How Motherboards Work

by Gary Brown

The **motherboard** has been an integral part of most personal computers for more than 20 years. Think of a motherboard as a scale model of a futuristic city with many modular plug-in buildings, each using power from a common electrical system. Multiple-lane highways of various widths transport data between the buildings. The motherboard is the data and power infrastructure for the entire computer.

Motherboards (also called **mainboards**) are actually a carryover from architecture used for years in mainframe computers. Various circuit cards performing various functions all plug into many similar sockets on a common circuit board. Each circuit card performs a unique function in the computer and gets its power from the socket.

Due to improvements in circuitry and packaging, motherboards have essentially stayed the same size or shrunk while their functionality has skyrocketed. In this edition of **HowStuffWorks**, you will learn how the motherboard operates and what its many sockets and connectors do.

Background

The original IBM PC contained the original PC motherboard. In this design, which premiered in 1982, the motherboard itself was a large printed circuit card that contained the 8088 microprocessor, the BIOS, sockets for the CPU's RAM and a collection of **slots** that auxiliary cards could plug into. If you wanted to add a floppy disk drive or a parallel port or a joystick, you bought a separate card and plugged it into one of the slots. This approach was pioneered in the mass market by the Apple II machine. By making it easy to add cards, Apple and IBM accomplished two huge things:

- They made it easy to add new features to the machine over time.
- They opened the computer to creative opportunities for third-party vendors.

Different motherboards of different vintages typically have different **form factors**. The form factor is essentially the size, shape and design of the actual motherboard. There are more than a half-dozen form factors for motherboards -- check out PC Guide's Motherboard Form Factors to find out about the various designations.

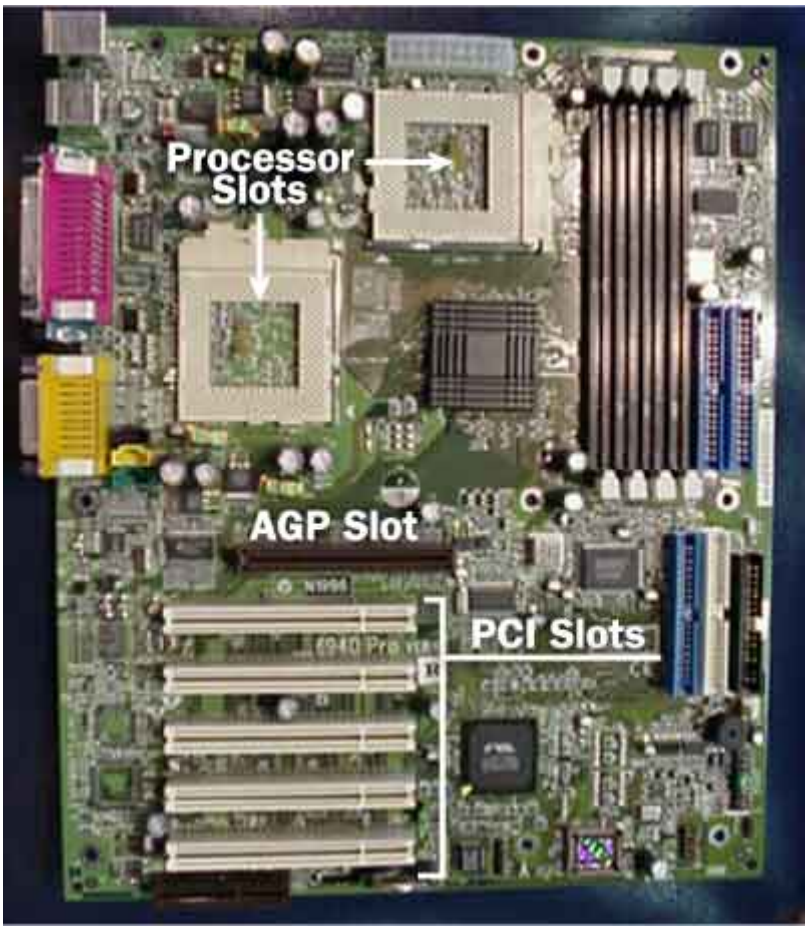
The motherboard, by enabling pluggable components, allows users to personalize a computer system depending on their applications and needs.

On the Motherboard

A motherboard is a multi-layered **printed circuit board**. Copper circuit paths called **traces** that resemble a complicated roadmap carry signals and voltages across the motherboard. Layered fabrication techniques are used so that some layers of a board can carry data for the BIOS, processor and memory buses while other layers carry voltage and ground returns without the paths short-circuiting at intersections. The insulated layers are manufactured into one complete, complex sandwich. Chips and sockets are soldered onto the motherboard.

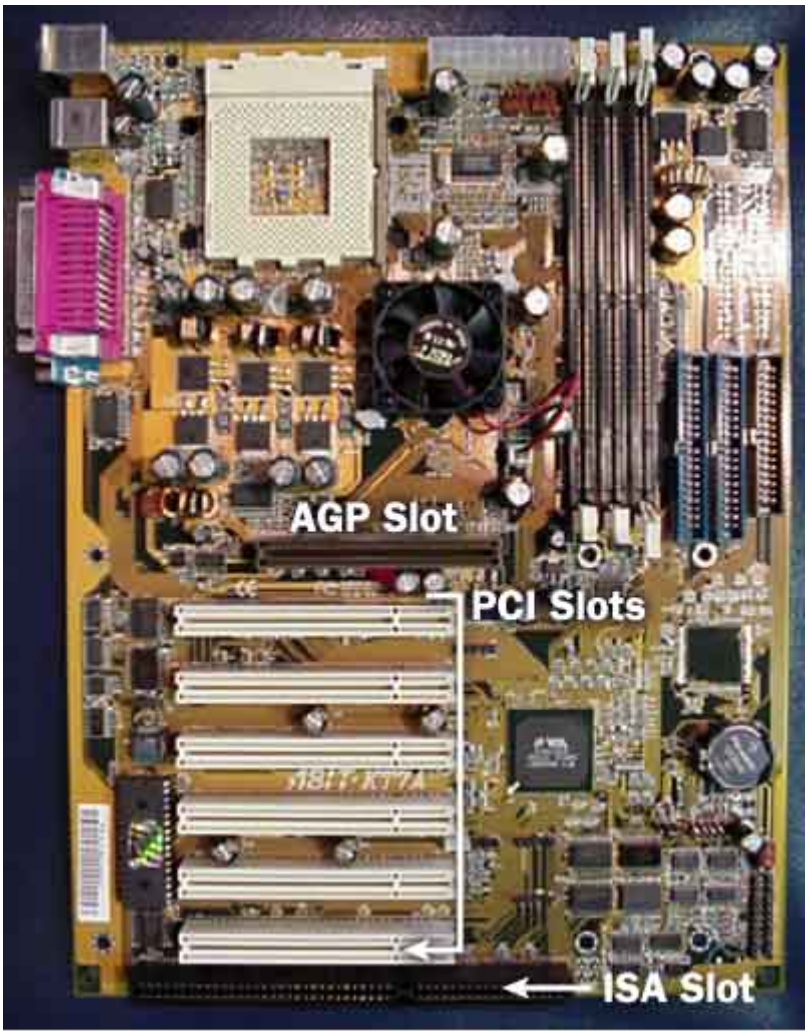
Examples

The MSI 694D Pro AR supports dual Pentium microprocessors, has five PCI slots and a communications network riser (CNR) slot. The board supports 133 MHz bus speeds and ultra-direct memory access-100 (UDMA). There are four USB ports and onboard audio in the ATX form factor board.



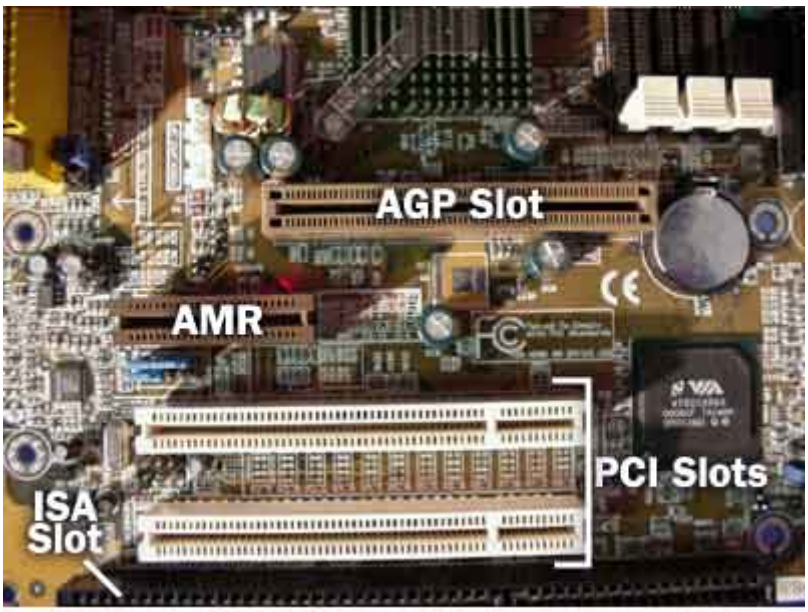
MSI 694D Pro AR Dual Flip Chip Socket 370 motherboard

The Abit KT-7A supports Advanced Micro Devices (AMD) processors and has the KT-133A chipset. The card slots on the Abit KT-7A, from bottom to top in the image below, shows that ISA has one slot, PCI has six slots and AGP has one slot. A special fan cools the chipset.



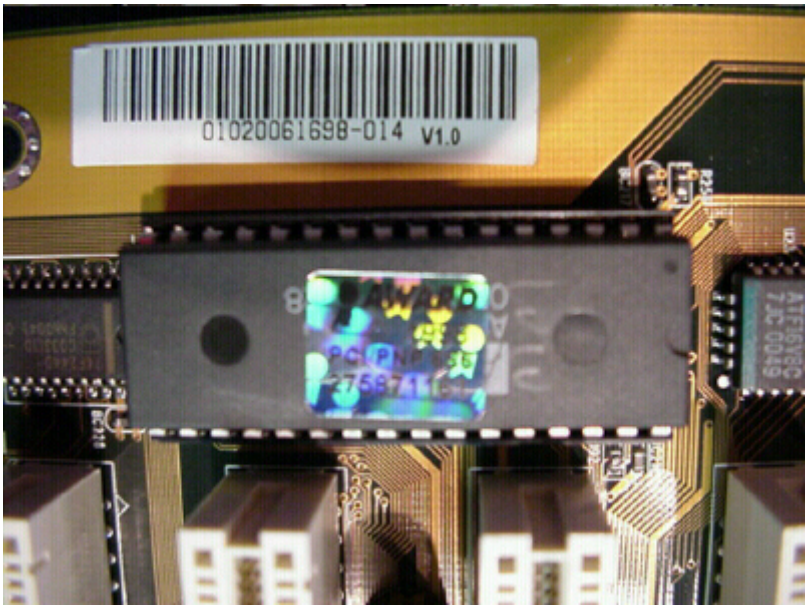
Abit KT-7A AMD Processor Motherboard

A partial view of the TechRam S3ProM motherboard shows slots: From bottom to top, ISA has one slot, PCI has two slots, audio modem riser (AMR) has one slot, and AGP has one slot.



TechRam S3ProM Motherboard

The BIOS chip is common to many motherboards.



BIOS Chip

Data Bus Width

Modern Pentium class motherboards have a data bus with 64 bits. That is the width of the data highway that goes in and out of the processor. The Pentium processors, however, do use 32-bit registers to handle 32-bit instructions.

Bus speeds and widths have increased due to faster processors and the needs of multimedia applications. Typical bus names and widths are:

- Industry Standard Architecture (ISA) - 8 or 16 bits
- Extended Industry Standard Architecture (EISA) - 8 or16 bits
- Microchannel Architecture (MCA) - 16 or 32 bits
- VESA Local Bus (VLB) - 32 bits
- Peripheral Component Interconnect (PCI) - 32 or 64 bits
- Accelerated Graphics Port (AGP) - 32 bits

Chipsets

Chipsets provide the support for the **processor chip** on the motherboard. The Intel 440BX is the dominant chipset in the non-Apple personal computers. The chipset is the heart of the computer since it controls and determines how fast and which type of processor, memory, and slots are used. Another chip on the motherboard is called the **Super I/O controller**. Its main function is to control the floppy disk drive, keyboard, mouse, serial and printer ports. Check out PCGuide's Super I/O Controller Functions to learn more.

Recent motherboard designs include additional chips to support USB, sound card, video adapter, computer host and network adapter. These chips save the cost of an adapter slot.

Fans

Speeds, temperatures, density, faster chipset designs and component count have driven the need for circuit cooling via miniature electric fans. These fans mount inside the actual computer case. **Heat sinks** act like a car radiator, providing additional surface area to help cool a

component.

Replaceable fan/heat-sink assemblies are often used to help dissipate the considerable amount of heat on modern processor chips. The assembly conducts heat away from the chip by convection, using a layer of thermal grease between the two mating metal surfaces. Fans often have a third wire used for monitoring the speed of the fan.