



Chapter 3 Advanced Computer Hardware

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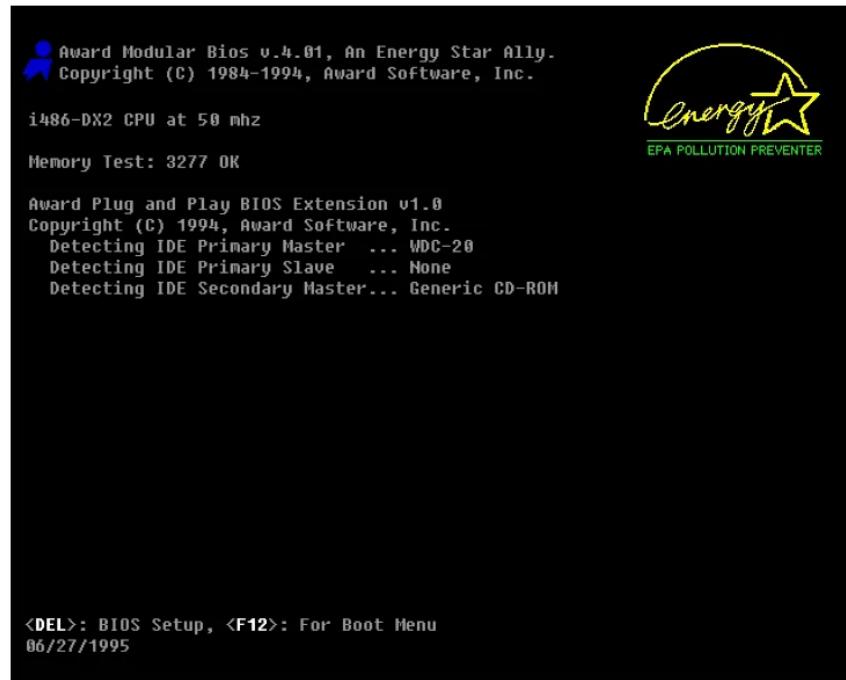
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Boot the Computer

POST

When a computer is booted, the basic input/output system (BIOS) performs a hardware check on the main components of the computer. This check is called a **power-on self-test (POST)**.

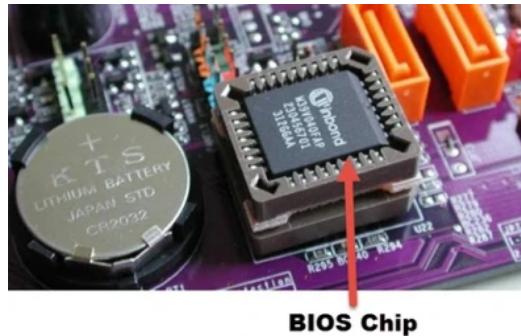
If a device is malfunctioning, an error or a beep code alerts the technician of the problem.



POST

BIOS and CMOS

All motherboards need BIOS to operate. BIOS is a ROM chip on the motherboard that contains a small program. This program controls the communication between the operating system and the hardware.



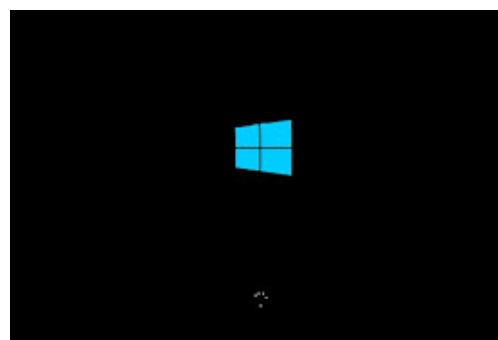
Along with the POST, BIOS also identifies:

- which drives are available
- which drives are bootable
- how the memory is configured and when it can be used
- how PCIe and PCI expansion slots are configured

- how SATA and USB ports are configured
- motherboard power management features

POST checking :

- Check all hardware components (quick check: RAM, CPU, adapter cards)
- If all checks are ok, one BEEP (the speaker on the motherboard) and initialized all checking (restart/reset all devices)
- Begin searching for bootstrap - loading files (The BIOS chip looks for it)
 - Win: 开机画面



- Linux: grub file
- After locating bootstrap - loading files is found, the system will go to command line and wait for further command.

The motherboard manufacturer saves the motherboard BIOS settings in a Complementary Metal Oxide Semiconductor (CMOS) memory chip.

CMOS setting: BIOS stores in CMOS (battery independent)

BIOS is a program and CMOS is configuration setting.

通过BIOS的program对CMOS里的参数进行设置

- UEFI is replacing BIOS

The BIOS settings are retained by CMOS using a battery, If the battery fails, important settings can be lost.

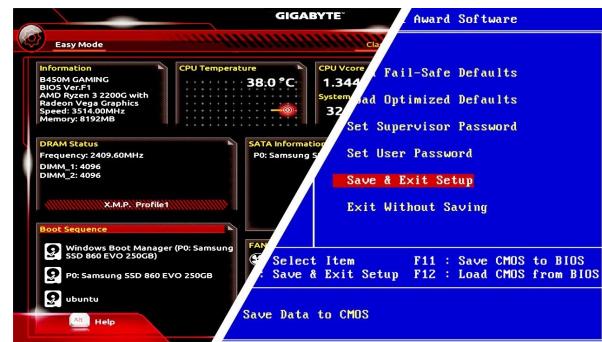
UEFI

Unified Extensible Firmware Interface (UEFI)

provides additional features and addresses

security issues with legacy BIOS.

UEFI can run on 32-bit and 64-bit systems, supports larger boot drives and includes additional features such as secure boot.



BIOS and UEFI security

- Passwords
 - Supervisor password can access all user-access passwords and all BIOS screens and settings
 - User password gives access to the BIOS based on a defined level
- Drive encryption
- LoJack is a security feature that consists of two programs
 - Persistence module is embedded in the BIOS
 - Application agent is installed by user.
- LoJack functions
 - Locate the device using Wi-Fi or IP geolocation to see the last location
 - Lock the device remotely to prevent access to your personal information
 - Display a customized message on the screen
 - Delete all files on the device to protect personal information and prevent identity theft.
- Trusted platform model (TPM) is a chip designed to secure hardware by storing encryption keys, digital certificates, passwords, and data.
- Secure boot is a UEFI security standard that ensures that a computer only boots an OS that is trusted by the motherboard manufacturer.

Update the firmware

Updating the firmware is risky. Before updating motherboard firmware, **record the manufacturer of the BIOS and the motherboard model**. Use this information to identify the exact files to download from the motherboard manufacturer's site.

Electrical Power

Wattage and Voltage

Ohm's law

$$\text{Voltage}(V) = \text{Current } (I) \times \text{Resistance}(R)$$

$$\text{Power}(P) = \text{Voltage}(V) \times \text{Current}(I)$$

Power supply voltage setting

Voltage selector switch sets the input voltage to the power supply to either 110V/115V or 220V/230V.

A power supply with this switch is called a **dual voltage power supply**.

Power fluctuation and protection

Types of power fluctuation

- Blackout: complete loss of AC power.
- Brownout: reduced voltage level of AC power that lasts for a period of time.
- Noise: interference from generators and lightning.
- Spike: sudden increase in voltage that lasts for a short period and exceeds 100% of the normal voltage on a line.
- Power surge: dramatic increase in voltage above the normal flow of electrical current.

Advanced Computer Functionality

CPU architectures and operation

Types of instruction sets:

- Reduced instruction set computer (RISC): uses a relatively small set of instructions. RISC chips are designed to execute these instructions very **rapidly**.
 - Simpler instruction
 - Less data types
- Complex instruction set computer (CISC): uses a broad set of instructions, resulting in **fewer steps per operations** but at the cost of increase in number of cycles per instruction.

- Complex instruction
- Instructions are larger than one-word size
- More data types
- Instruction may take more than a single clock cycle to get executed

Enhancing CPU operation

The power of a CPU is measured by the speed and the amount of data that it can process. The speed of a CPU is rated in cycles per second. The amount of data that a CPU can process at one time depends on the size of the front side bus (FSB). Current processors use a 32-bit or 64-bit FSB.

Overclocking is a technique used to make a processor work at a faster speed than its original specification. The opposite of overclocking is CPU throttling which is a technique used when the processor runs at less than the rated speed to conserve power or produce less heat.

CPU virtualization is a hardware feature supported by AMD and Intel CPUs that enables a single processor to act as multiple processors.

Multicore processors

- Single core CPU
- Dual core CPU
- Triple core CPU
- Quad core CPU: 4 cores
- Hexa-core CPU: 6 cores
- Octa-core CPU: 8 cores

GPU in a CPU is dependent on system RAM - **integrated 集成显卡**

GPU in a CPU is independent on system RAM and is a separate chip with its own video memory dedicated exclusively for graphical processing - **dedicated 独立显卡**

Advanced computer functionality

CPU cooling mechanisms

- Case Fan: active cooling solution
- CPU Heatsink: passive cooling
- CPU Fan: active cooling

- Graphics card cooling system
- Water cooling system

RAID

Redundant array of independent disks (RAID) technology provides a way to store data across multiple storage devices for availability, reliability, capacity, and redundancy and/or performance improvement.

- **Striping:** enables data to be distributed across multiple drives. **The failure of a single drive means that all data is lost.**
- **Mirroring:** stores duplicate data on one or more other drives. **The failure of a drive does not cause the loss of data.**
- **Parity:** provides basic error checking and fault tolerance by storing checksums separately from data. **This enables the reconstruction of lost data without sacrificing speed and capacity.**
- **Double parity:** **provides fault tolerance up to two failed drives.**

RAID levels

RAID level	Minimum number of drives	Features	Advantages	Disadvantages
0	2	Striping	Performance and capacity	All data is lost if one drive fails
1	2	Mirroring	Performance and reliability	Capacity is half of total drive size
5	3	Striping with parity	Performance, reliability, and capacity	It takes time to rebuild array if a drive fails
6	3	Striping with double parity	Same as RAID 5 but can tolerate the loss of two drives	It takes time to rebuild array if one or more drives fail.
10 (0 + 1)	4	Mirroring and Striping	Performance, Capacity, and High Reliability	Capacity is half of total drive size

Ports, Connectors, and Cables

Legacy ports

- Serial ports were used to connect various peripherals.
 - 9-pin DB-9 port
 - 25-pin port



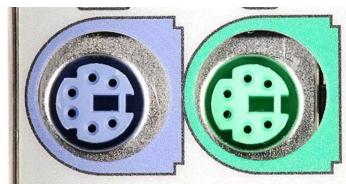
- Parallel ports have a 25-pin receptacle used to connect various peripheral devices



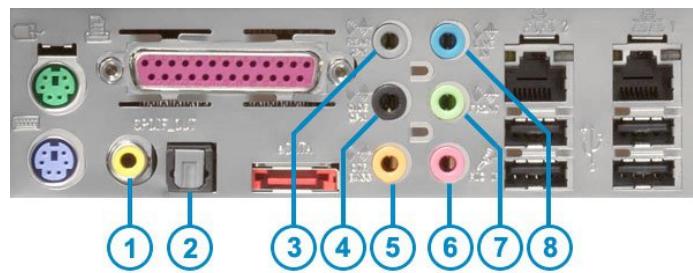
- Game is the 15-pin port was used as a connector for joystick input.



- PS/2 is a 6-pin din connector used for connecting a keyboard and mouse.



- Audio ports connect audio devices to the computer.



- 1.** (RCA style) Coaxial S/PDIF **5.** Center/Bass Channel
2. (Toslink style) Fiber-optic S/PDIF **6.** Microphone
3. Rear Channel **7.** Audio Out
4. Side (Left/Right) Channels **8.** Line In

Video and graphic ports

- VGA is an analog port and is the oldest graphics port. It accept a 15-pin connector.



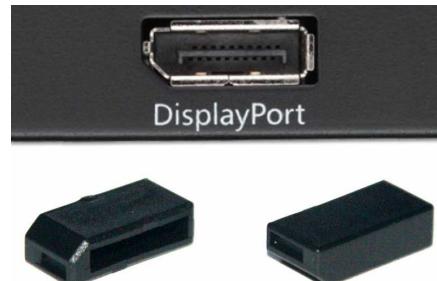
- DVI
 - DVI-A (analog)
 - DVI-D (digital)



- HDMI uses a 19-pin connector



- DisplayPort is a newer technology designed to replace both DVI and VGA for connecting computer monitors



USB cables and connectors

- USB Type-A
- Mini-USB
- Micro-USB
- USB Type-B
- USB Type-C
- Lightning



SATA cables and connectors

- SATA Cable



- SATA Data



- eSATA Cable



- eSATA Adapter Card



Twisted pair cables and connectors

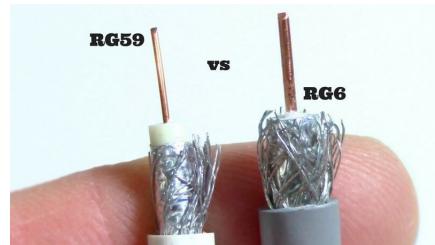
- RJ-45 Connector
- Twisted pairs
 - Unshielded twisted pair (UTP)
 - Shielded twisted pair (STP)
- RJ-11 Connector is smaller than RJ-45



RJ45 RJ11

Coax cables and connectors

- Coax cable construction
- RG-6 is heavy gauge and has insulation and shielding tuned for high-bandwidth, high-frequency application.
- RG-59 is thinner than RG-6 and has less shielding. It is recommended in low bandwidth and lower frequency applications.



- BNC connects coaxial cables to devices using a quarter-turn connection scheme.



SCSI cables and connectors

Small computer systems interface (SCSI) is a standard for connecting peripheral and storage devices.

Integrated drive electronics (IDE) is a standard type of interface used to connect some hard drives and optical drives to each other and to the motherboard.

- External SCSI cable: 36-pin and
- Internal SCSI
- IDE cable: 40-pin

50-pin



50-pin SCSI cable

cable: 50-pin



Monitors

- Screen size
- Resolution
- Monitor resolution
- Native resolution
- Native mode
- Connectivity

Technical monitor terms

Monitors	Resolution	Ratio
CGA	320 * 200	16:10
VGA	640 * 480	4:3
SVGA	800 * 600	4:3
HD	1280 * 720	16:9
FHD	1920 * 1080	16:9
QHD	2560 * 1440	16:9
UHD	3840 * 2160	16:9

Computer Configuration

Upgrade computer hardware

Motherboard upgrade

If you upgrade or replace a motherboard, consider that you might have to replace other components.

1. Record how the power supply, case fans, case LEDs, and case buttons attach to the old motherboard
2. Disconnect the cables from the old motherboard
3. Disconnect the expansion cards from the case. Remove each expansion card and place them in antistatic bags, or an antistatic mat
4. Carefully record how the old motherboard is secured to the case. Pay attention to screws and standoffs that are non-metallic, because these may be insulators. Replacing insulating screws and supports with metal hardware that conducts electricity might damage electrical components
5. Remove the old motherboard from the case
6. Examine the new motherboard and identify where all of the components are such as power, SATA, fan, USB, audio, front panel connectors, and others.
7. Examine the I/O shield located at the back of the computer case. Replace the old I/O shield with the I/O shield that comes with the new motherboard
8. Insert and secure the motherboard into the case
9. Connect the power supply, case fans, case LEDs, front panel, and any other required cables
10. After the new motherboard is in place and the cables are connected, install and secure the expansion cards

CPU upgrade

You must apply thermal compound between the new CPU and the heat sink and fan assembly.

1. Align the fan so that it faces the correct direction to either draw air in or blow air out
2. Mount the fan using the predrilled holes in the case
3. Connect the fan to the power supply or the motherboard, depending on the case fan plug type

Storage device upgrade

1. Place the hard drive in an empty drive bay, and tighten the screws to secure the hard drive
2. Connect the drive to the motherboard using the correct cable
3. Attach the power cable to the drive

Configuration for specialized computers

CAx workstation

A computer-aided design (CAD) or computer-aided manufacturing (CAM) workstation is used to design products and control the manufacturing process.

- Video card: high-end
- RAM: maximum
- Storage: SSD

Audio and Video editing workstation

- Video card: specialized
- Audio card: specialized
- Storage: large and fast
- Monitor: multiple

Virtualization workstation

Virtual desktop infrastructure (VDI) allows users to log in to a server to access virtual computers.

- Processor: multi-core
- RAM: maximum

Gaming PC

- Video card: high-end
- Audio card: specialized
- Storage: SSD
- Cooling: high-end

Thick and Thin clients

- **Think clients:** standard computers; the computers have their own operating systems, a multitude of applications, and local storage.
- **Thin clients:** low-end network computers that rely on remote servers to **perform all data processing**. It requires a network connection to a server and usually access resources using a web browser.

	Think Clients	Thin Clients
Resources required	Monitor, mouse, keyboard, tower (with CPU and RAM), internal storage	Monitor, mouse, keyboard, small computer
Footprint	Large	Small

	Think Clients	Thin Clients
Network access	Optional	Required
Data processing performed	Locally on computer	Remotely on servers
Effort to deploy corporately	More	Less
Cost to deploy corporately	More	Less
Applications	Locally installed desktop applications	Not locally installed. Interfaces with applications that run on a server
Hardware requirements	Recommended requirements or better for installing Windows and any software applications	Only minimum requirements for installing Windows

NAS

Network attached storage (NAS) devices are servers that are connect to a network to provide file-level data storage to clients. This specialized computer is single-purposed, running a stripped-down operating system to perform only the function of file serving.

The NAS will offer high-speed networking through the use of a gigabit network interface card (NIC).

Protecting the Environment

Safe disposal methods

Batteries

Batteries contain rare earth metals that can be harmful to the environment. All batteries are subject to disposal procedures that comply with local environment regulations.

Monitors

Handle CRT monitors with care. Extremely high voltage can be stored in CRT monitors, even after being disconnected from a power supply.

Monitors must be disposed of in compliance with environmental regulations because monitors can contain approximately 4 pounds of lead.

Safety Data Sheets

A safety data sheets (SDS), aka Material safety and data sheets (MSDS), is a fact sheet that summarizes information about material identification, including hazardous ingredients that can affect personal health, and first-aid requirements.

Safety Data Sheets (HCS 2012/GHS Format)

On May 26, 2012, OSHA published the final rule of the revised Hazard Communication Standard (HCS) under the Occupational Safety and Health Act (OSHA). The revised standard will be fully implemented by December 1, 2013. The revised standard replaces the previous HCS.

One of many changes in the HCS is the creation of a hazard communication section to include a section on how to read a safety data sheet. This section is intended to help employers and employees quickly identify key information found on a safety data sheet. The revised standard also includes a new hazard communication section that requires employers to provide training to employees on how to read and understand a safety data sheet.

Related Requirements:

- Employers must have an SDS in the workplace for each hazard category.
- SDS must be readily available to employees during work hours.
- SDS must be in English.
- SDS must be in a certain form that includes hazard statements, PICT symbols, hazard and associated information.

Cooperation Notice:

- OSHA and GHS 2012 standards both rely on one safe data sheet.
- The "Montgomery" acronym (for hazard communication) is used to denote the revised standard. They are included to show what a fully GHS-compliant document is, relative to the GHS-relevant area.

Information source: OSHA 2012

HOW TO READ A SAFETY DATA SHEET

OSHA Brief

The revised Hazard Communication Standard (HCS) (29 CFR 1910.1200) (referred to as the "revised standard"), which became effective on December 1, 2013, replaced the previous standard. The revised standard is intended to help employers and employees quickly identify key information found on a safety data sheet (SDS).

The SDS includes information such as the properties of each chemical, its physical and chemical properties, hazard information, recommendations for handling and storing the chemical, and emergency contact information. This information is intended to help those involved in the manufacture, distribution, use, or disposal of the chemical to make informed decisions about the safe handling and use of the chemical.

The SDS must also contain Sections 1 through 15, as is consistent with the UN Globally Harmonized System of Classification and Labelling of Chemicals (GHS), and OSHA will accept SDSs that conform to either the revised standard or the GHS.

This section provides recommendations for reading a safety data sheet.

Section 1: Identification

Identifies the product and provides key information for identifying the substance or mixture, including the manufacturer or distributor's name, address, phone number, and emergency telephone number.

Section 2: Hazard(s) Identification

Provides hazard classification information, including hazard pictograms, hazard statements, and hazard categories.

Section 3: Composition/Information on Ingredients

Identifies the chemical ingredients and their concentrations, along with information on any impurities (e.g., stabilizers, solvents, diluents, preservatives).

Section 4: First-Aid Measures

This section describes the initial care that should be given if someone is exposed to the chemical. It includes information on symptoms, first aid measures, and medical treatment.

Section 5: Fire-Fighting Measures

This section provides recommendations for fighting fires involving the chemical, including information on fire hazards, extinguishing media, and special hazards.

Section 6: Accidental Release Measures

This section provides recommendations for handling spills or releases of the chemical, including information on personal protection, containment procedures, and cleanup methods.

Section 7: Handling and Storage

This section provides recommendations for handling and storing the chemical, including information on personal protection, handling procedures, storage conditions, and compatibility.

Section 8: Exposure Controls/Personal Protection

This section provides exposure limits, engineering controls, and personal protective equipment (PPE) required to protect workers from exposure to the chemical.

Section 9: Physical and Chemical Properties

This section identifies the physical and chemical properties of the chemical, including its appearance, density, pH, melting point, boiling point, flash point, and reactivity.

Section 10: Stability and Reactivity

This section identifies the stability of the chemical and any conditions to avoid, as well as information on its reactivity with other chemicals.

Section 11: Toxicological Information

This section provides information on health effects resulting from exposure to the chemical, including information on acute and chronic effects, and any numerical values used to describe the effects.

Section 12: Ecological Information

This section provides information on the environmental impact of the chemical, including its potential to harm aquatic life, birds, and other organisms.

Section 13: Disposal Considerations

This section provides guidance on proper disposal practices and information on the environmental impact of disposal.

Section 14: Transport Information

This section provides guidance on classification information for shipping, including hazard class, packing group, and shipping names.

Section 15: Regulatory Information

This section identifies the safety, health, and environmental regulations applicable to the chemical.

Section 16: Other Information

This section indicates when the SDS was prepared or last revised, and provides a reference to the original document.

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