PhoenixBIOS 4.0

Programmer's Guide

Version 1.0

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Purpose of Document

This guide explains how to use the BIOS function calls in writing computer programs.

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Programmer's Guide

This manual gives programmers and expert PC users a detailed description of *Phoenix*BIOS. It contains the following sections:

- What is a ROM BIOS?
- System Hardware Requirements
- Fixed-Disk Tables
- PhoenixBIOS Function Keys
- POST Errors and Beep Codes
- PhoenixBIOS 4.0 Services
- Interrupt Vectors

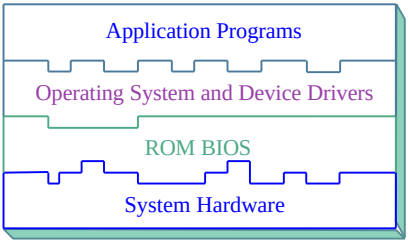
What is a ROM BIOS?

This section briefly explains the function of a BIOS in managing the special features of your system.

A **ROM BIOS** (**Basic Input/Output System**) is a set of programs permanently stored in a **ROM** (Read-Only Memory) chip located on the computer motherboard. These programs micro-manage the hardware devices installed on your computer. When you turn on your computer, the ROM BIOS initializes and tests these devices. During run-time, the ROM BIOS provides the Operating System and application programs with access to these devices. You can also use the BIOS **Setup** program to change your computer's hardware or behavior.

Software works best when it operates in layers, and the ROM BIOS is the bottom-most software layer in the computer. It functions as the interface between the hardware and the other layers of software, isolating them from the details of how the hardware works. This arrangement enables you to change hardware devices without having to install a new operating system.

The following diagram shows the function of the ROM BIOS as the interface between the hardware and other layers of software:



ROM BIOS Functions

The *Phoenix*BIOS software performs these functions:

The Setup Program	Using the Setup program, you can install, configure, and optimize the hardware devices on your system (clock, memory, disk drives, etc.).
Initialize Hardware at Boot	At power-on or reset, perform Power-On Self Test (POST) routines to test system resources and run the operating system.
Run-Time Routines	Basic hardware routines that can be called from DOS and Windows applications.

Initialize and Configure the computer

The first job of a ROM BIOS is to initialize and configure the computer hardware when you turn on your computer (system boot). The BIOS runs a series of complex programs called the **Power On Self Test** (POST), which performs a number of tasks, including:

- Test Random Access Memory (RAM)
- Conduct an inventory of the hardware devices installed in the computer
- Configure hard and floppy disks, keyboard, monitor, and serial and parallel ports
- Configure other devices installed in the computer such as CD-ROM drives and sound cards
- Initialize computer hardware required for computer features such as Plug and Play and Power Management
- Run Setup if requested
- Load and run the Operating System such as DOS, OS/2, UNIX, or Windows 95 or NT.

BIOS Services

The second task of the ROM BIOS is to provide the Operating System, device drivers, and application programs with access to the system hardware. It performs this task with a set of program routines called **BIOS Services**, which are loaded into high memory at boot time.

The number of BIOS Services is always changing. The BIOS Services of PhoenixBIOS 4.05 provide precise control of hardware devices such as disk drives, which require careful management and exhaustive checking for errors. They also help manage new computer features such as Power Management, Plug and Play, and MultiBoot.

System Hardware Requirements

PhoenixBIOS 4.0 requires the following hardware components on the motherboard:

System Board Requirements
1. CPU (486 or later) 2. AT-compatible and MC146818 RTC-compatible chipset. 3. AT or PS/2-compatible Keyboard controller 4. At least 1 MB of system RAM

The power on self test (POST) of the BIOS initializes additional ROM BIOS extensions (Option ROMs) if they are accessible in the proper format. The requirements are:

Adapter ROM Requirements
1. The code must reside in the address space between C0000H and F0000H. 2. The code must reside on a 2K boundary. 3. The first two bytes of the code must be 55H and AAH. 4. The third byte must contain the number of 512-byte blocks. 5. The fourth byte must contain a jump to the start of the initialization code. 6. The code must checksum to zero (byte sum).

NOTE: The address space from C0000H to C8000H is reserved for external video adapters (e.g. EGA, VGA). Part of the address space from D0000H to E0000H is typically used by expanded memory (EMS).

Fixed Disk Tables

PhoenixBIOS 4.0 supports up to four fixed-disk drives. For each drive, it supports 39 pre-defined drive types and four user-defined types (40-43). Below is a table of the pre-defined drive types and their default values.

End users can modify the user-defined drive type for each fixed disk listed in Setup by using the menus of the Setup program. This feature avoids the need for customized software for non-standard drives.

Fixed Disk Tables					
Type	Cylinders	Heads	Sectors	Wrt Pre	Landing
1	306	4	17	128	305
2	615	4	17	300	615
3	615	6	17	300	615
4	940	4	17	512	940
5	940	6	17	512	940
6	615	4	17	-1	615
7	462	8	17	256	511
8	733	5	17	-1	733
9	900	15	17	-1	901
10	820	3	17	-1	820
11	855	5	17	-1	855
12	855	7	17	-1	855
13	306	8	17	128	319
14	733	7	17	-1	733
15	Reserved				
16	612	4	17	0	633
17	977	5	17	300	977
18	977	7	17	-1	977
19	1024	7	17	512	1023
20	733	5	17	300	732
21	733	7	17	300	732
22	733	5	17	300	733
23	306	4	17	0	336
24	612	4	17	305	663
25	612	2	17	300	612
26	614	4	17	-1	614
27	820	6	17	-1	820
28	977	5	17	-1	977
29	1218	15	36	-1	1218

30	1224	15	17	-1	1224
31	823	10	17	512	823
32	809	6	17	128	809

Type	Cylinders	Heads	Sectors	Wrt Pre	Landing
33	830	7	17	-1	830
34	830	10	17	-1	830
35	1024	5	17	-1	1024
36	1024	8	17	-1	1024
37	615	8	17	128	615
38	1024	8	26	-1	1024
39	925	9	17	-1	925
40	User def.				
41	User def.				
42	User def.				
43	User def.				

PhoenixBIOS Function Keys

The following are the special PhoenixBIOS function keys:

<F2>	Enter SETUP program during POST
Ctrl-Alt-<->	Switch to slow CPU speed
Ctrl-Alt-<+>	Switch to fast CPU speed

The speed switching keys are only operational when speed switching is available.

POST Errors and Beep Codes

Recoverable POST Errors

Whenever a recoverable error occurs during POST, *Phoenix*BIOS displays an error message describing the problem.

*Phoenix*BIOS also issues a beep code (one long tone followed by two short tones) during POST if the video configuration fails (no card installed or faulty) or if an external ROM module does not properly checksum to zero.

An external ROM module (e.g. VGA) can also issue audible errors, usually consisting of one long tone followed by a series of short tones.

Terminal POST Errors

There are several POST routines that issue a **POST Terminal Error** and shut down the system if they fail. Before shutting down the system, the terminal-error handler issues a beep code signifying the test point error, writes the error to port 80h, attempts to initialize the video, and writes the error in the upper left corner of the screen (using both mono and color adapters).

The routine derives the beep code from the test point error as follows:

1. The 8-bit error code is broken down to four 2-bit groups (Discard the most significant group if it is 00).
2. Each group is made one-based (1 through 4) by adding 1.
3. Short beeps are generated for the number in each group.

Example:

Testpoint 01Ah = 00 01 10 10 = 1-2-3-3 beeps

Test Points and Beep Codes

At the beginning of each POST routine, the BIOS outputs the test point error code to I/O address 80h. Use this code during trouble shooting to establish at what point the system failed and what routine was being performed.

Some motherboards are equipped with a seven-segment LED display that displays the current value of port 80h. For production boards which do not contain the LED display, you can purchase a card that performs the same function.

If the BIOS detects a terminal error condition, it halts POST after issuing a terminal error beep code (See above) and attempting to display the error code on upper left corner of the screen and on the port 80h LED display. It attempts repeatedly to write the error to the screen. This may cause "hash" on some CGA displays.

If the system hangs before the BIOS can process the error, the value displayed at the port 80h is the last test performed. In this case, the screen does not display the error code.

The following is a list of the checkpoint codes written at the start of each test and the beep codes issued for terminal errors. Unless otherwise noted, these codes are valid for PhoenixBIOS 4.0 Release 6.0.

Code	Beeps	POST Routine Description
02h		Verify Real Mode
03h		Disable Non-Maskable Interrupt (NMI)
04h		Get CPU type
06h		Initialize system hardware
07h		Disable shadow and execute code from the ROM.
08h		Initialize chipset with initial POST values
09h		Set IN POST flag
0Ah		Initialize CPU registers
0Bh		Enable CPU cache
0Ch		Initialize caches to initial POST values
0Eh		Initialize I/O component
0Fh		Initialize the local bus IDE
10h		Initialize Power Management
11h		Load alternate registers with initial POST values
12h		Restore CPU control word during warm boot
13h		Initialize PCI Bus Mastering devices
14h		Initialize keyboard controller
16h	1-2-2-3	BIOS ROM checksum
17h		Initialize cache before memory Autosize
18h		8254 timer initialization
1Ah		8237 DMA controller initialization
1Ch		Reset Programmable Interrupt Controller
20h	1-3-1-1	Test DRAM refresh
22h	1-3-1-3	Test 8742 Keyboard Controller

Code	Beeps	POST Routine Description
24h		Set ES segment register to 4 GB
28h		Autosize DRAM
29h		Initialize POST Memory Manager
2Ah		Clear 512 kB base RAM
2Ch	1-3-4-1	RAM failure on address line ***xxxx****
2Eh	1-3-4-3	RAM failure on data bits ***xxxx**** of low byte of memory bus
2Fh		Enable cache before system BIOS shadow
32h		Test CPU bus-clock frequency
33h		Initialize Phoenix Dispatch Manager
36h		Warm start shut down
38h		Shadow system BIOS ROM
3Ah		Autosize cache
3Ch		Advanced configuration of chipset registers
3Dh		Load alternate registers with CMOS values
41h		Initialize extended memory for RomPilot
42h		Initialize interrupt vectors
45h		POST device initialization
46h	2-1-2-3	Check ROM copyright notice
47h		Initialize I20 support
48h		Check video configuration against CMOS
49h		Initialize PCI bus and devices
4Ah		Initialize all video adapters in system
4Bh		QuietBoot start (optional)
4Ch		Shadow video BIOS ROM
4Eh		Display BIOS copyright notice
4Fh		Initialize MultiBoot
50h		Display CPU type and speed
51h		Initialize EISA board
52h		Test keyboard
54h		Set key click if enabled
55h		Enable USB devices
58h	2-2-3-1	Test for unexpected interrupts
59h		Initialize POST display service
5Ah		Display prompt "Press F2 to enter SETUP"
5Bh		Disable CPU cache
5Ch		Test RAM between 512 and 640 kB
60h		Test extended memory
62h		Test extended memory address lines
64h		Jump to UserPatch1
66h		Configure advanced cache registers
67h		Initialize Multi Processor APIC
68h		Enable external and CPU caches
69h		Setup System Management Mode (SMM) area

Code	Beeps	POST Routine Description
6Ah		Display external L2 cache size
6Bh		Load custom defaults (optional)
6Ch		Display shadow-area message
6Eh		Display possible high address for UMB recovery
70h		Display error messages
72h		Check for configuration errors
76h		Check for keyboard errors
7Ch		Set up hardware interrupt vectors
7Dh		Initialilze Intelligent System Monitoring
7Eh		Initialize coprocessor if present
80h		Disable onboard Super I/O ports and IRQs
81h		Late POST device initialization
82h		Detect and install external RS232 ports
83h		Configure non-MCD IDE controllers
84h		Detect and install external parallel ports
85h		Initialize PC-compatible PnP ISA devices
86h		Re-initialize onboard I/O ports.
87h		Configure Motheboard Configurable Devices (optional)
88h		Initialize BIOS Data Area
89h		Enable Non-Maskable Interrupts (NMIs)
8Ah		Initialize Extended BIOS Data Area
8Bh		Test and initialize PS/2 mouse
8Ch		Initialize floppy controller
8Fh		Determine number of ATA drives (optional)
90h		Initialize hard-disk controllers
91h		Initialize local-bus hard-disk controllers
92h		Jump to UserPatch2
93h		Build MPTABLE for multi-processor boards
95h		Install CD ROM for boot
96h		Clear huge ES segment register
97h		Fixup Multi Processor table
98h	1-2	Search for option ROMs. One long, two short beeps on checksum failure
99h		Check for SMART Drive (optional)
9Ah		Shadow option ROMs
9Ch		Set up Power Management
9Dh		Initialize security engine (optional)
9Eh		Enable hardware interrupts
9Fh		Determine number of ATA and SCSI drives
A0h		Set time of day
A2h		Check key lock
A4h		Initialize typematic rate
A8h		Erase F2 prompt

Code	Beeps	POST Routine Description
AAh		Scan for F2 key stroke
ACh		Enter SETUP
AEh		Clear Boot flag
B0h		Check for errors
B1h		Inform RomPilot about the end of POST.
B2h		POST done - prepare to boot operating system
B4h	1	One short beep before boot
B5h		Terminate QuietBoot (optional)
B6h		Check password (optional)
B7h		Initialize ACPI BIOS
B9h		Prepare Boot
BAh		Initialize DMI parameters
BBh		Initialize PnP Option ROMs
BCh		Clear parity checkers
BDh		Display MultiBoot menu
BEh		Clear screen (optional)
BFh		Check virus and backup reminders
C0h		Try to boot with INT 19
C1h		Initialize POST Error Manager (PEM)
C2h		Initialize error logging
C3h		Initialize error display function
C4h		Initialize system error handler
C5h		PnPnd dual CMOS (optional)
C6h		Initialize note dock (optional)
C7h		Initialize note dock late
C8h		Force check (optional)
C9h		Extended checksum (optional)
CAh		Redirect Int 15h to enable remote keyboard
CBh		Redirect Int 13h to Memory Technologies Devices such as ROM, RAM, PCMCIA, and serial disk
CCh		Redirect Int 10h to enable remote serial video
CDh		Remap I/O and memory for PCMCIA
CEh		Initialize digitizer and display message
D2h		Unknown interrupt
		The following are for boot block in Flash ROM
E0h		Initialize the chipset
E1h		Initialize the bridge
E2h		Initialize the CPU
E3h		Initialize system timer
E4h		Initialize system I/O
E5h		Check force recovery boot
E6h		Checksum BIOS ROM

Code	Beeps	POST Routine Description
E7h		Go to BIOS
E8h		Set Huge Segment
E9h		Initialize Multi Processor
EAh		Initialilze OEM special code
EBh		Initialize PIC and DMA
ECh		Initialize Memory type
EDh		Initialize Memory size
EEh		Shadow Boot Block
EFh		System memory test
F0h		Initialize interrupt vectors
F1h		Initialize Run Time Clock
F2h		Initialize video
F3h		Initialize System Management Manager
F4h		Output one beep
F5h		Boot to Mini DOS
F6h		Clear Huge Segment
F7h		Boot to Full DOS

* If the BIOS detects error 2C, 2E, or 30 (base 512K RAM error), it displays an additional word-bitmap (***xxxx***) indicating the address line or bits that failed. For example, "2C 0002" means address line 1 (bit one set) has failed. "2E 1020" means data bits 12 and 5 (bits 12 and 5 set) have failed in the lower 16 bits. Note that error 30 cannot occur on 386SX systems because they have a 16 rather than 32-bit bus. The BIOS also sends the bitmap to the port-80 LED display. It first displays the check point code, followed by a delay, the high-order byte, another delay, and then the low-order byte of the error. It repeats this sequence continuously.

PhoenixBIOS 4.0 Services

The ROM BIOS contains a number of useful run-time **BIOS Services** that are easily called by an outside program. As a programmer, you can execute these services, which are nothing more than subroutines, by invoking one of the BIOS interrupt routines (or, when specified, calling a protected-mode entry point and offset). Invoking a software interrupt causes the CPU to fetch an address from the **interrupt table** in low memory and execute the service routine. Some services return exit values in certain registers. All registers are preserved unless they return data or status.

Generally, a Carry flag set on exit indicates a failed service. A zero on exit in the AH register usually indicates no error; any other value is the service's **exit status code**.

BIOS32 Service Directory

While the standard BIOS services are accessed through the interrupt table, newer services are accessed by a FAR CALL to a service entry point. Programmers can determine the entry point by searching for a particular signature (such as "$PnP") in the BIOS range and finding the entry point in the header.

The **BIOS32 Service Directory** (standard in PhoenixBIOS 4.0) provides a single entry point for all those services in the BIOS that are designed for BIOS clients running in a 32-bit code segment, such as 32-bit operating systems and 32-bit device drivers. The BIOS32 Service Directory itself is a 32-bit BIOS service that provides a single entry point for the other 32-bit services. For a full description of this service, see the **Standard BIOS 32-Bit Service Directory Proposal, Rev 0.4** published by Phoenix and available on the Phoenix Web site at:

`http://www.ptltd.com/desktop/specs.html`

Programs calling the 32-bit BIOS services should scan 0E0000h to 0FFFF0h on the 16-byte boundaries for the contiguous 16-byte data structure beginning with the ASCII signature "_32_".

If they do not find this data structure, then the platform does not support the BIOS32 Service Directory. The following chart describes the data structure.

Offset	Size	Description
0h	4 bytes	ASCII signature "_32_" Offset 0 = underscore Offset 1 = "3" Offset 2 = "2" Offset 3 = underscore
4h	4 bytes	Entry point for the BIOS32 Service Directory, a 32-bit physical address
8h	1 byte	Revision level. Currently 00h.
9h	1 byte	Length of this structure in 16-byte units. This structure is 16 bytes long, so the field = 01h.
0Ah	1 byte	Checksum of whole data structure. Result must be 0.
0Bh	5 bytes	Reserved. Must be zero.

Once the data structure is found and verified, the program can do a FAR CALL to the entry point specified in the above structure. The calling environment requires:

1. The CS code segment selector and the DS data segment selector must encompass the physical page of the entry point as well as the following page.
2. The SS stack segment selector must have available 1 kB of stack space.
3. Access to I/O space.

The BIOS32 Service Directory provides a single call that:

1. Determines if the called 32-bit service is available, and, if it is available,
2. Returns three values:
   a) Physical address of the base of the BIOS service.
   b) Length of the BIOS service.
   c) Entry point into the BIOS service (offset of the base).

BIOS32 Service Directory

Entry:

EAX — Service Identifier. Four-character string identifying the 32-bit service requested (e.g., "$PCI").

EBX — Low-order byte [BL] is the BIOS32 Service Directory Function Selector. Currently, zero supplies the values described below. Upper three bytes are reserved and must be zero on entry.

Exit:

AL — Return code:
00h = Service corresponding to the Service Identifier is present.
80h = Service corresponding to the Service Identifier is not present.
81h = Function Selector specified not supported.

EBX — Physical address of base of 32-bit service.

ECX — Length of BIOS service.

EDX	Entry point of BIOS service (offset to base in EBX).

Interrupt 10h–Video Services

The INT 10h software interrupt handles all video services. The results of some of these functions may depend on the active video mode and the particular video controller installed.

Interrupt 10 Video Services

AH = 00h	**Set video mode**
Entry:	
AL	Mode value (0-7): 0 = 40x25 Black & White 1 = 40x25 Color 2 = 80x25 Black & White 3 = 80x25 Color 4 = 320x200 Color 5 = 320x200 Black & White 6 = 640x200 Black & White 7 = Monochrome only
AH = 01h	**Set cursor size**
Entry:	
CH	Bits 4-0 = Cursor top scan line
CL	Bits 4-0 = Cursor bottom scan line
AH = 02h	**Set cursor position**
Entry:	
BH	Page to set cursor
DL	Character column position
DH	Character row position
AH = 03h	**Get cursor position of page**
Entry:	
BH	Page to return cursor
Exit:	
DL	Character column position
DH	Character row position
CL	Cursor top scan line
CH	Cursor bottom scan line
AH = 05h	**Change displayed (active) page**
Entry:	
AL	Page number to display
AH = 06h	**Scroll active page up**
Entry:	
CL	Upper left column to scroll up
CH	Upper left row to scroll up
DL	Lower right column to scroll up
DH	Lower right row to scroll up
BH	Attribute for blanked space
AL	Number of lines to scroll up 0 = Blank screen

Continued

Continued

AH = 07h Scroll active page down

Entry:

CL	Upper left column to scroll down
CH	Upper left row to scroll down
DL	Lower right column to scroll down
DH	Lower right row to scroll down
BH	Attribute for blanked space
AL	Number of lines to scroll down 0 = Blank screen

AH = 08h Read character and attribute

Entry:

BH	Video page to read character

Exit:

AL	Character
AH	Character attribute

AH = 09h Write character and attribute

Entry:

AL	Character to write
BL	Character attribute (alpha) Character color (graphics)
BH	Page to write character
CX	Count of characters to write

AH = 0Ah Write character at cursor

Entry:

BH	Page to write character
AL	Character to write
CX	Count of characters to write

AH = 0Bh Set color palette

Entry:

BH = 00 Set colors:

	If mode = 4 or 5, BL = background color If mode = 0-3, BL = border color If mode = 6 or 11, BL = foreground color
BL	0-31 = Intense versions of colors 0-15

BH = 01 Set palette for mode 4 or 5

BL	00 Palette = Green (1), Red (2), Yellow (3) 01 Palette = Cyan (1), Magenta (2), White (3)

AH = 0Ch Write graphics pixel

Entry:

AL	Color value for pixel (XORed if bit7=1)
CX	Column to write pixel
DX	Row to write pixel

AH = 0D Read graphics pixel

Entry:

CX	Column to read pixel
DX	Row to read pixel

Exit:

AL	Value of pixel read

Continued

Continued

AH = 0E **Teletype write character**

Entry:

AL	Character to write
BL	Foreground color (graphics only)

AH = 0F **Return Current Video Parameters**

Exit:

AL	Current video mode
AH	Number of character columns
BH	Active page

AH = 13h **Write string**

Entry:

ES:BP	Pointer to string
CX	Length of string to display
DH	Character row for display
DL	Character column for display
BL	Display attribute
AL	Write string mode 0 = Chars only, no cursor update 1 = Chars only, update cursor 2 = Char, Attrib, no cursor update 3 = Char, Attrib, update cursor

Interrupt 11h–Return System Information

This service returns the equipment installed as determined by the BIOS on power-up diagnostics and stored in the BIOS Data Area.

Interrupt 11 Return System Information

Exit:

AX Equipment information:

Bit	Definition
0	Not used
1	Math coprocessor installed
2	PS/2 mouse installed
3	Not used
4,5	Initial video mode: 00 = EGA/VGA 01 = 40x25 CGA 10 = 80x25 CGA 11 = Monochrome
6,7	Diskette drives: 00 = 1 drive 01 = 2 drives 10 = 3 drives 11 = 4 drives
8	Not used
9-11	Number of serial adapters
12	Game Adapter installed
13	Not used
14,15	Number of parallel adapters

Interrupt 12h–Return Memory Size

Returns the amount of system memory determined during the power on diagnostics.

Interrupt 12 Return System Memory Size	
Exit:	
AX	Number of 1-kilobyte memory blocks

Interrupt 13h–Diskette Services

Interrupt 13 is the BIOS software interface for access to the 5-¼" and 3-½" inch diskette drives. When there is a fixed disk in the system, the BIOS assigns Interrupt 13h to the fixed disk and routes diskette calls to Interrupt 40h.

The following table lists the AH error codes.

Int 13 Diskette Exit Status Codes	
AH	00h = No error
	If Carry = 1:
AH	01h = Illegal BIOS command
	02h = Bad address mark
	03h = Write-protect occurred
	04h = Sector not found
	06h = Media changed
	09h = DMA crossed 64K boundary
	08h = DMA failed
	0Ch = Media not found
	10h = CRC failed
	20h = NEC failed
	30h = Drive does not support media sense
	31h = No media in drive
	32h = Drive does not support media type
	40h = Seek failed
	80h = Time out occurred

The following table contains the combinations of drive types and media types supported by the INT 13 services 02h to 05h.

Diskette Types			
Media	**Drive**	**Sec/Trk**	**Tracks**
360 kB	360 kB	8-9	40
360 kB	1.2 MB	8-9	40
1.2 MB	1.2 MB	15	80
720 kB	720 kB	9	80
720 kB	1.44 MB	9	80
1.44 MB	1.44 MB	18	80
720 kB	2.88 MB	9	80
1.44 MB	2.88 MB	18	90
2.88 MB	2.88 MB	36	80

The following describes the diskette services with their entry and exit values.

Interrupt 13h Diskette Services

AH = 00h **Reset diskette system**

AH = 01h **Return diskette status**

Exit:

AH	00h = No error 01h = Illegal BIOS command 02h = Address mark not found 03h = Write-protect error 04h = Sector not found 06h = Media has been changed 08h = DMA overrun 09h = DMA boundary error 0Ch = Media not found 10h = CRC error 20h = NEC error 40h = Seek error 80h = Time out occurred

AH = 02h **Read diskette sectors**

Entry:

ES:BX	Buffer address
DL	Drive number (0-1)
DH	Head number (0-1)
CH	Track number (0-79)
CL	Sector number (8-36)
AL	Number of sectors (1-15)

Exit:

AL	Number of sectors transferred

AH = 03h **Write diskette sectors**

Entry:

ES:BX	Buffer address
DL	Drive number (0-1)
DH	Head number (0-1)
CH	Track number (0-79)
CL	Sector number (8-36)
AL	Number of sectors (1-15)

Exit:

AL	Number of sectors transferred

AH = 04h **Verify diskette sectors**

Entry:

DL	Drive number (0-1)
DH	Head number (0-1)
CH	Track number (0-79)
CL	Sector number (8-36)
AL	Number of sectors (1-15)

Exit:

AL	Number of sectors verified

Continued

Continued

AH = 05h Format diskette track

Entry:

ES:BX	Buffer address
DL	Drive number (0-1)
DH	Head number (0-1)
CH	Track number (0-79)
CL	Sector number (8-36)
AL	Number of sectors (1-15)

Exit:

AL	Number of sectors formatted

AH = 08h Read drive parameters

Entry:

DL	Drive number

Exit:

ES:DI	Pointer to parameter table
DH	Maximum head number
DL	Number of diskette drives present
CH	Maximum track number
CL	Drive capacity: Bits 0-5 Maximum sector number Bits 6-7 Maximum track number
BL	Diskette drive type from CMOS: Bits 0-3: 00 = CMOS not present or invalid 01 = 360 kB 02 = 1.2 MB 03 = 720 kB 04 = 1.44 MB 06 = 2.88 MB Bits 4-7: 0

AH = 15h Read drive type

Entry:

DL	Drive number

Exit:

AH	00 = Drive not present 01 = Drive cannot detect media change 02 = Drive can detect media change 03 = Fixed disk

AH = 16h Detect media change

Entry:

DL	Drive Number (0-1)

Exit:

	If Carry = 0:
AH	00 = Disk change not active 01 = Invalid drive number 06 = Either disk change line active or change line not supported 80h = Drive not ready or no drive present: (timeout)

Continued

Continued

AH = 17h **Set diskette type**
Entry:
AL Format:
00 = Invalid Request
01 = 360kB floppy in 360kB drive
02 = 360kB floppy in 1.2MB drive
03 = 1.2MB floppy in 1.2MB drive
04 = 720kB floppy in 720kB (1.44MB not supported)
DL Drive Number (0-1)

AH = 18h **Set media type for format**
Entry:
CH Maximum track number
CL Diskette parameters:
Bits 0-5: Maximum sector number
Bits 6-7: Maximum track number
DL Drive Number (0-1)
Exit:
ES:DI Pointer to parameter table

AH = 20h **Get media type**
Entry:
DL Drive number (0-1)
Exit:
AL Type of media installed:
00h = 720 kB diskette
01h = 1.44 MB diskette
02h = 2.88 MB diskette
03h = 1 MB diskette
04h = 2 MB diskette
06h = 4 MB diskette

Interrupt 13h–Fixed Disk Services

Interrupt 13h acceses these Services:

Standard Fixed-Disk Services, 00h-15h
Enhanced Disk Drive Services, 41h -48h
Bootable CD-ROM Services, 4Ah-4Dh

The following box describes the errors returned by these services:

Int 13h Fixed-Disk Exit Codes

AH 00h = No error
If Carry = 1:
AH 01 = Bad command or parameter
02h = Address mark not found
04h = Sector not found
05h = Reset failed
07h = Drive parameter activity failed
0Ah = Bad sector flag detected
10h = ECC data error
11h = ECC data corrected
20h = Controller failure
40h = Seek failed
80h = Time out occurred
AAh = Drive not ready
BBh = Undocumented controller error

CCh = Controller write fault
E0h = Unrecognized controller error

The following describes the Standard Fixed-Disk services of PhoenixBIOS 4.0:

Interrupt 13 Standard Fixed Disk Services

AH = 00 **Reset diskette and fixed-disk systems**

AH = 01h **Read disk status**

Entry:
DL Drive number (80h-81h)
Exit:
AH 001h = Bad command
002h = Bad address mark
004h = Record not found
005h = Controller reset error
007h = Drive initialization error
00Ah = Bad sector
010h = ECC data error
020h = Controller failed
040h = Seek error
0AAh = Drive not ready
0BBh = Invalid controller error
0CCh = Controller write fault
0E0h = Unrecognized controller error

AH = 02h **Read disk sectors**

Entry:
ES:BX Buffer address
DL Drive number (80h-81h)
DH Head number (0-15)
CH Track number (0-1023)
Put the two high-order bits (8 and 9)
in the high-order bits of CL
CL Sector number (1-17)
AL Number of sectors (1-80h for read)
(1-79h for long read, includes ECC)
Exit:
AL Number of sectors transferred

AH = 03h **Write disk sectors**

Entry:
ES:BX Buffer address
DL Drive number (80H-81H)
DH Head number (0-15)
CH Track number (0-1023)
Put the two high-order bits (8 and 9)
in the high-order bits of CL
CL Sector number (1-17)
AL Number of sectors (1-80h for write)
(1-79h for long write, includes ECC)
Exit:
AL Number of sectors transferred

Continued

Continued

AH = 04h Verify disk sectors

Entry:

ES:BX	Buffer address
DL	Drive number (80h-81h)
DH	Head number (0-15)
CH	Track number (0-1023) Put the two high-order bits (8 and 9) in the high-order bits of CL
CL	Sector number (1-17)
AL	Number of sectors (1-80h for write) (1-79h for long write, includes ECC)

Exit:

AL	Number of sectors verified

AH = 05h Format disk cylinder

Entry:

ES:BX	Pointer to table containing the following byte pair for each sector in the track: Byte 0: 00h if sector is good 80h if sector is bad Byte 1: Sector Number (0-255)
DL	Drive number (80H-81H)
DH	Head number (0-15)
CH	Track number (0-1023) Put the two high-order bits (8 and 9) in the high-order bits of CL
CL	Sector number (1-17)
AL	Number of sectors (1-80h for write) (1-79h for long write, includes ECC)

Exit:

AL	Number of sectors formatted

AH = 08h Read drive parameters

Entry:

DL	Drive number (80H-81H)

Exit:

CL	Maximum sector number
CH	Maximum cylinder number (High bits in CL)
DH	Maximum head number
DL	Number of responding drives (0-2) If Carry - 1:
AH	07h = Invalid drive number
AL	0 = Error
CX	0 = Error
DX	0 = Error

AH = 09h Initialize drive parameters

Entry:

DL	Drive number (80H-81H)

Continued

Continued

AH = 0Ah **Read long sector**

Entry:

ES:BX	Buffer address
DL	Drive number (80H-81H)
DH	Head number
CH	Cylinder number
CL	Sector number/Cyl high
AL	Number of sectors

Exit:

AL	Number of sectors transferred

AH = 0Bh **Write long sector**

Entry:

ES:BX	Buffer address
DL	Drive number (80H-81H)
DH	Head number
CH	Cylinder number
CL	Sector number/Cyl high
AL	Number of sectors

Exit:

AL	Number of sectors transferred

AH = 0Ch **Seek drive**

Entry:

ES:BX	Buffer address
DL	Drive number (80H-81H)
DH	Head number
CH	Cylinder number
CL	Cylinder high

AH = 0Dh **Alternate disk reset**

Entry:

DL	Drive number (80H-81H)

AH = 10h **Test drive ready**

Entry:

DL	Drive number (80H-81H)

AH = 11h **Recalibrate drive**

Entry:

DL	Drive number (80H-81H)

AH = 14h **Controller diagnostic**

Entry:

DL	Drive number (80H-81H)

AH = 15h **Read drive type**

Entry:

DL	Drive number (80H-81H)

Exit:

AH	00 = Drive not present 01 = Drive cannot detect media change 02 = Drive can detect media change 03 = Fixed disk
CX	High word of number of 512-byte blocks
DX	Low word of number of 512-byte blocks

Interrupt 13h–Extended Fixed Disk Services

The following describes the Interrupt 13h Extended Fixed Disk Services, including the *Phoenix*BIOS **Enhanced Disk Drive** (**EDD**) services:

Int 13h Extended Fixed Disk Services

AH = 41h Check Extensions Present

Entry:

BX	55AAh
DL	Drive Number

Exit:

AH	Major version number (20h)
AL	Internal use only
BX	55AAh = Extensions present
CX	Feature support map: Bit 0: 1 = Extended disk access Bit 1: 1 = Removable drive control Bit 2: 1 = Enhanced Disk Drive Extensions Bits 3-7, Reserved, must be 0

AH = 42h Extended Read

Entry:

DL	Drive Number
DS:SI	Disk address packet

AH = 43h Extended Write

Entry:

AL	Verify Bits: Bit 0: 0 = Write with verify off 1 = Write with verify on Bits 1-7 Reserved, set to 0
DL	Drive number
DS:SI	Disk address packet

AH = 44h Verify Sectors

Entry:

DL	Drive number
DS:SI	Disk address packet

AH = 47h Extended Seek

Entry:

DL	Drive number
DS:SI	Disk address packet

Continued

Continued

AH = 48h Get Drive Parameters

Entry:
DL Drive Number
DS:SI Address of Result Buffer
Exit:
DS:SI Pointer to Result Buffer:

```
info_size  dw 30        ;size of this buffer
flags  dw ?             ;info flags (See below)
cylinders  dd ?         ;cylinders on disk
heads  dd ?             ;heads on disk
sec_per_track  dd ?     ;sectors per track
sectors  dq ?           ;sectors on disk
sector_size  dw ?       ;bytes per sector
extended_table dd?      ;extended table ptr
                        ; (See below)
```

info flags:

Bit 0 0 = DMA boundary errors possible
1 = DMA errors handled
Bit 1 0 = CHS info not supplied
1 = CHS info valid
Bit 2 0 = Drive not removable
1 = Drive removable
Bit 3 0 = No write with verify
1 = Write with verify
Bit 4 0 = No change-line support
1 = Change-line support
Bit 5 0 = Drive not lockable
1 = Drive lockable
Bit 6 0 = CHS values for installed media
1 = Maximum CHS values for drive (media absent)

Extended Fixed Disk Parameter Table

Byte		Type	Description
0-1	Word		I/O port address
2-3	Word		Control port address
4	Bit 0-3		Reserved, must be 0
	Bit 4		0 = Master, 1 = Slave
	Bit 5		Reserved, must be 0
	Bit 6		1 = LBA enabled
	Bit 7		Reserved, must be 1
5	Bits0-3		Phoenix Proprietrary
	Bits 4-7		Reserved, must be 0
6	Bits 0-3		IRQ for this drive
	Bits 4-7		Reserved, must be 0
7	Byte		Sector count for multi-sectored transfers
8	Bits 0-3		DMA channel
	Bits 4-7		DMA type
9	Bits 0-3		PIO type
	Bits 1-7		Reserved, must be 0

Continued

Continued

Byte	Type	Description
10-11	Bit 0	1 = Fast PIO access enabled
	Bit 1	1 = DMA access enabled
	Bit 2	1 = Block PIO access enabled
	Bit 3	1 = CHS translation enabled
	Bit 4	1 = LBA translation enabled
	Bit 5	1 = Removable media
	Bit 6	1 = CD ROM
	Bit 7	1 = 32-bit transfer mode
	Bit 8	1 = ATAPI Device uses Interrupt DRQ
	Bits 9-10	CHS Translation Type
	Bits 11-15	Reserved, must be 0
12-13	Byte	Reserved, must be 0
14	Byte	Extension Revision number
15	Byte	Checksum, 2s complement of the sum of bytes 0-14

Interrupt 13h–Bootable CD-ROM Services

Bootable CD-ROM Services 4Ah-4Ch use a pointer to the **Specification Packet**, described here:

Bootable CD-ROM Specification Packet

Offset	Type	Description
0h	Byte	Packet size, currently 13h
1h	Byte	Boot media type: Bits 0-3: 00h = No emulation 01h = 1.2 MB diskette 02h = 1.44 MB diskette 03h = 2.88 MB diskette 04h = Hard disk (drive C:) Bits 05h-07h: Reserved Bit 6: 01h = Sysem has ATAPI driver with 8 & 9 below describing IDE interface. Bit 7: 01h = System has SCSI drivers with 8 & 9 below describing SCSI interface
2h	Byte	Drive number: 00h = Floppy image 80 = Bootable hard disk 81h -FFh = "Non-bootable" or "No emulation"

Continued

Continued

Offset	Type	Description
3h	Byte	Controller index of CD drive
4h-7h	Dword	Logical Block Address
8h-9h	Word	Device specification: For SCSI: Byte 8: LUN and PUN of CD drive Byte 9: Bus number For IDE: Byte 8 LSB: 0 = Master, 1 = Slave
Ah-Bh	Word	User buffer segment
Ch-Dh	Word	Load segment (only for Int 13h 4Ch): 00h = 7C0h
Eh-Fh	Word	Virtual sector count (only for Int 13h 4Ch)
10h	Byte	Low-order bits (0-7) of the cylinder count (Matches returned CH of Int 13h 08h)
11h	Byte	Bits 0-5: Sector count Bits 6-7: High order 2 bits of cylinder count (Matches returned CL of Int 13h 08h)
12h	Byte	Head count (Matches returned DH of Int 13h 0h)

Bootable CD-ROM Service 4Dh uses a pointer to the **Command Packet**, described here:

Bootable CD-ROM Command Packet

Offset	Type	Description
0h	Byte	Packet size in bytes, currently 08h
1h	Byte	Count of sectors in boot catalog to transfer
2-h	Dword	Pointer to destination buffer for boot catalog
6-7h	Word	Beginning sector to transfer, relative to start of the boot catalog. Int 14 4Dh should set this value to 00h.

The following describes the Interrupt 13 Bootable CD-ROM Services of PhoenixBIOS 4.0:

Int 13 Bootable CD-ROM Services

AH = 4Ah	Initiate disk emulation
Entry:	
AL	00
DS:SI	Pointer to Specification Packet (See above)
CF	0 = Specified drive emulating 1 = System not in emulation mode

Continued

Continued

AH = 4Bh Terminate disk emulation

Entry:	
AL	00h = Return status and terminate emulation
	01h = Return status only, do not terminate
DL	Drive number to terminate
	7Fh = Terminate all
DS:SI	Empty Specification Packet
Exit:	
DS:SI	Completed Specification Packet (See above)
AX	Exit status codes
CF	0 = System released
	1 = System not in emulation mode

AH = 4Ch Initiate disk emulation and boot

Entry:	
AL	00h
DS:SI	Specification Packet (See above)

AH = 4Dh Return boot catalog

Entry :	
AL	00h
DS:SI	Point to Command Packet (See above)

Interrupt 14h–Serial Services

The INT 14 software interrupt handles serial I/O service requests. Use the AH register to specify the service to invoke. This describes the UART Modem and Line Status returned by these services. It also includes two services, 04h and 05h, that support the extended communication capabilities of PS/2.

The following describes the modem status returned by serial services.

Modem Status

AL	Description
Bit 0	1 = Delta clear to send
Bit 1	1 = Delta data set ready
Bit 2	1 = Trailing edge ring indicator
Bit 3	1 = Delta data carrier detect
Bit 4	1 = Clear to send
Bit 5	1 = Data set ready
Bit 6	1 = Ring indicator
Bit 7	1 = Received line signal detect

The following describes the line status returned by Int 14h Serial Services.

Line Status

AH	Description
Bit 0	1 = Data ready
Bit 1	1 = Overrun error
Bit 2	1 = Parity error
Bit 3	1 = Framing error
Bit 4	1 = Break detect
Bit 5	1 = Trans holding register empty
Bit 6	1 = Trans shift register empty
Bit 7	1 = Time out error

The following describes the serial communication services of *Phoenix*BIOS 4.0:

Interrupt 14h Serial Services

AH = 00 Initialize Serial Adapter

Entry:

AL	Init parameters:	
	Bit 1,0	10 = 7 data bits
		11 = 8 data bits
	Bit 2	0 = 1 stop bit
		1 = 2 stop bits
	Bit 4,3	00 = No parity
		10 = No parity
		01 = Odd parity
		11 = Even parity
	Bit 7-5	000 = 110 Baud- 417 divisor
		001 = 150 Baud-300 divisor
		010 = 300 Baud-180 divisor
		011 = 600 Baud-0C0 divisor
		100 = 1200 Baud-060 divisor
		101 = 2400 Baud-030 divisor
		110 = 4800 Baud-018 divisor
		111 = 9600 Baud-00C divisor
DX	Serial port (0-3)	

Exit:

AL	Modem status
AH	Line status

AH = 01h Send character

Entry:

AL	Character to transmit
DX	Serial port (0-3)

Exit:

AH	Line status

Continued

Continued

AH = 02h Receive character

Entry:
DX Serial port (0-3)
Exit:
AL Character received
AH Line Status

AH = 03h Return serial port status

Entry:
DX Serial port (0-3)
Exit:
AH Line status
AL Modem status

AH = 04h Extended Initialize (PS/2)

Entry:
DX 0-3 = Communications adapter
AL 00 = Break
01 = No break
BH Parity:
00 = None
01 = Odd
02 = Even
03 = Stick parity odd
04 = Stick parity even
BL Stop bits:
00 = One
01 = Two if 6,7, or 8-bit word length
One and one-half if 5-bit word length
CH Word length:
00 = 5 bits
01 = 6 bits
02 = 7 bits
03 = 8 bits
CL Baud rate:
00 = 110 baud
01 = 150 baud
02 = 300 baud
03 = 600 baud
04 = 1200 baud
05 = 2400 baud
06 = 6000 baud
07 = 9600 baud
08 = 19200 baud
Exit:
AL Modem status
AH Line status

Continued

Continued

AH = 05h Extended Communications Port Control (PS/2)

AL = 00 Read modem control register

Entry:
DX Serial port (0-3)
Exit:
BL Modem control register

AL = 01 Write modem control register

Entry:
DX Serial port (0-3)
BL Modem control register
Exit:
AL Modem status
AH Line status

Interrupt 15h–System Services

The INT 15 software interrupt handles a variety of system services:

- Multi-tasking–80h, 81h, 82h, 85h, 90h, and 91h
- Joystick support–84h
- Wait routines–83h and 86h
- Protected-mode support–87h and 89h
- Report extended memory to 64 kB–88h
- System information–C0h
- Advanced Power Management (optional)–53h
- Report extended memory above 64 kB (optional)–8Ah and E8h
- PS/2 Mouse support (optional)–C2h
- EISA Support (optional)–D8h

The first section describes the standard Interrupt 15 services, followed by separate sections describing each of the optional services.

Interrupt 15h System Services

AH = 00-03h Cassette services

Entry:
No longer supported
Exit:
Carry 1 = Not supported

Continued

Continued

AH = 80h **Device open**

Entry:
BX Device identifier
CX Process identifier

AH = 81h **Device close**

Entry:
BX Device identifier
CX Process identifier

AH = 82h **Program termination**

Entry:
BX Device identifier

AH = 83h **Event wait**

AL **00 = Set interval**

Entry:
ES:BX Pointer to byte in caller's memory that will have bit 7 set when interval expires.
CX Microseconds before post (high byte)
DX Microseconds before post (low byte)
Exit:
AH 83h
AL A value written to CMOS register B
00h = Function busy

AL **01 = Cancel set interval**

Exit:
AH 83
AL 00

AH = 84h **Joystick support**

Entry:
DL 00 = Read switch settings
Exit:
AL Switch settings
DL 01 Return resistive inputs
Exit:
AX Input bit 0 (Joystick A, x coordinate)
BX Input bit 1 (Joystick A, y coordinate)
CX Input bit 2 (Joystick B, x coordinate)
DX Input bit 3 (Joystick B, y coordinate)

AH = 85h **System request key pressed**

Entry:
AL 00 System request key pressed
AL 01 System request key released

AH = 86h **Wait**

Entry:
CX Number of microseconds to wait (high byte)
DX Number of microseconds to wait (low byte)

Continued

Continued

AH = 87h **Extended memory move block**

Entry:

CX Number of words to move

ES:SI Pointer to Global Descriptor

Byte 0-1 Bits 0-15 of Segment Limit
Byte 2-3 Bits 0-15 of Base Address
Byte 4 Bits 16-23 of Base Address
Byte 5 Access Rights
Byte 6 Bits 7-4 more Access Rights
Bits 3-0 upper 4 bits of Segment Limit
Byte 7 Bits 24-31 of Base Address
(See Intel programmer's reference)

AH = 88h **Extended memory size**

Exit:

For DOS and Windows 3.x (AT Compatible):

AX Amount of extended memory to 64 MB, in 1 kB blocks

For Windows NT 3.1 and OS/2 2.11 and 2.20:

AX Amount of extended memory to 64 MB in 1 kB blocks
3C00 = 15 MB or > 64 MB (Test further with INT 15 E8)

AH = 89h **Enter protected mode**

Entry:

ES:SI Pointer to Global Descriptor (See service 87)

BH Offset in IDT for IRQ 00-07

BL Offset in IDT for IRQ 08-0F

AH = 90h **Device busy**

Entry:

AL Type code:
00h = Fixed disk (May time out)
01h = Diskette (May time out)
02h = Keyboard (No time out)
03h = Pointing device (May time out)
80h = Network (No time out)
FCh = Fixed disk reset (May time out)
FDh = Diskette drive motor start (May time out)
FEh = Printer (May time out)

ES:BX Points to request block if AL = 80h-FFh

Exit:

Carry 0 = No wait performed
(Driver must perform own wait)
1 = Wait performed (I/O complete or time out)

AH = 91h **Interrupt complete**

Entry:

AL Type code: See service 90h

Continued

Continued

AH = C0h Return system parameters

Exit:
ES:BX Pointer to System Configuration
Bytes 1-2 Length of table in bytes (8)
Byte 3 Model (FCh = AT
Byte 4 Sub model (01h = AT)
Byte 5 BIOS revision level (0)
Byte 6 Feature information:
Bit 0 0 = Reserved
Bit 1 0 = ISA-type I/O channel
Bit 2 0 = EDBA not allocated
Bit 3 0 = Wait for external event supported
Bit 4 1 = Keyboard intercept (INT 154F) called by INT 09h
Bit 5 1 = Real time clock present
Bit 6 1 = Second PIC present
Bit 7 0 = Fixed disk BIOS does not use DMA channel 3
Byte 7 Reserved
Byte 8 Reserved

AH = C1h Return Extended BIOS Data Area Address

Exit:
ES Extended BIOS Data Area Segment Address
If Carry = 1
AH 86 = Invalid BIOS routine call (No EBDA)

Interrupt 15h–APM Services

The INT 15 software interrupt optionally handles the calls supporting APM (Advanced Power Management).

The following are the APM exit status codes:

APM Service Exit Status Codes

AH 00h = No error
If Carry = 1:
AH 01h = Power Management disabled
02h = Real Mode interface already connected
03h = Interface not connected
05h = 16-bit protected mode interface already connected
06h = 16-bit protected mode interface not supported
07h = 32-bit protected mode interface already connected
08h = 32-bit protected mode interface not supported
09h = Unrecognized Device ID
0Ah = Parameter value out of range
0Bh = Interface not engaged
60h = Unable to enter requested state
80h = No PM events pending
86h = No APM present

The following are the Interrupt 15 APM Services of *Phoenix*BIOS 4.0:

Interrupt 15h APM Services

AH = 53h APM 1.0 and APM 1.1 BIOS Services

AL = 00h Installation Check

Entry:

BX 0000h = Power Device ID (APM BIOS)
All other values reserved

Exit:

AH APM major revision in BCD
AL APM minor revision in BCD
BH ASCII "P"
BL ASCII "M"
CX APM information:
Bit 0 1 = 16 bit Prot Mode supported
Bit 1 1 = 32 Bit Prot Mode supported
Bit 2 1 = CPU IDLE slows down CPU speed.
Requires APM CPU Busy service
Bit 3 1 = BIOS Power Management is disabled
Bit 4 1 = APM disengaged

AL = 01h Interface Connect

Entry:

BX 0000h = Power Device ID (APM BIOS)
All other values reserved

AL = 02h Protected-mode 16-bit interface connect

Entry:

BX 0000h = Power Device ID (APM BIOS)
All other values reserved

Exit:

AX APM 16-bit code segment (real mode segment base address)
BX Offset of entry point into the BIOS
CX APM 16-bit data segment (real mode segment address)
SI BIOS code segment length
DI BIOS data segment length

AL = 03h Protected-mode 32-bit interface connect

Entry:

BX Power Device ID, 0000h
All other values reserved

Exit:

AX APM 32-bit code segment (real mode segment base address)
EBX Offset of entry point into the BIOS
CX APM 16-bit data segment (real mode segment address)
DX APM data segment (real mode segment address)
SI BIOS code segment length
DI BIOS data segment length

Continued

Continued

AL = 04h Protected-mode 32-bit interface connect

Entry:

BX 0000h = Power Device ID (APM BIOS)
All other values reserved

AL = 05h CPU Idle

AL = 06h CPU busy

AL = 07h Set Power State

Entry:

BX Power Device ID:
0001h = All PM devices managed by the BIOS
01XXh = Display
02XXh = Secondary Storage
03XXh = Parallel Ports
04XXh = Serial Ports
05XXh = Network Adapters
06XXh = PCMCIA Sockets
E000h-EFFFh = OEM-defined power-device IDs
where:
XXh = Unit Number (0 based)
Unit Number FFh = all units in this class

CX Power State:
*0000h = APM enabled
0001h = Standby
0002h = Suspend
0003h = Off
**0004h = Last Request Processing Notification
**0005h = Last Request Rejected
0006h-001Fh = Reserved system states
0020h-003Fh = OEM-defined system states
0040h-007Fh = OEM-defined device states
0080-FFFFh = Reserved device states
* Not supported for Power Device ID 0001h
**Only supported for Power Device ID 0001h

AL = 08h Enable/disable power management

Entry:

BX Power Device ID:
0001h = All PM devices controlled by the BIOS
FFFFh = All PM devices controlled by the BIOS (For compatibility with APM 1.0)
All other values reserved

CX Function code:
0000h = Disable power management
0001h = Enable power management

AL = 09h Restore Power-On Defaults

Entry:

BX Power Device ID:
0001h = All PM devices managed by the BIOS
FFFFh = All PM devices managed by the BIOS (For compatibility with APM 1.0)
All other values reserved

Continued

Continued

AL = 0Ah Get Power Status

Entry:

BX Power Device ID, 0000h = APM BIOS
All other values reserved

Exit:

BH AC line status:
00h = Off line
01h = On line
02h = On backup power
FFh = Unknown
All other values reserved

BL Battery status:
00h = High
01h = Low
02h = Critical
03h = Charging
FFh = Unknown

CL Percentage of charge remaining:
0-100 = Percentage of full charge
FFh = Unknown
All other values reserved

AL = 0Bh Get PM Event

Exit:

BX PM event code

AL = 0Ch Get Power State

Entry:

BX Power Device ID:
0001h = All PM devices managed by the BIOS
01XXh = Display
02XXh = Secondary Storage
03XXh = Parallel Ports
04XXh = Serial Ports
05XXh = Network Adapters
06XXh = PCMCIA Sockets
E000h-EFFFh = OEM-defined power-device IDs
All other values reserved
where:
XXh = Unit Number (0 based)

AH = 53h APM 1.1 BIOS Services

AL = 0Dh Enable/Disable power management (APM 1.1 only)

Entry:

BX Power Device ID:
0001h = All PM devices managed by the BIOS
01XXh = Display
02XXh = Secondary Storage
03XXh = Parallel Ports
04XXh = Serial Ports
05XXh = Network Adapters
06XXh = PCMCIA Sockets
E000h-EFFFh = OEM-defined power-device IDs
All other values reserved
where:
XXh = Unit Number (0 based)

Continued

Continued

AL = 0Eh APM Driver Version (APM 1.1 only)

Entry:
BX 0000h = BIOS device
CH APM Driver major version number (BCD)
CL APM Driver minor version number (BCD)
Exit:
AH APM Connection major version number (BCD)
AL APM Connection minor version number (BCD)

AL = 0Fh Engage/disengage power management (APM 1.1 only)

Entry:
BX Power Device ID:
0001h = All PM devices managed by the BIOS
01XXh = Display
02XXh = Secondary Storage
03XXh = Parallel Ports
04XXh = Serial Ports
05XXh = Network Adapters
06XXh = PCMCIA Sockets
E000h-EFFFh = OEM-defined power-device IDs
All other values reserved
where:
XXh = Unit Number (0 based)
Unit Number FFh = all devices in this class
CX Function code:
0000h = Disengage power management
0100h = Engage power managment

Interrupt 15h–Big Memory Services

The INT 15 software interrupt optionally handles the calls reporting extended memory over 64 MB.

The first function, 8Ah, only supports certain versions of UNIX.

The second function, E8h, incorporates these sub functions:

Big memory for Windows NT 3.01 and OS/2 2.11 and 2.20–E801h (16 bit) and E881h (32 bit).

System Memory Map–E820h

Interrupt 15h Big Memory Services

AH = 8Ah Big Memory size, Phoenix definition

Entry:
(For certain versions of UNIX)
AX Low 16-bit value
DX High 16-bit value
= memory above 1024 kB in 1 kB blocks

Continued

Continued

AH = E8h Big Memory size (over 64 kB)

AL = 01h Big Memory Size, 16 Bit
(Windows NT 3.1 and OS/2 2.11 and 2.20)

Exit:

Carry	0 = E801 Supported
AX	Memory 1 MB to 16 MB, in 1 kB blocks
BX	Memory above 16 MB, in 64 kB blocks
CX	Configured memory 1 MB to 16 MB, in 1 kB blocks
DX	Configured memory above 16 MB, in 64 kB blocks

AL = 20h System Memory Map

Entry:

EBX	Continuation value
ES:DI	Address of Address Range Descriptor
ECX	Length of Address Range Descriptor (=> 20 bytes)
EDX	"SMAP" signature

Exit:

Carry	0 = E820 Supported
EAX	"SMAP" signature
ES:DI	Same value as entry
ECX	Length of actual reported information in bytes
EBX	Continuation value

Structure of Address Range Descriptor:

Bytes 0-3	Low 32 bits of Base Address
Bytes 4-7	High 32 bits of Base Address
Bytes 8-11	Low 32 bits of Length in bytes
Bytes 12-15	High 32 bits of Length in bytes
Bytes 16-20	Type of Address Range:

1 = AddressRangeMemory, available to OS
2 = AddressRangeReserved, not available
3 = AddressRangeACPI, available to OS
4 = AddressRangeNVS, not available to OS
Other = Not defined, not available

NOTE: Each call of this service defines a descriptor buffer and requests the memory status of the address range specified by the continuation value, where zero = first address range. The function fills the buffer and returns the continuation value for the next address range range, where zero = last address range.

AL = 81h Big Memory Size, 32-Bit Protected Mode
(Windows NT 3.1 and OS/2 2.11 and 2.20)

Exit:

Carry	0 = E881 supported
EAX	Memory 1 MB to 16 MB, 1 kB blocks
EBX	Memory above 16 MB, 64 kB blocks
ECX	Configured memory 1 MB to 16 MB, 1 kB blocks
EDX	Configured memory above 16 MB, 64 kB blocks

Interrupt 15h–PS/2 Mouse Services

The INT 15 software interrupt optionally supports systems with the PS/2 mouse or similar devices installed on the motherboard. The following table describes the exit status codes:

PS/2 Mouse Exit Status Codes	
AH	00h = No error 01h = Invalid function call 02h = Invalid input value 03h = Interface error 04h = Request for resend received from 8042 05h = No driver installed (i.e., Function C207 has not been called)

The following table describes the Interrupt 15h PS/2 mouse services of *Phoenix*BIOS 4.0:

Interrupt 15h PS/2 Mouse Services	
AH = C2h	**PS/2 Mouse Support**
AL	**00 = Enable/Disable PS/2 Mouse**
Entry:	
BH	00h = Disable 01h = Enable
AL	**01 = Reset PS/2 Mouse**
Exit:	
BH	Device ID
AL	**02 = Set Sample Rate**
Entry:	
BH	Sample rate: 00h = 10 reports per second 01h = 20 reports per second 02h = 30 reports per second 03h = 40 reports per second 04h = 60 reports per second 04h = 80 reports per second 05h = 100 reports per second 06h = 200 reports per second
AL	**03h = Set resolution**
Entry:	
BH	Resolution value: 00h = 1 count per millimeter 01h = 2 counts per millimeter 02h = 4 counts per millimeter 03h = 8 counts per millimeter
AL	**04h = Read Device Type**
Exit:	
BH	Device ID
AL	**05h = Initialize PS/2 mouse**
Entry:	
BH	Data package size (01-08h, in bytes)

Continued

Interrupt 15h-PS/2 Mouse Services, continued

AL 06h = Set Scaling or Get Status

Entry:

BH 00 = Return status (See Exit Status below)
01 = Set Scaling Factor to 1:1
02 = Set Scaling Factor to 2:1

Exit:

If Entry BH = 00:

BL Status byte 1:
Bit 0 1 = Right button pressed
Bit 1 0 = Reserved
Bit 2 1 = Left button pressed
Bit 3 0 = Reserved
Bit 4 0 = 1:1 Scaling
1 = 2:1 Scaling
Bit 5 0 = Disable
1 = Enable
Bit 6 0 = Stream mode
1 = Remote mode
Bit 7 0 = Reserved

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

AL 07 = Set PS/2 mouse driver address

Entry:

ES:BX Pointer to mouse driver

Interrupt 15h–EISA Services

The INT 15 software interrupt optionally supports systems with EISA (Extended Industry Standard Architecture) with these services:

- Read slot configuration information–D800h, D880h
- Read function configuration information–D801h, D881h
- Clear EISA CMOS–D802h , D882h
- Write slot configuration information to EISA CMOS–D803h, D883h
- Read physical slot information–D804, D884h

The EISA BIOS services accommodate real and protected mode and 16 and 32-bit addressing. See the EISA specifications for descriptions of these services.

The following are the exit status codes for the Int 15 EISA services:

Int 15 EISA Exit Status Codes

AH	00h = No error
	If Carry = 1
AH	80h = Invalid slot number
	81h = Invalid function number
	82h = Extended CMOS corrupted
	83h = Empty slot specified
	84h = Error writing to CMOS
	85h = CMOS is full
	86h = Invalid BIOS routine call
	87h = Invalid system configuration
	88h = Configuration utility not supported

The following are the Interrupt 15 EISA services of *Phoenix*BIOS 4.0:

Interrupt 15h EISA Services

AH = D8h Access EISA System Information

AL	**00h = Read slot config information**
	80h = Read slot config information, 32 bit
Entry:	
CL	Slot number (0-63)
Exit:	
AL	Vendor information byte:
	Bits 3-0 Duplicate ID number:
	0000 = No duplicate ID
	0001 = First duplicate ID
	Bits 5-4 Slot type:
	00 = Expansion slot
	01 = Embedded device
	10 = Virtual device
	11 = Reserved
	Bit 6 Product ID:
	00 = Readable
	01 = Not readable
	Bit 7 Duplicate ID:
	00 = No duplicate ID
	01 = Duplicate IDs
BH	Major revision level of config utility
BL	Minor revision level of config utility
CH	MSbyte of checksum of config file
	LSbyte of checksum of config file
DH	Number of device functions

Continued

***Fehler! Formatvorlage nicht definiert.**, Continued*

DL Combined function information byte:
- Bit 7 Reserved
- Bit 6 Slot has free-form data entries
- Bit 5 Slot has port initialization entries
- Bit 4 Slot has port range entries
- Bit 3 Slot has DMA entries
- Bit 2 Slot has IRQ entries
- Bit 1 Slot has memory entries
- Bit 0 Slot has function type entries

DI First word of compressed device ID

SI Second word of compressed device ID
(See "Read physical slot information" below)

AL 01h = Read function config information
81h = Read function config information, 32 bit

Entry:

CH Function number (0 to n-1)

CL Slot number (0-63)

DS:SI Pointer to output data buffer

Exit:

DS Segment for return data buffer

SI Offset to return data buffer (16 bit)

ESI Offset to return data buffer (32 bit)

AL 02h = Clear EISA CMOS configuration
82h = Clear EISA CMOS configuration 32 bit

Entry:

BH Configuration utility major revision level

BL Configuration utility minor revision level

AL 03h = Write slot config information
83h = Write slot config information, 32 bit

Entry:

CX Length of data structure in bytes

DS Segment of data table

SI Offset of data table (16-bit call)

ESI Offset of data table (32-bit call)

AL 04h = Read board ID registers
84h = Read board ID registers, 32 bit

Entry:

CL Slot number (0-63)

Exit:

DI First word of compressed ID:
- Byte 0:
- Bits 1-0 2nd character of manufacturer code
- Bits 6-2 1st character of manufacturer code
- Bit 7 Reserved
- Byte 1:
- Bits 4-0 3rd character of manufacturer code
- Bits 5-7 2nd character of manufacture code, cont.

SI Second word of compressed ID:
- Byte 0:
- Bits 3-0 2nd hex digit of product number
- Bits 7-4 1st hex digit of product number
- Byte 1:
- Bits 3-0 Hex digit of revision number
- Bits 7-4 3rd hex digit of product number

	If Carry = 1:

Interrupt 16h–Keyboard Services

The INT 16 software interrupt handles keyboard I/O services. The following describes the keyboard services of *Phoenix*BIOS 4.0:

Interrupt 16h Keyboard Services

AH = 00h	**Read keyboard input**
Exit:	
AL	ASCII keystroke pressed
AH	Scan code of key
AH = 01h	**Return keyboard status**
Exit:	
AL	ASCII keystroke pressed
AH	Scan code of key
ZF	No keystroke available
NZ	Keystroke in buffer
AH = 02h	**Return shift-flag status**
Exit:	
AL	Current shift status
AH = 03h	**Set typematic rate and delay.**
Entry:	
AL	05 (subfunction number)
BL	00H through 1FH, typematic rate (30 chars/sec to 2 char/sec)
BH	Delay rate: 00h = 250 ms 01h = 500 ms 02h = 750 ms 03h = 1000 ms 04h to 07h = Reserved
AH = 05h	**Add key to Keyboard buffer.**
Entry:	
CL	ASCII code
CH	Scan code
Exit:	
	If Carry = 1:
AL	Keyboard buffer full
AH = 10h	**Read extended character from buffer.**
Exit:	
AL	ASCII keystroke pressed
AH	Scan code of key
AH = 11h	**Return extended buffer status.**
Exit:	
AL	ASCII keystroke pressed
AH	Scan code of key
ZF	No keystroke available
NZ	Keystroke in buffer

Continued

Continued

AH = 12h **Return extended shift status.**

Exit:

AL Shift status:

Bit 7	1 = Sys Req pressed
Bit 6	1 = Caps Lock active
Bit 5	1 = Num Lock active
Bit 4	1 = Scroll Lock active
Bit 3	1 = Right Alt active
Bit 2	1 = Right Ctrl active
Bit 1	1 = Left Alt active
Bit 0	1 = Left Ctrl active

AH Extended shift status:

Bit 7	1 = Insert active
Bit 6	1 = Caps Lock active
Bit 5	1 = Num Lock active
Bit 4	1 = Scroll Lock active
Bit 3	1 = Alt pressed
Bit 2	1 = Ctrl pressed
Bit 1	1 = Left Shift pressed
Bit 0	1 = Right Shift pressed

Interrupt 17h–Parallel Printer Services

The INT 17 software interrupt supports up to 4 parallel adapters. The BIOS stores the standard base addresses for three parallel adapters in the BIOS Data Area at 3FCh, 378h, and 278h. These services use the I/O ports 0278h-027Ah, 0378h-037Ah, and 03BCh-03BEh.

Interrupt 17h Parallel Printer Services

AH = 00h **Print character**

Entry:

AL Character to print

DX Printer port (0-3)

Exit:

AH Printer Status (see below)

AH = 01h **Initialize printer port**

Entry:

DX Printer port (0-3)

Exit:

AH Printer Status (see below)

AH = 02h **Return printer status**

Entry:

DX Printer port (0-3)

Exit:

AH Printer Status:

Bit 0	1 = Time-out error
Bit 1	Reserved
Bit 2	Reserved
Bit 3	1 = I/O error
Bit 4	1 = Printer selected
Bit 5	1 = Out of paper
Bit 6	1 = Acknowledgment from printer
Bit 7	1 = Printer not busy

Interrupt 17h–EPP Services

Use Interrupt 17h 02h to obtain the BIOS entry point (also called the EPP Vector) to Enhanced Parallel Printer (EPP) Services. To use the other EPP services, load AH with an appropriate function value and Far call the EPP Vector.

The following are the EPP exit status codes:

EPP Services Exit Status Codes

AH	00h = No error 01h = Failed I/O function 02h = Invalid function 03h = EPP not supported 04h = Not an EPP port 20h = Multiplexor not present 40h = Multiplexor already locked

The following are the Int 17 EPP services of *Phoenix*BIOS 4.0:

Interrupt 17h EPP Service

AH = 02h EPP Installation check

Entry:

DX	EPP printer port (0-2)
AL	0
CH	45h = "E"
BL	50h = "P"
BH	50h = "P"

Exit:

AL	45h
CX	5050h
DX:BX	EPP BIOS entry point

Vectored EPP Services
(Call entry point)
AH = 00h Query EPP port configuration

Entry:

DL	EPP printer port (0-2)

Exit:

AL	Interrupt level of EPP port (00-15h) FFh = Interrupts not supported
BH	EPP BIOS revision (MMMMnnnn or M.n)
BL	I/O capabilities: Bit 0 Multiplexor present Bit 1 PS/2 bi-directional capable Bit 2 Daisy chain present Bit 3 ECP capable
CX	SPP I/O base address
ES:DI	FAR pointer to EPP BIOS manufacturer's info/version text string, zero terminated

Continued

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AH = 01h Set mode

Entry:
DL EPP printer port (0-2)
AL Modes:
Bit 0 Set compatibility mode
Bit 1 Set Bi-directional mode
Bit 2 Set EPP mode
Bit 3 Set ECP mode
Bit 4 Set EPP software emulation (via standard parallel port)

AH = 02h Get mode

Entry:
DL EPP printer port (0-2)
Exit:
AL Modes:
Bit 0 In compatibility mode
Bit 1 In Bi-directional mode
Bit 2 In EPP mode
Bit 3 In ECP mode
Bit 4 In EPP software-emulation mode
Bit 7 EPP port interrupts enabled

AH = 03h Interrupt control

Entry:
DL EPP printer port (0-2)
AL 0 = Disable EPP port interrupts
1 = Enable EPP port interrupts

AH = 04h Reset EPP port

Entry:
DL EPP printer port (0-2)

AH = 05h Write address/select device

Entry:
DL EPP printer port (0-2)
AL Device address to write

AH = 06h Read address

Entry:
DL EPP printer port (0-2)
AL Device address to write
Exit:
AL Address/device data returned

AH = 07 Write byte

Entry:
DL EPP printer port (0-2)
AL Data byte

AH = 08 Write block

Entry:
DL EPP printer port (0-2)
CX Number of bytes to write (0 = 64k)
ES:SI Client buffer w/data
Exit:
CX Bytes not transferred (0 = no error)

AH = 09h Read byte

Entry:
DL EPP printer port (0-2)
Exit:
AL Data byte returned

Continued

Continued

AH = 0Ah Read block

Entry:
DL EPP printer port (0-2)
CX Number of bytes to read (0 = 64k)
ES:DI Client buffer for returned data
Exit:
CX Bytes not transferred (0 = no error)

AH = 0Bh Write address, read byte

Entry:
DL EPP printer port (0-2)
AL Device address
Exit:
AL Data byte returned

AH = 0Ch Write address, write byte

Entry:
DL EPP printer port (0-2)
AL Device address
DH Data byte to write

AH = 0Dh Write address, read block

Entry:
DL EPP printer port (0-2)
AL Device address
CX Number of bytes to read (0 = 64k)
ES:DI Client buffer for data
Exit:
AL Returned byte data
CX Bytes not transferred (0 = no error)

AH = 0Eh Write address, write block

Entry:
DL EPP printer port (0-2)
AL Device address
CX Number of bytes to write
ES:SI Client buffer w/data
Exit:
CX Bytes not transferred (0 = no error)

AH = 0Fh Lock port

Entry:
DL EPP printer port (0-2)
BL Port address:
Bits 7-4 Daisy chain port number (1-8)
Bits 3-0 Mux device port number (1-8)
0 = No multiplexor

AH = 10h Unlock port

Entry:
DL EPP printer port (0-2)

AH = 11h Device interrupt

Entry:
DL EPP printer port (0-2)
BL The multiplexor device port (1-8)
0 = No multiplexor
AL 0 = Disable device interrupts
1 = Enable device interrupts
ES:DI Far pointer to interrupt-event handler

Continued

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AH = 12h Real time mode

Entry:
AL 0 = Query if any real-time device present
1 = Add (advertise) real-time device
2 = Remove real-time device

Exit:
AL 0 = No real-time devices present
1 = One or more real-time devices present

AH = 40h Query multiplexor

Entry:
DL EPP printer port (0-2)

Exit:
AL Bit 0 1 = Channel locked
Bit 1 1 = Interrupt pending
BL Currently selected port

AH = 41h Query multiplexor device port

Entry:
DL EPP printer port (0-2)
BL The multiplexor device port (1-8)
0 = No multiplexor

Exit:
AL Status flags:
Bit 0 1 = Port selected
Bit 1 1 = Port locked
Bit 2 1 = Interrupts enabled
Bit 3 1 = Interrupt pending
CX EPP product/Device ID
0 = Undefined

AH = 42h Set product ID

Entry:
DL EPP printer port (0-2)
AL Mapped EPP Mux device port (1-8)
CX EPP Product ID

AH = 50h Rescan daisy chain

Entry:
DL EPP printer port (0-2)
BL The multiplexor device port (1-8)
0 = No multiplexor

AH = 51h Query daisy chain

Entry:
DL EPP printer port (0-2)
BL The multiplexor device port (1-8)
0 = No multiplexor

Exit:
AL Status flags:
Bit 0 1 = Channel locked
Bit 1 1 = Interrupt pending
BL Currently selected device
CL Depth of daisy chain on this port
0 = No daisy chain on this port
ES:DI Pointer to ASCII string, driver vendor ID

Interrupt 1Ah–Time of Day Services

The INT 1Ah software interrupt handles the time of day I/O services. A Carry flag set on exit may indicate the clock is not operating.

Interrupt 1Ah Time-of-Day Services

AH = 00h	**Read current time**
Exit:	
CX	High word of tick count
DX	Low word of tick count
AL	00h = Day rollover has not occurred (Timer count is less than 24 hours since last power on or reset)
AH = 01h	**Set current time (Clear rollover bit)**
Entry:	
CX	High word of tick count
DX	Low word of tick count
AH = 02h	**Read real time clock**
Exit:	
CH	BCD hours
CL	BCD minutes
DH	BCD seconds
DL	00 = Standard Time 01h = Daylight Savings
AH = 03h	**Set the real time clock**
Entry:	
CH	BCD hours
CL	BCD minutes
DH	BCD seconds
DL	01h = Daylight saving 00h = Otherwise
AH = 04h	**Read date from real time clock**
Exit:	
CH	BCD century
CL	BCD year
DH	BCD month
DL	BCD date
AH = 05h	**Set date in real time clock**
Entry:	
CH	BCD century
CL	BCD year
DH	BCD month
DL	BCD date

Continued

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AH = 06h	**Set real-time alarm**
Entry:	
CH	BCD hours to alarm
CL	BCD minutes to alarm
DH	BCD seconds to alarm
Exit:	
C	1 = Alarm already set
AH = 07h	**Reset real-time alarm**
Exit:	
AL	Value written to CMOS RAM register 0Bh

Interrupt 1Ah–General PCI Services

PhoenixBIOS 4.0 optionally supports General PCI Interrupt 1Ah Services. The following are the exit status codes:

PCI Services Exit Status Codes

AH	00h = Successful
	If Carry = 1:
AH	81h = Function not supported
	83h = Bad vendor ID
	86h = Device not found
	87h = Bad register number
	88h = Set failed
	89h = Buffer too small

The following are the PCI Services:

Interrupt 1Ah General PCI Services

AH = B1h	**PCI Services**
AL	**01h = PCI BIOS present**
Exit:	
EDX	"PCI", "P" in [DL], "C" in [DH], etc.
AL	Hardware mechanism:
	Bit Description
	5 Spec. Cycle–Config Mechanism #2 support
	4 Spec. Cycle–Config Mechanism #1 support
	1 Config Mechanism #2 support
	0 Config Mechanism #1 support
BH	Interface level major version
BL	Interface level minor version
CL	Number of last PCI bus

Continued

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AL 02h = Find PCI Device

Entry:
CX Device ID (0-65535)
DX Vendor ID (0-65534)
SI Index (0-n)
Exit:
BH Bus number (0-255)
BL Bits 7-3 Device number
Bits 2-0 Function number

AL 03h = Find PCI class code

Entry:
ECX Class code in lower three bytes
SI Index (0-n)
Exit:
BH Bus number (0-255)
BL Bits 7-3 Device number
Bits 2-0 Function number

AL 06h = Generate special cycle

Entry:
BH Bus number (0-255)
EDX Special cycle data

AL 08h = Read configuration byte

Entry:
BH Bus number (0-255)
BL Bits 7-3 Device number
Bits 2-0 Function number
DI Register number (0-255)
Exit:
CL Byte read

AL 09h = Read configuration word

Entry:
BH Bus number (0-255)
BL Bits 7-3 Device number
Bits 2-0 Function number
DI Register number (0, 2, 4,...254)
Exit:
CX Word read

AL 0Ah = Read configuration dword

Entry:
BH Bus number (0-255)
BL Bits 7-3 Device number
Bits 2-0 Function number
DI Register number (0, 4, 8,...252)
Exit:
ECX Dword read

Continued

Continued

AL 0Bh = Write configuration byte
Entry:
BH Bus number (0-255)
BL Bits 7-3 Device number
Bits 2-0 Function number
DI Register number (0-255)
CL Byte value to write

AL 0Ch = Write configuration word
Entry:
BH Bus number (0-255)
BL Bits 7-3 Device number
Bits 2-0 Function number
DI Register number (0, 2, 4,...254))
CX Word value to write

AL 0Dh = Write configuration dword
Entry:
BH Bus number (0-255)
BL Bits 7-3 Device number
Bits 2-0 Function number
DI Register number (0, 4, 8,...252)
ECX Dword value to write

AL 0Eh = Get PCI IRQ routing options
Entry:
DS Segment or Selector for BIOS data
ES Segment or Selector for Route Buffer parameter
DI 16-bit offset for Route Buffer parameter
EDI 32-bit offset for Route Buffer parameter
Exit:
BX Exclusive-PCI IRQ data map:
Bit 0 1 = IRQ0 PCI only
Bit 1 1 = IRQ1 PCI only
...
Bit 15 1 = IRQ15 PCI only

AL 0Fh = Set PCI hardware interrupt
Entry:
BH Bus number (0-255)
BL Bits 7-3 Device number
Bits 2-0 Function number
CL PCI interrupt pin (0Ah...0Dh)
CH IRQ number (0-15)
DS Segment or Selector for BIOS data

PnP Run-Time Services

Plug and Play automatically configures PC hardware and attached devices without requiring you to manually configure the device with jumpers or in Setup. You can install a new device such as sound or fax card ("plug it in") and start working ("begin playing").

To work properly, however, Plug-and-Play must be supported in the hardware and software, including the BIOS, the operating system (such as Microsoft Windows 95), and the hardware drivers.

Each Plug and Play device must have all of the following capabilities:

1. It must be uniquely identified
2. It must state the services it provides and the resources it requires
3. It must allow software to configure it.

Note: To register a new unique vendor ID or manufacturer ID for Plug and Play hardware, please send e-mail to pnpid@microsoft.com.

NOTE: There are a variety of Plug and Play technologies, including BIOS, ISA, SCSI, IDE, CD-ROM, LPT, COM, PCMCIA, and drivers. For complete instructions on using the PnP BIOS Services, consult the *Plug and Play BIOS Specification V. 1.0a.* You can download this specification and other PnP specifications from this Microsoft Web site:

http://www.microsoft.com/hwdev/specs/pnpspecs.htm

PhoenixBIOS 4.0 optionally supports PnP (Plug and Play) Runtime Services in Real and Protected Mode in with the following routines:

PnP Run-Time Services	
00h	Get Number of Device Nodes
01h	Get Device Node
02h	Set Device Node
03h	Get Event
04h	Send Message
05h	Get Docking Station Information
09h	Set Statically Allocated Resources
0Ah	Get Statically Allocated Resources
0Bh	Get APM 1.1 ID Table
40h	Get ISA Configuration Structure
41h	Get ESCD Information
42h	Read ESCD Data Image
43h	Write ESCD Data Image

The following are the exit status codes for the PnP Runtime Services

PnP Runtime Service Exit Status Codes

AH	00h = No error
	If Carry = 1:
AH	7Fh = Device not set statically
	81h = Unknown or invalid function
	82h = Function not supported
	83h = Handle for Device Node invalid or out of range
	84h = Bad resource descriptors
	85h = Set Device Node function failed
	86h = No events pending
	87h = System currently not docked
	88h = No ISA PnP cards installed
	89h = Cannot determine docking station capabilities
	8Ah = Undocking failed: no battery
	8Bh = Docking failed: conflict with primary boot device
	8Ch = Caller's memory buffer too small
	8Dh = Use ESCD support function instead
	8Eh = Send Message 04h function not supported
	8Fh = Hardware error

To find the PnP entry points, search for the **PnP BIOS Support Installation Check** structure by searching for the "$PnP" signature in system memory staring from F0000h to FFFFFh at every 16-byte boundary. Check the validity of the structure by adding the values of *Length* bytes, including the *Checksum* field, into a 8-bit value. Zero indicates a valid checksum.

The following describes the support structure:

PnP Support Installation Check

Offset	Size	Description
00h	4	ASCII "$PnP" signature
04h	1	Version (10h)
05h	1	Length (21h)
06h	2	Control field
08h	1	Checksum
09h	4	Event-notification flag address
0Dh	2	Real Mode 16-bit offset to entry point
0Fh	2	Real Mode 16-bit code segment address
11h	2	16-bit Protected Mode offset to entry point
13h	4	16-bit Protected Mode code segment base address
17h	4	OEM Device Identifier
1Bh	2	Real Mode 16-bit data segment address
1Dh	4	16-bit Protected Mode data segment base address

Call each service by loading the function parameters on the stack and FAR calling the appropriate entry point. The following are the Runtime Services of *Phoenix*BIOS 4.0, in 'C' syntax.

PnP Runtime-Service Function Parameters

00h Get Number of Device Nodes

```
Entry:
int FAR (*entryPoint)(Function, NumNodes, NodeSize,
BiosSelector);
int  Function;
unsigned char  FAR  *NumNodes;
unsigned int  FAR  *NodeSize;
unsigned int    BiosSelector;
```

01h Get System Device Node

```
Entry:
int FAR (*entryPoint)(Function, Node, devNodeBuffer,
Control, BiosSelector);
int  Function;
unsigned char        FAR  *Node;
struc DEV_NODE    FAR                    *devNodeBuffer;
unsigned int  Control;
unsigned int      BiosSelector;
```

02h Set System Device Node

```
Entry:
int FAR (*entryPoint)(Function, Node, devNodeBuffer,
Control, BiosSelector);
int  Function;
unsigned char  Node;
struc DEV_NODE  FAR                    *devNodeBuffer;
unsigned int      Control;
unsigned int      BiosSelector;
```

03h Get Event

```
Entry:
int FAR (*entryPoint)(Function, Message, BiosSelector);
int  Function;
unsigned int  FAR                      *Message;
unsigned int      BiosSelector;
```

04h Send Message

```
Entry:
int FAR (*entryPoint)(Function, Message, BiosSelector);
int  Function;
unsigned int  Message:
unsigned int  BiosSelector;
```

Continued

Continued

05h Get Docking Station Information

Entry:
int FAR (*entryPoint)(Function, DockingStationInfo,
BiosSelector);
int Function;
unsigned char FAR
*DockingStationInfo;
unsigned int BiosSelector;
Exit:
Docking station info buffer:

Offset 00h Docking station location identifier
Offset 04h Serial Number
Offset 08h Docking Capabilities:
Bits 2-1:
00 = Cold Docking
01 = Warm Docking
10 = Hot Docking
Bit 0:
0 = Surprise-style docking
1 = VCR-style docking

09h Set Statically Allocated Resources

Entry:
int FAR (*entryPoint)(Function, Resource Block,
BiosSelector);
int Function;
unsigned char FAR *ResourceBlock;
unsigned int BiosSelector;

0Ah Get Statically Allocated Resources

Entry:
int FAR (*entryPoint)(Function, Resource Block,
BiosSelector);
int Function;
unsigned char FAR *ResourceBlock;
unsigned int BiosSelector;

0Bh Get APM ID Table (For APM 1.1 only)

Entry:
int FAR (*entryPoint)(Function, BufSize, APMIdTAble
BiosSelector);
int Function;
unsigned int FAR *BufSize;
unsigned char FAR *APMIdTable;
unsigned int BiosSelector;
Exit:
APM ID table:

Length	**Description**
Dword	Device identifier
Word	APM 1.1 identifier

Continued

Continued

40h Get PnP ISA Configuration Structure

Entry:
int FAR (*entryPoint)(Function, Configuration, BiosSelector);
int Function;
unsigned char FAR *Configuration;
unsigned int BIOS Selector;
Exit:
PnP ISA Configuration structure:

Offset	Description
00h	Structure revision
01h	Number of Card Select Numbers assigned
02h	ISA Read Data port
04h	Reserved

41h Get Extended System Configuration Data (ESCD)

Entry:
int FAR (*entryPoint)(Function, MinESCDWriteSize, ESCDSize, NVStorageBase, BiosSelector);
int Function;
unsigned int FAR *MinESCDWriteSize;
unsigned int FAR *ESCDSize;
unsigned long FAR *NVStorageBase;
unsigned int BiosSelector;

42h Read Extended System Configuration Data

Entry:
int FAR (*entryPoint)(Function, ESCDBuffer, ESCDSelector, BiosSelector);
int Function;
char FAR *ESCDBuffer;
unsigned int ESCDSelector;
unsigned int BiosSelector;

43h Write Extended System Configuration Data (ESCD)

Entry:
int FAR (*entryPoint)(Function, ESCDBuffer, ESCDSelector, BiosSelector);
int Function;
char FAR *ESCDBuffer;
unsigned int ESCDSelector;
unsigned int BiosSelector;

DMI BIOS 2.0 Services

The **Desktop Management Interface** (DMI) is a new method for the management of PCs in an enterprise. Using DMI, a Manager of Information Systems can access up-to-date information about the hardware and software installed on every computer on a network. The BIOS component of DMI supplies information about the devices on the motherboard.

NOTE: For complete instructions on using these services, see the **Desktop Management BIOS Specification Ver. 2.0**, available at the Phoenix Web site: http://www.ptltd.com/desktop/specs.html

For descriptions of the DMI architecture, see the Web site of the **Desktop Management Task Force** at: http://www.dmtf.org

The DMI BIOS 2.0 Services are functions 50h and 51h of the PnP Run Time Services. See "PnP Run-Time Services" above for a description of how to find the PnP entry points to these DMI 2.0 Services. The following are the DMI services supported in PhoenixBIOS 4.0:

DMI BIOS 2.0 Services	
50h	Get DMI Information
51h	Get DMI Structure

The following are the exit status codes for the DMI 2.0 Services:

DMI BIOS 2.0 Services Exit Status Codes	
AH	00h = No error
	If Carry = 1:
AH	81h = Unknown or invalid function
	82h = Function not supported
	83h = DMI Structure number/handle invalid or out of range
	84h = The function detected invalid parameter
	85h = The SubFunction parameter supplied on a DMI Control function is not supported by the system BIOS

Call each service by loading the function parameters on the stack and FAR calling the appropriate entry point. The following are the DMI 2.0 Services in 'C' syntax.

DMI 2.0 Function Parameters

50h Get DMI Information

```
Entry:
short FAR (*entryPoint)(Function, dmiBIOSRevision,
NumStructures, StructureSize, dmiStorageBase,
dmiStorageSize, BiosSelector);
short Function;
unsigned char FAR *dmiBIOSRevision;
unsigned short FAR *NumStructures;
unsigned short FAR *StructureSize;
unsigned long FAR *dmiStorageBase;
unsigned short FAR *dmiStorageSize;
unsigned short BiosSelector;
```

51h Get DMI Structure

```
Entry:
short FAR (*entryPoint)(Function, Structure, dmiStrucBuffer,
dmiSelector, BiosSelector);
short Function;
unsigned short FAR *Structure;
unsigned char FAR *dmiStrucBuffer;
unsigned short dmiSelector;
unsigned short BiosSelector;
```

MultiBoot II Run-Time Services

An OS or application program can access the features of PhoenixBIOS MultiBoot II during run-time by using the following MultiBoot II Run-Time Services. You can use these services to query the number and type of Initial Program Load (IPL) devices in the system or display an IPL device menu for specifying the boot priority on the next system restart.

MultiBoot II Run-Time Services are extensions to the Plug and Play run-time functions that implement the *BIOS Boot Specification Ver. 1.01*. You can access this specification in Acrobat format from the Phoenix Web site at:

http://www.phoenix.com/desktop/bbs101.pdf

PnP functions 60h through 6Fh are reserved for the BIOS Boot Specification. See Appendix C of the *Plug and Play BIOS Specification* mentioned above for the details of the calling conventions. These functions are available in Real Mode and 16-bit Protected Mode.

MultiBoot II Run-Time Services

60h Get Version and Installation Check

```
Entry:
short FAR (* entryPoint) (Function, Version, BiosSelector);
short Function;
unsigned short FAR *Version;
unsigned short BiosSelector;
```

61h Get Device Count

```
Entry:
short FAR (* entryPoint) (Function, Switch, Count,
MaxCount, StructSize, BiosSelector);
short Function;
short Switch;
unsigned short FAR *Count;
unsigned short FAR *MaxCount;
unsigned short FAR *StructSize;
unsigned short BiosSelector;
```

62h Get Priority and Table

```
Entry:
short FAR (* entryPoint) (Function, Switch, Priority, Table,
 BiosSelector);
short Function;
short Switch;
unsigned char FAR *Priority;
unsigned char FAR *Table;
unsigned short BiosSelector;
```

63h Set Priority

```
Entry:
short FAR (* entryPoint) (Function, Switch, Priority,
BiosSelector);
short Function;
short Switch;
unsigned byte FAR *Priority;
unsigned short BiosSelector;
```

64h Get IPL Device from Last Boot

```
Entry:
short FAR (* entryPoint) (Function, IPLEntry, BiosSelector);
short Function;
unsigned short FAR *IPLEntry;
unsigned short BiosSelector;
```

BIOS Data Area

The BIOS keeps information about the current operating environment of the AT system in the BIOS Data Area. The normal way to access this information is by means of the BIOS Services, described above. The BIOS Data Area is located from physical address 400h to 501h.

BIOS Data Area Description

Offset	Size	Description
00	2	Com1 address
02	2	Com2 address
04	2	Com3 address
06	2	Com4 address
08	2	Lpt1 address
0A	2	Lpt2 address
0C	2	Lpt3 address
0E	2	LPT4/EBDA address*
10	2	Equipment installed:
	Bit	**Definition**
	0	Not used
	1	Math coprocessor installed
	2	PS/2 mouse installed
	3	Not used
	4,5	Initial video mode:
		00 = EGA/VGA
		01 = 40x25 CGA
		10 = 80x25 CGA
		11 = Monochrome
	6,7	Diskette drives:
		00 = 1 drive
		01 = 2 drives
		10 = 3 drives
		11 = 4 drives

Continued

BIOS Data Area, Continued

8 Not used
9-11 Number of serial adapters
12 Game Adapter installed
13 Not used
14,15 Number of parallel adapters

Offset	Size	Description
12	1	Interrupt flag (POST)
13	2	Memory size (K bytes)
15	1	Reserved
16	1	Control flag

Keyboard Data Area

Offset	Size	Description
17	1	Keyboard flag 0:

Bit.... Definition
0 ..... Right shift key pressed
1 ..... Left shift key pressed
2 ..... Control key pressed
3 ..... Alt key pressed
4 ..... Scroll lock on
5 ..... Num lock on
6 ..... Caps lock on
7 ..... Insert mode on

18	1	Keyboard flag 1:

Bit.... Definition
3 ..... Freeze state
4 ..... Scroll lock pressed
5 ..... Num lock pressed
6 ..... Caps lock pressed
7 ..... Insert mode pressed

19	1	Keypad input byte
1A	2	Key buffer head
1C	2	Key buffer tail
1E	20	Key buffer

Diskette Data Area

3E	1	Seek/recalibrate status
3F	1	Drive motor status
40	1	Motor on time
41	1	Diskette status:

Bit Definition
7 ..... 1 = Drive not ready
6 ..... 1 = Seek error occurred
5 ..... 1 = Diskette controller failed
4-0 ... Error codes:
... 01h = Illegal function request
... 02h = Address mark not found
... 03h = Write protected error
... 04h = Sector not found
... 06h = Diskette change line active
... 08h = DMA overrun on operation
... 09h = Data-boundary error (64k)
... 0Ch = Media type not found
... 10h = Uncorrectable ECC or CRC error
... 20h = General controller failure
... 40h = Seek operation failed
... 80h = Device did not respond

42	7	Controller status

Continued

BIOS Data Area, Continued

Video Data Area

Offset	Size	Description
49	1	Video mode
4A	2	Video columns
4C	2	Video length
4E	2	Video start
50	10	Cursor locations
60	2	Cursor size
62	1	Active page
63	2	6845 address
65	1	Mode register value
66	1	Video palette

Extended Work Area

67	4	ROM check address
6B	1	CPU rate control

Timer Data Area

6C	2	Timer count low word
6E	2	Timer count high word
70	1	Timer overflow byte

System Data Area

71	1	Break pressed flag
72	2	Soft reset flag

Fixed Disk Data Area

74	1	Fdisk status
75	1	Number of fixed disks
76	1	Fixed disk control
77	1	Reserved

Serial and Parallel Timeout Counters

78	4	Lpt1-4 time-out values
7C	4	Com1-4 time-out values

Extended Keyboard Data Area

80	2	Key buffer start
82	2	Key buffer end

EGA/VGA Data Area

84	1	Number of video rows
85	2	Bytes per character
87	1	EGA Status A
88	1	EGA Status B
89	1	VGA Status A
8A	1	Display Combination Code index

Extended Diskette Area

8B	1	Last diskette data rate

Extended Fixed Disk Area

8C	1	FDisk status
8D	1	FDisk error value
8E	1	FDisk interrupt flag

Continued

BIOS Data Area, Continued

Additional Extended Diskette Area

Offset	Size	Description
8F	1	Floppy info nibbles
90	4	Floppy state information
94	2	Floppy cylinder number

Additional Extended Keyboard Data Area

96	1	Keyboard control
97	1	Keyboard flag 2:

Bit.... Definition
0 ..... Scroll LED on
1 ..... Num lock LED on
2 ..... Caps lock LED on
4 ..... Ack code received
5 ..... Resend received
6 ..... LED being updated
7 ..... Keyboard error

Real Time Clock Area

Offset	Size	Description
98	4	RTC user flag
9C	2	RTC time low word
9E	2	RTC time high word
A0	1	RTC wait flag

Network Data Area

A1	7	Network work area

Extended EGA/VGA Data Area

A8	4	EGA/VGA environment pointer

Miscellaneous

AC-FF		Reserved
100	1	Print screen flag

* If the BIOS supports the Extended BIOS Data Area, it uses the LPT4 address in the BIOS data area (Offset 0E) for the Extended BIOS Data Area segment.

Extended BIOS Data Area

The Extended BIOS Data Area (EBDA), located in the top 1k of system RAM, contains information about the pointing device (PS/2 mouse).

INT 15h AH = C1h returns the segment starting address of this table.

Extended BIOS Data Area

Offset	Size	Description
00h	1	Size of EBDA in kbytes
01h	33	Reserved
21h	4	Pointer to device routine
25h	1	First byte of pointer information: Bit.... Definition 4 ..... Pointer error 5 ..... Pointer acknowledge 6 ..... Resend request 7 ..... Command in progress
26h	1	Second byte of pointer information Bit.... Definition 6 ..... Enable pointer device 7 ..... Pointer external device
27h	2	Pointer data package

Interrupt Vectors

The following table describes the AT system interrupt vectors. Status indicates whether the BIOS supports the interrupt.

INT	Description	Status
00	Divide by zero	Not Supported
01	Single step	Not Supported
02	Non-Maskable interrupt	Supported
03	Breakpoint	Not Supported
04	Overflow	Not Supported
05	Print Screen Interrupt	Supported
06	286 LoadAll Handler	Supported
07	Reserved	Not Supported
08	IRQ0 - System Timer Interrupt	Supported
09	IRQ1 - Keyboard Interrupt	Supported
0A	IRQ2 - Reserved	Not Supported
0B	IRQ3 - COM2: Interrupt	Supported
0C	IRQ4 - COM1: Interrupt	Supported
0D	IRQ5 - LPT2: Interrupt	Supported
0E	IRQ6 - Floppy Disk Interrupt	Supported
0F	IRQ7 - LPT1: Interrupt	Supported
10	BIOS Video Interface	Supported
11	BIOS Equipment Check	Supported
12	BIOS Memory Request	Supported
13	BIOS Fixed Disk/Diskette Interface	Supported
14	BIOS Serial Interface	Supported
15	BIOS System Functions Interface	Supported
16	BIOS Keyboard Interface	Supported
17	BIOS Parallel Printer Interface	Supported
18	BIOS Secondary Boot Request	Supported
19	BIOS Primary Boot Request	Supported
1A	BIOS System Timer Interface	Supported
1B	BIOS Control Break Interrupt	Supported
1C	BIOS User System Timer Interrupt	Supported
1D	BIOS Video Init Parameters	Supported
1E	BIOS Diskette Parameters	Supported
1F	BIOS Video Graphic Characters	Supported
40	BIOS Diskette (when fixed disk present)	Supported
41	BIOS Fixed disk 0 parameters	Supported
46	BIOS Fixed disk 1 parameters	Supported
70	IRQ8 - Real time clock interrupt	Supported
71	IRQ9 - IRQ2 redirection	Supported
72	IRQ10 - Reserved	Not Supported
73	IRQ11 - Reserved	Not Supported
74	IRQ12 - Available/PS/2 Mouse	Supported
75	IRQ13 - Math coprocessor	Supported
76	IRQ14 - Primary IDE HDD	Supported
77	IRQ15 - Available/Secondary IDE HDD	Supported

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