABEL   DWORD
0100                    125             ORG     040H*4                  ; NEW DISKETTE INTERRUPT VECTOR
0100                    126     DISK_VECTOR     LABEL   DWORD
0104                    127             ORG     041H*4                  ; FIXED DISK PARAMETER VECTOR
0104                    128     HF_TBL_VEC      LABEL   DWORD
7C00                    129             ORG     7C00H                   ; BOOTSTRAP LOADER VECTOR
7C00                    130     BOOT_LOCN       LABEL   FAR
----                    131     DUMMY   ENDS
                        132
----                    133     DATA    SEGMENT AT 40H
0042                    134             ORG     42H
0042                    135     CMD_BLOCK       LABEL   BYTE
0042 (7 ??)             136     HD_ERROR        DB      7 DUP(?)        ; OVERLAYS DISKETTE STATUS
006C                    137             ORG     06CH
006C ????               138     TIMER_LOW       DW      ?               ; TIMER LOW WORD
0072                    139             ORG     72H
0072 ????               140     RESET_FLAG      DW      ?               ; 1234H IF KEYBOARD RESET UNDERWAY
0074                    141             ORG     74H
0074 ??                 142     DISK_STATUS     DB      ?               ; FIXED DISK STATUS BYTE
0075 ??                 143     HF_NUM          DB      ?               ; COUNT OF FIXED DISK DRIVES
0076 ??                 144     CONTROL_BYTE    DB      ?               ; CONTROL BYTE DRIVE OPTIONS
0077 ??                 145     PORT_OFF        DB      ?               ; PORT OFFSET
----                    146     DATA    ENDS
                        147
----                    148     CODE    SEGMENT
                        149
                        150     ;--------------------------------------------------------
                        151     ; HARDWARE SPECIFIC VALUES                              :
                        152     ;                                                       :
                        153     ;  -  CONTROLLER I/O PORT                              :
                        154     ;       > WHEN READ FROM:                               :
```

```
LOC OBJ                  LINE    SOURCE

                         155     ;       HF_PORT+0 - READ DATA (FROM CONTROLLER TO CPU)  :
                         156     ;       HF_PORT+1 - READ CONTROLLER HARDWARE STATUS     :
                         157     ;                   (CONTROLLER TO CPU)                 :
                         158     ;       HF_PORT+2 - READ CONFIGURATION SWITCHES         :
                         159     ;       HF_PORT+3 - NOT USED                            :
                         160     ;     > WHEN WRITTEN TO:                                :
                         161     ;       HF_PORT+0 - WRITE DATA (FROM CPU TO CONTROLLER) :
                         162     ;       HF_PORT+1 - CONTROLLER RESET                    :
                         163     ;       HF_PORT+2 - GENERATE CONTROLLER SELECT PULSE     :
                         164     ;       HF_PORT+3 - WRITE PATTERN TO DMA AND INTERRUPT  :
                         165     ;                   MASK REGISTER                       :
                         166     ;                                                       :
                         167     ;-------------------------------------------------------
                         168
  0320                   169     HF_PORT         EQU     0320H           ; DISK PORT
  0008                   170     R1_BUSY         EQU     00001000B       ; DISK PORT 1 BUSY BIT
  0004                   171     R1_BUS          EQU     00000100B       ;             COMMAND/DATA BIT
  0002                   172     R1_IOMODE       EQU     00000010B       ;             MODE BIT
  0001                   173     R1_REQ          EQU     00000001B       ;             REQUEST BIT
                         174
  0047                   175     DMA_READ        EQU     01000111B       ; CHANNEL 3 (047H)
  004B                   176     DMA_WRITE       EQU     01001011B       ; CHANNEL 3 (04BH)
  0000                   177     DMA             EQU     0               ; DMA ADDRESS
  0082                   178     DMA_HIGH        EQU     082H            ; PORT FOR HIGH 4 BITS OF DMA
                         179
  0000                   180     TST_RDY_CMD     EQU     00000000B       ; CNTLR READY (00H)
  0001                   181     RECAL_CMD       EQU     00000001B       ;       RECAL (01H)
  0003                   182     SENSE_CMD       EQU     00000011B       ;       SENSE (03H)
  0004                   183     FMTDRV_CMD      EQU     00000100B       ;       DRIVE (04H)
  0005                   184     CHK_TRK_CMD     EQU     00000101B       ;       T CHK (05H)
  0006                   185     FMTTRK_CMD      EQU     00000110B       ;       TRACK (06H)
  0007                   186     FMTBAD_CMD      EQU     00000111B       ;       BAD   (07H)
  0008                   187     READ_CMD        EQU     00001000B       ;       READ  (08H)
  000A                   188     WRITE_CMD       EQU     00001010B       ;       WRITE (0AH)
  000B                   189     SEEK_CMD        EQU     00001011B       ;       SEEK  (0BH)
  000C                   190     INIT_DRV_CMD    EQU     00001100B       ;       INIT  (0CH)
  000D                   191     RD_ECC_CMD      EQU     00001101B       ;       BURST (0DH)
  000E                   192     RD_BUFF_CMD     EQU     00001110B       ;       BUFFR (0EH)
  000F                   193     WR_BUFF_CMD     EQU     00001111B       ;       BUFFR (0FH)
  00E0                   194     RAM_DIAG_CMD    EQU     11100000B       ;       RAM   (E0H)
  00E3                   195     CHK_DRV_CMD     EQU     11100011B       ;       DRV   (E3H)
  00E4                   196     CNTLR_DIAG_CMD  EQU     11100100B       ;       CNTLR (E4H)
  00E5                   197     RD_LONG_CMD     EQU     11100101B       ;       RLONG (E5H)
  00E6                   198     WR_LONG_CMD     EQU     11100110B       ;       WLONG (E6H)
                         199
  0020                   200     INT_CTL_PORT    EQU     20H             ; 8259 CONTROL PORT
  0020                   201     EOI             EQU     20H             ; END OF INTERRUPT COMMAND
                         202
  0008                   203     MAX_FILE        EQU     8
  0002                   204     S_MAX_FILE      EQU     2
                         205
                         206             ASSUME  CS:CODE
0000                     207             ORG     0H
0000 55                  208             DB      055H                    ; GENERIC BIOS HEADER
0001 AA                  209             DB      0AAH
0002 10                  210             DB      16D
                         211
                         212     ;--------------------------------------------------------------
                         213     ; FIXED DISK I/O SETUP                                       :
                         214     ;                                                            :
                         215     ;  -  ESTABLISH TRANSFER VECTORS FOR THE FIXED DISK         :
                         216     ;  -  PERFORM POWER ON DIAGNOSTICS                          :
                         217     ;     SHOULD AN ERROR OCCUR A "1701" MESSAGE IS DISPLAYED    :
                         218     ;                                                            :
                         219     ;--------------------------------------------------------------
                         220
0003                     221     DISK_SETUP      PROC    FAR
0003 EB1E                222             JMP     SHORT   L3
0005 35303030303539      223             DB      '5000059 (C)COPYRIGHT  IBM 1982'        ; COPYRIGHT NOTICE
     20284329434F50
     59524947485420
     2049424D203139
     3832
0023                     224     L3:
                         225             ASSUME  DS:DUMMY
0023 2BC0                226             SUB     AX,AX                                   ; ZERO
0025 8ED8                227             MOV     DS,AX
```

```
LOC OBJ                 LINE    SOURCE

0027 FA                 228             CLI
0028 A14C00             229             MOV     AX,WORD PTR ORG_VECTOR                  ; GET DISKETTE VECTOR
002B A30001             230             MOV     WORD PTR DISK_VECTOR,AX                 ;  INTO INT 40H
002E A14E00             231             MOV     AX,WORD PTR ORG_VECTOR+2
0031 A30201             232             MOV     WORD PTR DISK_VECTOR+2,AX
0034 C7064C005602       233             MOV     WORD PTR ORG_VECTOR, OFFSET DISK_IO     ; HDISK HANDLER
003A 8C0E4E00           234             MOV     WORD PTR ORG_VECTOR+2,CS
003E B86007             235             MOV     AX, OFFSET HD_INT                       ; HDISK INTERRUPT
0041 A33400             236             MOV     WORD PTR HDISK_INT,AX
0044 8C0E3600           237             MOV     WORD PTR HDISK_INT+2,CS
0048 C70664008601       238             MOV     WORD PTR BOOT_VEC,OFFSET BOOT_STRAP     ; BOOTSTRAP
004E 8C0E6600           239             MOV     WORD PTR BOOT_VEC+2,CS
0052 C7060401E703       240             MOV     WORD PTR HF_TBL_VEC,OFFSET FD_TBL       ; PARAMETER TBL
0058 8C0E0601           241             MOV     WORD PTR HF_TBL_VEC+2,CS
005C FB                 242             STI
                        243
                        244             ASSUME  DS:DATA
005D B84000             245             MOV     AX,DATA                 ; ESTABLISH SEGMENT
0060 8ED8               246             MOV     DS,AX
0062 C606740000         247             MOV     DISK_STATUS,0           ; RESET THE STATUS INDICATOR
0067 C606750000         248             MOV     HF_NUM,0                ; ZERO COUNT OF DRIVES
006C C606430000         249             MOV     CMD_BLOCK+1,0           ; DRIVE ZERO, SET VALUE IN BLOCK
0071 C606770000         250             MOV     PORT_OFF,0              ; ZERO CARD OFFSET
                        251
0076 B92500             252             MOV     CX,25H                  ; RETRY COUNT
0079                    253     L4:
0079 E8F200             254             CALL    HD_RESET_1              ; RESET CONTROLLER
007C 7305               255             JNC     L7
007E E2F9               256             LOOP    L4                      ; TRY RESET AGAIN
0080 E9BF00             257             JMP     ERROR_EX
0083                    258     L7:
0083 B90100             259             MOV     CX,1
0086 BA8000             260             MOV     DX,80H
                        261
0089 B80012             262             MOV     AX,1200H                ; CONTROLLER DIAGNOSTICS
008C CD13               263             INT     13H
008E 7303               264             JNC     P7
0090 E9AF00             265             JMP     ERROR_EX
0093                    266     P7:
0093 B80014             267             MOV     AX,1400H                ; CONTROLLER DIAGNOSTICS
0096 CD13               268             INT     13H
0098 7303               269             JNC     P9
009A E9A500             270             JMP     ERROR_EX
009D                    271     P9:
009D C7066C000000       272             MOV     TIMER_LOW,0             ; ZERO TIMER
00A3 A17200             273             MOV     AX,RESET_FLAG
00A6 3D3412             274             CMP     AX,1234H                ; KEYBOARD RESET
00A9 7506               275             JNE     P8
00AB C7066C009A01       276             MOV     TIMER_LOW,410D          ; SKIP WAIT ON RESET
00B1                    277     P8:
00B1 E421               278             IN      AL,021H                 ; TIMER
00B3 24FE               279             AND     AL,0FEH                 ; ENABLE TIMER
00B5 E621               280             OUT     021H,AL                 ; START TIMER
00B7                    281     P4:
00B7 E8B400             282             CALL    HD_RESET_1              ; RESET CONTROLLER
00BA 7207               283             JC      P10
00BC B80010             284             MOV     AX,1000H                ; READY
00BF CD13               285             INT     13H
00C1 730B               286             JNC     P2
00C3                    287     P10:
00C3 A16C00             288             MOV     AX,TIMER_LOW
00C6 3DBE01             289             CMP     AX,446D                 ; 25 SECONDS
00C9 72EC               290             JB      P4
00CB EB7590             291             JMP     ERROR_EX
00CE                    292     P2:
00CE B90100             293             MOV     CX,1
00D1 BA8000             294             MOV     DX,80H
                        295
00D4 B80011             296             MOV     AX,1100H                ; RECALIBRATE
00D7 CD13               297             INT     13H
00D9 7267               298             JC      ERROR_EX
                        299
00DB B80009             300             MOV     AX,0900H                ; SET DRIVE PARAMETERS
00DE CD13               301             INT     13H
00E0 7260               302             JC      ERROR_EX
                        303
00E2 B800C8             304             MOV     AX,0C800H               ; DMA TO BUFFER
```

```
LOC OBJ                 LINE    SOURCE

00E5 8EC0               305             MOV     ES,AX                   ; SET SEGMENT
00E7 2BDB               306             SUB     BX,BX
00E9 B8000F             307             MOV     AX,0F00H                ; WRITE SECTOR BUFFER
00EC CD13               308             INT     13H
00EE 7252               309             JC      ERROR_EX
                        310
00F0 FE067500           311             INC     HF_NUM                  ; DRIVE ZERO RESPONDED
                        312
00F4 BA1302             313             MOV     DX,213H                 ; EXPANSION BOX
00F7 B000               314             MOV     AL,0
00F9 EE                 315             OUT     DX,AL                   ; TURN BOX OFF
00FA BA2103             316             MOV     DX,321H                 ; TEST IF CONTROLLER
00FD EC                 317             IN      AL,DX                   ; ... IS IN THE SYSTEM UNIT
00FE 240F               318             AND     AL,0FH
0100 3C0F               319             CMP     AL,0FH
0102 7406               320             JE      BOX_ON
0104 C7066C00A401       321             MOV     TIMER_LOW,420D          ; CONTROLLER IS IN SYSTEM UNIT
010A                    322     BOX_ON:
010A BA1302             323             MOV     DX,213H                 ; EXPANSION BOX
010D B0FF               324             MOV     AL,0FFH
010F EE                 325             OUT     DX,AL                   ; TURN BOX ON
                        326
0110 B90100             327             MOV     CX,1                    ; ATTEMPT NEXT DRIVES
0113 BA8100             328             MOV     DX,081H
0116                    329     P3:
0116 2BC0               330             SUB     AX,AX                   ; RESET
0118 CD13               331             INT     13H
011A 7240               332             JC      POD_DONE
011C B80011             333             MOV     AX,01100H               ; RECAL
011F CD13               334             INT     13H
0121 730B               335             JNC     P5
0123 A16C00             336             MOV     AX,TIMER_LOW
0126 3DBE01             337             CMP     AX,446D                 ; 25 SECONDS
0129 72EB               338             JB      P3
012B EB2F90             339             JMP     POD_DONE
012E                    340     P5:
012E B80009             341             MOV     AX,0900H                ; INITIALIZE CHARACTERISTICS
0131 CD13               342             INT     13H
0133 7227               343             JC      POD_DONE
0135 FE067500           344             INC     HF_NUM                  ; TALLY ANOTHER DRIVE
0139 81FA8100           345             CMP     DX,(80H + S_MAX_FILE - 1)
013D 731D               346             JAE     POD_DONE
013F 42                 347             INC     DX
0140 EBD4               348             JMP     P3
                        349
                        350     ;----- POD ERROR
                        351
0142                    352     ERROR_EX:
0142 B00F00             353             MOV     BP,0FH                  ; POD ERROR FLAG
0145 2BC0               354             SUB     AX,AX
0147 8BF0               355             MOV     SI,AX
0149 B9060090           356             MOV     CX,F17L                 ; MESSAGE CHARACTER COUNT
014D B700               357             MOV     BH,0                    ; PAGE ZERO
014F                    358     OUT_CH:
014F 2E8A846801         359             MOV     AL,CS:F17[SI]           ; GET BYTE
0154 B40E               360             MOV     AH,14D                  ; VIDEO OUT
0156 CD10               361             INT     10H                     ; DISPLAY CHARACTER
0158 46                 362             INC     SI                      ; NEXT CHAR
0159 E2F4               363             LOOP    OUT_CH                  ; DO MORE
015B F9                 364             STC
015C                    365     POD_DONE:
015C FA                 366             CLI
015D E421               367             IN      AL,021H                 ; BE SURE TIMER IS DISABLED
015F 0C01               368             OR      AL,01H
0161 E621               369             OUT     021H,AL
0163 FB                 370             STI
0164 E8A500             371             CALL    DSBL
0167 CB                 372             RET
                        373
0168 31373031           374     F17     DB      '1701',0DH,0AH
016C 0D
016D 0A
  0006                  375     F17L    EQU     $-F17
                        376
016E                    377     HD_RESET_1      PROC    NEAR
016E 51                 378             PUSH    CX                      ; SAVE REGISTER
016F 52                 379             PUSH    DX
```

```
LOC OBJ                 LINE    SOURCE

0170 F8                 380             CLC                             ; CLEAR CARRY
0171 B90001             381             MOV     CX,0100H                ; RETRY COUNT
0174                    382     L6:
0174 E80706             383             CALL    PORT_1
0177 EE                 384             OUT     DX,AL                   ; RESET CARD
0178 E80306             385             CALL    PORT_1
017B EC                 386             IN      AL,DX                   ; CHECK STATUS
017C 2402               387             AND     AL,2                    ; ERROR BIT
017E 7403               388             JZ      R3
0180 E2F2               389             LOOP    L6
0182 F9                 390             STC
0183                    391     R3:
0183 5A                 392             POP     DX                      ; RESTORE REGISTER
0184 59                 393             POP     CX
0185 C3                 394             RET
                        395     HD_RESET_1      ENDP
                        396
                        397     DISK_SETUP      ENDP
                        398
                        399     ;----- INT 19 ----------------------------------------------------
                        400     ;                                                                 :
                        401     ; INTERRUPT 19 BOOT STRAP LOADER                                  :
                        402     ;                                                                 :
                        403     ;  -  THE FIXED DISK BIOS REPLACES THE INTERRUPT 19              :
                        404     ;     BOOT STRAP VECTOR WITH A POINTER TO THIS BOOT ROUTINE       :
                        405     ;  -  RESET THE DEFAULT DISK AND DISKETTE PARAMETER VECTORS       :
                        406     ;  -  THE BOOT BLOCK TO BE READ IN WILL BE ATTEMPTED FROM         :
                        407     ;     CYLINDER 0 SECTOR 1 OF THE DEVICE.                          :
                        408     ;  -  THE BOOTSTRAP SEQUENCE IS:                                 :
                        409     ;     > ATTEMPT TO LOAD FROM THE DISKETTE INTO THE BOOT           :
                        410     ;       LOCATION (0000:7C00) AND TRANSFER CONTROL THERE           :
                        411     ;     > IF THE DISKETTE FAILS THE FIXED DISK IS TRIED FOR A       :
                        412     ;       VALID BOOTSTRAP BLOCK. A VALID BOOT BLOCK ON THE          :
                        413     ;       FIXED DISK CONSISTS OF THE BYTES  055H 0AAH  AS THE       :
                        414     ;       LAST TWO BYTES OF THE BLOCK                               :
                        415     ;     > IF THE ABOVE FAILS CONTROL IS PASSED TO RESIDENT BASIC     :
                        416     ;                                                                 :
                        417     ;-----------------------------------------------------------------
                        418
0186                    419     BOOT_STRAP:
                        420             ASSUME  DS:DUMMY,ES:DUMMY
0186 2BC0               421             SUB     AX,AX
0188 8ED8               422             MOV     DS,AX                   ; ESTABLISH SEGMENT
                        423
                        424     ;----- RESET PARAMETER VECTORS
                        425
018A FA                 426             CLI
018B C7060401E703       427             MOV     WORD PTR HF_TBL_VEC, OFFSET FD_TBL
0191 8C0E0601           428             MOV     WORD PTR HF_TBL_VEC+2, CS
0195 C70678000102       429             MOV     WORD PTR DISKETTE_PARM, OFFSET DISKETTE_TBL
019B 8C0E7A00           430             MOV     WORD PTR DISKETTE_PARM+2, CS
019F FB                 431             STI
                        432
                        433     ;----- ATTEMPT BOOTSTRAP FROM DISKETTE
                        434
01A0 B90300             435             MOV     CX,3                    ; SET RETRY COUNT
01A3                    436     H1:                                     ; IPL_SYSTEM
01A3 51                 437             PUSH    CX                      ; SAVE RETRY COUNT
01A4 2BD2               438             SUB     DX,DX                   ; DRIVE ZERO
01A6 2BC0               439             SUB     AX,AX                   ; RESET THE DISKETTE
01A8 CD13               440             INT     13H                     ; FILE IO CALL
01AA 720F               441             JC      H2                      ; IF ERROR, TRY AGAIN
01AC B80102             442             MOV     AX,0201H                ; READ IN THE SINGLE SECTOR
                        443
01AF 2BD2               444             SUB     DX,DX
01B1 8EC2               445             MOV     ES,DX                   ; ESTABLISH SEGMENT
01B3 BB007C             446             MOV     BX,OFFSET BOOT_LOCN
                        447
01B6 B90100             448             MOV     CX,1                    ; SECTOR 1, TRACK 0
01B9 CD13               449             INT     13H                     ; FILE IO CALL
01BB 59                 450     H2:     POP     CX                      ; RECOVER RETRY COUNT
01BC 730A               451             JNC     H4                      ; CF SET BY UNSUCCESSFUL READ
01BE 80FC80             452             CMP     AH,80H                  ; IF TIME OUT, NO RETRY
01C1 740A               453             JZ      H5                      ; TRY FIXED DISK
01C3 E2DE               454             LOOP    H1                      ; DO IT FOR RETRY TIMES
01C5 EB0690             455             JMP     H5                      ; UNABLE TO IPL FROM THE DISKETTE
01C8                    456     H4:                                     ; IPL WAS SUCCESSFUL
```

```
LOC OBJ                 LINE    SOURCE

01C8 EA007C0000         457             JMP     BOOT_LOCN
                        458
                        459     ;----- ATTEMPT BOOTSTRAP FROM FIXED DISK
                        460
01CD                    461     H5:
01CD 2BC0               462             SUB     AX,AX                   ; RESET DISKETTE
01CF 2BD2               463             SUB     DX,DX
01D1 CD13               464             INT     13H
01D3 B90300             465             MOV     CX,3                    ; SET RETRY COUNT
01D6                    466     H6:                                     ; IPL_SYSTEM
01D6 51                 467             PUSH    CX                      ; SAVE RETRY COUNT
01D7 BA8000             468             MOV     DX,0080H                ; FIXED DISK ZERO
01DA 2BC0               469             SUB     AX,AX                   ; RESET THE FIXED DISK
01DC CD13               470             INT     13H                     ; FILE IO CALL
01DE 7212               471             JC      H7                      ; IF ERROR, TRY AGAIN
01E0 B80102             472             MOV     AX,0201H                ; READ IN THE SINGLE SECTOR
01E3 2BDB               473             SUB     BX,BX
01E5 8EC3               474             MOV     ES,BX
01E7 BB007C             475             MOV     BX,OFFSET BOOT_LOCN     ; TO THE BOOT LOCATION
01EA BA8000             476             MOV     DX,80H                  ; DRIVE NUMBER
01ED B90100             477             MOV     CX,1                    ; SECTOR 1, TRACK 0
01F0 CD13               478             INT     13H                     ; FILE IO CALL
01F2 59                 479     H7:     POP     CX                      ; RECOVER RETRY COUNT
01F3 7208               480             JC      H8
01F5 A1FE7D             481             MOV     AX,WORD PTR BOOT_LOCN+510D
01F8 3D55AA             482             CMP     AX,0AA55H               ; TEST FOR GENERIC BOOT BLOCK
01FB 74CB               483             JZ      H4
01FD                    484     H8:
01FD E2D7               485             LOOP    H6                      ; DO IT FOR RETRY TIMES
                        486
                        487     ;------ UNABLE TO IPL FROM THE DISKETTE OR FIXED DISK
                        488
01FF CD18               489             INT     18H                     ; RESIDENT BASIC
                        490
0201                    491     DISKETTE_TBL:
                        492
0201 CF                 493             DB      11001111B               ; SRT=C, HD UNLOAD=OF - 1ST SPEC BYTE
0202 02                 494             DB      2                       ; HD LOAD=1, MODE=DMA - 2ND SPEC BYTE
0203 25                 495             DB      25H                     ; WAIT AFTER OPN TIL MOTOR OFF
0204 02                 496             DB      2                       ; 512 BYTES PER SECTOR
0205 08                 497             DB      8                       ; EOT (LAST SECTOR ON TRACK)
0206 2A                 498             DB      02AH                    ; GAP LENGTH
0207 FF                 499             DB      0FFH                    ; DTL
0208 50                 500             DB      050H                    ; GAP LENGTH FOR FORMAT
0209 F6                 501             DB      0F6H                    ; FILL BYTE FOR FORMAT
020A 19                 502             DB      25                      ; HEAD SETTLE TIME (MILLISECONDS)
020B 04                 503             DB      4                       ; MOTOR START TIME (1/8 SECOND)
                        504
                        505     ;----- MAKE SURE THAT ALL HOUSEKEEPING IS DONE BEFORE EXIT
                        506
020C                    507     DSBL    PROC    NEAR
                        508             ASSUME  DS:DATA
020C 1E                 509             PUSH    DS                      ; SAVE SEGMENT
020D B84000             510             MOV     AX,DATA
0210 8ED8               511             MOV     DS,AX
                        512
0212 8A267700           513             MOV     AH,PORT_OFF
0216 50                 514             PUSH    AX                      ; SAVE OFFSET
                        515
0217 C606770000         516             MOV     PORT_OFF,0H
021C E86905             517             CALL    PORT_3
021F 2AC0               518             SUB     AL,AL
0221 EE                 519             OUT     DX,AL                   ; RESET INT/DMA MASK
0222 C606770004         520             MOV     PORT_OFF,4H
0227 E85E05             521             CALL    PORT_3
022A 2AC0               522             SUB     AL,AL
022C EE                 523             OUT     DX,AL                   ; RESET INT/DMA MASK
022D C606770008         524             MOV     PORT_OFF,8H
0232 E85305             525             CALL    PORT_3
0235 2AC0               526             SUB     AL,AL
0237 EE                 527             OUT     DX,AL                   ; RESET INT/DMA MASK
0238 C60677000C         528             MOV     PORT_OFF,0CH
023D E84805             529             CALL    PORT_3
0240 2AC0               530             SUB     AL,AL
0242 EE                 531             OUT     DX,AL                   ; RESET INT/DMA MASK
0243 B007               532             MOV     AL,07H
0245 E60A               533             OUT     DMA+10,AL               ; SET DMA MODE TO DISABLE
```

```
LOC OBJ                 LINE    SOURCE

0247 FA                 534             CLI                             ; DISABLE INTERRUPTS
0248 E421               535             IN      AL,021H
024A 0C20               536             OR      AL,020H
024C E621               537             OUT     021H,AL                 ; DISABLE INTERRUPT 5
024E FB                 538             STI                             ; ENABLE INTERRUPTS
024F 58                 539             POP     AX                      ; RESTORE OFFSET
0250 88267700           540             MOV     PORT_OFF,AH
0254 1F                 541             POP     DS                      ; RESTORE SEGMENT
0255 C3                 542             RET
                        543     DSBL    ENDP
                        544
                        545     ;---------------------------------------
                        546     ;       FIXED DISK BIOS ENTRY POINT     :
                        547     ;---------------------------------------
                        548
0256                    549     DISK_IO PROC    FAR
                        550             ASSUME  DS:NOTHING,ES:NOTHING
0256 80FA80             551             CMP     DL,80H                  ; TEST FOR FIXED DISK DRIVE
0259 7305               552             JAE     HARD_DISK               ; YES, HANDLE HERE
025B CD40               553             INT     40H                     ; DISKETTE HANDLER
025D                    554     RET_2:
025D CA0200             555             RET     2                       ; BACK TO CALLER
0260                    556     HARD_DISK:
                        557             ASSUME  DS:DATA
0260 FB                 558             STI                             ; ENABLE INTERRUPTS
0261 0AE4               559             OR      AH,AH
0263 7509               560             JNZ     A3
0265 CD40               561             INT     40H                     ; RESET NEC WHEN AH=0
0267 2AE4               562             SUB     AH,AH
0269 80FA81             563             CMP     DL,(80H + S_MAX_FILE - 1)
026C 77EF               564             JA      RET_2
026E                    565     A3:
026E 80FC08             566             CMP     AH,08                   ; GET PARAMETERS IS A SPECIAL CASE
0271 7503               567             JNZ     A2
0273 E91A01             568             JMP     GET_PARM_N
0276                    569     A2:
0276 53                 570             PUSH    BX                      ; SAVE REGISTERS DURING OPERATION
0277 51                 571             PUSH    CX
0278 52                 572             PUSH    DX
0279 1E                 573             PUSH    DS
027A 06                 574             PUSH    ES
027B 56                 575             PUSH    SI
027C 57                 576             PUSH    DI
                        577
027D E86A00             578             CALL    DISK_IO_CONT            ; PERFORM THE OPERATION
                        579
0280 50                 580             PUSH    AX
0281 E888FF             581             CALL    DSBL                    ; BE SURE DISABLES OCCURRED
0284 B84000             582             MOV     AX,DATA
0287 8ED8               583             MOV     DS,AX                   ; ESTABLISH SEGMENT
0289 58                 584             POP     AX
028A 8A267400           585             MOV     AH,DISK_STATUS          ; GET STATUS FROM OPERATION
028E 80FC01             586             CMP     AH,1                    ; SET THE CARRY FLAG TO INDICATE
0291 F5                 587             CMC                             ;  SUCCESS OR FAILURE
0292 5F                 588             POP     DI                      ; RESTORE REGISTERS
0293 5E                 589             POP     SI
0294 07                 590             POP     ES
0295 1F                 591             POP     DS
0296 5A                 592             POP     DX
0297 59                 593             POP     CX
0298 5B                 594             POP     BX
0299 CA0200             595             RET     2                       ; THROW AWAY SAVED FLAGS
                        596     DISK_IO ENDP
                        597
029C                    598     M1      LABEL   WORD                    ; FUNCTION TRANSFER TABLE
029C 3803               599             DW      DISK_RESET              ; 000H
029E 4D03               600             DW      RETURN_STATUS           ; 001H
02A0 5603               601             DW      DISK_READ               ; 002H
02A2 6003               602             DW      DISK_WRITE              ; 003H
02A4 6A03               603             DW      DISK_VERF               ; 004H
02A6 7203               604             DW      FMT_TRK                 ; 005H
02A8 7903               605             DW      FMT_BAD                 ; 006H
02AA 8003               606             DW      FMT_DRV                 ; 007H
02AC 3003               607             DW      BAD_COMMAND             ; 008H
02AE 2704               608             DW      INIT_DRV                ; 009H
02B0 CF04               609             DW      RD_LONG                 ; 00AH
02B2 DD04               610             DW      WR_LONG                 ; 00BH
```

```
LOC OBJ                 LINE    SOURCE

02B4 F204               611             DW      DISK_SEEK               ; 00CH
02B6 3803               612             DW      DISK_RESET              ; 00DH
02B8 F904               613             DW      RD_BUFF                 ; 00EH
02BA 0705               614             DW      WR_BUFF                 ; 00FH
02BC 1505               615             DW      TST_RDY                 ; 010H
02BE 1C05               616             DW      HDISK_RECAL             ; 011H
02C0 2305               617             DW      RAM_DIAG                ; 012H
02C2 2A05               618             DW      CHK_DRV                 ; 013H
02C4 3105               619             DW      CNTLR_DIAG              ; 014H
  002A                  620     M1L     EQU     $-M1
                        621
02C6                    622     SETUP_A PROC    NEAR
                        623
02C6 C606740000         624             MOV     DISK_STATUS,0           ; RESET THE STATUS INDICATOR
02CB 51                 625             PUSH    CX                      ; SAVE CX
                        626
                        627     ;----- CALCULATE THE PORT OFFSET
                        628
02CC 8AEA               629             MOV     CH,DL                   ; SAVE DL
02CE 80CA01             630             OR      DL,1
02D1 FECA               631             DEC     DL
02D3 D0E2               632             SHL     DL,1                    ; GENERATE OFFSET
02D5 88167700           633             MOV     PORT_OFF,DL             ; STORE OFFSET
02D9 8AD5               634             MOV     DL,CH                   ; RESTORE DL
02DB 80E201             635             AND     DL,1
                        636
02DE B105               637             MOV     CL,5                    ; SHIFT COUNT
02E0 D2E2               638             SHL     DL,CL                   ; DRIVE NUMBER (0,1)
02E2 0AD6               639             OR      DL,DH                   ; HEAD NUMBER
02E4 88164300           640             MOV     CMD_BLOCK+1,DL
02E8 59                 641             POP     CX
02E9 C3                 642             RET
                        643     SETUP_A ENDP
                        644
02EA                    645     DISK_IO_CONT    PROC    NEAR
02EA 50                 646             PUSH    AX
02EB B84000             647             MOV     AX,DATA
02EE 8ED8               648             MOV     DS,AX                   ; ESTABLISH SEGMENT
02F0 58                 649             POP     AX
02F1 80FC01             650             CMP     AH,01H                  ; RETURN STATUS
02F4 7503               651             JNZ     A4
02F6 EB5590             652             JMP     RETURN_STATUS
02F9                    653     A4:
02F9 80EA80             654             SUB     DL,80H                  ; CONVERT DRIVE NUMBER TO 0 BASED RANGE
02FC 80FA08             655             CMP     DL,MAX_FILE             ; LEGAL DRIVE TEST
02FF 732F               656             JAE     BAD_COMMAND
                        657
0301 E8C2FF             658             CALL    SETUP_A
                        659
                        660     ;----- SET UP COMMAND BLOCK
                        661
0304 FEC9               662             DEC     CL                      ; SECTORS 0-16 FOR CONTROLLER
0306 C606420000         663             MOV     CMD_BLOCK+0,0
030B 880E4400           664             MOV     CMD_BLOCK+2,CL          ; SECTOR AND HIGH 2 BITS CYLINDER
030F 882E4500           665             MOV     CMD_BLOCK+3,CH          ; CYLINDER
0313 A24600             666             MOV     CMD_BLOCK+4,AL          ; INTERLEAVE / BLOCK COUNT
0316 A07600             667             MOV     AL,CONTROL_BYTE         ; CONTROL BYTE (STEP OPTION)
0319 A24700             668             MOV     CMD_BLOCK+5,AL
031C 50                 669             PUSH    AX                      ; SAVE AX
031D 8AC4               670             MOV     AL,AH                   ; GET INTO LOW BYTE
031F 32E4               671             XOR     AH,AH                   ; ZERO HIGH BYTE
0321 D1E0               672             SAL     AX,1                    ; *2 FOR TABLE LOOKUP
0323 8BF0               673             MOV     SI,AX                   ; PUT INTO SI FOR BRANCH
0325 3D2A00             674             CMP     AX,M1L                  ; TEST WITHIN RANGE
0328 58                 675             POP     AX                      ; RESTORE AX
0329 7305               676             JNB     BAD_COMMAND
032B 2EFFA49C02         677             JMP     WORD PTR CS:[SI + OFFSET M1]
0330                    678     BAD_COMMAND:
0330 C606740001         679             MOV     DISK_STATUS,BAD_CMD     ; COMMAND ERROR
0335 B000               680             MOV     AL,0
0337 C3                 681             RET
                        682     DISK_IO_CONT    ENDP
                        683
                        684     ;-----------------------------------------------
                        685     ;       RESET THE DISK SYSTEM  (AH = 000H)      :
                        686     ;-----------------------------------------------
                        687
```

```
LOC OBJ                 LINE    SOURCE

0338                    688     DISK_RESET      PROC    NEAR
0338 E84304             689             CALL    PORT_1                  ; RESET PORT
033B EE                 690             OUT     DX,AL                   ; ISSUE RESET
033C E83F04             691             CALL    PORT_1                  ; CONTROLLER HARDWARE STATUS
033F EC                 692             IN      AL,DX                   ; GET STATUS
0340 2402               693             AND     AL,2                    ; ERROR BIT
0342 7406               694             JZ      DR1
0344 C606740005         695             MOV     DISK_STATUS,BAD_RESET
0349 C3                 696             RET
034A                    697     DR1:
034A E9DA00             698             JMP     INIT_DRV                ; SET THE DRIVE PARAMETERS
                        699     DISK_RESET      ENDP
                        700
                        701     ;--------------------------------------------------
                        702     ;       DISK STATUS ROUTINE   (AH = 001H)       :
                        703     ;--------------------------------------------------
                        704
034D                    705     RETURN_STATUS   PROC    NEAR
034D A07400             706             MOV     AL,DISK_STATUS          ; OBTAIN PREVIOUS STATUS
0350 C606740000         707             MOV     DISK_STATUS,0           ; RESET STATUS
0355 C3                 708             RET
                        709     RETURN_STATUS   ENDP
                        710
                        711     ;--------------------------------------------------
                        712     ;       DISK READ ROUTINE   (AH = 002H)         :
                        713     ;--------------------------------------------------
                        714
0356                    715     DISK_READ       PROC    NEAR
0356 B047               716             MOV     AL,DMA_READ             ; MODE BYTE FOR DMA READ
0358 C606420008         717             MOV     CMD_BLOCK+0,READ_CMD
035D E9E501             718             JMP     DMA_OPN
                        719     DISK_READ       ENDP
                        720
                        721     ;--------------------------------------------------
                        722     ;       DISK WRITE ROUTINE   (AH = 003H)        :
                        723     ;--------------------------------------------------
                        724
0360                    725     DISK_WRITE      PROC    NEAR
0360 B04B               726             MOV     AL,DMA_WRITE            ; MODE BYTE FOR DMA WRITE
0362 C60642000A         727             MOV     CMD_BLOCK+0,WRITE_CMD
0367 E9DB01             728             JMP     DMA_OPN
                        729     DISK_WRITE      ENDP
                        730
                        731     ;--------------------------------------------------
                        732     ;       DISK VERIFY   (AH = 004H)               :
                        733     ;--------------------------------------------------
                        734
036A                    735     DISK_VERF       PROC    NEAR
036A C606420005         736             MOV     CMD_BLOCK+0,CHK_TRK_CMD
036F E9C401             737             JMP     NDMA_OPN
                        738     DISK_VERF       ENDP
                        739
                        740     ;--------------------------------------------------
                        741     ;       FORMATTING   (AH = 005H 006H 007H)      :
                        742     ;--------------------------------------------------
                        743
0372                    744     FMT_TRK PROC    NEAR                    ; FORMAT TRACK  (AH = 005H)
0372 C606420006         745             MOV     CMD_BLOCK,FMTTRK_CMD
0377 EB0C               746             JMP     SHORT   FMT_CONT
                        747     FMT_TRK ENDP
                        748
0379                    749     FMT_BAD PROC    NEAR                    ; FORMAT BAD TRACK  (AH = 006H)
0379 C606420007         750             MOV     CMD_BLOCK,FMTBAD_CMD
037E EB05               751             JMP     SHORT   FMT_CONT
                        752     FMT_BAD ENDP
                        753
0380                    754     FMT_DRV PROC    NEAR                    ; FORMAT DRIVE  (AH = 007H)
0380 C606420004         755             MOV     CMD_BLOCK,FMTDRV_CMD
                        756     FMT_DRV ENDP
                        757
0385                    758     FMT_CONT:
0385 A04400             759             MOV     AL,CMD_BLOCK+2          ; ZERO OUT SECTOR FIELD
0388 24C0               760             AND     AL,11000000B
038A A24400             761             MOV     CMD_BLOCK+2,AL
038D E9A601             762             JMP     NDMA_OPN
                        763
```

```
LOC OBJ                 LINE    SOURCE

                        764     ;-----------------------------------------------
                        765     ;       GET PARAMETERS   (AH = 8)               :
                        766     ;-----------------------------------------------
                        767
0390                    768     GET_PARM_N      LABEL   NEAR
0390                    769     GET_PARM        PROC    FAR             ; GET DRIVE PARAMETERS
0390 1E                 770             PUSH    DS                      ; SAVE REGISTERS
0391 06                 771             PUSH    ES
0392 53                 772             PUSH    BX
                        773
                        774             ASSUME  DS:DUMMY
0393 2BC0               775             SUB     AX,AX                   ; ESTABLISH ADDRESSING
0395 8ED8               776             MOV     DS,AX
0397 C41E0401           777             LES     BX,HF_TBL_VEC
                        778             ASSUME  DS:DATA
039B B84000             779             MOV     AX,DATA
039E 8ED8               780             MOV     DS,AX                   ; ESTABLISH SEGMENT
                        781
03A0 80EA80             782             SUB     DL,80H
03A3 80FA08             783             CMP     DL,MAX_FILE             ; TEST WITHIN RANGE
03A6 732F               784             JAE     G4
                        785
03A8 E81BFF             786             CALL    SETUP_A
                        787
03AB E8DF03             788             CALL    SW2_OFFS
03AE 7227               789             JC      G4
03B0 03D8               790             ADD     BX,AX
                        791
03B2 268B07             792             MOV     AX,ES:[BX]              ; MAX NUMBER OF CYLINDERS
03B5 2D0200             793             SUB     AX,2                    ; ADJUST FOR 0-N
                        794                                             ; AND RESERVE LAST TRACK
03B8 8AE8               795             MOV     CH,AL
03BA 250003             796             AND     AX,0300H                ; HIGH TWO BITS OF CYL
03BD D1E8               797             SHR     AX,1
03BF D1E8               798             SHR     AX,1
03C1 0C11               799             OR      AL,011H                 ; SECTORS
03C3 8AC8               800             MOV     CL,AL
                        801
03C5 268A7702           802             MOV     DH,ES:[BX][2]           ; HEADS
03C9 FECE               803             DEC     DH                      ; 0-N RANGE
03CB 8A167500           804             MOV     DL,HF_NUM               ; DRIVE COUNT
03CF 2BC0               805             SUB     AX,AX
03D1                    806     G5:
03D1 5B                 807             POP     BX                      ; RESTORE REGISTERS
03D2 07                 808             POP     ES
03D3 1F                 809             POP     DS
03D4 CA0200             810             RET     2
03D7                    811     G4:
03D7 C606740007         812             MOV     DISK_STATUS,INIT_FAIL   ; OPERATION FAILED
03DC B407               813             MOV     AH,INIT_FAIL
03DE 2AC0               814             SUB     AL,AL
03E0 2BD2               815             SUB     DX,DX
03E2 2BC9               816             SUB     CX,CX
03E4 F9                 817             STC                             ; SET ERROR FLAG
03E5 EBEA               818             JMP     G5
                        819     GET_PARM        ENDP
                        820
                        821     ;-------------------------------------------------------
                        822     ; INITIALIZE DRIVE CHARACTERISTICS                     :
                        823     ;                                                      :
                        824     ; FIXED DISK PARAMETER TABLE                           :
                        825     ;                                                      :
                        826     ;  -  THE TABLE IS COMPOSED OF A BLOCK DEFINED AS:    :
                        827     ;                                                      :
                        828     ;       (1 WORD) - MAXIMUM NUMBER OF CYLINDERS         :
                        829     ;       (1 BYTE) - MAXIMUM NUMBER OF HEADS             :
                        830     ;       (1 WORD) - STARTING REDUCED WRITE CURRENT CYL  :
                        831     ;       (1 WORD) - STARTING WRITE PRECOMPENSATION CYL  :
                        832     ;       (1 BYTE) - MAXIMUM ECC DATA BURST LENGTH       :
                        833     ;       (1 BYTE) - CONTROL BYTE (DRIVE STEP OPTION)    :
                        834     ;                  BIT    7 DISABLE DISK-ACCESS RETRIES :
                        835     ;                  BIT    6 DISABLE ECC RETRIES         :
                        836     ;                  BITS 5-3 ZERO                        :
                        837     ;                  BITS 2-0 DRIVE OPTION                :
                        838     ;       (1 BYTE) - STANDARD TIME OUT VALUE (SEE BELOW) :
                        839     ;       (1 BYTE) - TIME OUT VALUE FOR FORMAT DRIVE     :
                        840     ;       (1 BYTE) - TIME OUT VALUE FOR CHECK DRIVE      :
                        841     ;       (4 BYTES)                                      :
```

```
LOC OBJ                 LINE    SOURCE

                        842     ;               - RESERVED FOR FUTURE USE               :
                        843     ;                                                       :
                        844     ;       - TO DYNAMICALLY DEFINE A SET OF PARAMETERS     :
                        845     ;         BUILD A TABLE OF VALUES AND PLACE THE         :
                        846     ;         CORRESPONDING VECTOR INTO INTERRUPT 41.        :
                        847     ;                                                       :
                        848     ;       NOTE:                                           :
                        849     ;               THE DEFAULT TABLE IS VECTORED IN FOR    :
                        850     ;               AN INTERRUPT 19H (BOOTSTRAP)            :
                        851     ;                                                       :
                        852     ;                                                       :
                        853     ; ON THE CARD SWITCH SETTINGS                           :
                        854     ;                                                       :
                        855     ;                 DRIVE 0    DRIVE 1                    :
                        856     ;               -----------------------                 :
                        857     ;         ON    :          /          :                 :
                        858     ;               : -1-  -2- / -3-  -4- :                 :
                        859     ;         OFF   :          /          :                 :
                        860     ;               -----------------------                 :
                        861     ;                                                       :
                        862     ;                                                       :
                        863     ;       TRANSLATION TABLE                               :
                        864     ;                                                       :
                        865     ;       1/3  :  2/4  :  TABLE ENTRY                     :
                        866     ;       --------------------------                      :
                        867     ;        ON  :   ON  :      0                            :
                        868     ;        ON  :  OFF  :      1                            :
                        869     ;       OFF  :   ON  :      2                            :
                        870     ;       OFF  :  OFF  :      3                            :
                        871     ;                                                       :
                        872     ;-------------------------------------------------------
                        873
03E7                    874     FD_TBL:
                        875
                        876     ;----- DRIVE TYPE 00
                        877
03E7 3201               878             DW      0306D
03E9 02                 879             DB      02D
03EA 3201               880             DW      0306D
03EC 0000               881             DW      0000D
03EE 0B                 882             DB      0BH
03EF 00                 883             DB      00H
03F0 0C                 884             DB      0CH                     ; STANDARD
03F1 B4                 885             DB      0B4H                    ; FORMAT DRIVE
03F2 28                 886             DB      028H                    ; CHECK DRIVE
03F3 00000000           887             DB      0,0,0,0
                        888
                        889     ;----- DRIVE TYPE 01
                        890
03F7 7701               891             DW      0375D
03F9 08                 892             DB      08D
03FA 7701               893             DW      0375D
03FC 0000               894             DW      0000D
03FE 0B                 895             DB      0BH
03FF 05                 896             DB      05H
0400 0C                 897             DB      0CH                     ; STANDARD
0401 B4                 898             DB      0B4H                    ; FORMAT DRIVE
0402 28                 899             DB      028H                    ; CHECK DRIVE
0403 00000000           900             DB      0,0,0,0
                        901
                        902     ;----- DRIVE TYPE 02
                        903
0407 3201               904             DW      0306D
0409 06                 905             DB      06D
040A 8000               906             DW      0128D
040C 0001               907             DW      0256D
040E 0B                 908             DB      0BH
040F 05                 909             DB      05H
0410 0C                 910             DB      0CH                     ; STANDARD
0411 B4                 911             DB      0B4H                    ; FORMAT DRIVE
0412 28                 912             DB      028H                    ; CHECK DRIVE
0413 00000000           913             DB      0,0,0,0
                        914
                        915     ;----- DRIVE TYPE 03
                        916
0417 3201               917             DW      0306D
0419 04                 918             DB      04D
```

```
LOC OBJ                 LINE    SOURCE

041A 3201               919             DW      0306D
041C 0000               920             DW      0000D
041E 0B                 921             DB      0BH
041F 05                 922             DB      05H
0420 0C                 923             DB      0CH                     ; STANDARD
0421 B4                 924             DB      0B4H                    ; FORMAT DRIVE
0422 28                 925             DB      028H                    ; CHECK DRIVE
0423 00000000           926             DB      0,0,0,0
                        927
0427                    928     INIT_DRV        PROC    NEAR
                        929
                        930     ;----- DO DRIVE ZERO
                        931
0427 C60642000C         932             MOV     CMD_BLOCK+0,INIT_DRV_CMD
042C C606430000         933             MOV     CMD_BLOCK+1,0
0431 E81000             934             CALL    INIT_DRV_R
0434 720D               935             JC      INIT_DRV_OUT
                        936
                        937     ;----- DO DRIVE ONE
                        938
0436 C60642000C         939             MOV     CMD_BLOCK+0,INIT_DRV_CMD
043B C606430020         940             MOV     CMD_BLOCK+1,00100000B
0440 E80100             941             CALL    INIT_DRV_R
0443                    942     INIT_DRV_OUT:
0443 C3                 943             RET
                        944     INIT_DRV        ENDP
                        945
0444                    946     INIT_DRV_R      PROC    NEAR
                        947             ASSUME  ES:CODE
0444 2AC0               948             SUB     AL,AL
0446 E81901             949             CALL    COMMAND                 ; ISSUE THE COMMAND
0449 7301               950             JNC     B1
044B C3                 951             RET
044C                    952     B1:
044C 1E                 953             PUSH    DS                      ; SAVE SEGMENT
                        954             ASSUME  DS:DUMMY
044D 2BC0               955             SUB     AX,AX
044F 8ED8               956             MOV     DS,AX                   ; ESTABLISH SEGMENT
0451 C41E0401           957             LES     BX,HF_TBL_VEC
0455 1F                 958             POP     DS                      ; RESTORE SEGMENT
                        959             ASSUME  DS:DATA
0456 E83403             960             CALL    SW2_OFFS
0459 7257               961             JC      B3
045B 03D8               962             ADD     BX,AX
                        963
                        964     ;----- SEND DRIVE PARAMETERS MOST SIGNIFICANT BYTE FIRST
                        965
045D BF0100             966             MOV     DI,1
0460 E85F00             967             CALL    INIT_DRV_S
0463 724D               968             JC      B3
                        969
0465 BF0000             970             MOV     DI,0
0468 E85700             971             CALL    INIT_DRV_S
046B 7245               972             JC      B3
                        973
046D BF0200             974             MOV     DI,2
0470 E84F00             975             CALL    INIT_DRV_S
0473 723D               976             JC      B3
                        977
0475 BF0400             978             MOV     DI,4
0478 E84700             979             CALL    INIT_DRV_S
047B 7235               980             JC      B3
                        981
047D BF0300             982             MOV     DI,3
0480 E83F00             983             CALL    INIT_DRV_S
0483 722D               984             JC      B3
                        985
0485 BF0600             986             MOV     DI,6
0488 E83700             987             CALL    INIT_DRV_S
048B 7225               988             JC      B3
                        989
048D BF0500             990             MOV     DI,5
0490 E82F00             991             CALL    INIT_DRV_S
0493 721D               992             JC      B3
                        993
0495 BF0700             994             MOV     DI,7
0498 E82700             995             CALL    INIT_DRV_S
```

```
LOC OBJ                 LINE    SOURCE

049B 7215               996             JC      B3
                        997
049D BF0800             998             MOV     DI,8                    ; DRIVE STEP OPTION
04A0 268A01             999             MOV     AL,ES:[BX + DI]
04A3 A27600            1000             MOV     CONTROL_BYTE,AL
                       1001
04A6 2BC9              1002             SUB     CX,CX
04A8                   1003     B5:
04A8 E8D302            1004             CALL    PORT_1
04AB EC                1005             IN      AL,DX
04AC A802              1006             TEST    AL,R1_IOMODE            ; STATUS INPUT MODE
04AE 7509              1007             JNZ     B6
04B0 E2F6              1008             LOOP    B5
04B2                   1009     B3:
04B2 C606740007        1010             MOV     DISK_STATUS,INIT_FAIL   ; OPERATION FAILED
04B7 F9                1011             STC
04B8 C3                1012             RET
                       1013
04B9                   1014     B6:
04B9 E8B502            1015             CALL    PORT_0
04BC EC                1016             IN      AL,DX
04BD 2402              1017             AND     AL,2                    ; MASK ERROR BIT
04BF 75F1              1018             JNZ     B3
04C1 C3                1019             RET
                       1020             ASSUME  ES:NOTHING
                       1021     INIT_DRV_R      ENDP
                       1022
                       1023     ;----- SEND THE BYTE OUT TO THE CONTROLLER
                       1024
04C2                   1025     INIT_DRV_S      PROC    NEAR
04C2 E8C501            1026             CALL    HD_WAIT_REQ
04C5 7207              1027             JC      D1
04C7 E8A702            1028             CALL    PORT_0
04CA 268A01            1029             MOV     AL,ES:[BX + DI]
04CD EE                1030             OUT     DX,AL
04CE                   1031     D1:
04CE C3                1032             RET
                       1033     INIT_DRV_S      ENDP
                       1034
                       1035     ;---------------------------------------
                       1036     ;       READ LONG  (AH = 0AH)           :
                       1037     ;---------------------------------------
                       1038
04CF                   1039     RD_LONG         PROC    NEAR
04CF E81900            1040             CALL    CHK_LONG
04D2 726B              1041             JC      G8
04D4 C6064200E5        1042             MOV     CMD_BLOCK+0,RD_LONG_CMD
04D9 B047              1043             MOV     AL,DMA_READ
04DB EB68              1044             JMP     SHORT   DMA_OPN
                       1045     RD_LONG         ENDP
                       1046
                       1047     ;---------------------------------------
                       1048     ;       WRITE LONG  (AH = 0BH)          :
                       1049     ;---------------------------------------
                       1050
04DD                   1051     WR_LONG         PROC    NEAR
04DD E80B00            1052             CALL    CHK_LONG
04E0 725D              1053             JC      G8
04E2 C6064200E6        1054             MOV     CMD_BLOCK+0,WR_LONG_CMD
04E7 B04B              1055             MOV     AL,DMA_WRITE
04E9 EB5A              1056             JMP     SHORT   DMA_OPN
                       1057     WR_LONG         ENDP
                       1058
04EB                   1059     CHK_LONG        PROC    NEAR
04EB A04600            1060             MOV     AL,CMD_BLOCK+4
04EE 3C80              1061             CMP     AL,080H
04F0 F5                1062             CMC
04F1 C3                1063             RET
                       1064     CHK_LONG        ENDP
                       1065
                       1066     ;---------------------------------------
                       1067     ;       SEEK   (AH = 0CH)               :
                       1068     ;---------------------------------------
                       1069
04F2                   1070     DISK_SEEK       PROC    NEAR
04F2 C60642000B        1071             MOV     CMD_BLOCK,SEEK_CMD
04F7 EB3D              1072             JMP     SHORT   NDMA_OPN
```

```
LOC OBJ                 LINE    SOURCE

                        1073    DISK_SEEK       ENDP
                        1074
                        1075    ;-----------------------------------------------
                        1076    ;       READ SECTOR BUFFER   (AH = 0EH)         :
                        1077    ;-----------------------------------------------
                        1078
04F9                    1079    RD_BUFF PROC    NEAR
04F9 C60642000E         1080            MOV     CMD_BLOCK+0,RD_BUFF_CMD
04FE C606460001         1081            MOV     CMD_BLOCK+4,1           ; ONLY ONE BLOCK
0503 B047               1082            MOV     AL,DMA_READ
0505 EB3E               1083            JMP     SHORT   DMA_OPN
                        1084    RD_BUFF ENDP
                        1085
                        1086    ;-----------------------------------------------
                        1087    ;       WRITE SECTOR BUFFER   (AH = 0FH)        :
                        1088    ;-----------------------------------------------
                        1089
0507                    1090    WR_BUFF PROC    NEAR
0507 C60642000F         1091            MOV     CMD_BLOCK+0,WR_BUFF_CMD
050C C606460001         1092            MOV     CMD_BLOCK+4,1           ; ONLY ONE BLOCK
0511 B04B               1093            MOV     AL,DMA_WRITE
0513 EB30               1094            JMP     SHORT   DMA_OPN
                        1095    WR_BUFF ENDP
                        1096
                        1097    ;-----------------------------------------------
                        1098    ;       TEST DISK READY   (AH = 010H)           :
                        1099    ;-----------------------------------------------
                        1100
0515                    1101    TST_RDY PROC    NEAR
0515 C606420000         1102            MOV     CMD_BLOCK+0,TST_RDY_CMD
051A EB1A               1103            JMP     SHORT   NDMA_OPN
                        1104    TST_RDY ENDP
                        1105
                        1106    ;-----------------------------------------------
                        1107    ;       RECALIBRATE   (AH = 011H)               :
                        1108    ;-----------------------------------------------
                        1109
051C                    1110    HDISK_RECAL     PROC    NEAR
051C C606420001         1111            MOV     CMD_BLOCK,RECAL_CMD
0521 EB13               1112            JMP     SHORT   NDMA_OPN
                        1113    HDISK_RECAL     ENDP
                        1114
                        1115    ;-------------------------------------------------------
                        1116    ;       CONTROLLER RAM DIAGNOSTICS   (AH = 012H)        :
                        1117    ;-------------------------------------------------------
                        1118
0523                    1119    RAM_DIAG        PROC    NEAR
0523 C6064200E0         1120            MOV     CMD_BLOCK+0,RAM_DIAG_CMD
0528 EB0C               1121            JMP     SHORT   NDMA_OPN
                        1122    RAM_DIAG        ENDP
                        1123
                        1124    ;-----------------------------------------------
                        1125    ;       DRIVE DIAGNOSTICS   (AH = 013H)         :
                        1126    ;-----------------------------------------------
                        1127
052A                    1128    CHK_DRV PROC    NEAR
052A C6064200E3         1129            MOV     CMD_BLOCK+0,CHK_DRV_CMD
052F EB05               1130            JMP     SHORT   NDMA_OPN
                        1131    CHK_DRV ENDP
                        1132
                        1133    ;-------------------------------------------------------
                        1134    ;      CONTROLLER INTERNAL DIAGNOSTICS   (AH = 014H)      :
                        1135    ;-------------------------------------------------------
                        1136
0531                    1137    CNTLR_DIAG      PROC    NEAR
0531 C6064200E4         1138            MOV     CMD_BLOCK+0,CNTLR_DIAG_CMD
                        1139    CNTLR_DIAG      ENDP
                        1140
                        1141    ;-------------------------------------------------------
                        1142    ;                       SUPPORT ROUTINES                :
                        1143    ;-------------------------------------------------------
                        1144
0536                    1145    NDMA_OPN:
0536 B002               1146            MOV     AL,02H
0538 E82700             1147            CALL    COMMAND                 ; ISSUE THE COMMAND
053B 7221               1148            JC      G11
053D EB16               1149            JMP     SHORT   G3
```

```
LOC OBJ                 LINE    SOURCE

053F                    1150    G8:
053F C606740009         1151            MOV     DISK_STATUS,DMA_BOUNDARY
0544 C3                 1152            RET
0545                    1153    DMA_OPN:
0545 E85701             1154            CALL    DMA_SETUP               ; SET UP FOR DMA OPERATION
0548 72F5               1155            JC      G8
054A B003               1156            MOV     AL,03H
054C E81300             1157            CALL    COMMAND                 ; ISSUE THE COMMAND
054F 720D               1158            JC      G11
0551 B003               1159            MOV     AL,03H
0553 E60A               1160            OUT     DMA+10,AL               ; INITIALIZE THE DISK CHANNEL
0555                    1161    G3:
0555 E421               1162            IN      AL,021H
0557 24DF               1163            AND     AL,0DFH
0559 E621               1164            OUT     021H,AL
055B E8AA01             1165            CALL    WAIT_INT
055E                    1166    G11:
055E E83B00             1167            CALL    ERROR_CHK
0561 C3                 1168            RET
                        1169
                        1170    ;---------------------------------------------------
                        1171    ; COMMAND                                         :
                        1172    ;       THIS ROUTINE OUTPUTS THE COMMAND BLOCK     :
                        1173    ; INPUT                                           :
                        1174    ;       AL = CONTROLLER DMA/INTERRUPT REGISTER MASK :
                        1175    ;                                                 :
                        1176    ;---------------------------------------------------
                        1177
0562                    1178    COMMAND PROC    NEAR
0562 BE4200             1179            MOV     SI,OFFSET CMD_BLOCK
0565 E81B02             1180            CALL    PORT_2
0568 EE                 1181            OUT     DX,AL                   ; CONTROLLER SELECT PULSE
0569 E81C02             1182            CALL    PORT_3
056C EE                 1183            OUT     DX,AL
056D 2BC9               1184            SUB     CX,CX                   ; WAIT COUNT
056F E80C02             1185            CALL    PORT_1
0572                    1186    WAIT_BUSY:
0572 EC                 1187            IN      AL,DX                   ; GET STATUS
0573 240F               1188            AND     AL,0FH
0575 3C0D               1189            CMP     AL,R1_BUSY OR R1_BUS OR R1_REQ
0577 7409               1190            JE      C1
0579 E2F7               1191            LOOP    WAIT_BUSY
057B C606740080         1192            MOV     DISK_STATUS,TIME_OUT
0580 F9                 1193            STC
0581 C3                 1194            RET                             ; ERROR RETURN
0582                    1195    C1:
0582 FC                 1196            CLD
0583 B90600             1197            MOV     CX,6                    ; BYTE COUNT
0586                    1198    CM3:
0586 E8E801             1199            CALL    PORT_0
0589 AC                 1200            LODSB                           ; GET THE NEXT COMMAND BYTE
058A EE                 1201            OUT     DX,AL                   ; OUT IT GOES
058B E2F9               1202            LOOP    CM3                     ; DO MORE
                        1203
058D E8EE01             1204            CALL    PORT_1                  ; STATUS
0590 EC                 1205            IN      AL,DX
0591 A801               1206            TEST    AL,R1_REQ
0593 7406               1207            JZ      CM7
0595 C606740020         1208            MOV     DISK_STATUS,BAD_CNTLR
059A F9                 1209            STC
059B                    1210    CM7:
059B C3                 1211            RET
                        1212    COMMAND ENDP
                        1213
                        1214    ;-------------------------------------------------
                        1215    ;               SENSE STATUS BYTES              :
                        1216    ;                                               :
                        1217    ; BYTE 0                                        :
                        1218    ;       BIT    7   ADDRESS VALID, WHEN SET      :
                        1219    ;       BIT    6   SPARE, SET TO ZERO           :
                        1220    ;       BITS 5-4   ERROR TYPE                   :
                        1221    ;       BITS 3-0   ERROR CODE                   :
                        1222    ;                                               :
                        1223    ; BYTE 1                                        :
                        1224    ;       BITS 7-6   ZERO                         :
                        1225    ;       BIT    5   DRIVE (0-1)                  :
                        1226    ;       BITS 4-0   HEAD NUMBER                  :
```

```
LOC OBJ                 LINE    SOURCE

                        1227    ;                                               :
                        1228    ; BYTE 2                                        :
                        1229    ;       BITS 7-5   CYLINDER HIGH                :
                        1230    ;       BITS 4-0   SECTOR NUMBER                :
                        1231    ;                                               :
                        1232    ; BYTE 3                                        :
                        1233    ;       BITS 7-0   CYLINDER LOW                 :
                        1234    ;                                               :
                        1235    ;-----------------------------------------------
                        1236
059C                    1237    ERROR_CHK       PROC    NEAR
                        1238            ASSUME  ES:DATA
059C A07400             1239            MOV     AL,DISK_STATUS          ; CHECK IF THERE WAS AN ERROR
059F 0AC0               1240            OR      AL,AL
05A1 7501               1241            JNZ     G21
05A3 C3                 1242            RET
                        1243
                        1244    ;----- PERFORM SENSE STATUS
                        1245
05A4                    1246    G21:
05A4 B84000             1247            MOV     AX,DATA
05A7 8EC0               1248            MOV     ES,AX                   ; ESTABLISH SEGMENT
05A9 2BC0               1249            SUB     AX,AX
05AB 8BF8               1250            MOV     DI,AX
05AD C606420003         1251            MOV     CMD_BLOCK+0,SENSE_CMD
05B2 2AC0               1252            SUB     AL,AL
05B4 E8ABFF             1253            CALL    COMMAND                 ; ISSUE SENSE STATUS COMMAND
05B7 7223               1254            JC      SENSE_ABORT             ; CANNOT RECOVER
05B9 B90400             1255            MOV     CX,4
05BC                    1256    G22:
05BC E8CB00             1257            CALL    HD_WAIT_REQ
05BF 7220               1258            JC      G24
05C1 E8AD01             1259            CALL    PORT_0
05C4 EC                 1260            IN      AL,DX
05C5 26884542           1261            MOV     ES:HD_ERROR[DI],AL      ; STORE AWAY SENSE BYTES
05C9 47                 1262            INC     DI
05CA E8B101             1263            CALL    PORT_1
05CD E2ED               1264            LOOP    G22
05CF E8B800             1265            CALL    HD_WAIT_REQ
05D2 720D               1266            JC      G24
05D4 E89A01             1267            CALL    PORT_0
05D7 EC                 1268            IN      AL,DX
05D8 A802               1269            TEST    AL,2
05DA 740F               1270            JZ      STAT_ERR
05DC                    1271    SENSE_ABORT:
05DC C6067400FF         1272            MOV     DISK_STATUS,SENSE_FAIL
05E1                    1273    G24:
05E1 F9                 1274            STC
05E2 C3                 1275            RET
                        1276    ERROR_CHK       ENDP
                        1277
05E3 1A06               1278    T_0     DW      TYPE_0
05E5 2706               1279    T_1     DW      TYPE_1
05E7 6A06               1280    T_2     DW      TYPE_2
05E9 7706               1281    T_3     DW      TYPE_3
                        1282
05EB                    1283    STAT_ERR:
05EB 268A1E4200         1284            MOV     BL,ES:HD_ERROR          ; GET ERROR BYTE
05F0 8AC3               1285            MOV     AL,BL
05F2 240F               1286            AND     AL,0FH
05F4 80E330             1287            AND     BL,00110000B            ; ISOLATE TYPE
05F7 2AFF               1288            SUB     BH,BH
05F9 B103               1289            MOV     CL,3
05FB D3EB               1290            SHR     BX,CL                   ; ADJUST
05FD 2EFFA7E305         1291            JMP     WORD PTR CS:[BX + OFFSET T_0]
                        1292            ASSUME ES:NOTHING
                        1293
0602                    1294    TYPE0_TABLE     LABEL   BYTE
0602 00204020800020     1295            DB      0,BAD_CNTLR,BAD_SEEK,BAD_CNTLR,TIME_OUT,0,BAD_CNTLR
0609 0040               1296            DB      0,BAD_SEEK
  0009                  1297    TYPE0_LEN       EQU     $-TYPE0_TABLE
060B                    1298    TYPE1_TABLE     LABEL   BYTE
060B 1010020004         1299            DB      BAD_ECC,BAD_ECC,BAD_ADDR_MARK,0,RECORD_NOT_FND
0610 400000110B         1300            DB      BAD_SEEK,0,0,DATA_CORRECTED,BAD_TRACK
  000A                  1301    TYPE1_LEN       EQU     $-TYPE1_TABLE
0615                    1302    TYPE2_TABLE     LABEL   BYTE
0615 0102               1303            DB      BAD_CMD,BAD_ADDR_MARK
```

```
LOC OBJ                 LINE    SOURCE

  0002                  1304    TYPE2_LEN       EQU     $-TYPE2_TABLE
0617                    1305    TYPE3_TABLE     LABEL   BYTE
0617 202010             1306            DB      BAD_CNTLR,BAD_CNTLR,BAD_ECC
  0003                  1307    TYPE3_LEN       EQU     $-TYPE3_TABLE
                        1308
                        1309    ;----- TYPE 0 ERROR
                        1310
061A                    1311    TYPE_0:
061A BB0206             1312            MOV     BX,OFFSET TYPE0_TABLE
061D 3C09               1313            CMP     AL,TYPE0_LEN            ; CHECK IF ERROR IS DEFINED
061F 7363               1314            JAE     UNDEF_ERR_L
0621 2ED7               1315            XLAT    CS:TYPE0_TABLE          ; TABLE LOOKUP
0623 A27400             1316            MOV     DISK_STATUS,AL          ; SET ERROR CODE
0626 C3                 1317            RET
                        1318
                        1319    ;------ TYPE 1 ERROR
                        1320
0627                    1321    TYPE_1:
0627 BB0B06             1322            MOV     BX,OFFSET TYPE1_TABLE
062A 8BC8               1323            MOV     CX,AX
062C 3C0A               1324            CMP     AL,TYPE1_LEN            ; CHECK IF ERROR IS DEFINED
062E 7354               1325            JAE     UNDEF_ERR_L
0630 2ED7               1326            XLAT    CS:TYPE1_TABLE          ; TABLE LOOKUP
0632 A27400             1327            MOV     DISK_STATUS,AL          ; SET ERROR CODE
0635 80E108             1328            AND     CL,08H                  ; CORRECTED ECC
0638 80F908             1329            CMP     CL,08H
063B 752A               1330            JNZ     G30
                        1331
                        1332    ;----- OBTAIN ECC ERROR BURST LENGTH
                        1333
063D C606420000D        1334            MOV     CMD_BLOCK+0,RD_ECC_CMD
0642 2AC0               1335            SUB     AL,AL
0644 E81BFF             1336            CALL    COMMAND
0647 721E               1337            JC      G30
0649 E83E00             1338            CALL    HD_WAIT_REQ
064C 7219               1339            JC      G30
064E E82001             1340            CALL    PORT_0
0651 EC                 1341            IN      AL,DX
0652 8AC8               1342            MOV     CL,AL
0654 E83300             1343            CALL    HD_WAIT_REQ
0657 720E               1344            JC      G30
0659 E81501             1345            CALL    PORT_0
065C EC                 1346            IN      AL,DX
065D A801               1347            TEST    AL,01H
065F 7406               1348            JZ      G30
0661 C606740020         1349            MOV     DISK_STATUS,BAD_CNTLR
0666 F9                 1350            STC
0667                    1351    G30:
0667 8AC1               1352            MOV     AL,CL
0669 C3                 1353            RET
                        1354
                        1355    ;----- TYPE 2 ERROR
                        1356
066A                    1357    TYPE_2:
066A BB1506             1358            MOV     BX,OFFSET TYPE2_TABLE
066D 3C02               1359            CMP     AL,TYPE2_LEN            ; CHECK IF ERROR IS DEFINED
066F 7313               1360            JAE     UNDEF_ERR_L
0671 2ED7               1361            XLAT    CS:TYPE1_TABLE          ; TABLE LOOKUP
0673 A27400             1362            MOV     DISK_STATUS,AL          ; SET ERROR CODE
0676 C3                 1363            RET
                        1364
                        1365    ;----- TYPE 3 ERROR
                        1366
0677                    1367    TYPE_3:
0677 BB1706             1368            MOV     BX,OFFSET TYPE3_TABLE
067A 3C03               1369            CMP     AL,TYPE3_LEN
067C 7306               1370            JAE     UNDEF_ERR_L
067E 2ED7               1371            XLAT    CS:TYPE3_TABLE
0680 A27400             1372            MOV     DISK_STATUS,AL
0683 C3                 1373            RET
                        1374
0684                    1375    UNDEF_ERR_L:
0684 C6067400BB         1376            MOV     DISK_STATUS,UNDEF_ERR
0689 C3                 1377            RET
                        1378
068A                    1379    HD_WAIT_REQ     PROC    NEAR
068A 51                 1380            PUSH    CX
```

```
LOC OBJ                 LINE    SOURCE

068B 2BC9               1381            SUB     CX,CX
068D E8EE00             1382            CALL    PORT_1
0690                    1383    L1:
0690 EC                 1384            IN      AL,DX
0691 A801               1385            TEST    AL,R1_REQ
0693 7508               1386            JNZ     L2
0695 E2F9               1387            LOOP    L1
0697 C606740080         1388            MOV     DISK_STATUS,TIME_OUT
069C F9                 1389            STC
069D                    1390    L2:
069D 59                 1391            POP     CX
069E C3                 1392            RET
                        1393    HD_WAIT_REQ     ENDP
                        1394
                        1395    ;--------------------------------------------------------
                        1396    ; DMA_SETUP                                            :
                        1397    ;       THIS ROUTINE SETS UP FOR DMA OPERATIONS.       :
                        1398    ; INPUT                                                :
                        1399    ;       (AL) = MODE BYTE FOR THE DMA                   :
                        1400    ;       (ES:BX) = ADDRESS TO READ/WRITE THE DATA       :
                        1401    ; OUTPUT                                               :
                        1402    ;       (AX) DESTROYED                                 :
                        1403    ;--------------------------------------------------------
069F                    1404    DMA_SETUP       PROC    NEAR
069F 50                 1405            PUSH    AX
06A0 A04600             1406            MOV     AL,CMD_BLOCK+4
06A3 3C81               1407            CMP     AL,81H                  ; BLOCK COUNT OUT OF RANGE
06A5 58                 1408            POP     AX
06A6 7202               1409            JB      J1
06A8 F9                 1410            STC
06A9 C3                 1411            RET
06AA                    1412    J1:
06AA 51                 1413            PUSH    CX                      ; SAVE THE REGISTER
06AB FA                 1414            CLI                             ; NO MORE INTERRUPTS
06AC E60C               1415            OUT     DMA+12,AL               ; SET THE FIRST/LAST F/F
06AE 50                 1416            PUSH    AX
06AF 58                 1417            POP     AX
06B0 E60B               1418            OUT     DMA+11,AL               ; OUTPUT THE MODE BYTE
06B2 8CC0               1419            MOV     AX,ES                   ; GET THE ES VALUE
06B4 B104               1420            MOV     CL,4                    ; SHIFT COUNT
06B6 D3C0               1421            ROL     AX,CL                   ; ROTATE LEFT
06B8 8AE8               1422            MOV     CH,AL                   ; GET HIGHEST NYBBLE OF ES TO CH
06BA 24F0               1423            AND     AL,0F0H                 ; ZERO THE LOW NYBBLE FROM SEGMENT
06BC 03C3               1424            ADD     AX,BX                   ; TEST FOR CARRY FROM ADDITION
06BE 7302               1425            JNC     J33
06C0 FEC5               1426            INC     CH                      ; CARRY MEANS HIGH 4 BITS MUST BE INC
06C2                    1427    J33:
06C2 50                 1428            PUSH    AX                      ; SAVE START ADDRESS
06C3 E606               1429            OUT     DMA+6,AL                ; OUTPUT LOW ADDRESS
06C5 8AC4               1430            MOV     AL,AH
06C7 E606               1431            OUT     DMA+6,AL                ; OUTPUT HIGH ADDRESS
06C9 8AC5               1432            MOV     AL,CH                   ; GET HIGH 4 BITS
06CB 240F               1433            AND     AL,0FH
06CD E682               1434            OUT     DMA_HIGH,AL             ; OUTPUT THE HIGH 4 BITS TO PAGE REG
                        1435
                        1436    ;------ DETERMINE COUNT
                        1437
06CF A04600             1438            MOV     AL,CMD_BLOCK+4          ; RECOVER BLOCK COUNT
06D2 D0E0               1439            SHL     AL,1                    ; MULTIPLY BY 512 BYTES PER SECTOR
06D4 FEC8               1440            DEC     AL                      ;   AND DECREMENT VALUE BY ONE
06D6 8AE0               1441            MOV     AH,AL
06D8 B0FF               1442            MOV     AL,0FFH
                        1443
                        1444    ;----- HANDLE READ AND WRITE LONG (516D BYTE BLOCKS)
                        1445
06DA 50                 1446            PUSH    AX                      ; SAVE REGISTER
06DB A04200             1447            MOV     AL,CMD_BLOCK+0          ; GET COMMAND
06DE 3CE5               1448            CMP     AL,RD_LONG_CMD
06E0 7407               1449            JE      ADD4
06E2 3CE6               1450            CMP     AL,WR_LONG_CMD
06E4 7403               1451            JE      ADD4
06E6 58                 1452            POP     AX                      ; RESTORE REGISTER
06E7 EB11               1453            JMP     SHORT   J20
06E9                    1454    ADD4:
06E9 58                 1455            POP     AX                      ; RESTORE REGISTER
06EA B80402             1456            MOV     AX,516D                 ; ONE BLOCK (512) PLUS 4 BYTES ECC
06ED 53                 1457            PUSH    BX
```

```
LOC OBJ                 LINE    SOURCE

06EE 2AFF               1458            SUB     BH,BH
06F0 8A1E4600           1459            MOV     BL,CMD_BLOCK+4
06F4 52                 1460            PUSH    DX
06F5 F7E3               1461            MUL     BX                      ; BLOCK COUNT TIMES 516
06F7 5A                 1462            POP     DX
06F8 5B                 1463            POP     BX
06F9 48                 1464            DEC     AX                      ; ADJUST
06FA                    1465    J20:
                        1466
06FA 50                 1467            PUSH    AX                      ; SAVE COUNT VALUE
06FB E607               1468            OUT     DMA+7,AL                ; LOW BYTE OF COUNT
06FD 8AC4               1469            MOV     AL,AH
06FF E607               1470            OUT     DMA+7,AL                ; HIGH BYTE OF COUNT
0701 FB                 1471            STI                             ; INTERRUPTS BACK ON
0702 59                 1472            POP     CX                      ; RECOVER COUNT VALUE
0703 58                 1473            POP     AX                      ; RECOVER ADDRESS VALUE
0704 03C1               1474            ADD     AX,CX                   ; ADD, TEST FOR 64K OVERFLOW
0706 59                 1475            POP     CX                      ; RECOVER REGISTER
0707 C3                 1476            RET                     ; RETURN TO CALLER, CFL SET BY ABOVE IF ERROR
                        1477    DMA_SETUP       ENDP
                        1478
                        1479    ;--------------------------------------------
                        1480    ; WAIT_INT                                  :
                        1481    ;       THIS ROUTINE WAITS FOR THE FIXED DISK   :
                        1482    ;       CONTROLLER TO SIGNAL THAT AN INTERRUPT  :
                        1483    ;       HAS OCCURRED.                           :
                        1484    ;--------------------------------------------
0708                    1485    WAIT_INT        PROC    NEAR
0708 FB                 1486            STI                             ; TURN ON INTERRUPTS
0709 53                 1487            PUSH    BX                      ; PRESERVE REGISTERS
070A 51                 1488            PUSH    CX
070B 06                 1489            PUSH    ES
070C 56                 1490            PUSH    SI
070D 1E                 1491            PUSH    DS
                        1492            ASSUME  DS:DUMMY
070E 2BC0               1493            SUB     AX,AX
0710 8ED8               1494            MOV     DS,AX                   ; ESTABLISH SEGMENT
0712 C4360401           1495            LES     SI,HF_TBL_VEC
                        1496            ASSUME  DS:DATA
0716 1F                 1497            POP     DS
                        1498
                        1499    ;----- SET TIMEOUT VALUES
                        1500
0717 2AFF               1501            SUB     BH,BH
0719 268A5C09           1502            MOV     BL,BYTE PTR ES:[SI][9]          ; STANDARD TIME OUT
071D 8A264200           1503            MOV     AH,CMD_BLOCK
0721 80FC04             1504            CMP     AH,FMTDRV_CMD
0724 7506               1505            JNZ     W5
0726 268A5C0A           1506            MOV     BL,BYTE PTR ES:[SI][0AH]        ; FORMAT DRIVE
072A EB09               1507            JMP     SHORT   W4
072C 80FCE3             1508    W5:     CMP     AH,CHK_DRV_CMD
072F 7504               1509            JNZ     W4
0731 268A5C0B           1510            MOV     BL,BYTE PTR ES:[SI][0BH]        ; CHECK DRIVE
0735                    1511    W4:
0735 2BC9               1512            SUB     CX,CX
                        1513
                        1514    ;----- WAIT FOR INTERRUPT
                        1515
0737                    1516    W1:
0737 E84400             1517            CALL    PORT_1
073A EC                 1518            IN      AL,DX
073B 2420               1519            AND     AL,020H
073D 3C20               1520            CMP     AL,020H                 ; DID INTERRUPT OCCUR
073F 740A               1521            JZ      W2
0741 E2F4               1522            LOOP    W1                      ; INNER LOOP
0743 4B                 1523            DEC     BX
0744 75F1               1524            JNZ     W1                      ; OUTER LOOP
0746 C606740080         1525            MOV     DISK_STATUS,TIME_OUT
074B                    1526    W2:
074B E82300             1527            CALL    PORT_0
074E EC                 1528            IN      AL,DX
074F 2402               1529            AND     AL,2                    ; ERROR BIT
0751 08067400           1530            OR      DISK_STATUS,AL          ; SAVE
0755 E83000             1531            CALL    PORT_3                  ; INTERRUPT MASK REGISTER
0758 32C0               1532            XOR     AL,AL                   ; ZERO
075A EE                 1533            OUT     DX,AL                   ; RESET MASK
075B 5E                 1534            POP     SI                      ; RESTORE REGISTERS
```

```
LOC OBJ                 LINE    SOURCE

075C 07                 1535            POP     ES
075D 59                 1536            POP     CX
075E 5B                 1537            POP     BX
075F C3                 1538            RET
                        1539    WAIT_INT        ENDP
                        1540
0760                    1541    HD_INT  PROC    NEAR
0760 50                 1542            PUSH    AX
0761 B020               1543            MOV     AL,EOI                  ; END OF INTERRUPT
0763 E620               1544            OUT     INT_CTL_PORT,AL
0765 B007               1545            MOV     AL,07H                  ; SET DMA MODE TO DISABLE
0767 E60A               1546            OUT     DMA+10,AL
0769 E421               1547            IN      AL,021H
076B 0C20               1548            OR      AL,020H
076D E621               1549            OUT     021H,AL
076F 58                 1550            POP     AX
0770 CF                 1551            IRET
                        1552    HD_INT  ENDP
                        1553
                        1554    ;---------------------------------------
                        1555    ; PORTS                                 :
                        1556    ;       GENERATE PROPER PORT VALUE      :
                        1557    ;       BASED ON THE PORT OFFSET        :
                        1558    ;---------------------------------------
                        1559
0771                    1560    PORT_0  PROC    NEAR
0771 BA2003             1561            MOV     DX,HF_PORT              ; BASE VALUE
0774 50                 1562            PUSH    AX
0775 2AE4               1563            SUB     AH,AH
0777 A07700             1564            MOV     AL,PORT_OFF             ; ADD IN THE OFFSET
077A 03D0               1565            ADD     DX,AX
077C 58                 1566            POP     AX
077D C3                 1567            RET
                        1568    PORT_0  ENDP
                        1569
077E                    1570    PORT_1  PROC    NEAR
077E E8F0FF             1571            CALL    PORT_0
0781 42                 1572            INC     DX                      ; INCREMENT TO PORT ONE
0782 C3                 1573            RET
                        1574    PORT_1  ENDP
                        1575
0783                    1576    PORT_2  PROC    NEAR
0783 E8F8FF             1577            CALL    PORT_1
0786 42                 1578            INC     DX                      ; INCREMENT TO PORT TWO
0787 C3                 1579            RET
                        1580    PORT_2  ENDP
                        1581
0788                    1582    PORT_3  PROC    NEAR
0788 E8F8FF             1583            CALL    PORT_2
078B 42                 1584            INC     DX                      ; INCREMENT TO PORT THREE
078C C3                 1585            RET
                        1586    PORT_3  ENDP
                        1587
                        1588    ;-----------------------------------------------
                        1589    ; SW2_OFFS                                    :
                        1590    ;       DETERMINE PARAMETER TABLE OFFSET      :
                        1591    ;       USING CONTROLLER PORT TWO AND         :
                        1592    ;       DRIVE NUMBER SPECIFIER (0-1)          :
                        1593    ;-----------------------------------------------
                        1594
078D                    1595    SW2_OFFS        PROC    NEAR
078D E8F3FF             1596            CALL    PORT_2
0790 EC                 1597            IN      AL,DX                   ; READ PORT 2
0791 50                 1598            PUSH    AX
0792 E8E9FF             1599            CALL    PORT_1
0795 EC                 1600            IN      AL,DX
0796 2402               1601            AND     AL,2                    ; CHECK FOR ERROR
0798 58                 1602            POP     AX
0799 7516               1603            JNZ     SW2_OFFS_ERR
079B 8A264300           1604            MOV     AH,CMD_BLOCK+1
079F 80E420             1605            AND     AH,00100000B            ; DRIVE 0 OR 1
07A2 7504               1606            JNZ     SW2_AND
07A4 D0E8               1607            SHR     AL,1                    ; ADJUST
07A6 D0E8               1608            SHR     AL,1
07A8                    1609    SW2_AND:
07A8 2403               1610            AND     AL,011B                 ; ISOLATE
07AA B104               1611            MOV     CL,4
```

```
LOC OBJ                  LINE    SOURCE

07AC D2E0                1612            SHL     AL,CL                   ; ADJUST
07AE 2AE4                1613            SUB     AH,AH
07B0 C3                  1614            RET
07B1                     1615    SW2_OFFS_ERR:
07B1 F9                  1616            STC
07B2 C3                  1617            RET
                         1618    SW2_OFFS        ENDP
                         1619
07B3 30382F31362F38      1620            DB      '08/16/82'              ; RELEASE MARKER
     32
                         1621
07BB                     1622    END_ADDRESS     LABEL   BYTE
----                     1623    CODE    ENDS
                         1624            END
```

Notes: