



*Personal Computer
Hardware Reference
Library*

**IBM Personal Computer
20MB Fixed Disk
Drive Adapter**

Notes:

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Notes:

Description

The 20MB Fixed Disk Drive Adapter attaches to one or two fixed disk drive units through an internal, daisy-chained, flat cable (data/control cable).

The adapter is buffered on the I/O bus and uses the system board's direct memory access (DMA) for fixed-disk-drive data transfers. When the adapter is enabled, an interrupt request occurs on the IRQ-5 line to the 8259A Interrupt Controller. The 8259A then causes an interrupt hex 0D.

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

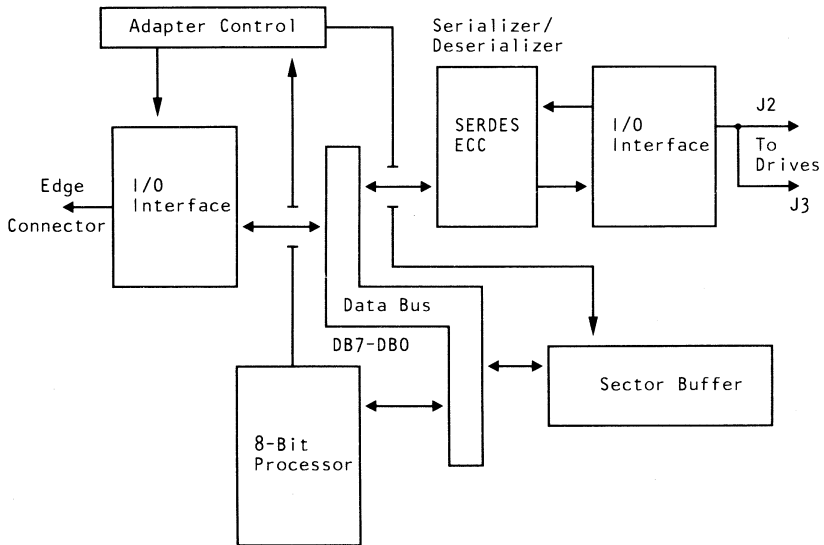
The device level control for the Fixed Disk Adapter is contained on a ROM module on the adapter. A listing of this device level control can be found in "BIOS Listing" of this section.

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 three registers that may be accessed by the system unit's microprocessor: a status register, a data register, and a read-option-jumpers register. The 8-bit status register contains the status information of the disk controller, and can be accessed at any time. This register is read-only and is used to help the transfer of data between the system unit's microprocessor and the disk controller. 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 controller-select pulse is generated by writing to port address hex 322.

The following is a block diagram of the IBM 20MB Fixed Disk Drive Adapter.



Programming Considerations

Types of Drives

The fixed disk drive adapter will accommodate any two of four different types of drives. The figure below shows the configuration of the different type drives.

Type	Cylinders	Heads	Start of Write Pre-Comp	Landing Zone
1	306	4	0	306
2	615	4	300	615
13	306	8	128	336
16	612	4	0	663

Fixed Disk Types

The figure below shows the switch settings for the above mentioned drive types. Switches 1 and 2 set the parameters of Drive 0, and switches 3 and 4 set Drive 1.

	Drive 0		Drive 1	
	Switch		Switch	
	1	2	3	4
Type 1	0n	0n	0n	0n
Type 2	Off	0n	Off	0n
Type 13	Off	Off	Off	Off
Type 16	0n	Off	0n	Off

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

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

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

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

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

Disk Controller Error Tables

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

The address-valid bit (bit 7) is only set when the previous command required a disk address. Bit 6 is set to 0 (spare).

	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 had 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 had 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 Polynomial 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 format of the DCB, and defines the bytes that make up the DCB.

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

Byte 5 Bits 7 through 0 contain the control field.

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

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

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

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 0 Bits 7, 6, and 5 identify the class of the command. Bits 4 through 0 contain the Opcode (see command byte on page 10)

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:

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

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 Byte

Command	Data Control Block	Remarks
Test Drive Ready (Class 0, Opcode 00)	Bit 7 6 5 4 3 2 1 0	d = drive (0 or 1)
	Byte 0 0 0 0 0 0 0 0 0	x = don't care
	Byte 1 0 0 d x x x x x	Bytes 2, 3, 4, 5, = don't care.
Recalibrate (Class 0, Opcode 00)	Bit 7 6 5 4 3 2 1 0	d = drive (0 or 1)
	Byte 0 0 0 0 0 0 0 0 1	x = don't care
	Byte 1 0 0 d x x x x x	r = retries
	Byte 5 r 0 0 0 0 s s s	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	d = drive (0 or 1)
	Byte 0 0 0 0 0 0 0 1 1	x = don't care
	Byte 1 0 0 d x x x x x	Bytes 2, 3, 4, 5, = don't care.
Format Drive (Class 0, Opcode 04)	Bit 7 6 5 4 3 2 1 0	d = drive (0 or 1)
	Byte 0 0 0 0 0 0 1 0 0	r = retries
	Byte 1 0 0 d Head No.	s = Step Option
	Byte 2 ch 0 0 0 0 0 0	ch = cylinder high
	Byte 3 Cylinder Low	
	Byte 4 0 0 0 Interleave	Interleave 1 to 16
	Byte 5 r 0 0 0 0 s s s	for 512-byte sectors.
Ready Verify (Class 0, Opcode 05)	Bit 7 6 5 4 3 2 1 0	d = drive (0 or 1)
	Byte 0 0 0 0 0 0 1 0 1	r = retries
	Byte 1 0 0 d Head No.	s = Step Option
	Byte 2 ch Sector No.	a = retry option on data ECC
	Byte 3 Cylinder Low	
	Byte 4 Block Count	ch = cylinder high
	Byte 5 r a 0 0 0 s s s	for 512-byte sectors.

Command	Data Control Block	Remarks
Format Track (Class 0, Opcode 06)	Bit 7 6 5 4 3 2 1 0	d = drive (0 or 1)
	Byte 0 0 0 0 0 0 1 1 0	r = retries
	Byte 1 0 0 d Head No.	s = step option
	Byte 2 ch 0 0 0 0 0 0	ch = cylinder high
	Byte 3 Cylinder Low	
	Byte 4 0 0 0 Interleave	Interleave 1 to 16
	Byte 5 r 0 0 0 0 s s s	for 512-byte sectors.
Format Bad Track (Class 0, Opcode 07)	Bit 7 6 5 4 3 2 1 0	d = drive (0 or 1)
	Byte 0 0 0 0 0 0 1 1 1	x = don't care
	Byte 1 0 0 d Head No.	s = Step Option
	Byte 2 ch 0 0 0 0 0 0	ch = cylinder high
	Byte 3 Cylinder Low	
	Byte 4 0 0 0 Interleave	Interleave 1 to 16
	Byte 5 r 0 0 0 0 s s s	for 512-byte sectors.
Read (Class 0, Opcode 08)	Bit 7 6 5 4 3 2 1 0	d = drive (0 or 1)
	Byte 0 0 0 0 0 1 0 0 0	r = retries
	Byte 1 0 0 d Head No.	a = retry option on data ECC error
	Byte 2 ch Sector No.	
	Byte 3 Cylinder Low	s = step option
	Byte 5 r a 0 0 0 s s s	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	d = drive (0 or 1)
	Byte 0 0 0 0 0 1 0 1 0	r = retries
	Byte 1 0 0 d Head No.	s = step option
	Byte 2 ch Sector No.	ch = cylinder high
	Byte 3 Cylinder Low	
	Byte 4 Block Count	
	Byte 5 r 0 0 0 0 s s s	

Command	Data Control Block	Remarks
Seek (Class 0, Opcode 0B)	Bit 7 6 5 4 3 2 1 0	d = drive (0 or 1)
	Byte 0 0 0 0 0 1 0 1 1	r = retries
	Byte 1 0 0 d Head No.	s = Step Option
	Byte 2 ch 0 0 0 0 0 0	x = don't care
	Byte 3 Cylinder Low	
	Byte 4 x x x x x x x x	
	Byte 5 r 0 0 0 0 s s s	
Initialize Drive Characteristics* (Class 0, Opcode 0C)	Bit 7 6 5 4 3 2 1 0	Bytes 1, 2, 3, 4, 5, =
	Byte 0 0 0 0 0 1 1 0 0	don't care.
Read ECC Burst Length (Class 0, Opcode 0D)	Bit 7 6 5 4 3 2 1 0	Bytes 1, 2, 3, 4, 5, =
	Byte 0 0 0 0 0 1 1 0 1	don't care.
Read Data from Sector Buffer (Class 0, Opcode 0E)	Bit 7 6 5 4 3 2 1 0	Bytes 1, 2, 3, 4, 5, =
	Byte 0 0 0 0 0 1 1 1 0	don't care.
Write Data to Sector Buffer (Class 0, Opcode 0F)	Bit 7 6 5 4 3 2 1 0	Bytes 1, 2, 3, 4, 5, =
	Byte 0 0 0 0 0 1 1 1 1	don't care.
RAM Diagnostic (Class 7, Opcode 00)	Bit 7 6 5 4 3 2 1 0	Bytes 1, 2, 3, 4, 5, =
	Byte 0 1 1 1 0 0 0 0 0	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)

Command	Data Control Block	Remarks
Drive Diagnostic (Class 7, Opcode 03)	Bit 7 6 5 4 3 2 1 0	d = drive (0 or 1)
	Byte 0 1 1 1 0 0 0 1 1	r = retries
	Byte 1 0 0 d x x x x x	s = step option
	Byte 2 x x x x x x x x	x = don't care
	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	
Controller Internal Diagnostics (Class 7, Opcode 04)	Bit 7 6 5 4 3 2 1 0	Bytes 1, 2, 3, 4, 5, = don't care.
	Byte 0 1 1 1 0 0 1 0 0	
Read Long * Track (Class 7, Opcode 05)	Bit 7 6 5 4 3 2 1 0	d = drive (0 or 1)
	Byte 0 1 1 1 0 0 1 0 1	r = retries
	Byte 1 0 0 d Head No.	s = step option
	Byte 2 ch Sector No.	ch = cylinder high
	Byte 3 Cylinder Low	
	Byte 4 Block Count	
	Byte 5 r 0 0 0 0 s s s	
Write Long ** (Class 7, Opcode 06)	Bit 7 6 5 4 3 2 1 0	d = drive (0 or 1)
	Byte 0 1 1 1 0 0 1 1 0	s = step option
	Byte 1 0 0 d Head No.	s = step option
	Byte 2 ch Sector No.	ch = cylinder high
	Byte 3 Cylinder Low	s = step option
	Byte 4 Block Count	
	Byte 5 r 0 0 0 0 s s s	

* 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 active, the I/O port decoder is disabled.

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

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

Interface

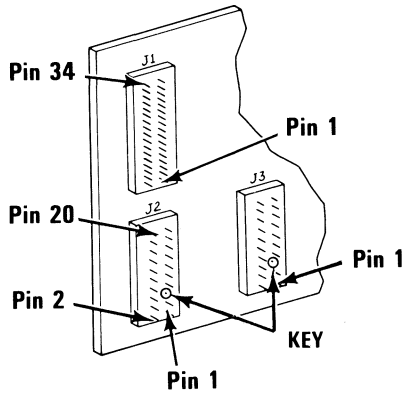
The following lines are used by the disk controller:

- 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 hex C9FFF.
- DO–D7** Positive 8-bit data bus over which data and status information is passed between the system board and the controller.
- IOR** This signal is active when the system board reads status or data from the controller under either programmed I/O or DMA control.
- IOW** This signal is active when the system board sends a command or data to the controller under either programmed I/O or DMA control.
- AEN** This signal is active 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** This signal forces the disk controller to its initial power-up condition.
- IRQ 5** This signal is active by the controller when enabled to interrupt the system board on the return ending status byte from the controller.
- DRQ 3** This signal is activated 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 active when negative, and is generated by the system board DMA channel in response to a DMA request (DRQ 3).

Connectors

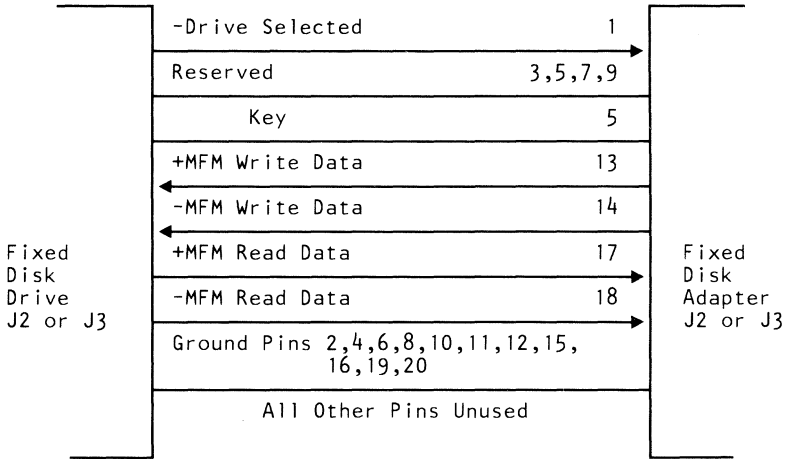
The 20MB Fixed Disk Drive Adapter connector and interface specifications follow.



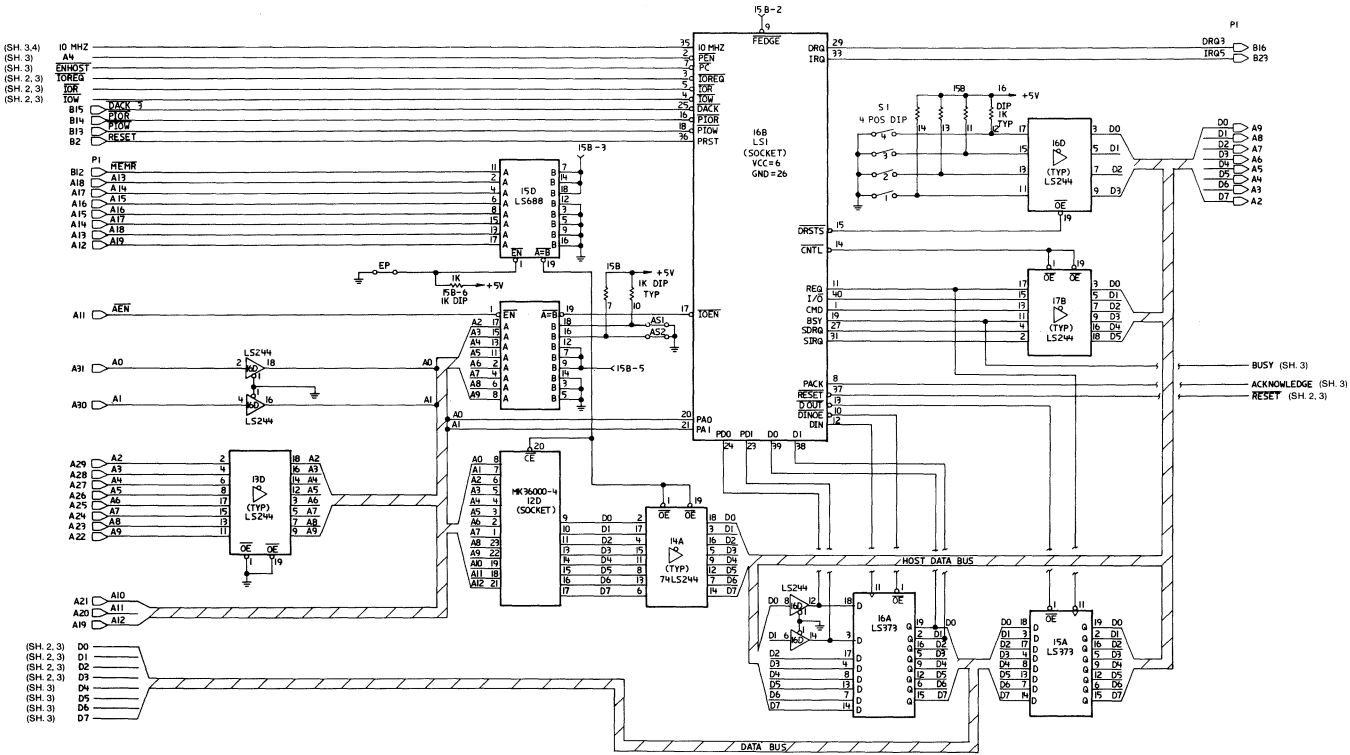
At Standard TTL Levels		Land Number
Ground—Odd Numbers		1—33
-Reserved	2, 16, 30, 32	
-Head Select 2	4	
← -Write Gate	6	
← -Seek Complete	8	
-Track 000	10	→
-Write Fault	12	→
-Head Select 0	14	→
← -Head Select 1	18	
← -Index	20	
-Ready	22	→
-Step	24	→
← -Drive Select 1	26	
← -Drive Select 2	28	
← -Drive Select 3	30	
← -Drive Select 4	32	
← -Direction In	34	

Disk Drive J1

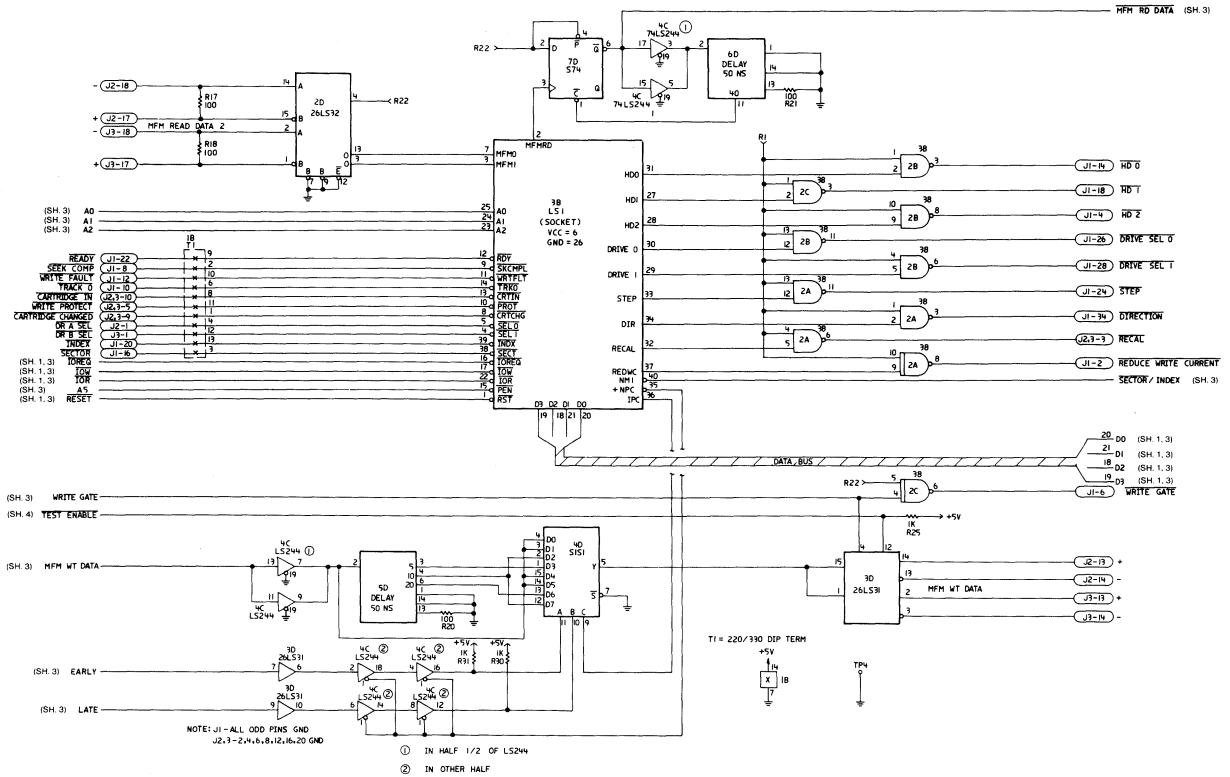
Disk Adapter J1



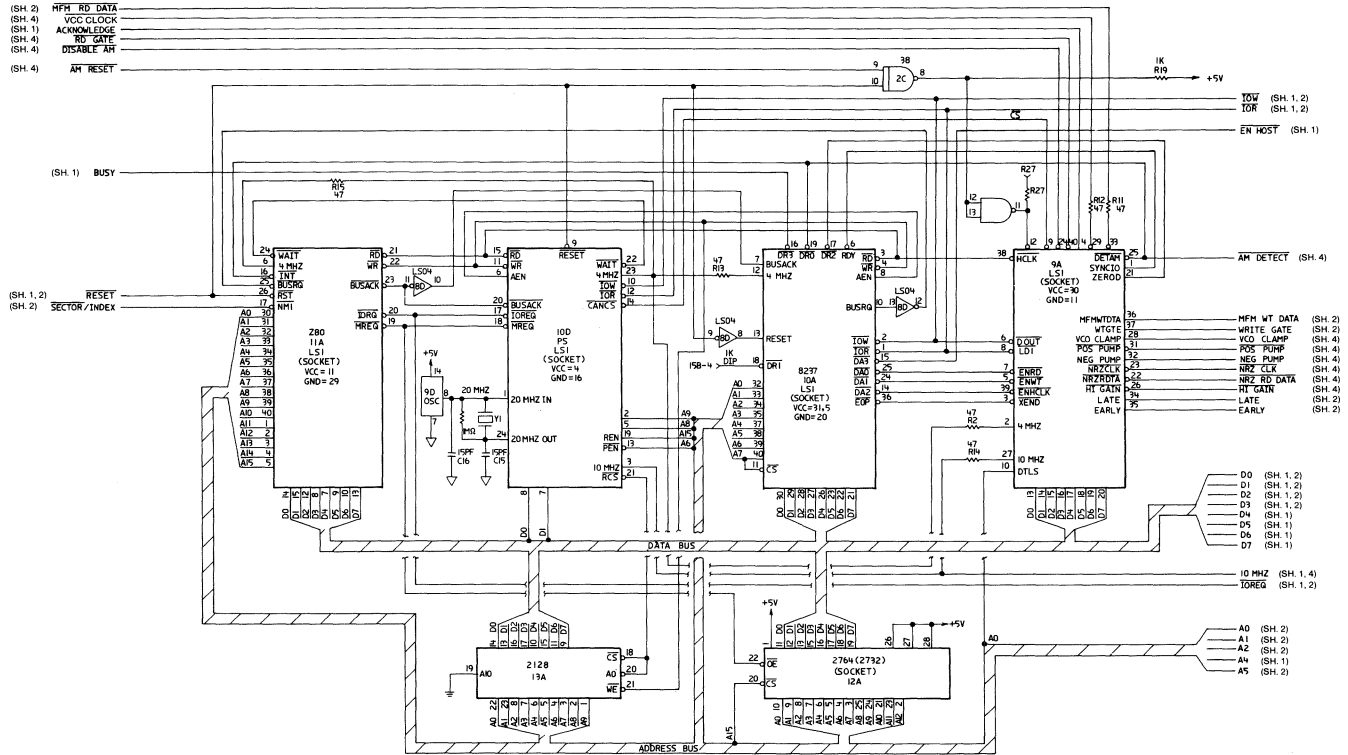
Logic Diagrams



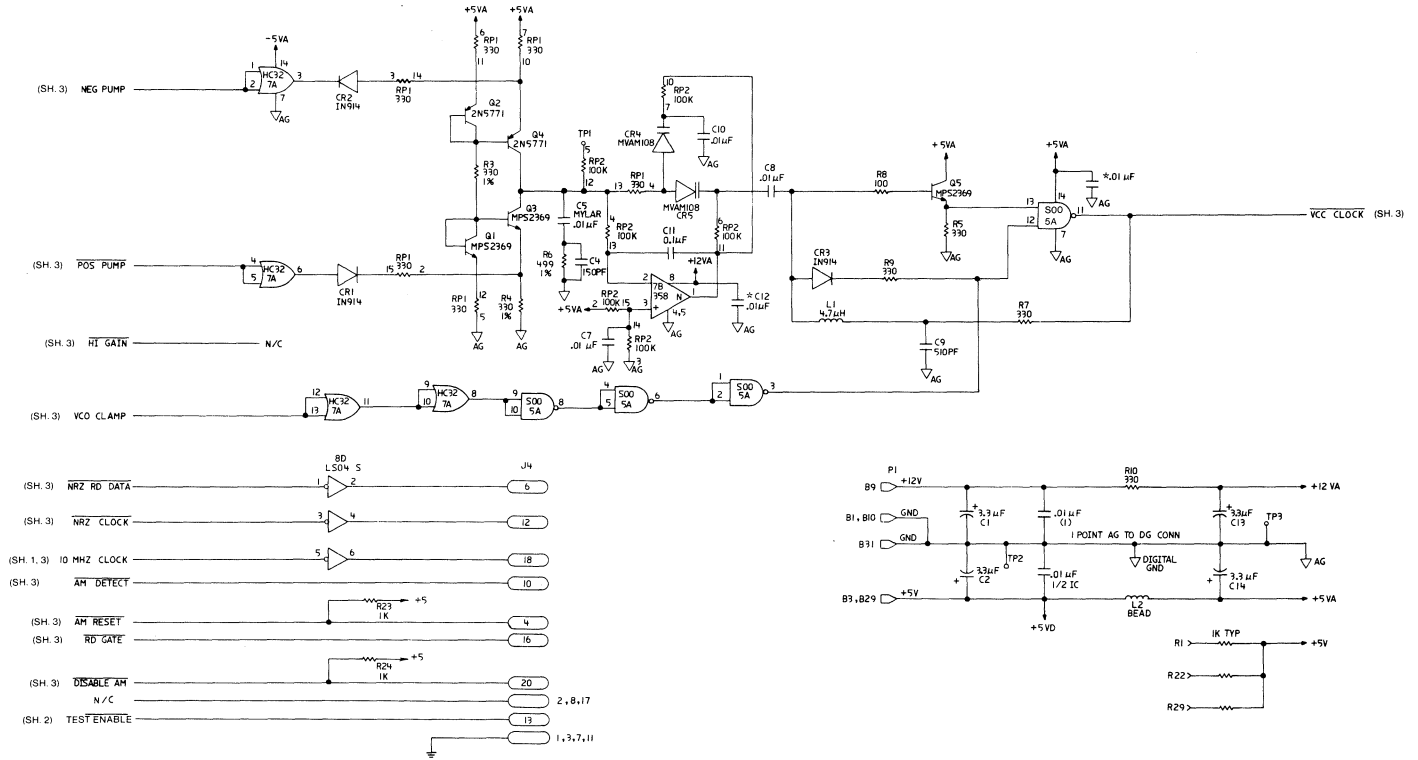
20MB Fixed Disk Drive Adapter (Sheet 1 of 4)



20MB Fixed Disk Drive Adapter (Sheet 2 of 4)



20MB Fixed Disk Drive Adapter (Sheet 3 of 4)



20MB Fixed Disk Drive Adapter (Sheet 4 of 4)

BIOS Listing

The BIOS Listing for the IBM 20MB Fixed Disk Drive Adapter follows.

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1 PAGE 118,121
2 TITLE DISK2 ---- 10/28/85 FIXED DISK BIOS
3
4 --- INT 13H
5 :
6 : FIXED DISK I/O INTERFACE
7 :
8 : THIS INTERFACE PROVIDES ACCESS TO FIXED DISKS
9 : THROUGH THE IBM FIXED DISK CONTROLLER.
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 :
24 : (AH) = 00H RESET DISK (DL = 80H,81H) / DISKETTE
25 : (AH) = 01H READ THE STATUS OF THE LAST DISK OPERATION INTO (AL)
26 : NOTE: DL < 80H = DISKETTE
27 : DL > 80H = DISK
28 : (AH) = 02H READ THE DESIRED SECTORS INTO MEMORY
29 : (AH) = 03H WRITE THE DESIRED SECTORS FROM MEMORY
30 : (AH) = 04H VERIFY THE DESIRED SECTORS
31 : (AH) = 05H FORMAT THE DESIRED TRACK
32 : (AH) = 06H FORMAT THE DESIRED TRACK AND SET BAD SECTOR FLAGS
33 : (AH) = 07H FORMAT THE DRIVE STARTING AT THE DESIRED TRACK
34 : (AH) = 08H RETURN THE CURRENT DRIVE PARAMETERS
35 :
36 : (AH) = 09H INITIALIZE DRIVE PAIR CHARACTERISTICS
37 : INTERRUPT 41H POINTS TO DATA BLOCK
38 : (AH) = 0AH READ LONG
39 : (AH) = 0BH WRITE LONG
40 : NOTE: READ AND WRITE LONG ENCOMPASS
41 : 512 BYTES + 4 BYTES OF ECC
42 : (AH) = 0CH SEEK
43 : (AH) = 0DH ALTERNATE DISK RESET (SEE DL)
44 : (AH) = 0EH READ SECTOR BUFFER
45 : (AH) = 0FH WRITE SECTOR BUFFER,
46 : (RECOMMENDED PRACTICE BEFORE FORMATTING)
47 : (AH) = 10H TEST DRIVE READY
48 : (AH) = 11H RECALIBRATE
49 : (AH) = 12H CONTROLLER RAM DIAGNOSTIC
50 : (AH) = 13H DRIVE DIAGNOSTIC
51 : (AH) = 14H CONTROLLER INTERNAL DIAGNOSTIC
52 :
53 : REGISTERS USED FOR FIXED DISK OPERATIONS
54 :
55 : (DL) - DRIVE NUMBER (80H-87H FOR DISK, VALUE CHECKED)
56 : (DH) - HEAD NUMBER (0-7D ALLOWED, NOT VALUE CHECKED)
57 : (CH) - CYLINDER NUMBER (0-1023D, NOT VALUE CHECKED) (SEE CL)
58 : (CL) - SECTOR NUMBER (1-17D, NOT VALUE CHECKED)
59 :
60 : NOTE: HIGH 2 BITS OF CYLINDER NUMBER ARE PLACED
61 : IN THE HIGH 2 BITS OF THE CL REGISTER
62 : (10 BITS TOTAL)
63 : (AL) - NUMBER OF SECTORS (MAXIMUM POSSIBLE RANGE 1-80H,
64 : FOR READ/WRITE LONG 1-79H)
65 : (INTERLEAVE VALUE FOR FORMAT 1-16D)
66 : (ES:BX) - ADDRESS OF BUFFER FOR READS AND WRITES,
67 : (NOT REQUIRED FOR VERIFY)
68 :
69 : OUTPUT
70 :
71 : AH = STATUS OF CURRENT OPERATION
72 : STATUS BITS ARE DEFINED IN THE EQUATES BELOW
73 : CY = 0 SUCCESSFUL OPERATION (AH= 00H ON RETURN)
74 : CY = 1 FAILED OPERATION (AH HAS ERROR REASON)
75 :
76 : NOTE: ERROR 11H INDICATES THAT THE DATA READ HAD A RECOVERABLE
77 : ERROR WHICH WAS CORRECTED BY THE ECC ALGORITHM. THE DATA
78 : IS PROBABLY GOOD, HOWEVER THE BIOS ROUTINE INDICATES AN
79 : ERROR TO ALLOW THE CONTROLLING PROGRAM A CHANCE TO DECIDE
80 : FOR ITSELF. THE ERROR MAY NOT RECUR IF THE DATA IS
81 : REWRITTEN. (AL) CONTAINS THE BURST LENGTH.
82 :
83 : IF DRIVE PARAMETERS WERE REQUESTED,
84 :
85 : DL = NUMBER OF CONSECUTIVE ACKNOWLEDGING DRIVES
86 : ATTACHED (0-2) (CONTROLLER CARD ZERO TALLY ONLY)
87 : DH = MAXIMUM USEABLE VALUE FOR HEAD NUMBER
88 : CH = MAXIMUM USEABLE VALUE FOR CYLINDER NUMBER
89 : CL = MAXIMUM USEABLE VALUE FOR SECTOR NUMBER
90 : AND CYLINDER NUMBER HIGH BITS
91 :
92 : IF AN ERROR OCCURS ON READ DRIVE PARAMETERS,
93 :
94 : AH = ERROR CODE (INIT_FAIL)
95 : AL = CX = DX = 0
96 :
97 : REGISTERS WILL BE PRESERVED EXCEPT WHEN THEY ARE USED TO RETURN
98 : INFORMATION.
99 :
100 : NOTE: IF AN ERROR IS REPORTED BY THE DISK CODE, THE APPROPRIATE
101 : ACTION IS TO RESET THE DISK, THEN RETRY THE OPERATION.
102 :-----
    
```

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103 PAGE
104 :-----:
105 : ERROR RETURN STATUS (AH)= ??H WHEN CY= 1 :
106 :-----:
107
108 = 00FF SENSE_FAIL EQU 0FFH ; SENSE OPERATION FAILED
109 = 000C WRITE_FAULT EQU 0C0H ; WRITE FAULT ON SELECTED DRIVE
110 = 00BB UNDEF_ERR EQU 0BBH ; UNDEFINED ERROR OCCURRED
111 = 0080 TIME_OUT EQU 080H ; ATTACHMENT FAILED TO RESPOND
112 = 0040 BAD_SEEK EQU 040H ; SEEK OPERATION FAILED
113 = 0020 BAD_CNTRL EQU 020H ; CONTROLLER HAS FAILED
114 = 0011 DATA_CORRECTED EQU 011H ; ECC CORRECTED DATA ERROR
115 = 0010 BAD_ECC EQU 010H ; BAD ECC ON DISK READ
116 = 000B BAD_TRACK EQU 00BH ; BAD TRACK FLAG DETECTED
117 = 0009 DMA_BOUNDARY EQU 009H ; ATTEMPT TO DMA ACROSS 64K BOUNDARY
118 = 0007 INIT_FAIL EQU 007H ; DRIVE PARAMETER ACTIVITY FAILED
119 = 0005 BAD_RESET EQU 005H ; RESET FAILED
120 = 0004 RECOR_D NOT_FND EQU 004H ; REQUESTED SECTOR NOT FOUND
121 = 0002 BAD_ADDR_MARK EQU 002H ; ADDRESS MARK NOT FOUND
122 = 0001 BAD_CMD EQU 001H ; BAD COMMAND PASSED TO DISK I/O
123 :-----:
124 :
125 : INTERRUPT AND STATUS AREAS :
126 :-----:
127
128 0000 ABS0 SEGMENT AT 0H
129 0034 ORG 00DH*4 ; FIXED DISK INTERRUPT VECTOR
130 0034 HDISK_INT LABEL DWORD
131 004C ORG 013H*4 ; DISK INTERRUPT VECTOR
132 004C ORC_VECTOR LABEL DWORD
133 0064 ORG 019H*4 ; BOOTSTRAP INTERRUPT VECTOR
134 0064 BOOT_VEC LABEL DWORD
135 0078 ORG 01EH*4
136 0078 DISKETTE_PARM LABEL DWORD ; DISKETTE PARAMETERS
137 0100 ORG 040H*4 ; NEW DISKETTE INTERRUPT VECTOR
138 0100 DISK_VECTOR LABEL DWORD
139 0104 ORG 041H*4
140 0104 HF_TBL_VEC LABEL DWORD ; FIXED DISK PARAMETER VECTOR
141 7C00 ORG 7C00H ; BOOTSTRAP LOADER VECTOR
142 7C00 BOOT_LOCK LABEL FAR
143 7C00 ABS0 ENDS
144
145 0000 DATA SEGMENT AT 40H
146 006C ORG 06CH
147 006C 7777 TIMER_LOW DW ? ; TIMER LOW WORD
148 0072 ORG 072H
149 0072 7777 RESET_FLAG DW ? ; 1234H IF KEYBOARD RESET INTERWAY
150 0074 ORG 074H
151 0074 ?? DISK_STATUS DB ? ; FIXED DISK STATUS BYTE
152 0075 ?? HF_NUM DB ? ; COUNT OF FIXED DISK DRIVES
153 0076 ?? CONTROL_BYTE DB ? ; CONTROL BYTE DRIVE OPTIONS
154 0077 ?? PORT_OFF DB ? ; PORT OFFSET
155 0078 DATA ENDS
156
157 0000 CODE SEGMENT
158 :-----:
159 : HARDWARE SPECIFIC VALUES :
160 :-----:
161 :
162 : CONTROLLER I/O PORT :
163 : > WHEN READ FROM: :
164 : HF_PORT+0 - READ DATA (FROM CONTROLLER TO CPU) :
165 : HF_PORT+1 - READ CONTROLLER HARDWARE STATUS :
166 : (CONTROLLER TO CPU) :
167 : HF_PORT+2 - READ CONFIGURATION SWITCHES :
168 : HF_PORT+3 - NOT USED :
169 : > WHEN WRITTEN TO: :
170 : HF_PORT+0 - WRITE DATA (FROM CPU TO CONTROLLER) :
171 : HF_PORT+1 - CONTROLLER RESET :
172 : HF_PORT+2 - GENERATE CONTROLLER SELECT PULSE :
173 : HF_PORT+3 - WRITE PATTERN TO DMA AND INTERRUPT :
174 : MASK REGISTER :
175 :-----:
176 :
177 :
178 = CMD_BLOCK EQU BYTE PTR [BP]-8 ; CMD_BLOCK HEAD
179 = 0320 HF_PORT EQU 0320H ; DISK PORT
180 = 0020 INTA00 EQU 020H ; 8259 PORT
181 = 0021 INTA01 EQU 021H ; 8259 PORT
182 = 0020 EI EQU 020H ; END OF INTERRUPT COMMAND
183 = 0008 R1_BUSY EQU 00001000B ; DISK PORT 1 BUSY BIT
184 = 0004 R1_BUS EQU 00001000B ; COMMAND/DATA BIT
185 = 0002 R1_IOMODE EQU 000000100B ; MODE BIT
186 = 0001 R1_REQ EQU 000000010B ; REQUEST BIT
187
188 = 0047 DMA_READ EQU 010001110B ; CHANNEL 3 (047H)
189 = 004B DMA_WRITE EQU 010010110B ; CHANNEL 3 (04BH)
190 = 0000 DMA EQU 000H ; DMA ADDRESS
191 = 0082 DMA_HIGH EQU 082H ; PORT FOR HIGH 4 BITS OF DMA
192
193 = 0000 TST_RDY_CMD EQU 000000000B ; CNTLR READY (00H)
194 = 0001 RECAL_CMD EQU 000000010B ; RECAL (01H)
195 = 0003 SENSE_CMD EQU 000001010B ; SENSE (03H)
196 = 0004 FMTDRV_CMD EQU 000001000B ; DRIVE (04H)
197 = 0005 CHK_TRK_CMD EQU 000001010B ; T CHK (05H)
198 = 0006 FMTTRK_CMD EQU 000001100B ; TRACK (06H)
199 = 0007 FMTBAD_CMD EQU 000001110B ; BAD (07H)
200 = 0008 READ_CMD EQU 000010000B ; READ (08H)
201 = 000A WRITE_CMD EQU 000010100B ; WRITE (0AH)
202 = 000B SEEK_CMD EQU 000010110B ; SEEK (0BH)
203 = 000C INIT_DRV_CMD EQU 000010000B ; INIT (0CH)
204 = 000D RD_ECC_CMD EQU 000010101B ; BURST (0DH)
205 = 000E RD_BUFF_CMD EQU 000011100B ; BUFFR (0EH)
206 = 000F WR_BUFF_CMD EQU 000011110B ; BUFFR (0FH)
207 = 00E0 RAM_DIAG_CMD EQU 111000000B ; RAM (E0H)
208 = 00E3 CHK_DRV_CMD EQU 111000110B ; DRV (E3H)
209 = 00E4 CNTLR_DTAG_CMD EQU 111001000B ; CNTLR (E4H)
210 = 00E5 RD_LONG_CMD EQU 110010100B ; RLONG (E5H)
211 = 00E6 WR_LONG_CMD EQU 111001100B ; WLONG (E6H)
212
213 = 0008 MAX_FILE EQU 8
214 = 0002 S_MAX_FILE EQU 2
    
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215                                     PAGE
216
217 0000                                     ASSUME CS:CODE,DS:ABS0
218 0000 55                                ORG 0H
219 0001 AA                                DB 055H ; GENERIC BIOS HEADER
220 0002 08                                DB 0AAH
221                                     DB 08D ; 4K MODULE
222
223 -----
224 ; FIXED DISK I/O SETUP
225 ;
226 ; - ESTABLISH TRANSFER VECTORS FOR THE FIXED DISK
227 ; - PERFORM POWER ON DIAGNOSTICS
228 ; - SHOULD AN ERROR OCCUR A "1701" MESSAGE IS DISPLAYED
229 ;
230 -----
231 0003                                     DISK_SETUP PROC FAR
232 0003 EB 35                                JMP SHORT L3
233 0005 35 39 58 37 32 39                DB '59X7291 (C) COPYRIGHT IBM CORP.' ; COPYRIGHT NOTICE
234                                     ;
235                                     ;
236                                     ;
237                                     ;
238                                     ;
239 0025 2C 31 39 38 32 20                DB ',1982,1985.'
240 0031 20 31 39 38 35 2E                DB '10/28/85' ; RELEASE MARKER
241                                     ;
242                                     ;
243 003A                                     L3:
244 003A 2B C0                                SUB AX,AX
245 003C 8E D8                                MOV DS,AX ; ADDRESS LOW RAM
246 003E FA                                CLI
247 003F A1 004C R                            MOV AX,WORD PTR ORG_VECTOR ; LOAD DISKETTE IP
248 0042 A3 0100 R                            WORD PTR DISK_VECTOR,AX ; STORE AT INT 40H
249 0045 A1 004E R                            MOV AX,WORD PTR ORG_VECTOR+2 ; LOAD DISKETTE CS
250 0048 A3 0102 R                            WORD PTR DISK_VECTOR+2,AX ; STORE AT INT 40H
251 004B C7 06 004C R 0251 R                MOV WORD PTR ORG_VECTOR, OFFSET DISK_IO ; FIXED DISK HANDLER
252 0051 8C 0E 004E R                            WORD PTR ORG_VECTOR+2,CS ; AT INT 13H
253 0055 B8 0755 R                            MOV AX, OFFSET HD_INT ; FIXED DISK INTERRUPT
254 0058 A3 0034 R                            MOV WORD PTR HDISK_INT,AX ; HANDLER AT INT 0DH
255 005B 8C 0E 0036 R                            WORD PTR HDISK_INT+2,CS
256 005F C7 06 0064 R 0192 R                MOV WORD PTR BOOT_VEC,OFFSET BOOT_STRAP ; BOOTSTRAP ROUTINE AT
257 0065 8C 0E 0066 R                            MOV WORD PTR BOOT_VEC+2,CS ; INT 19H
258 0069 C7 06 0104 R 03FF R                MOV WORD PTR HF_TBL_VEC,OFFSET FD_TBL ; PARAMETER TABLE AT
259 006F 8C 0E 0106 R                            WORD PTR HF_TBL_VEC+2,CS ; INT 41H
260 0073 FB                                STI
261
262                                     ASSUME DS:DATA
263 0074 B8 ---- R                            MOV AX,DATA ; ESTABLISH SEGMENT
264 0077 8E D8                                MOV DS,AX
265 0079 C6 06 0074 R 00                    MOV DISK_STATUS,0 ; RESET THE STATUS INDICATOR
266 007E C6 06 0075 R 00                    MOV HF_NUM,0 ; ZERO COUNT OF DRIVES
267 0083 C6 06 0077 R 00                    MOV PORT_OFF,0 ; ZERO CARD OFFSET
268 0088 B9 0025                            MOV CX,25H ; RETRY COUNT
269 008B
270 008B E8 0177 R                            L4: CALL HD_RESET_I ; RESET CONTROLLER
271 008E 73 05                                JNC L7
272 0090 E2 F9                                LOOP L4 ; TRY RESET AGAIN
273 0092 E9 0154 R                            JMP ERROR_EX
274
275 0095 B9 0001                            L7: MOV CX,1
276 0098 BA 0080                            MOV DX,80H
277 009B B8 1200                            MOV AX,1200H ; CONTROLLER DIAGNOSTICS
278 009E CD 13                                INT 13H ; CHECK THE INTERNAL RAM
279 00A0 73 03                                JNC P7 ; BUFFERS
280 00A2 E9 0154 R                            JMP ERROR_EX
281 00A5
282 00A5 B8 1400                            P7: MOV AX,1400H ; CONTROLLER DIAGNOSTICS
283 00A8 CD 13                                INT 13H ; INTERNAL CHECKSUM AND
284 00AA 73 03                                JNC P9 ; ECC CIRCUITRY TEST.
285 00AC E9 0154 R                            JMP ERROR_EX
286 00AF
287 00AF C7 06 006C R 0000                    P9: MOV TIMER_LOW,0 ; ZERO TIMER
288 00B5 81 3E 0072 R 1234                    CMP RESET_FLAG,1234H ; KEYBOARD RESET
289 00B8 75 06                                JNE P8
290 00BD C7 06 006C R 019A                    MOV TIMER_LOW,410D ; SKIP WAIT ON RESET
291 00C3
292 00C3 FA                                P8: CLI ; DISABLE INTERRUPTS
293 00C4 E4 21                                IN AL,INTA01 ; TIMER
294 00C6 24 FE                                AND AL,0FEH ; ENABLE TIMER
295 00C8 E6 21                                OUT INTA01,AL ; START TIMER
296 00CA FB                                STI ; INTERRUPTS ON
297 00CB
298 00CB E8 0177 R                            P4: CALL HD_RESET_I ; RESET CONTROLLER
299 00CE 72 07                                JC P10
300 00D0 B8 1000                            MOV AX,1000H ; TEST TO SEE IF THE DRIVE
301 00D3 CD 13                                INT 13H ; IS READY
302 00D5 73 0A                                JNC P2
303 00D7
304 00D7 A1 006C R                            P10: MOV AX,TIMER_LOW
305 00DA 3D 01BE                            CMP AX,446D ; 25 SECONDS
306 00DD 72 EC                                JB P4
307 00DF EB 73                                JMP SHORT ERROR_EX
308 00E1
309 00E1 B8 1100                            P2: MOV AX,1100H ; RECALIBRATE THE DRIVE 0
310 00E4 CD 13                                INT 13H
311 00E6 72 6C                                JC ERROR_EX
312
313 00E8 B8 0900                            MOV AX,0900H ; SET DRIVE PARAMETERS
314 00EB CD 13                                INT 13H ; FOR DRIVE 0
315 00ED 72 65                                JC ERROR_EX
316
317 00EF B8 C800                            MOV AX,0C800H ; DMA TO BUFFER
318 00F2 8E C0                            MOV ES,AX ; SET SEGMENT
319 00F4 2B DB                            SUB BX,BX
320 00F6 B8 0F00                            MOV AX,0F00H ; WRITE SECTOR BUFFER
321 00F9 CD 13                                INT 13H
322 00FB 72 57                                JC ERROR_EX
323
324 00FD FE 06 0075 R                            INC HF_NUM ; DRIVE ZERO RESPONDED
325 0101 BA 0213                            MOV DX,213H ; EXPANSION BOX
326 0104 B8 00                                MOV AL,0
327 0106 EA                                OUT DX,AL ; TURN BOX OFF
328 0107 BA 0321                            MOV DX,321H ; TEST IF CONTROLLER
    
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329 010A EC          IN      AL,DX          ; ... IS IN THE SYSTEM UNIT
330 010B 24 0F      AND      AL,0FH
331 010D 3C 0F      CMP      AL,0FH
332 010F 74 06      JE       BOX_ON
333 0111 C7 06 006C R 01A4  MOV     TIMER_LOW,420D ; CONTROLLER IS IN SYSTEM UNIT
334 0117
335 0117 BA 0213    BOX_ON:  MOV     DX,213H      ; EXPANSION BOX
336 011A B0 FF      MOV     AL,0FFH
337 011C EE          OUT     DX,AL
338 011D B9 0001    MOV     CX,1          ; TURN BOX ON
339 0120 BA 0081    MOV     DX,081H      ; ATTEMPT NEXT DRIVES
340 0123
341 0123 2B C0      P3:     SUB     AX,AX          ; RESET THE CONTROLLER
342 0125 CD 13      INT     13H
343 0127 72 42      JC      POD_DONE
344 0129 B8 1100    MOV     AX,01100H    ; RECALIBRATE THE DRIVE 1
345 012C CD 13      INT     13H
346 012E 73 0A      JNC     PS
347 0130 A1 006C R  MOV     AX,TIMER_LOW
348 0133 3D 01BE    CMP     AX,446D      ; 25 SECONDS
349 0136 72 EB      JB      P3
350 0138 EB 31      JMP     SHORT POD_DONE
351 013A
352 013A B8 0900    P5:     MOV     AX,0900H    ; INITIALIZE DRIVE CHARACTERISTICS
353 013D CD 13      INT     13H          ; FOR DRIVE 1
354 013F 72 2A      JC      POD_DONE
355 0141 FE 06 0075 R  INC     HF_NUM
356 0145 81 FA 0081  CMP     DX,(80H + S_MAX_FILE - 1)
357 0149 73 20      JAE     POD_DONE
358 014B 42         INC     DX
359 014C EB D5      JMP     P3
360
361 014E 31 37 30 31 0D 0A  F17    DB      'I701',0DH,0AH ; POST MESSAGE
362 = 0006          F17L   EQU     $-F17
363
364 ;----- POD ERROR
365
366 0154
367 0154 BD 000F    ERROR_EX: MOV     BP,0FH      ; POD ERROR FLAG
368 0157 2B F6      SUB     SI,SI
369 0159 B9 0006    MOV     CX,F17L      ; MESSAGE CHARACTER COUNT
370 015C B7 00      MOV     BH,0         ; PAGE ZERO
371 015E
372 015E 2E: 8A 84 014E R  OUT_CH:  MOV     AL,CS:F17[S1] ; GET BYTE
373 0163 B4 0E      MOV     AH,14D      ; VIDEO OUT
374 0165 CD 10      INT     10H         ; DISPLAY CHARACTER
375 0167 46         INC     SI           ; NEXT CHAR
376 0168 E2 F4      LOOP    OUT_CH      ; DO MORE
377 016A F9
378 016B
379 016B FA         POD_DONE: STC
380 016C E4 21      CLD
381 016E 0C 01      IN     AL,INTA01    ; NO INTERRUPTS
382 0170 E6 21      OR     AL,10H      ; READ THE INTERRUPT MASK
383 0172 FB          OUT    INTA01,AL   ; DISABLE THE TIMER
384 0173 EB 0232 R  CALL   DSBL
385 0176 CB          RET
386
387 0177
388 0177 51         HD_RESET_1  PROC   NEAR
389 0178 52         PUSH  CX
390 0179 B9 0100    MOV     CX,0100H   ; SAVE REGISTER
391 017C
392 017C E8 076D R  L6:     CALL   PORT_0
393 017F 42         INC   DX           ; RETRY COUNT
394 0180 EE          OUT   DX,AL
395 0181 EB 00      JMP   $+2          ; ADDRESS PORT_1
396 0183 EB 00      JMP   $+2          ; RESET CARD
397 0185 EB 00      JMP   $+2          ; I/O DELAY AT LEAST +5us
398 0187 EC          IN   AL,DX        ; ALLOW TIME TO CLEAR THE
399 0188 24 3F      AND   AL,00111111B ; HARDWARE STATUS REGISTER
400 018A 74 03      JZ   R3           ; READ THE HARDWARE STATUS
401 018C E2 EE      LOOP L6           ; MASK OFF UPPER 2 BITS AND CLEAR CY
402 018E F9          STC
403 018F
404 018F 5A         R3:     POP   DX          ; EXIT IF REGISTER IS CLEARED WITH CY=0
405 0190 59        POP   CX          ; TRY AGAIN
406 0191 C3          RET             ; SET ERROR CONDITION CY=1
407 0192
408 0192          HD_RESET_1  ENDP
                     DISK_SETUP ENDP
    
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409 PAGE
410 :--- INT 19 H -----
411 :
412 : INTERRUPT 19 BOOT STRAP LOADER
413 :
414 : - THE FIXED DISK BIOS REPLACES THE INTERRUPT 19H BOOT
415 : STRAP VECTOR WITH A POINTER TO THIS BOOT ROUTINE AND
416 : RESETS THE DEFAULT DISK AND DISKETTE PARAMETER VECTORS
417 :
418 : - THE BOOT BLOCK TO BE READ IN WILL BE ATTEMPTED FROM
419 : CYLINDER 0 SECTOR 1 OF THE DEVICE.
420 :
421 : - THE BOOTSTRAP SEQUENCE IS:
422 : ATTEMPT TO LOAD FROM THE DISKETTE INTO THE BOOT
423 : LOCATION 10000:7C00H WHERE CONTROL IS TRANSFERRED.
424 : IF THE DISKETTE FAILS THE FIXED DISK IS TRIED FOR A
425 : VALID BOOTSTRAP BLOCK. A VALID BOOT BLOCK ON THE
426 : FIXED DISK CONSISTS OF THE BYTES 055H 0AAH AS THE
427 : LAST TWO BYTES OF THE BLOCK.
428 : IF THE ABOVE FAILS CONTROL IS PASSED TO RESIDENT BASIC
429 :
430 :-----
431
432 0192 BOOT_STRAP:
433 ASSUME DS:ABS0,ES:ABS0
434 SUB AX,AX
435 0194 8E D8 MOV DS,AX ; ESTABLISH SEGMENT
436 0196 B4 C0 MOV AH,0C0H
437 0198 CD 15 INT 15H ; READ CONFIGURATION PARAMETERS
438 ; IF XT OR PC, INTERRUPTS ARE DISABLED
439 ; AT THIS POINT.
440
441 :----- RESET PARAMETER VECTORS
442 CLI
443 019A FA MOV WORD PTR HF_TBL_VEC,OFFSET FD_TBL
444 01A1 8C 0E 0104 R MOV WORD PTR HF_TBL_VEC+2,CS
445 01A5 73 0A JNC H0 ; JMP IF INT 15 FUNCTION IMPLEMENTED
446 01A7 C7 06 0078 R 0227 R MOV WORD PTR DISKETTE_PARM,OFFSET DISKETTE_TBL
447 01AD 8C 0E 007A R MOV WORD PTR DISKETTE_PARM+2,CS
448 01B1 H0: STI
449 01B1 FB
450
451 :----- ATTEMPT BOOTSTRAP FROM DISKETTE
452
453 01B2 2B D2 SUB DX,DX ; DRIVE ZERO
454
455 :----- ESTABLISH ES:BX POINTER
456 MOV ES,DX ; ESTABLISH SEGMENT
457 01B4 8E C2 MOV BX,OFFSET BOOT_LOCN ; SET BX TO 7C00H
458 01B6 BB 7C00 R
459
460 :----- CLEAR BOOT_LOCN
461 CLD ; DIRECTION FORWARD
462 01B9 FC XOR AX,AX
463 01BA 33 C0 MOV CX,256 ; CLEAR 256 WORDS
464 01BC B9 0100 MOV D1,BX ; POINT TO BOOT LOCATION BUFFER
465 01BF BB FB MOV REP STOSW ; ZERO THE BOOT LOCATION BUFFER
466 01C1 F3 AB
467
468 01C3 B9 0004 H1: MOV CX,4 ; SET RETRY COUNT
469 01C6 51 PUSH CX ; IPL SYSTEM
470 01C7 2B C0 SUB AX,AX ; SAVE RETRY COUNT
471 01C9 CD 13 INT 13H ; RESET THE DISKETTE
472 01CB 72 08 JC H2 ; FILE IO CALL
473 01CD B8 00 01 MOV AX,0201H ; IF ERROR, TRY AGAIN
474
475 01CD B8 00 01 MOV AX,0201H ; READ IN THE SINGLE SECTOR
476 01DD B9 0001 MOV CX,1 ; SECTOR 1, TRACK 0
477 01D3 CD 13 INT 13H ; FILE IO CALL
478 01D5 59 POP CX ; RECOVER RETRY COUNT
479 01D6 73 09 JNC H3 ; CARRY FLAG SET BY UNSUCCESSFUL READ
480
481 01D8 80 FC 80 CMP AH,80H ; IF TIME OUT, NO RETRY
482 01DB 74 22 JZ H6 ; TRY FIXED DISK
483
484 01DD E2 E7 LOOP H1 ; DO IT FOR RETRY TIMES
485 01DF EB 1E JMP SHORT H6 ; UNABLE TO IPL FROM THE DISKETTE
486
487 01E1 80 3E 7C00 R 06 H3: CMP BYTE PTR BOOT_LOCN,06H ; CHECK FOR FIRST INSTRUCTION INVALID
488 01E6 72 3D JB H10 ; IF BOOT NOT VALID, GO TO BASIC
489
490 :----- INSURE DATA PATTERN FIRST 8 WORDS NOT ALL EQUAL
491
492 01EB BF 7C00 R MOV D1,OFFSET BOOT_LOCN ; CHECK DATA PATTERN
493 01EB B9 0008 MOV CX,8 ; CHECK THE NEXT 8 WORDS
494 01EE A1 7C00 R MOV AX,WORD PTR BOOT_LOCN ; LOAD THE FIRST WORD
495
496 01F1 83 C7 02 H4: ADD D1,2 ; POINT TO NEXT WORD
497 01F4 3B 05 CMP AX,[D1] ; CHECK DATA PATTERN FOR A FILL PATTERN
498 01F6 E1 F9 LOOPZ H4 ;
499 01F8 74 2B JZ H5 ; BOOT NOT VALID, GO TO BASIC
500 01FA H5:
501 01FA EA 7C00 ---- R JMP BOOT_LOCN
502
503 :----- ATTEMPT BOOTSTRAP FROM FIXED DISK
504
505 01FF 2B C0 H6: SUB AX,AX ; RESET DISKETTE
506 0201 CD 13 INT 13H ;
507 0203 B9 0003 MOV CX,3 ; SET RETRY COUNT
508 0206 BA 0080 MOV DX,0080H ; FIXED DISK ZERO
509 0209 H7: ; IPL SYSTEM
510 0209 51 PUSH CX ; SAVE RETRY COUNT
511 020A 2B C0 SUB AX,AX ; RESET THE FIXED DISK
512 020C CD 13 INT 13H ; FILE IO CALL
513 020E 72 08 JC H6 ; IF ERROR, TRY AGAIN
514
515 :----- ES AND BX ALREADY ESTABLISHED
516
517 0210 B8 00 01 MOV AX,0201H ; READ IN THE SINGLE SECTOR
518 0213 B9 0001 MOV CX,1 ; SECTOR 1, TRACK 0
519 0216 CD 13 INT 13H ; FILE IO CALL
520 0218 59 POP CX ; RECOVER RETRY COUNT
521 0219 72 08 JC H8
522

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523 021B A1 TDFE R      MOV     AX,WORD PTR BOOT_LOCN+510D      ; TEST FOR GENERIC BOOT BLOCK
524 021E 3D AA55        CMP     AX,0AA55H      ; H5
525 0221 74 D7          JZ      H5              ; GO TO BOOT LOCATION
526 0223                H9:      LOOP    H7              ; DO IT FOR RETRY TIMES
527 0223 E2 E4          ;----- UNABLE TO IPL FROM THE DISKETTE OR FIXED DISK
528
529
530
531 0225                H10:     INT     18H          ; RESIDENT BASIC
532 0225 CD 18
533
534 0227                DISKETTE_TBL:
535
536 0227 CF              DB      11001111B      ; SRT=D, HD UNLOAD=OF - 1ST SPEC BYTE
537 0228 02            DB      2              ; HD LOAD=1, MODE=DMA - 2ND SPEC BYTE
538 0229 25            DB      25             ; MOTOR TIMEOUT AFTER OPERATION
539 022A 02            DB      2              ; 512 BYTES PER SECTOR
540 022B 08            DB      8              ; EOT (LAST SECTOR ON TRACK)
541 022C 2A            DB      02AH          ; GAP LENGTH
542 022D FF            DB      0FFH          ; DTL
543 022E 50            DB      050H          ; GAP LENGTH FOR FORMAT
544 022F F6            DB      0F6H          ; FILL BYTE FOR FORMAT
545 0230 19            DB      25            ; HEAD SETTLE TIME (MILLI)SECONDS)
546 0231 04            DB      4              ; MOTOR START TIME (1/8 SECOND)
547
548
549
550 0232                ;----- MAKE SURE THAT ALL HOUSEKEEPING IS DONE BEFORE EXIT
551 0232 2A C0          DSBL   PROC    NEAR
552 0234 BA 0323        SUB     AL,AL          ; RESET INT/DMA MASK
553 0231 FA            MOV     DX,HF_PORT+3  ; LOAD FOR PORT ADDRESS 3
554 0238 EE            OUT    DX,DX          ; DISABLE INTERRUPTS
555 0239 83 C2 04      ADD     DX,4           ; RESET INT/DMA MASK CARD 0
556 023C EE            OUT    DX,DX          ; RESET INT/DMA MASK CARD 1
557 023D 83 C2 04      ADD     DX,4           ; RESET INT/DMA MASK CARD 2
558 0240 EE            OUT    DX,DX          ; RESET INT/DMA MASK CARD 3
559 0241 83 C2 04      ADD     DX,4
560 0244 EE            OUT    DX,DX          ; RESET INT/DMA MASK CARD 3
561
562 0245 B0 07          MOV     AL,07H
563 0247 E6 0A          OUT    DMA+10,AL      ; SET DMA MODE TO DISABLE
564 0249 EA 21          IN     AL,INTA01
565 024B 0C 20          OR     AL,020H
566 024D E6 21          OUT    INTA01,AL     ; DISABLE IRQ 5
567 024F FB            STI
568 0250 C3            RET                  ; ENABLE INTERRUPTS
569 0251                DSBL   ENDP
570
571
572
573
574
575
576
577 0251                ;--- DISK_IO -----
578
579 0251 80 FA 80      DISK_IO PROC    FAR      DS:DATA,ES:NOTHING
580 0254 73 05        ASSUME DL,080H        ; TEST FOR FIXED DISK DRIVE
581 0256 CD 20        CMP     JAE     HARD_DISK ; YES, HANDLE HERE
582 0258              INT     40H          ; DISKETTE HANDLER
583 0258 CA 0002      RET     2            ; BACK TO CALLER
584
585 025B              HARD_DISK:
586 025B FB            STI                  ; ENABLE INTERRUPTS
587 025C 0A E4        OR     AH,AH
588 025E 75 09        JNZ    40H
589 0260 CD 40        INT     40H          ; RESET NEC WHEN AH=0
590 0262 2A E4        SUB     AH,AH
591 0264 80 FA 81      CMP     DL,(80H+S_MAX_FILE-1) ; DL IN LIMITS?
592 0267 77 EF        JNC    RET_2
593 0269              A3:
594 0269 80 FC 08      CMP     AH,8         ; GET PARAMETERS IS A SPECIAL CASE
595 026C 75 03        JNZ    A2
596 026E E9 0380 R    JMP     GET_PARM_N
597 0271              A2:
598 0271 55            PUSH   BP            ; SAVE THE BASE POINTER
599 0272 8B EC        MOV     BP,SP        ; LOAD THE CMD_BLOCK POINTER
600 0274 83 EC 08      SUB     SP,8         ; ALLOCATE SPACE FOR THE COMMAND BLOCK
601
602 0277 53            PUSH   BX            ; SAVE REGISTERS DURING OPERATION
603 0278 51            PUSH   CX
604 0279 52            PUSH   DX
605 027A 1E            PUSH   DS
606 027B 06            PUSH   ES
607 027C 56            PUSH   SI
608 027D 57            PUSH   DI
609 027E BE ---- R    MOV     SI,DATA
610 0281 8E DE        MOV     DS,SI        ; ESTABLISH DATA SEGMENT
611
612 0283 E8 02D0 R    CALL  DISK_IO_CONT ; PERFORM THE OPERATION
613
614 0286 50            PUSH   AX
615 0287 E8 0232 R    CALL  DSBL          ; BE SURE DISABLES OCCURRED
616 028A B8 ---- R    MOV     AX,DATA
617 028D 8E D8        MOV     DS,AX        ; ESTABLISH SEGMENT
618 028F 58            POP    AX            ; RESTORE THE REGISTERS
619 0290 8A 26 0074 R MOV     AH,DISK_STATUS ; GET STATUS FROM OPERATION
620 0294 5F            POP    DI
621 0295 5E            POP    SI
622 0296 07            POP    ES
623 0297 1F            POP    DS
624 0298 5A            POP    DX
625 0299 59            POP    CX
626 029A 5B            POP    BX
627
628 029B 83 C4 08      ADD     SP,8         ; ADJUST FOR THE COMMAND BLOCK.
629 029E 5D            POP    BP            ; RESTORE BASE POINTER
630 029F 80 FC 01      CMP     AH,1        ; SET THE CARRY FLAG TO INDICATE
631 02A2 F5            CMC
632 02A3 CA 0002      RET     2            ; SUCCESS OR FAILURE
633 02A6              DISK_IO ENDP
        ; THROW AWAY SAVED FLAGS
    
```

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634                                     PAGE
635 02A6                                M1 LABEL WORD ; FUNCTION TRANSFER TABLE
636 02A6 032E R                          DW DISK_RESET ; 000H
637 02A8 0347 R                          DW RETURN_STATUS ; 001H
638 02AA 0350 R                          DW DISK_READ ; 002H
639 02AC 0359 R                          DW DISK_WRITE ; 003H
640 02AE 0362 R                          DW DISK_VERIFY ; 004H
641 02B0 0369 R                          DW FMT_TRK ; 005H
642 02B2 036F R                          DW FMT_BAD ; 006H
643 02B4 0375 R                          DW FMT_DRV ; 007H
644 02B6 037E R                          DW BAD_COMMAND ; 008H
645 02B8 038F R                          DW INIT_DRV ; 009H
646 02BA 04F4 R                          DW RD_LONG ; 00AH
647 02BC 0501 R                          DW WR_LONG ; 00BH
648 02BE 0515 R                          DW DISK_SEEK ; 00CH
649 02C0 032E R                          DW DISK_RESET ; 00DH
650 02C2 051B R                          DW RD_BUFF ; 00EH
651 02C4 0527 R                          DW WR_BUFF ; 00FH
652 02C6 0533 R                          DW TST_RDY ; 010H
653 02C8 0539 R                          DW HDISK_RECAL ; 011H
654 02CA 053F R                          DW RAM_DTAG ; 012H
655 02CC 0545 R                          DW CHK_DRV ; 013H
656 02CE 0548 R                          DW CNTLR_DIAG ; 014H
657 = 002A                                MIL EQU $-M1
658
659 02D0                                DISK_IO_CONT PROC NEAR
660 02D0 80 FC 01                          CMP AH,01H ; RETURN STATUS
661 02D3 74 72                              JE RETURN_STATUS
662
663 02D5 80 EA 80                          SUB DL,080H ; CONVERT DRIVE NUMBER TO 0 BASED RANGE
664 02D8 80 FA 08                          CMP DL,MAX_FILE ; LEGAL DRIVE TEST
665 02DB 73 49                              JAE BAD_COMMAND
666
667 02DD C6 06 0074 R 00                    MOV DISK_STATUS,0 ; RESET THE STATUS INDICATOR
668
669 ;----- SET UP COMMAND BLOCK
670
671 02E2 FE C9                              DEC CL ; SECTORS 0-16 FOR CONTROLLER
672 02E4 C5 F5 F8 00                       MOV CMD_BLOCK+0,0 ; SET TO ZERO THE OP CODE
673 02E8 88 4E FA                          MOV CMD_BLOCK+2,CL ; SECTOR AND HIGH 2 BITS CYLINDER
674 02EB 88 6E FB                          MOV CMD_BLOCK+3,CH ; CYLINDER LOW
675 02EE 88 46 FC                          MOV CMD_BLOCK+4,AL ; INTERLEAVE / BLOCK COUNT
676 02F0 A0 0076 R R                       MOV AL,CONTROL_BYTE ; CONTROL BYTE (STEP OPTION)
677 02F4 88 46 FD                          MOV CMD_BLOCK+5,AL ; SET THE CONTROL FIELD
678
679 ;----- CALCULATE THE PORT OFFSET
680
681 02F7 8A EA                              MOV CH,DL ; SAVE DL
682 02F9 80 CA 01                          OR DL,1
683 02FC FE CA 01                          DEC DL,1
684 02FE D0 E2                              SHL DL,1 ; GENERATE OFFSET
685 0300 88 16 0077 R                      MOV PORT_OFF,DL ; STORE OFFSET
686 0304 8A D5                              MOV DL,CH ; RESTORE DL
687 0306 80 E2 01                          AND DL,1 ; MAKE DRIVE 0 OR 1
688 0309 B1 05                              MOV CL,5 ; SHIFT COUNT
689 030B D2 E2                              SHL DL,CL ; DRIVE NUMBER (0,1)
690 030D 0A D6                              OR DL,DH ; HEAD NUMBER
691 030F 88 56 F9                          MOV CMD_BLOCK+1,DL ; SET THE DRIVE AND HEAD
692
693 0312 8B C8                              MOV CX,AX ; CALCULATE JUMP ADDRESS
694 0314 8A CD                              MOV CL,CH ; GET INTO LOW BYTE
695 0316 32 ED                              XOR CH,CH ; ZERO HIGH BYTE
696 0318 D1 E1                              SAL CX,1 ; *2 FOR TABLE LOOKUP
697 031A 8B F1                              MOV SI,CX ; PUT INTO SI FOR BRANCH
698 031C 83 F9 2A                          CMP CX,MI ; TEST WITHIN RANGE
699 031F 73 05                              JNB BAD_COMMAND
700 0321 2E: FF A4 02A6 R                    JMP WORD PTR CS:[SI+OFFSET MI] ; GO DO THE COMMAND
701 0326 C6 06 0074 R 01                    BAD_COMMAND: MOV DISK_STATUS,BAD_CMD ; SET BAD COMMAND ERROR
702 0328 B0 00                              MOV AL,0
703 032D B0 00                              MOV AL,0
704 032D C3                              RET ; EXIT
705 032E                                DISK_IO_CONT ENDP
706
707 ;-----
708 ; RESET THE DISK SYSTEM (AH = 000H) :
709 ;-----
710
711 032E                                DISK_RESET PROC NEAR
712 032E E8 076D R                          CALL PORT_0 ; RESET PORT
713 0331 42                              INC DX ; PORT 1 ADDRESS
714 0332 EE                              OUT DX,AL ; RESET CARD
715 0333 EB 00                              JMP $+2 ; I/O DELAY AT LEAST +5us
716 0335 EB 00                              JMP $+2 ; ALLOW TIME TO CLEAR THE
717 0337 EB 00                              JMP $+2 ; HARDWARE STATUS REGISTER
718 0339 EC                              IN AL,DX ; READ THE HARDWARE STATUS
719 033A 24 3F                              AND AL,00111111B ; MASK OFF UPPER 2 BITS AND CLEAR CY
720 033C 74 06                              JZ DR1 ; EXIT IF REGISTER IS CLEARED WITH CY=0
721 033E C6 06 0074 R 05                    MOV DISK_STATUS,BAD_RESET ; SET THE ERROR CONDITION
722 0343 C3                              RET ; EXIT
723 0344
724 0344 E9 043F R                          JMP INIT_DRV ; SET THE DRIVE PARAMETERS
725
726 0347                                DISK_RESET ENDP
727
728 ;-----
729 ; DISK STATUS ROUTINE (AH = 001H) :
730 ;-----
731
732 0347                                RETURN_STATUS PROC NEAR
733 0347 A0 0074 R                          MOV AL,DISK_STATUS ; OBTAIN PREVIOUS STATUS
734 034A C6 06 0074 R 00                    MOV DISK_STATUS,0 ; RESET STATUS
735 034F C3                              RET
736 0350                                RETURN_STATUS ENDP
737
738 ;-----
739 ; DISK READ ROUTINE (AH = 002H) :
740 ;-----
741
742 0350                                DISK_READ PROC NEAR
743 0350 B0 47                              MOV AL,DMA_READ ; MODE BYTE FOR DMA READ
744 0352 C6 46 F8 08                       MOV CMD_BLOCK+0,READ_CMD ; CONTROL BYTE
745 0356 E9 055E R                          JMP DMA_OPN
746 0359                                DISK_READ ENDP
747
    
```

```

748 ;-----
749 ; DISK WRITE ROUTINE (AH = 003H) ;
750 ;-----
751
752 0359 DISK_WRITE PROC NEAR
753 0359 B0 4B MOV AL,DMA_WRITE ; MODE BYTE FOR DMA WRITE
754 035B C6 46 F8 0A MOV CMD_BLOCK+0,WRITE_CMD
755 035F E9 055E R DMA_OPN
756 0362 DISK_WRITE ENDP
757
758 ;-----
759 ; DISK VERIFY (AH = 004H) ;
760 ;-----
761
762 0362 DISK_VERF PROC NEAR
763 0362 C6 46 F8 05 MOV CMD_BLOCK+0,CHK_TRK_CMD
764 0366 E9 054F R NDMA_OPN
765 0369 DISK_VERF ENDP
766
767 ;-----
768 ; FORMATTING (AH = 005H 006H 007H) ;
769 ;-----
770
771 0369 FMT_TRK PROC NEAR ; FORMAT TRACK (AH = 005H)
772 0369 C6 46 F8 06 MOV CMD_BLOCK+0,FMTTRK_CMD
773 036D EB 0A JMP SHORT FMT_CONT
774 036F FMT_TRK ENDP
775
776 036F FMT_BAD PROC NEAR ; FORMAT BAD TRACK (AH = 006H)
777 036F C6 46 F8 07 MOV CMD_BLOCK+0,FMTBAD_CMD
778 0373 EB 04 JMP SHORT FMT_CONT
779 0375 FMT_BAD ENDP
780
781 0375 FMT_DRV PROC NEAR ; FORMAT DRIVE (AH = 007H)
782 0375 C6 46 F8 04 MOV CMD_BLOCK+0,FMTDRV_CMD
783 0379 FMT_DRV ENDP
784
785 0379 FMT_CONT ;
786 0379 80 66 FA C0 AND CMD_BLOCK+2,11000000B ; ZERO OUT SECTOR FIELD
787 037D E9 054F R NDMA_OPN
788
789 ;-----
790 ; GET PARAMETERS (AH = 8) ;
791 ;-----
792
793 0380 GET_PARM_N LABEL NEAR
794 0380 GET_PARM PROC FAR ; GET DRIVE PARAMETERS
795 0380 1E PUSH DS ; SAVE REGISTERS
796 0381 06 PUSH ES
797 0382 53 PUSH BX
798
799 ASSUME DS:ABS0
800 0383 2B C0 SUB AX,AX ; ESTABLISH ADDRESSING
801 0385 8E D8 MOV DS,AX
802 0387 C4 1E 0104 R BX,HF_TBL_VEC
803
804 ASSUME DS:DATA
805 0388 B8 ---- R MOV AX,DATA ; ESTABLISH SEGMENT
806 038E 8E D8 MOV DS,AX
807 0390 80 EA 80 SUB DL,80H
808 0393 80 FA 08 CMP DL,MAX_FILE ; TEST WITHIN RANGE
809 0396 73 57 JAE G4
810 0398 C6 06 0074 R 00 MOV DISK_STATUS,0 ; RESET THE STATUS INDICATOR
811 039D 8A EA MOV CH,DL ; SAVE THE DRIVE
812 039F 80 CA 01 OR DL,1
813 03A2 FE CA DEC DEC
814 03A4 D0 E2 SHL DL,1 ; GENERATE OFFSET
815 03A6 88 16 0077 R MOV PORT_OFF,DL ; STORE OFFSET
816 03AA 8A D5 MOV DL,CH ; RESTORE DL
817 03AC 80 E2 01 AND DL,00000001B ; DRIVE 0 OR DRIVE 1
818 03AF 8A E2 MOV AH,DL
819 03B1 E8 076D R CALL PORT_0 ; PORT_2 ADDRESS
820 03B4 42 INC DX
821 03B5 42 INC DX
822 03B6 EC IN AL,DX ; READ SWITCH SETTINGS
823 03B7 50 FC 00 CMP AH,0 ; DRIVE 0 OR 1
824 03BA 75 04 JNZ G0
825 03BC D0 E8 SHR AL,1 ; RIGHT JUSTIFY THE SWITCH BITS
826 03BE D0 E8 SHR AL,1
827 03C0
828 03C0 24 03 AND AL,00000011B ; ISOLATE THE TABLE BITS
829 03C2 B1 04 MOV CL,4 ; TABLE LENGTH IS 16 BYTES
830 03C4 D2 E0 SHL AL,CL ; ADJUST
831 03C6 2A E4 SUB AH,AH
832 03C8 03 D8 ADD BX,AX
833 03CA 26: 8B 07 MOV AX,ES:[BX] ; MAX NUMBER OF CYLINDERS
834 03CD 2D 0002 SUB AX,2 ; ADJUST FOR 0-N ; AND RESERVE LAST TRACK
835
836 03D0 8A E8 MOV CH,AL
837 03D2 25 0300 AND AX,0300H ; HIGH TWO BITS OF CYLINDER
838 03D5 D1 E8 SHR AX,1
839 03D7 D1 E8 SHR AX,1
840 03D9 0C 11 OR AL,011H ; SECTORS
841 03DB 8A C8 MOV CL,AL
842 03DD 26: 8A 77 02 MOV DH,ES:[BX][2] ; HEADS
843 03E1 FE CE DEC DH ; 0-N RANGE
844 03E3 8A 16 0075 R MOV DL,HF_NUM ; DRIVE COUNT
845 03E7 2B C0 SUB AX,AX
846 03E9
847 03E9 5B POP BX ; RESTORE REGISTERS
848 03EA 07 POP ES
849 03EB 1F POP DS
850 03EC CA 0002 RET 2 ; EXIT
851 03EF
852 03EF C6 06 0074 R 07 MOV DISK_STATUS,INIT_FAIL ; OPERATION FAILED
853 03F4 B4 07 MOV AH,INIT_FAIL
854 03F6 2A C0 SUB AL,AL
855 03F8 2B C2 SUB DX,DX
856 03FA 2B C9 SUB CX,CX
857 03FC F9 STC ; SET ERROR FLAG
858 03FD EB EA JMP ; EXIT
859 03FF GET_PARM ENDP
    
```

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PAGE
;-----
; INITIALIZE DRIVE CHARACTERISTICS
;-----
; FIXED DISK PARAMETER TABLE
;-----
; THE TABLE IS COMPOSED OF A BLOCK DEFINED AS:
;-----
; (1 WORD) - MAXIMUM NUMBER OF CYLINDERS
; (1 BYTE) - MAXIMUM NUMBER OF HEADS
; (1 WORD) - STARTING REDUCED WRITE CURRENT CYL
; (1 WORD) - STARTING WRITE PRECOMPENSATION CYL
; (1 BYTE) - MAXIMUM ECC DATA BURST LENGTH
; (1 BYTE) - CONTROL BYTE (DRIVE STEP OPTION)
; (1 BYTE) - BIT 7 DISABLE DISK-ACCESS RETRIES
; (1 BYTE) - BIT 6 DISABLE ECC RETRIES
; (1 BYTE) - BITS 5-3 ZERO
; (1 BYTE) - BITS 2-0 DRIVE OPTION
; (1 BYTE) - STANDARD TIME OUT VALUE (SEE BELOW)
; (1 BYTE) - TIME OUT VALUE FOR FORMAT DRIVE
; (1 BYTE) - TIME OUT VALUE FOR CHECK DRIVE
; (1 WORD) - LANDING ZONE
; (1 BYTE) - SECTORS/TRACK
; (1 BYTE) - RESERVED FOR FUTURE USE
;-----
; TO DYNAMICALLY DEFINE A SET OF PARAMETERS
; BUILD A TABLE OF VALUES AND PLACE THE
; CORRESPONDING VECTOR INTO INTERRUPT 41.
;-----
; NOTE: THE DEFAULT TABLE IS VECTORED IN FOR
; AN INTERRUPT 19H (BOOTSTRAP)
;-----
; ON THE CARD SWITCH SETTINGS
;-----
; DRIVE 0 DRIVE 1
;-----
; ON : -1- -2- / -3- -4- ;
; OFF : / / ;
;-----
; TRANSLATION TABLE
;-----
; DRIVE 0 : DRIVE 1 : TABLE ENTRY
; 1/2 : 3/4 :
;-----
; ON ON : ON ON : 0
; ON OFF : ON OFF : 1
; OFF ON : OFF ON : 2
; OFF OFF : OFF OFF : 3
;-----
;-----
; FD_TBL:
;-----
;----- DRIVE TABLE 0
;-----
917 03FF 0132 DW 0306D ; MAX CYLINDERS
918 0401 04 DB 04D ; MAX HEADS
919 0402 0132 DW 0306D ; START REDUCED WRITE CURRENT CYL
920 0404 0000 DW 0 ; START WRITE PRECOMPENSATION CYL
921 0406 0B DB 0BH ; MAX ECC BURST DATA LENGTH
922 0407 05 DB 00000101B ; CONTROL BYTE
923 0408 10 DB 010H ; STANDARD TIME OUT
924 0409 C0 DB C00H ; TIME OUT FOR FORMAT DRIVE
925 040A 28 DB 028H ; TIME FOR CHECK DRIVE
926 040B 0132 DW 0306D ; LANDING ZONE
927 040D 11 DB 017D ; SECTORS/TRACK
928 040E 00 DB 0 ; RESERVED
929
930
;----- DRIVE TABLE 1
931
932 040F 0264 DW 0612D ; MAX CYLINDERS
933 0411 04 DB 04D ; MAX HEADS
934 0412 0264 DW 0612D ; START REDUCED WRITE CURRENT CYL
935 0414 0000 DW 0 ; START WRITE PRECOMPENSATION CYL
936 0416 0B DB 0BH ; MAX ECC BURST DATA LENGTH
937 0417 05 DB 00000101B ; CONTROL BYTE
938 0418 28 DB 028H ; STANDARD TIME OUT
939 0419 E0 DB 0E0H ; TIME OUT FOR FORMAT DRIVE
940 041A 42 DB 042H ; TIME FOR CHECK DRIVE
941 041B 0297 DW 0663D ; LANDING ZONE
942 041D 11 DB 017D ; SECTORS/TRACK
943 041E 00 DB 0 ; RESERVED
944
945
;----- DRIVE TABLE 2
946
947 041F 0267 DW 0615D ; MAX CYLINDERS
948 0421 04 DB 04D ; MAX HEADS
949 0422 0267 DW 0615D ; START REDUCED WRITE CURRENT CYL
950 0424 012C DW 0300D ; START WRITE PRECOMPENSATION CYL
951 0426 0B DB 0BH ; MAX ECC BURST DATA LENGTH
952 0427 05 DB 00000101B ; CONTROL BYTE
953 0428 28 DB 028H ; STANDARD TIME OUT
954 0429 E0 DB 0E0H ; TIME OUT FOR FORMAT DRIVE
955 042A 42 DB 042H ; TIME FOR CHECK DRIVE
956 042B 0267 DW 0615D ; LANDING ZONE
957 042D 11 DB 017D ; SECTORS/TRACK
958 042E 00 DB 0 ; RESERVED
959
960
;----- DRIVE TABLE 3
961
962 042F 0132 DW 0306D ; MAX CYLINDERS
963 0431 0B DB 0BD ; MAX HEADS
964 0432 0132 DW 0306D ; START REDUCED WRITE CURRENT CYL
965 0434 0080 DW 0128D ; START WRITE PRECOMPENSATION CYL
966 0436 0B DB 0BH ; MAX ECC BURST DATA LENGTH
967 0437 05 DB 00000101B ; CONTROL BYTE
968 0438 28 DB 028H ; STANDARD TIME OUT
969 0439 E0 DB 0E0H ; TIME OUT FOR FORMAT DRIVE
970 043A 42 DB 042H ; TIME FOR CHECK DRIVE
971 043B 0150 DW 0336D ; LANDING ZONE
972 043D 11 DB 017D ; SECTORS/TRACK
973 043E 00 DB 0 ; RESERVED
    
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974
975
976
977
978
979 043F
980
981
982
983 043F C6 46 F8 0C
984 0443 C6 46 F9 00
985 0447 E8 0458 R
986 044A 72 0B
987
988
989
990 044C C6 46 F8 0C
991 0450 C6 46 F9 20
992 0454 F8 0458 R
993 0457
994 0457 C3
995 0458
996
997 0458
998 0458 2A C0
999 045A E8 057C R
1000 045D 73 01
1001 045F C3
1002 0460
1003 0460 8C D9
1004
1005
1006 0462 2B C0
1007 0464 8E D8
1008 0466 C4 1E 0104 R
1009 046A 8E D9
1010
1011
1012
1013
1014
1015
1016
1017 046C 42
1018 046D 42
1019 046E EC
1020 046F 8A 66 F9
1021 0472 80 E4 20
1022 0475 75 04
1023 0477 D0 E8
1024 0479 D0 E8
1025 047B
1026 047B 24 03
1027 047D B1 04
1028 047F D2 E0
1029 0481 2A E4
1030 0483 03 D8
1031 0485 B4 09
1032
1033
1034
1035 0487 BF 0001
1036 048A E8 04E9 R
1037 048D 72 4C
1038
1039 048F BF 0000
1040 0492 E8 04E9 R
1041 0495 72 44
1042
1043 0497 BF 0002
1044 049A E8 04E9 R
1045 049D 72 3C
1046
1047 049F BF 0004
1048 04A2 E8 04E9 R
1049 04A5 72 34
1050
1051 04A7 BF 0003
1052 04AA E8 04E9 R
1053 04AD 72 2C
1054
1055 04AF BF 0006
1056 04B2 E8 04E9 R
1057 04B5 72 24
1058
1059 04B7 BF 0005
1060 04BA E8 04E9 R
1061 04BD 72 1C
1062
1063 04BF BF 0007
1064 04C2 E8 04E9 R
1065 04C5 72 14
1066
1067 04CF BF 0008
1068 04CA 2E 8A 01
1069 04CD A2 0076 R
1070
1071 04DD 2B C9
1072 04D2 B4 0F
1073 04D4
1074 04D4 E8 068D R
1075 04D7 73 09
1076 04D9 E2 F9
1077 04DB
1078 04DB C6 06 0074 R 07
1079 04E0 F9
1080 04E1 C3
1081 04E2
1082 04E2 4A
1083 04E3 EC
1084 04E4 24 02
1085 04E6 75 F3
1086 04E8 C3
1087 04E9

```

```

;-----
; INITIALIZE DRIVE (AH = 09H) ;
;-----
INIT_DRV PROC NEAR
;----- DO DRIVE ZERO
MOV CMD_BLOCK+0,INIT_DRV_CMD
MOV CMD_BLOCK+1,0 ; SET FOR DRIVE 0
CALL INIT_DRV_R ; SEND THE PARAMETERS
JC INIT_DRV_OUT ; ERROR?
;----- DO DRIVE ONE
MOV CMD_BLOCK+0,INIT_DRV_CMD
MOV CMD_BLOCK+1,00100000B ; SET TO DRIVE 1
CALL INIT_DRV_R ; SEND THE PARAMETERS
INIT_DRV_OUT:
RET ; EXIT
INIT_DRV ENDP
INIT_DRV R PROC NEAR
SUB AL,AL
CALL COMMAND ; ISSUE THE COMMAND
JNC B1 ; DX = PORT 0 AFTER CALL
RET
B1:
MOV CX,DS ; SAVE SEGMENT
ASSUME DS:ABS0
SUB AX,AX
MOV DS,AX ; ESTABLISH SEGMENT
LES BX,HF_TBL_VEC ; LOAD THE TABLE VECTOR
MOV DS,CX ; RESTORE SEGMENT
ASSUME DS:DATA
;-----
; DETERMINE PARAMETER TABLE OFFSET ;
; USING CONTROLLER PORT TWO AND ;
; DRIVE NUMBER SPECIFIER (0-1) ;
;-----
INC DX ; ADDRESS PORT 2
INC DX ; READ THE SWITCH SETTINGS
IN AL,DX
MOV AH,CMD_BLOCK+1
AND AH,00100000B ; DRIVE 0 OR 1
JNZ B2
SHR AL,1 ; ADJUST
SHR AL,1
B2:
AND AL,011B ; ISOLATE
MOV CL,4
SHL AL,CL ; ADJUST
SUB AH,AH
ADD BX,AX
MOV AH,00001001B ; SET MASK FOR DATA MODE CPU TO CARD
;----- SEND DRIVE PARAMETERS MOST SIGNIFICANT BYTE FIRST
MOV DI,1 ; SEND MSB OF MAX CYLINDER
CALL INIT_DRV_S
JC B3
MOV DI,0 ; SEND LSB OF MAX CYLINDER
CALL INIT_DRV_S
JC B3
MOV DI,2 ; SEND THE MAXIMUM HEADS
CALL INIT_DRV_S
JC B3
MOV DI,4 ; SEND MSB OF REDUCE WRITE CURRENT
CALL INIT_DRV_S
JC B3
MOV DI,3 ; SEND LSB OF REDUCE WRITE CURRENT
CALL INIT_DRV_S
JC B3
MOV DI,6 ; SEND MSB OF WRITE PRECOMP CYLINDER
CALL INIT_DRV_S
JC B3
MOV DI,5 ; SEND LSB OF WRITE PRECOMP CYLINDER
CALL INIT_DRV_S
JC B3
MOV DI,7 ; SEND ECC BURST LENGTH
CALL INIT_DRV_S
JC B3
MOV DI,8 ; LOAD THE CONTROL BYTE AND PLACE IN
MOV AL,ES:[BX*DI] ; MEMORY AT 40:76H
MOV CONTROL_BYTE,AL
SUB CX,CX
JNC B6
MOV AH,00001111B ; SET THE MASK FOR STATUS MODE
B5:
CALL HD_WAIT ; GO WAIT FOR THE STATE TO HAPPEN
JMP TO_READ THE STATUS BYTE ; TRY AGAIN
B3:
MOV DISK_STATUS,INIT_FAIL ; OPERATION FAILED
STC ; SET THE ERROR CONDITION
RET
B6:
DEC DX ; ADDRESS PORT 0
IN AL,DX ; READ STATUS BYTE OF THE OPERATION
AND AL,2 ; MASK ERROR BIT
JNZ B3 ; ERROR BIT SET?
RET
INIT_DRV R ENDP

```

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1088
1089
1090
1091 04E9
1092 04E9 EB 068D R
1093 04EC 72 05
1094 04EE 4A
1095 04EF 26: 8A 01
1096 04F2 EE
1097 04F3
1098 04F3 C3
1099 04F4
1100
1101
1102
1103
1104
1105 04F4
1106 04F4 EB 050E R
1107 04F7 72 5F
1108 04F9 C6 46 F8 E5
1109 04FD B0 47
1110 04FF EB 5D
1111 0501
1112
1113
1114
1115
1116
1117 0501
1118 0501 EB 050E R
1119 0504 72 05
1120 0506 C6 46 F8 E6
1121 050A B0 4B
1122 050C EB 50
1123 050E
1124
1125 050E
1126 050E 8A 46 FC
1127 0511 3C 80
1128 0513 F5
1129 0514 C3
1130 0515
1131
1132
1133
1134
1135
1136 0515
1137 0515 C6 46 F8 0B
1138 0519 EB 34
1139 051B
1140
1141
1142
1143
1144
1145 051B
1146 051B C6 46 F8 0E
1147 051F C6 46 FC 01
1148 0523 B0 47
1149 0525 EB 37
1150 0527
1151
1152
1153
1154
1155
1156 0527
1157 0527 C6 46 F8 0F
1158 052B C6 46 FC 01
1159 052F B0 4B
1160 0531 EB 2B
1161 0533
1162
1163
1164
1165
1166
1167 0533
1168 0533 C6 46 F8 00
1169 0537 EB 16
1170 0539
1171
1172
1173
1174
1175
1176 0539
1177 0539 C6 46 F8 01
1178 053D EB 10
1179 053F
    
```

```

;----- SEND THE BYTE OUT TO THE CONTROLLER
INIT_DRV_S PROC NEAR
    CALL HD_WAIT ; GO WAIT FOR REQUEST
    D1 ; AFTER CALL DX = PORT 1
    DEC DX ; ADDRESS PORT 0
    MOV AL,ES:[BX+D1]
    OUT DX,AL ; WRITE THE DATA TO THE CARD
DISK2: RET
INIT_DRV_S ENDP
;-----
; READ LONG (AH = 0AH) ;
;-----
RD_LONG PROC NEAR
    CALL CHK_LONG ; CHECK LIMITS
    JC GB
    MOV CMD_BLOCK+0,RD_LONG_CMD
    MOV AL,DMA_READ
    JMP SHORT DMA_OPN
RD_LONG ENDP
;-----
; WRITE LONG (AH = 0BH) ;
;-----
WR_LONG PROC NEAR
    CALL CHK_LONG ; CHECK LIMITS
    JC GB
    MOV CMD_BLOCK+0,WR_LONG_CMD
    MOV AL,DMA_WRITE
    JMP SHORT DMA_OPN
WR_LONG ENDP
CHK_LONG PROC NEAR
    MOV AL,CMD_BLOCK+4
    CMP AL,080H ; LOAD THE NUMBER OF SECTORS
    CMC ; COMPARE WITH LIMITS
    RET ; SET THE CONDITION
CHK_LONG ENDP
;-----
; SEEK (AH = 0CH) ;
;-----
DISK_SEEK PROC NEAR
    MOV CMD_BLOCK+0,SEEK_CMD
    JMP SHORT NDMA_OPN
DISK_SEEK ENDP
;-----
; READ SECTOR BUFFER (AH = 0EH) ;
;-----
RD_BUFF PROC NEAR
    MOV CMD_BLOCK+0,RD_BUFF_CMD
    MOV CMD_BLOCK+4,I
    MOV AL,DMA_READ
    JMP SHORT DMA_OPN
RD_BUFF ENDP
;-----
; WRITE SECTOR BUFFER (AH = 0FH) ;
;-----
WR_BUFF PROC NEAR
    MOV CMD_BLOCK+0,WR_BUFF_CMD
    MOV CMD_BLOCK+4,I
    MOV AL,DMA_WRITE
    JMP SHORT DMA_OPN
WR_BUFF ENDP
;-----
; TEST DISK READY (AH = 010H) ;
;-----
TST_RDY PROC NEAR
    MOV CMD_BLOCK+0,TST_RDY_CMD
    JMP SHORT NDMA_OPN
TST_RDY ENDP
;-----
; RECALIBRATE (AH = 011H) ;
;-----
HDISK_RECAL PROC NEAR
    MOV CMD_BLOCK+0,RECAL_CMD
    JMP SHORT NDMA_OPN
HDISK_RECAL ENDP
    
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1180 PAGE
1181 ;-----
1182 ; CONTROLLER RAM DIAGNOSTICS (AH = 012H) ;
1183 ;-----
1184
1185 053F RAM_DIAG PROC NEAR
1186 053F C6 46 F8 E0 MOV CMD_BLOCK+0, RAM_DIAG_CMD
1187 0543 EB 0A JMP SHORT NDMA_OPN
1188 0545 RAM_DIAG ENDP
1189
1190 ;-----
1191 ; DRIVE DIAGNOSTICS (AH = 013H) ;
1192 ;-----
1193
1194 0545 CHK_DRV PROC NEAR
1195 0545 C6 46 F8 E3 MOV CMD_BLOCK+0, CHK_DRV_CMD
1196 0549 EB 04 JMP SHORT NDMA_OPN
1197 054B CHK_DRV ENDP
1198
1199 ;-----
1200 ; CONTROLLER INTERNAL DIAGNOSTICS (AH = 014H) ;
1201 ;-----
1202
1203 054B CNTLR_DIAG PROC NEAR
1204 054B C6 46 F8 E4 MOV CMD_BLOCK+0, CNTLR_DIAG_CMD
1205 054F CNTLR_DIAG ENDP
1206
1207 ;-----
1208 ; SUPPORT ROUTINES ;
1209 ;-----
1210
1211 054F NDMA_OPN:
1212 054F B0 02 MOV AL, 02H
1213 0551 E8 057C R CALL COMMAND ; ISSUE THE COMMAND
1214 0554 72 22 JC G11
1215 0556 EB 16 JMP SHORT G3
1216 0558 G8: MOV MOV DISK_STATUS, DMA_BOUNDARY
1217 0558 C6 06 0074 R 09 RET
1218 055D C3
1219 055E DMA_OPN:
1220 055E E8 06A5 R CALL DMA_SETUP ; SET UP FOR DMA OPERATION
1221 0561 72 F5 JC G8
1222 0563 B0 03 MOV AL, 03H
1223 0565 E8 057C R CALL COMMAND ; ISSUE THE COMMAND
1224 0568 72 0E JC G11
1225 056A B0 03 MOV AL, 03H
1226 056C E6 0A OUT DMA+10, AL ; INITIALIZE THE DISK CHANNEL
1227 056E G3: CLI ; NO INTERRUPTS
1228 056E FA IN AL, INTA01 ; READ THE MASK
1229 056F E4 21 AND AL, 0DFH ; ENABLE IRQ-5
1230 0571 24 DF OUT INTA01, AL ; WRITE THE MASK OUT
1231 0573 E6 21 CALL WAIT_INT ; PROCEDURE DOES STI
1232 0575 E8 0700 R ;
1233 0578 G11: CALL ERROR_CHK ; SEE IF THERE IS AN ERROR
1234 0578 E8 05AD R RET ; EXIT
1235 057B C3
1236
1237 ;-----
1238 ; COMMAND ;
1239 ; THIS ROUTINE OUTPUTS THE COMMAND BLOCK ;
1240 ; INPUT ;
1241 ; AL = CONTROLLER DMA/INTERRUPT REGISTER MASK ;
1242 ;-----
1243
1244
1245 057C COMMAND PROC NEAR
1246 057C E8 076D R CALL PORT_0 ; GET THE BASE ADDRESS
1247 057F 42 INC DX
1248 0580 42 INC DX ; ADDRESS PORT_2
1249 0581 EE OUT DX, AL ; ISSUE CONTROLLER SELECT PULSE
1250 0582 42 INC DX ; ADDRESS PORT_3
1251 0583 2B C9 SUB CX, CX ; WAIT COUNT
1252 0585 EE OUT DX, AL ; WRITE DMA MASK REGISTER
1253 0586 4A DEC DX
1254 0587 4A DEC DX ; ADDRESS PORT 1
1255 0588 WAIT_BUSY:
1256 0588 EC IN AL, DX ; READ THE HARDWARE STATUS
1257 0589 24 0F AND AL, 0FH
1258 058B 3C 00 CMP AL, RI_BUSY OR RI_BUS OR RI_REQ ; CHECK FOR BUSY, COMMAND
1259 058D 74 09 JE C1 ; AND REQUEST BITS
1260 058F E2 F7 LOOP WAIT_BUSY ; KEEP TRYING
1261 0591 C6 06 0074 R 80 MOV DISK_STATUS, TIME_OUT
1262 0596 F9 STC ; SET THE ERROR CONDITION
1263 0597 C3 RET ; ERROR RETURN
1264 0598 C1:
1265 0598 B9 0006 MOV CX, 6 ; SET FOR 6 BYTES OF COMMAND
1266 0598 4A DEC DX ; ADDRESS PORT 0
1267 059C 8B F5 MOV SI, BP ; SAVE THE BASE POINTER
1268 059E 83 ED 08 SUB SI, 8 ; SET FIRST BYTE OF COMMAND BLOCK
1269 05A1 FA CLI ; NO INTERRUPTS IN COMMAND SEQUENCE
1270 05A2 CM3:
1271 05A2 8A 46 00 MOV AL, [BP] ; GET A COMMAND BYTE
1272 05A5 EE OUT DX, AL ; ALLOW AT LEAST 2µs BETWEEN EACH BYTE
1273 05A6 45 BP INC BP ; ON SENDING THE COMMAND SEQUENCE.
1274 05A7 E2 F9 LOOP CM3 ; DO MORE
1275 05A9 8B EE MOV BP, SI ; RESTORE THE BASE POINTER
1276 05AB FB STI ; INTERRUPTS BACK ON
1277 05AC C3 RET
1278 05AD COMMAND ENDP
    
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1279 PAGE
1280 :-----:
1281 :
1282 : SENSE STATUS BYTES
1283 :
1284 : BYTE 0
1285 : BIT 7 ADDRESS VALID, WHEN SET
1286 : BIT 6 SPARE, SET TO ZERO
1287 : BITS 5-4 ERROR TYPE
1288 : BITS 3-0 ERROR CODE
1289 :
1290 : BYTE 1
1291 : BITS 7-6 ZERO
1292 : BIT 5 DRIVE (0-1)
1293 : BITS 4-0 HEAD NUMBER
1294 :
1295 : BYTE 2
1296 : BITS 7-5 CYLINDER HIGH
1297 : BITS 4-0 SECTOR NUMBER
1298 :
1299 : BYTE 3
1300 : BITS 7-0 CYLINDER LOW
1301 :-----:
1302
1303 05AD
1304 05AD A0 0074 R
1305 05B0 0A C0
1306 05B2 75 01
1307 05B4 C3
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1310 :-----:
1311 : PERFORM SENSE STATUS :
1312 :
1313 : SENSE STATUS CAN BE ISSUED MULTIPLE
1314 : TIMES
1315
1316 05B5
1317 05B5 C6 46 F8 03
1318 05B9 2A C0
1319 05BB E8 057C R
1320 05BE 72 26
1321
1322 05C0 2B FF
1323 05C2 B9 0004
1324 05C5 B4 0B
1325 05C7
1326 05C7 E8 068D R
1327 05CA 72 1A
1328 05CC 4A
1329 05CD EC
1330 05CE 88 43 F8
1331 05D1 41
1332 05D2 E2 F3
1333 05D4 B4 0F
1334 05D6 E8 068D R
1335 05D9 72 0B
1336 05DB 4A
1337 05DC EC
1338 05DD A8 02
1339 05DF 74 0F
1340
1341 05E1 C6 06 0074 R FF
1342 05E6 F9
1343 05E7 C3
1344 05E8
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1346 05E8 061E R
1347 05EA 062B R
1348 05EC 066D R
1349 05EE 067A R
1350
1351 05F0
1352 05F0 8A 5E F8
1353 05F3 8A C3
1354 05F5 24 0F
1355 05F7 80 E3 30
1356 05FA 2A FF
1357 05FC B1 03
1358 05FE D3 EB
1359 0600 2E: FF A7 05E8 R
1360
1361 0605
1362 0605 00 20 40 CC 80 00
1363 20
1364 060C 00 40
1365 = 0009
1366
1367 060E
1368 060E 04 10 02 00 04
1369 0613 40 00 00 11 0B
1370 = 000A
1371
1372 0618
1373 0618 01 02 01
1374 = 0003
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1376 061B
1377 061B 20 20 10
1378 = 0003
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1380 05AD
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1382 05B0 0A C0
1383 05B2 75 01
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1378                                     PAGE
1379                                     ;----- TYPE 0 ERROR
1380
1381 061E                                     TYPE_0:
1382 061E BB 0605 R                         MOV     BX,OFFSET TYPE0_TABLE
1383 0621 3C 09                             CMP     AL,TYPE0_LEN           ; CHECK IF ERROR IS DEFINED
1384 0623 73 62                             JAE    UNDEF_ERR_L           ; UNDEF_ERR_L
1385 0625 2E1 D7                             XLAT   CS:TYPE0_TABLE         ; TABLE LOOKUP
1386 0627 A2 0074 R                         MOV     DISK_STATUS,AL        ; SET ERROR CODE
1387 062A C3                                 RET
1388
1389                                     ;----- TYPE 1 ERROR
1390
1391 062B                                     TYPE_1:
1392 062B BB 060E R                         MOV     BX,OFFSET TYPE1_TABLE
1393 062E BB C8                             MOV     CX,AX
1394 0630 3C 0A                             CMP     AL,TYPE1_LEN           ; CHECK IF ERROR IS DEFINED
1395 0632 73 53                             JAE    UNDEF_ERR_L           ; UNDEF_ERR_L
1396 0634 2E1 D7                             XLAT   CS:TYPE1_TABLE         ; TABLE LOOKUP
1397 0636 A2 0074 R                         MOV     DISK_STATUS,AL        ; SET ERROR CODE
1398 0639 80 E1 08                         AND    CL,08H                 ; CORRECTED ECC
1399 063C 80 F9 08                         CMP    CL,08H                 ; SET ERROR CODE
1400 063F 75 29                             JNZ    G30
1401
1402                                     ;----- OBTAIN ECC ERROR BURST LENGTH
1403
1404 0641 C6 46 FB 0D                         MOV     CMD_BLOCK+0,RD_ECC_CMD
1405 0645 2A C0                             SUB    AL,AL
1406 0647 E8 057C R                         CALL   COMMAND                 ; ISSUE THE COMMAND
1407 064A 72 1E                             JC     G30
1408 064C B4 0B                             MOV    AH,00001011B           ; SET MASK FOR DATA INPUT CARD TO CPU
1409 064E E8 068D R                         CALL   HD_WAIT                 ; GO WAIT FOR THE INPUT STATE
1410 0651 72 17                             JC     G30
1411 0653 4A                                 DEC    DX
1412 0654 EC                             IN    AL,DX                   ; ADDRESS PORT 0
1413 0655 8A C8                             MOV    CL,AL                   ; READ THE LENGTH OF THE ERROR
1414 0657 B4 0F                             MOV    AH,00001111B           ; CORRECTED AND SAVE IN CL
1415 0659 EB 068D R                         CALL   HD_WAIT                 ; SET MASK FOR STATUS STATE
1416 065C 72 0C                             JC     G30                     ; GO WAIT FOR STATUS STATE
1417 065E 4A                                 DEC    DX                       ; ADDRESS PORT 0
1418 065F EC                             IN    AL,DX                   ; READ THE STATUS BYTE
1419 0660 A8 02                             TEST   AL,2                     ; ERROR BIT SET?
1420 0662 74 06                             JZ     G30
1421 0664 C6 06 0074 R 20                   MOV    DISK_STATUS,BAD_CNTRLR
1422 0669 F9                             MOV    STC
1423 066A
1424 066A 8A C1                             G30: MOV    AL,CL
1425 066C C3                                 RET
1426
1427                                     ;----- TYPE 2 ERROR
1428
1429 066D                                     TYPE_2:
1430 066D BB 0618 R                         MOV     BX,OFFSET TYPE2_TABLE
1431 0670 3C 03                             CMP     AL,TYPE2_LEN           ; CHECK IF ERROR IS DEFINED
1432 0672 73 13                             JAE    UNDEF_ERR_L           ; UNDEF_ERR_L
1433 0674 2E1 D7                             XLAT   CS:TYPE2_TABLE         ; TABLE LOOKUP
1434 0676 A2 0074 R                         MOV     DISK_STATUS,AL        ; SET ERROR CODE
1435 0679 C3                                 RET
1436
1437                                     ;----- TYPE 3 ERROR
1438
1439 067A                                     TYPE_3:
1440 067A BB 061B R                         MOV     BX,OFFSET TYPE3_TABLE
1441 067D 3C 03                             CMP     AL,TYPE3_LEN           ; CHECK IF ERROR IS DEFINED
1442 067F 73 06                             JAE    UNDEF_ERR_L           ; UNDEF_ERR_L
1443 0681 2E1 D7                             XLAT   CS:TYPE3_TABLE         ; TABLE LOOKUP
1444 0683 A2 0074 R                         MOV     DISK_STATUS,AL        ; SET ERROR CODE
1445 0686 C3                                 RET
1446
1447 0687                                     UNDEF_ERR_L:
1448 0687 C6 06 0074 R BB                   MOV    DISK_STATUS,UNDEF_ERR
1449 068C C3                                 RET
1450
1451                                     ;-----
1452                                     ; ON ENTRY AH CONTAINS THE CONTROLLER BUS STATUS DECODE ;
1453                                     ; MASK USED TO CHECK THE HARDWARE STATUS. ;
1454                                     ;-----
1455 068D                                     HD_WAIT PROC NEAR
1456 068D 51                             PUSH   CX                       ; SAVE CX
1457 068E 2B C9                             SUB    CX,CX                     ; SET THE LOOP COUNT
1458 0690
1459 0690 EB 076D R                         L1: CALL   PORT_0
1460 0693 A2                             INC    DX                       ; PORT 1 ADDRESS
1461 0694 EC                             IN    AL,DX                     ; READ THE HARDWARE STATUS
1462 0695 24 0F                             AND    AL,00001111B           ; CLEAR UPPER NIBBLE OF HARDWARE STATUS
1463 0697 3A C4                             CMP    AL,AH                     ; CHECK THE STATE WITH THE MASK
1464 0699 74 08                             JZ     L2                         ; JMP IF O.K WITH CARRY CLEARED
1465 069B E2 F3                             LOOP  L1                         ; TRY AGAIN
1466 069D C6 06 0074 R 80                   MOV    DISK_STATUS,TIME_OUT
1467 06A2 F9                             MOV    STC                       ; SET ERROR CONDITION
1468 06A3
1469 06A3 59                             L2: POP    CX                       ; RESTORE CX
1470 06A4 C3                                 RET
1471 06A5                                     HD_WAIT ENDP
    
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1472 PAGE
1473 -----
1474 : DMA_SETUP :
1475 : THIS ROUTINE SETS UP FOR DMA OPERATIONS. :
1476 : INPUT :
1477 : (AL) = MODE BYTE FOR THE DMA :
1478 : (ES:BX) = ADDRESS TO READ/WRITE THE DATA :
1479 : OUTPUT :
1480 : (AX) DESTROYED :
1481 -----
1482
1483 06A5 DMA_SETUP PROC NEAR
1484 06A5 80 7E FC 81 CMP CMD_BLOCK+4,81H ; BLOCK COUNT OUT OF RANGE
1485 06A9 72 02 JB J1 ;
1486
1487 06AB F9 STC ; SET THE ERROR CONDITION
1488 06AC C3 RET
1489
1490 06AD J1:
1491 06AD FA CLJ ; NO MORE INTERRUPTS
1492 06AE E6 0C OUT DMA+12,AL ; SET THE FIRST/LAST F/F
1493 06B0 B1 04 MOV CL,4 ; SHIFT COUNT
1494 06B2 E6 0B OUT DMA+11,AL ; OUTPUT THE MODE BYTE
1495 06B4 8C C0 MOV AX,ES ; GET THE ES VALUE
1496 06B6 D3 C0 ROL AX,CL ; ROTATE LEFT
1497 06B8 8A E8 MOV CH,AL ; GET HIGHEST NIBBLE OF ES TO CH
1498 06BA 24 F0 AND AL,0FH ; ZERO THE LOW NIBBLE FROM SEGMENT
1499 06BC 03 C3 ADD AX,BX ; TEST FOR CARRY FROM ADDITION
1500 06BE 80 D5 00 ADC CH,0 ; CARRY MEANS HIGH 4 BITS MUST BE INC
1501
1502 06C1 8B F0 MOV SI,AX ; SAVE START ADDRESS
1503 06C3 E6 06 OUT DMA+6,AL ; OUTPUT LOW ADDRESS
1504 06C5 8A C4 MOV AL,AH ;
1505 06C7 E6 06 OUT DMA+6,AL ; OUTPUT HIGH ADDRESS
1506 06C9 8A C5 MOV AL,CH ; GET HIGH 4 BITS
1507 06CB 24 0F AND AL,0FH ;
1508 06CD E6 82 OUT DMA_HIGH,AL ; OUTPUT THE HIGH 4 BITS TO PAGE REG
1509
1510 ;----- DETERMINE COUNT
1511
1512 06CF 8A 66 FC MOV AH,CMD_BLOCK+4 ; RECOVER BLOCK COUNT
1513 06D0 D0 E4 SHL AH,1 ; MULTIPLY BY 512 BYTES PER SECTOR
1514 06D4 32 C0 XOR AL,AL ; CLEAR LOW BYTE
1515 06D6 48 DEC AX ; AND DECREMENT VALUE BY ONE
1516
1517 ;----- HANDLE READ AND WRITE LONG (516D BYTE BLOCKS)
1518
1519 06D7 80 7E F8 E5 CMP CMD_BLOCK+0,RD_LONG_CMD
1520 06DB 74 06 JE ADD4
1521
1522 06DD 80 7E F8 E6 CMP CMD_BLOCK+0,WR_LONG_CMD
1523 06E1 75 0F JNE J20
1524 06E3 ADD4:
1525 06E3 B8 0204 MOV AX,516D ; ONE BLOCK (512) PLUS 4 BYTES ECC
1526 06E6 53 PUSH BX
1527 06E7 2A FF SUB BH,BH
1528 06E9 8A 5E FC MOV BL,CMD_BLOCK+4
1529 06EC 52 PUSH DX
1530 06ED F7 E3 MUL BX ; BLOCK COUNT TIMES 516
1531 06EF 5A POP DX
1532 06F0 5B POP BX
1533 06F1 48 DEC AX ; ADJUST
1534 06F2 J20:
1535 06F2 8B C8 MOV CX,AX ; SAVE COUNT VALUE
1536 06F4 E6 07 OUT DMA+7,AL ; LOW BYTE OF COUNT
1537 06F6 8A C4 MOV AL,AH ;
1538 06F8 E6 07 OUT DMA+7,AL ; HIGH BYTE OF COUNT
1539 06FA FB STI ; INTERRUPTS BACK ON
1540 06FB 8B C6 MOV AX,SI ; RECOVER ADDRESS VALUE
1541 06FD 03 C1 ADD AX,CX ; ADD, TEST FOR 64K OVERFLOW
1542 06FF C3 RET ; RETURN TO CALLER,
1543 ; CY SET BY ABOVE IF ERROR
1544 0700 DMA_SETUP ENDP
    
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1545                                     PAGE
1546                                     :-----:
1547                                     : WAIT_INT :
1548                                     : THIS ROUTINE WAITS FOR THE FIXED DISK :
1549                                     : CONTROLLER TO SIGNAL THAT AN INTERRUPT :
1550                                     : HAS OCCURRED. :
1551                                     :-----:
1552
1553 WAIT_INT PROC NEAR
1554     ASSUME DS:ABS0
1555     STI                                     ; TURN ON INTERRUPTS
1556     MOV DX,07H                             ; SAVE DS
1557     SUB BX,DS
1558     MOV DS,AX
1559     LES SI,HF_TBL_VEC                       ; ESTABLISH SEGMENT
1560                                         ; LOAD THE TABLE VECTOR
1561
1562     ASSUME DS:DATA,ES:NOTHING
1563     MOV DS,BX                               ; RESTORE DS
1564
1565     ;----- SET TIMEOUT VALUES
1566     SUB BH,BH
1567     BL,BYTE PTR ES:[SI][9]                 ; LOAD THE STANDARD TIME OUT
1568     MOV AH,CMD_BLOCK+0
1569     CMP AH,FMTDRV_CMD
1570     JNZ W5
1571
1572     MOV BL,BYTE PTR ES:[SI][0AH]           ; LOAD THE FORMAT DRIVE
1573     JMP SHORT W4                           ; TIME OUT VALUE
1574     W5:  CMP AH,CHK_DRV_CMD
1575         JNZ W4
1576
1577     MOV BL,BYTE PTR ES:[SI][0BH]           ; LOAD THE CHECK DRIVE
1578     CLC CY                                 ; TIME OUT VALUE
1579     MOV AX,9000H
1580     INT 15H                               ; CLEAR CY
1581     STI                                     ; DEVICE WAIT INTERRUPT
1582     SUB CX,CX
1583                                         ; ENABLE INTERRUPTS FOR PC AND
1584                                         ; XT MACHINES.
1585                                         ; SET THE LOOP COUNT
1586
1587     ;----- WAIT FOR INTERRUPT
1588     W1:  CALL PORT_0
1589         INC DX                               ; PORT I ADDRESS
1590         IN AL,DX                             ; READ THE HARDWARE STATUS
1591         TEST AL,020H                         ; DID INTERRUPT OCCUR
1592         JNZ W2                               ; JUMP IF YES
1593
1594         LOOP W1                               ; INNER LOOP
1595         DEC BX
1596         JNZ W1                               ; OUTER LOOP
1597
1598     MOV DISK_STATUS,TIME_OUT
1599     W2:  DEC DX                               ; ADDRESS PORT 0
1600         IN AL,DX                             ; READ THE STATUS BYTE
1601         AND AL,2                             ; ISOLATE THE ERROR BIT
1602         OR DISK_STATUS,AL                   ; SAVE IN THE STATUS
1603         ADD DX,3                             ; PORT_3 ADDRESS
1604         XOR AL,AL                             ; ZERO
1605         OUT DX,AL                           ; RESET INTERRUPT MASK
1606
1607     WAIT_INT ENDP
1608
1609     ;----- HD_INT
1610     HD_INT PROC NEAR
1611     ;-----
1612     ; FIXED DISK INTERRUPT 0DH ROUTINE IRQ-5
1613     ;-----
1614
1615     HD_INT PROC NEAR
1616     PUSH AX                                 ; SAVE WORK REGISTER
1617     MOV AL,07H                             ; SET DMA MODE TO DISABLE
1618     OUT DMA+10,AL
1619     CLI                                     ; NO INTERRUPTS
1620     IN AL,INTA01                            ; LOAD THE INTERRUPT ENABLE MASK
1621     OR AL,020H                              ; TURN OFF FIXED DISK IRQ-5
1622     OUT INTA01,AL                           ; REPLACE THE MASK
1623     MOV AL,E01                              ; LOAD THE END OF INTERRUPT MASK
1624     OUT INTA00,AL                           ; CLEAR THE ACTIVE INTERRUPT LEVEL
1625     STI                                     ; INTERRUPTS BACK ON
1626     MOV AX,9100H                            ; DEVICE POST
1627     INT 15H                                 ; INTERRUPT
1628     POP AX                                  ; RESTORE AX
1629     IRET
1630     HD_INT ENDP
1631
1632     ;-----
1633     ; PORTS
1634     ;-----
1635     ; GENERATE PROPER PORT VALUE
1636     ; BASED ON THE PORT OFFSET
1637     ;-----
1638
1639     PORT_0 PROC NEAR
1640     MOV DX,HF_PORT
1641     ADD DL,PORT_OFF                         ; BASE VALUE
1642     RET                                     ; ADD IN OFFSET VALUE (00,04,08,0C)
1643
1644     PORT_0 ENDP
1645
1646     END ADDRESS LABEL BYTE
1647     CODE ENDS
1648     END
1649
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