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# Section 1. Introduction to BIOS

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**Notes:**

The Basic Input/Output System (BIOS) for IBM Personal System/2 and Personal Computer products is a software interface or "layer" that isolates operating systems and application programs from specific hardware devices. BIOS routines allow assembly-language programmers to perform block- and character-level operations without concern for device addresses or hardware operating characteristics. BIOS also provides system services, such as time-of-day and memory-size determination.

Operating systems and application programs should make functional requests to BIOS instead of directly manipulating I/O ports and control words of the hardware. Hardware design and timing changes then become less critical, and software compatibility across systems and features is enhanced.

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## **Interrupts**

BIOS is accessed through software interrupts; each BIOS entry point is available through its own interrupt. Within each interrupt, the AH register indicates the specific function that is being executed.

The table on the following page lists each interrupt, its function, and whether a detailed description of the interrupt is included in this technical reference manual.

<b>Interrupt Number</b>	<b>Interrupt Function</b>	<b>In This Technical Reference?</b>
00H	Divide by 0	
01H	Single Step	
02H	Nonmaskable Interrupt (NMI)	Yes
03H	Breakpoint	
04H	Overflow	
05H	Print Screen	Yes
06H to 07H	Reserved	
08H	System Timer	Yes
09H	Keyboard	Yes
0AH to 0DH	Reserved	
0EH	Diskette	
0FH	Reserved	
10H	Video	Yes
11H	Equipment Determination	Yes
12H	Memory Size Determination	Yes
13H	Fixed Disk/Diskette	Yes
14H	Asynchronous Communication	Yes
15H	System Services	Yes
16H	Keyboard	Yes
17H	Printer	Yes
18H	Resident BASIC	
19H	Bootstrap Loader	Yes
1AH	System-Timer and Real-Time Clock Services	Yes
1BH	Keyboard Break	
1CH	User Timer Tick	
1DH	Video Parameters	
1EH	Diskette Parameters	
1FH	Video Graphics Characters	
20H to 3FH	Diskette BIOS Revector	
41H	Fixed Disk Parameters	
42H to 45H	Reserved	
46H	Fixed Disk Parameters	
47H to 49H	Reserved	
4AH	User Alarm	
4BH	Advanced Services	Yes
4CH to 5FH	Reserved	
60H to 67H	Reserved for User-Program Interrupts	
68H to 6FH	Reserved	
70H	Real-Time Clock	Yes
71H to 74H	Reserved	
75H	Redirect to NMI	
76H to 7FH	Reserved	
80H to 85H	Reserved	
86H to F0H	Used by BASIC Interpreter When Running BASIC	
F1H to FFH	Reserved for User-Program Interrupts	

*Figure 1-1. Interrupts*

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## Parameter Passing

All parameters that are passed to and from the BIOS routines go through the microprocessor registers. Each BIOS interrupt routine indicates which registers are used on the call and on the return. In general, if a BIOS routine has several possible functions, (AH) is used to select the desired function. For example, to set the time, the following code is required:

```
MOV AH,1           ;Function is to set time of day.
MOV CX,HIGH_COUNT ;Establish the current time.
MOV DX,LOW_COUNT  ;
INT 1AH           ;Set the time.
```

To read the time, the following code is required:

```
MOV AH,0           ;Function is to read time of day.
INT 1AH           ;Read the timer.
```

| The BIOS interrupt handlers save all registers (including the extended portion) except (AX), the flags, and registers that return values to the caller. In some cases, other registers are modified. See the “Interrupts” section for additional information.

All parameters are 1-based (that is, the count starts with 1, not with 0), unless they are noted as 0-based.

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## Data Areas and ROM Tables

Data areas are the memory locations that are allocated specifically to system BIOS and adapter BIOS to be used as work areas. Read-only memory (ROM) tables are used by BIOS to define the characteristics of hardware devices that are supported by a particular system BIOS or adapter BIOS.

See the “Data Areas” section and the “ROM Tables” section for additional information.

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## BIOS-Level Determination

BIOS is contained in ROM modules on the system boards of Personal System/2 and Personal Computer products. It is also contained in ROM modules on some optional features (usually adapters) to provide device-level control of the features.

BIOS has been amended several times since it was first developed. All BIOS versions are dated. In this technical reference, BIOS-version dates are used when necessary to indicate interface differences in similar systems.

To determine the BIOS-version date of a system, run the following BASIC program. The date that is displayed is the version date of BIOS for that system.

```
10 DEF SEG=&HF000
20 FOR X=&HFFF5 TO &HFFFC
30 PRINT CHR$(PEEK(X));
40 NEXT
RUN
```

See “System Identification” in the “Additional Information” section for a list of IBM products and their BIOS-version dates. To access this information, see Interrupt 15H, Return System Configuration Parameters function ((AH) = C0H).

---

## System Groups

In this technical reference, IBM systems are categorized into groups of systems that have similar BIOS interfaces. When these groups are referred to, any exceptions are noted. These groups include:

- Personal System/2 products, all models
- Personal Computer XT\* products, including the Portable Personal Computer.
- Personal Computer AT\* products, all models.

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\* Personal Computer XT and Personal Computer AT are trademarks of the International Business Machines Corporation.

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## **Section 2. Interrupts**

**Notes:**

## Interrupt 02H—Nonmaskable Interrupt (NMI)

The nonmaskable interrupt (NMI) handler is used to process severe errors. In most cases, the fault is in the hardware, but it is also possible for a software error to force an NMI to occur.

When an NMI occurs, the interrupt handler displays the error code that is associated with the error and halts the processor. The error codes are as follows.

Value	Description
Parity check 1	System-board memory failure
Parity check 2	I/O-channel parity error
110	System-board memory failure
111	Channel check activated (assumes channel memory)
112	Watchdog time-out
113	Direct memory access (DMA) bus time-out
210	System-board memory failure
211	Channel check activated (assumes channel memory)
00021000	System-board memory failure
000210xy	System-board memory failure in memory module x, which is of type y
00021100	Channel check activated (assumes channel memory)
000211x0	Channel check activated in slot x
0xxx1200	Watchdog time-out xxx = 129 - Processor card = 001 - System board
0xxx1300	Direct memory access (DMA) bus time-out xxx = 129 - Processor card = 001 - System board
01290400	Level 2 cache memory failure

**Note:** Not all codes apply to every system.

Figure 2-1. Nonmaskable Interrupt Error Codes

When a system-board memory failure (parity error) occurs, the NMI handler attempts to find the storage location that contains the bad parity. If the location is found, the segment address is displayed. If no parity error is found, "?????" appears in place of the address, indicating an intermittent read problem. When performing this test, the NMI handler does not check memory above 640KB, so it is possible for a recurring problem to exist that the NMI handler cannot find. Some of the Personal System/2 Model 90 and 95 systems display the socket number of the memory module that contains the error, and they display the type of the memory module.

| When a channel check occurs, the NMI handler assumes that the  
| error was caused by an error in a channel adapter card. The  
| Personal System/2 Model 90 and 95 systems attempt to determine  
| which card caused the error and display the slot number along with  
| the error code.

When the watchdog timer is enabled and a timer interrupt (IRQ 0) is missing, the system generates an NMI.

When a DMA-driven device uses the bus longer than the allowable time period (7.8 microseconds) after it is preempted by another device, the central arbitration control point generates an NMI.

When an NMI occurs, the central arbitration control point is implicitly disabled. The NMI handler explicitly reenables the central arbitration control point by writing hex 0 to port hex 90.

A system that has a math coprocessor must direct math coprocessor errors to this interrupt. An 8087 math coprocessor error on 8088- or 8086-based systems drives the NMI of the 8088 or 8086, respectively. An 80287 or 80387 math coprocessor error on 80286-, 80386-, and 80486-based systems drives the IRQ 13 line. The IRQ 13 interrupt handler issues a software Interrupt 02H to be compatible with software that expects the NMI to occur. For all systems, the math coprocessor application that points the NMI vector to itself must be sensitive to NMI errors. If an NMI occurs because of an NMI error, control should be transferred to the system NMI handler.

**Notes:**

1. For PCjr\*, the NMI is attached to the keyboard interrupt.
2. For PC Convertible, the NMI is attached to the keyboard, the diskette, the real-time clock, and the system-suspend interrupts. The NMI is activated by an I/O channel check.

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\* PCjr is a trademark of the International Business Machines Corporation.

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## Interrupt 05H—Print Screen

This interrupt handler prints the screen to printer port 0. When Interrupt 05H is invoked, the cursor position is saved and is restored when the interrupt is completed. Interrupt 05H runs with interrupts enabled; however, additional print-screen requests are ignored when a print-screen operation is already in progress. An initial status error from the printer ends the print-screen request. The byte at address hex 50:00 contains the status of the print-screen operation.

The following figure lists the status indications for the print-screen status byte (address hex 50:00).

Value	Description
00H	Print screen not called or, on return, operation successfully completed
01H	Print screen in progress, ignore request
FFH	Error encountered during printing

*Figure 2-2. Print Screen Status*

For PC Convertible, an initial status error ends the print-screen request and also sounds a "beep." The Ctrl-Break sequence ends the print-screen operation.

**Notes:**

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## Interrupt 08H—System Timer

This interrupt handler services the timer interrupt from channel 0 of the system timer. This interrupt occurs approximately 18.2 times per second.

The interrupt handler:

- Maintains a count of interrupts at data area address hex 40:6C (timer counter) since power-on that can be used to establish the time of day. After 24 hours of operation, address hex 40:70 (timer overflow) is increased (made nonzero). When the time counter crosses a day boundary, address hex 40:CE (day counter) is increased.
- Decreases the value at address hex 40:40 (motor-off counter of the diskette drive) and, when the count reaches 0, turns the diskette-drive motor off and resets the motor-running flags in address hex 40:3F (motor status).
- Issues a software Interrupt 1CH.

For PC Convertible, this interrupt handler calls a user routine through software Interrupt 4AH when an alarm interrupt occurs.

**Notes:**

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## Interrupt 09H—Keyboard

This interrupt handler is issued on the make or break of every keystroke.

For ASCII keys, when a make code is read from port hex 60, the character code and scan code are put into the 32-byte keyboard buffer that begins at address hex 40:1E in the BIOS data area, at the address pointed to by the keyboard-buffer tail pointer (hex 40:1C). The keyboard-buffer tail pointer is then increased by 2, unless it extends past the end of the buffer. In this case, it is reinitialized to the start of the buffer.

For every Ctrl, Alt, or Shift key make or break, BIOS data area addresses hex 40:17 and hex 40:18 (keyboard control) and hex 40:96 (keyboard flags) are updated.

The Ctrl-Alt-Delete sequence causes the interrupt handler to set the reset flag (hex 40:72) to hex 1234 (bypass memory test) then jump to the power-on self-test (POST). POST checks the reset flag (hex 40:72); if the reset flag is set to hex 1234, POST does not retest the memory. For the PC Convertible, a processor reset is performed instead of a jump to POST, causing POST to be executed.

Pressing the Pause key causes the interrupt handler to loop until a valid ASCII keystroke occurs. The PC Convertible issues Interrupt 15H, Wait for External Event function ((AH) = 41H) to wait for a valid ASCII keystroke.

Pressing the Print Screen key causes Interrupt 05H (Print Screen) to be issued.

The Ctrl-Break sequence causes Interrupt 1BH (Keyboard Break) to be issued.

For PC/XT<sup>\*</sup> BIOS dated 1/10/86 and later, AT<sup>\*</sup>, PC/XT Model 286, PC Convertible, and Personal System/2 products, pressing the SysRq key causes the interrupt handler to issue Interrupt 15H, System Request Key Pressed function ((AH) = 85H) to inform the system of a SysRq key make or break operation. Also, the keyboard interrupt issues

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\* PC/XT and AT are trademarks of the International Business Machines Corporation.

Interrupt 15H, Interrupt Complete function ((AH) = 91H) with (AL) = 02H (Type = Keyboard) to indicate that a keystroke is available.

For AT BIOS dated 6/10/85 and later, PC/XT Model 286, PC Convertible, and Personal System/2 products, Interrupt 15H, Keyboard Intercept function ((AH) = 4FH) is issued after the scan code is read from port hex 60. This allows the system to replace or absorb the scan code. An End of Interrupt (EOI) instruction is processed by the Interrupt 09H handler after control is returned from the keyboard intercept handler.

| For Personal System/2 Model 56, Model 57, Model 90, and Model 95,  
| the following procedure causes the system to be booted from the  
| system partition on the fixed disk:

- | 1. Perform a Ctrl-Alt-Delete sequence.
- | 2. Wait for the cursor to appear in the upper-right corner of the  
| display.
- | 3. Perform a Ctrl-Alt-Insert sequence.

---

## Interrupt 10H—Video

The following is a summary of the video functions of Interrupt 10H.

(AH) = 00H	— Set Mode
(AH) = 01H	— Set Cursor Type
(AH) = 02H	— Set Cursor Position
(AH) = 03H	— Read Cursor Position
(AH) = 04H	— Read Light-Pen Position
(AH) = 05H	— Select Active Display Page
(AH) = 06H	— Scroll Active Page Up
(AH) = 07H	— Scroll Active Page Down
(AH) = 08H	— Read Attribute/Character at Current Cursor Position
(AH) = 09H	— Write Attribute/Character at Current Cursor Position
(AH) = 0AH	— Write Character at Current Cursor Position
(AH) = 0BH	— Set Color Palette
(AH) = 0CH	— Write Dot
(AH) = 0DH	— Read Dot
(AH) = 0EH	— Write Teletype to Active Page
(AH) = 0FH	— Read Current Video State
(AH) = 10H	— Set Palette Registers
(AH) = 11H	— Character Generator
(AH) = 12H	— Alternative Selection
(AH) = 13H	— Write String
(AH) = 14H	— Load LCD Character Font/Set LCD High-Intensity Substitute
(AH) = 15H	— Return Physical-Display Parameters for Active Display
(AH) = 16H to 19H	— Reserved
(AH) = 1AH	— Read/Write Display-Combination Code
(AH) = 1BH	— Return Functionality/State Information
(AH) = 1CH	— Save/Restore Video State
(AH) = 1DH to FFH	— Reserved

Figure 2-3. INT 10H Video Functions

**Note:** All reserved input fields must be set to 0.

## (AH) = 00H—Set Mode

(AL) - Requested video mode

The following table lists the supported video modes.

Mode (Hex)	Type	Maximum Colors	Alphanumeric Format	Buffer Start
0, 1	A/N	16	40x25	B8000H
2, 3	A/N	16	80x25	B8000H
4, 5	APA	4	40x25	B8000H
6	APA	2	80x25	B8000H
7	A/N	Monochrome	80x25	B0000H
8	APA	16	20x25	B0000H
9	APA	16	40x25	B0000H
A	APA	4	80x25	B0000H
B, C	Reserved			
D	APA	16	40x25	A0000H
E	APA	16	80x25	A0000H
F	APA	Monochrome	80x25	A0000H
10	APA	16	80x25	A0000H
11	APA	2	80x30	A0000H
12	APA	16	80x30	A0000H
13	APA	256	40x25	A0000H
14	A/N	16	132x25	B8000H

APA = All points addressable (graphics)  
A/N = Alphanumeric (text)

Figure 2-4. Video Modes

The following table lists the characteristics of each video subsystem for each of the video modes.

<b>Mode (Hex)</b>	<b>Display Size</b>	<b>Box Size</b>	<b>Supporting IBM Products</b>	<b>Maximum Pages</b>
0, 1	320x200	8x8	PCjr, Color/Graphics Monitor Adapter (CGA), Enhanced Graphics Adapter (EGA), PC Convertible, and Personal System/2 products except Model 25 and Model 30	8
	320x350	8x14	EGA and Personal System/2 products except Model 25 and Model 30	8
	320x400	8x16	Personal System/2 Model 25 and Model 30	8
	360x400	9x16	Personal System/2 products except Model 25 and Model 30	8
2, 3	640x200	8x8	PCjr, CGA, and PC Convertible	4
	640x200	8x8	EGA and Personal System/2 products except Model 25 and Model 30	8
	640x350	8x14	EGA and Personal System/2 products except Model 25 and Model 30	8
	640x400	8x16	Personal System/2 Model 25 and Model 30	8
	720x400	9x16	Personal System/2 products except Model 25 and Model 30	8
4, 5	320x200	8x8	PCjr, CGA, EGA, and Personal System/2 products	1
6	640x200	8x8	PCjr, CGA, EGA, and Personal System/2 products	1
7	720x350	9x14	Monochrome Display and Printer Adapter (MDPA) and PC Convertible	1
	720x350	9x14	EGA and Personal System/2 products except Model 25 and Model 30	8
	720x400	9x16	Personal System/2 products except Model 25 and Model 30	8
	640x200	8x8	PC Convertible	4
8	160x200	8x8	PCjr	1
9	320x200	8x8	PCjr	1
A	640x200	8x8	PCjr	1
B, C	Reserved			

Figure 2-5 (Part 1 of 2). Video Mode Characteristics

Mode (Hex)	Display Size	Box Size	Supporting IBM Products	Maximum Pages
D	320x200	8x8	EGA and Personal System/2 products except Model 25 and Model 30	8
E	640x200	8x8	EGA and Personal System/2 products except Model 25 and Model 30	4
F, 10	640x350	8x14	EGA and Personal System/2 products except Model 25 and Model 30	2
11	640x480	8x16	Personal System/2 products	1
12	640x480	8x16	Personal System/2 products except Model 25 and Model 30	1
13	320x200	8x8	Personal System/2 products	1
14	1056x200	8x8	Personal System/2 Model 90 and Model 95 with IML update, Model 35 LS, Model 35 SX, Model 40 SX, and Model 57 SX	4
	1056x350	8x14	Personal System/2 Model 90 and Model 95 with IML update, Model 35 LS, Model 35 SX, Model 40 SX, and Model 57 SX	4
	1056x400	8x16	Personal System/2 Model 90 and Model 95 with IML update, Model 35 LS, Model 35 SX, Model 40 SX, and Model 57 SX	4

Figure 2-5 (Part 2 of 2). Video Mode Characteristics

**Notes:**

1. For PCjr and IBM Color/Graphics Monitor Adapter (CGA):
  - The cursor is not displayed in graphics (APA) modes.
  - Modes 0, 2, and 5 are identical to modes 1, 3, and 4, except that color burst is not enabled. Color-burst-on enables color information on composite displays; color-burst-off disables it. RGB displays are not affected by the state of color burst.
  - For PCjr during mode setting, if bit 7 of (AL) is set to 1, the video buffer is not cleared.
2. For IBM Enhanced Graphics Adapter (EGA):
  - The cursor is not displayed in graphics (APA) modes.
  - Modes 0, 2, and 5 are identical to modes 1, 3, and 4, except that color burst is not enabled. Color-burst-on enables color information on composite displays; color-burst-off disables it. RGB displays are not affected by the state of color burst.
  - The power-on default mode is determined by switch settings on the adapter.

- During mode setting, if bit 7 of (AL) is set to 1, the video buffer is not cleared.

See BIOS data area address hex 40:A8 in "BIOS Data Areas" for save-pointer dynamic overrides.

3. For PC Convertible:

- The cursor is not displayed in graphics (APA) modes.
- Modes 0, 2, and 5 are identical to modes 1, 3, and 4, except that color burst is not enabled. Color-burst-on enables color information on composite displays; color-burst-off disables it. RGB displays are not affected by the state of color burst.
- The power-on default mode for the color/graphics mode is 2.
- The power-on default mode for the monochrome mode is 7.
- During mode setting, if bit 7 of (AL) is set to 1, the video buffer is not cleared.
- Mode 7 (640x200) is used for a liquid crystal display (LCD) as monochrome.
- Mode 7 (720x350) is used for a monochrome display.

4. For Personal System/2 Model 25 and Model 30:

- The cursor is not displayed in graphics (APA) modes.
- Modes 0, 2, and 5 are identical to modes 1, 3, and 4.
- The power-on default mode is 3.
- During mode setting, if bit 7 of (AL) is set to 1, the video buffer is not cleared.
- In all modes except mode hex 13, the first 16 color registers are initialized, and the values in the remaining 240 color registers are undefined.
- In mode hex 13, 248 color registers are loaded.

5. For Personal System/2 products except Model 25 and Model 30:

- The cursor is not displayed in graphics (APA) modes.
- Modes 0, 2, and 5 are identical to modes 1, 3, and 4.
- When a color display is attached, the power-on default mode is 3. When a monochrome display is attached, the power-on default mode is 7.
- During mode setting, if bit 7 of (AL) is set to 1, the video buffer is not cleared.
- In all modes except mode hex 13, the first 64 color registers are initialized, and the values in the remaining 192 color registers are undefined.
- Refer to (AH) = 12H, (BL) = 30H on page 2-IN10-22 to select scan lines (200, 350, or 400) for alphanumeric modes.

See BIOS data area address hex 40:A8 in "BIOS Data Areas" for save-pointer dynamic overrides.

### **(AH) = 01H—Set Cursor Type**

- (CH) - Top line for cursor (bits 4 to 0)  
(Hardware causes blinking cursor;  
setting bit 6 or 5 causes erratic  
blinking or no cursor.)
- (CL) - Bottom line for cursor (bits 4 to 0)

#### **Notes:**

1. BIOS maintains only one cursor type for all video pages.
2. For Personal System/2 Model 25 and Model 30, before the hardware video ports are written to, (CH) is multiplied by 2, and (CL) is multiplied by 2 and increased by 1.

### **(AH) = 02H—Set Cursor Position**

- (BH) - Page number (0 based); see Figure 2-5 on page 2-IN10-3 for maximum pages
- (DH,DL) - Row, column (0,0 is upper left)

### **(AH) = 03H—Read Cursor Position**

- (BH) - Page number (0 based); see Figure 2-5 on page 2-IN10-3 for maximum pages

On Return:

- (CH,CL) - Cursor type currently set
- (DH,DL) - Row, column of current cursor for requested page

### **(AH) = 04H—Read Light-Pen Position**

For PC Convertible and Personal System/2 products, this function is not supported:

On Return:

- (AH) = 00H - Light pen is not supported
- (BX), (CX), and (DX) are altered on return.

For all others:

On Return:

- (AH) = 00H - Light-pen switch not activated
- (BX), (CX), and (DX) are altered on return.

(AH) = 01H - Valid light-pen value in registers  
(BX) - Pel column (from 0 to 319 639)  
(CH) - Raster line (from 0 to 199)  
(CX) - Raster line (from 0 to *nnn*), new graphics modes  
(DH,DL) - Row, column of character

### **(AH) = 05H—Select Active Display Page**

For PCjr:

(AL) = 80H - Read microprocessor- and display-page registers

(AL) = 81H - Set microprocessor-page register  
(BL) - Microprocessor-page register

(AL) = 82H - Set display-page register  
(BH) - Display-page register

(AL) = 83H - Set microprocessor- and display-page registers  
(BH) - Display-page register  
(BL) - Microprocessor-page register

On Return:

(BH) - Display-page register  
(BL) - Microprocessor-page register

For all others:

(AL) - New page number (0 based); see Figure 2-5 on page 2-IN10-3 for maximum pages

### **(AH) = 06H—Scroll Active Page Up**

(AL) - Number of lines to be blanked at bottom of window  
= 00H - Blank entire window

(BH) - Attribute to be used on blank line

(CH,CL) - Row, column of upper-left corner of scroll  
(DH,DL) - Row, column of lower-right corner of scroll

### **(AH) = 07H—Scroll Active Page Down**

(AL) - Number of input lines to be blanked at top of window  
= 00H - Blank entire window

(BH) - Attribute to be used on blank line

(CH,CL) - Row, column of upper-left corner of scroll  
(DH,DL) - Row, column of lower-right corner of scroll

## **(AH) = 08H—Read Attribute/Character at Current Cursor Position**

(BH) - Page number (0 based); see Figure 2-5 on page 2-IN10-3 for maximum pages

On Return:

(AH) - Attribute of character that was read (alphanumeric modes only)

(AL) - Character that was read

## **(AH) = 09H—Write Attribute/Character at Current Cursor Position**

For the read- and write-character interface in graphics modes 4, 5, and 6, the characters are formed from a character generator that is maintained in the system ROM, which contains only the first 128 characters. To read or write the second 128 characters, initialize the pointer at interrupt vector hex 1F (address hex 0007C) to point to the 1KB table that contains the code points for the second 128 characters (128 to 255).

In all other graphics modes, 256 graphics characters are supplied in the system ROM.

For the write-character interface in graphics mode, the character count that is contained in (CX) produces valid results for characters in the same row only. Continuation to succeeding rows produces invalid results.

(AL) - Character to be written

(BH) - Page number (0 based); see Figure 2-5 on page 2-IN10-3 for maximum pages

(BL) - Attribute of character (alphanumeric) or color of character (graphics)

(CX) - Count of characters to be written

### **Notes:**

1. The Write Attribute/Character function ((AH) = 09H) and the Write Character function ((AH) = 0AH) are similar. Use the Write Attribute/Character function ((AH) = 09H) for graphics modes.
2. In graphics modes, if bit 7 of (BL) is set to 1, the color value is exclusively ORed with the current video memory (except in mode hex 13).
3. In mode hex 13, the value that is passed in (BH) is used as the background color.

## **(AH) = 0AH—Write Character at Current Cursor Position**

(AL) - Character to be written

(BH) - Page number (0 based); see Figure 2-5 on page 2-IN10-3 for maximum pages

(CX) - Count of characters to be written

Use the Write Attribute/Character function ((AH) = 09H) for graphics modes.

## **(AH) = 0BH—Set Color Palette**

(BH) - Color ID being set (from 0 to 1)

(BL) - Color value to be used with color ID

(BH) = 00H - For 320x200 graphics modes, set background color

- For alphanumeric modes, set border color

- For 640x200 graphics modes, set foreground color

(BL) = from 0 to 31

(BH) = 01H - Select palette for 320x200 graphics modes

(BL) = 0 - Green (1)/red (2)/brown (3)

= 1 - Cyan (1)/magenta (2)/white (3)

### **Notes:**

1. This interface has meaning for 320x200 graphics modes only.
2. In 40x25 or 80x25 alphanumeric modes, the value that is set for palette color 0 indicates which border color is to be used (0 to 31); values 16 to 31 indicate the high-intensity background set.
3. For EGA and Personal System/2 products, when the 640x200 graphics mode is active and the color ID is 0, the background color is set.

## **(AH) = 0CH—Write Dot**

(AL) - Color value

(CX) - Column number

(DX) - Row number

**Note:** If bit 7 of (AL) is set to 1, the color value is exclusively ORed with the current contents of the dot (except in mode hex 13).

In graphics modes that support more than one page:

(BH) - Page number (0 based); see Figure 2-5 on page 2-IN10-3 for maximum pages

## **(AH) = 0DH—Read Dot**

(CX) - Column number

(DX) - Row number

In graphics modes that support more than one page:

(BH) - Page number (0 based); see Figure 2-5 on page 2-IN10-3 for maximum pages

On Return:

(AL) - Dot that was read

## **(AH) = 0EH—Write Teletype to Active Page**

(AL) - Character to be written

(BL) - Foreground color in graphics mode

### **Notes:**

1. The mode that is currently set controls the screen width.
2. Carriage Return, Line Feed, Backspace, and Bell are treated as commands, not as printable characters.
3. For PC BIOS dated 4/24/81 and 10/19/81, (BH) must be set to the active page.

## **(AH) = 0FH—Read Current Video State**

On Return:

(AH) - Number of character columns on screen

(AL) - Mode that is currently set

(see (AH) = 00H on page 2-IN10-2 for explanation)

(BH) - Current active page number (0 based); see

Figure 2-5 on page 2-IN10-3 for maximum pages

## **(AH) = 10H—Set Palette Registers**

For PCjr, systems with EGA capability, and Personal System/2 products except Model 25 and Model 30:

(AL) = 00H - Set individual palette register

(BH) - Value to be set

(BL) - Palette register to be set

(AL) = 01H - Set overscan register

(BH) - Value to be set

(AL) = 02H - Set all palette registers and overscan  
(ES:DX) - Pointer to 17-byte table  
Byte 16 - Overscan value  
Bytes 15 to 0 - Palette values

(AL) = 03H - Toggle intensify/blinking bit  
(BL) = 00H - Enable intensify  
= 01H - Enable blinking

## For Personal System/2 products except Model 25 and Model 30:

(AL) = 04H to 06H - Reserved

(AL) = 07H - Read individual palette register  
(BL) - Palette register to be read (from 0 to 15)

On Return:  
(BH) - Value that was read

(AL) = 08H - Read overscan register

On Return:  
(BH) - Value that was read

(AL) = 09H - Read all palette registers and overscan  
(ES:DX) - Pointer to 17-byte buffer for return values

On Return:  
(ES:DX) - Pointer to 17-byte table destination  
Byte 16 - Overscan value  
Bytes 15 to 0 - Palette values

(AL) = 10H - Set individual color register  
(BX) - Color register to be set  
(CH) - Green value to be set  
(CL) - Blue value to be set  
(DH) - Red value to be set

(AL) = 11H - Reserved

(AL) = 12H - Set block of color registers  
(BX) - First color register to be set  
(CX) - Number of color registers to be set  
(ES:DX) - Pointer to table of color values  
(Table format: red, green, blue, red, green, blue)

(AL) = 13H - Select color page (not valid for mode hex 13)  
(BH) - Paging mode  
= 00H - Selects 4 register blocks of 64 registers  
= 01H - Selects 16 register blocks of 16 registers  
(BL) = 00H - Select paging mode

(BH) - Page number (0 based); see Figure 2-5 on page 2-IN10-3  
for maximum pages

For 64-register block mode:

- = 00H - Selects first block of 64 color registers
- = 01H - Selects second block of 64 color registers
- = 02H - Selects third block of 64 color registers
- = 03H - Selects fourth block of 64 color registers

For 16-register block mode:

- = 00H - Selects first block of 16 color registers
- = 01H - Selects second block of 16 color registers

.  
.  
.

= 0FH - Selects 16th block of 16 color registers

(BL) = 01H - Select page

**Note:** The Set Mode function ((AH)=00H) defaults to the 64-register block mode, with the first block of 64 color registers active. Only these 64 color registers are initialized during mode setting. When using page selection, initialize the other blocks of the color registers.

(AL) = 14H - Reserved

(AL) = 15H - Read individual color register

(BX) - Color register to be read

On Return:

(CH) - Green value that was read

(CL) - Blue value that was read

(DH) - Red value that was read

(AL) = 16H - Reserved

(AL) = 17H - Read block of color registers

(BX) - First color register to be read

(CX) - Number of color registers to be read

(ES:DX) - Pointer to destination table for values

(Table format: red, green, blue, red, green, blue)

On Return:

(ES:DX) - Pointer to table of values

(AL) = 18H to 19H - Reserved

(AL) = 1AH - Read color-page state

On Return:

(BH) - Current page

(BL) - Current paging mode

**Note:** See (AL) = 13H on page 2-IN10-11 for paging modes and page information.

(AL) = 1BH - Sum color values to gray shades  
(BX) - First color register to be summed  
(CX) - Number of color registers to be summed

**Note:** This call reads the red, green, and blue values that are found in the color registers, performs a weighted sum (30% red + 59% green + 11% blue), then writes the result into each red, green, and blue component of the color register (the original data is not retained).

For Personal System/2 Model 25 and Model 30:

(AL) = 00H  
(BX) = 0712H - Color registers to be set, resulting  
in 8 consistent colors

(AL) = 01H to 02H - Reserved

(AL) = 03H - Toggle intensify/blinking bit  
(BL) = 00H - Enable intensify  
= 01H - Enable blinking

(AL) = 04H to 07H - Reserved

(AL) = 10H - Set individual color register  
(BX) - Color register to be set  
(CH) - Green value to be set  
(CL) - Blue value to be set  
(DH) - Red value to be set

(AL) = 11H - Reserved

(AL) = 12H - Set block of color registers  
(BX) - First color register to be set  
(CX) - Number of color registers to be set  
(ES:DX) - Pointer to table of color values  
(Table format: red, green, blue, red, green, blue)

(AL) = 13H to 14H - Reserved

(AL) = 15H - Read individual color register  
(BX) - Color register to be read

On Return:  
(CH) - Green value that was read  
(CL) - Blue value that was read  
(DH) - Red value that was read

(AL) = 16H - Reserved

(AL) = 17H - Read a block of color registers  
(BX) - First color register to be read  
(CX) - Number of color registers to be read  
(ES:DX) - Pointer to destination table for values  
(Table format: red, green, blue, red, green, blue)

On Return:  
(ES:DX) - Pointer to table of values

(AL) = 18H to 1AH - Reserved

(AL) = 1BH - Sum color values to gray shades  
(BX) - First color register to be summed  
(CX) - Number of color registers to be summed

**Note:** This call reads the red, green, and blue values that are found in the color registers, performs a weighted sum (30% red + 59% green + 11% blue), then writes the result into each red, green, and blue component of the color register (the original data is not retained).

For all others, no action is performed.

## **(AH) = 11H—Character Generator**

For systems with EGA capability, this call initiates a mode setting that completely resets the video environment but maintains the regenerative buffer.

(AL) = 00H - User alphanumeric load  
(BH) - Number of bytes per character  
(BL) - Block to be loaded  
(CX) - Count to be stored  
(DX) - Character offset into table  
(ES:BP) - Pointer to user table

(AL) = 01H - ROM monochrome set  
(BL) - Block to be loaded

(AL) = 02H - ROM 8x8 double dot  
(BL) - Block to be loaded

(AL) = 03H - Set block specifier (valid in alphanumeric modes)  
(BL) - Character-generator block selection  
If bit 3 of the character-attribute byte is set to 0,  
bits 1 and 0 of (BL) select a block from 0 to 3.  
If bit 3 of the character-attribute byte is set to 1,  
bits 3 and 2 of (BL) select a block from 0 to 3.

For example:

- To set a 256-character set using block 3, set (BL) to hex 0F; this selects a single block. Bit 3 of the character-attribute byte turns the foreground intensity on or off.
- To specify a 512-character set using blocks 0 and 3, set (BL) to hex 0C; this selects block 0 when bit 3 of the character-attribute byte is set to 0, and it selects block 3 when bit 3 of the character-attribute byte is set to 1.

If bits 1 and 0 and bits 3 and 2 are the same, only one block is selected, and bit 3 of the character-attribute byte turns the foreground intensity on or off.

When the 512-character set is active, a function call with (AX) set to hex 1000 and (BX) set to hex 0712 is recommended to set the color registers with eight consistent colors.

Register values (AL) = 10H, 11H, and 12H are similar to register values (AL) = 00H, 01H, and 02H, respectively, with the following exceptions:

- Page 0 must be active.
- Points (bytes per character) are recalculated.
- Rows are calculated as follows:

$$\text{INT} [(200 \text{ or } 350) / \text{points}] - 1$$

- The length of the regenerative buffer is calculated as follows:

$$(\text{Number of rows on screen}) \times (\text{Number of columns on screen}) \times 2$$

- The display controller registers are reprogrammed as follows:

Maximum scan line	Points - 1
Cursor start	Points - 2
Cursor end	Points - 1
Vertical display end	$[(\text{Number of rows on screen}) \times \text{Points}] - 1$
Underline location (mode hex 7 only)	Points - 1

- Register calculations must be close to the original table values, or the results might be unpredictable.

- (AL) = 10H - User alphanumeric load
- (BH) - Number of bytes per character
- (BL) - Block to be loaded
- (CX) - Count to be stored
- (DX) - Character offset into table
- (ES:BP) - Pointer to user table
  
- (AL) = 11H - ROM monochrome set
- (BL) - Block to be loaded
  
- (AL) = 12H - ROM 8x8 double dot
- (BL) - Block to be loaded
  
- (AL) = 20H - Set user-graphics-characters pointer at Interrupt 1FH
- (ES:BP) - Pointer to user table
  
- (AL) = 21H - Set user-graphics-characters pointer at Interrupt 43H
- (BL) - Row specifier
  - = 00H - User
- (CX) - Points (bytes per character)
- (DL) - Rows
  - = 01H - 14 (0EH)
  - = 02H - 25 (19H)
  - = 03H - 43 (2BH)
- (ES:BP) - Pointer to user table
  
- (AL) = 22H - ROM 8x14 set
- (BL) - Row specifier
  
- (AL) = 23H - ROM 8x8 double dot
- (BL) - Row specifier

**Note:** (AL) = 10H, 11H, 12H, 20H, 21H, 22H, or 23H should be called only immediately after a mode setting is issued, or the results might be unpredictable.

- (AL) = 30H - Information
- (BH) - Font pointer
  - = 00H - Return current Interrupt 1FH pointer
  - = 01H - Return current Interrupt 44H pointer
  - = 02H - Return ROM 8x14 font pointer
  - = 03H - Return ROM double-dot pointer
  - = 04H - Return ROM double-dot pointer (top)
  - = 05H - Return ROM alphanumeric alternative 9x14

On Return:

- (CX) - Points
- (DL) - Rows
- (ES:BP) - Pointer to table

**For Personal System/2 products except Model 25 and Model 30:**

(AL) = 00H - User alphanumeric load  
(BH) - Number of bytes per character  
(BL) - Block to be loaded  
(CX) - Count to be stored  
(DX) - Character offset into table  
(ES:BP) - Pointer to user table

(AL) = 01H - ROM 8x14 font  
(BL) - Block to be loaded

(AL) = 02H - ROM 8x8 double-dot font  
(BL) - Block to be loaded

(AL) = 03H - Set block specifier (valid in alphanumeric modes)  
(BL) - Character-generator block selection  
If bit 3 of the character-attribute byte is set to 0,  
bits 4, 1, and 0 of (BL) select a block from 0 to 7.  
If bit 3 of the character-attribute byte is set to 1,  
bits 5, 3, and 2 of (BL) select a block from 0 to 7.

**For example:**

- To set a 256-character set using block 6, set (BL) to hex 03A; this selects a single block. Bit 3 of the character-attribute byte turns the foreground intensity on or off.
- To specify a 512-character set using blocks 0 and 6, set (BL) to hex 028; this selects block 0 when bit 3 of the character-attribute byte is set to 0, and it selects block 6 when bit 3 of the character-attribute byte is set to 1.

If bits 4, 1, and 0 and bits 5, 3, and 2 are the same, only one block is selected, and bit 3 of the character-attribute byte turns foreground intensity on or off.

When the 512-character set is active, a function call with (AX) set to hex 1000 and (BX) set to hex 0712 is recommended to set the color registers with eight consistent colors.

(AL) = 04H - ROM 8x16 font  
(BL) - Block to be loaded

Register values (AL) = 10H, 11H, 12H, and 14H are similar to register values (AL) = 00H, 01H, 02H, and 04H, respectively, with the following exceptions:

- Page 0 must be active.
- Points (bytes per character) are recalculated.

- Rows are calculated as follows:

$\text{INT} [(200, 350, \text{ or } 450) / \text{points}] - 1$

- The length of the regenerative buffer is calculated as follows:

$(\text{Number of rows on screen}) \times (\text{Number of columns on screen}) \times 2$

- The display controller registers are reprogrammed as follows:

Maximum scan line	Points - 1
Cursor start	Points - 2
Cursor end	Points - 1
Vertical displacement end	For 350- and 400-scan-line modes: $[(\text{Number of rows on screen}) \times \text{Points}] - 1$ For 200-scan-line modes: $\{[(\text{Number of rows on screen}) \times \text{Points}] \times 2\} - 1$
Underline location (mode hex 7 only)	Points - 1

- Register calculations must be close to the original table values, or the results might be unpredictable.

(AL) = 10H - User alphanumeric load  
 (BH) - Number of bytes per character  
 (BL) - Block to be loaded  
 (CX) - Count to be stored  
 (DX) - Character offset into table  
 (ES:BP) - Pointer to user table

(AL) = 11H - ROM 8x14 font  
 (BL) - Block to be loaded

(AL) = 12H - ROM 8x8 double-dot font  
 (BL) - Block to be loaded

(AL) = 14H - ROM 8x16 font  
 (BL) - Block to be loaded

(AL) = 20H - Set user-graphics-characters pointer at Interrupt 1FH  
 (ES:BP) - Pointer to user table

(AL) = 21H - Set user-graphics-characters pointer at Interrupt 43H  
 (BL) - Row specifier  
     = 00H - User  
 (CX) - Points (bytes per character)  
 (DL) - Rows  
     = 01H - 14 (0EH)  
     = 02H - 25 (19H)  
     = 03H - 43 (2BH)  
 (ES:BP) - Pointer to user table

(AL) = 22H - ROM 8x14 font  
 (BL) - Row specifier

(AL) = 23H - ROM 8x8 double-dot font  
(BL) - Row specifier

(AL) = 24H - ROM 8x16 font  
(BL) - Row specifier

**Note:** (AL) = 10H, 11H, 12H, 14H, 20H, 21H, 22H, 23H, or 24H should be called only immediately after a mode setting is issued, or the results might be unpredictable.

(AL) = 30H - Information  
(BH) - Font pointer  
= 00H - Return current Interrupt 1FH pointer  
= 01H - Return current Interrupt 43H pointer  
= 02H - Return ROM 8x14 font pointer  
= 03H - Return ROM 8x8 font pointer  
= 04H - Return ROM 8x8 font pointer (top)  
= 05H - Return ROM 9x14 font alternative  
= 06H - Return ROM 8x16 pointer  
= 07H - Return ROM 9x16 font alternative

On Return:

(CX) - Points  
(DL) - Rows (number of character rows on screen – 1)  
(ES:BP) - Pointer to table

**For Personal System/2 Model 25 and Model 30:**

(AL) = 00H - User alphanumeric load  
(BH) = 16 bytes per character for 400 scan lines  
(BL) - Block to be loaded  
(CX) - Count to be stored  
(DX) - Character offset into table  
(ES:BP) - Pointer to user table

**Note:** If (BH) is set to 14 bytes per character for 400 scan lines, characters are extended to 16 high by extending the last line of 14-high characters.

(AL) = 01H - Reserved  
(If this function is called, (AL) = 04H is executed.)

(AL) = 02H - ROM 8x8 double-dot font  
(BL) - Block to be loaded

(AL) = 03H - Set block specifier (valid in alphanumeric modes)  
(BL) - Character-generator block selection  
If bit 3 of the character-attribute byte is set to 0,  
bits 1 and 0 of (BL) select a block from 0 to 3.  
If bit 3 of the character-attribute byte is set to 1,  
bits 3 and 2 of (BL) select a block from 0 to 3.

For example:

- To set a 256-character set using block 2, set (BL) to hex 0A; this selects a single block. Bit 3 of the character-attribute byte turns the foreground intensity on or off.
- To specify a 512-character set using blocks 0 and 2, set (BL) to hex 08; this selects block 0 when bit 3 of the character-attribute byte is set to 0, and it selects block 2 when bit 3 of the character-attribute byte is set to 1.

If bits 1 and 0 and bits 3 and 2 are the same, only one block is selected, and bit 3 of the character-attribute byte turns the foreground intensity on or off.

When the 512-character set is active, a function call with (AX) set to hex 1000 and (BX) set to hex 0712 is recommended to set the color registers with eight consistent colors.

A block-specifier command must be issued after any character-load command to make the loaded block an active character set.

(AL) = 04H - ROM 8x16 font  
(BL) - Block to be loaded

The following register values are reserved. Calls to functions (AL) = 10H, 11H, 12H, and 14H are executed as if they were calls to (AL) = 00H, 01H, 02H, and 04H, respectively.

(AL) = 10H - Reserved  
(If this function is called, (AL) = 00H is executed.)

(AL) = 11H - Reserved  
(If this function is called, (AL) = 01H is executed.)

(AL) = 12H - Reserved  
(If this function is called, (AL) = 02H is executed.)

(AL) = 14H - Reserved  
(If this function is called, (AL) = 04H is executed.)

(AL) = 20H - Set user-graphics-characters pointer at Interrupt 1FH  
(ES:BP) - Pointer to user table

(AL) = 21H - Set user-graphics-characters pointer at Interrupt 43H  
(BL) - Row specifier  
= 00H - User  
(CX) - Points (bytes per character)  
(DL) - Rows  
= 01H - 14 (0EH)  
= 02H - 25 (19H)  
= 03H - 43 (2BH)  
(ES:BP) - Pointer to user table

(AL) = 22H - Reserved  
(If this function is called, (AL) = 24H is executed.)

(AL) = 23H - ROM 8x8 double-dot font  
(BL) - Row specifier

(AL) = 24H ROM 8x16 font  
(BL) - Row specifier

**Note:** (AL) = 20H, 21H, 22H, 23H, or 24H should be called only immediately after a mode setting is issued, or the results might be unpredictable.

(AL) = 30H - Information  
(BH) - Font pointer  
= 00H - Return current Interrupt 1FH pointer  
= 01H - Return current Interrupt 43H pointer  
= 02H - Reserved (if called, ROM 8x16 pointer is returned)  
= 03H - Return ROM 8x8 font pointer  
= 04H - Return ROM 8x8 font pointer (top)  
= 05H - Reserved  
= 06H - Return ROM 8x16 pointer  
= 07H - Reserved

On Return:

(CX) - Points  
(DL) - Rows (number of character rows on screen - 1)  
(ES:BP) - Pointer to table

For all others, no action is performed.

## **(AH) = 12H—Alternative Selection**

For systems with EGA capability and Personal System/2 products except Model 25 and Model 30:

- (BL) = 10H - Return EGA information
- (BH) = 00H - Color mode in effect (3Dx address range)
  - = 01H - Monochrome mode in effect (3Bx address range)
- (BL) - Memory value
  - = 00H - 64KB
  - = 01H - 128KB
  - = 02H - 192KB
  - = 03H - 256KB
  - = 04H to FFH - Reserved
- (CH) = Adapter bits
- (CL) = Switch setting
  
- (BL) = 20H - Select alternative print-screen routine

For Personal System/2 products except Model 25 and Model 30:

- (BL) = 30H - Select scan lines for alphanumeric modes (takes effect on the next mode setting)
- (AL) = 0 - 200 scan lines
  - = 1 - 350 scan lines
  - = 2 - 400 scan lines
  
- On Return:
  - (AL) = 12H - Function is supported
  
- (BL) = 31H - Default palette loading during mode setting
- (AH) = 00H
- (AL) = 0 - Enable default palette loading
  - = 1 - Disable default palette loading
  
- On Return:
  - (AL) = 12H - Function is supported

**Note:** The EGA palette registers, the overscan register, and the color registers are not altered during any mode setting when they are disabled.

- (BL) = 32H - Video
- (AL) = 0 - Enable video
  - = 1 - Disable video
  
- On Return:
  - (AL) = 12H - Function is supported

**Note:** Decoding of the video I/O port addresses and the regenerative buffer addresses is enabled or disabled for the display that is currently active.

(BL) = 33H - Summing to gray shades  
(AL) = 0 - Enable summing  
      = 1 - Disable summing

On Return:  
(AL) = 12H - Function is supported

**Note:** When enabled, summing occurs when color registers are loaded through the Set Mode function ((AH) = 00H) and the Set Palette Registers function ((AH) = 10H).

(BL) = 34H - Cursor emulation  
(AL) = 0 - Enable cursor emulation  
      = 1 - Disable cursor emulation

On Return:  
(AL) = 12H - Function is supported

**Note:** When enabled, the requested start or end value that is passed to the Set Cursor Type function ((AH) = 01H) is scaled to the current character height. The power-on default condition is for cursor emulation to be enabled.

**For Personal System/2 Model 25 and Model 30:**

(BL) = 20H - Select alternative print-screen routine

(BL) = 30H - Reserved

(BL) = 31H - Default palette loading during mode setting ((AH) = 00H)  
(AL) = 0 - Enable default palette loading  
      = 1 - Disable default palette loading (the 256 color registers are not altered during any mode setting when default palette loading is disabled)

On Return:  
(AL) = 12H - Function is supported

(BL) = 32H - Video I/O address and buffers  
(AL) = 0 - Enable video I/O address and buffers  
      = 1 - Disable video I/O address and buffers

On Return:  
(AL) = 12H - Function is supported

(BL) = 33H - Summing to gray shades  
(AL) = 0 - Enable summing  
      = 1 - Disable summing

On Return:

(AL) = 12H - Function is supported

(BL) = 34H - Reserved

**Note:** When enabled, summing occurs when color registers are loaded through the Set Mode function ((AH)=00H) and the Set Palette Registers function ((AH)=10H).

For Personal System/2 products:

(BL) = 35H - Display switching  
(AL) = 00H - Initial adapter video off  
      (ES:DX) - Pointer to 128-byte switch-state save area  
(AL) = 01H - Initial system-board video on  
(AL) = 02H - Switch active video off  
      (ES:DX) - Pointer to switch-state buffer save area  
(AL) = 03H - Switch inactive video on  
      (ES:DX) - Pointer to previously-saved switch-state buffer

On Return:

(AL) = 12H - Function is supported

This interface enables display switching between a system-board-video driven display and an adapter-video driven display when there is overlap in the use of the BIOS data area and in hardware capabilities.

Display switching requires that a disable function ((AH) = 12H, (BL) = 32H) be available for the system-board-video and adapter-video functions.

If there is no conflict between the adapter video and the system-board video, both video functions are active in the system, and display switching is not required.

If there is a conflict between the adapter video and the system-board video, the system-board video function is the primary video source. The adapter-video function remains disabled until it disables the system-board video and enables itself.

When display switching is performed for the first time, the following steps are used:

1. Call Initial Adapter Video Off ((AL)=00H).
2. Call Initial System-Board Video On ((AL)=01H).

These steps are valid only the first time switching is performed. After the initiation steps, switching between the system-board video and adapter video is performed through the Switch Active Video Off request ((AL)=02H) and the Switch Inactive Video On request ((AL)=03H).

When Switch Active Video Off ((AL)=02H) is called, the currently-active video function and display are disabled. The switch-state buffer saves the video-state information, which is required when the display is reactivated through a Switch Inactive Video On ((AL)=03H) request.

When Switch Inactive Video On ((AL)=03H) is called, the currently-inactive video function and display are enabled. The switch-state buffer restores the video-state information, which was saved on a previous Switch Active Video Off ((AL)=02H) request for the display.

### **Video Adapter**

If a video adapter supports display switching, it must perform the following steps.

For Initial Adapter Video Off ((AL)=00H), the adapter:

1. Tests bit 6 at address hex 40:89 to ensure that the bit is set to 0, which indicates that this is the first call.
2. Issues Interrupt 42H with bit 7 in (AL) set to 1. Interrupt 42H activates display switching and sets bit 6 at address hex 40:89 to 1.
3. Tests bit 6 at address hex 40:89 to ensure that display switching is now active.
4. Switches the active video off ((AL)=02H).

For Switch Active Video Off ((AL)=02H), the adapter:

1. Tests bit 6 at address hex 40:89 to ensure that display switching is now active
2. Disables the system interrupts
3. Saves the BIOS data areas
4. Swaps the active and inactive video vectors to pass control to the inactive video BIOS
5. Disables the adapter
6. Enables the system interrupts.

For Switch Inactive Video On ((AL) = 03H), the adapter:

1. Tests bit 6 at address hex 40:89 to ensure that display switching is now active
2. Disables the system interrupts
3. Restores the BIOS data areas
4. Enables the adapter
5. Enables the system interrupts.

In addition, the following areas are affected by display switching:

- Bits 5 and 4 of data area address hex 40:10 (installed hardware, video bits)
- Data area addresses hex 40:49 to hex 40:66 (video-control data area 1)
- Data area addresses hex 40:84 to hex 40:8A (video-control data area 2)
- Pointer to video parameter table
- Interrupt 05H vector (print screen)
- Interrupt 1DH vector (CGA video parameters)
- Interrupt 1FH vector (upper 128 8x8 characters)
- Interrupt 43H vector (graphics character table).

For Personal System/2 products except Model 25 and Model 30:

(BL) = 36H - Video screen off or on  
(AL) = 0 - Screen on  
      = 1 - Screen off

On Return:  
(AL) = 12H - Function is supported

For Personal System/2 Model 35 SX, Model 35 LS, Model 40 SX, and Model 57 SX:

(BL) = 37H - MFI alternative attribute set  
(AL) = 0 - Disable MFI attributes  
      = 1 - Enable MFI attributes

On Return:  
(AL) = 12H - Function is supported

For all others, no action is performed.

## **(AH) = 13H—Write String**

For PC/XT BIOS dated 1/10/86 and later, AT, EGA, PC Convertible, and Personal System/2 products:

(AL) = 00H

(BL) - Attribute

String: "char, char, char, . . .";  
the cursor is not moved

(AL) = 01H

(BL) - Attribute

String: "char, char, char, . . .";  
the cursor is moved

(AL) = 02H

String: "char, attr, char, attr, . . .";  
the cursor is not moved; valid for alphanumeric modes only

(AL) = 03H

String: "char, attr, char, attr, . . .";  
the cursor is moved; valid for alphanumeric modes only

(BH) - Page number (0 based); see Figure 2-5 on page 2-IN10-3 for maximum pages

(CX) - Character-only count

(DX) - Position in which to begin string, in cursor terms

(ES:BP) - Pointer to string to be written

**Note:** Carriage Return, Line Feed, Backspace, and Bell are treated as commands, not as printable characters.

For all others, no action is performed.

## **(AH) = 14H—Load LCD Character Font/Set LCD High-Intensity Substitute**

For PC Convertible:

(AL) = 00H - Load user-specified font

(BH) - Number of bytes per character (from 1 to 255), value checked

(BL) = 00H - Load main font (block 0)

= 01H - Load alternative font (block 1)

= 02H to FFH - No operation

(CX) - Number of characters to be stored (from 1 to 256),  
value checked

(DX) - Character offset into RAM font area

(ES:DI) - Pointer to character font within user table where  
loading starts

(AL) = 01H - Load system-ROM default font

(BL) = 00H - Load main font (block 0)

= 01H - Load alternative font (block 1)

= 02H to FFH - No operation

- (AL) = 02H - Set mapping of LCD high-intensity attribute
- (BL) = 00H - Ignore high-intensity attribute
  - = 01H - Map high intensity to reverse image
  - = 02H - Map high intensity to underscore
  - = 03H - Map high intensity to select alternative font
  - = 04H to FFH - No operation

(AL) = 03H to FFH - No operation

For all others, no action is performed.

**(AH) = 15H—Return Physical-Display Parameters for Active Display**

For PC Convertible:

On Return:

- (AX) - Alternative display-adapter type
  - = 0 - No alternative display adapter
  - = 5140 - LCD
  - = 5153 - CGA-type display
  - = 5151 - Monochrome-type display

(ES:DI) - Points to table defined as follows:

- Word 1 - Display model number
- Word 2 - Number of vertical pels per meter
- Word 3 - Number of horizontal pels per meter
- Word 4 - Total number of vertical pels
- Word 5 - Total number of horizontal pels
- Word 6 - Horizontal pel separation, in micrometers  
(center to center)
- Word 7 - Vertical pel separation, in micrometers  
(center to center)

The following figure lists the display types that are defined for the PC Convertible:

Word	Monochrome	CGA	LCD as CGA	LCD (Monochrome)
1	5151H	5153H	5140H	5140H
2	0	0498H	08E1H	0
3	0	0A15H	0987H	0
4	0	00C8H	00C8H	0
5	0	0280H	0280H	0
6	0	0352H	01B8H	0
7	0	0184H	019AH	0

Figure 2-6. Display Types for PC Convertible

For all others, no action is performed.

**(AH) = 16H to 19H—Reserved**

## **(AH) = 1AH—Read/Write Display-Combination Code**

For Personal System/2 products:

(AL) = 00H - Read display-combination code

On Return:

(AL) = 1AH - Function is supported (see display codes on page 2-IN10-29)

(BH) - Alternative display code

(BL) - Active display code

(AL) = 01H - Write display-combination code (see display codes on page 2-IN10-29)

(BH) - Alternative display code

(BL) - Active display code

On Return:

(AL) = 1AH - Function supported

Display Codes:

00H - No display

01H - Monochrome with 5151 (monochrome)

02H - CGA with 5153/5154 (color)

03H - Reserved

04H - EGA with 5153/5154 (color)

05H - EGA with 5151 (monochrome)

06H - Professional Graphics System with 5175 (color)

07H - Personal System/2 products, except Model 25 and Model 30, with monochrome display (for Model 25 and Model 30, see display code 0BH)

08H - Personal System/2 products, except Model 25 and Model 30, with color display (for Model 25 and Model 30, see display code 0BH)

09H to 0AH - Reserved

0BH - Personal System/2 products, except Model 25 and Model 30, video with analog monochrome

0CH - Personal System/2 Model 25 and Model 30 video with analog color

0DH to FEH - Reserved

For all others, no action is performed.

## **(AH) = 1BH—Return Functionality/State Information**

For Personal System/2 products:

(BX) - Implementation type

(ES:DI) - User-buffer pointer for return of information

On Return:

User buffer contains functionality/state information

(AL) = 1BH - Function is supported

For implementation type hex 00:

- (BX) = 00H
- (ES:DI) = Buffer size is hex 40 bytes
- (DI + 00H) word - Offset to static functionality information
- (DI + 02H) word - Segment to static functionality information

Video states (the following information is dynamically generated and reflects the current video state):

- (DI + 04H) byte - Video mode (see (AH) = 00H on page 2-IN10-2 for supported modes)
  - (DI + 05H) word - Columns on screen (character columns on screen)
  - (DI + 07H) word - Length of regenerative buffer (in bytes)
  - (DI + 09H) word - Starting address in regenerative buffer
  - (DI + 0BH) word - Cursor position for eight display pages (row, column)
  - (DI + 1BH) word - Cursor-type setting (cursor start/end value)
  - (DI + 1DH) byte - Active display page
  - (DI + 1EH) word - Display-controller address (3Bx – monochrome, 3Dx – color)
  - (DI + 20H) byte - Current setting of 3x8 register
  - (DI + 21H) byte - Current setting of 3x9 register
  - (DI + 22H) byte - Rows on screen (character lines on screen)
  - (DI + 23H) word - Character height (scan lines per character)
  - (DI + 25H) byte - Display-combination code (active)
  - (DI + 26H) byte - Display-combination code (alternative)
  - (DI + 27H) word - Colors supported for current video mode
  - (DI + 29H) byte - Display pages supported for current video mode
  - (DI + 2AH) byte - Scan lines in current video mode
    - = 0 - 200 scan lines
    - = 1 - 350 scan lines
    - = 2 - 400 scan lines
    - = 3 - 480 scan lines
    - = 4 to 255 - Reserved
  - (DI + 2BH) byte - Primary character block (reserved on Personal System/2 Model 25 and Model 30)
    - = 0 - Block 0
    - = 1 - Block 1
    - = 2 - Block 2
    - . . .
    - . . .
    - . . .
    - = 255 - Block 255
- This information is based on the block specifier. See the Character Generator function ((AH) = 11H), (AL) = 03H.
- (DI + 2CH) byte - Secondary character block (reserved on Personal System/2 Model 25 and Model 30)
    - = 0 - Block 0
    - = 1 - Block 1
    - = 2 - Block 2
    - . . .
    - . . .
    - . . .
    - = 255 - Block 255

This information is based on the block specifier. See the Character Generator function ((AH) = 11H), (AL) = 03H.

(DI+2DH) byte - Miscellaneous state information

Bits 7, 6 - Reserved

Bit 5 = 0 - Background intensity

= 1 - Blinking

Bit 4 = 1 - Cursor emulation active (always set to 0 for

Personal System/2 Model 25 and Model 30)

Bit 3 = 1 - Mode setting default palette loading disabled

Bit 2 = 1 - Monochrome display attached

Bit 1 = 1 - Summing active

Bit 0 = 1 - All modes on all displays active (always set to

0 for Personal System/2 Model 25 and Model 30)

(DI+2EH) byte - Video that requires the video adapter interface

driver to support modes outside of the current  
VGA range

Bits 7 to 5 - Reserved

Bit 4 = 0 - 132-column mode not supported

= 1 - 132-column mode supported

Bit 3 = 0 - VGA attributes set

= 1 - MFI attributes set

Bit 2 = 0 - 16-bit VGA graphics not present

= 1 - 16-bit VGA graphics present

Bit 1 = 0 - AI driver not required

= 1 - AI driver required

Bit 0 = 0 - BIOS does not support AI information return

= 1 - BIOS supports AI information return

(DI+2FH) byte - Reserved

(DI+30H) byte - Reserved

(DI+31H) byte - Video memory available

= 0 - 64KB

= 1 - 128KB

= 2 - 192KB

= 3 - 256KB

= 4 to 255 - Reserved

(DI+32H) byte - Save pointer-state information

Bits 7, 6 - Reserved

Bit 5 = 1 - DCC extension active

Bit 4 = 1 - Palette override active

Bit 3 = 1 - Graphics font override active

Bit 2 = 1 - Alphanumeric font override active

Bit 1 = 1 - Dynamic save area active

Bit 0 = 1 - 512-character set active

(DI+33H) to (DI+3FH) 13 bytes - Reserved

Format of static functionality table:

= 0 - Not supported

= 1 - Supported

(00H) byte - Video modes

Bit 7 = 1 - Mode 07H

Bit 6 = 1 - Mode 06H

Bit 5 = 1 - Mode 05H

Bit 4 = 1 - Mode 04H

Bit 3 = 1 - Mode 03H

Bit 2 = 1 - Mode 02H

Bit 1 = 1 - Mode 01H

Bit 0 = 1 - Mode 00H

**(01H) byte - Video modes**

- Bit 7 = 1 - Mode 0FH
- Bit 6 = 1 - Mode 0EH
- Bit 5 = 1 - Mode 0DH
- Bit 4 = 1 - Mode 0CH
- Bit 3 = 1 - Mode 0BH
- Bit 2 = 1 - Mode 0AH
- Bit 1 = 1 - Mode 09H
- Bit 0 = 1 - Mode 08H

**(02H) byte - Video modes**

- Bits 7 to 5 - Reserved
- Bit 4 = 1 - Mode 14H
- Bit 3 = 1 - Mode 13H
- Bit 2 = 1 - Mode 12H
- Bit 1 = 1 - Mode 11H
- Bit 0 = 1 - Mode 10H

See (AH) = 00H on page 2-IN10-2 for video mode information.

**(03H) to (07H) 4 bytes - Reserved**

**(07H) byte - Scan lines available in text modes**

- Bits 7 to 3 - Reserved
- Bit 2 = 400 scan lines
- Bit 1 = 350 scan lines
- Bit 0 = 200 scan lines

See (AH) = 12H, (BL) = 30H on page 2-IN10-22 for text-mode scan-line selection.

**(08H) byte - Character blocks available in text modes**

**(09H) byte - Maximum number of active character blocks in text modes (see (AH) = 11H on page 2-IN10-14 for character-block loading interfaces)**

**(0AH) byte - Miscellaneous functions**

- Bit 7 = Color paging (always set to 0 for Personal System/2 Model 25 and Model 30; see (AH) = 10H on page 2-IN10-10)
- Bit 6 = Color palette (see (AH) = 10H)
- Bit 5 = EGA palette (see (AH) = 10H)
- Bit 4 = Cursor emulation (see (AH) = 01H on page 2-IN10-6)
- Bit 3 = Mode-setting default-palette loading (see (AH) = 12H on page 2-IN10-22)
- Bit 2 = Character-font loading (see (AH) = 11H on page 2-IN10-14)
- Bit 1 = Summing (see (AH) = 10H and (AH) = 12H)
- Bit 0 = All modes on all displays (always set to 0 for Personal System/2 Model 25 and Model 30)

(0BH) byte - Miscellaneous functions

Bits 7 to 4 - Reserved

Bit 3 = DCC (see (AH) = 1AH on page 2-IN10-6)

Bit 2 = Background intensity/blinking control (see (AH) = 10H on page 2-IN10-10)

Bit 1 = Save/restore (always set to 0 for Personal System/2

Model 25 and Model 30; see (AH) = 1CH on page 2-IN10-33)

Bit 0 = Light pen (see (AH) = 04H on page 2-IN10-6)

(0CH) to (0DH) 2 bytes - Reserved

(0EH) byte - Save pointer functions

Bits 7, 6 = Reserved

Bit 5 = DCC extension (always set to 0 for Personal System/2 Model 25 and Model 30)

Bit 4 = Palette override

Bit 3 = Graphics font override

Bit 2 = Alphanumeric font override

Bit 1 = Dynamic save area

Bit 0 = 512-character set

(0FH) byte - Reserved

For all others, no action is performed.

### **(AH) = 1CH—Save/Restore Video State**

For Personal System/2 products except Model 25 and Model 30:

(AL) = 00H - Return save/restore state buffer size

(CX) - Requested states (see supported save/restore states on page 2-IN10-34)

On Return:

(AL) = 1CH - Function is supported

(BX) - Save/restore buffer-size block count (number of 64-byte blocks for saving requested states in (CX))

(AL) = 01H - Save state

(CX) = Requested states (see supported save/restore states on page 2-IN10-34)

(ES:BX) - Buffer pointer to save state

On Return:

(AL) = 1CH - Function is supported

The requested states are saved.

(AL) = 02H - Restore state

(CX) - Requested states (see supported save/restore states below)

(ES:BX) - Buffer pointer to restore state

On Return:

(AL) = 1CH - Function is supported

The requested states are restored.

Supported save/restore states:

Bits 15 to 3 - Reserved and set to 0

Bit 2 = 1 - Save/restore video DAC state and color registers

Bit 1 = 1 - Save/restore video BIOS data area

Bit 0 = 1 - Save/restore video hardware state

**Note:** The current video state is altered during the save-state operation. To maintain the current video state, perform a restore-state operation.

For all others, no action is performed.

**(AH) = 1DH to FFH—Reserved**

---

## Interrupt 11H—Equipment Determination

This routine returns information about the optional devices that are attached to the system.

BIOS data area hex 40:10 (installed hardware) is set during POST as follows:

On Return:

(AX) - Equipment flags

Bits 15, 14 - Number of parallel ports

Bit 13 = 1 - Internal modem installed (PC Convertible only)

Bit 12 - Not used

Bits 11 to 9 - Number of asynchronous communication ports

Bit 8 - Not used

Bits 7, 6 - Number of diskette drives installed, other than physical drive 0 (values are binary). These 2 bits do not indicate the locations of the installed drives.

= 00 - No other drives

= 01 - 1 drives

= 10 - 2 drives

= 11 - 3 drives

Bits 5, 4 - Video mode type (values are binary)

= 00 - Reserved

= 01 - 40x25 (color)

= 10 - 80x25 (color)

= 11 - 80x25 (monochrome)

Bit 3 - Not used

Bit 2 = 1 - Pointing device installed

Bit 1 = 1 - Math coprocessor installed

Bit 0 = 0 - Diskette drive 0 is not present

= 1 - Diskette drive 0 is present

**Notes:**

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## **Interrupt 12H—Memory Size Determination**

This routine returns the amount of RAM up to 640KB in the system as determined by POST, minus the memory that is allocated to the extended BIOS data area. See Interrupt 15H, Return Extended BIOS Data Area Segment Address function ((AH) = C1H) and Interrupt 15H, Extended-Memory Size Determination function ((AH) = 88H) for additional information.

On return, (AX) contains the number of contiguous 1KB blocks of memory.

**Notes:**

## Interrupt 13H—Diskette

This interface provides access to diskette drives. The following is a summary of the diskette functions of Interrupt 13H.

(AH) = 00H	— Reset Diskette System
(AH) = 01H	— Read Status of Last Operation
(AH) = 02H	— Read Desired Sectors into Memory
(AH) = 03H	— Write Desired Sectors from Memory
(AH) = 04H	— Verify Desired Sectors
(AH) = 05H	— Format Desired Track
(AH) = 06H to 07H	— Reserved
(AH) = 08H	— Read Drive Parameters
(AH) = 09H to 14H	— Reserved
(AH) = 15H	— Read Diskette Drive Type
(AH) = 16H	— Diskette Change Line Status
(AH) = 17H	— Set Diskette Type for Format
(AH) = 18H	— Set Media Type for Format
(AH) = 19H	— Reserved
(AH) = 20H	— Get Media Type
(AH) = 21H to FFH	— Reserved

Figure 2-7. INT 13H Diskette Functions

### Notes:

1. All reserved input fields must be set to 0.
2. For the diskette drive parameters, see the Diskette Drive Parameter Table in the “ROM Tables” section.

For AT, PC/XT BIOS dated 1/10/86 and later, PC/XT Model 286, PC Convertible, and Personal System/2 products, operations that require the diskette-drive motor to be turned on call Interrupt 15H, Diskette Drive Motor Start function ((AH)=90FDH). This allows the operating system to perform a different task while waiting for the diskette-drive motor to accelerate.

Before waiting for the diskette interrupt, BIOS calls Interrupt 15H, Device Busy function ((AH)=90H) with (AL)=01H (Type=Diskette). This informs the operating system of the wait. The complementary Interrupt 15H, Interrupt Complete function ((AH)=91H) with (AL)=01H (Type=Diskette) is called to indicate that the operation is complete. See “Multitasking Provisions” in the “Additional Information” section.

If the caller changes the values of the head settle time (byte 9) and the motor startup time (byte 10) to values that are inconsistent with the diskette drive specifications, BIOS enforces the minimum values for these parameters as specified for the diskette drive. (For the

| diskette drive parameters, see the Diskette Drive Parameter Table in  
| the “ROM Tables” section.) The values of these parameters can be  
| increased to allow for correcting possible future problems if some  
| diskette drives require more than the nominal values for these  
| parameters.

### **(AH) = 00H—Reset Diskette System**

(DL) - Drive number (0-based)  
Bit 7 = 0 - Diskette (value checked)

On Return:

(AH) - Status of operation  
= 00H - No error  
= 01H - Invalid diskette parameter  
= 02H - Address mark not found  
= 03H - Write-protect error  
= 04H - Requested sector not found  
= 06H - 'Diskette change' line active  
= 08H - DMA overrun on operation  
= 09H - DMA attempt across a 64KB boundary  
= 0CH - Media type not found  
= 10H - Cyclic redundancy check (CRC) error on diskette  
read  
= 20H - General controller failure  
= 30H - Drive does not support media sense  
= 31H - No media in drive  
= 32H - Media type not supported by drive  
= 40H - Seek operation failed  
= 80H - Diskette drive not ready  
CF = 0 - Status is 0  
= 1 - Status is non 0

Address hex 40:41 is set to the status of operation.

### **Notes:**

1. If the diskette BIOS reports an error, reset the diskette system and retry the operation.
2. If the value in (DL) is greater than or equal to hex 80, the diskette system is reset, then the fixed-disk system is reset. The status returned in (AH) is the status of the fixed-disk reset. Read the status of the diskette system after completing the operation.

## **(AH) = 01H—Read Status of Last Operation**

(DL) - Drive number (0-based)  
Bit 7 = 0 - Diskette (value checked)

On Return:

(AH) - Status of operation (see values for the status of operation in (AH) = 00H on page 2-IN13D-2)  
CF = 0 - Status is 0  
= 1 - Status is non 0

## **(AH) = 02H—Read Desired Sectors Into Memory**

(AL) - Number of sectors (not value checked)  
(CH) - Track number (not value checked; low 8 bits of 10-bit track number, 0-based)  
(CL) - Bits 7, 6 - High 2 bits of 10-bit track number, 0-based  
Bits 5 to 0 - Sector number (not value checked)  
(DH) - Head number (not value checked, 0-based)  
(DL) - Drive number (0-based)  
Bit 7 = 0 - Diskette (value checked)  
(ES:BX) - Address of buffer

On Return:

(AH) - Status of operation (see values for the status of operation in (AH) = 00H on page 2-IN13D-2)  
(AL) - Number of sectors actually transferred  
CF = 1 - Status is non 0  
= 0 - Status is 0

Address hex 40:41 is set to the status of operation.

**Note:** If the diskette BIOS reports an error, reset the diskette system and retry the operation.

## **(AH) = 03H—Write Desired Sectors from Memory**

(AL) - Number of sectors (not value checked)  
(CH) - Track number (not value checked; low 8 bits of 10-bit track number, 0-based)  
(CL) - Bits 7, 6 - High 2 bits of 10-bit track number, 0-based  
Bits 5 to 0 - Sector number (not value checked)  
(DH) - Head number (not value checked, 0-based)  
(DL) - Drive number (0-based)  
Bit 7 = 0 - Diskette (value checked)  
(ES:BX) - Address of buffer

**On Return:**

- (AH) - Status of operation (see values for the status of operation in (AH) = 00H on page 2-IN13D-2)
- (AL) - Number of sectors actually transferred
- CF = 0 - Status is 0
- = 1 - Status is non 0

Address hex 40:41 is set to the status of operation.

**Notes:**

1. If the diskette BIOS reports an error, reset the diskette system and retry the operation.
2. For PC/XT Model 286, (AL) is not required.

**(AH) = 04H—Verify Desired Sectors**

- (AL) - Number of sectors (not value checked)
- (CH) - Track number (not value checked; low 8 bits of 10-bit track number, 0-based)
- (CL) - Bits 7, 6 - High 2 bits of 10-bit track number, 0-based
- Bits 5 to 0 - Sector number (not value checked)
- (DH) - Head number (not value checked, 0-based)
- (DL) - Drive number (0-based)
- Bit 7 = 0 - Diskette (value checked)
- (ES:BX) - Address of buffer

**On Return:**

- (AH) - Status of operation (see values for the status of operation in (AH) = 00H on page 2-IN13D-2)
- (AL) - Number of sectors verified
- CF = 0 - Status is 0
- = 1 - Status is non 0

Address hex 40:41 is set to the status of operation.

**Notes:**

1. If the diskette BIOS reports an error, reset the diskette system and retry the operation.
2. (ES:BX) is not required for AT BIOS dated 11/15/85 and later, PC/XT Model 286, PC Convertible, or Personal System/2 products.

## **(AH) = 05H—Format Desired Track**

The buffer pointer (ES:BX) must point to the collection of desired address fields for the track. Each field has the following 4 bytes:

Byte 0 - Track number  
Byte 1 - Head number  
Byte 2 - Sector number  
Byte 3 - Number of bytes per sector  
= 00H - Reserved  
= 01H - Reserved  
= 02H - 512 bytes per sector  
= 03H - Reserved

There must be one entry for every sector on the track. This information is used to find the requested sector during read or write access. Before a diskette is formatted, if more than one format is supported for the drive that is being used, it is necessary to call Interrupt 13H, Set Diskette Type for Format function ((AH) = 17H) or Interrupt 13H, Set Media Type for Format function ((AH) = 18H) to specify the diskette type that is to be formatted.

(AL) - Number of sectors (not value checked)  
(CH) - Track number (not value checked; low 8 bits of 10-bit track number, 0-based)  
(CL) - Bits 7, 6 - High 2 bits of 10-bit track number, 0-based  
Bits 5 to 0 - Not used  
(DH) - Head number (not value checked, 0-based)  
(DL) - Drive number (0-based)  
Bit 7 = 0 - Diskette (value checked)  
(ES:BX) - Address of buffer

### On Return:

(AH) - Status of operation (see values for the status of operation in (AH) = 00H on page 2-IN13D-2)  
CF = 0 - Status is 0  
= 1 - Status is non 0

Address hex 40:41 is set to the status of operation.

### Notes:

1. If the diskette BIOS reports an error, reset the diskette system and retry the operation.
2. The diskette drive parameter table is used to format the diskette. See the Diskette Drive Parameter Table in the "ROM Tables" section.
3. For PC/XT Model 286, (AL) is not required.

**(AH) = 06H to 07H—Reserved**

**(AH) = 08H—Read Drive Parameters**

Each supported media type has a parameter table.

For PCjr, PC, PC/XT, and for AT BIOS dated 1/10/84, this function is not supported:

On Return:

(AH) - Status of operation  
= 01H - Invalid command

CF = 1 - Error

Address hex 40:41 is set to the status of operation.

For all others:

(DL) - Drive number (0-based)

Bit 7 = 0 - Diskette (value checked)

On Return:

(AH) = Status of operation

(AL) = 0

(BH) = 0

(BL) - Bits 7 to 4 = 0

Bits 3 to 0 - Valid drive type value in CMOS

= 01H - 360KB, 5.25 inch, 40 track

= 02H - 1.2MB, 5.25 inch, 80 track

= 03H - 720KB, 3.5 inch, 80 track

= 04H - 1.44MB, 3.5 inch, 80 track

= 05H - 720KB, 5.25 inch, 80 track

= 06H - 2.88MB, 3.5 inch, 80 track

(KB = 1024 bytes; MB = 1 048 576 bytes.)

(CH) - Maximum number of tracks (low 8 bits of 10-bit track number, 0-based)

(CL) - Bits 7, 6 - Maximum number of tracks (high 2 bits of 10-bit track number, 0-based)

- Bits 5 to 0 - Maximum sectors per track

(DH) - Maximum head number

(DL) - Number of diskette drives installed

(ES:DI) - Pointer to 11-byte parameter table that is associated with the maximum supported media type within the drive (see the Diskette Drive Parameter Table in the "ROM Tables" section)

All registers are returned as described above, except that (BL) is set to 0, when the drive type is known and any of the following conditions exists:

- The CMOS type is invalid.
- The CMOS is not present.
- The CMOS battery is discharged.
- The CMOS checksum is invalid.

If the requested drive is not installed, (AX), (BX), (CX), (DX), (DI), and (ES) are set to 0.

Address hex 40:41 is set to 0, and CF is set to 0.

For drive number hex 80 or above (indicating fixed disks), this function is not supported:

(AH) - Status of operation  
 = 01H - Invalid command  
 CF = 1 - Error

(ES), (AX), (BX), (CX), (DH), and (DI) are equal to 0, and (DL) contains the number of drives when any of the following conditions exists:

- The drive number is invalid.
- The drive type is unknown, and the CMOS is not present.
- The CMOS battery is discharged, or the CMOS checksum is invalid.
- The drive type is unknown, and the CMOS drive type is invalid.

Address hex 40:41 is set to 0, and CF is set to 0.

### **(AH) = 09H to 14H—Reserved**

### **(AH) = 15H—Read Diskette Drive Type**

For AT, PC/XT BIOS dated 1/10/86 and later, PC/XT Model 286, PC Convertible, and Personal System/2 products:

(DL) - Drive number (0-based)  
 Bit 7 = 0 - Diskette (value checked)

On Return:

(AH) = 00H - Drive not present  
 = 01H - Diskette, no 'diskette change' line available  
 = 02H - Diskette, 'diskette change' line available  
 = 03H - Reserved  
 CF = 0 - Operation successfully completed

Address hex 40:41 is set to the status of operation.

For all others, this function is not supported:

On Return:

(AH) - Status of operation  
= 01H - Invalid command  
CF = 1 - Error

Address hex 40:41 is set to the status of operation.

### **(AH) = 16H—'Diskette Change' Line Status**

For AT, PC/XT BIOS dated 1/10/86 and later, PC/XT Model 286, PC Convertible, and Personal System/2 products:

(DL) - Drive number (0-based)  
Bit 7 = 0 - Diskette (value checked)

On Return:

(AH) = 00H - 'Diskette change' signal not active  
= 01H - Invalid diskette parameter  
= 06H - 'Diskette change' signal active  
= 80H - Diskette drive not ready  
CF = 0 if (AH) is 0  
= 1 if (AH) is non 0

Address hex 40:41 is set to the value in (AH).

For all others, this function is not supported:

On Return:

CF = 1 - Error  
(AH) - Status of operation  
= 01H - Invalid command

Address hex 40:41 is set to the status of operation.

### **(AH) = 17H—Set Diskette Type for Format**

For AT, PC/XT BIOS dated 1/10/86 and later, PC Convertible, and Personal System/2 products:

(DL) - Drive number (0-based)  
Bit 7 = 0 - Diskette (value checked)

- (AL) = 00H - Invalid request
  - = 01H - Diskette 320/360KB in 360KB drive
  - = 02H - Diskette 360KB in 1.2MB drive
  - = 03H - Diskette 1.2MB in 1.2MB drive
  - = 04H - AT BIOS before 6/10/85: Invalid request
    - All others: Diskette 720KB in 720KB drive
  - = 05H to 0FFH - Invalid request

On Return:

- (AH) - Status of operation (see values for the status of operation in (AH) = 00H on page 2-IN13D-2)
- CF = 0 - Status is 0
  - = 1 - Status is non 0

Address hex 40:41 is set to the status of operation.

For all others, this function is not supported:

On Return:

- CF = 1 - Error
- (AH) - Status of operation
  - = 01H - Invalid command

Address hex 40:41 is set to the status of operation.

### **(AH) = 18H—Set Media Type for Format**

For AT BIOS dated 11/15/85 and later, PC/XT BIOS dated 1/10/86 and later, PC/XT Model 286, and Personal System/2 products, this function is called before Interrupt 13H, Format the Desired Track function ((AH) = 05H) is issued. If the diskette is changed, the function is called again. A diskette must be present in the drive.

Each supported media type has a parameter table.

- (DL) - Drive number (0-based)
  - Bit 7 = 0 - Diskette (value checked)
- (CH) - Number of tracks (low 8 bits of 10-bit track number, 0-based)
- (CL) - Bits 7, 6 - Number of tracks (high 2 bits of 10-bit track number, 0-based)
  - Bits 5 to 0 - Sectors per track

On Return:

(ES:DI) - Pointer to 11-byte parameter table for this media type, unchanged if (AH) is non 0 (see the Diskette Drive Parameter Table in the "Data Areas and ROM Tables" section)

(AH) - Status of operation (see values for the status of operation in (AH) = 00H on page 2-IN13D-2)

CF = 0 - Status is 0  
= 1 - Status is non 0

**Note:** For PC/XT Model 286 and Personal System/2 products, this function monitors the 'diskette change' signal. If the signal is active, BIOS attempts to reset the 'diskette change' line to the inactive state. If the attempt is successful (for example, when media is present), BIOS sets the correct data rate for formatting. If the attempt fails (for example, when no media is present), BIOS returns hex 80 in (AH) (Diskette Drive Not Ready), and the carry flag is set to 1.

When the 'diskette change' signal is inactive, BIOS performs the function as requested.

For all others, this function is not supported:

On Return:

(AH) - Status of operation  
= 01H - Invalid command  
CF = 1 - Error

Address hex 40:41 is set to the status of operation.

## **(AH) = 19H—Reserved**

## **(AH) = 20H—Get Media Type**

(DL) - Drive number (0-based)  
Bit 7 = 0 - Diskette (value checked)

On Return:

(AH) - Status of operation  
= 01H - Invalid request  
= 30H - Drive does not support media sense  
= 31H - No media in drive  
= 32H - Drive does not support media type

(AL) - Type of media installed  
= 06H - 4MB diskette  
= 04H - 2MB diskette  
= 03H - 1MB diskette  
- All others are reserved

CF = 0 - Status is 0  
= 1 - Status is non 0

**(AH) = 21H to FFH—Reserved**

**Supported Drives and Media**

Interrupt 13H supports the following drives.

5.25"	40 track	180KB	One head
5.25"	40 track	360KB	Two heads
5.25"	80 track	1.2MB	Two heads
3.5"	80 track	720KB	Two heads
3.5"	80 track	1.44MB	Two heads
3.5"	80 track	2.88MB	Two heads

*Figure 2-8. INT 13H Supported Diskette Drives*

Interrupt 13H supports the following media.

5.25"	40 track	8 sectors/track	320KB	Double sided
5.25"	40 track	9 sectors/track	360KB	Double sided
5.25"	80 track	15 sectors/track	1.2MB	Double sided
3.5"	80 track	9 sectors/track	720KB	Double sided
3.5"	80 track	18 sectors/track	1.44MB	Double sided
3.5"	80 track	36 sectors/track	2.88MB	Double sided

*Figure 2-9. INT 13H Supported Media*

## Diskette Drive Parameters

The following tables contain the recommended parameters for diskette drives that are supported on Personal System/2 products.

<b>Byte Definition</b>	<b>320K Media</b>	<b>360K Media</b>
First specification byte	D0H	D0H
Second specification byte	02H	02H
Motor-off time	25H	25H
Bytes per sector	02H	02H
Sectors per track	08H	09H
Gap length	2AH	2AH
Data length	FFH	FFH
Gap length (format)	50H	50H
Fill byte (format)	F6H	F6H
Head settle time (in microseconds)	0FH	0FH
Motor start (in 1/6-seconds)	06H	06H
Maximum track numbers	27H	27H
Data-transfer rate	80H	80H
Multi-rate capability	00H	00H

Figure 2-10. Media Parameter Table – 360KB Slimline Drive

<b>Byte Definition</b>	<b>720K Media</b>
First specification byte	D0H
Second specification byte	02H
Motor-off time	25H
Bytes per sector	02H
Sectors per track	09H
Gap length	2AH
Data length	FFH
Gap length (format)	50H
Fill byte (format)	F6H
Head settle time (in microseconds)	0FH
Motor start (in 1/6-seconds)	04H
Maximum track numbers	4FH
Data-transfer rate	80H
Multi-rate capability	00H

Figure 2-11. Media Parameter Table – 720KB Slimline Drive

<b>Byte Definition</b>	<b>320K Media</b>	<b>360K Media</b>	<b>1.2M Media</b>
First specification byte	E0H	E0H	D0H
Second specification byte	02H	02H	02H
Motor-off time	25H	25H	25H
Bytes per sector	02H	02H	02H
Sectors per track	08H	09H	0FH
Gap length	2AH	2AH	1BH
Data length	FFH	FFH	FFH
Gap length (format)	50H	50H	54H
Fill byte (format)	F6H	F6H	F6H
Head settle time (in microseconds)	0FH	0FH	0FH
Motor start (in 1/8-seconds)	04H	04H	04H
Maximum track numbers	27H	27H	4FH
Data-transfer rate	40H	40H	00H
Multi-rate capability	02H	02H	02H

*Figure 2-12. Media Parameter Table – 1.2MB Slimline Drive*

<b>Byte Definition</b>	<b>720K Media</b>	<b>1.44M Media</b>
First specification byte	E0H	D0H
Second specification byte	02H	02H
Motor-off time	25H	25H
Bytes per sector	02H	02H
Sectors per track	09H	12H
Gap length	2AH	1BH
Data length	FFH	FFH
Gap length (format)	50H	65H
Fill byte (format)	F6H	F6H
Head settle time (in microseconds)	0FH	0FH
Motor start (in 1/8-seconds)	04H	04H
Maximum track numbers	4FH	4FH
Data-transfer rate	80H	00H
Multi-rate capability	02H	02H

*Figure 2-13. Media Parameter Table – 1.44MB Slimline Drive*

<b>Byte Definition</b>	<b>720K Media</b>	<b>1.44M Media</b>	<b>2.88M Media</b>
First specification byte	E0H	D0H	A0H
Second specification byte	02H	02H	02H
Motor-off time	25H	25H	25H
Bytes per sector	02H	02H	02H
Sectors per track	09H	12H	24H
Gap length	2AH	1BH	38H
Data length	FFH	FFH	FFH
Gap length (format)	50H	65H	53H
Fill byte (format)	F6H	F6H	F6H
Head settle time (in microseconds)	0FH	0FH	0FH
Motor start (in 1/4-seconds)	04H	04H	04H
Maximum track numbers	4FH	4FH	4FH
Data-transfer rate	80H	00H	C0H
Multi-rate capability	02H	02H	02H

*Figure 2-14. Media Parameter Table – 2.88MB Slimline Drive*

<b>Byte Definition</b>	<b>720K Media</b>	<b>1.44M Media</b>
First specification byte	D0H	A0H
Second specification byte	02H	02H
Motor-off time	25H	25H
Bytes per sector	02H	02H
Sectors per track	09H	12H
Gap length	2AH	1BH
Data length	FFH	FFH
Gap length (format)	50H	65H
Fill byte (format)	F6H	F6H
Head settle time (in microseconds)	0FH	0FH
Motor start (in 1/4-seconds)	04H	04H
Maximum track numbers	4FH	4FH
Data-transfer rate	80H	00H
Multi-rate capability	02H	02H

*Figure 2-15. Media Parameter Table – 1.44MB Half-High Drive*

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## Interrupt 13H—Fixed Disk

This interface provides access to fixed disk drives. The following is a summary of the fixed disk functions of Interrupt 13H.

(AH) = 00H	–	Reset Disk System
(AH) = 01H	–	Read Status of Last Operation
(AH) = 02H	–	Read Desired Sectors into Memory
(AH) = 03H	–	Write Desired Sectors from Memory
(AH) = 04H	–	Verify Desired Sectors
(AH) = 05H	–	Format Desired Track
(AH) = 06H	–	Format Desired Track and Set Bad-Sector Flags
(AH) = 07H	–	Format Drive Starting at Desired Cylinder
(AH) = 08H	–	Read Drive Parameters
(AH) = 09H	–	Initialize Drive Pair Characteristics
(AH) = 0AH to 0BH	–	Reserved
(AH) = 0CH	–	Seek
(AH) = 0DH	–	Alternative Disk Reset
(AH) = 0EH to 0FH	–	Reserved
(AH) = 10H	–	Test Drive Ready
(AH) = 11H	–	Recalibrate
(AH) = 12H to 14H	–	Reserved
(AH) = 15H	–	Read DASD Type
(AH) = 16H to 18H	–	Reserved
(AH) = 19H	–	Park Heads
(AH) = 1AH to 20H	–	Reserved
(AH) = 21H	–	Read Multiple Sectors into Memory
(AH) = 22H	–	Write Multiple Sectors from Memory
(AH) = 23H	–	Reserved
(AH) = 24H	–	Set Multiple Mode
(AH) = 25H	–	Identify Drive
(AH) = 26H to FFH	–	Reserved

Figure 2-16. INT 13H Fixed Disk Functions

### Notes:

1. All reserved input fields must be set to 0.
2. If a fixed disk drive adapter is not installed, the code is not hooked into Interrupt 13H; the values that are returned are described in "Interrupt 13H—Diskette."
3. For the fixed disk interface, the drive number in (DL) is value checked for all functions that use the device number.
4. For AT, PC/XT Model 286, and Personal System/2 products, before waiting for this interrupt, BIOS calls Interrupt 15H, Device Busy function ((AH)=90H) with (AL)=00H (Type=Disk) to inform the operating system of the wait. The complementary Interrupt 15H, Interrupt Complete function ((AH)=91H) with (AL)=00H (Type=Disk) is called to indicate that the operation is complete.

5. For Personal System/2 products, before waiting for the fixed disk reset, BIOS calls Interrupt 15H, Device Busy function ((AH) = 90H) with (AL) = FCH (Type = Fixed Disk Reset). This is a time-out-only function. There is no complementary power-on self-test (POST) operation. (See "Multitasking Provisions" in the "Additional Information" section.)
6. Bit 7 of the drive number in (DL) must be set upon entry to the fixed disk BIOS.
7. For the drive parameters see the Fixed Disk Drive Parameter Table in the "ROM Tables" section.

### **(AH) = 00H—Reset Disk System**

(DL) - Drive number; bit 7 = 1 for fixed disk drive (0-based)

On Return:

(AH) - Status of operation

- = 00H - No error
- = 01H - Unsupported function or parameter
- = 02H - Address mark not found
- = 03H - Write-protect error
- = 04H - Sector not found
- = 05H - Reset failed
- = 07H - Drive parameter activity failed
- = 08H - DMA overrun on operation
- = 09H - Data-boundary error
- = 0AH - Bad sector flag detected
- = 0BH - Bad cylinder detected
- = 0DH - Invalid number of sectors on format
- = 0EH - Control data address mark detected
- = 0FH - DMA arbitration level out of range
- = 10H - Uncorrectable error checking and correction (ECC) or cyclic redundancy check (CRC) error
- = 11H - ECC corrected data error
- = 12H - Command in progress
- = 13H - Device not powered-on
- = 20H - General controller failure
- = 40H - Seek operation failed
- = 80H - Time-out
- = AAH - Drive not ready
- = BBH - Undefined error occurred
- = CCH - Write fault on selected drive
- = E0H - Status error/error register = 0
- = FFH - Sense operation failed

CF = 0 - Status is 0

= 1 - Status is non 0

Address hex 40:74 is set to the status of operation.

## Notes:

1. This function is issued only if the 7-bit drive number is less than the maximum number of fixed disk drives that are installed. The diskette system is also reset for all values of (DL).
2. For Personal System/2 products, before waiting for the fixed disk reset, BIOS calls Interrupt 15H, Device Busy function ((AH) = 90H) with (AL) = FCH (Type = Fixed Disk Reset) to inform the operating system of the wait.
3. For Personal System/2 Model 35 SX, Model 35 LS, Model 40 SX, and Model L40 SX, both the master drive and the slave drive respond to the Reset function that is issued to either drive. Both drives are reset.

## (AH) = 01H—Read Status of Last Operation

(DL) - Drive number; bit 7 = 1 for fixed disk drive (0-based)

On Return:

(AH) - Status of this operation (see values for the status of operation on page 2-IN13F-2)

(AL) - Status of the last operation

CF = 0 - Status is 0

  = 1 - Status is non 0

Address hex 40:74 is set to 0.

**Note:** This function returns the status of the last operation that was performed on the specified drive. The result is not valid if another drive has been accessed since the last operation was performed on the specified drive.

## (AH) = 02H—Read Desired Sectors into Memory

(AL) - Number of sectors

(CH) - Cylinder number (low 8 bits of 10-bit cylinder number, 0-based, not value checked)

(CL) - Bits 7, 6 - Cylinder number (high 2 bits of 10-bit cylinder number, 0-based, not value checked)

  - Bits 5 to 0 - Sector number (not value checked)

(DH) - Head number (0-based, not value checked)

(DL) - Drive number; bit 7 = 1 for fixed disk drive (0-based)

(ES:BX) - Address of buffer

On Return:

(AH) - Status of operation (see values for the status of operation on page 2-IN13F-2)

CF = 0 - Status is 0

= 1 - Status is non 0

Address hex 40:74 is set to the status of operation.

### Notes:

1. (AH) = 11H indicates that the data that was read had a recoverable error that was corrected by the error checking and correction (ECC) algorithm. The data is good; however, the BIOS routine indicates an error to notify the controlling program of the correction. The error might not recur if the data is rewritten.
2. If the fixed disk BIOS reports an error, reset the disk system and retry the operation.

### (AH) = 03H—Write Desired Sectors from Memory

(AL) - Number of sectors

(CH) - Cylinder number (low 8 bits of 10-bit cylinder number, 0-based, not value checked)

(CL) - Bits 7, 6 - Cylinder number (high 2 bits of 10-bit cylinder number, 0-based, not value checked)

- Bits 5 to 0 - Sector number (not value checked)

(DH) - Head number (0-based, not value checked)

(DL) - Drive number; bit 7 = 1 for fixed disk drive (0-based)

(ES:BX) - Address of buffer

On Return:

(AH) - Status of operation (see values for the status of operation on page 2-IN13F-2)

CF = 0 - Status is 0

= 1 - Status is non 0

Address hex 40:74 is set to the status of operation.

**Note:** If the fixed disk BIOS reports an error, reset the disk system and retry the operation.

## **(AH) = 04H—Verify Desired Sectors**

- (AL) - Number of sectors
- (CH) - Cylinder number (low 8 bits of 10-bit cylinder number, 0-based, not value checked)
- (CL) - Bits 7, 6 - Cylinder number (high 2 bits of 10-bit cylinder number, 0-based, not value checked)
  - Bits 5 to 0 - Sector number (not value checked)
- (DH) - Head number (0-based, not value checked)
- (DL) - Drive number; bit 7 = 1 for fixed disk drive (0-based)

### On Return:

- (AH) - Status of operation (see values for the status of operation on page 2-IN13F-2)
- CF = 0 - Status is 0
  - = 1 - Status is non 0

Address hex 40:74 is set to the status of operation.

**Note:** If the fixed disk BIOS reports an error, reset the disk system and retry the operation.

## **(AH) = 05H—Format Desired Track**

- (CH) - Cylinder number (low 8 bits of 10-bit cylinder number, 0-based, not value checked)
- (CL) - Bits 7, 6 - Cylinder number (high 2 bits of 10-bit cylinder number, 0-based, not value checked)
  - Bits 5 to 0 - Sector number (not value checked)
- (DH) - Head number (0-based, not value checked)
- (DL) - Drive number; bit 7 = 1 for fixed disk drive (0-based)

### For PC/XT:

- (AL) - Interleaving value

### On Return:

- (AH) - Status of operation (see values for the status of operation on page 2-IN13F-2)
- CF = 0 - Status is 0
  - = 1 - Status is non 0

For AT, PC/XT Model 286, and Personal System/2 products:

(ES:BX) - Address of buffer

(ES:BX) points to a 512-byte buffer. The first  
[2 x (number of sectors per track)] bytes contain *F* and *N*  
for each sector, where  
F = 00H - Good sector  
= 80H - Bad sector  
N - Sector number

On Return:

(AH) - Status of operation (see values for the status of  
operation on page 2-IN13F-2)  
CF = 0 - Status is 0  
= 1 - Status is non 0

Address hex 40:74 is set to the status of operation.

For any device that uses enhanced small device interface (ESDI)  
type or small computer system interface (SCSI) type commands,  
this function is not supported:

On Return:

(AH) - Status of operation  
= 01H - Invalid function request  
CF = 1 - Error

Address hex 40:74 is set to the status of operation.

**Note:** If the fixed disk BIOS reports an error, reset the disk  
system and retry the operation.

**(AH) = 06H—Format Desired Track and Set Bad-Sector Flags**

**Warning:** Formatting destroys all information on the fixed disk.

For PC/XT:

- (AL) - Interleaving value
- (CH) - Cylinder number (low 8 bits of 10-bit cylinder number, 0-based, not value checked)
- (CL) - Bits 7, 6 - Cylinder number (high 2 bits of 10-bit cylinder number, 0-based, not value checked)
  - Bits 5 to 0 - Sector number (not value checked)
- (DH) - Head number (0-based, not value checked)
- (DL) - Drive number; bit 7 = 1 for fixed disk drive (0-based)

On Return:

(AH) - Status of operation (see values for the status of operation on page 2-IN13F-2)

CF = 0 - Status is 0

= 1 - Status is non 0

Address hex 40:74 is set to the status of operation.

For AT, PC/XT Model 286, Personal System/2 products, and any device that uses ESDI- or SCSI-type commands, this function is not supported:

On Return:

(AH) - Status of operation

= 01H - Invalid function request

CF = 1 - Error

**Note:** If the fixed disk BIOS reports an error, reset the disk system and retry the operation.

## **(AH) = 07H—Format Drive Starting at Desired Cylinder**

For PC/XT:

- (AL) - Interleaving value
- (CH) - Cylinder number (low 8 bits of 10-bit cylinder number, 0-based, not value checked)
- (CL) - Bits 7, 6 - Cylinder number (high 2 bits of 10-bit cylinder number, 0-based, not value checked)  
- Bits 5 to 0 - Sector number (not value checked)
- (DL) - Drive number; bit 7 = 1 for fixed disk drive (0-based)

On Return:

- (AH) - Status of operation (see values for the status of operation on page 2-IN13F-2)
- CF = 0 - Status is 0  
= 1 - Status is non 0

Address hex 40:74 is set to the status of operation.

For AT, PC/XT Model 286, Personal System/2 products, and any device that uses ESDI- or SCSI-type commands, this function is not supported:

On Return:

- (AH) - Status of operation  
= 01H - Invalid function request
- CF = 1 - Error

**Note:** If the fixed disk BIOS reports an error, reset the disk system and retry the operation.

## **(AH) = 08H—Read Drive Parameters**

If the drive number is not valid, (AH) and address hex 40:74 are set to hex 07 (last fixed disk drive operation status), (CX) and (DX) are set to 0, and CF is set to 1. If no fixed disk drive is attached or no fixed disk drive adapter is installed, (AH) and address hex 40:41 are set to hex 01 (last diskette drive operation status), and CF is set to 1.

(DL) - Drive number; bit 7 = 1 for fixed disk drive (0-based)

On Return:

- (CH) - Maximum value for cylinder number (range is from 0 to hex 3FFF)
- (CL) - Maximum value for sector and high-order 2 bits of cylinder numbers
- (DL) - Number of consecutive drives attached
- (DH) - Maximum value for head number (range is from 0 to hex 3F)

## **(AH) = 09H—Initialize Drive Pair Characteristics**

(DL) - Drive number; bit 7 = 1 for fixed disk drive (0-based)

On Return:

(AH) - Status of operation (see values for the status of operation on page 2-IN13F-2)

CF = 0 - Status is 0

= 1 - Status is non 0

For PC/XT:

Interrupt 41H points to the parameter tables. Four entries in the PC/XT table correspond to the switch setting on the fixed disk drive adapter. The switches act as an index into the parameter table. For example, if both switches are set to the "on" position, the drive is initialized with the first entry of the parameter table. If the drive number is an allowable value (that is,  $80H \leq (DL) \leq 87H$ ), both drive 0 and drive 1 are initialized. For all other values, an unsupported-command status is returned. If drive 0 initialization fails, drive 1 initialization is not attempted. If either attempt fails, address hex 40:74 (last fixed disk drive operation status) and (AH) are updated with the appropriate error code.

For AT, PC/XT Model 286, and Personal System/2 products with Micro Channel\* architecture that do not have ESDI or SCSI:

Interrupt 41H points to the single parameter table for drive 0, and Interrupt 46H points to the single parameter table for drive 1. If (DL) = 80H, drive 0 is initialized through Interrupt 41H. If (DL) = 81H, drive 1 is initialized through Interrupt 46H. For all other values, an unsupported-command status is returned.

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\* Micro Channel is a trademark of the International Business Machines Corporation.

For any device that uses ESDI- or SCSI-type commands:

This function performs no action. Drive configuration information is obtained from the drive, not from a table in the system ROM. The controller automatically performs drive-type initialization.

**Note:** If the fixed disk BIOS reports an error, reset the disk system and retry the operation.

#### **(AH) = 0AH to 0BH—Reserved**

#### **(AH) = 0CH—Seek**

(CH) - Cylinder number (low 8 bits of 10-bit cylinder number, 0-based, not value checked)

(CL) - Bits 7, 6 - Cylinder number (high 2 bits of 10-bit cylinder number, 0-based, not value checked)  
- Bits 5 to 0 - Sector number (not value checked)

(DH) - Head number (0-based, not value checked)

(DL) - Drive number; bit 7 = 1 for fixed disk drive (0-based)

On Return:

(AH) - Status of operation (see values for the status of operation on page 2-IN13F-2)

CF = 0 - Status is 0

= 1 - Status is non 0

Address hex 40:74 is set to the status of operation.

**Note:** If the fixed disk BIOS reports an error, reset the disk system and retry the operation.

#### **(AH) = 0DH—Alternative Disk Reset**

(DL) - Drive number; bit 7 = 1 for fixed disk drive (0-based)

On Return:

(AH) - Status of operation (see values for the status of operation on page 2-IN13F-2)

CF = 0 - Status is 0

= 1 - Status is non 0

Address hex 40:74 is set to the status of operation.

**Notes:**

1. The Alternative Disk Reset function is issued only if the 7-bit drive number is less than the maximum number of fixed disk drives that are installed. The diskette system is not reset.
2. For Personal System/2 Model 35 SX, Model 35 LS, Model 40 SX, and Model L40 SX, both the master drive and the slave drive respond to the Reset function that is issued to either drive. Both drives are reset.

**(AH) = 0EH to 0FH—Reserved**

**(AH) = 10H—Test Drive Ready**

(DL) - Drive number; bit 7 = 1 for fixed disk drive (0-based)

On Return:

(AH) - Status of operation (see values for the status of operation on page 2-IN13F-2)

CF = 0 - Status is 0

= 1 - Status is non 0

Address hex 40:74 is set to the status of operation.

**(AH) = 11H—Recalibrate**

(DL) - Drive number; bit 7 = 1 for fixed disk drive (0-based)

On Return:

(AH) - Status of operation (see values for the status of operation on page 2-IN13F-2)

CF = 0 - Status is 0

= 1 - Status is non 0

Address hex 40:74 is set to the status of operation.

**Note:** If the fixed disk BIOS reports an error, reset the disk system and retry the operation.

**(AH) = 12H to 14H—Reserved**

## **(AH) = 15H—Read DASD Type**

For PC/XT, this function is not supported:

On Return:

- (AH) - Status of operation
  - = 01H - Invalid function request
- CF = 1 - Error

Address hex 40:74 is set to the status of operation.

For AT, PC/XT Model 286, and Personal System/2 products:

(DL) - Drive number; bit 7 = 1 for fixed disk drive (0-based)

On Return:

- (CX,DX) - Number of 512-byte blocks
  - DX - Least significant byte
  - CX - Most significant byte
  - If (AH) = 0, (CX) = 0 and (DX) = 0
- (AH) = 00H - Drive not present or (DL) is not supported
  - = 01H - Reserved
  - = 02H - Reserved
  - = 03H - Fixed disk
- CF = 0 - Operation successfully completed

Address hex 40:74 is set to the status of operation.

## **(AH) = 16H to 18H—Reserved**

## **(AH) = 19H—Park Heads**

For PC/XT, AT, and PC/XT Model 286, this function is not supported:

On Return:

- (AH) - Status of operation
  - = 01H - Invalid function request
- CF = 1 - Error

Address hex 40:74 is set to the status of operation.

For Personal System/2 products except Model 35 SX,  
Model 35 LS, Model 40 SX, and Model L40 SX:

(DL) - Drive number; bit 7 = 1 for fixed disk drive (0-based)

On Return:

(AH) - Status of operation (see values for the status of  
operation on page 2-IN13F-2)

CF = 0 - Status is 0

= 1 - Status is non 0

Address hex 40:74 is set to the status of operation.

### **(AH) = 1AH to 20H—Reserved**

### **(AH) = 21H—Read Multiple Sectors into Memory**

For Personal System/2 Model 35 SX, Model 35 LS, Model 40 SX,  
and Model L40 SX:

(AL) - Number of sectors

(CH) - Cylinder number (low 8 bits of 10-bit cylinder number,  
0-based, not value checked)

(CL) - Bits 7, 6 - Cylinder number (high 2 bits of 10-bit  
cylinder number, 0-based, not value checked)  
- Bits 5 to 0 - Sector number (not value checked)

(DH) - Head number (0-based, not value checked)

(DL) - Drive number; bit 7 = 1 for fixed disk drive (0-based)

(ES:BX) - Address of buffer

On Return:

(AH) - Status of operation (see values for the status of  
operation on page 2-IN13F-2)

CF = 0 - Status is 0

= 1 - Status is non 0

Address hex 40:74 is set to the status of operation.

This function is exactly the same as the Read Desired Sectors  
into Memory function ((AH) = 02H) except for the way in which  
data transfers are performed. The unit of data transfer (block  
size) must be specified through the Set Multiple Mode function  
((AH) = 24H) before this function is called.

## **(AH) = 22H—Write Multiple Sectors from Memory**

For Personal System/2 Model 35 SX, Model 35 LS, Model 40 SX, and Model L40 SX:

- (AL) - Number of sectors
- (CH) - Cylinder number (low 8 bits of 10-bit cylinder number, 0-based, not value checked)
- (CL) - Bits 7, 6 - Cylinder number (high 2 bits of 10-bit cylinder number, 0-based, not value checked)
  - Bits 5 to 0 - Sector number (not value checked)
- (DH) - Head number (0-based, not value checked)
- (DL) - Drive number; bit 7 = 1 for fixed disk drive (0-based)
- (ES:BX) - Address of buffer

On Return:

- (AH) - Status of operation (see values for the status of operation on page 2-IN13F-2)
- CF = 0 - Status is 0
  - = 1 - Status is non 0

Address hex 40:74 is set to the status of operation.

This function is exactly the same as the Write Desired Sectors from Memory function ((AH) = 03H) except for the way in which data transfers are performed. The unit of data transfer (block size) must be specified through the Set Multiple Mode function ((AH) = 24H) before this function is called.

## **(AH) = 23H—Reserved**

## **(AH) = 24H—Set Multiple Mode**

For Personal System/2 Model 35 SX, Model 35 LS, Model 40 SX, and Model L40 SX, this function specifies the number of sectors that are transferred by the Read Multiple Sectors into Memory function ((AH) = 21H) and the Write Multiple Sectors from Memory function ((AH) = 22H).

If the specified number of sectors is 0, the multiple-transfer mode is disabled. If an error is detected during execution of the Set Multiple Mode function, the number of sectors is set to 0, which causes the multiple-transfer mode to be disabled until the Set Multiple Mode function is called again.

- (AL) - Block size (the number of sectors per interrupt that are transferred by multiple read or write operations)
- (DL) - Drive number; bit 7 = 1 for fixed disk drive (0-based)

On Return:

- (AH) - Status of operation (see values for the status of operation on page 2-IN13F-2)
- CF = 0 - Status is 0
- = 1 - Status is non 0

Address hex 40:74 is set to the status of operation.

The maximum value for the block size depends on the fixed disk drive type. The value is stored in byte hex 15 of the fixed disk drive parameter table that is created by POST.

### **(AH) = 25H—Identify Drive**

For Personal System/2 Model 35 SX, Model 35 LS, Model 40 SX, and Model L40 SX:

- (DL) - Drive number; bit 7 = 1 for fixed disk drive (0-based)
- (ES:BX) - Address of buffer

On Return:

- (AH) - Status of operation (see values for the status of operation on page 2-IN13F-2)
- CF = 0 - Status is 0
- = 1 - Status is non 0

Address hex 40:74 is set to the status of operation.

The buffer stores 512 bytes of characteristic information for the fixed disk drive:

Word	Definition
0	General configuration
1	Number of logical cylinder
2	Reserved
3	Number of logical cylinder
4	Number of unformatted bytes per logical track
5	Number of unformatted bytes per sector
6	Number of logical sectors per track
7	Number of bytes in the inter-sector gaps
8	Number of bytes in the Sync field
9	Number of bytes of vendor-unique status
10 to 19	Serial number (20 ASCII characters)
20	Controller type
21	Controller-buffer size (in 512-byte increments)
22	Number of ECC bytes passed on read/write long
23 to 26	Controller-firmware revision (8 ASCII characters)
27 to 46	Model number (40 ASCII characters)
47	Number of sectors for multiple read/write
48	Doubleword I/O capacity
49	Programmable reallocation capacity
50 to 255	Reserved

Figure 2-17. Fixed Disk Drive Identification Buffer

**(AH) = 26H to FFH—Reserved**

## Interrupt 14H—Asynchronous Communication

These routines provide RS-232C support. The following is a summary of the RS-232C support functions of Interrupt 14H.

(AH) = 00H – Initialize the Communication Port
(AH) = 01H – Send Character
(AH) = 02H – Receive Character
(AH) = 03H – Read Status
(AH) = 04H – Extended Initialization
(AH) = 05H – Extended Communication Port Control
(AH) = 06H to FFH – Reserved

Figure 2-18. INT 14H Asynchronous Communication Functions

**Note:** All reserved input fields must be set to 0.

### (AH) = 00H—Initialize the Communication Port

(AL) - Parameters for initialization

Bits 7 to 5 - Baud rate (values are binary)

- = 000 - 110 baud
- = 001 - 150 baud
- = 010 - 300 baud
- = 011 - 600 baud
- = 100 - 1200 baud
- = 101 - 2400 baud
- = 110 - 4800 baud
- = 111 - 9600 baud

For Personal System/2 products, for baud rates above 9600, see Interrupt 14H, (AH) = 04H and (AH) = 05H.

Bits 4, 3 - Parity (values are binary)

- = 00 - None
- = 01 - Odd
- = 10 - None
- = 11 - Even

Bit 2 - Stop bit

- = 0 - 1
- = 1 - 2

Bits 1, 0 - Data length (values are binary)

= 00 - Reserved

= 01 - Reserved

= 10 - 7 bits

= 11 - 8 bits

(DX) - RS-232C communication line (0, 1, 2, or 3) to be used, corresponding to the actual port base addresses at address hex 40:00

On Return:

(AH) - Line status

Bit 7 = 1 - Time-out

Bit 6 = 1 - Transmitter shift register empty

Bit 5 = 1 - Transmitter holding register empty

Bit 4 = 1 - Break detection

Bit 3 = 1 - Framing error

Bit 2 = 1 - Parity error

Bit 1 = 1 - Overrun error

Bit 0 = 1 - Data ready

(AL) - Modem status

Bit 7 = 1 - Receive line signal detection

Bit 6 = 1 - Ring indicator

Bit 5 = 1 - Data set ready

Bit 4 = 1 - Clear to send

Bit 3 = 1 - Delta receive line signal detection

Bit 2 = 1 - Trailing-edge ring detector

Bit 1 = 1 - Delta data set ready

Bit 0 = 1 - Delta clear to send

**Note:** If bit 7 of the line-status byte is set to 1, settings of other bits are unpredictable.

### **(AH) = 01H—Send Character**

(AL) - Character to be sent

(DX) - RS-232C communication line (0, 1, 2, or 3) to be used, corresponding to actual port base addresses at address hex 40:00

On Return:

(AH) - Line status (see values for the line status on page 2-IN14-2)

(AL) is preserved

### **(AH) = 02H—Receive Character**

(DX) - RS-232C communication line (0, 1, 2, or 3) to be used, corresponding to actual port base addresses at address hex 40:00

On Return:

(AH) - Line status (see values for the line status on page 2-IN14-2)

(AL) - Character that was received

### **Notes:**

1. The routine waits for the character.
2. If bit 7 of the line status byte is set to 1, settings of other bits are unpredictable.

### **(AH) = 03H—Read Status**

(DX) - RS-232C communication line (0, 1, 2, or 3) to be used, corresponding to actual port base addresses at address hex 40:00

On Return:

(AH) - Line status (see values for the line status on page 2-IN14-2)

(AL) - Modem status (see values for the modem status on page 2-IN14-2)

### **(AH) = 04H—Extended Initialization**

For Personal System/2 products:

(AL) - Break

= 00H - No break

= 01H - Break

(BH) - Parity

= 00H - None

= 01H - Odd

= 02H - Even

= 03H - Stick parity odd

= 04H - Stick parity even

(BL) - Stop bit

= 00H - 1

= 01H - If the data-bit length is 6, 7, or 8 bits, the stop-bit length is 2 bits.

If the data-bit length is 5 bits, the stop-bit length is 1½ bits.

(CH) - Data-bit length

- = 00H - 5 bits
- = 01H - 6 bits
- = 02H - 7 bits
- = 03H - 8 bits

(CL) - Baud rate

- = 00H - 110 baud
- = 01H - 150 baud
- = 02H - 300 baud
- = 03H - 600 baud
- = 04H - 1200 baud
- = 05H - 2400 baud
- = 06H - 4800 baud
- = 07H - 9600 baud
- = 08H - 19200 baud
- = 09H - 31250 baud

(DX) - RS-232C communication line (0, 1, 2, or 3) to be used, corresponding to actual port base addresses at address hex 40:00

On Return:

(AH) - Line status (see values for the line status on page 2-IN14-2)

(AL) - Modem status (see values for the modem status on page 2-IN14-2)

For all others, no action is performed.

### **(AH) = 05H—Extended Communication Port Control**

For Personal System/2 products:

(AL) = 00H - Read modem-control register

(DX) - RS-232C communication line (0, 1, 2, or 3) to be used, corresponding to actual port base addresses at address hex 40:00

On Return:

(BL) - Modem-control register

Bits 7 to 5 - Reserved

Bit 4 = 1 - Loop

Bit 3 = 1 - Out2

Bit 2 = 1 - Out1

Bit 1 = 1 - Request to send

Bit 0 = 1 - Data terminal ready

- (AL) = 01H - Write modem-control register
- (BL) - Modem-control register
  - Bits 7 to 5 - Reserved
  - Bit 4 = 1 - Loop
  - Bit 3 = 1 - Out2
  - Bit 2 = 1 - Out1
  - Bit 1 = 1 - Request to send
  - Bit 0 = 1 - Data terminal ready
- (DX) - RS-232C communication line (0, 1, 2, or 3) to be used, corresponding to actual port base addresses at address hex 40:00

On Return:

- (AH) - Line status (see values for the line status on page 2-IN14-2)
- (AL) - Modem status (see values for the modem status on page 2-IN14-2)

For all others, no action is performed.

**(AH) = 06H to FFH—Reserved**

**Programming Consideration**

| If the communication line that is specified in (DX) does not have a  
| corresponding port base address at hex 40:00, the function is not  
| executed, and it does not return an error to the caller.

## **Notes:**

## Interrupt 15H—System Services

The following is a summary of the system services of Interrupt 15H.

(AH) = 00H – Turn Cassette Motor On  
(AH) = 01H – Turn Cassette Motor Off  
(AH) = 02H – Read Blocks from Cassette  
(AH) = 03H – Write Blocks to Cassette  
(AH) = 04H – Build System Parameters Table  
(AH) = 05H – Build Initialization Table  
(AH) = 06H to 0EH – Reserved  
(AH) = 0FH – Format-Unit Periodic Interrupt  
(AH) = 10H to 20H – Reserved  
(AH) = 21H – Power-On Self-Test Error Log  
(AH) = 22H – ROM BASIC Support  
(AH) = 23H – Reserved  
(AH) = 24H – A20 Gate Support  
(AH) = 25H to 3FH – Reserved  
(AH) = 40H – Read/Modify Profiles  
(AH) = 41H – Wait for External Event  
(AH) = 42H – Request System Power-Off  
(AH) = 43H – Read System Status  
(AH) = 44H – Activate/Deactivate Internal Modem Power  
(AH) = 45H to 4EH – Reserved  
(AH) = 4FH – Keyboard Intercept  
(AH) = 50H – Reserved  
(AH) = 51H – Expansion-Unit Information  
(AH) = 52H to 7FH – Reserved  
(AH) = 80H – Device Open  
(AH) = 81H – Device Close  
(AH) = 82H – Program Termination  
(AH) = 83H – Event Wait  
(AH) = 84H – Joystick Support  
(AH) = 85H – System Request Key Pressed  
(AH) = 86H – Wait  
(AH) = 87H – Move Block  
(AH) = 88H – Extended-Memory Size Determination  
(AH) = 89H – Switch Processor to Protected Mode  
(AH) = 8AH to 8FH – Reserved  
(AH) = 90H – Device Busy  
(AH) = 91H – Interrupt Complete  
(AH) = 92H to BFH – Reserved  
(AH) = C0H – Return System Configuration Parameters  
(AH) = C1H – Return Extended BIOS Data Area Segment Address  
(AH) = C2H – Pointing Device BIOS Interface  
(AH) = C3H – Enable/Disable Watchdog Time-Out  
(AH) = C4H – Programmable Option Select  
(AH) = C5H to C6H – Reserved

Figure 2-19 (Part 1 of 2). INT 15H System Services Functions

(AH) = C7H – Return Memory-Map Information
(AH) = C8H – Enable/Disable Processor Functions
(AH) = C9H – Processor Type and Stepping Level
(AH) = CAH to CDH – Reserved
(AH) = CEH – Allocate Arbitration Level
(AH) = CFH – Deallocate Arbitration Level
(AH) = D0H – Reserved
(AH) = D1H – Return Device Descriptor Table (DDT) Information
(AH) = D2H to D3H – Reserved
(AH) = D4H – Return Physical Fixed Disk Drive Number (Selectable Boot)
(AH) = D5H – Reserved
(AH) = D6H – Return Boot Device ID and Key
(AH) = D7H to FFH – Reserved

*Figure 2-19 (Part 2 of 2). INT 15H System Services Functions*

**Note:** All reserved input fields must be set to 0.

**(AH) = 00H—Turn Cassette Motor On**

For PCjr and PC:

On Return:  
 (AH) = 00H  
 CF = 0

For all others, this function is not supported:

On Return:  
 (AH) = 86H  
 CF = 1

**(AH) = 01H—Turn Cassette Motor Off**

For PCjr and PC:

On Return:  
 (AH) = 00H  
 CF = 0

For all others, this function is not supported:

On Return:  
 (AH) = 86H  
 CF = 1

## **(AH) = 02H—Read Blocks from Cassette**

For *PCjr* and PC:

(CX) - Count of bytes to be read  
(ES:BX) - Pointer to data buffer

On Return:

(DX) - Count of bytes read  
(ES:BX) - Pointer to last byte that was read + 1  
CF = 0 - Operation successfully completed  
= 1 - Operation failed  
For *PCjr*, when CF = 1:  
(AH) = 01H - CRC error  
= 02H - Lost data transitions  
= 04H - No data found

For all others, this function is not supported:

On Return:  
(AH) = 86H  
CF = 1

## **(AH) = 03H—Write Blocks to Cassette**

For *PCjr* and PC:

(CX) - Count of bytes to be written  
(ES:BX) - Pointer to data buffer

On Return:

(CX) = 00H  
(ES:BX) - Pointer to last byte that was written + 1  
CF = 0 - Operation successfully completed  
= 1 - Operation failed  
For *PCjr*, when CF = 1:  
(AH) = 01H - CRC error  
= 02H - Lost data transitions  
= 04H - No data found

For all others, this function is not supported:

On Return:  
(AH) = 86H  
CF = 1

| **(AH) = 04H—Build System Parameters Table**

| See “Build System Parameters Table—Operating System” and “Build System Parameters Table—BIOS” in the Advanced BIOS “Initialization” section.

| **(AH) = 05H—Build Initialization Table**

| See “Build Initialization Table—Operating System” and “Build Initialization Table—BIOS” in the Advanced BIOS “Initialization” section.

**(AH) = 0FH—Format-Unit Periodic Interrupt**

For any device that uses ESDI-type commands:

(AL) - Phase code  
= 00H - Reserved  
= 01H - Surface analysis  
= 02H - Formatting

On Return:  
CF = 0 - Continue formatting or scanning  
= 1 - End formatting or scanning

**Note:** This function provides a hook to the caller when the formatting or scanning of each cylinder is complete. If no handler is hooked, CF is set to 1 on return.

For PCjr and PC, this function is not supported:

On Return:  
(AH) = 80H  
CF = 1

For all others, this function is not supported:

On Return:  
(AH) = 86H  
CF = 1

**(AH) = 10H to 20H—Reserved**

## **(AH) = 21H—Power-On Self-Test Error Log**

| This function reads from and writes to the power-on self-test (POST) error log area, which is used to communicate POST errors to the operating system.

For PCjr and PC, this function is not supported:

On Return:  
(AH) = 80H  
CF = 1

For Personal System/2 products except Model 25 and Model 30:

(AL) = 00H - Read POST error log

On Return:  
(BX) - Number of POST error codes that were stored  
(ES:DI) - Pointer to POST error log  
(AH) = 00H  
CF = 0

(AL) = 01H - Write error code to POST error log  
(BX) - POST error code (word)  
(BH) - Device code  
(BL) - Device error

On Return:  
(AH) = 00H - Successfully stored  
= 01H - Error code location full  
CF = 0 - Successfully stored  
= 1 - Error code location full

For all others, this function is not supported:

On Return:  
(AH) = 86H  
CF = 1

## **(AH) = 22H—ROM BASIC Support**

On Return:  
(ES:BX) - Pointer to ROM BASIC  
CF = 0 - Operation successfully completed  
= 1 - Request failed  
(AH) - Return code  
= 00H - Operation successfully completed  
= 86H - Function not supported (ROM BASIC is at address hex F600:0000)

**(AH) = 23H—Reserved**

**(AH) = 24H—A20 Gate Support**

(AL) = 00H - Disable A20 gate

On Return:

(AH) - Return code

- = 00H - Operation successfully completed
- = 01H - Keyboard controller is in secure mode
- = 86H - Function not supported

CF = 0 - Operation successfully completed  
= 1 - Operation failed

(AL) = 01H - Enable A20 gate

On Return:

(AH) - Return code

- = 00H - Operation successfully completed
- = 01H - Keyboard controller is in secure mode
- = 86H - Function not supported

CF = 0 - Operation successfully completed  
= 1 - Operation failed

(AL) = 02H - Query status of A20 gate

On Return:

(AL) - Status of A20 gate

- = 00H - Disabled
- = 01H - Enabled

(AH) - Return code

- = 00H - Operation successfully completed
- = 01H - Keyboard controller is in secure mode
- = 86H - Function not supported

CF = 0 - Operation successfully completed  
= 1 - Operation failed

(AL) = 03H - Query A20 gate support

On Return:

(BX) - Status of A20 gate support

- Bit 15 = 0 - No additional data available
- = 1 - All bits in register are used;  
additional data is available (location  
of additional data is to be determined)

- Bit 1 = 0 - Not supported with bit 1 of port hex 92
- = 1 - Supported with bit 1 of port hex 92

- Bit 0 = 0 - Not supported on keyboard controller
- = 1 - Supported on keyboard controller

(AH) - Return code

- = 00H - Operation successfully completed
- = 01H - Keyboard controller is in secure mode
- = 86H - Function not supported

CF = 0 - Operation successfully completed  
= 1 - Operation failed

**(AH) = 25H to 3FH—Reserved**

**(AH) = 40H—Read/Modify Profiles**

For PCjr and PC, this function is not supported:

On Return:  
(AH) = 80H  
CF = 1

For PC Convertible:

(AL) = 00H - Read system profile

On Return:  
(CX,BX) - Profile information

(AL) = 01H - Modify system profile  
(CX,BX) - Profile information

(AL) = 02H - Read internal modem profile

On Return:  
(BX) - Profile information

(AL) = 03H - Modify internal modem profile  
(BX) - Profile information

On Return for all:  
(AL) = 00H - Operation successfully completed  
      = 80H - Profile execution failed  
CF = 0 - Operation successfully completed  
      = 1 - Operation failed

For all others, this function is not supported:

On Return:  
(AH) = 86H  
CF = 1

**(AH) = 41H—Wait for External Event**

For PCjr and PC, this function is not supported:

On Return:  
(AH) = 80H  
CF = 1

For products that support this function:

- (AL) - Event-type code
  - = 00H - Return after any event has occurred
  - = 01H - Compare values, return if equal
  - = 02H - Compare values, return if not equal
  - = 03H - Test bit, return if not 0
  - = 04H - Test bit, return if 0
- (BH) - Condition compare or mask value
- (BL) - Time-out value (in 55-millisecond units)
  - = 0 - No time-out
- (ES:DI) - Pointer to byte in user area for event determination (event-type codes 01H to 04H)
  - or -
  - (DX) contains the I/O port address to be read for event determination (event-type codes 11H to 14H)

On Return:  
CF = 1 - Time-out

#### Notes:

1. Event type codes (AL) = 11H, 12H, 13H, and 14H are the same as codes (AL) = 01H, 02H, 03H, and 04H, respectively, except that (DX) is used to contain the event determination address.
2. To determine which products support this function, see Interrupt 15H, Return System Configuration Parameters function ((AH) = C0H), feature information byte 1, bit 3.

For all others, this function is not supported:

On Return:  
(AH) = 86H  
CF = 1

#### (AH) = 42H—Request System Power-Off

For PCjr and PC, this function is not supported:

On Return:  
(AH) = 80H  
CF = 1

For PC Convertible:

(AL) = 00H - Use system profile for suspend/IPL determination  
(AL) = 01H - Force system suspend mode, regardless of profile

On Return:  
(AX) is modified

For all others, this function is not supported:

On Return:  
(AH) = 86H  
CF = 1

### **(AH) = 43H—Read System Status**

For PCjr and PC:

On Return:  
CF = 1  
(AH) = 80H

For PC Convertible:

On Return:  
(AH) is modified  
(AL) - Status

- Bit 7 - Low battery indication
- Bit 6 - Operating on external power source
- Bit 5 - Standby power lost (real-time clock time bad)
- Bit 4 - Power activated by real-time clock alarm
- Bit 3 - Internal modem power-on
- Bit 2 - RS-232C/parallel power-on
- Bit 1 - Reserved
- Bit 0 - LCD detached

For all others, this function is not supported:

On Return:  
(AH) = 86H  
CF = 1

**(AH) = 44H—Activate/Deactivate Internal Modem Power**

For PCjr and PC, this function is not supported:

On Return:  
(AH) = 80H  
CF = 1

For PC Convertible:

(AL) = 00H - Power-off internal modem  
(AL) = 01H - Power-on internal modem and configure according  
to system profile

On Return:  
(AL) = 00H - Operation successfully completed  
= 80H - Operation failed  
CF = 0 - Operation successfully completed  
= 1 - Operation failed

For all others, this function is not supported:

On Return:  
(AH) = 86H  
CF = 1

**(AH) = 45H to 4EH—Reserved**

**(AH) = 4FH—Keyboard Intercept**

For PCjr and PC, this function is not supported:

On Return:  
(AH) = 80H  
CF = 1

For PC/XT BIOS dated 11/8/82 and AT BIOS dated 1/10/84, this  
function is not supported:

On Return:  
(AH) = 86H  
CF = 1

For all others, Interrupt 09H (Keyboard) calls the keyboard intercept (keyboard escape) to allow the keystroke to be changed or absorbed. Normally, the system returns the scan code unchanged, but the operating system can point Interrupt 15H to itself and do one of the following:

1. Replace (AL) with a different scan code and return the carry flag set to 1, effectively changing the keystroke.
2. Process the keystroke and return with the carry flag reset, causing Interrupt 09H to ignore the keystroke.

(AL) - Scan code  
CF = 1

On Return:  
CF = 1  
(AL) - New scan code  
- or -  
CF = 0  
(AL) - Unchanged scan code

**Note:** To determine which products support this function, see Interrupt 15H, Return System Configuration Parameters function ((AH) = C0H), feature information byte 1, bit 4.

**(AH) = 50H to 7FH—Reserved**

## **(AH) = 51H—Expansion-Unit Information**

(AL) = 01H - Return configuration number

On Return:

(AL) - Current configuration number  
= 00H - System unit only  
= FFH - Configuration not recognized

(BX) - Status flag

Bit 15 = 0 - No additional configuration information is available  
= 1 - Additional configuration information is available  
(the access method is to be determined)

Bits 14 to 0 - Reserved

(AH) - Return code  
= 00H - Operation successfully completed  
= 01H - Expansion unit is not present  
= 86H - Function not supported

CF = 0 - Operation failed  
= 1 - Operation successfully completed

## **(AH) = 80H—Device Open**

For PCjr and PC, this function is not supported:

On Return:  
(AH) = 80H  
CF = 1

For PC/XT BIOS dated 11/8/82, this function is not supported:

On Return:  
(AH) = 86H  
CF = 1

For all others:

(BX) - Device ID  
(CX) - Process ID

## **(AH) = 81H—Device Close**

For PCjr and PC, this function is not supported:

On Return:  
(AH) = 80H  
CF = 1

For PC/XT BIOS dated 11/8/82, this function is not supported:

On Return:  
(AH) = 86H  
CF = 1

For all others:

(BX) - Device ID  
(CX) - Process ID

### **(AH) = 82H—Program Termination**

For PCjr and PC, this function is not supported:

On Return:  
(AH) = 80H  
CF = 1

For PC/XT BIOS dated 11/8/82, this function is not supported:

On Return:  
(AH) = 86H  
CF = 1

For all others:

(BX) - Device ID

### **(AH) = 83H—Event Wait**

For PCjr and PC, this function is not supported:

On Return:  
(AH) = 80H  
CF = 1

For PC/XT, this function is not supported:

On Return:  
(AH) = 86H  
CF = 1

For AT BIOS dated 1/10/84:

- (CX,DX) - Microseconds until posting  
(granularity is 976 microseconds)
- (ES:BX) - Pointer to byte in caller's memory that has the high-order bit set by BIOS as soon as possible after the interval expires

On Return:  
CF = 0 - Operation successfully completed  
= 1 - Operation failed; function busy

For all others:

- (AL) = 00H - Set interval
- (ES:BX) - Pointer to byte in caller's memory that has the high order bit set by BIOS as soon as possible after the interval expires
- (CX,DX) - Microseconds until posting  
(granularity is 976 microseconds)

On Return:  
CF = 0 - Operation successfully completed  
= 1 - Operation failed, function busy

(AL) = 01H - Cancel set interval

On Return:  
CF = 0 - Operation successfully completed

(Personal System/2 Model 25 and Model 30 always return with CF = 1.)

### **(AH) = 84H—Joystick Support**

For PCjr, PC, and PC Convertible, this function is not supported:

On Return:  
(AH) = 80H  
CF = 1

For PC/XT BIOS dated 11/8/82, this function is not supported:

On Return:  
(AH) = 86H  
CF = 1

For all others:

(DX) = 00H - Read current switch settings

On Return:

(AL) - Switch settings (bits 7 to 4)

CF = 1 - Invalid call

(DX) = 01H - Read resistive inputs

On Return:

(AX) - Joystick A, x value

(BX) - Joystick A, y value

(CX) - Joystick B, x value

(DX) - Joystick B, y value

CF = 1 - Invalid call

### **(AH) = 85H—System Request Key Pressed**

For PCjr and PC, this function is not supported:

On Return:

(AH) = 80H

CF = 1

For PC/XT BIOS dated 11/8/82, this function is not supported:

On Return:

(AH) = 86H

CF = 1

For all others:

(AL) = 00H - Key make

(AL) = 01H - Key break

### **(AH) = 86H—Wait**

For PCjr and PC, this function is not supported:

On Return:

(AH) = 80H

CF = 1

For PC/XT, this function is not supported:

On Return:  
(AH) = 86H  
CF = 1

For all others:

(CX,DX) - Time before return to caller, in microseconds  
(granularity is 976 microseconds)

On Return:  
CF = 0 - Successful wait  
= 1 - Wait function already in progress

### **(AH) = 87H—Move Block**

For PCjr and PC, this function is not supported:

On Return:  
(AH) = 80H  
CF = 1

For PC/XT, PC Convertible, and Personal System/2 Model 25 and Model 30, this function is not supported:

On Return:  
(AH) = 86H  
CF = 1

For AT, PC/XT Model 286, and Personal System/2 products except Model 25 and Model 30, this function allows a real-mode program or system to transfer a block of data to and from storage above the 1MB protected-mode address range by switching to the protected mode.

(CX) - Word count of storage block to be moved  
(maximum count = 8000H for 32KB words [65KB])  
(ES:SI) - Location of a global descriptor table (GDT) that was built by a routine that is using this function

(ES:SI) points to a global descriptor table (GDT) that was built before this function was called. The descriptors are used to perform the block move in the protected mode. The source and target descriptors that are built by the user must have a segment length equal to or greater than  $2 \times ((CX) - 1)$ . The data-access rights byte must be set to current privilege level 0 with read/write

access (hex 93). The 24-bit address (byte high, word low) must be set to the target or source.

**Note:** No interrupts are allowed during transfers. Large block moves might cause lost interrupts.

On Return:

(AH) = 00H - Operation successfully completed

(AH) = 01H - RAM parity (parity error registers cleared)

(AH) = 02H - Other exception interrupt error occurred

(AH) = 03H - Gate address line 20H failed; all registers except (AH) are restored

If (AH) = 00H:

CF = 0

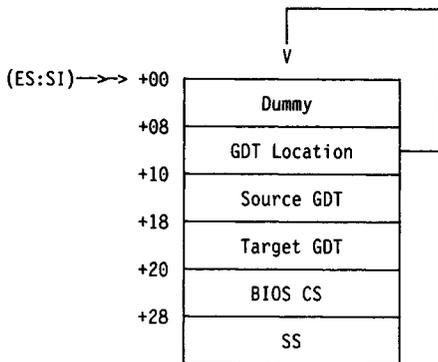
ZF = 1

If (AH) = 01H to 03H:

CF = 1

ZF = 0

The following figure shows the organization of a block-move global descriptor table (GDT).



*Figure 2-20. Block Move Global Descriptor Table*

The following is the format of the global descriptor table (the actual location that is pointed to by (ES:SI)):

```
BLOCKMOVE_GDT_DEF  STRUC
                    DW    0,0,0,0    ; First descriptor not accessible
CGDT_LOC           DW    ?,?,?,0    ; Location of calling routine GDT
SOURCE             DW    ?,?,?,0    ; Source descriptor
TARGET            DW    ?,?,?,0    ; Target descriptor
BIOS_CS           DW    ?,?,?,0    ; BIOS code descriptor
TEMP_SS           DW    ?,?,?,0    ; Stack descriptor
BLOCKMOVE_GDT_DEF  ENDS
```

*Figure 2-21. Global Descriptor Table Format*

The descriptors are defined as follows:

- The first descriptor is the required dummy and is user-initialized to 0.
- The second descriptor points to the GDT as a data segment. It is user-initialized to 0 and can be modified by BIOS.
- The third descriptor points to the source to be moved and is user-initialized (see Figure 2-22 on page 2-IN15-19).
- The fourth descriptor points to the destination segment and is user-initialized (see Figure 2-22 on page 2-IN15-19).
- The fifth descriptor is used by BIOS to create the protected-mode code segment. It is user-initialized to 0 and can be modified by BIOS.
- The sixth descriptor is used by BIOS to create a protected-mode stack segment. It is user-initialized to 0, can be modified by BIOS, and points to the user stack.

The following is an example of a source or target descriptor:

```
SOURCE_TARGET_DEF  STRUC
SEG_LIMIT           DW      ?      ; Segment limit (1 to 65536 bytes)
LO_WORD             DW      ?      ; 24-bit segment physical
HI_BYTE             DB      ?      ; address (0 to [16MB-1])
DATA_ACC_RIGHTS    DB      93H    ; Access rights byte (CPL 0-R/W)
Reserved            DW      0      ; Reserved word (must be 0)
SOURCE_TARGET_DEF  ENDS
```

*Figure 2-22. Source or Target Descriptor Example*

### **(AH) = 88H—Extended-Memory Size Determination**

For PCjr and PC, this function is not supported:

On Return:  
(AH) = 80H  
CF = 1

For PC/XT, PC Convertible, and Personal System/2 Model 25 and Model 30, this function is not supported:

On Return:  
(AH) = 86H  
CF = 1

For 80286-, 80386-, and 80486-processor systems, this function returns the amount of system memory that is between addresses hex 100000 and hex FFFFFFFF, as determined by POST.

On Return:  
(AX) - Contiguous 1KB blocks of available memory between addresses hex 100000 and hex FFFFFFFF (1MB to 16MB)

**Note:** The Return Memory-Map Information function ((AH) = C7H), if it is supported, returns the complete memory information.

### **(AH) = 89H—Switch Processor to Protected Mode**

For PCjr and PC, this function is not supported:

On Return:  
(AH) = 80H  
CF = 1

For PC/XT, PC Convertible, and Personal System/2 Model 25 and Model 30, this function is not supported:

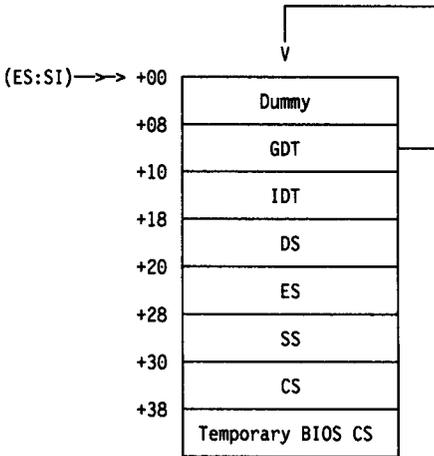
On Return:  
(AH) = 86H  
CF = 1

For AT, PC/XT Model 286, and Personal System/2 products except Model 25 and Model 30, this function allows the user to switch the system microprocessor into the protected (virtual address) mode. When this function is completed, the system microprocessor is in the protected mode, and control is transferred to the code segment that is specified by the user.

The entry requirements are as follows:

- (ES:SI) points to a global descriptor table (GDT) that was built before this function was called. These descriptors initialize the interrupt descriptor table (IDT) register, the GDT register, and the stack segment (SS) selector. The data segment (DS) selector, the extra segment (ES) selector, and the code segment (CS) selector are initialized from descriptors that were built by the routine that is using this function.
- (BH) contains an index into the interrupt descriptor table that indicates where the first eight hardware interrupts begin (interrupt level 1). (BL) contains an index into the interrupt descriptor table that indicates where the second eight hardware interrupts begin (interrupt level 2).

The following figure shows the organization of the selectors in this GDT; the actual location is pointed to by (ES:SI).



*Figure 2-23. Global Descriptor Table*

Each descriptor must contain the limit, the base address, and the access-rights byte. The descriptors are defined as follows:

- The first descriptor is the required dummy and is user-initialized to 0.
- The second descriptor points to the GDT as a data segment and is user-initialized.
- The third descriptor points to the user-defined interrupt descriptor table (IDT) and is user-initialized.
- The fourth descriptor points to the user data segment (DS) and is user-initialized.
- The fifth descriptor points to the user extra segment (ES) and is user-initialized.
- The sixth descriptor points to the user stack segment (SS) and is user-initialized.
- The seventh descriptor points to the user code segment (CS) that this function returns to. It is user-initialized.
- The eighth descriptor is used to establish a code segment for itself. This is necessary for this function to complete its operation while the system microprocessor is in the

protected mode. When control is passed to the user code, this descriptor can be reused.

(AH) = 89H  
(ES:SI) - Location of GDT built by a routine that is using this function

On Return:  
(AH) = 00H - Operation successfully completed

All segment registers are changed; (AX) and (BP) are modified.

### Considerations:

- BIOS functions are not available to the user. The user must handle all I/O commands.
- Interrupt vector locations must be moved, because of the 80286 reserved areas.
- The hardware interrupt controllers must be reinitialized to define locations that do not reside in the 80286 reserved areas.
- An exception interrupt table and handler must be initialized by the user.
- The interrupt descriptor table cannot overlap the real-mode BIOS interrupt descriptor table.

The following is an example of a way to switch the system microprocessor to the protected (virtual address) mode:

```
- User code -  
MOV     AX, gdt segment  
MOV     ES, AX  
MOV     SI, gdt offset  
MOV     BH, hardware interrupt level 1 offset into IDT  
MOV     BL, hardware interrupt level 2 offset into IDT  
MOV     AH, 89H  
INT     15H  
- User code -  
(Protected mode established)
```

The following is the format of the global descriptor table (the actual location that is pointed to by (ES:SI)).

```
VIRTUAL_ENABLE_GDT_DEF STRUC
        DW      0,0,0,0      ; First descriptor not accessible
GDTPTR_DW    DW      ?,?,?,0 ; GDT descriptor
IDTPTR      DW      ?,?,?,0 ; IDT descriptor
USER_DS     DW      ?,?,?,0 ; User data segment descriptor
USER_ES     DW      ?,?,?,0 ; User extra segment descriptor
USER_SS     DW      ?,?,?,0 ; User stack segment descriptor
USER_CS     DW      ?,?,?,0 ; User code segment descriptor
BIO_CS      DW      ?,?,?,0 ; Temporary BIOS descriptor
VIRTUAL_ENABLE_GDT_DEF ENDS
```

*Figure 2-24. Global Descriptor Table Format*

**(AH) = 8AH to 8FH—Reserved**

**(AH) = 90H—Device Busy**

For PCjr and PC, this function is not supported:

On Return:  
(AH) = 80H  
CF = 1

For PC/XT BIOS dated 11/8/82, this function is not supported:

On Return:  
(AH) = 86H  
CF = 1

For all others, this function is called to tell the operating system that the system is about to wait for a device.

The type-code assignments for (AH) = 90H and (AH) = 91H use the following general guidelines:

- Type codes hex 00 to hex 7F are for serially-reusable devices (the operating system must serialize access).
- Type codes hex 80 to hex BF are for reentrant devices. (ES:BX) is used to distinguish between different calls (multiple I/O calls are allowed simultaneously).
- Type codes hex C0 to hex FF are for wait-only calls. There is no complementary posting for these waits. These are time-out only. Times are function-number dependent.

(AL) - Type code  
= 00H - Disk (time-out)  
= 01H - Diskette (time-out)  
= 02H - Keyboard (no time-out)  
= 03H - Pointing device (time-out)  
= 80H - Network (no time-out)  
    (ES:BX) - Network control block (NCB)  
= FCH - Fixed disk reset for Personal System/2 products only  
    (time-out)  
= FDH - Diskette drive motor start (time-out)  
= FEH - Printer (time-out)

On Return:  
CF = 0 - Wait not satisfied  
    = 1 - Minimum wait time satisfied for  
        this type code

### **(AH) = 91H—Interrupt Complete**

For PCjr and PC, this function is not supported:

On Return:  
(AH) = 80H  
CF = 1

For PC/XT BIOS dated 11/8/82, this function is not supported:

On Return:  
(AH) = 86H  
CF = 1

For all others, the interrupt-complete flag is set to tell the operating system that the interrupt has occurred.

(AL) - Type code (see the type codes for the Device Busy function ((AH) = 90H) on page 2-IN15-24)

### **(AH) = 92H to BFH—Reserved**

### **(AH) = C0H—Return System Configuration Parameters**

To obtain a complete Micro Channel configuration table, the Return Memory-Map Information function ((AH) = C7H), the Processor Type and Stepping Level function ((AH) = C9H), and the Return Device Descriptor Table (DDT) Information function ((AH) = D1H) must be called in addition to the Return System Configuration Parameters function ((AH) = C0H).

For PCjr and PC, this function is not supported:

On Return:  
(AH) = 80H  
CF = 1

For PC/XT BIOS dated 11/8/82 and AT BIOS dated 1/10/84, this function is not supported:

On Return:  
(AH) = 86H  
CF = 1

For AT BIOS dated 6/10/85 and later, PC/XT BIOS dated 1/10/86 and later, PC/XT Model 286, PC Convertible, and Personal System/2 products:

On Return:  
(ES:BX) - Pointer to system configuration parameter table  
(AH) = 0  
CF = 0

System configuration parameters:

DW	XXXX	Length of table (in bytes)
DB	XX	Model byte
DB	XX	Submodel byte
DB	XX	BIOS revision level
DB	XX	Feature information byte 1
		Bit 7 = 0 - Fixed-disk BIOS does not use DMA channel 3 or channel-3 usage cannot be determined
		= 1 - Fixed-disk BIOS uses DMA channel 3 (not used in Micro Channel systems)
		Bit 6 = 0 - Second interrupt chip is not present
		= 1 - Second interrupt chip is present
		Bit 5 = 0 - Real-time clock is not present
		= 1 - Real-time clock is present
		Bit 4 = 0 - Keyboard escape sequence (Interrupt 15H, (AH)=4FH) is not called in Keyboard interrupt (09H)
		= 1 - Keyboard escape sequence is called in Keyboard interrupt

		<p>Bit 3 = 0 - Wait for External Event function (Interrupt 15H, (AH) = 41H) is not supported</p> <p>= 1 - Wait for External Event function is supported</p> <p>Bit 2 = 0 - Extended BIOS data area is not allocated</p> <p>= 1 - Extended BIOS data area is allocated</p> <p>Bit 1 = 0 - PC-type I/O channel is implemented</p> <p>= 1 - Micro Channel bus is implemented</p> <p>Bit 0 = 0 - System does not have dual-bus capability</p> <p>= 1 - System has dual-bus capability</p>
DB	XX	<p>Feature information byte 2</p> <p>Bit 7 - Reserved</p> <p>Bit 6 = 0 - Keyboard Functionality Determination function (Interrupt 16H, (AH) = 09H) is not supported</p> <p>= 1 - Keyboard Functionality Determination function is supported</p> <p>Bit 5 = 0 - Return POS Data function (Interrupt 15H, (AH) = C6H) is not supported</p> <p>= 1 - Return POS Data function is supported</p> <p>Bit 4 = 0 - Return Memory-Map Information function (Interrupt 15H, (AH) = C7H) is not supported</p> <p>= 1 - Return Memory-Map Information function is supported</p> <p>Bit 3 = 0 - Enable/Disable Processor Functions function (Interrupt 15H, (AH) = C8H) is not supported</p> <p>= 1 - Enable/Disable Processor Functions function is supported</p> <p>Bit 2 = 0 - 8042 keyboard controller is in the system</p> <p>= 1 - Non-8042 keyboard controller is in the system</p> <p>Bit 1 = 0 - Data streaming is not supported</p> <p>= 1 - Data streaming is supported</p> <p>Bit 0 - Reserved</p>
DB	XX	<p>Feature information byte 3</p> <p>Bits 7 to 4 - Reserved</p> <p>Bit 3 = 0 - SCSI subsystem is not supported on the system board</p> <p>= 1 - SCSI subsystem is supported on the system board</p> <p>Bit 2 = 0 - Information panel is not installed</p> <p>= 1 - Information panel is installed</p> <p>Bit 1 = 0 - Non-IML system</p> <p>= 1 - IML system</p> <p>Bit 0 = 0 - No SCSI support in IML</p> <p>= 1 - SCSI support in IML</p>

DB	XX	Feature information byte 4 Bits 7 to 0 - Reserved
DB	XX	Feature information byte 5 Bits 7 to 0 - Reserved

**Note:** For Personal System/2 products except Model 25 and Model 30, if the system model cannot be determined, this function returns (AH)=86H and CF=1, and (ES:BX) is not changed.

### **(AH) = C1H—Return Extended BIOS Data Area Segment Address**

On Return:

(ES) - Extended BIOS data area segment address  
CF = 0 - No error  
= 1 - Error

For PCjr and PC, this function is not supported:

On Return:

(AH) = 80H  
CF = 1

For PC/XT, AT, PC/XT Model 286, and PC Convertible, this function is not supported:

On Return:

(AH) = 86H  
CF = 1

### **(AH) = C2H—Pointing-Device BIOS Interface**

(AL) = 00H - Enable/disable pointing device  
(BH) = 00H - Disable  
= 01H - Enable

On Return:

(AH) - Status  
= 00H - No error  
= 01H - Invalid function call  
= 02H - Invalid input  
= 03H - Interface error  
= 04H - Resend  
= 05H - No far call installed  
CF = 0 - Operation successfully completed  
= 1 - Operation failed

(AL) = 01H - Reset pointing device

On Return:

(BL) - Value returned by the attached device after reset

((BL) is set to hex AA if the device is a mouse)

(AH) - Status (see return for (AL) = 00H)

CF = 0 - Operation successfully completed

= 1 - Operation failed

If the operation is successfully completed:

(BH) - Device ID

= 00H

The pointing-device state is as follows:

- Disabled

- Sample rate of 100 reports per second

- Resolution of 4 counts per millimeter

- Scaling of 1:1

- Data package size remains the same as before this function was called

(AL) = 02H - Set sample rate

(BH) - Sample rate value

= 00H - 10 reports per second

= 01H - 20 reports per second

= 02H - 40 reports per second

= 03H - 60 reports per second

= 04H - 80 reports per second

= 05H - 100 reports per second

= 06H - 200 reports per second

On Return:

(AH) - Status (see return for (AL) = 00H)

CF = 0 - Operation successfully completed

= 1 - Operation failed

(AL) = 03H - Set resolution

(BH) - Resolution value

= 00H - 1 count per millimeter

= 01H - 2 counts per millimeter

= 02H - 4 counts per millimeter

= 03H - 8 counts per millimeter

On Return:

(AH) - Status (see return for (AL) = 00H)

CF = 0 - Operation successfully completed

= 1 - Operation failed

(AL) = 04H - Read device type

On Return:

(AH) - Status (see return for (AL) = 00H)

CF = 0 - Operation successfully completed

= 1 - Operation failed

If the operation is successfully completed:

(BH) - Device ID

= 00H

(AL) = 05H - Pointing-device interface initialization

(BH) - Data package size

- = 00H - Reserved
- = 01H - 1 byte
- = 02H - 2 bytes
- = 03H - 3 bytes
- = 04H - 4 bytes
- = 05H - 5 bytes
- = 06H - 6 bytes
- = 07H - 7 bytes
- = 08H - 8 bytes

On Return:

(AH) - Status (see return for (AL) = 00H)

- CF = 0 - Operation successfully completed
- = 1 - Operation failed

The pointing-device state is as follows:

- Disabled
- Sample rate of 100 reports per second
- Resolution of 4 counts per millimeter
- Scaling at 1:1

(AL) = 06H - Extended commands

(BH) = 00H - Return status

On Return:

(AH) - Status (see return for (AL) = 00H)

- CF = 0 - Operation successfully completed
- = 1 - Operation failed

If the operation is successfully completed:

(BL) - Status byte 1

- Bit 7 = 0 - Reserved
- Bit 6 = 0 - Stream mode
- = 1 - Remote mode
- Bit 5 = 0 - Disable
- = 1 - Enable
- Bit 4 = 0 - 1:1 scaling
- = 1 - 2:1 scaling
- Bit 3 = 0 - Reserved
- Bit 2 = 1 - Left button pressed
- Bit 1 = 0 - Reserved
- Bit 0 = 1 - Right button pressed

(CL) - Status byte 2

- = 00H - 1 count per millimeter
- = 01H - 2 counts per millimeter
- = 02H - 4 counts per millimeter
- = 03H - 8 counts per millimeter

(DL) - Status byte 3  
= 0AH - 10 reports per second  
= 14H - 20 reports per second  
= 28H - 40 reports per second  
= 3CH - 60 reports per second  
= 50H - 80 reports per second  
= 64H - 100 reports per second  
= C8H - 200 reports per second

(BH) = 01H - Set scaling to 1:1

On Return:

(AH) - Status (see return for (AL) = 00H)  
CF = 0 - Operation successfully completed  
= 1 - Operation failed

(BH) = 02H - Set scaling to 2:1

On Return:

(AH) - Status (see return for (AL) = 00H)  
CF = 0 - Operation successfully completed  
= 1 - Operation failed

(AL) = 07H - Device-driver far-call initialization  
(ES) - Segment  
(BX) - Offset

On Return:

(AH) - Status (see return for (AL) = 00H)  
CF = 0 - Operation successfully completed  
= 1 - Operation failed

For PCjr and PC, this function is not supported:

On Return:

(AH) = 80H  
CF = 1

For PC/XT, AT, PC/XT Model 286, and PC Convertible, this function is not supported:

On Return:

(AH) = 86H  
CF = 1

The user codes a routine to receive control when the pointing-device data is available. The device-driver far-call initialization communicates the address of this routine to the BIOS. Each time the pointing-device data is available, the pointing-device interrupt handler calls the user routine, with the following parameters on the stack:

Status - First word pushed on the stack  
X data - Second word pushed on the stack  
Y data - Third word pushed on the stack  
Z data - Fourth word pushed on the stack

Word 1 on the stack:

Low byte - Status  
Bit 7 - Y data overflow  
= 1 - Overflow  
Bit 6 - X data overflow  
= 1 - Overflow  
Bit 5 - Y data sign  
= 1 - Negative  
Bit 4 - X data sign  
= 1 - Negative  
Bit 3 - Reserved (must be set to 1)  
Bit 2 - Reserved (must be set to 0)  
Bit 1 - Right-button status  
= 1 - Pressed  
Bit 0 - Left-button status  
= 1 - Pressed  
High byte = 0

Word 2 on the stack:

Low byte - X data  
Bit 7 = Most-significant bit  
Bit 0 - Least-significant bit  
High byte = 0

Word 3 on the stack:

Low byte - Y data  
Bit 7 = Most-significant bit  
Bit 0 - Least-significant bit  
High byte = 0

Word 4 on the stack:

Low byte = 0  
High byte = 0

The pointing-device interrupt handler uses a far call to transfer control to the user routine. This routine should be coded as a far procedure and should not pop the parameters off the stack before returning.

### **(AH) = C3H—Enable/Disable Watchdog Time-Out**

For PCjr and PC, this function is not supported:

On Return:  
(AH) = 80H  
CF = 1

For PC/XT, AT, PC/XT Model 286, PC Convertible, and Personal System/2 Model 25 and Model 30, this function is not supported:

On Return:  
(AH) = 86H  
CF = 1

For Personal System/2 products except Model 25 and Model 30:

(AL) = 00H - Disable the PS/2\* watchdog timer  
= 01H - Enable the PS/2 watchdog timer  
= 02H - Disable the Gearbox\* system  
= 03H - Enable the Gearbox system

(BX) - Watchdog timer count (values from 1 to 255 are valid for Personal System/2 products)

On Return:  
CF = 0 - Operation successfully completed  
= 1 - Operation failed or function not supported

### **(AH) = C4H—Programmable Option Select (POS)**

For PCjr and PC, this function is not supported:

On Return:  
(AH) = 80H  
CF = 1

---

\* PS/2 and Gearbox are trademarks of the International Business Machines Corporation.

For PC/XT, AT, PC/XT Model 286, PC Convertible, and Personal System/2 Model 25 and Model 30, this function is not supported:

On Return:  
(AH) = 86H  
CF = 1

For Personal System/2 products except Model 25 and Model 30:

(AL) = 00H - Return base POS-adapter-register address

On Return:  
(DX) - Base POS-adapter-register address  
CF = 0 - Operation successfully completed  
= 1 - Operation failed or function not supported

(AL) = 01H - Enable selected slot for setup cycles  
(BL) - Slot number

On Return:  
CF = 0 - Operation successfully completed  
= 1 - Operation failed or function not supported

(AL) = 02H - Disable setup cycles for all slots

On Return:  
CF = 0 - Operation successfully completed  
= 1 - Operation failed or function not supported

| The following is the procedure for reading the POS registers for all  
| slots in the system:

- | 1. Call the Return Base POS Adapter Register Address function  
| ((AL)=00H). (Examine the return code and carry flag after each  
| BIOS call.)
- | 2. Call the Enable Selected Slot for Setup Cycles function  
| ((AL)=01H) with (BL) set to 1 to put slot 1 into setup mode.
- | 3. Read the POS registers for slot 1, beginning with the base POS  
| adapter register address.
- | 4. Repeat steps 2 and 3 (with the slot number in (BL)) for each slot.
- | 5. Call the Disable Setup Cycles for All Slots function ((AL)=02H) to  
| take all slots out of setup mode.

| For additional information about the POS adapter registers, see the  
| "Programmable Option Select" section in the *Personal System/2*  
| *Hardware Interface Technical Reference*.

**(AH) = C5H to C6H—Reserved**

## **(AH) = C7H—Return Memory-Map Information**

To obtain a complete Micro Channel configuration table, the Return System Configuration Parameters function ((AH) = C0H), the Processor Type and Stepping Level function ((AH) = C9H), and the Return Device Descriptor Table (DDT) Information function ((AH) = D1H) must be called in addition to the Return Memory-Map Information function ((AH) = C7H).

This function is not supported on all systems. If the function is not supported, the carry flag is set to 1, and the value that is returned in (AH) is either hex 80 (for PCjr and PC) or hex 86.

(DS:SI) - Pointer to the user-supplied memory-map table  
with a minimum length of 66 bytes

On Return:

(AH) = 80H or 86H - Function not supported  
CF = 0 - Operation successfully completed  
= 1 - Operation failed or function not supported

The word at offset hex 00 is the number of bytes that make up the rest of the table; the minimum value is hex 42 (decimal 66). Memory values are expressed as the number of 1KB blocks.

Memory-map table structure:

<b>Size</b>	<b>Offset</b>	<b>Description</b>
Word	00H	Number of significant bytes of returned data (excluding this word)
DWord	02H	Amount of local memory between 1MB and 16MB, in 1KB blocks
DWord	06H	Amount of local memory between 16MB and 4GB, in 1KB blocks
DWord	0AH	Amount of system memory between 1MB and 16MB, in 1KB blocks
DWord	0EH	Amount of system memory between 16MB and 4GB, in 1KB blocks
DWord	12H	Amount of cacheable memory between 1MB and 16MB, in 1KB blocks
DWord	16H	Amount of cacheable memory between 16MB and 4GB, in 1KB blocks
DWord	1AH	Number of 1KB blocks before the start of non-system memory between 1MB and 16MB
DWord	1EH	Number of 1KB blocks before the start of non-system memory between 16MB and 4GB
DWord	22H to 2AH	Reserved

The various memory types are defined as follows:

<b>Local memory</b>	Memory on the system board or memory that is not accessible from the channel. It can be system or non-system memory.
<b>Channel memory</b>	Memory on adapters. It can be system or non-system memory.
<b>System memory</b>	Memory that is managed and allocated by the primary operating system. This memory is cached if the cache is enabled.
<b>Non-system memory</b>	Memory that is not managed or allocated by the primary operating system. This memory includes memory-mapped I/O devices; memory that is on an adapter and can be directly modified by the adapter; and memory that can be relocated within its address space, such as bank-switched and expanded-memory-specifications (EMS) memory. This memory is not cached.

The following are constraints on memory configurations for Personal System/2 systems:

- Memory below 1MB is local memory.
- All local memory is system memory and can be cached except for:
  - The extended BIOS data area
  - The video-buffer areas (hex A000 and hex B000)
  - The adapter-ROM areas (hex C000 and hex D000)
  - The BIOS code areas (hex E000 and hex F000).
- Local memory from 1MB to 16MB is configured contiguously from 1MB.
- System memory on adapters from 1MB to 16MB is configured contiguously from 1MB and immediately after any local memory in this range.
- Local memory from 16MB to 4GB is configured contiguously from 16MB.
- System memory on adapters from 16MB to 4GB is configured contiguously from 16MB and immediately after any local memory in this range.

- Local memory that is reassigned from the first 1MB might be configured above channel system memory in either range to make full use of the first 1MB. This memory is treated as an extension of the channel memory in that range.

### **(AH) = C8H—Enable/Disable Processor Functions**

**Note:** In an 80486 processor, any external caches must be disabled when the on-chip cache (L1) is disabled.

**For Personal System/2 Model 70-A21:**

(AL) = 00H - Disable cache  
 = 01H - Enable cache  
 = 02H to FFH - Reserved

On Return:

CF = 0 - Operation successfully completed  
 = 1 - Operation failed

**For Personal System/2 Model 70/486 and Model 80-A21:**

(AL) = 00H - Disable cache  
 = 01H - Enable cache  
 = 02H to FFH - Reserved

On Return:

(AH) - Return code  
 = 00H - Operation successfully completed  
 = 01H - Function choice in (AL) is invalid  
 = 02H - NVRAM data is invalid  
 = 03H - Cache test error  
 CF = 0 - Operation successfully completed  
 = 1 - Operation failed

**For Personal System/2 Model 90 and Model 95:**

(AL) = 00H - Disable cache L1 (cache is flushed when disabled)  
 = 01H - Enable cache L1 (cache is flushed when enabled)  
 = 02H - Disable cache L2 (cache is flushed when disabled)  
 = 03H - Enable cache L2 (cache is flushed when enabled)  
 = 04H - Disable both caches  
 = 05H - Enable both caches

On Return:

- (AH) - Return code
  - = 00H - Operation successfully completed
  - = 01H - Function choice in (AL) is invalid
  - = 02H - NVRAM data is invalid
  - = 03H - Cache test error
  - = 04H - Cannot perform the operation because of the state of the other cache
  - = 05H - No L2 cache is present
- CF = 0 - Operation successfully completed
- = 1 - Operation failed

(AL) = 06H - Return status of both caches

On Return:

- (BH) - Status of cache L2
  - = 0 - Enabled
  - = 1 - Disabled
- (BL) - Status of cache L1
  - = 0 - Enabled
  - = 1 - Disabled

If the L2 cache is not installed, the L2 cache status is always set to 1 (disabled).

- (AH) - Return code
  - = 00H - Operation successfully completed
  - = 01H - Function choice in (AL) is invalid
  - = 02H - NVRAM data is corrupt
  - = 03H - Cache test error
  - = 04H - Cannot perform the operation because of the state of the other cache
  - = 05H - No L2 cache is present
- CF = 0 - Operation successfully completed
- = 1 - Operation failed

(AL) = 07H to FFH - Reserved

For all other Personal System/2 systems, this function is not supported:

On Return:

- (AH) = 86H - Function not supported
- CF = 0 - Operation successfully completed
- = 1 - Operation failed

### **(AH) = C9H—Processor Type and Stepping Level**

To obtain a complete Micro Channel configuration table, the Return System Configuration Parameters function ((AH) = C0H), the Return Memory-Map Information function ((AH) = C7H), and the Return Device Descriptor Table (DDT) Information function ((AH) = D1H) must be called in addition to the Processor Type and Stepping Level function ((AH) = C9H).

This function is not supported on all systems. If the function is not supported, the carry flag is set to 1, and the value that is returned in (AH) is either hex 80 (for PCjr and PC) or hex 86.

On Return:

(CH) - Microprocessor type

= 03 - 80386

= 23 - 80386 SX

= 04 - 80486

(CL) - Microprocessor stepping level

(AH) - Return code

= 00H - Operation successfully completed

= 80H or 86H - Function not supported

CF = 0 - Operation successfully completed

= 1 - Operation failed or function not supported

### **(AH) = CAH to CDH—Reserved**

### **(AH) = CEH—Allocate DMA Arbitration Level**

This function is not supported on all systems. If the function is not supported, the carry flag is set to 1, and the value that is returned in (AH) is either hex 80 (for PCjr and PC) or hex 86.

DMA channels are either physical or virtual. A physical channel can have only one arbitration level assigned to it. A virtual channel can be programmed to use any arbitration level that is not currently assigned to a different channel.

There is no difference in function between physical and virtual channels. Priority of the channels is determined by the arbitration level; arbitration level 0 has the highest priority, and arbitration level hex 0E has the lowest priority.

To perform a DMA transfer operation, the caller performs the following steps:

1. Request that CBIOS DMA allocate an arbitration level.
2. Set up the hardware and perform the transfer to a device.
3. Request that CBIOS DMA deallocate the arbitration level. See the Deallocate DMA Arbitration Level function ((AH) = CFH) on page 2-IN15-39.

Failure to use this function for the allocation of arbitration levels can cause unpredictable results.

(BL) = 00H to 0EH - Arbitration level to be allocated  
= 0FH to FFH - Reserved

(AL) - Option byte

Bits 7 to 1 = 0 - Reserved

Bit 0 = 0 - Need DMA channel for arbitration level requested

= 1 - No channel required for arbitration level

On Return:

(AL) - Channel number

= 00H to 07H - Channel number allocated for the arbitration level

= 08H to FEH - Reserved

= FFH - No channel requested for arbitration level

(AH) - Return code

= 00H - Operation successfully completed

= 01H - Arbitration level not available

= 02H - Channel not available

= 03H - Invalid arbitration level passed

= 80H or 86H - Function not supported

CF = 0 - Operation successfully completed

= 1 - Operation failed or function not supported

### **(AH) = CFH—Deallocate DMA Arbitration Level**

This function is not supported on all systems. If the function is not supported, the carry flag is set to 1, and the value that is returned in (AH) is either hex 80 (for PCjr and PC) or hex 86.

(BL) = 00H to 0EH - Arbitration level to be deallocated  
= 0FH to FFH - Reserved

On Return:

(AH) - Return code

= 00H - Operation successfully completed

= 04H - Arbitration level not allocated

= 80H or 86H - Function not supported

CF = 0 - Operation successfully completed

= 1 - Operation failed or function not supported

Failure to use this function for the allocation of arbitration levels can cause unpredictable results.

### **(AH) = D0H—Reserved**

## **(AH) = D1H—Return Device Descriptor Table (DDT) Information**

This function is not supported on all systems. If the function is not supported, the carry flag is set to 1, and the value that is returned in (AH) is either hex 80 (for PCjr and PC) or hex 86.

To obtain a complete Micro Channel configuration table, the Return System Configuration Parameters function ((AH) = C0H), the Return Memory-Map Information function ((AH) = C7H), and the Processor Type and Stepping Level function ((AH) = C9H) must be called in addition to the Return Device Descriptor Table Information function ((AH) = D1H).

(AL) = 00H - Return number of device descriptor table (DDT) entries  
(DX) - Reserved (set to 0)

On Return:

(BL) - Size of one DDT entry, in bytes  
(CX) - Number of DDT entries  
(AH) - Return code  
= 00H - Operation successfully completed  
= 01H - Requested DDT entry not found  
= 02H - DDT data not valid  
= 86H - Function not supported  
CF = 0 - Operation successfully completed  
= 1 - Operation failed or function not supported

(AL) = 01H - Return DDT entry on the basis of the entry number  
(BX) - Number of requested entry (one-based)  
(DX) - Reserved (set to 0)  
(ES:DI) - Pointer to buffer that contains DDT entry

On Return:

(ES:DI) - Pointer to buffer that contains DDT entry  
(AH) - Return code  
= 00H - Operation successfully completed  
= 01H - Requested DDT entry not found  
= 02H - DDT data not valid  
= 86H - Function not supported  
CF = 0 - Operation successfully completed  
= 1 - Operation failed or function not supported

- (AL) = 02H - Return DDT entry on the basis of the I/O port address  
(The DDT is searched from the specified entry for the I/O port in (CX), and the first entry that is found is returned.)
- (BX) - Entry number from which to start search
- (CX) - Requested I/O port address
- (DX) - Reserved (set to 0)
- (ES:DI) - Pointer to buffer that contains DDT entry

**On Return:**

- (BX) - DDT entry number where requested I/O port address was found  
(If the requested I/O port address is not found, this value is the total number of DDT entries plus 1.)
- (ES:DI) - Pointer to buffer that contains DDT entry
- (AH) - Return code
  - = 00H - Operation successfully completed
  - = 01H - Requested DDT entry not found
  - = 02H - DDT data not valid
  - = 86H - Function not supported
- CF = 0 - Operation successfully completed
- = 1 - Operation failed or function not supported

- (AL) = 03H - Return entire DDT
- (DX) - Reserved (set to 0)
- (ES:DI) - Pointer to buffer that contains DDT entry

**On Return:**

- (ES:DI) - Pointer to buffer that contains DDT entry
- (AH) - Return code
  - = 00H - Operation successfully completed
  - = 01H - Requested DDT entry not found
  - = 02H - DDT data not valid
  - = 86H - Function not supported
- CF = 0 - Operation successfully completed
- = 1 - Operation failed or function not supported

- (AL) = 04H - Return DDT entry on the basis of the device ID  
(The DDT is searched from the specified entry for the device ID in (CX), and the first entry that is found is returned.)
- (BX) - Entry number from which to start search
- (CX) - Requested device ID
- (DX) - Reserved (set to 0)
- (ES:DI) - Pointer to buffer that contains DDT entry

**On Return:**

- (BX) - Entry number where requested device ID was found  
(If the requested device ID is not found, this value is the total number of DDT entries plus 1.)
- (ES:DI) - Pointer to buffer that contains DDT entry
- (AH) - Return code
  - = 00H - Operation successfully completed
  - = 01H - Requested DDT entry not found
  - = 02H - DDT data not valid
  - = 86H - Function not supported
- CF = 0 - Operation successfully completed
- = 1 - Operation failed or function not supported

The device descriptor table (DDT) contains information about resources that are used by each device. An adapter is considered to be a single device unless it is divided into multiple devices by the BEGIN and END keywords in the adapter descriptor files (refer to the *Personal System/2 Hardware Technical Reference* for a description of adapter descriptor files). The first byte of the data block that contains the DDT indicates the size of each DDT entry. The format of the DDT entry is shown in the following table.

Offset	Size	Bit	Definition
0	Byte	7 to 4 3 to 0	Reserved (set to 0) Slot of device (0 = system board)
1	Byte	7 to 4 3 to 0	Second interrupt for this device (0 = no second interrupt) First interrupt for this device (0 = no first interrupt)
2	Byte	7 to 4 3 to 0	Second arbitration level for this device First arbitration level for this device

Figure 2-25 (Part 1 of 2). Device Descriptor Table (DDT) Entry Format

Offset	Size	Bit	Definition
3	Word		DDT indicators
		15	Reserved (set to 0)
		14	Second arbitration-level indicator = 0 - No second arbitration level = 1 - Second arbitration level exists
		13	First arbitration-level indicator = 0 - No first arbitration level = 1 - First arbitration level exists
		12	Serial-interface type = 0 - Not RS-422 = 1 - RS-422
		11	Not address limited = 0 - Address limited = 1 - Not address limited
		10	DMA channel required = 0 - DMA channel not used = 1 - DMA channel used
		9	Second arbitration level can be shared = 0 - Not shared = 1 - Shared
		8	First arbitration level can be shared = 0 - Not shared = 1 - Shared
5	Byte		Reserved (set to 0)
6	Word		Device ID = 0 - No device ID
8	Word		Starting address of first I/O block = 0 - No first I/O block
10	Word		Starting address of second I/O block = 0 - No second I/O block
12	Word		Starting address of third I/O block = 0 - No third I/O block
14	DWord		Start of first non-system memory block = 0 - No first non-system memory block
18	Word		Size of first non-system memory block (number of 1KB blocks)
20	DWord		Start of second non-system memory block = 0 - No first non-system memory block
24	Word		Size of second non-system memory block (number of 1KB blocks)
<b>Note:</b> I/O block addresses and non-system memory addresses are listed in ascending order.			
26	Byte		Implementation identifier of the device
27	Byte		Implementation revision level of the device

Figure 2-25 (Part 2 of 2). Device Descriptor Table (DDT) Entry Format

**(AH) = D2H to D3H—Reserved**

## **(AH) = D4H—Return Physical Fixed Disk Drive Number (Selectable Boot)**

This function is not supported on all systems. If the function is not supported, the carry flag is set to 1, and the value that is returned in (AH) is either hex 80 (for PCjr and PC) or hex 86.

(DL) - Logical fixed disk drive number

On Return:

(AL) - Physical fixed disk drive number

(AH) - Return code

= 00H - Operation successfully completed

= 01H - Specified logical drive number is invalid

= 86H - Function not supported

CF = 0 - Operation successfully completed

= 1 - Operation failed

## **(AH) = D5H—Reserved**

## **(AH) = D6H—Return Boot Device ID and Key**

(AL) = 00H - Read/write boot device ID

(BL) = 0 - Read

= 1 - Write

(DX) - Device ID to be written/read

On Return:

(AH) = 00H - Operation successfully completed

= 86H - Function not supported

CF = 0

(AL) = 01H - Read/write boot device key

(BL) = 0 - Read

= 1 - Write

(DX) - Device ID to be written/read

On Return:

(AH) = 00H - Operation successfully completed

= 86H - Function not supported

CF = 0

(AL) = 02H - Query boot reference partition

On Return:

(AL) - Status of reference-partition boot request

= 00H - Reference-partition boot not requested

= 01H - Reference-partition boot requested

(AH) = 00H - Operation successfully completed

= 86H - Function not supported

CF = 0

## **(AH) = D7H to FFH—Reserved**

## Interrupt 16H—Keyboard

These routines provide keyboard support. The following is a summary of the keyboard functions of Interrupt 16H.

(AH) = 00H	– Keyboard Read
(AH) = 01H	– Keystroke Status
(AH) = 02H	– Shift Status
(AH) = 03H	– Set Typematic Rate
(AH) = 04H	– Keyboard Click Adjustment
(AH) = 05H	– Keyboard Write
(AH) = 06H to 08H	– Reserved
(AH) = 09H	– Keyboard Functionality Determination
(AH) = 0AH	– Return Keyboard ID
(AH) = 0BH to 0FH	– Reserved
(AH) = 10H	– Extended-Keyboard Read
(AH) = 11H	– Extended Keystroke Status
(AH) = 12H	– Extended Shift Status
(AH) = 13H to 1FH	– Reserved
(AH) = 20H	– Keyboard Read for the 122-Key Keyboard
(AH) = 21H	– Keystroke Status for the 122-Key Keyboard
(AH) = 22H	– Shift Status for the 122-Key Keyboard
(AH) = 23H to FFH	– Reserved

*Figure 2-26. INT 16H Keyboard Functions*

**Note:** All reserved input fields must be set to 0.

Functions (AH) = 10H, 11H, and 12H support the 101-/102-key keyboard. Functions (AH) = 20H, 21H, and 22H support the 122-key keyboard. The keyboard scan codes for these functions fall into three categories:

- When only one key produces an ASCII character, the scan code that is read from the keyboard port is the same as that with standard keyboards.
- When more than one key produces the same character, one of the keys generates the standard keyboard scan code. The other key generates a unique sequence of scan codes, enabling the system to differentiate between the keys.
- New scan codes are assigned to keys that do not exist on the standard keyboards.

The 101-/102-key keyboard functions and the 122-key keyboard functions enable new programs to take advantage of all categories and avoid compatibility problems with existing programs.

If the system BIOS does not support the 101-/102-key keyboard functions and the 122-key keyboard functions, the scan code/character code combination that was put into the keyboard buffer by the keyboard interrupt handler is returned unchanged when the Keyboard Read function ((AH)=00H) and the Keystroke Status function ((AH)=01H) are called.

If the system BIOS supports the 101-/102-key keyboard functions and the 122-key keyboard functions:

- Keys with identical names are differentiated by the character code that is put into the keyboard buffer by the keyboard interrupt handler.
- The keyboard interrupt handler puts the scan code/character code combination for new keys into the keyboard buffer.
- The Extended-Keyboard Read function ((AH)=10H), the Extended Keystroke Status function ((AH)=11H), the Keyboard Read function for the 122-Key Keyboard function ((AH)=20H), and the Keystroke Status for the 122-Key Keyboard function ((AH)=21H), extract the scan code/character code combination from the buffer as is and return it to the caller. The scan code/character code combination is returned for new keys. It is also returned for keys with identical names, and the character code is used to differentiate between them. If the character code is hex F0 and the scan code is not hex 00, the character code is set to hex 00.
- The Keyboard Read function ((AH)=00H) and the Keystroke Status function ((AH)=01H) extract the scan code/character code combination and translate it, if necessary, to the scan code/character code combination that is compatible with previous keyboards. The translation:
  1. Converts like codes to compatible codes
  2. Extracts scan code/character code combinations until a compatible combination is found.
- The Extended Shift Status function ((AH)=12H) and the Shift Status for the 122-Key Keyboard function ((AH)=22H) return the existing keyboard shift state and the shift state of the separate Ctrl and Alt keys.

If the Keyboard Functionality Determination function ((AH)=09H) is supported, use it to determine whether the system BIOS supports the functions for the 101-/102-key keyboard ((AH)=10H, 11H, and 12H) and the 122-key keyboard ((AH)=20H, 21H, and 22H).

If the Keyboard Functionality Determination function ((AH) = 09H) is not supported, the program must use the following procedure:

1. Use Interrupt 16H, Keyboard Write function ((AH) = 05H) to write a scan code/character code combination of hex FFFF to the buffer.
2. If (AL) is set to 00H on return, the function has successfully written hex FFFF to the buffer.
3. Use Interrupt 16H, Extended-Keyboard Read function ((AH) = 10H) or Keyboard Read for the 122-Key Keyboard function ((AH) = 20H) to read the scan code/character code combination from the keyboard buffer.
4. If (AX) is set to hex FFFF on return, the functions for the 101-/102-key keyboard and the functions for the 122-key keyboard are supported.
5. If (AX) is not set to hex FFFF on return, call Interrupt 16H, (AH) = 10H or (AH) = 20H repeatedly until (AX) is set to hex FFFF on return.
6. If (AX) is still not set to hex FFFF after 16 calls to (AH) = 10H or (AH) = 20H, the functions for the 101-/102-key keyboard and the functions for the 122-key keyboard are not supported.

See the “Scan Code/Character Code Combinations” section.

### **(AH) = 00H—Keyboard Read**

The scan code/character code combination is extracted from the buffer. The keyboard-buffer head pointer (address hex 40:1A) is increased by 2 or, if the pointer is already at the end, it is reinitialized to the start of the buffer.

On Return:

(AH) - Scan code

(AL) - ASCII character code

For AT, PC/XT Model 286, PC Convertible, and Personal System/2 products, if no keystroke is available, Interrupt 15H, Device Busy function ((AH) = 90H) is called with (AL) = 02H (Type = Keyboard) to inform the operating system that a keyboard loop is about to take place, enabling the operating system to perform another task. When the keyboard operation is complete, Interrupt 09H calls Interrupt 15H, Interrupt Complete function ((AH) = 91H), with (AL) = 02H (Type = Keyboard). See “Multitasking Provisions” in the “Additional Information” section.

**Note:** Control is returned only when a keystroke is available. The keystroke is removed from the buffer.

### **(AH) = 01H—Keystroke Status**

On Return:

CF = 0 - Code is available  
= 1 - No code is available

If a code is available:

(AH) - Scan code  
(AL) - ASCII character code

**Note:** The keystroke is not removed from the buffer.

### **(AH) = 02H—Shift Status**

On Return:

(AH) - Reserved  
(AL) - Current shift status  
Bit 7 = 1 - Insert locked  
Bit 6 = 1 - Caps Lock locked  
Bit 5 = 1 - Num Lock locked  
Bit 4 = 1 - Scroll Lock locked  
Bit 3 = 1 - Alt key pressed  
Bit 2 = 1 - Ctrl key pressed  
Bit 1 = 1 - Left Shift key pressed  
Bit 0 = 1 - Right Shift key pressed

### **(AH) = 03H—Set Typematic Rate**

For *PCjr* and Personal System/2 BIOS that supports Interrupt 16H, Keyboard Functionality Determination function ((AH) = 09H) with bit 0 set to 1:

(AL) = 00H - Returns to default; restores original state (typematic on, normal initial delay and normal typematic rate)

For *PCjr* only:

(AL) = 01H - Increases the initial delay (this is the delay between the first character and the burst of typematic characters)  
(AL) = 02H - Slows typematic characters by one-half  
(AL) = 03H - Increases the initial delay and slows typematic characters by one-half

For PCjr and Personal System/2 BIOS that supports Interrupt 16H, Keyboard Functionality Determination function ((AH) = 09H) with bit 1 set to 1:

(AL) = 04H - Turns off typematic characters

For AT BIOS dated 11/15/85 and later, PC/XT Model 286, and Personal System/2 products:

(AL) = 05H - Set typematic rate and delay

(BH) - Delay value (in milliseconds)

00H = 250

01H = 500

02H = 750

03H = 1000

04H to FFH - Reserved

(BL) - Typematic rate (in characters per second)

00H = 30.0      0BH = 10.9      16H = 4.3

01H = 26.7      0CH = 10.0      17H = 4.0

02H = 24.0      0DH = 9.2      18H = 3.7

03H = 21.8      0EH = 8.6      19H = 3.3

04H = 20.0      0FH = 8.0      1AH = 3.0

05H = 18.5      10H = 7.5      1BH = 2.7

06H = 17.1      11H = 6.7      1CH = 2.5

07H = 16.0      12H = 6.0      1DH = 2.3

08H = 15.0      13H = 5.5      1EH = 2.1

09H = 13.3      14H = 5.0      1FH = 2.0

0AH = 12.0      15H = 4.6      20H to FFH - Reserved

For Personal System/2 BIOS that supports Interrupt 16H, Keyboard Functionality Determination function ((AH) = 09H) with bit 3 set to 1:

(AL) = 06H - Return current typematic rate and delay

On Return:

(BH) - Delay value

(BL) - Typematic rate

For all others, no action is performed.

### **(AH) = 04H—Keyboard Click Adjustment**

For PCjr and PC Convertible:

(AL) = 00H - Set keyboard click off

(AL) = 01H - Set keyboard click on

For all others, no action is performed.

### **(AH) = 05H—Keyboard Write**

For AT BIOS dated 11/15/85 and later, PC/XT dated 1/10/86 and later, PC/XT Model 286, and Personal System/2 products, this function puts scan code/character code combinations into the keyboard buffer as if they came from the keyboard.

(CH) - Scan code  
(CL) - ASCII character code

On Return:

(AL) = 00H - Operation successfully completed  
= 01H - Buffer full

For all others, no action is performed.

### **(AH) = 06H to 08H—Reserved**

### **(AH) = 09H—Keyboard Functionality Determination**

To determine whether Interrupt 16H, Keyboard Functionality Determination function ((AH) = 09H) is supported, the program must use Interrupt 15H, Return System Configuration Parameters function ((AH) = C0H), testing bit 6 of feature information byte 2. If this bit is set to 0, the function is not supported. If this bit is set to 1, the function is as follows. This test can be performed for all systems that support Interrupt 15H, Return System Configuration Parameters function ((AH) = C0H).

On Return:

(AL) - Function code

Bit 7 - Reserved

Bit 6 = 1 - 122-key keyboard functions are supported

= 0 - 122-key keyboard functions are not supported

Bit 5 = 1 - 101-/102-key keyboard functions are supported

= 0 - 101-/102-key keyboard functions are not supported

Bit 4 = 1 - Keyboard ID is supported

= 0 - Keyboard ID is not supported

Bit 3 = 1 - Get current typematic rate/delay is supported

= 0 - Get current typematic rate/delay is not supported

Bit 2 = 1 - Set typematic rate/delay is supported

= 0 - Set typematic rate/delay is not supported

Bit 1 = 1 - Turn on/off typematic is supported

= 0 - Turn on/off typematic is not supported

Bit 0 = 1 - Return to default typematic rate/delay is supported

= 0 - Return to default typematic rate/delay is not supported

## **(AH) = 0AH—Return Keyboard ID**

Use this function to determine the type of keyboard that is attached.

To determine whether this function is supported, use Interrupt 16H, Keyboard Functionality Determination function ((AH) = 09H), testing bit 4 of the AL register. If this bit is set to 0, the function is not supported. If this bit is set to 1, the function is as follows:

On Return:

- (BX) = Keyboard ID
  - = 0000 - No keyboard attached
  - = 0001 to FFFFH - Keyboard attached, reserved for keyboard IDs
- (BH) - Second byte of keyboard ID
- (BL) - First byte of keyboard ID

The valid keyboard IDs are:

- (BX) = 41AB - G-layout, 101- and 102-key (translated)
  - = 83AB - G-layout, 101- and 102-key
  - = 54AB - P-layout (translated)
  - = 84AB - P-layout
  - = 86AB - 122-key
  - = 90AB - DBCS G-layout (5576-002)
  - = 91AB - DBCS P-layout (5576-003)
  - = 92AB - DBCS A-layout (5576-001)

## **(AH) = 0BH to 0FH—Reserved**

## **(AH) = 10H—Extended-Keyboard Read**

For AT BIOS dated 11/15/85 and later, PC/XT dated 1/10/86 and later, PC/XT Model 286, and Personal System/2 products, the scan code/character code combination is extracted from the buffer. The keyboard-buffer head pointer (address hex 40:1A) is increased by 2 or, if the pointer is already at the end, it is reinitialized to the start of the buffer.

On Return:

- (AH) - Scan code
- (AL) - ASCII character code

**Note:** Control is returned only when a keystroke is available. The keystroke is removed from the buffer.

For all others, no action is performed.

### **(AH) = 11H—Extended Keystroke Status**

For AT BIOS dated 11/15/85 and later, PC/XT dated 1/10/86 and later, PC/XT Model 286, and Personal System/2 products:

On Return:

CF = 0 - Code is available  
= 1 - No code is available

If a code is available:

(AL) - ASCII character code  
(AH) - Scan code

**Note:** The keystroke is not removed from the buffer.

For all others, no action is performed.

### **(AH) = 12H—Extended Shift Status**

For AT BIOS dated 11/15/85 and later, PC/XT dated 1/10/86 and later, PC/XT Model 286, and Personal System/2 products:

On Return:

(AH) - Extended shift status

Bit 7 = 1 - SysRq key pressed  
Bit 6 = 1 - Caps Lock key pressed  
Bit 5 = 1 - Num Lock key pressed  
Bit 4 = 1 - Scroll Lock key pressed  
Bit 3 = 1 - Right Alt key pressed  
Bit 2 = 1 - Right Ctrl key pressed  
Bit 1 = 1 - Left Alt key pressed  
Bit 0 = 1 - Left Ctrl key pressed

(AL) - Shift status

Bit 7 = 1 - Insert locked  
Bit 6 = 1 - Caps Lock locked  
Bit 5 = 1 - Num Lock locked  
Bit 4 = 1 - Scroll Lock locked  
Bit 3 = 1 - Alt key pressed  
Bit 2 = 1 - Ctrl key pressed  
Bit 1 = 1 - Left Shift key pressed  
Bit 0 = 1 - Right Shift key pressed

For all others, no action is performed.

### **(AH) = 13H to 1FH—Reserved**

### **(AH) = 20H—Keyboard Read for the 122-Key Keyboard**

For Personal System/2 Model 35 SX, Model 35 LS, Model 40 SX, and Model 57 SX, the scan code/character code combination is extracted from the buffer. The keyboard-buffer head pointer (address hex 40:1A) is increased by 2 or, if the pointer is already at the end, it is reinitialized to the start of the buffer.

**On Return:**

(AH) - Scan code  
(AL) - ASCII character code

**Note:** Control is returned only when a keystroke is available. The keystroke is removed from the buffer.

### **(AH) = 21H—Keystroke Status for the 122-Key Keyboard**

For Personal System/2 Model 35 SX, Model 35 LS, Model 40 SX, and Model 57 SX:

**On Return:**

CF = 0 - Code is available  
= 1 - No code is available

**If a code is available:**

(AL) - ASCII character code  
(AH) - Scan code

**Note:** The keystroke is not removed from the buffer.

**(AH) = 22H—Shift Status for the 122-Key Keyboard**

For Personal System/2 Model 35 SX, Model 35 LS, Model 40 SX,  
and Model 57 SX:

On Return:

(AH) - Extended shift status

- Bit 7 = 1 - SysRq key pressed
- Bit 6 = 1 - Caps Lock key pressed
- Bit 5 = 1 - Num Lock key pressed
- Bit 4 = 1 - Scroll Lock key pressed
- Bit 3 = 1 - Right Alt key pressed
- Bit 2 = 1 - Right Ctrl key pressed
- Bit 1 = 1 - Left Alt key pressed
- Bit 0 = 1 - Left Ctrl key pressed

(AL) - Shift status

- Bit 7 = 1 - Insert locked
- Bit 6 = 1 - Caps Lock locked
- Bit 5 = 1 - Num Lock locked
- Bit 4 = 1 - Scroll Lock locked
- Bit 3 = 1 - Alt key pressed
- Bit 2 = 1 - Ctrl key pressed
- Bit 1 = 1 - Left Shift key pressed
- Bit 0 = 1 - Right Shift key pressed

**(AH) = 23H to FFH—Reserved**

---

## Interrupt 17H—Printer

These routines provide printer support. The following is a summary of the printer-support functions of Interrupt 17H.

(AH) = 00H – Print Character
(AH) = 01H – Initialize the Printer Port
(AH) = 02H – Read Status
(AH) = 03H to FFH – Reserved

*Figure 2-27. INT 17H Printer Functions*

**Note:** All reserved input fields must be set to 0.

### **(AH) = 00H—Print Character**

(AL) - Character to be printed  
(DX) - Printer to be used (0, 1, or 2); index into the port base address table at address hex 40:08

On Return:

(AH) - Status  
Bit 7 = 1 - Not busy  
Bit 6 = 1 - Acknowledgment  
Bit 5 = 1 - Out of paper  
Bit 4 = 1 - Selected  
Bit 3 = 1 - I/O error  
Bits 2, 1 - Reserved  
Bit 0 = 1 - Time-out

### **(AH) = 01H—Initialize the Printer Port**

(DX) - Printer to be used (0, 1, or 2); index into the port base address table at address hex 40:08

On Return:

(AH) - Status (see status values on page 2-IN17-1)

### **(AH) = 02H—Read Status**

(DX) - Printer to be used (0, 1, or 2); index into the port base address table at address hex 40:08

On Return:

(AH) - Status (see status values on page 2-IN17-1)

### **(AH) = 03H to FFH—Reserved**

**Notes:**

1. For AT, PC/XT Model 286, PC Convertible, and Personal System/2 products, when the printer is busy, BIOS calls Interrupt 15H, Device Busy function ((AH)=90H) with (AL)=FEH (Type=Printer) to inform the operating system that a time-out loop is about to begin. See "Multitasking Provisions" in the "Additional Information" section.
2. For AT BIOS dated before 11/15/85, PCjr, PC, and PC/XT BIOS dated 11/8/82, the printer-port number that is associated with (DX) is tested for 0. If (DX) is set to 0, no action occurs. If (DX) is not set to 0, the print operation is performed. The (DX) register is not tested for a valid printer-port number at the offset into the printer base address data area at address hex 40:08.
3. For PC/XT BIOS dated 1/10/86 and later, if the value of (DX) is greater than 3 or the printer port that is associated with (DX) is printer port 0, no action is performed, and on return, (AH) is set to 29H.
4. For PC Convertible, if the printer port that is associated with (DX) is printer port 0, (AH) is set to 01H on return. If (DX) is not set to 0, the print operation is performed. The (DX) register is not tested to determine whether a valid printer-port number exists at the offset into the printer base address data area at address hex 40:08.
5. For AT BIOS dated 11/15/85 and PC/XT Model 286, if the value of (DX) is greater than 3 or the printer port that is associated with (DX) is printer port 0, no action is performed, and (AH) is returned unchanged.
6. For Personal System/2 products, if the value of (DX) is greater than 2 or the printer port that is associated with (DX) is printer port 0, no action is performed, and (AH) is returned unchanged.

## Interrupt 19H—Bootstrap Loader

Devices that are supported by Interrupt 13H read the boot record from cylinder 0, head 0, sector 1. Devices that are supported by Interrupt 4BH read the boot record from logical block address 1. The boot record is then read into system memory at address hex 0000:7C00.

The power-on self-test (POST) checks for the following characteristics to validate a boot record:

- For a device with removable media, such as a diskette, the boot record must contain valid code. For example, the value of the first byte of the boot record must be greater than 6.
- For a device with nonremovable media, such as a fixed disk, there must be a signature of hex 55AA at the end of the boot record.

Parameters that identify the device from which the boot record was obtained are passed to the boot record. Passing of these parameters enables the boot record to continue the system boot operation.

In systems that do not support Interrupt 15H, Return Boot Device and Key function ((AH)=D6H), the following information is passed to the boot record:

- (CS) = 0000H
- (IP) = 7C00H
- (DL) - Drive from which the boot record was read

In systems that support Interrupt 15H, Return Boot Device and Key function ((AH)=D6H), information is passed also to the DX register. If the access-mode bit (bit 5) is set to 0, the DX register is defined as the "boot device identifier"; if the access-mode bit is set to 1, the DX register is defined as the "device key." The device key is a 16-bit value that is returned by Interrupt 4BH, Allocate Device function ((AH)=80H, (AL)=02H), (AX)=8002H. (The device key is available also from Interrupt 15H, Return Boot Device ID and Key function ((AH)=D6H).)

The following information is passed to the boot record:

(CS) = 0000H

(IP) = 7C00H

(DX) - Boot device identifier or device key

When (DX) is a boot device identifier, (DH) and (DL) are defined as follows:

(DH) - Device identifier

Bit 7 - Removable-media indicator

= 0 - Nonremovable media

= 1 - Removable media

Bit 6 - Reserved

Bit 5 - Access mode

= 0 - Device is supported by Interrupt 13H

= 1 - Device is supported by Interrupt 4BH

Bits 4 to 0 - Peripheral-device type

(DL) - Device instance

= 00H - First diskette drive (if the access-mode bit is set to 0)

- First CD-ROM drive (if the access-mode bit is set to 1)

= 80H - First fixed disk drive (if the access-mode bit is set to 0)

## Interrupt 1AH—System-Timer and Real-Time Clock Services

The following is a summary of the system-timer and real-time clock services of Interrupt 1AH.

(AH) = 00H	– Read System-Timer Time Counter
(AH) = 01H	– Set System-Timer Time Counter
(AH) = 02H	– Read Real-Time Clock Time
(AH) = 03H	– Set Real-Time Clock Time
(AH) = 04H	– Read Real-Time Clock Date
(AH) = 05H	– Set Real-Time Clock Date
(AH) = 06H	– Set Real-Time Clock Alarm
(AH) = 07H	– Reset Real-Time Clock Alarm
(AH) = 08H	– Set Real-Time Clock Activated Power-On Mode
(AH) = 09H	– Read Real-Time Clock Alarm Time and Status
(AH) = 0AH	– Read System-Timer Day Counter
(AH) = 0BH	– Set System-Timer Day Counter
(AH) = 0CH to 7FH	– Reserved
(AH) = 80H	– Set Up Sound Multiplexer
(AH) = 81H to FFH	– Reserved

*Figure 2-28. INT 1AH System-Timer and Real-Time Clock Services Functions*

### Notes:

1. All reserved input fields must be set to 0.
2. Some models of Personal System/2 Model 25 do not support a real-time clock; therefore, functions (AH) = 02H through (AH) = 09H do not apply to those systems. The system-timer functions do apply.

### (AH) = 00H—Read System-Timer Time Counter

On Return:

- (AL) = 0 - Timer has not passed 24 hours' worth of counts since power-on, last system reset, last system-timer time counter read, or last system-timer time counter set
- > 0 - Timer has passed 24 hours' worth of counts since power-on, last system reset, last system-timer time counter read, or last system-timer time counter set
- (CX) - High portion of count
- (DX) - Low portion of count

**Note:** Execution causes the timer overflow flag (hex 40:70) to be reset to 0. Counts occur at the rate of approximately 18.2 per second.

## **(AH) = 01H—Set System-Timer Time Counter**

(CX) - High portion of count  
(DX) - Low portion of count

**Note:** Execution causes the timer overflow flag (hex 40:70) to be reset to 0. Counts occur at the rate of approximately 18.2 counts per second.

## **(AH) = 02H—Read Real-Time Clock Time**

For AT BIOS dated before 6/10/85:

On Return:  
(CH) - Hours, in binary-coded decimal notation (BCD)  
(CL) - Minutes, in BCD  
(DH) - Seconds, in BCD  
CF = 0 - Clock operating  
    = 1 - Clock not operating

For AT BIOS dated 6/10/85 and later, PC/XT Model 286, PC Convertible, and Personal System/2 products:

On Return:  
(CH) - Hours, in BCD  
(CL) - Minutes, in BCD  
(DH) - Seconds, in BCD  
(DL) = 01H - Daylight saving time option  
      = 00H - No daylight saving time option  
CF = 0 - Clock operating  
    = 1 - Clock not operating

For all others, no action is performed.

## **(AH) = 03H—Set Real-Time Clock Time**

For AT, PC/XT Model 286, PC Convertible, and Personal System/2 products:

(CH) - Hours, in BCD  
(CL) - Minutes, in BCD  
(DH) - Seconds, in BCD  
(DL) = 01H - Daylight saving time option  
      = 00H - No daylight saving time option

**Note:** For Personal System/2 Model 30, (DL) is not used.

For all others, no action is performed.

### **(AH) = 04H—Read Real-Time Clock Date**

For AT, PC/XT Model 286, PC Convertible, and Personal System/2 products:

On Return:

(CH) - Century (19 or 20), in BCD

(CL) - Year, in BCD

(DH) - Month, in BCD

(DL) - Day, in BCD

CF = 0 - Clock operating

= 1 - Clock not operating

For all others, no action is performed.

### **(AH) = 05H—Set Real-Time Clock Date**

For AT, PC/XT Model 286, PC Convertible, and Personal System/2 products:

(CH) - Century (19 or 20), in BCD

(CL) - Year, in BCD

(DH) - Month, in BCD

(DL) - Day, in BCD

For all others, no action is performed.

### **(AH) = 06H—Set Real-Time Clock Alarm**

For AT, PC/XT Model 286, PC Convertible, and Personal System/2 products:

(CH) - Hours, in BCD

(CL) - Minutes, in BCD

(DH) - Seconds, in BCD

On Return:

CF = 0 - Operation successfully completed

= 1 - Alarm already set or clock not operating

**Note:** The alarm interrupt occurs at the specified hour, minute, and second that are passed in (CH), (CL), and (DH), respectively. When the alarm interrupt occurs, software Interrupt 4AH is issued. The user must point software Interrupt 4AH to an alarm routine before setting the real-time clock alarm through Interrupt 1AH, Set Real-Time Clock Alarm function (AH) = 06H). Only one alarm function can be active at any time. The alarm interrupt occurs every 24 hours at the specified time until it is reset.

For all others, no action is performed.

**(AH) = 07H—Reset Real-Time Clock Alarm**

For AT, PC/XT Model 286, PC Convertible, and Personal System/2 products, this function stops the real-time clock alarm interrupt from occurring.

For all others, no action is performed.

**(AH) = 08H—Set Real-Time Clock Activated Power-On Mode**

For PC Convertible:

- (CH) - Hours, in BCD
- (CL) - Minutes, in BCD
- (DH) - Seconds, in BCD

On Return:

- CF = 0 - Operation successfully completed
- = 1 - Alarm already set or clock not operating

For AT BIOS dated 6/10/85 and later, PC/XT Model 286, and Personal System/2 products, this function is not supported:

On Return:

- CF = 1 - Invalid function request

For all others, no action is performed.

**(AH) = 09H—Read Real-Time Clock Alarm Time and Status**

For PC Convertible and Personal System/2 Model 30:

On Return:

- (CH) - Hours, in BCD
- (CL) - Minutes, in BCD
- (DH) - Seconds, in BCD
- (DL) - Alarm status
  - = 00H - Alarm not enabled
  - = 01H - Alarm enabled but will not power-on the system
  - = 02H - Alarm enabled and will power-on the system

**Note:** Personal System/2 Model 30 does not support the power-on system feature.

For AT BIOS dated 6/10/85 and later, PC/XT Model 286, and Personal System/2 products except Model 30, this function is not supported:

On Return:  
CF = 1 - Invalid function request

For all others, no action is performed.

### **(AH) = 0AH—Read System-Timer Day Counter**

For AT and PC/XT Model 286, this function is not supported:

On Return:  
CF = 1 - Invalid function request

For PC/XT BIOS dated 1/10/86 and later and Personal System/2 products:

On Return:  
(CX) - Count of days since 1 January 1980 (1-1-80)

**Note:** The count of days since 1 January 1980 is initialized to 0 during POST.

For all others, no action is performed.

### **(AH) = 0BH—Set System-Timer Day Counter**

For AT and PC/XT Model 286, this function is not supported:

On Return:  
CF = 1 - Invalid function request

For PC/XT BIOS dated 1/10/86 and later and Personal System/2 products:

(CX) - Count of days since 1 January 1980 (1-1-80)

**Note:** The count of days since 1 January 1980 is initialized to 0 during POST.

For all others, no action is performed.

### **(AH) = 0CH to 7FH—Reserved**

## **(AH) = 80H—Set Up Sound Multiplexer**

For PCjr:

- (AL) - Source of sound ("Audio Out" or RF modulator)
- = 00H - 8253 channel 2
- = 01H - Cassette input
- = 02H - "Audio In" line on I/O channel
- = 03H - Complex sound generator chip

For AT BIOS dated 6/10/85 and later, PC/XT Model 286, PC Convertible, and Personal System/2 products, this function is not supported:

On Return:

CF = 1 - Invalid function request

For all others, no action is performed.

## **(AH) = 81H to FFH—Reserved**

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## Interrupt 4BH—Advanced Services

The following is a summary of the services available through Interrupt 4BH.

(AH) = 00H to 7FH – Reserved
(AH) = 80H – SCSI Devices (page 2-IN4B-2)
(AH) = 81H – Operating-System DMA Services (page 2-IN4B-15)
(AH) = 82H to FFH – Reserved

*Figure 2-29. INT 4BH Advanced Services*

**Note:** All reserved input fields must be set to 0.

The BIOS services that are available through Interrupt 4BH provide an interface to certain functions. Before making calls to these routines, test the appropriate bits at address hex 40:7B to determine whether the routines are supported.

Services in the SCSI Devices function ((AH)=80H) provide a generic interface to small computer system interface (SCSI) devices.

Services in the Operating-System DMA Services function ((AH)=81H) provide bus masters and operating systems with an interface for controlling memory addresses.

## **(AH) = 80H—SCSI Devices**

These BIOS services are intended for use by device drivers. Application programs should use operating-system interfaces to access small computer system interface (SCSI) devices.

The following is a summary of the SCSI functions.

(AH) = 00H – Get Device Count (page 2-IN4B-3)
(AH) = 01H – Get Device Data (page 2-IN4B-4)
(AH) = 02H – Allocate Device (page 2-IN4B-4)
(AH) = 03H – Deallocate Device (page 2-IN4B-5)
(AH) = 04H – Send Device SCB (page 2-IN4B-5)
(AH) = 05H – Send Device Immediate (page 2-IN4B-8)
(AH) = 06H – Reset Adapter (page 2-IN4B-8)
(AH) = 07H – Set Time-Out Value (page 2-IN4B-9)
(AH) = 08H to FFH – Reserved

*Figure 2-30. SCSI Device Functions*

IBM fixed disk drives are defined as having SCSI peripheral type 0, 512-byte sectors, and nonremovable media.

## **BIOS Data Area**

The following flags are located at address hex 40:7B in the BIOS data area. These flags indicate the services that are supported through Interrupt 4BH.

Address hex 40:7B

Bits 7 to 6 - Reserved

Bit 5 - Operating-system DMA services indicator

= 0 - Not supported; all memory is mapped linear = physical

= 1 - Supported

Bit 4 - Reserved

Bit 3 - Interrupt-4BH-intercepted indicator

= 0 - Interrupt vector is not intercepted

= 1 - Interrupt vector is intercepted

Bit 2 - Reserved

Bit 1 - Generic SCSI CBIOS services support

= 0 - Interrupt 4BH does not support SCSI

= 1 - Interrupt 4BH supports SCSI

Bit 0 - Reserved

If bit 5 is set to 1, DMA services are available. If bit 5 is set to 0, DMA services are not available.

Providers of the operating-system DMA services must set bit 3 when hooking into Interrupt 4BH.

If bit 3 is set to 1, a program that provides services through Interrupt 4BH must link into the interrupt chain by saving the interrupt vector for Interrupt 4BH and replacing the old vector with the pointer to the start of the program's code. Then, if the program does not provide the requested services, it can pass the call to the next link in the chain.

For Personal System/2 systems with Micro Channel architecture, if bit 3 is set to 0, the following test must be performed:

If bit 1 of 40:7B is set to 0,  
— or —  
the contents of the Interrupt 4BH vector are 0:0,  
— or —  
the Interrupt 4BH vector contains a segment value of  
hex E000 or hex F000,

the interrupt vector must not be chained.

Else, the interrupt vector must be chained.

If this test indicates that the interrupt vector must not be chained, the program puts its pointer into the vector and sets bit 3 to 1; however, if it does not provide the requested services, the program must return status that indicates that the call is not supported ((AH) = 86H and CF = 1).

### **(AL) = 00H—Get Device Count**

This function returns the total count of SCSI devices in the system for the specified peripheral type.

(DL) - Device-type indicator  
Bit 7 = 1 - Removable media  
Bits 6 to 0 - SCSI peripheral type

On Return:  
(AH) - Return code  
(CL) - Device count  
CF = 0 - Return code is 0  
= 1 - Return code is non 0

## **(AL) = 01H—Get Device Data**

This function returns various parameters for the specified SCSI device.

- (DL) - Device-type indicator
  - Bit 7 = 1 - Removable media
  - Bits 6 to 0 - SCSI peripheral type
- (DH) - Device index (range is from 1 to the device count)

On Return:

- (AL) - Device status
  - Bits 7 - Reserved
  - Bit 6 = 0 - Scatter/gather supported in hardware
    - = 1 - Scatter/gather not supported in hardware
  - Bit 5 = 1 - Device allocated
  - Bit 4 = 0 - Cache buffer not enabled
    - = 1 - Cache buffer enabled
  - Bit 3 = 1 - IBM fixed disk drive (nonremovable media, 512-byte sectors)
  - Bit 2 = 1 - Removable media
  - Bit 1 = 1 - Defective device (error during POST)
  - Bit 0 = 1 - Device not powered-on (during POST)
- (BH) - Level
  - Bits 7 to 4 - Reserved
  - Bits 3 to 0 - Adapter number
- (BL) - Unit number
  - Bits 7 to 4 - Logical unit number
  - Bits 3 to 0 - Physical unit number
- (CL) - Time-out value
  - Bit 7 = 0 - Time-out count, in seconds
    - = 1 - Time-out count, in minutes
  - Bits 6 to 0 - Time-out count
- (AH) - Return code
  - CF = 0 - Return code is 0
    - = 1 - Return code is non 0

## **(AL) = 02H—Allocate Device**

This function returns a device key for the specified SCSI device. This device key is unique for each device and is used with the Deallocate Device function ((AL)=03H), the Send SCB to Device function ((AL)=04H), the Send Immediate Command to Device function ((AL)=05H), the Reset Adapter function ((AL)=06H), and the Set Time-Out Value function ((AL)=07H).

The value of the device key varies, depending on the configuration, the BIOS version, and other factors. Therefore, to ensure compatibility, use this function to obtain a valid device key. The device key is valid only when the carry flag is set to 0.

If the device has already been allocated, a device key is not returned.

- (DH) - Device index
  - = 0 - Allocate next available device
  - = From 1 to the device count - Allocate specified device
- (DL) - Device-type indicator
  - Bit 7 = 1 - Removable media
  - Bits 6 to 0 - SCSI peripheral type

On Return:

- (AH) - Return code
- (DX) - Device key
- CF = 0 - Return code is 0
- = 1 - Return code is non 0

**Note:** IBM fixed disk drives are accessible through Interrupt 13H—Fixed Disk. Any device driver that allocates an IBM fixed disk drive through this function must also intercept Interrupt 13H requests for that device, or substitute for the operating-system device driver that issues the Interrupt 13H requests.

#### **(AL) = 03H—Deallocate Device**

This function frees the device that is associated with the specified device key so that it can be allocated by another device driver. After the device has been deallocated, an error occurs if that device key is used. The Allocate Device function must be used to regain access to the device.

(DX) - Device key

On Return:

- (AH) - Return code
- CF = 0 - Return code is 0
- = 1 - Return code is non 0

#### **(AL) = 04H—Send SCB to Device**

This function sends a subsystem control block (SCB) command to the specified SCSI device. (Refer to the technical references for the SCSI adapter and the device for details on the SCB structure and other programming information.)

(CL) - SCB type indicator

Bits 7 to 4 - Reserved

Bit 3 = 0 - Original chain header or no chain header passed  
(see note on page 2-IN4B-7)

= 1 - Extended chain header passed

Bit 2 = 0 - 32-bit SCB physical address pointer not passed  
(SI and DI are undefined on input)

= 1 - 32-bit SCB physical pointer passed in (SI,DI)

Bit 1 = 0 - No chain header or extended chain header passed  
(see note on page 2-IN4B-7)

= 1 - Original chain header passed

Bit 0 = 0 - Send SCB (use with all commands except the  
Send Other SCSI SCB command)

= 1 - Send long SCB (use with Send Other SCSI SCB  
command)

(DX) - Device key

(ES:BX) - Logical pointer to SCB

(SI,DI) - 32-bit physical address pointer to SCB (SI is MSW;  
DI is LSW; valid when bit 2 of CL is set to 1)

On Return:

(AH) - Return code

(AL) - Error status (see "Return Codes" on page 2-IN4B-10 for a definition  
of this error status)

CF = 0 - Return code is 0

= 1 - Return code is non 0

### Notes:

1. The Read and Write SCB commands are the primary interface to devices such as IBM fixed disk drives. The Send Other SCSI command should not be used to read or write to IBM fixed disk drives because system data might be lost.
2. All addresses within the subsystem control block (SCB) are physical. Before making a call to BIOS, the calling program must translate logical addresses to physical addresses and ensure that all subsystem control blocks, termination status blocks, and data buffers are locked into memory. See Interrupt 4BH, Operating-System DMA Services function ((AH)=81H).

3. When SCBs are chained, (ES:BX) points to the first SCB. Each SCB is built with a chain header, which immediately precedes the SCB. The format of the chain header is as follows:

Size	Offset	Description
Word	-10H	Reserved
DWord	-0CH	Logical-pointer data buffer
Word	-0AH	Reserved
Word	-08H	Reserved
DWord	-04H	Logical pointer to scatter/gather list (set to 0 if no scatter/gather list)
Word	-02H	Reserved
Word	00H	Reserved
DWord	02H	Logical pointer to next SCB header in chain, or chain-ending indicator (0)
Word	06H	Reserved
Word	08H	Reserved
DWord	0AH	Logical pointer to TSB associated with this SCB
Word	0EH	Reserved
	10H	Beginning of SCB

- A chain length of 1 is allowed.
- The chain must have an ending.
- A logical pointer to the next SCB header in the chain equal to 0 ends the chain.
- The chain header must immediately precede the SCB.

Bit 2 in (CL) can be set, and the physical address to the first SCB can be passed in (SI,DI). However, (ES:BX) and the chain headers must still be built and passed. If the linear address of the SCB does not equal the physical address, the physical address must be passed to BIOS. See Interrupt 4BH, Operating-System DMA Services function ((AH)=81H).

See "Send Device SCB Chaining" on page 2-IN4B-12 for chaining data structures and example.

To determine the chain-header type, the SCB-indicator bits 1 and 3 must be evaluated together. There are two types of chain headers as input to BIOS: the original header and the extended header. It is recommended that all software use the extended header as input. Using the extended header ensures portability to non-bus-master implementations of SCSI controllers. Bits 1 and 3 are evaluated as follows:

- When bit 3 is set to 0 and bit 1 is set to 0, no chain header is passed.
- When bit 3 is set to 0 and bit 1 is set to 1, the original chain header is passed.

- When bit 3 is set to 1 and bit 1 is set to 0, an extended chain header is passed.
- When bit 3 is set to 1 and bit 1 is set to 1, an invalid condition exists, and an error return code is returned.

### **(AL) = 05H—Send Immediate Command to Device**

This function sends an immediate command to the specified SCSI device. (Refer to the technical references for the SCSI adapter and the device for details on the immediate commands and other programming information.)

(BX) - Word 0 of the immediate command  
 (CX) - Word 1 of the immediate command  
 (DX) - Device key

On Return:

(AH) - Return code  
 (AL) - Error status (see "Return Codes" on page 2-IN4B-10 for a definition of this error status)  
 CF = 0 - Return code is 0  
     = 1 - Return code is non 0

### **(AL) = 06H—Reset Adapter**

This function issues a hardware reset to the adapter for the specified device. This causes the card to perform power-on diagnostic routines to determine whether various components on the adapter are functioning properly. All device operations in progress on the adapter are terminated. After the reset, BIOS restores the device assignments, device time-out values, and the device-cache status.

**Note:** This function should be used only as part of an error-recovery procedure. See "Return Codes" on page 2-IN4B-10 to determine when this function should be issued.

(DX) - Device key

On Return:

(AH) - Return code  
 (AL) - Error status (see "Return Codes" on page 2-IN4B-10 for a definition of this error status)  
 CF = 0 - Return code is 0  
     = 1 - Return code is non 0

### **(AL) = 07H—Set Time-Out Value**

This function specifies the maximum time that the adapter will wait for a device to complete a command. The default time-out value for each device is 45 seconds. The time-out value is specified in bits 6 to 0 of the CL register. Bit 7 determines whether the time is in seconds or in minutes.

If bits 6 to 0 are set to 0, BIOS programs the adapter not to time out any commands to the device. On subsequent commands to the device, BIOS waits up to 127 minutes for the operation to be completed before posting an error. If more time is required, the controlling program must chain into Interrupt 15H, screen the Wait (AX=9000H) and Post (AX=9100H) calls, and provide the correct wait time before allowing BIOS to post an error.

(CL) - Time-out value

Bit 7 = 0 - Time-out count, in seconds

= 1 - Time-out count, in minutes

Bits 6 to 0 - Time-out count

(DX) - Device key

On Return:

(AH) - Return code

(AL) - Error status (see "Return Codes" on page 2-IN4B-10 for a definition of this error status)

CF = 0 - Return code is 0

= 1 - Return code is non 0

### **(AL) = 08H to FFH—Reserved**

## Return Codes

The following figure lists the return codes and their meanings. Return codes are returned in the AH register.

Value	Description
00H	Operation Successfully Completed
01H	Invalid BIOS Function or Parameter
02H	Device Not Allocated
03H	Device Already Allocated
04H	Function Not Allowed (see note 1)
05H	Request Refused, Adapter Reset Required
06H	Request Ended in Error (see note 2)
07H	Adapter Reset Failed (see note 2)
08H	Adapter Reconfiguration Failed after Reset
09H	Adapter Time-Out Error
0AH	Adapter in Use (see note 3)
0BH	Extended Header Required to Complete the Request (see note 4)

Figure 2-31. Return Codes – SCSI Devices

### Notes:

1. This code is returned when the Set Feature Control immediate command is issued. Instead, the device driver must use the Set Time-Out Value function ((AL) = 07H).
2. The following defines the error status value in (AL):

(AL) - Error status

Bit 7 = 1 - Reset adapter before attempting the next command

Bit 6 = 1 - Request command-complete status to get additional error-status data

Bit 5 - Reserved

Bit 4 = 1 - Bits 3 to 0 contain interrupt ID of interrupt status register

Bits 3 to 0 - Interrupt ID of interrupt status register

3. This code is returned when the adapter is in use. The device driver should retry the operation at a later time.
4. In an operating-system DMA-services environment, this error occurs when:
  - No chain header (original or extended) was passed and the caller's termination status block must be filled in, or
  - No extended chain header was passed and the caller requested a scatter/gather operation on hardware that does not support scatter/gather.

## Programming Considerations

- BIOS tests the device key parameter and the device index parameter to protect the integrity of the system. Any calls that are directed to BIOS for SCSI devices and have an unrecognized function value generate a return code of 01H (Invalid BIOS Function or Parameter).
- SCSI devices are controlled by immediate commands or subsystem control blocks (SCBs) that are issued to the device. These commands contain a function number and other necessary parameters.

If the device driver specifies an SCB command, the device performs the command pointed to by (ES:BX).

If the device driver specifies an immediate command, the device performs the 32-bit command that is contained in (CX,BX) (CX = MSW; BX = LSW).

The device driver must ensure that subsystem control blocks and any data buffers or termination status block areas that are needed for command processing are locked into memory. The device driver must also ensure that the correct physical addresses are used.

- Before any of the BIOS for SCSI Devices functions are invoked, the device driver must test bit 1 of address hex 40:7B. If this bit is set to 1, the SCSI services are available, and the bit no longer has to be tested.
- The AX register and the carry flags are used to return the status of the operation. The carry flag signals the status of each operation on return from BIOS. If the carry flag is set to 0, the operation was successful, and (AH) is set to 0. If the carry flag is set to 1, the operation was not successful, and (AH) contains a return code as defined in "Return Codes" on page 2-IN4B-10. If more information is needed, use the Request Sense command.

## Programming Example

The following is an example of a procedure that uses these BIOS routines. The scenario describes a peripheral-type device driver that does not have information about how many devices of that type are attached.

**1. Determine how many devices of that type are attached:**

Get Device Count function  
(DL) = 81H - Specifies removable-media tape drive

On Return:  
CF = 0  
(CL) = 03H - Three devices

**2. Get the device key for the specific drive. The device key is unique for each drive in the system:**

Allocate Device function  
(DL) = 81H  
(DH) = 01H - First tape drive

On Return:  
CF = 0  
(DX) = Device key for first tape drive in the system

**3. Send a Device Inquiry command using BIOS routines with (DX) = device key, and check the device-dependent information to determine whether it is the correct device. If it is not:**

Deallocate Device function  
(DX) = Device key

Allocate Device function  
(DL) = 81H  
(DH) = 02H - Next tape

## **Send Device SCB Chaining**

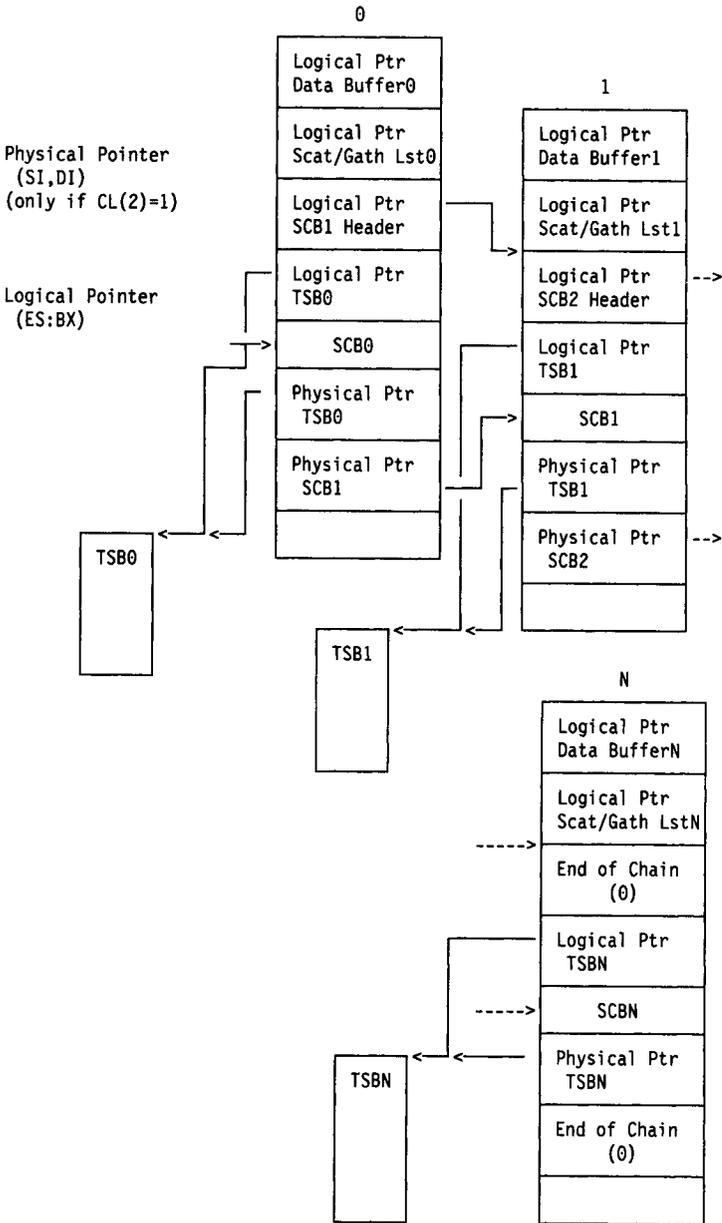
Before chaining subsystem control blocks:

- When bit 3 of the CL register is set to 1, the extended SCB chain header is being used.
- (ES:BX) is the logical pointer to the first SCB. This pointer must always exist. It points to the SCB, not to the SCB chain header.
- (SI,DI) is the 32-bit physical pointer to the first SCB. Bit 2 of the CL register is set to 1. If the SCB is not in linear-equals-physical memory, this information must be provided.

- The following describes the data structures that must be used when SCBs are chained:

<b>Size</b>	<b>Offset</b>	<b>Description</b>
Word	-10H	Reserved
DWord	-0CH	Logical-pointer data buffer
Word	-0AH	Reserved
Word	-08H	Reserved
DWord	-04H	Logical pointer to scatter/gather list (set to 0 if no scatter/gather list)
Word	-02H	Reserved
Word	00H	Reserved
DWord	02H	Logical pointer to next SCB header in chain or chain-ending indicator (0)
Word	06H	Reserved
Word	08H	Reserved
DWord	0AH	Logical pointer to TSB that is associated with this SCB
Word	0EH	Reserved
	10H	Beginning of SCB

# BIOS Send Device SCB Chain Example



## **(AH) = 81H—Operating-System DMA Services**

This interface is provided by the operating system, not by BIOS or A BIOS. It enables communication of physical address information between the operating system and other programs. This interface provides a means for:

- Identifying the version and functional level of the support that is provided
- Identifying the physical address of an I/O buffer
- Determining whether the memory for an I/O buffer is a contiguous block
- Locking and unlocking the I/O buffer into a specific memory space
- Remapping memory to put the I/O buffer into a contiguous memory space
- Allocating a contiguous block of memory for I/O buffers
- Copying data to or from the allocated buffers.

The following is a summary of the Operating-System DMA Services functions.

(AH) = 00H to 001H – Reserved
(AH) = 02H – Return DMA-Service Parameters (page 2-IN4B-20)
(AH) = 03H – Lock I/O Buffer (page 2-IN4B-20)
(AH) = 04H – Unlock I/O Buffer (page 2-IN4B-22)
(AH) = 05H – Scatter/Gather Lock Buffer (page 2-IN4B-23)
(AH) = 06H – Scatter/Gather Unlock Buffer (page 2-IN4B-25)
(AH) = 07H – Request Operating-System Buffer (page 2-IN4B-9)
(AH) = 08H – Release Operating-System Buffer (page 2-IN4B-26)
(AH) = 09H – Copy Data into Operating-System Buffer (page 2-IN4B-27)
(AH) = 0AH – Copy from Operating-System Buffer (page 2-IN4B-27)
(AH) = 0BH – Disable DMA Translation (page 2-IN4B-28)
(AH) = 0CH – Enable DMA Translation (page 2-IN4B-28)
(AH) = 0DH to FFH – Reserved

*Figure 2-32. Operating-System DMA Services Functions*

Micro Channel bus-master adapters can access memory locations without assistance from the operating system and without using the system microprocessor or DMA controller.

When the system microprocessor is operating in the protected (virtual address) mode, the device drivers for these adapters communicate with the operating system to exchange address information. In this mode, the physical address of the data buffers that are used in I/O operations is not available to BIOS or device-driver routines that initiate the I/O operations.

## Operating-System Requirements

Any operating system that supports operating-system DMA services must provide the following minimum requirements:

- Functions hex 02 through hex 0C describe the minimum subset of DMA services that must be implemented by the provider.
- The operating system must support either I/O buffer allocation or automatic page remapping, but it can provide both services. If I/O buffer allocation is supported, the minimum size of the buffer is 16KB.
- During initialization of an operating system that provides DMA services, the device drivers must remain at the previously-allocated memory addresses. Operating systems that provide DMA services can implement an interface that allows for the device drivers to be relocated. However, all in-process I/O transactions must be completed before the device drivers are relocated.
- The operating system must indicate that these DMA services are provided in the BIOS data area by setting bit 5 at address hex 40:7B to 1.
- BIOS locks and unlocks the extended BIOS data area as required. When DMA services are provided (bit 5 at address hex 40:7B is set to 1), the provider must ensure that requests to lock the extended BIOS data area are successful. When the extended BIOS data area is locked, it is contiguous, and the physical address is available in the Physical Address field of the DMA descriptor structure (DDS).
- Interrupt 15H, Return Extended BIOS Data Area Segment Address function ((AH) = C1H) returns the address segment for the extended BIOS data area. The first byte (offset hex 00) is the length of the extended BIOS data area, in KB. The extended BIOS data area has an assumed offset of hex 0. Interrupt 15H, Return System Configuration Parameters function ((AH) = C0H) indicates whether the extended BIOS data area has been allocated.

## BIOS Data Area

The following flags are located at address hex 40:7B in the BIOS data area. These flags indicate the services that are supported through Interrupt 4BH.

Address hex 40:7B

Bits 7 to 6 - Reserved

Bit 5 - Operating-system DMA services indicator

= 0 - Not supported; all memory is mapped linear = physical

= 1 - Supported

Bit 4 - Reserved

Bit 3 - Interrupt-4BH-intercepted indicator

= 0 - Interrupt vector is not intercepted

= 1 - Interrupt vector is intercepted

Bit 2 - Reserved

Bit 1 - Generic SCSI CBIOS services support

= 0 - Interrupt 4BH does not support SCSI

= 1 - Interrupt 4BH supports SCSI

Bit 0 - Reserved

If bit 5 is set to 1, DMA services are available. If bit 5 is set to 0, DMA services are not available.

Providers of the operating-system DMA services must set bit 3 when hooking into Interrupt 4BH.

If bit 3 is set to 1, a program that provides services through Interrupt 4BH must link into the interrupt chain by saving the interrupt vector for Interrupt 4BH and replacing the old vector with the pointer to the start of the code for the program. Then, if the program does not provide the requested services, it can pass the call to the next link in the chain.

For Personal System/2 systems with Micro Channel architecture, if bit 3 is set to 0, the following test must be performed:

If bit 1 of 40:7B is set to 0,

— or —

the contents of the Interrupt 4BH vector are 0:0,

— or —

the Interrupt 4BH vector contains a segment value of hex E000 or hex F000,

the interrupt vector must not be chained.

Else, the interrupt vector must be chained.

If this test indicates that the interrupt vector must not be chained, the program puts its pointer into the vector and sets bit 3 to 1; however, if it does not provide the requested services, the program must return status that indicates that the call is not supported ((AH) = 86H and CF = 1).

### **Programming Considerations**

- Before attempting to physically address memory, device drivers and other programs that use the operating-system DMA services must determine whether physical-address services are available. At initialization, the device driver tests bit 5 (physical-address services indicator) at address hex 40:7B to make this determination.

If bit 5 is set to 1, the services are available, and the device driver must use the services to lock the required buffers into memory and to get the physical addresses of the buffers. Any locked buffers must be unlocked after the I/O operation is complete. This bit is retested before each operation that accesses memory.

If bit 5 is set to 0, the services are not available, and the device driver requests a block of memory to use as buffer space. After the buffer space has been allocated, that space remains locked into memory as long as the driver remains installed. The device driver does not retest bit 5 for accesses to buffers that have been allocated in this manner. However, if the device driver receives an address that is not within its boundaries, the device driver must retest bit 5 and use the physical-address services, if they are available.

- With the exception of the AX register, the contents of all registers and the values in the DMA descriptor structure must be preserved, unless otherwise noted. If the carry flag is set to 1, the AL register contains an error code. If the carry flag is set to 0, the AH and AL registers are undefined, unless otherwise noted.

## The DMA Descriptor Structure (DDS)

The DMA descriptor structure (DDS) is used to pass parameters between the operating system and the calling program. The DDS can be constructed in the memory of the calling program or on the stack. Reserved fields in the DDS must be set to 0.

The format of the DMA descriptor structure is as follows:

Size	Offset	Description
DWord	00H	Buffer size (in bytes)
DWord	04H	Offset This is a 32-bit offset. If a 16-bit offset is specified, the calling program must set the word at offset hex 06 to 0. If the Segment/Selector field is set to 0, the offset is a 32-bit linear offset.
Word	08H	Segment/selector This is the segment or selector of the buffer. If this field is set to 0, the Offset field contains the 32-bit linear address of the buffer.
Word	0AH	Buffer ID This field is filled in by the provider of DMA services. When this field is set to 0, a buffer was not allocated.
Word	0CH	Physical address This is the 32-bit value of the physical address that can be used to program the DMA controller or Bus-Master Address register. This field is filled in by the provider of DMA services.

### (AL) = 00H to 01H—Reserved

On Return:

- (AL) - Error code
  - = 0FH - Function not supported
- (CF) = 1 - Operation failed

## **(AL) = 02H—Return DMA-Service Parameters**

This function returns the version level of DMA services, the operating-system identification, the DMA-service revision level, hardware address restrictions, the maximum buffer size that is available from the operating system, and the automatic memory-remapping-support indicator.

(DX) - Flags  
All bits are reserved and must be set to 0

On Return:

(AH) - Major specification version number (binary)  
(AL) - Minor specification version number (binary)  
(BX) - Product number  
(CX) - Product revision number  
(SI:DI) - Maximum single operating-system buffer size that can be requested from the operating system (in bytes). A value of 0 indicates that no operating-system buffer is available or supported.

(DX) - Flags

Bit 0 - Memory address space size  
= 0 - Memory addresses greater than 1MB exist  
= 1 - All memory addresses are less than 1MB  
Bit 1 - Physical buffer/remap buffer location  
= 0 - Physical buffer/remap buffer can be above 1MB  
= 1 - Physical buffer/remap buffer is below 1MB  
Bit 2 - Automatic page remapping support  
= 0 - Automatic page remapping is not supported  
= 1 - Automatic page remapping is supported  
Bit 3 - Memory-paging indicator  
= 0 - Memory is not physically contiguous  
= 1 - All memory is physically contiguous  
Bits 4 to 15 - Reserved (set to 0)  
CF = 0 - Operation successfully completed

## **(AL) = 03H—Lock I/O Buffer**

This function determines whether the I/O buffer for the calling program is in contiguous physical memory. If it is, the physical address of the I/O buffer is returned in the DMA descriptor structure (DDS), and the buffer is locked in memory.

A locked buffer must be unlocked after the I/O operation is completed, either successfully or unsuccessfully.

Automatic page remapping, if supported, can be enabled or disabled. If automatic page remapping is enabled, the operating system moves the buffer pages to force the I/O buffer into contiguous physical memory. Automatic remapping might reduce performance because of the movement of data in memory.

An option is provided to allocate a buffer in the memory of the operating system if the buffer for the calling program is not in contiguous memory. The calling program can also specify that the data is to be copied from the buffer of the calling program into the allocated buffer. The physical address that is returned in the DDS points to the allocated buffer that contains the data for the calling program.

**(DX) - Flags**

Bit 0 - Reserved

Bit 1 - Automatic data copy indicator

= 0 - Do not copy data into operating-system buffer

= 1 - Copy data into operating-system buffer

(ignored if bit 2 = 1)

Bit 2 - Automatic buffer-allocation indicator

= 0 - Allocate buffer

= 1 - Do not allocate buffer

Bit 3 - Automatic remapping request indicator

= 0 - Automatic remapping requested

= 1 - Do not remap memory

Bit 4 - 64KB I/O buffer boundary restriction indicator

= 0 - No 64KB physical address boundary restrictions

= 1 - Buffer must not cross 64KB physical address boundary

Bit 5 - 128KB I/O buffer boundary restriction indicator

= 0 - No 128KB physical address boundary restrictions

= 1 - Buffer must not cross 128KB physical address boundary

Bits 6 to 15 - Reserved (set to 0)

**(ES:DI) - Pointer to DMA descriptor structure (DDS)**

The calling program must fill in the Buffer Size field, the Offset field, and the Segment/Selector field in the DDS.

**On Return:**

**(AL) - Error code**

= 01H - Specified buffer is not in contiguous memory,  
or automatic remapping was not successful

= 02H - Buffer crossed a physical alignment boundary

= 03H - Unable to lock pages; insufficient memory

(virtual-memory systems only)

= 05H - Requested buffer size too large

= 06H - Buffer currently in use

= 07H - Invalid memory buffer specified

= 10H - Reserved flag bits set in (DX)

**CF = 0 - Operation successfully completed.**

Buffer memory is locked.

The Physical Address field of the DDS contains the starting physical address of the buffer.

The Buffer ID field contains the ID of the allocated buffer, or the Buffer ID field contains 0 if no buffer was allocated.

**= 1 - Operation failed.**

Buffer memory is not locked

The Buffer Size field of the DDS contains the maximum contiguous length, in bytes.

**Notes:**

1. If the DMA services return a physical address that is not compatible with the DMA controller or the bus-master addressing capabilities, the calling program can unlock the I/O buffer and request that the DMA services allocate a buffer from the free memory of the operating system (see (AL) = 07H on page 2-IN4B-25).
2. If an operating-system buffer is not available, the calling program can enable interrupts, and a wait loop can repeatedly attempt to allocate a buffer.
3. After the I/O operation has been initiated, a wait loop with interrupts enabled can be used to wait for the completion of the I/O operation. The buffer can be released on the hardware-interrupt level, enabling other tasks that are waiting for buffer space to continue.
4. This function can be called repeatedly.

**(AL) = 04H—Unlock I/O Buffer**

This function unlocks a previously-locked I/O buffer.

**(DX) - Flags**

Bits 15 to 2 - Reserved (set to 0)

Bit 1 - Automatic data copy indicator

= 0 - Do not copy data

= 1 - Copy data from the operating-system buffer to a buffer of the calling program

Bit 0 - Reserved (set to 0)

(ES:DI) - Pointer to DMA descriptor structure (DDS)

The calling program must return a DDS with the buffer size, physical address, and buffer ID of a buffer that is currently locked.

**On Return:**

(AL) - Error code

= 08H - Memory was not locked

= 0AH - Invalid buffer ID

= 10H - Reserved flag bits set in (DX)

CF = 0 - Operation successfully completed.

Memory is unlocked; the buffer is no longer valid.

= 1 - Operation failed.

All memory remains locked

## (AL) = 05H—Scatter/Gather Lock Buffer

This function determines the physical addresses of the memory areas that make up the buffer of the calling program and locks each of these memory areas. The list of physical addresses and the size of each area are returned to the calling program in the DMA descriptor structure (DDS). The calling program can use these parameters to program bus masters that support the scatter/gather functions or to break up a bus-master or DMA-I/O operation into multiple operations.

### (DX) - Flags

Bit 6 - Return physical address/page table entries

= 0 - Return physical addresses

= 1 - Return page table entries

Bit 7 - Allocate page indicator (only if bit 6 is set to 1)

= 0 - All pages must be allocated and present

= 1 - Lock only those pages that are present.

All page-table entries must be returned in the DDS, whether they are present or not.

The calling program must determine the presence or absence of pages in memory from bit 0 of the page-table entry:

Bits 31 to 12 - Page-frame address if bit 0 = 1.

All set to 0 if bit 0 = 0.

Bits 11 to 1 - Reserved (set to 0)

Bit 0 - Presence indicator

= 0 - Page is absent from memory

= 1 - Page is present in memory

All other bits are reserved and must be set to 0.

(ES:DI) - Pointer to scatter/gather DDS

When bit 6 is set to 0, the DMA descriptor structure returns the physical addresses of the memory areas:

Size	Offset	Description
DWord	00H	Buffer size, in bytes
DWord	04H	Offset
Word	08H	Segment/selector
Word	0AH	Reserved
Word	0CH	Number of physical buffers available
Word	0EH	Number of physical buffers that are used
DWord	10H	Buffer 0 physical address
DWord	14H	Buffer 0 size, in bytes
DWord	18H	Buffer 1 physical address
DWord	1CH	Buffer 1 size, in bytes
.	.	.
.	.	.
.	.	.
DWord	10H + (n×8)	Buffer n physical address
DWord	14H + (n×8)	Buffer n size, in bytes

When bit 6 is set to 1, the DMA descriptor structure returns the page-table entries of the memory areas:

Size	Offset	Description
DWord	00H	Buffer size, in bytes
DWord	04H	Offset
Word	08H	Segment/selector
Word	0AH	Reserved
Word	0CH	Number of page-table entries available
Word	0EH	Number of page-table entries that are used
DWord	10H	Page-table entry 0
DWord	14H	Page-table entry 1
.	.	.
.	.	.
.	.	.
DWord	10H + (n×4)	Page-table entry <i>n</i>

The calling program must fill in the Buffer Size field, the Segment/Selector field, the Offset field, and the Number of Physical Buffers/Page-Table Entries Available field.

The maximum number of physical buffers that are required can be computed as:

$$\frac{(\text{Linear Address AND } 0\text{FFFH}) + \text{Buffer Size in hexadecimal} + 0\text{FFFH}}{1000\text{H}}$$

On Return:

(AL) = Error code

03H = Unable to lock pages, insufficient memory

07H = Invalid memory buffer specified

09H = Number of physical buffers/pages is greater than the table length. Offset hex 0E of the DDS contains the number of entries that are actually required to represent the buffer of the calling program.

10H = Reserved flag bits set in (DX)

CF = 0 - Operation successfully completed.

Offset hex 0E of the DDS contains the number of physical buffers or page-table entries that are filled in.

If bit 6 of (DX) is set to 1, the low 12 bits of (BX) contain the offset in the first page to the start of the buffer.

The high 4 bits are set to 0.

= 1 - Operation failed.

Memory is not locked.

The Buffer Size field of the DDS contains the maximum length, in bytes, that can be locked and described in the DDS.

Either the list of physical addresses and their sizes or the page-table entries are undefined.

### **(AL) = 06H—Scatter/Gather Unlock Buffer**

This function unlocks a buffer that was locked by the Scatter/Gather Lock Buffer function ((AL) = 05H).

(DX) - Flags

All bits are reserved and must be set to 0.

(ES:DI) - Pointer to the extended DDS that was used when the Scatter/Gather Lock Buffer function was called

On Return:

(AL) - Error code

= 08H - Memory was not locked

= 10H - Reserved flag bits set in (DX)

CF = 0 - Operation successfully completed; memory is unlocked

= 1 - Operation failed

### **(AL) = 07H—Request Operating-System Buffer**

This function allocates and locks a buffer of physically-contiguous memory from the operating-system free memory. If requested, data is copied from the buffer of the calling program into the buffer that was allocated by the operating system.

The data must be copied to or from the operating-system buffer before the Release Operating-System Buffer function ((AL) = 08H) is called. The physical address of the buffer is invalid after the buffer is released.

(DX) - Flags

Bit 1 - Automatic data copy indicator

= 0 - Do not copy data

= 1 - Copy data into the operating-system buffer

All other bits are reserved and must be set to 0.

(ES:DI) - Pointer to DMA descriptor structure (DDS)

The calling program must fill in the Buffer Size field. If automatic copy is selected, the calling program must also fill in the Segment/Selector field and the Offset field to point to the data that is to be copied into the allocated buffer.

On Return:

(AL) - Error code

- = 04H - No buffer available
- = 05H - Buffer size too large
- = 06H - Buffer currently in use
- = 07H - Invalid memory buffer specified
- = 10H - Reserved flag bits set in (DX)

CF = 0 - Operation successfully completed

The Physical Address field of the DDS contains the starting physical address of the buffer.

The Buffer Size field of the DDS specifies the size of the buffer.

The Buffer ID field of the DDS contains the ID of the allocated buffer.

If automatic copy is selected, data is copied into the operating-system buffer.

= 1 - Operation failed

### Notes:

1. If an operating-system buffer is not available, the calling program can enable interrupts, and a wait loop can repeatedly attempt to allocate a buffer.
2. After the I/O operation has been initiated, a wait loop with interrupts enabled can be used to wait for the completion of the I/O operation. The buffer can be released on the hardware-interrupt level, enabling other tasks that are waiting for buffer space to continue.
3. This function can be called repeatedly.

### (AL) = 08H—Release Operating-System Buffer

This function releases an operating-system buffer that was previously allocated. The physical address is invalid after the buffer is released.

(DX) - Flags

Bit 1 - Automatic data copy indicator

= 0 - Do not copy data

= 1 - Copy data out of the operating-system buffer

All other bits are reserved and must be set to 0.

(ES:DI) - Pointer to DMA descriptor structure (DDS)

The calling program must return a pointer to a DDS that contains a Buffer ID field of the previously-allocated buffer.

On Return:

(AL) - Error code

= 0AH - Invalid buffer ID

= 10H - Reserved flag bits set in (DX)

CF = 0 - Operation successfully completed

= 1 - Operation failed

### **(AL) = 09H—Copy Data Into Operating-System Buffer**

This function copies data from the buffer of the calling program into the buffer that has been allocated by the operating system to prepare for an I/O write operation.

(DX) - Flags

All bits are reserved and must be set to 0.

(ES:DI) - Pointer to DMA descriptor structure (DDS)

The calling program must fill in the Buffer ID field, the Buffer Size field, the Segment/Selector field, and the Offset field to specify the source address to copy from. The Buffer Size field of the DDS determines the number of bytes that are to be copied.

(BX:CX) - Starting offset in operating-system buffer to be copied

On Return:

(AL) - Error code

= 0AH - Invalid buffer ID

= 0BH - (Copy count + offset) is greater than the buffer size

= 10H - Reserved flag bits set in (DX)

CF = 0 - Operation successfully completed

= 1 - Operation failed

### **(AL) = 0AH—Copy from Operating-System Buffer**

This function copies data from the buffer that has been allocated by the operating system into the buffer of the calling program after an I/O read operation.

(DX) - Flags

All bits are reserved and must be set to 0.

(ES:DI) - Pointer to DMA descriptor structure (DDS)

The calling program must fill in the Buffer ID field, the Buffer Size field, the Segment/Selector field, and the Offset field to specify the destination address to copy to. The Buffer Size field of the DDS determines the number of bytes that are to be copied.

(BX:CX) - Starting offset in operating-system buffer to be copied

On Return:

- (AL) - Error code
  - = 0AH - Invalid buffer ID
  - = 0BH - (Copy count + offset) is greater than the buffer size
  - = 10H - Reserved flag bits set in (DX)
- CF = 0 - Operation successfully completed
- = 1 - Operation failed

### **(AL) = 0BH—Disable DMA Translation**

This function disables the operating-system function that traps the DMA I/O ports and remaps the buffer address to a physical address. BIOS and device drivers that use the DMA services to determine the physical address of I/O buffers must disable the automatic DMA translation by calling this function.

A disable count is maintained. Each disable call must have a corresponding enable call before automatic DMA translation is enabled.

- (BX) - DMA channel number
- (DX) - Flags
  - All bits are reserved and must be set to 0.

On Return:

- (AL) - Error code
  - = 0CH - Invalid DMA channel number
  - = 0DH - Disable-count overflow
  - = 10H - Reserved flag bits set in (DX)
- CF = 0 - Operation successfully completed
- = 1 - Operation failed

### **(AL) = 0CH—Enable DMA Translation**

This function enables automatic DMA translation.

A disable count is maintained. Each disable call must have a corresponding enable call before automatic DMA translation is enabled.

- (BX) - DMA channel number
- (DX) - Flags
  - All bits are reserved and must be set to 0.

**On Return:**

- (AL) - Error code
  - = 0CH - Invalid DMA channel number
  - = 0EH - Disable-count underflow (was not previously disabled; count remains 0)
  - = 10H - Reserved flag bits set in (DX)
- CF = 0 - Operation successfully completed
- = 1 - Operation failed
- ZF = 0 - Disable count is not equal to 0
- = 1 - Disable count is equal to 0

**(AL) = 0DH to FFH—Reserved**

All registers are reserved (set to 0).

**On Return:**

- (AL) - Error code
  - = 0FH - Function not supported
- CF = 1 - Operation failed

## Error Codes and Option Flags

The following figure lists the error codes and their meanings. Error codes are returned in the AL register.

Value	Description
01H	Specified buffer was not in contiguous memory
02H	Buffer crossed a physical alignment boundary
03H	Unable to lock pages
04H	No buffer available
05H	Buffer too large
06H	Buffer currently in use
07H	Invalid memory buffer specified
08H	Buffer was not locked
09H	Number of physical pages was greater than table length
0AH	Invalid buffer ID
0BH	Copy out of buffer range
0CH	Invalid DMA channel number
0DH	Disable-count overflow
0EH	Disable-count underflow
0FH	Function not supported
10H	Reserved flag bits set in (DX)

*Figure 2-33. Error Codes – Operating-System DMA Services*

The following figure lists the option flags. Option flags are returned in the DX register.

Bit 7	Lock and return presently-available pages
Bit 6	Return physical address/page table entries
Bit 5	128KB I/O-buffer boundary restriction indicator
Bit 4	64KB I/O-buffer boundary restriction indicator
Bit 3	Automatic remapping request indicator
Bit 2	Automatic buffer allocation indicator
Bit 1	Automatic data-copy indicator

*Figure 2-34. Option Flags – Operating-System DMA Services*

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## Interrupt 70H—Real-Time Clock Interrupt

For AT, PC/XT Model 286, and Personal System/2 products except Model 25:

This interrupt handler services the periodic and alarm interrupt functions from the real-time clock.

**Periodic function** — When activated, the interrupt occurs approximately 1024 times per second. The interrupt handler decreases the doubleword microsecond counter by 976 microseconds (1/1024 of a second). When the counter becomes less than or equal to 0, bit 7 of the designated location is set to hex 80. For Interrupt 15H, Event Wait function ((AH) = 83H), the designated location is provided by the user. For Interrupt 15H, Wait function ((AH) = 86H), the designated location is bit 7 of BIOS data area hex 40:A0 (Wait Active Flag).

**Alarm function** — When activated, the interrupt occurs at the specified time, and a software Interrupt 4AH is issued. The user must point Interrupt 4AH to an alarm routine before setting Interrupt 1AH, Real-Time Clock Alarm function ((AH) = 06H).

For all others, the real-time clock interrupt is not supported.

### Notes:

1. The PC Convertible supports the Periodic and Alarm Interrupt functions, but the real-time clock interrupt generates a nonmaskable interrupt, rather than invoking Interrupt 70H. Additionally, the PC Convertible uses the real-time-clock update ended interrupt function (one interrupt per second) when certain system profiles are enabled.
2. For Personal System/2 Model 30, the Periodic Interrupt function is not supported.

**Notes:**