

A close look at a growing lineage

IBM PC Family BIOS Comparison

by Jon Shiell

In the two years since the first BIOS comparison table appeared in *BYTE* [Editor's note: See the "IBM PC Family BIOS Comparison" in *BYTE's* Inside the IBM PCs, Fall 1985], the number of machines in the family has more than doubled. This article presents an expanded and updated BIOS table. Except for the Model 30, the PS/2 systems actually have two versions of the BIOS in their ROMs. The first version, for use in real mode and compatible with the BIOS in the prior PCs, is covered in this article. The other BIOS is for use with the OS/2 operating system and will not be covered here.

As the PC family has grown, there have been additions and deletions to the basic hardware set of the machines. (Because the Model 25 was only recently introduced, detailed information on its BIOS was not available for this article.) This article attempts to provide a comparative perspective of the various Basic I/O System (BIOS) features. If you wish to program on one machine, this article can help determine which functions apply across all machines in the family.

Table 1 gives the system configurations for IBM PC computers, with the exception of the 3270 PC. Table 2 describes the ROM BIOS interrupt vectors; table 3 lists BIOS video modes; and table 4 lists low-memory reserved addresses. Table 5 describes hardware interrupt request lines; table 6 covers Expanded Memory Specification (EMS) function-call interfaces. Table 7 covers multitasking hooks using interrupt 15; table 8 gives BIOS extension addresses; and table 9 lists the



NETBIOS modifications and additions to DOS.

The purpose of the BIOS is to present a common interface to the program, be it an applications program or an operating system, to minimize the amount of code that must be rewritten when using different machines. The BIOS lets the programmer isolate hardware dependence to a single set of primitive routines. What you gain from this is portability and compatibility between different hardware en-

vironments. At the same time, you retain almost all the speed and control of direct hardware access.

The BIOS is made up of the code and programs that provide the device-level control for the major I/O devices in the system. In the IBM PC family, the BIOS is contained in ROM on the system board, along with cassette BASIC and a set of routines (called POST, for power-on self test) that check out the machine when you turn it on.

The BIOS creates hardware independence by providing a level of indirection and separation from the hardware. For example, when using a BIOS call to send a character to a printer, a programmer doesn't need to know what the I/O address of the printer port is or how to control it.

The BIOS is normally invoked via a set of interrupts vectored into various BIOS entry points. Other interrupt vectors are used to service hardware interrupts, such as "disk operation finished." In practical terms, the software invokes the BIOS by loading the appropriate registers in the microprocessor and issuing an

INT instruction. For example,

```
MOV AH,0 ; Load AH with the BIOS
          ; function code for
          ; "print the character
          ; in register AL"
```

continued

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Table 1: System configurations for the IBM PC family of computers.

Feature	PC	PC XT	PCjr	PC AT	PC AT 3x9	XT/2	XT/286	PC CVT	PS/2 30	PS/2 50	PS/2 60	PS/2 80	Comments
Model byte	FF	FE	FD	FC	FC	FB	FC	F9	FA	FC	FC	F8	@ FFFFE
Type byte	N/U	N/U	N/U	N/U	01	01	02	00	00	04	05	00	
BIOS level	N/U	N/U	N/U	N/U	00	00	00	00	00	00	00	00	
Hardware configuration	N/U	N/U	N/U	N/U	70	D0	70	38	FA	F6	F6	F6	Note 1
Processor type	8088	8088	8088	80286	80286	8088	80286	80C88	8086	80286	80286	80386	
Processor speed	4.77	4.77	4.77	6	8	4.77	6, 0 WS	4.77	8	10	10	16/20	Note 2; 1 wait state (WS) unless otherwise noted.
Num coprocessor speed	4.77	4.77	4.77	4	5.3	4.77	6	4.77	8	10	10	16/20	
DMA speed	4.77	4.77	4.77	3	4	4.77	3	4.77	4	10	10	8/10	
Bus width	8	8	8	16	16	8	16	8	8	16	16	32	Note 3
Maximum memory (in bytes)	640K	640K	640K	15M	15M	640K	15M	512K	640K	16M	16M	>16M	Note 4
8-bit DMA channels	4	4	0	4	4	4	4	3	4	4	4	4	Note 5
16-bit DMA channels	0	0	0	3	3	0	3	0	0	3	3	3	
Timer channels 0 and 2	●	●	●	●	●	●	●	●	●	●	●	●	Note 6
Timer channel 1	●	●	●	●	●	●	●	○	●	●	●	●	Note 7
System clock	○	○	○	●	●	○	●	●	●	●	●	●	Note 8
Number of function keys	10	10	10	10	10/12	10/12	10/12	12	12	12	12	12	Note 9

Notes:

All memory addresses and interrupts are in hexadecimal. The PC AT 3x9 models are the 319 and 339. The older models are the 099, 068, and 239. The PS/2 Model 25 has the same system configuration as the Model 30, except it has no hard disk and a different model version in the BIOS.

● = Yes; ○ = No; N/U = not used.

- Configuration parameters, INT 15 (AH=0C0) returns a pointer to a block with the following format:

DW	8	Length of following table
DB	Model__byte	System model; see hardware table for specific values
DB	Type__byte	System model type
DB	BIOS__level	BIOS revision level
DB	HW__config	10000000 = DMA channel 3 used by fixed disk BIOS 01000000 = Cascaded interrupt Level 2 00100000 = Real-time clock available (RT/CMOS RAM chip) 00010000 = Keyboard scan code hook 1A (PC AT and XT 286) 00010000 = Keyboard intercept (INT 15, AH=41) supported (PC CVT and PS/2) 00001000 = Wait on external event (INT 15, AH=41) supported (PC CVT); reserved on PS/2 systems 00000100 = Extended BIOS data area allocated 00000010 = Micro Channel system 00000001 = Reserved
DW	0	Reserved
DW	0	Reserved

The PC XT 2 (Model 5160, model = FB, type = 01, BIOS date 01/10/86) returns an incorrect value for the configuration parameter. The incorrect value indicates that the level 2 interrupt is cascaded into another interrupt controller, and that DMA channel 3 is not used by the system BIOS when a hard disk is installed.

- In the PCjr, the video is mapped into the lower 128K bytes of memory. Accesses to that area tend to be 50 percent slower than accesses for a normal PC. The PC CVT uses static CMOS RAM, so it needs no refresh cycles; thus, programs may run slightly (up to 5 percent) faster than expected. The PS/2 Model 80 comes in two speeds—16 MHz and 20 MHz, both with one wait state.
- The PS/2 Model 30's memory is 16 bits, but the I/O bus is the 8-bit PC bus.
- The PCjr has up to 128K bytes of internal memory; full expansion requires sidecars. The PS/2 Model 80 supports 32-bit memory addresses, so in theory you could put up to 4 gigabytes in one.
- The PC CVT doesn't need to use one channel for dynamic RAM refresh, so its channel 3 acts like a PC's channel 4.
- The PC CVT supports only modes 0, 2, 3, and 4 on channel 0.
- Use depends on model (mostly refresh timing).
- RT/CMOS RAM chip; PC CVT does not save configuration here.
- The PC XT Models 089, 268, and 278 have the new keyboard; the other three models have the old keyboard. The PC AT Model 339 has the new keyboard, and the Model 319 has the old keyboard. The PC CVT generates function keys F11 and F12 with multiple keystrokes.

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Table 2: ROM BIOS interrupt vectors.

Interrupt	Function code	PC	PC XT	PCjr	PC AT	XT /2	XT /286	PS CVT	PS/2 30	PS/2 other	BIOS	Comments
0	N/A	●	●	●	●	●	●	●	●	●		Divide by zero trap
1	N/A	●	●	●	●	●	●	●	●	●		Single-step mode (used by debug)
2 NMI	N/U	●	●	○	●	●	●	○	●	●		Parity check routine
	N/U	●	●	○	○	●	○	○	●	○		Coprocessor interrupt (directly)
	N/U	○	○	○	●	○	●	○	○	●		Coprocessor interrupt (via redirection from Int 75, IRQ 13)
	N/U	○	○	●	○	○	○	●	○	○		Keyboard interrupt routine (with data ready)
	N/U	○	○	○	○	○	○	●	○	●		I/O channel check
	N/U	○	○	○	○	○	○	○	●	○		Disk-controller power-on request
	N/U	○	○	○	○	○	○	○	●	○		System suspend
	N/U	○	○	○	○	○	○	●	○	○		Real-time clock (periodic, update-ended, or alarm interrupt)
	N/U	○	○	○	○	○	○	○	○	●		System watchdog timer, time-out interrupt (IRQ0 interrupt missed)
	N/U	○	○	○	○	○	○	○	○	●		Uchannel DMA timer, time-out interrupt (DMA burst greater than 7.8 microseconds)
3	N/A	●	●	●	●	●	●	●	●	●		Breakpoint (used by debug)
4	N/A	●	●	●	●	●	●	●	●	●		Overflow trap
5	N/A	●	●	●	●	●	●	●	●	●		Print-screen function (uses address 50:0 for status)
6	N/U	○	○	○	○	○	○	○	○	○		Reserved
7	N/U	○	○	○	○	○	○	○	○	○		Reserved
8 (IRQ 0)	N/A	●	●	●	●	●	●	●	●	●		Timer interrupt handler (entered about 18.2 times per second)
9 (IRQ 1)	N/A	●	●	●	●	●	●	●	●	●		Keyboard interrupt handler
A (IRQ 2)	N/A	○	○	○	●	○	●	○	○	●		Cascade for IRQ8 to IRQ15
	N/A	○	○	○	○	○	○	○	○	●	EGA	Vertical retrace interrupt for EGA and VGA
B (IRQ 3)	N/A	●	●	●	●	●	●	●	●	●		COM2: controller (e.g., serial port) hardware interrupt entry
C (IRQ 4)	N/A	●	●	●	●	●	●	●	●	●		COM1: controller (e.g., serial port) hardware interrupt entry
D (IRQ 5)	N/A	●	●	○	●	●	●	○	●	○		Alternate printer LPT2: (PC AT's 80287 initial-interrupt entry)
	N/A	○	●	○	○	●	○	○	●	○		Hard disk controller
	N/A	○	○	●	○	○	○	○	○	○		Vertical retrace interrupt (display)
E (IRQ 6)	N/A	●	●	●	●	●	●	●	●	●		Disk-controller interrupt entry
F (IRQ 7)	N/A	●	●	●	●	●	●	●	●	●		Parallel printer, LPT1:
10 Video I/O	0	●	●	●*	●	●	●	●	●	●	EGA	Set CRT mode
	1	●	●	●	●	●	●	●	●	●		Set cursor type
	2	●	●	●	●	●	●	●	●	●		Set cursor position
	3	●	●	●	●	●	●	●	●	●		Read cursor position
	4	●	●	●	●	●	●	●	○	○		Read light-pen position
	5	●	●	●*	●	●	●	●	●	●		Select active display page
	6	●	●	●	●	●	●	●	●	●		Scroll active page up
	7	●	●	●	●	●	●	●	●	●		Scroll active page down
	8	●	●	●	●	●	●	●	●	●		Read attribute/character at current cursor position
	9	●	●	●	●	●	●	●	●	●		Write attribute/character at current cursor position
	0A	●	●	●*	●	●	●	●	●	●		Write character only at current cursor position
	0B	●	●	●*	●	●	●	●	●	●		Set color palette
	0C	●	●	●	●	●	●	●	●	●		Write dot
	0D	●	●	●	●	●	●	●	●	●		Read dot
	0E	●	●	●	●	●	●	●	●	●		Teletype write to active page
0F	●	●	●	●	●	●	●	●	●		Return current video state	
10	○	○	○	○	○	○	○	○	●	●	EGA	Set palette registers
11	○	○	○	○	○	○	○	○	●	●	EGA	Character-generator routine
12	○	○	○	○	○	○	○	○	●	●	EGA	Alternate select
13	○	○	○	●	○	●	○	●	●	●	EGA	Write string (with optional attributes)
14	○	○	○	○	○	○	●	○	○			Load LCD character font or set LCD high-intensity substitute
15	○	○	○	○	○	○	○	●	○	○		Return active-display type and parameters
1A	○	○	○	○	○	○	○	○	●	●		Read/write display combination code
1B	○	○	○	○	○	○	○	○	●	●		Return functionality/state information

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Interrupt	Function code	PC	PC XT	PCjr	PC AT	XT /2	XT /286	PS CVT	PS/2 30	PS/2 other	BIOS Comments
11	1C	○	○	○	○	○	○	○	○	●	Save/restore video state
	N/U	●	●	●	●	●	●	●	●	●	Equipment determination; returns the EQUIP_FLAG from BIOS data area
12	N/U	●	●	●	●	●	●	●	●	●	Memory size determination; returns amount of memory in the system
13 Disk	0	●	●	●	●	●	●	●	●	●	Reset disk system
	1	●	●	●	●	●	●	●	●	●	Read status of last operation
	2	●	●	●	●	●	●	●	●	●	Read sectors into memory
	3	●	●	●	●	●	●	●	●	●	Write sectors from memory
	4	●	●	●	●	●	●	●	●	●	Verify sectors
	5	●	●	●	●	●	●	●	●	●	Format a track
	8	○	○	○	3x9	○	●	●	●	●	Return the current drive parameters
	15	○	○	○	●	●	●	●	●	●	Read disk type (none, disk-no-change line, disk, hard disk)
	16	○	○	○	●	●	●	●	●	●	Disk-change line status
	17	○	○	○	●	●	●	●	●	●	Set disk type for format
	18	○	○	○	3x9	●	●	○	●	●	Set media type for format
	N/A	●	●	●	●	●	●	●	●	●	Uses BIOS data area DISK_POINTER
	N/A	○	○	○	●	○	●	●	●	●	Uses disk-drive-media-type bytes at 40:90 and 40:91
N/A	○	○	○	●	○	●	○	●	●	Uses rest of disk "state machine" at 40:92 to 95	
13 Hard disk	N/U	●	○	●	○	○	○	●	○	○	Not used by PC, PCjr, or PC CVT
	0	○	●	○	●	○	○	○	○	○	Reset disk system
	1	○	●	○	●	○	○	○	○	○	Read status of last disk operation
	2	○	●	○	●	○	○	○	○	○	Read sectors into memory
	3	○	●	○	●	○	○	○	○	○	Write sectors from memory
	4	○	●	○	●	○	○	○	○	○	Verify sectors
	5	○	●	○	●	○	○	○	○	○	Format a track (not enhanced-small-device-interface [ESDI] disks)
	6	○	●	○	N/U	○	N/U	○	N/U	N/U	Format a track and set bad-sector flags
	7	○	●	○	N/U	○	N/U	○	N/U	N/U	Format the drive starting at the desired track
	8	○	●	○	●	○	○	○	○	○	Return the current drive parameters
	9	○	●	○	●	○	○	○	○	○	Initialize drive-pair character (uses INT 41 and 46, not ESDI disks)
	0A	○	●	○	●	○	○	○	D	D	Read long
	0B	○	●	○	●	○	○	○	D	D	Write long
	0C	○	●	○	●	○	○	○	○	○	Seek to desired track
	0D	○	●	○	●	○	○	○	○	○	Alternate disk reset (not ESDI disks)
	0E	○	●	○	N/U	○	N/U	○	D	D	Read sector buffer
	0F	○	●	○	N/U	○	N/U	○	D	D	Write sector buffer
	10	○	●	○	●	○	○	○	○	○	Test drive ready
	11	○	●	○	●	○	○	○	○	○	Recalibrate
	12	○	●	○	N/U	○	N/U	○	D	D	Controller RAM diagnostic
13	○	●	○	N/U	○	N/U	○	D	D	Drive diagnostic	
14	○	●	○	●	○	○	○	D	D	Controller internal diagnostic	
15	○	○	○	●	○	○	○	○	○	Read disk type (none, disk-no-change line, disk, hard disk)	
14	19	○	○	○	○	○	○	○	○	○	Park heads
	1A	○	○	○	○	○	○	○	○	○	ESDI disks only; format unit
14 RS-232C I/O	0	●	●	●	●	●	●	●	●	●	Initialize communications port
	1	●	●	●	●	●	●	●	●	●	Send a character
	2	●	●	●	●	●	●	●	●	●	Receive a character
	3	●	●	●	●	●	●	●	●	●	Get port status
	4	○	○	○	○	○	○	○	○	○	Extended initialize
	5	○	○	○	○	○	○	○	○	○	Extended communications port control
15 Cassette I/O and System services	2	2	2	2	2	2	2	2	4	4	Number of serial ports supported (four ports via extended control functions)
	N/U	○	●	○	○	○	○	○	○	○	Not used on PC XT
	0	●	○	●	○	○	○	○	○	○	Turn cassette motor on
	1	●	○	●	○	○	○	○	○	○	Turn cassette motor off
	2	●	○	●	○	○	○	○	○	○	Read from cassette
	3	●	○	●	○	○	○	○	○	○	Write to cassette
	0F	○	○	○	○	○	○	○	○	○	ESDI drive only; format unit periodic interrupt (invoked once per cycle)
20	○	○	○	●	○	○	○	○	○	AL=10, setup of SYSREQ routine \$ (software only)	

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		○	○	○	●	○	●	○	○	●	AL=11, completion of SYSREQ function \$ (software only)
	21	○	○	○	○	○	○	○	○	●	Power-on self-test error log
	40	○	○	○	○	○	○	●	○	○	Read or write system (AL= 0,1) or modem (AL= 2,3) profile
	41	○	○	○	○	○	○	●	○	○	Wait on external event
	42	○	○	○	○	○	○	●	○	○	Request system power off (system suspend)
	43	○	○	○	○	○	○	●	○	○	Read current system status information
	44	○	○	○	○	○	○	○	○	○	Activate or deactivate internal modem power
	4F	○	○	○	3x9	●	●	●	●	●	BIOS keyboard interrupt hexadecimal 9 intercept
	80	○	○	○	●	●	●	○	●	●	Device open \$
	81	○	○	○	●	●	●	○	●	●	Device close \$
	82	○	○	○	●	●	●	○	●	●	Program termination \$
	83	○	○	○	●	○	●	●	●	●	Event wait
	84	○	○	○	●	●	●	○	●	●	Joystick support
	85	○	○	○	●	●	●	●	●	●	AL=0, system request key has been pressed \$
		○	○	○	●	●	●	●	●	●	AL=1, system request key has been released \$
	86	○	○	○	●	○	●	●	●	●	Wait (for n microseconds)
	87	○	○	○	●	○	●	○	●	●	Move block of memory (can move to and from extended memory)
	88	○	○	○	●	○	●	○	●	●	Return amount of memory above 1 megabyte
	89	○	○	○	●	○	●	○	●	●	Switch processor to virtual mode
	90	○	○	○	●	●	●	●	●	●	Device-busy loop \$
	91	○	○	○	●	●	●	●	●	●	Interrupt complete flag set \$
	C0	○	○	○	3x9	●	●	●	●	●	Return system parameter pointer; see table 1 for definitions
	C1	○	○	○	○	○	○	○	●	●	Return extended-BIOS data-area segment address
	C2	○	○	○	○	○	○	○	●	●	Pointing-device BIOS interface
	C3	○	○	○	○	○	○	○	○	●	Enable/disable watchdog time-out
	C4	○	○	○	○	○	○	○	○	●	Programmable option select
16	0	●	●	●	●	●	●	●	●	●	Read next ASCII character
Keyboard	1	●	●	●	●	●	●	●	●	●	Set Z flag if buffer not empty
	2	●	●	●	●	●	●	●	●	●	Read shift status
	3	○	○	●	339	○	○	○	●	●	Set typematic rates
	4	○	○	○	○	○	○	○	○	○	Turn on/off keyboard click
	5	○	○	○	339	●	●	○	●	●	Place ASCII character/scan code combination in keyboard buffer as if from keyboard
	10	○	○	○	339	●	●	○	●	●	Extended read interface for the enhanced (101-/102-key) keyboard
	11	○	○	○	339	●	●	○	●	●	Extended ASCII status for the enhanced (101-/102-key) keyboard
	12	○	○	○	339	●	●	○	●	●	Return extended shift status in AX register (101-/102-key keyboard)
17	0	●	●	●	●	●	●	●	●	●	NB Print a character
Printer	1	●	●	●	●	●	●	●	●	●	NB Initialize printer port
	2	●	●	●	●	●	●	●	●	●	NB Return printer-port status
	3	3	3	3	3	3	3	2	2	2	Number of printer ports supported
18	N/A	●	●	●	●	●	●	●	●	●	Points to resident (ROM) BASIC
BASIC											
19	N/A	●	○	○	○	○	○	●	○	○	Bootstrap loader, IPL the system from a disk
	N/A	○	●	○	●	○	●	○	●	●	Bootstrap loader, IPL the system from a disk or hard disk
	N/A	○	○	●	○	○	○	○	○	○	Bootstrap loader, IPL the system from a disk or cartridge
1A	0	●	●	●	●	●	●	●	●	●	Read current clock setting
Time of day	1	●	●	●	●	●	●	●	●	●	Set the current clock
	2	○	○	○	○	○	○	○	○	○	Read the real-time clock
	3	○	○	○	○	○	○	○	○	○	Set the real-time clock
	4	○	○	○	○	○	○	○	○	○	Read date from real-time clock
	5	○	○	○	○	○	○	○	○	○	Set date into real-time clock
	6	○	○	○	○	○	○	○	○	○	Set the alarm (24 hour maximum, goes off and causes an INT 4A)
	7	○	○	○	○	○	○	○	○	○	Reset the alarm
	8	○	○	○	○	○	○	○	○	○	Set real-time clock alarm activated power-on mode
	9	○	○	○	○	○	○	○	○	○	Read alarm time and status

continued

IBM PC FAMILY BIOS COMPARISON

Interrupt	Function code	PC	PC XT	PCjr	PC AT	XT /2	XT /286	PS CVT	PS/2 30	PS/2 other	BIOS Comments
Sound select	0A	○	○	○	○	●	○	○	●	●	Read system-timer day counter
	0B	○	○	○	○	●	○	○	●	●	Set system-timer day counter
	80	○	○	●	○	○	○	○	○	○	Set up sound multiplexer
1B	N/U	●	●	●	●	●	●	●	●	●	Keyboard break address
1C	N/U	●	●	●	●	●	●	●	●	●	Timer tick
1D	N/U	●	●	●	●	●	●*	●	●	●	Video parameters for 6845 initialization
1E	N/U	●	●	●	●	●	●	●	●	●	Disk parameters
1F	N/U	●	●	●	●	●	●	●	●	●	Graphics character extension for modes 4, 5, and 6
20		○	○	○	○	○	○	○	○	○	DOS program terminate
21		○	○	○	○	○	○	○	○	○	NB DOS function call
22		○	○	○	○	○	○	○	○	○	DOS terminate address (don't issue this INT)
23		○	○	○	○	○	○	○	○	○	DOS control-break exit address (don't issue this INT)
24		○	○	○	○	○	○	○	○	○	DOS fatal-error vector
25		○	○	○	○	○	○	○	○	○	DOS absolute disk read
26		○	○	○	○	○	○	○	○	○	DOS absolute disk write
27		○	○	○	○	○	○	○	○	○	DOS terminate, stay resident (instead, use INT21, AH=31)
28		○	○	○	○	○	○	○	○	○	Used internally by DOS
29		○	○	○	○	○	○	○	○	○	Reserved for DOS
2A		○	○	○	○	○	○	○	○	○	Used by NETBIOS
2B		○	○	○	○	○	○	○	○	○	Reserved for DOS
2C		○	○	○	○	○	○	○	○	○	Reserved for DOS
2D		○	○	○	○	○	○	○	○	○	Reserved for DOS
2E		○	○	○	○	○	○	○	○	○	Reserved for DOS
2F		○	○	○	○	○	○	○	○	○	NB Interprocess multiplex interrupt (see notes)
	1	○	○	○	○	○	○	○	○	○	Call resident part of PRINT
	2	○	○	○	○	○	○	○	○	○	Call resident part of ASSIGN
	10	○	○	○	○	○	○	○	○	○	Call resident part of SHARE
	B7	○	○	○	○	○	○	○	○	○	Call resident part of APPEND
30 to 3F		○	○	○	○	○	○	○	○	○	Reserved for DOS
40	N/U	○	●	○	●	●	○	●	●	○	Points to disk BIOS entry
41	N/U	○	●	○	●	●	○	●	●	○	Pointer to first hard disk, parameter block (not ESDI disks)
42	N/U	○	○	○	○	○	○	○	●	●	EGA Points to screen BIOS entry
43	N/U	○	○	○	○	○	○	○	●	●	EGA Pointer to EGA initializing parameters
44	N/U	○	○	○	○	○	○	○	●	●	EGA Pointer to EGA graphics character table
	N/U	○	○	●	○	○	○	○	●	●	Pointer to lower graphics character table
45	N/U	○	○	○	○	○	○	○	○	○	Reserved
46	N/U	○	○	○	●	○	●	○	●	●	○ Pointer to second hard disk, parameter block (not ESDI disks)
47	N/U	○	○	○	○	○	○	○	○	○	Reserved
48	N/U	○	○	●	○	○	○	○	○	○	Cordless keyboard translation
49	N/U	○	○	●	○	○	○	○	○	○	Nonkeyboard scan-code translation table address
4A	N/U	○	○	○	○	○	○	●	●	●	Real-time clock alarm
4B to 4F	N/U	○	○	○	○	○	○	○	○	○	Reserved
50	N/U	○	○	○	○	○	○	○	○	○	Periodic alarm interrupt from timer
51 to 59	N/U	○	○	○	○	○	○	○	○	○	Reserved
5A	N/U	○	○	○	○	○	○	○	○	○	CLU Cluster adapter BIOS-entry address
5B	N/U	○	○	○	○	○	○	○	○	○	Reserved
5C		○	○	○	○	○	○	○	○	○	NB NETBIOS entry point
5D to 5F	N/U	○	○	○	○	○	○	○	○	○	Reserved
60 to 66	N/U	○	○	○	○	○	○	○	○	○	Reserved for user program interrupts

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Interrupt	Function code	PC	PC XT	PCjr	PC AT	XT /2	XT /286	PS CVT	PS/2 30	PS/2 other	BIOS Comments
67	N/U	○	○	○	○	○	○	○	○	○	Reserved for user program interrupts, LIM EMS interrupt entry
68 to 6B	N/U	○	○	○	○	○	○	○	○	○	Not used
6C	N/U	○	○	○	○	○	○	●	○	○	System resume vector
6D to 6F	N/U	○	○	○	○	○	○	○	○	○	Not used
70 (IRQ 8)	N/U	○	○	○	●	○	●	○	○	●	Real-time clock INT
71 (IRQ 9)	N/U	○	○	○	●	○	●	○	○	●	Redirected to IRQ2
72 (IRQ 10)	N/U	○	○	○	●	○	●	○	○	●	
73 (IRQ 11)	N/U	○	○	○	●	○	●	○	○	●	
74 (IRQ 12)	N/U	○	○	○	●	○	●	○	○	●	PS/2 others: mouse interrupt
75 (IRQ 13)	N/U	○	○	○	●	○	●	○	○	●	Coprocessor, BIOS redirect to NMI interrupt (INT 2)
76 (IRQ 14)	N/U	○	○	○	●	○	●	○	○	●	Hard disk controller
77 (IRQ 15)	N/U	○	○	○	●	○	●	○	○	●	
78 to 7F		○	○	○	○	○	○	○	○	○	Not used
80 to 85		○	○	○	○	○	○	○	○	○	Reserved by BASIC
86 to F0		○	○	○	○	○	○	○	○	○	Used by BASIC when the BASIC interpreter is running
F1 to FF		○	○	○	○	○	○	○	○	○	Reserved for user program interrupts

Notes:

tv = Topview function.
 NB = NETBIOS alters this function.
 EGA = Enhanced graphics adapter (and video graphics array) function.
 N/U = Not used.
 D = Used for diagnostics only.

○ = Not supported.
 ● = Supported.
 ●* = A superset is supported.
 \$ = These INT 15 functions are just operating system hooks. They perform no BIOS-level functions.
 3x9 = Only on PC AT Models 319 and 339.
 339 = Only on PC AT Model 339.

All PC AT interrupts are valid for real mode only. The PC Portable, PC/370, and 3270 PC all use the PC XT BIOS. The AT/370 uses the PC AT BIOS. PS/2 other systems are the Micro Channel systems and the Models 50, 60, and 80. The Typematic rate of the 84-key PC AT keyboard is programmable, but no explicit BIOS support is provided. Also, the AT's

keyboard has an internal 16-key buffer. When a hard disk is present, the INT 13 disk interrupt is rerouted to INT 40 and INT 13 points to the hard disk BIOS. For the multiplex interrupt (INT 2F), AH contains the identification of the routine to be called, where IDs 00-7F are reserved for DOS and C0-FF are reserved for user applications. AL contains the function code.

Table 3: BIOS video modes.

Mode	Type	Max colors	Alpha format	Buffer start	Display size	Box size	Max pages	Supporting cards
0, 1	A/N	16	40x25	B8000	320x200 320x350 320x400 360x400	8x8 8x14 8x16 9x14	8 8 8 8	PCjr, CGA, PC CVT, EGA, and PS/2 others EGA and PS/2 others PS/2 Model 30 PS/2 others
2, 3	A/N	16	80x25	B8000	640x200 640x200 640x350 640x400 720x400	8x8 8x8 8x14 8x16 9x16	4 8 8 8 8	PCjr, CGA, and PC CVT EGA and PS/2 others EGA and PS/2 others PS/2 Model 30 PS/2 others
4, 5	APA	4	40x25	B8000	320x200	8x8	1	PCjr, CGA, EGA, and all PS/2 systems
6	APA	2	80x25	B8000	640x200	8x8	1	PCjr, CGA, EGA, and all PS/2 systems

continued

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Mode	Type	Max colors	Alpha format	Buffer start	Display size	Box size	Max pages	Supporting cards
7	A/N	Mono	80×25	B0000	720×350	9×14	1	MDA and PC CVT
					720×350	9×14	8	EGA and PS/2 others
					720×400	9×16	8	PS/2 others
					640×200	8×8	4	PC CVT
8	APA	16	20×25	B8000	160×200	8×8	1	PCjr
9	APA	16	40×25	B8000	320×200	8×8	1	PCjr
A	APA	4	80×25	B8000	640×200	8×8	1	PCjr
B, C			-Reserved-					
D	APA	16	40×25	A0000	320×200	8×8	8	EGA and PS/2 others
E	APA	16	80×25	A0000	640×200	8×8	4	EGA and PS/2 others
F	APA	Mono	80×25	A0000	640×350	8×14	2	EGA and PS/2 others
10	APA	16	80×25	A0000	640×350	8×14	2	EGA and PS/2 others
11	APA	2	80×30	A0000	640×480	8×16	1	All PS/2 systems
12	APA	16	80×30	A0000	640×480	8×16	1	PS/2 others
13	APA	256	40×25	A0000	640×480	8×8	1	All PS/2 systems

Notes

APA = All points addressable (i.e., graphics mode)

A/N = Alphanumeric (i.e., text-only mode)

CGA = Color Graphics Adapter

MDA = Monochrome Display Adapter

EGA = Enhanced Graphics Adapter

The cursor is not displayed in APA modes.

Modes 0, 2, and 5 are identical to modes 1, 3, and 4, except color burst is not enabled. (This doesn't affect RGB displays.)

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Table 4: Low-memory reserved addresses.

00000-002FF	System interrupt vectors
00300-003FF	System interrupt vectors, power-on and bootstrap stack area
00400-004EF	BIOS data area
00400-00406	COM1: to COM4: I/O port base addresses, one word each.
00407-00408	LPT1: to LPT4: * I/O port base addresses, one word each.
00409-0040F	Reserved
00410-00411	Equipment flag word, returned in AX register by INT 11.
	Bits Meaning
	14-15 Number of printers attached (0 to 3, LPTs)
	13 Internal modem installed (PC CVT) or serial printer installed (PCjr)
	12 Joystick installed
	9-11 Number of COM devices (0 to 4, COMs)
	8 Unused (PCjr only; DMA chip present on system)
	6-7 Number of disk drives (if bit 0 is 1; 00=1, 01=2, 10 and 11 not used)
	4-5 Initial video mode
	00 Unused
	01 40 x 25 BW using color card
	01 80 x 25 BW using color card
	11 Monochrome card
	2-3 Unused, or, in the PC, old PC XT, and PCjr, planar RAM size; 00=16K bytes, 01=32K bytes, 10=48K bytes, 11=64K bytes
	1 Math coprocessor installed (unused on PCjr and PC CVT)
	0 IPL disk installed.
00412	Reserved, except in PC CVT power-on self-test status
00413-00414	Memory size in K bytes (0 to 640)
00415-00416	Reserved
00417	Keyboard Control
	Bits Meaning
	7 Insert locked
	6 Caps Lock locked
	5 Num Lock locked
	4 Scroll Lock locked
	3 Alt key pressed
	2 Control key pressed
	1 Left shift key pressed
	0 Right shift key pressed
00418	Keyboard Control
	Bits Meaning
	7 Insert key pressed
	6 Caps Lock key pressed
	5 Num Lock key pressed
	4 Scroll Lock key pressed
	3 Pause locked
	2 System request key pressed
	1 Left Alt key pressed
	0 Left Control key pressed
00419	Alternate keypad entry
0041A-0041B	Keyboard buffer head pointer
0041C-0041D	Keyboard buffer tail pointer
0041E-0043D	32-byte keyboard buffer
0043E-00448	Disk drive data area
00449-00466	Video-control data area 1
00467-0046A	Reserved, except PS/2 others, 00472=pointer to reset code upon system reset when memory is preserved.
0046B	Reserved
0046C-0046F	Timer counter
00470	Timer overflow
00471	Break key state
00472-00473	Reset flag
	Bits Meaning
	1234 Bypass memory test
	4321 Preserve memory (PS/2 other only)
	5678 System suspended (PC CVT only)
	9ABC Manufacturing test mode (PC CVT only)
	ABCD System POST loop mode (PC CVT only)

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00474-00477	Hard disk drive data area
00478-0047B	LPT1: to LPT4: * time-out values, 1 byte each.
0047C-0047F	COM1: to COM4: time-out values, 1 byte each.
00480-00481	Keyboard buffer start offset pointer
00482-00483	Keyboard buffer end offset pointer
00484-0048A	Video control data area 2
0048B-00495	Disk drive/hard disk drive control-data area (XT/2, AT, XT/286, and all PS/2s)
00496	Keyboard mode state and type flags
00497	Keyboard LED flags
00498-00499	Offset address to user wait complete flag
0049A-0049B	Segment address to user wait complete flag
0049C-0049D	User wait count in microseconds, low word
0049E-0049F	User wait count in ms, high word
004A0	Wait active flag
Bits	Meaning
7	Wait-time elapsed and posted flag
6-1	Reserved
0	INT 15, AH=86, Wait, has occurred.
004A1-004A7	Reserved
004A8-004AB	Pointer to video parameters and overrides
004AC-004EF	Reserved
004F0-004FF	Applications program communication area
500	Print screen-status flag
504	Single-drive mode status byte
00510-00521	Used by BASIC
00522-0052F	Used by DOS for disk initialization
00530-00533	Used by MODE command
00534-005FF	Reserved for DOS

* PS/2 systems don't support LPT4:.

Table 5: Hardware interrupt request lines.

Hardware interrupt request line	PC and PC/XT and PS/2 Model 30	PCjr	PC CVT	PC AT and XT/286	PS/2 Models 50, 60, 80
NMI	See notes	Keyboard interrupt	See notes	Parity errors	See notes
IRQ 0	Timer	Timer clock interrupt	Timer output 0	Timer output 0	Timer output 0
IRQ 1	Keyboard	I/O channel (reserved)	Keyboard (buffer full)	Keyboard (buffer full)	Keyboard (buffer full)
IRQ 2	Reserved	I/O channel	Reserved	Cascade for 8 to 15	Cascade for 8 to 15
IRQ 3	Serial port 2	Serial port 2	Serial port 2	Serial port 2	Serial port 2
IRQ 4	Serial port 1	Modem or serial port 1	Modem or serial port 1	Serial port 1	Serial port 1
IRQ 5	Hard disk (not PC)	Display vertical retrace	Reserved	Parallel port 2	Reserved
IRQ 6	Disk control	Disk	Disk control	Disk control	Disk control
IRQ 7	Parallel port 1	I/O channel (parallel printer)	Parallel port 1	Parallel port 1	Parallel port 1
IRQ 8*				Real-time clock	Real-time clock
IRQ 9				Redirected to IRQ2	Redirected to IRQ2
IRQ 10				Reserved	Reserved
IRQ 11				Reserved	Reserved
IRQ 12				Reserved	Reserved
IRQ 13				Mouse	Mouse
IRQ 14				Coprocessor	Coprocessor
IRQ 15				Hard disk controller	Hard disk controller
				Reserved	Reserved

* Interrupts 8 to 15 are not available on the PC, PC XT, PCjr, PC CVT, and PS/2 Model 30.

Notes:

PC, PC XT, and PS/2 Model 30 use NMI for parity errors and numeric coprocessor interrupt.

PC CVT uses NMI for I/O channel check, disk power-on request, keyboard, real-time clock alarm, or system suspend.

PS/2 Models 50, 60, and 80 use NMI for parity errors, I/O channel check, watchdog timer, and arbitrator time-out.

IRQ 3 and 4 (except in the PC CVT) may be used by SDLC or bisynchronous communication cards instead of serial ports.

Table 6: Expanded EMS function-call interfaces. This covers version 3.2 and is accessed via interrupt 67.

AH =	Function
40	Get manager status
41	Get page frame segment
42	Get number of pages
43	Get handle and allocate memory
44	Map memory
45	Release handle and memory
46	Get EMS version
47	Save mapping context
48	Restore mapping context
49	Get I/O port address
4A	Get logical-to-physical-page mapping
4B	Get number of EMM handles
4C	Get pages owned by handle
4D	Get pages for all handles
4F-5F	Reserved
60	Get physical window array

Table 7: Multitasking hooks using Interrupt 15.

Wait Function (AH=90, AL=type code). Used to tell the OS task dispatcher to dispatch another task while the current task waits for its I/O operation to finish.

Post Function (AH=91, AL=type code). I/O operation complete, which can be used to inform the OS task dispatcher that an I/O operation for a waiting task has completed, and the task should now be moved to the ready queue.

Type codes for Wait and Post functions

00-7F Serially reusable device; OS must serialize access.

- 00 Disk (time-out)
- 01 Disk (time-out)
- 02 Keyboard (no time-out)
- 03 Pointing device (time-out)

80-BF Reentrant devices; ES:BS points to a unique control block.

80 Network (no time-out), ES:BX points to network control block.

C0-FF Wait-only calls, no complementary Post function.

Time-out on nonoccurrence of event.

- FC Fixed-disk reset, PS/2 only (time-out)
- FD Disk drive motor start (time-out)
- FE Printer (time-out)

Table 8: BIOS-extension (ROM-area) addresses.

C0000-C3FFF	16K bytes EGA BIOS
C4000-C5FFF	
C6000-C63FF	256 bytes PGA communication area
C6400-C7FFF	
C8000-CBFFF	16K bytes hard disk BIOS
CC000-CFFFF	
D0000-D7FFF	32K bytes cluster adapter BIOS
D8000-DBFFF	
DC000-DFFFF	
E0000-EFFFF	64K bytes expansion ROM space (PC AT)
F0000-FFFFF	64K bytes ROM BASIC and simple BIOS

Note: PCjr uses D0000-DFFFF for expanded cartridges and E0000-EFFFF for standard cartridges.

Table 9: NETBIOS modifications and additions to DOS functions. This covers version 1.10.

INT	AH	AL	
21	3D	09	Open file with sharing specified
		0A	IOCTL, is device redirected?
	44	0B	IOCTL, is handle local or remote?
		0B	IOCTL, change sharing retry count
59	5A	00	Get extended error
		01	Create temporary file with unique name
	5B	00	Create new file
		01	Lock byte range
5E	00	01	Unlock byte range
		02	Get machine name
	5F	02	Set up printer-control string
		03	Get assign list entry
2A	00	03	Redirect device to network
		04	Cancel redirection
	03	00	NETBIOS installation check
		01	Get device-shared status
04	05	00	Execute NETBIOS
		01	Get network resource information
	06	02	Network print-stream control
		03	Append installation check
2F	87	00	Append version check
		02	Append version check
	88	00	Network command installation check
		03	Get server post address
04	09	04	Set server post address
		09	Network version check

```
MOV AL, 'B'; Character to be
                printed, in this case
                a 'B'
MOV DX, 0 ; Print it on LPT1
                (Printer number minus 1)
INT 17 ; Printer BIOS entry
                interrupt.
```

The BIOS is extensible. When the POST routines run, as part of their operation they scan the ROM address space for add-on routines, which are then invoked so that they can install themselves. The IBM EGA, for example, extends the video interrupt INT 10, as indicated in table 2.

The rule for BIOS entries is one software interrupt per device. There may also be one or more hardware entries, and entries that point to tables or blocks of data used by the device driver.

The interrupt vectors, used as pointers to data instead of code, allow easy alteration to the environment, such as changing the character set displayed for 80 to FF by the CGA.

According to IBM, the only time you safely bypass the BIOS is when you access the following I/O ports: 21-interrupt mask registers; 61-sound control; 40-, 41-(Note: Don't change this port.), 42-(timer frequency will remain fixed at

1.19 MHz), and 201-game control adapter.

Regarding absolute memory locations, note the following: Some functions have been added to interrupt vectors (0:0 to 3FF), but no functions have been redefined. The video display memory maps (A000:0, B000:0 and B800:0) will not change for a given video BIOS mode of operation. If the bit map is altered, a new mode is defined to support it. ROM BIOS data areas (starting at 40:0) will retain their current definitions as long as the corresponding functions are defined. In other words, the definitions can change at the whim of IBM. ■