

## Practical 05

### Understanding BIOS and POST operation

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#### Objectives

- Getting familiar with Basic Input Output System (BIOS) and its functions.
- Understanding the Power On Self Test (POST) operation and its role.
- Getting familiar with different options provided in BIOS interface.

#### Tools

- PC with working BIOS.

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**Keywords:** BIOS, POST, Booting, Shadowing, MBR, ROM, Cold Boot, Warm Boot.

**Duration:** 03 hours

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## 5 Introduction

### 5.1 Basic Input Output System (BIOS)

When you flick, push, or pull on the power to your PC, there are absolutely no instructions in memory for the PC to execute. In fact, when the PC is first powered on, it is almost like it is being turned on for the very first time ever. Although it is easy to think of the computer as having a brain and the ability to manage itself, the truth is that it is merely an electrical appliance and must be told what to do at all times. This is especially true at startup when the power is switched on. The importance of the PC's BIOS (Basic Input/output System) is that it performs all of the functions the PC needs to get started. The BIOS contains that first instruction the computer needs to get started, programming that checks that computer's hardware is attached and ready, and other routines to help the computer get up and running. Another of the activities of the BIOS is that it provides the interface that connects the CPU to the input and output devices attached to the PC. The BIOS relieves the PC from needing to know about how hardware devices are attached to the computer. As new hardware is added to the computer, the BIOS eliminates the need for every piece of software in the computer to be updated as to where the hardware and its drivers are located. Only the BIOS configuration data needs to be updated when new equipment is added to the PC, a process usually managed by the BIOS itself without outside intervention required. As illustrated in Figure 6-1, the BIOS services the needs of the CPU, the hardware devices, and the software on the computer. In this section we are going to see how we can open the system unit and unplug all the cables and internal components. First take a system unit box.

BIOS is the very first program that starts when the computer is turned on. Basic Input/Output System, the BIOS, ROM BIOS, or System BIOS is a chip located on all motherboards that contain instructions and setup for how your system should boot and how it operates.

The BIOS includes instructions on how to load basic computer hardware and includes a test referred to as a POST (Power On Self Test) that helps verify the computer meets requirements to boot up properly. If the computer does not pass the POST, you will receive a combination of beeps indicating what is malfunctioning within the computer.

The fundamental job of BIOS is to:

- Test the computer hardware components
  - Is all required hardware present?
  - Is all hardware working fine?
- Load the operating system or other programs

## 5.2 BIOS Manufacturers

The most well-known BIOS manufacturers are Award, AMI (American Megatrends, Inc.), and Phoenix. Like most BIOS manufacturers, these three license their BIOS ROM to motherboard manufacturers who install them on their motherboards and assume the support of the BIOS as well. AMI was once the sole BIOS provider to Intel, the leading motherboard producer. Today, over 80 percent of all motherboards are Intel boards that include a Phoenix BIOS. In 1998, Phoenix purchased Award and now markets the Award BIOS brand under the Phoenix name.



## 5.3 Booting the computer

The process used to start up a PC each time it is powered on is called the boot process. While it sounds like it could refer to kick-starting, this term is actually derived from the saying, “Pulling one’s self up by one’s own bootstraps,” which is a long-winded way of saying you are a self-starter. PCs are self-starters in the respect that when you flick on the power switch, the PC verifies its hardware configuration, runs a few function tests, and then gets its operating system loaded into memory and running on the CPU. It’s almost like magic...well, not quite.

The boot process is performed under the guidance of the BIOS. The BIOS contains the instructions needed to verify, test, and start the PC—in other words, boot the computer. When the computer boots up, the BIOS is behind the scenes causing and managing the actions that are taking place. The PC’s hardware cannot perform independent actions. It must have instructions to do anything at all. These instructions are in the form of the PC’s software, which are blocks of instructions that guide the hardware to perform specific activities.

### 5.3.1 Cold Boots versus Warm Boots

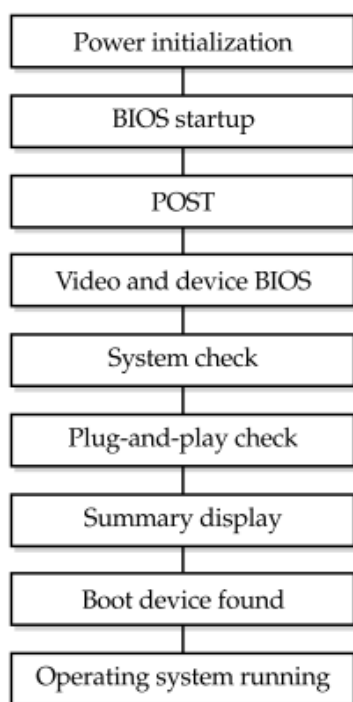
The boot sequence used when a PC is powered on from a powered off condition is called a cold boot. A cold boot is done when the computer is started from a cold (or completely powered off) status. A warm boot happens when the PC is already powered on. Pressing the key combination CTRL-ALT-DEL or pressing the reset button. A cold boot causes the complete boot and POST sequence to run. However, the POST process does not run after a warm boot.



- The Cold Boot is referred to as Hard Boot.
- The Warm Boot is also referred to as Soft Boot.

### 5.3.2 System Boot Sequence

The most important action of the BIOS is to boot the PC. The process used to do this is actually a fairly complex sequence of steps that verifies the configuration, checks the hardware, and loads the software. The actual steps included in a particular BIOS' boot sequence can vary by manufacturer, but the following are typical of the steps normally performed during the system boot sequence:



1. When you turn on the PC's power switch, the internal power supply initializes itself. The power supply does not provide power to the rest of the PC immediately. As soon as the power supply is able to supply reliable power to the motherboard, it transmits a "good power" signal to the motherboard's chipset, which sends a system reset command to the processor. At this point, from all outward appearances, the PC looks as if it is still powered off.

2. The system reset command sent by the motherboard's chipset causes the CPU to read its first instruction from what is called the jump address. The jump address is always located in a fixed preset location, typically address FFFF0h in system memory. The jump address contains the physical address of the BIOS' boot program on the ROM BIOS chip.
3. The CPU executes the first instruction, which copies the BIOS programs into system memory and starts the BIOS running.
4. The BIOS next performs the POST (Power-On Self-Test) process. The POST verifies and tests the hardware configuration stored in the BIOS configuration information. Should the POST detect any problems, it sounds beep codes, one or more beeps through the system speaker to indicate the nature of the problem, or displays an error message, and the boot process stops.
5. If the POST finds no problems, the boot process continues. At this point, the system BIOS (the one booting the PC) looks for the video adapter's BIOS and starts it. Virtually all peripheral devices on the PC have their own BIOS. This is the first time, aside from the noises of the disk drives and a single beep indicating all is well, that you will know the PC is booting. Information about the video card is displayed on the monitor's screen.
6. The display of the video adapter's information is followed by information about the system BIOS itself. This usually includes information on the manufacturer and version of the BIOS program.
7. Any device BIOS routines are started. The video card's BIOS starts first to turn on the display, then information about the system BIOS and the other BIOSs is displayed as they are started.
8. Next, the BIOS begins a series of tests on the system, including the amount of memory detected on the system. This test is usually displayed on the screen as a run-up counter showing the amount of memory detected and tested. Because the BIOS now has use of the monitor, it displays error messages for any problems detected instead of the beep codes that it had to use prior to the display being available.
9. With the device BIOSs loaded, the system BIOS checks if the devices listed in the CMOS configuration data are present and functioning, including their speeds, access modes, and other parameters. In this sequence, the serial and parallel ports are assigned their identities (COM1, COM2, LPT1, etc.). As each device is passed, a message is displayed that it was found, configured, and tested.
10. If the BIOS supports Plug and Play (PnP) technology, any PnP devices detected are configured. Information on each PnP device is displayed on the screen, although it typically goes by much too fast to read.
11. At the end of the test and configuration sequence, the BIOS should display a summary data screen that details the PC as the BIOS sees it and indicating that the system is verified and ready for use. Only one thing is missing...
12. To start the operating system running, the BIOS must first find it. Included in the CMOS data is a parameter that indicates the disk drives (floppy, hard, or CD-ROM) and the order in which they

should be accessed to find the operating system. In most cases, the boot sequence parameters will be set to look for the operating system on first the floppy disk drive, then the hard disk drive, and perhaps, if all else fails, the CD-ROM drive. This sequence can be changed to reflect the sequence desired. If the first boot device is the hard disk, the BIOS looks for the master boot record (MBR) to use to start the operating system. If the boot disk is a floppy disk, the BIOS looks at the first sector of the disk for the OS boot program. If the boot program is not found on the first device listed, then the next device is searched and so on until the boot program is found. If no boot device is found, the boot sequence stops and an error message ("No boot device available") is displayed.

The PC should now be up and running and ready for use. Next time you boot up a PC, watch this sequence more closely to see if you recognize the actions taking place.

## 5.4 The POST Process

Immediately after the BIOS programs are loaded to memory, the POST (Power-On Self-Test) starts. The POST performs a check of the system components and hardware listed in the system setup(CMOS) data are present and tests to see that they are functioning properly. The POST process is done before the BIOS begins its startup procedures. The POST process is fast and is typically unnoticed provided there are no problems. If the POST finds problems, it signals with beep codes (beeps emitted through the system speaker) indicating the source of the problem. At the time the POST runs, it has no other means of signaling problems because none of the hardware I/O functions have been loaded. The display and printer are not available, so the system speaker, which is technically a part of the motherboard, is the only means the POST has of signaling what is going wrong.

Depending on the cause of the error, the POST routine uses an established beep pattern to signal the type of problem encountered. The beep codes are similar to a POST Morse code. The pattern and meaning of the combinations of short and long beeps is unique to the BIOS' manufacturer. However, nearly all POST problems are fatal errors because the POST is testing only essential system components.

If the test fails the post operation will issue some error notifications. POST errors can be of two types:

1. Beep Codes
2. Messages displayed on monitor

### 5.4.1 BIOS Beep Codes

Not all beep codes mean something bad. Nearly all BIOS programs will sound a single beep code to indicate that all is well and then continue the boot process. However, if the boot process does not continue, the single beep has a different meaning or there were additional codes you didn't hear. You may need to cold boot the PC at least once to hear all of the beeps. Often the beep codes catch you by surprise the first time they are sounded. Once you are sure you have heard all of the beeps, the next step is to figure out what they mean. Each BIOS producer has its own collection of POST error beep codes, but the four primary beep code sets are IBM standard, AMI, Award, and Phoenix. As is illustrated in Table 6.1 through Table 6.4, there is no standard beep code set. Each set of beep codes

has a different sound pattern to indicate different problems. The different beep code sets involve short beeps, long beeps, and a varying number of beeps in a three- or four-beep series. Actually, the codes listed in Table 6.1 are only possible examples of Award BIOS' beep codes. Award relies on motherboard manufacturers to generate the beep codes used with its BIOS. So, if you have an Award BIOS on your PC, you'll need to check with its manufacturer or the manufacturer of its motherboard to get a list of the beep codes in use.

Beeps	Meaning
No beep	Power supply failure
Repeating short beeps	Power supply or system board failure
1 short	POST is complete
2 short	POST error
1 long, 1 short	System board error
1 long, 2 short	Video display adapter failure
1 long, 3 short	Video display adapter error
3 long	Keyboard error

Table 6.1: A Sample of the Standard IBM Beep Code Set

Beeps	Meaning
1 short	POST is complete
2 short	Memory failure
3 short	Memory/parity failure
4 short	System timer failure
5 short	Motherboard failure
6 short	Keyboard controller failure
7 short	CPU failure
8 short	Video adapter failure
9 short	ROM BIOS checksum error
10 short	CMOS read/write error
11 short	Cache memory error
1 long, 3 short	Memory failure
1 long, 8 short	Video adapter failure

Table 6.2: A Sample of the AMI BIOS Beep Code Set

The Phoenix BIOS POST error beep codes, listed in Table 6.4, are more complicated than most other beep code sets. When an error is detected, the first set of beeps is sounded followed by a slight pause before the next set of beeps, and so on. For example, the beep code pattern that indicates that the BIOS itself may be corrupt is 1-1-4. This would sound something like beep, pause, beep, pause, beep, beep, beep, beep.

Beep Codes	Meaning
1 long	Memory error
1 long, 2 short	Video error
1 long, 3 short	Video failure
Continuous beeps	Memory or video failure

Table 6.3: A Sample of the Award BIOS' Beep Code Set

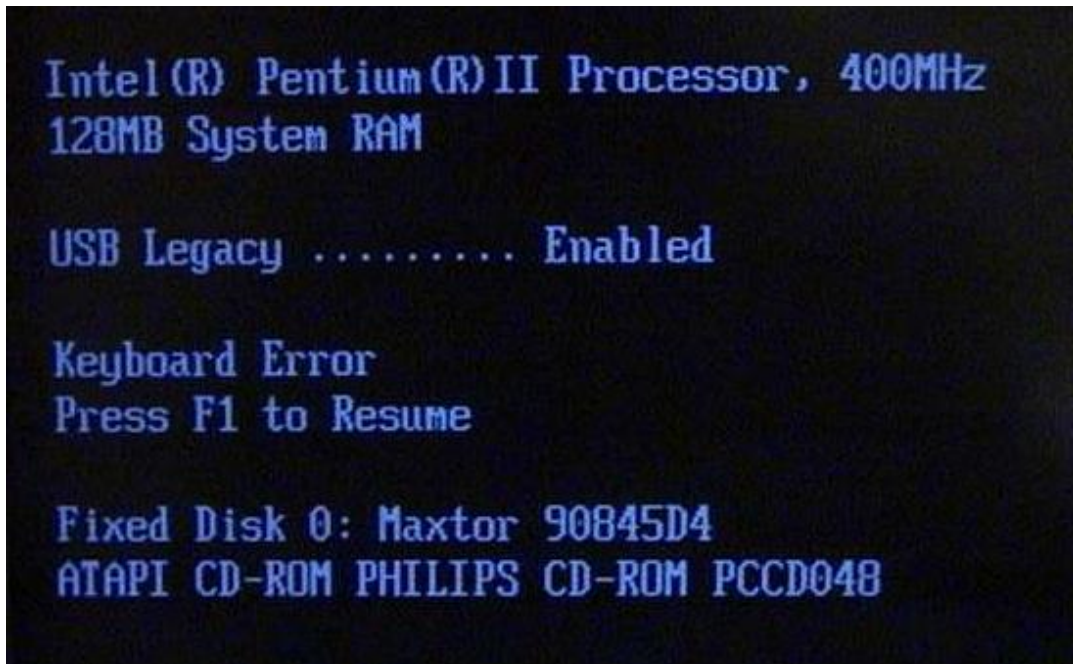
Beep Codes	Meaning
1-1-3	CMOS memory error
1-1-4	BIOS failed
1-2-1	System timer error
1-2-2	Motherboard error
1-2-3	Motherboard error
1-3-1	Motherboard error
1-4-1	Motherboard error
1-4-2	Memory error
2- _	Memory failure (2 beeps, followed by any beep combinations)
3-1- _	Chipset error (3 beeps, followed by 1 beep, followed by any beep combination)
3-2-4	Keyboard controller error
3-3-4	Video adapter failure
4-2-4	Expansion card failure
4-3-4	Time of day clock failure
4-4-1	Serial port error
4-4-2	Parallel port error
4-4-3	Math coprocessor error

Table 6.4: Phoenix BIOS Beep Codes



### 5.4.2 POST Error Messages

When an error occurs at POST operation, the BIOS can also display the error summary at the monitor screen known as POST error messages. Few of examples of POST error messages are shown below:







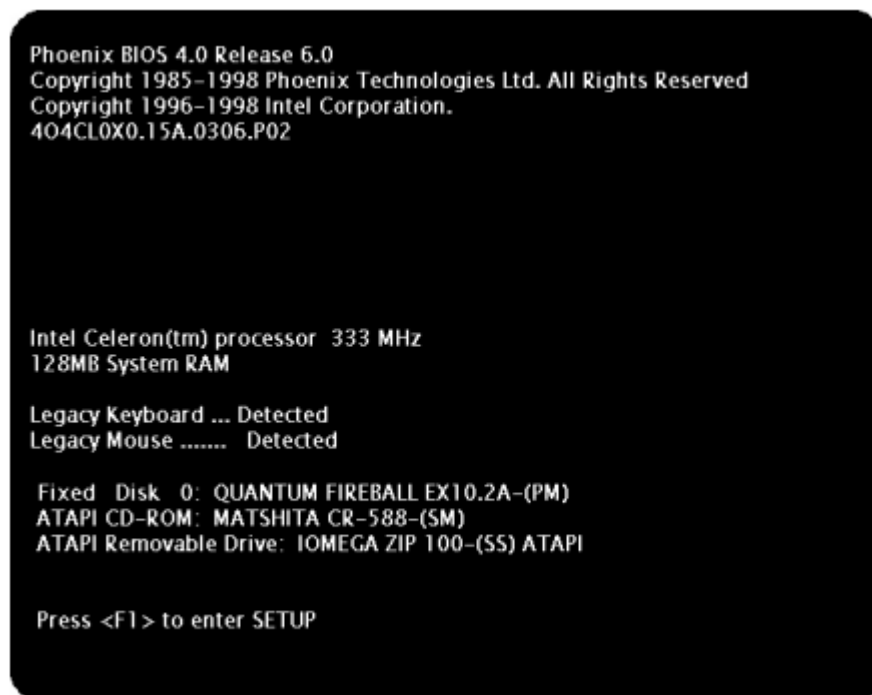
## 5.5 BIOS Startup Screen

If the POST completes successfully, the BIOS loads the video adapter's BIOS, which makes the PC display available. The BIOS then displays its startup screen. This display, which varies slightly from one manufacturer to the next, generally contains the following information:

- The name, and possibly the logo, of the manufacturer or supplier of the BIOS, the serial and version numbers of the BIOS, and its release or version date, which is the key indicator of the feature set included in the BIOS version.
- The BIOS' serial number, which indicates the motherboard, chipset, and BIOS version combination the BIOS was designed to support. The serial number is the key to upgrading the BIOS. The BIOS manufacturer should have information on its Web site to help you find the configuration associated with a particular serial number. For example, AMI (American Megatrends, Inc.) has downloadable utility software that you can use to decode the serial number of its BIOS versions. For more information on BIOS version and serial numbers, visit [www.ping.be/bios/](http://www.ping.be/bios/).
- The keyboard key that is pressed to gain access to the BIOS' setup program. The DELETE (DEL) key or a function (F1 or F2) key are the most commonly used, but a key combination such as CTRL-ESC is also used in some cases.
- The Energy Star logo. Nearly all PCs purchased today display this logo that indicates that the PC and its BIOS support the Green or Energy Star standard, which specifies power management and consumption guidelines. On older PCs, only those with an upgraded BIOS display this logo.

## 5.6 System Configuration Summary

To indicate that it has completed its task and is about to load the operating system and turn control of the PC over to it, the BIOS displays a summary of the PC's configuration.



Like all other BIOS displays, the information included depends on the manufacturer and version of the BIOS. The following lists what is typically included:

- **Processor:** The microprocessor, such as Pentium, Pentium II, K6, Athlon, etc., in the PC. The newer BIOS versions recognize all Intel, Cyrix, and AMD processors, but some older versions will sometimes indicate a 5x86 processor from one of the other manufacturers as a Pentium. This is a display problem and shouldn't affect the performance of the system. Those processors that incorporate the SMM (System Management Mode) power management standard may be listed as a Pentium-S processor.
- **Coprocessor:** Virtually every microprocessor since the 386DX (with the exception of SX models of the 386 and 486 processors) has had an FPU (floating point unit) integrated into the processor chip. The BIOS should indicate these as Integrated. However, if a separate math coprocessor or FPU chip is installed on the system, the coprocessor is indicated as Installed.
- **Clock speed:** The clock speed of the processor is its MHz (megahertz) rating, which indicates how many cycles per second the processor runs. This information is sometimes displayed with the processor type.
- **Floppy disk drives:** If one or more floppy drives is detected on the system, its size (3.5" or 5.25") and capacity (in kilobytes or megabytes) are displayed.
- **Hard disk and CD-ROM drives:** The following information is displayed for each IDE/ATA disk drive or ATAPI CD-ROM drive detected: whether it is the primary or secondary master or slave, the name of the manufacturer, the drive's capacity, and the access mode of the drive. The drive designation (C:, D:, E:, etc.) assigned to the drive by the BIOS is also displayed.
- **Memory size:** System memory is divided into base, extended, and cache. The BIOS displays the amount of memory allocated to each type. Base memory (a.k.a. conventional memory) is always 640KB. Extended memory represents the remaining amount of memory on the system. The amount of cache memory is displayed as a separate number.
- **Memory type:** This information regards the physical components making up the system memory and should not be confused with base, extended, or cache types of memory. The information displayed includes the number and technology of the memory banks or modules installed on the system. For example, the display may indicate "EDO DRAM at Bank 1" or "FP: 0 was detected."
- **Video type:** If your computer is relatively new (not more than 10 years old), the BIOS will display your video type as VGA/EGA. However, if your PC has a CGA (Color Graphics Adapter) or MGA (Monochrome Graphics Adapter) card in it, the display should reflect that.
- **Serial ports:** Each serial port detected on the PC is assigned certain system resources, including IRQ (interrupt request) and I/O (Input/Output) port addresses (see Chapter 13 for more information on system resources). The display shows the resources assigned to each serial port by the BIOS.
- **Parallel ports:** The system resources assigned to parallel ports by the BIOS is displayed.
- **Plug and Play devices:** If any Plug and Play (PnP) adapter cards are detected by the BIOS, their information is displayed.

### 5.6.1 What happens when you turn on the computer?

#### **Turn On PC**

- When you press the power on button the power supply unit (PSU) will receive the power.
- The PSU will first of all provide power to Motherboard Chipset.
- The motherboard chipset will then send reset command to CPU.
- The CPU receives reset command.
- Then CPU will reset itself by executing the very first instruction in the memory.
- The very first instruction is always placed at some fixed location usually 0FFFFH.
- 0FFFFH is known as Jump (JMP) address.
- It is actually the address of system BIOS.
- So the CPU will execute the BIOS.
- Then the BIOS will search for any Video Adapter.
- After finding the video adapter, BIOS will execute the Video Adapter BIOS.
- Then check is made whether the computer has been Cold Booted or Warm Booted.
- If there is a Cold Boot, BIOS will perform POST operation.
- If there is a Warm Boot, BIOS will skip POST operation.

#### **POST Operation**

- The POST operation is a test which can either fail or succeed.
- POST performs two checks:
  - Is all the required hardware is present?
  - Is all the hardware working properly?
- It checks for the presence of following devices:
  - Video Adapter (AGP Card)
  - RAM
  - CPU
- It checks all the devices which are attached are working properly or not?
  - Video Adapter
  - RAM
  - CPU
  - Keyboard
  - Mouse
  - LAN Card
  - Sound Card
  - Other devices
- If any of the required device is absent the test will fail.
- If any of the attached device is not working properly the test will fail.
- If all the required hardware is present and all the attached hardware is working fine, the test will succeed.

#### **POST Errors**

- If the test fails the post operation will issue some error notifications.
- POST errors can be of two types:

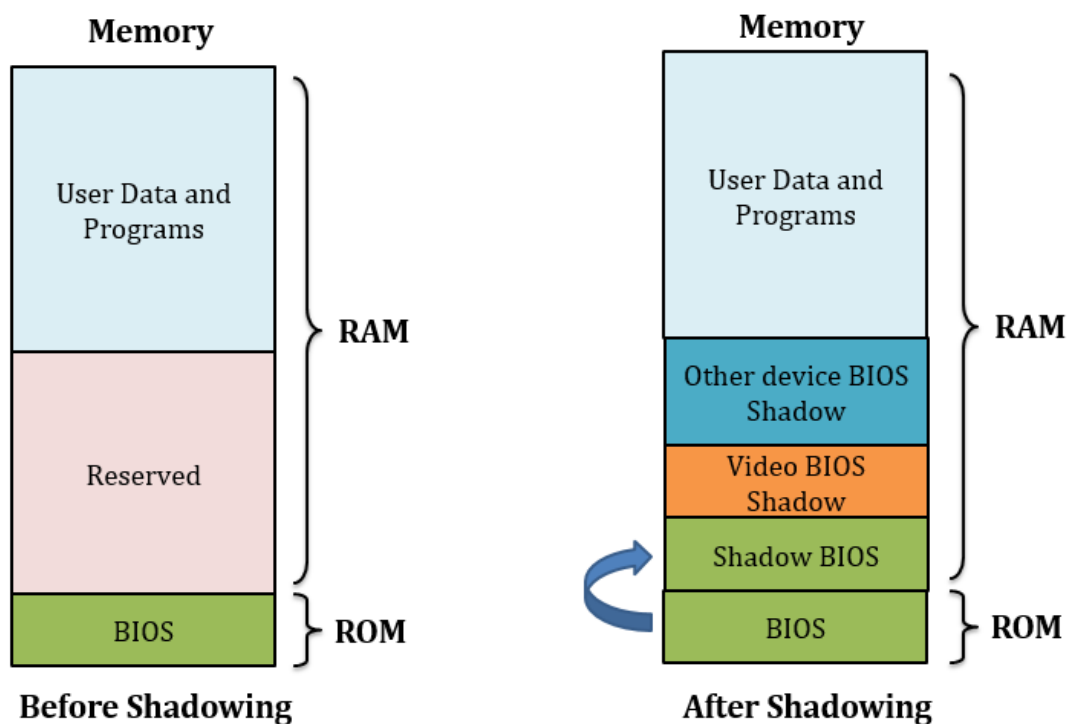
- Messages displayed on monitor
- Beep Codes

### **Post Error Diagnosis**

- Once you have identified the Beep Code problem then you need to resolve that issue and restart the computer.
- Remove or replace any damaged or faulty hardware.
- Plug in the missing hardware component.

### **BIOS Shadowing**

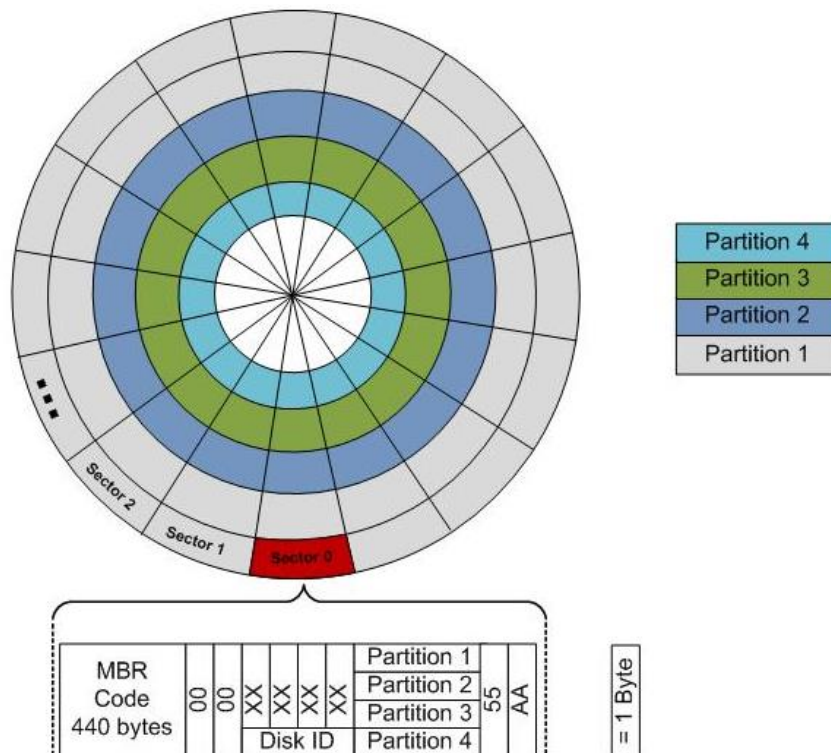
- After successful POST operation, the BIOS will perform BIOS Shadowing.
- As we know ROM is slower than RAM (RAM is three times faster than ROM)
- Hence in order to access the BIOS quickly, the contents of ROM (BIOS) are copied to the RAM.
- Process of copying the BIOS from ROM to RAM is called BIOS shadowing.
- Copied BIOS is called Shadow RAM or Shadow BIOS.
- Not only system ROM contains BIOS but almost every device has its own ROM and BIOS. Like the Video Card, Keyboard, LAN Card etc. has their own ROM and BIOS. BIOS of every device is copied in to RAM.



### **Search for MBR**

- After BIOS shadowing the BIOS will search for bootable program.
- For that it will locate bootable program at MBR (Master Boot Record).

- Every disk is divide in to tracks and sectors.
- Sector 0 track 0 is called MBR.



- First the BIOS will search for bootable program at MBR of floppy drive.
- If not found then it will search it on Hard Disk.
- If not found then it will search it in CD/DVD.
- Else it will search it on other bootable drives.
- If the bootable program is not found on any of the device the BIOS will display the message that "No Bootable device found".
- Then you have to install the bootable program and restart.
- If the Bootable program is found on any of the bootable device then the BIOS will load it in RAM.
- In case if Operating System is found at MBR then it will load the Kernel of the operating system.

### Operating System Kernel

- The central module of an operating system. It is the part of the operating system that loads first, and it remains in main memory.
- Because it stays in memory, it is important for the kernel to be as small as possible while still providing all the essential services required by other parts of the operating system and applications.
- Typically, the kernel is responsible for memory management, process and task management, and disk management.
- Once the kernel is loaded in to the memory (RAM) the operating system starts.



## 5.7 How to enter the BIOS or CMOS setup

Because of the wide variety of computer and BIOS manufacturers over the evolution of computers, there are numerous ways to enter the BIOS or CMOS Setup. Below is a listing of most of these methods, as well as other recommendations for entering the BIOS setup.

### 5.7.1 New computers

Computers manufactured in the last few years allow you to enter the BIOS setup using one of the five keys shown below during the boot process. Typically, it is one of the first three keys.

- F1
- F2
- DEL
- ESC
- F10

F10 is also used for the boot menu. If F10 opens a boot menu, your setup key is likely F2.

Setup keys are to be pressed as the computer is booting up. Most users will see a message similar to the example below upon startup. Some older computers may also display a flashing block to indicate when to press the F1 or F2 keys.

*Press <F2> to enter BIOS setup*

Once you have successfully entered the CMOS setup.

### 5.7.2 Older computers

Unlike the computers of today, older computers (before 1995) had numerous methods of entering the BIOS setup. Below is a listing of key sequences to press as the computer is booting to enter setup.

- CTRL + ALT + ESC
- CTRL + ALT + INS
- CTRL + ALT + ENTER
- CTRL + ALT + S
- PAGE UP KEY
- PAGE DOWN KEY

#### 5.7.2.1 ACER BIOS

If your computer cannot boot or you want to restore the BIOS back to its bootable settings and your computer uses an ACER BIOS, press and hold the F10 key as you turn on the computer. While continuing to hold the F10 key, you should hear two beeps indicating that the settings are restored.

### **5.7.2.2 AMI BIOS**

Older AMI BIOS could be restored back to bootable settings by pressing and holding the Insert key as the computer is booting.

### **5.7.2.3 Early IBM computers**

Some early IBM computers require you to press and hold both mouse buttons as the computer boots to enter the BIOS setup.

### **5.7.2.4 Other suggestions**

Finally, if none of the above suggestions help get you into your CMOS setup, you can cause a stuck key error, which causes the CMOS setup prompt to appear and remain until you press a key to continue. To do this, press and hold any key on the keyboard and do not let go (you may get several beeps as you are doing this). Keep pressing the key until the computer stops booting and you have the option to enter setup.

## EXERCISE

1. Launch BIOS configuration program in your PC and specify how you done it?
2. Look in to your system BIOS and name its manufacturer, version number and its manufacturing date.
3. Change the system Date and Time from the BIOS configuration program.
4. Create and remove a password for BIOS configuration program in to your PC.
5. For your PC specify the followings:
  - a. Number of CPUs
  - b. Clock speed of CPUs
  - c. Number of RAM modules attached
  - d. RAM size
  - e. Number of HDD attached
  - f. HDD space
  - g. Number of FDD attached
  - h. Number of CD/DVD ROMs attached
  - i. Current Boot Order
6. Change the boot order of your system to have CD/DVD drive as first bootable device and HDD as second.