

PC HARDWARE

a Beginner's Guide



RON GILSTER

Author of *Build Your Own Home Network*

- Learn basic PC concepts and terminology
- Get to know the functions of the internal and external components
- Maintain, troubleshoot, repair, and optimize your PC



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**This book is dedicated to George Price, my Dad,
as a small thanks for his love
and his belief in me.**

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INTRODUCTION

Everyday we are challenged with new technology and new adaptations of existing technology with the result that we are continually all beginners. While this book is written primarily for people who wish to know more about personal computer (PC) hardware, it may also prove to be helpful to people who wish to expand their knowledge of the PC's hardware.

It is remarkable that a personal digital assistant, such as the Handspring Visor or the Palm Pilot, holds more raw computing power than existed in the entire world only 20 years ago. It is also remarkable that the basic structure of the personal computer over this same 20 years has not changed all that much. The essential components that make a PC are the same today as they were in 1981. What has changed is the integration scale, the ability of the peripherals, and the size and capabilities of the software.

I have included all of the technology with which a PC user comes into contact and explain its function and interactions with the other components and technologies in the PC. While the details of all of the PC's components is included in the book, additional information has been included for the areas to which the beginning user has more contact, such as the audio/visual systems, CD-ROM and DVD drives, hard disk drives, keyboard, mouse, and others.

This book is intended to provide an in-depth introduction to the hardware and technology of the personal computer and to answer your questions about how it all works. I sincerely hope you enjoy the book and learn from it. If you have any feedback or questions, please contact me at feedback@rongilster.com.

CHAPTER 5

Chipsets and Controllers

Without question, the most important component of a PC is the motherboard. Among the components on the motherboard contributing to its importance are the chipset and its associated controllers. This group of devices provides much of a PC's functionality and its ability to accept, display, and move data. The logic circuits of the chipset and controllers give the motherboard its intelligence and its ability to function. The chipset and controllers also control the movement of data on the system buses so that data and instructions can move about the PC, between the CPU, cache memory, and peripherals. The system chipset plays a major role in a PC's function, feature set, and speed. Unless data and instructions are able to flow between one component of the PC and another, there isn't much point to even powering up the PC.

INTRODUCTION TO CHIPSETS

The chipset, like the one shown in Figure 5-1, is technically a group of chips that helps the processor and other components on the PC communicate with and control all of the devices plugged into the motherboard. The chipset only contains enough instructions to perform its functions at the very most rudimentary level. Most of the function that occurs between the chipset and a device is actually provided by the device's device driver reacting to the basic commands communicated to it from the chipset.

The chipset controls the bits (data, instructions, and control signals) that flow between the CPU, system memory, and over the motherboard's bus. The chipset also manages data transfers between the CPU, memory, and peripheral devices and provides support for the expansion bus and any power management features of the system.

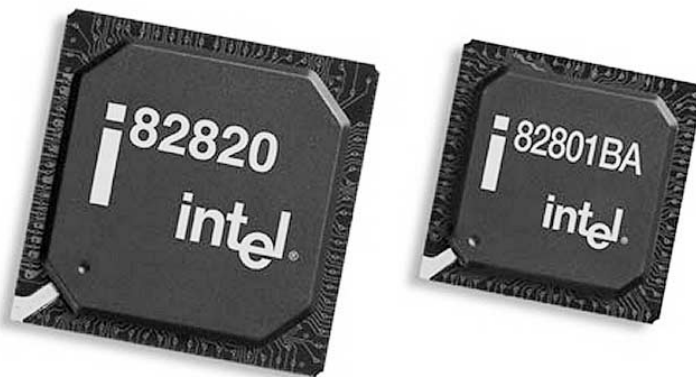


Figure 5-1. The Intel 820E chipset. Image courtesy of Intel Corporation

Socket Type

The socket type used to mount the CPU on the motherboard is the most common grouping for chipsets. You will find Socket 7 chipsets in one group, Socket 8 chipsets in another, Socket 1 and 370 chipsets in a third, and Slot A chipsets in another. There are chipsets that do not conform to this grouping technique, such as AMD's K7 chipset and others that generally form their own separate groupings. See Chapter 3 for more information on processor mountings.

North Bridge and South Bridge

Another characteristic that sets one chipset apart from another is whether it has one, two, or more chips in the set. The two-chip chipset, which contains what is called the north bridge and the south bridge, is the most common, but some manufacturers, such as SiS and VIA, produce mostly single chipsets today. Other chipsets have as many as six chips in the set. Figure 5-2 illustrates the relationship of these two elements.

The north bridge is the major bus circuitry that provides support and control for the main memory, cache memory, and the PCI bus controllers. The north bridge is typically a single chip (usually the larger of a two or more chipset), but it can be more than one chip. In a chipset, the north bridge supplies the chipset its alpha designation and distinction in a chipset family. For example, the chip *FW82439HX* is the north bridge chip of the Intel 430HX chipset.

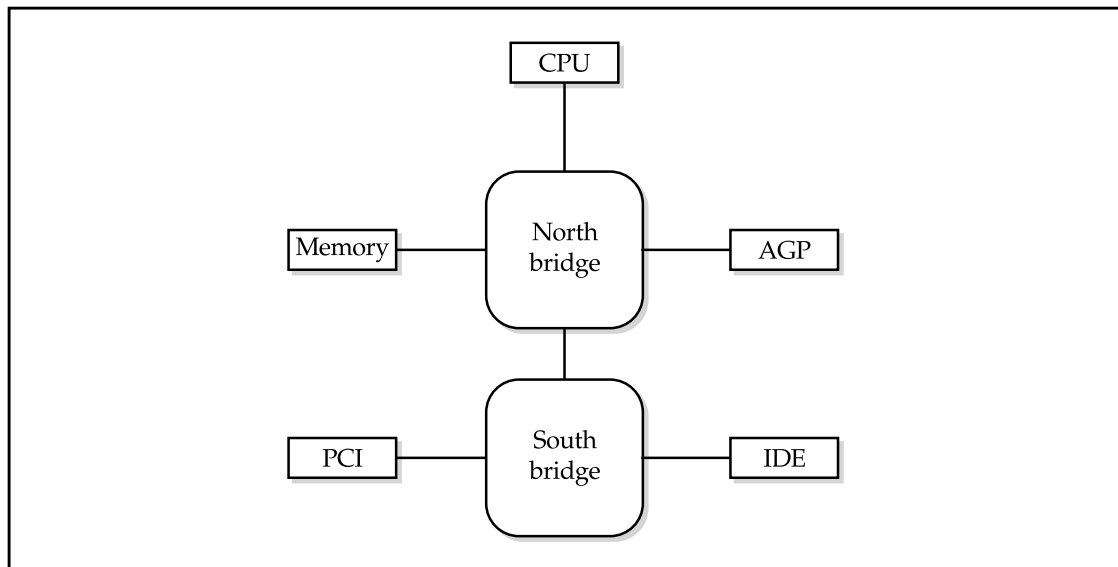


Figure 5-2. The relationship of a chipset's north bridge and south bridge

The south bridge includes the controllers for the peripheral devices and any controllers not essential to the PC's basic functions, such as the EIDE (Enhanced Integrated Device Electronics) controller and the serial port controllers. The south bridge is typically only one chip and is common among all variations in a chipset family and even between manufacturers, such as the SiS 5513 and the Intel PIIX south bridge chips.

Processor Generations

Another grouping technique that is fading away is the chipset's, and processor's, generation. As processors have evolved from the early days, processors have been grouped by their evolutionary generation. For example, the 8088 was a first-generation processor, the 386 a third-generation processor, the 486 a fourth-generation processor, the Pentium a fifth-generation processor, and so on. When Intel was the dominant processor manufacturer, the generations were much easier to follow, but now that AMD and VIA Cyrix processors have gained a foothold in the market, the generation of processors is more fuzzy. Chipsets emerged on the processor's fourth generation, and you will see some legacy chipsets categorized to the generation of the processor it supports.

At one time, a chipset was several smaller single-purpose controller chips. Each separate controller, which could be one or more chips, managed a single function, such as controlling the cache memory, handling interrupts, managing the data bus, and the like. Today's chipset combines this set of controller functions into one or two larger, multifunction chips, as shown in Figure 5-1.

Chipset chips are also referred to as *Application Specific Integration Circuits*, or *ASICs* (pronounced "a-six"), but not all ASICs are chipsets; some are timers, memory controllers, bus controllers, digital sound processors, and more, so avoid this generic classification. Manufacturers of video graphics cards also use the term chipset for the function set on their video cards, but don't confuse the two—one cannot be substituted for the other (see Chapter 12 for more information on video card chipsets).

CONTROLLER CHIPS

Generally, a chipset does not incorporate all of the controllers used to direct the actions of every peripheral device on the PC. In addition to the chipset, there are at least two, and possibly more, controllers mounted directly on the motherboard. In most cases, the motherboard will have at minimum a keyboard controller and an I/O controller (a.k.a. the Super I/O controller). Some expansion cards, such as video adapters, sound cards, network interface cards (NICs), and SCSI (Small Computer System Interface) adapters, have built-in controller chips. Individual controller chips come in all sizes and shapes, as illustrated in Figure 5-3.

A controller chip controls the transfer of data to and from a peripheral device, such as a disk drive, the monitor, the keyboard, or a printer. All of these devices depend on a device controller to interact with the CPU and the rest of the PC. For the most part, PC users

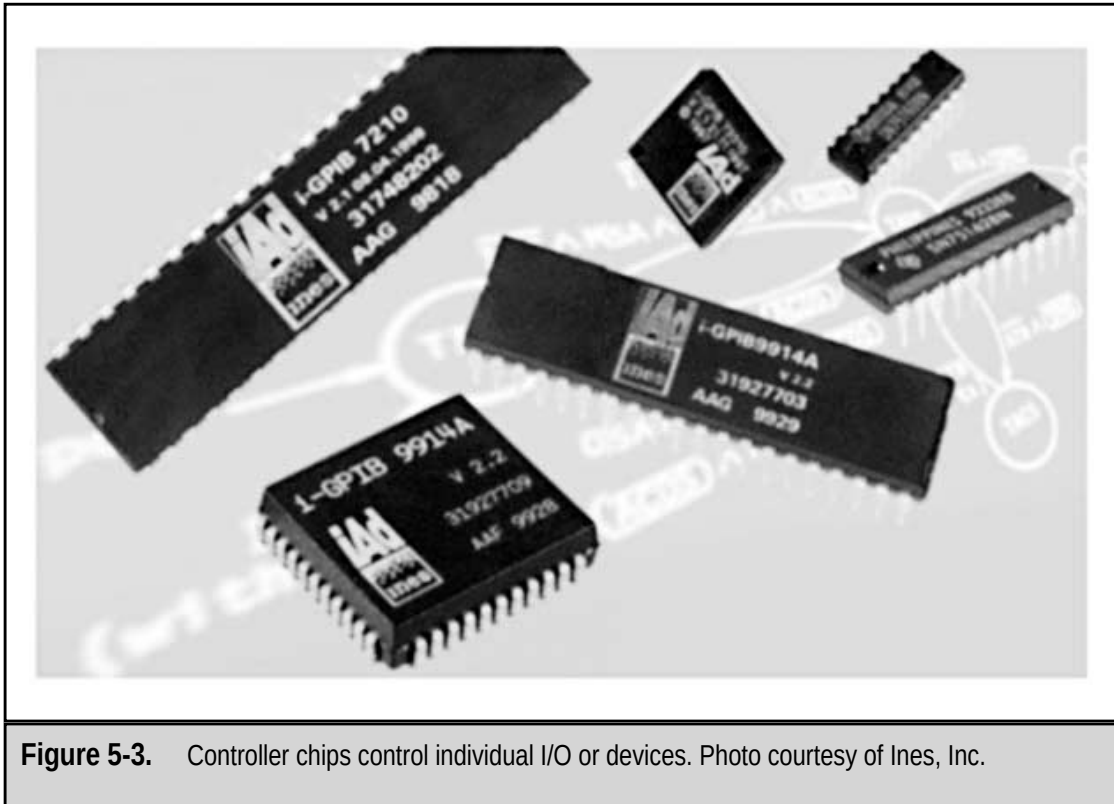


Figure 5-3. Controller chips control individual I/O or devices. Photo courtesy of Ines, Inc.

don't ever think about controller chips on their systems. In fact, most users probably don't even know they exist. How data gets to and from the keyboard is not of concern, only that it does.

On a PC, a controller is typically a single chip that either mounts directly on the motherboard or on a card that is inserted in an expansion slot on the motherboard. Because they control the flow of data to and from peripheral devices, controllers must be matched to the bus architecture of the PC.

Bus Architectures

The bus architecture of the PC is made up of the wires, connectors, and devices that move data and instructions around the PC (see Chapter 11 for more information on expansion bus architectures). The bus structure, which got its name from the fact that it resembles the lines on a city bus map, connects the controllers on the motherboard, the CPU, memory, I/O ports, and expansion slots.

The PC's bus architecture becomes very important when you add additional device controller cards to the motherboard's expansion slots. Most of the latest motherboard designs include expansion slots for multiple bus structures, including PCI (Peripheral Com-

ponent Interconnect) and AT Bus, and possibly SCSI. Each of the bus architectures supported on a motherboard requires a bus controller chip.

While not technically a bus architecture, another interface type you will see listed as a major feature of some, especially the newer chipsets, is support for *AGP (Accelerated Graphics Port)*. AGP is a 66MHz bus that is usually combined with a 32-bit 33MHz PCI bus to provide advanced support and faster data transfers from main memory for video and graphics adapters.

AT Bus

The AT expansion bus is included on current PC motherboards primarily for backward compatibility to expansion cards from older systems, such as network adapters. The AT bus, which runs at 8MHz and uses a 16-bit data path, is commonly referred to as *ISA (Industry Standard Architecture)*. However, the ISA bus standard also includes the 8-bit PC XT bus, which is rarely used on any current PC.

Another bus related to the AT bus is the *Extended Industry Standard Architecture*, or *EISA*, bus. EISA bus expansion slots have been included on some motherboards since the time of the 386 processor. It is a 32-bit bus but is also backward compatible to the AT and ISA buses.

Local Bus

AT and ISA bus structures are unable to keep up with the speeds required for high-resolution graphics and faster processors, so many manufacturers have moved to what are called *local bus* architectures. A local bus architecture is more directly connected to the microprocessor than nonlocal buses by communicating directly to the processor through its dedicated controller and bypassing the standard bus controller. Although they provide for faster data movement, local buses do not support many devices, which is why most motherboards also include AT or ISA expansion slots as well.

The most common of the local bus architectures are the PCI and the VESA (Video Electronics Standards Association) local bus, or VL-bus. Of these two, the PCI, promoted by Intel, is becoming the de facto standard for virtually all Pentium class computers.

SCSI Bus

The Small Computer System Interface, or SCSI (pronounced “skuzzy”) is a bus architecture that attaches peripheral devices to a PC through a dedicated controller card. SCSI supports very fast data transfer and multiple devices over the same I/O bus structure. Very few PCs, outside of the Macintosh, feature a SCSI interface as a standard, and if this bus is desired, it must be added to the PC through an expansion slot, typically a PCI slot.

USB

The *Universal Serial Bus*, or *USB*, is an emerging standard for device connectors and interface. USB is a plug-and-play architecture that allows users to add a wide range of periph-

eral devices to the PC without the need of an expansion card. It is considered a low-speed interface and works best for a keyboard, mouse, scanner, or printer.

Keyboard Controller

The keyboard controller's name describes what it does—it controls the keyboard. More specifically though, it controls the transfer of data from the keyboard to the PC. The keyboard controller on the motherboard interacts with a controller located inside the keyboard over a serial link built into the connecting cable and connector. When the keyboard controller receives data from the keyboard, it checks the data's parity, translates the scan code, places the data in its output buffer, and notifies the processor that the data is in its buffer. The keyboard controller is quite common on most older PCs, but newer PCs either include this control function in the chipset or in the Super I/O chip.

The functions performed by the keyboard controller, or its equivalent, are as follows:

- ▼ **Keyboard control and translation** When a key is pressed on the keyboard, a scan code is sent from the controller inside the keyboard to PC's keyboard controller, which then signals the processor through IRQ1 (interrupt request 1). The keyboard controller then translates the scan code into the character it represents and places it on the bus to move it to the appropriate location in memory.
- **Support for the PS/2 mouse** On those systems that have an integrated PS/2 connector on the motherboard, the keyboard controller supports its functions. This port is most commonly used to connect a PS/2-style mouse.
- ▲ **Access to the HMA** Although the support for the High Memory Area of system memory (RAM) is now incorporated into the system chipset on most newer PCs, access to this part of memory is controlled through the keyboard controller. See Chapter 7 for more information on the High Memory Area.

Super I/O Controller

The Super I/O (input/output) controller chip includes many controller functions that were previously performed by many separate chips. Combining these functions provides an economy of scale for similar activities and minimizes the space required on the motherboard and the cost of the chips used to support these activities.

The "super" in its name refers to the fact that the Super I/O controller combines many other chips and not what or how it carries out its functions. This chip controls the standard input/output peripheral devices and ports found on virtually every system. These functions can be combined onto a single chip because they control mature standardized devices that are virtually the same on every PC. Combining them on a single I/O chip frees the motherboard and system chipset to control other high-priority functions.

On some older PCs, many of the functions of the Super I/O controller were provided through I/O controller expansion cards, such as control for serial and parallel ports and the hard disk drive. Because these functions are common to every PC, incorporating them into a single chip placed on the motherboard has also freed up an expansion slot.

The major functions of the Super I/O controller chip are as follows:

- ▼ **Serial ports** The UART (universal asynchronous receiver-transmitter) is used to drive the serial ports and the control functions of data transfer are included in the Super I/O chip.
- **Parallel ports** The functions that drive the parallel ports, including the various parallel port standards, EPP (Enhanced Parallel Port) and ECP (Enhanced Capabilities Port), are included in the Super I/O controller.
- **Floppy disk drives** Support for the floppy disk drive and floppy-disk type tape drives are included on the Super I/O chip.
- ▲ **Miscellaneous functions** Newer versions of the Super I/O controller may also incorporate the keyboard controller's functions, the real-time clock, and perhaps the IDE hard disk controller, although this is more commonly found in the system chipset.

Other Device Controllers

Each device added to the PC that wishes to interact with the data bus requires a controller. In general, peripheral devices have their controller chips either on an adapter card (expansion card) or built into their electronics. On older, pre-Pentium PCs, every device generally had their own or shared a controller card. For example, it was common for the floppy disk and hard disk drives to share an I/O controller card.

Each device controller must be matched to the bus interface with which it is to interact. An IDE (Integrated Drive Electronics) disk drive requires an IDE controller and a SCSI controller is needed to connect a device with a SCSI interface.

Most peripheral devices installed inside the system case of a current PC interface through an IDE controller. For the most part, an IDE controller is included in either the PC's main chipset or the Super I/O controller. Most systems have the *floppy disk controller (FDC)* and the *hard disk controller (HDC)* built into the motherboard and, provided it is not a SCSI device, any tape drives, CD-ROM, or DVD devices added will share these controllers.

CHIPSETS

One of the fundamental design facts of a PC is that its microprocessor is always faster than the peripheral devices to which it must communicate. This fact has forced designers to develop interfaces that serve as buffers between the slower devices and the faster CPU to match up their speeds and help with the timing of the operations. The very first PCs had an individual chip to control each of the various operations.

It was common for an early PC to have the following separate chips:

- ▼ **Math coprocessor interface** This chip controls the flow of data between the processor and math coprocessor.
- **Clock generator** This chip controls the timing of the PC's operations.
- **Bus controller chip** This chip controls the flow of data on the motherboard's buses.
- **DMA controller** This chip controls the processes that allowed peripheral devices to interact with memory without involving the processor.
- **Programmable peripheral interface (PPI)** This chip supervises some of the simpler peripheral devices.
- **Floppy disk controller (FDC)** This chip controls the PC's diskette and tape drives.
- **CRT controller** This chip facilitates the PC's display.
- ▲ **UART (universal asynchronous receiver transmitter)** This chip is used to send and receive synchronous serial data.

These functions are explained more in the next section.

With the major design changes introduced with the 486 processor, many of these functions were combined for the first time onto a smaller group of chips that required less board space, which was in line with the shrinking size of the PC, and cost less to produce.

Every major component attached to a PC's motherboard depends on the system chipset for its ability to interact with the other components of the PC. The chipset of a PC is designed to support the functions of a particular CPU and, in some cases, a specific motherboard design. The design and function of the chipset is tied very closely to the designs of the CPU, motherboard, BIOS, and memory, the devices with which it directly interacts and supports. On a PC, you can upgrade the memory, the CPU, and even upgrade the hard disk, but to change the chipset, you have to change the motherboard. It is integral to the functions of the motherboard.

A number of a PC's characteristics are dictated by its chipset, including the memory type, the L2 cache type and size, the CPU, the data bus speed, and whether the PC supports one or more processors. Which interfaces are supported on the PC, such as AGP, IrDA, USB, and which IDE/EIDE features, are determined by the motherboard's chipset.

Intel is the largest chipset manufacturer, in terms of the number of chipsets produced and in use. Intel originally developed their first chipset to help promote the PCI bus for the Pentium processor platforms. There are other chipset manufacturers, listed later in this section, but Intel, since they produce the Pentium microprocessor, is usually the chipset of choice for motherboard manufacturers. More than likely Intel manufactured the chipset in your PC. The Windows Device Manager's listing for system devices (see Figure 5-4) should list the processor to PCI and PCI to ISA bridge controllers and the manufacturer. If these are Intel chips, then you can be sure you have an Intel chipset.

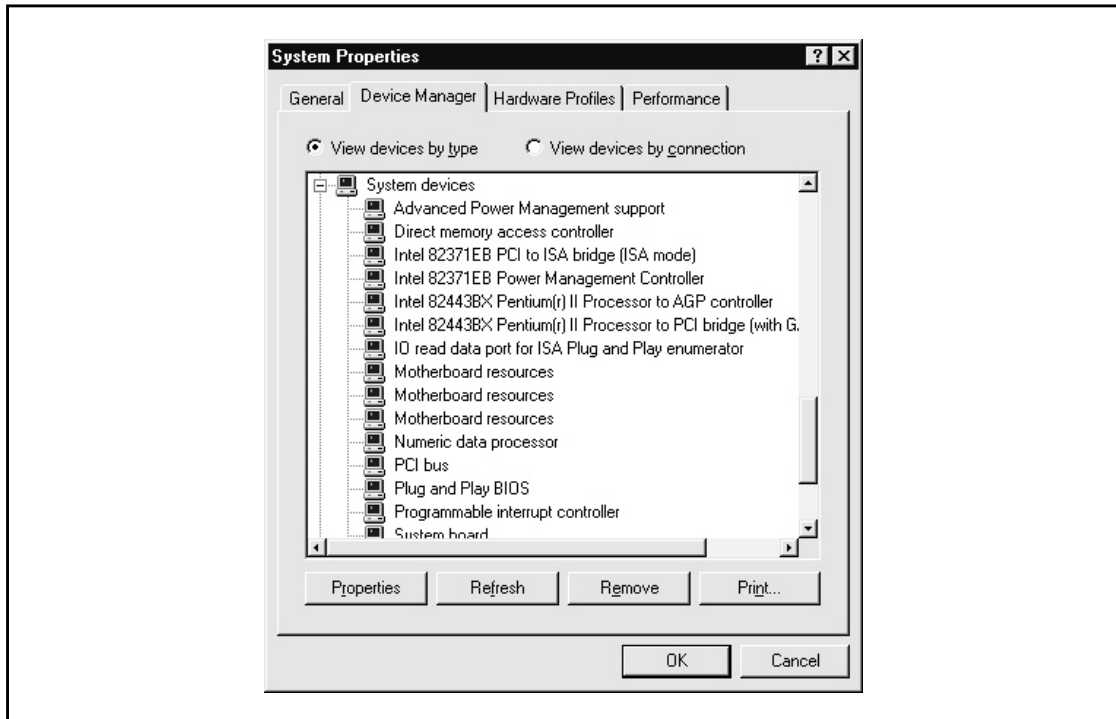


Figure 5-4. The Windows Device Manager System Devices displays the controller set (chipset) of a PC

Another way to check out the chipset on your PC is to open the system unit and find the large square chips, which are usually bigger than most everything else on the motherboard except the microprocessor. A chipset can have only one chip or as many as four separate chips.

Chipset Functions

A chipset integrates a number of *VLSI* (very large scale integration) chips that provide much of the PC's functionality. Each of the chips integrated into the chipset at one time could have easily been a stand-alone chip, but by combining them together into a single chip, the controllers and devices combined into the chipset can share common actions, reduce the physical space required on the motherboard, and reduce cost—all very important considerations in today's PC market.

Chipset Characteristics

The characteristics of a chipset can be broken down into six categories: host, memory, interfaces, arbitration, south bridge support, and power management. Each of these catego-

ries defines and differentiates one chipset from another. The characteristics defined in each of these categories are as follows:

- ▼ **Host** This category defines the host processor to which the chipset is matched along with its bus voltage, usually *GTL+* (*Gunning Transceiver Logic Plus*) or *AGTL+* (*Advanced Gunning Transceiver Logic Plus*), and the number of processors the chipset will support.
- **Memory** This category defines the characteristics of the DRAM support included in the chipset, including the DRAM refresh technique supported, the amount of memory support (in megabits usually), the type of memory supported, and whether memory interleave, ECC (error-correcting code), or parity is supported.
- **Interfaces** This category defines the type of PCI interface implemented and whether the chipset is AGP-compliant, supports integrated graphics, PIPE (pipelining), or *SBA* (*side band addressing*).
- **Arbitration** This category defines the method used by the chipset to arbitrate between different bus speeds and interfaces. The two most common arbitration methods are *MTT* (*Multi-Transaction Timer*) and *DIA* (*Dynamic Intelligent Arbiter*).
- **South bridge support** All Intel chipsets and most of the chipsets for all other manufacturers are two processor sets. In these sets, the north bridge is the main chip and handles CPU and memory interfaces among other tasks, while the south bridge (or the second chip) handles such things as the USB and IDE interfaces, the *RTC* (*real-time clock*), and support for serial and parallel ports.
- ▲ **Power management** All Intel chipsets support both the *SMM* (*System Management Mode*) and *ACPI* (*Advanced Configuration and Power Interface*) power management standards.

Chipset Built-in Controllers

The controllers and devices included in a chipset are typically those that are common to virtually every PC of the type the chipset is designed to support. The controllers and devices usually included in a chipset are as follows:

- ▼ **Memory controller** This is the logic circuit that controls the reading and writing of data to and from system memory (RAM). Other devices on the PC wishing to access memory must interface with the memory controller. This feature also usually includes error handling to provide for parity checking and ECC (*error-correcting code*) for every memory word.
- **EIDE controller** Nearly all mid- to upper-range motherboards now include at least one EIDE connector for hard disks, floppy disks, CD-ROMs, DVDs, or other types of internal storage drives. The EIDE controller typically supports

devices with ISA, ATA, and perhaps an ATA-33 or Ultra-DMA (UDMA) interface.

- **PCI bridge** Like a network bridge that connects two dissimilar networks, this device logically connects the PCI expansion bus on the motherboard to the processor and other non-PCI devices.
- **Real-time clock (RTC)** This clock holds the date and time on your PC; this is the date and time that is displayed to you on the monitor and is used to date-stamp file activities. This should not be confused with the system clock that provides the timing signal for the processor and other devices.
- **DMA (Direct Memory Access) controllers** The DMA controller manages the seven DMA channels available for use by ISA/ATA devices on most PCs. DMA channels are used by certain devices, such as floppy disk drives, sound cards, SCSI adapters, and some network adapters, to move data into memory without the assistance of the CPU.
- **IrDA controller** IrDA (Infrared Data Association) is the international organization that has created the standards for short-range, line-of-sight, point-to-point infrared devices, such as a keyboard, mouse, and network adapters. The IrDA port on your system is that small red window on the front or side of notebook and some desktop computers.
- **Keyboard controller** A chipset may include the keyboard controller, and many of the newer ones do. The keyboard controller is the interface between the keyboard and the processor. See the previous section for more information on this device.
- **PS/2 mouse controller** When IBM introduced the PS/2 system, the controller for the mouse was included in the keyboard controller. This design has persisted and usually wherever the keyboard controller is, so is the PS/2 mouse controller. This device provides the interface between the PS/2 mouse and the processor.
- **Secondary (Level 2, or L2) cache controller** Secondary (L2) cache is located on the motherboard, a daughterboard, or as on the Pentium Pro, in the processor package, and caches the primary memory (RAM), the hard disk, and the CD-ROM drives. The secondary cache controller controls the movement of data to and from the L2 cache and the processor.
- ▲ **CMOS SRAM** The PC's configuration settings are stored in what is called the CMOS memory. The chipset contains the controller used to access and modify this special SRAM area.

Intel Chipsets

Intel literally invented the chipset and has continued to dominate the market, giving ground on any level only when they decide to abandon it to move upward and onward to

newer developments. Intel began making chipsets back in the days of the 486 and continues to dominate the market. The primary reason for this dominance is simple—chipsets support processors and motherboards. Since Intel dominates the processor market and because they know the processor so intimately, it is easy for them to design chipsets that efficiently and effectively support the processor.

486 Chipsets

Because there were several styles of 486 systems, there were many different chipsets for them. The two most common chipsets for 486 systems (called *fourth-generation* chipsets) were

- ▼ **420EX (Aries)** This chipset provided support on motherboards that combined the PCI and VL buses.
- ▲ **420TX (Saturn)** This chipset family was designed for 80486 systems up to the 486 DX4 systems; it supported most of the 486 overdrive processors and provided for power management. It was released in three revision levels numbered 1, 2, and 4. Revision 4 is known as the Saturn II chipset.

Chipsets for the Pentium and Beyond

Pentium chipsets (referred to as *fifth-generation* chipsets) were more closely tied to the design of the processor than were the 486 chipsets. When Intel created the Pentium processor, it also developed the PCI bus and a chipset to support and integrate the capabilities of these two developments. This PCIset, as it became known, was developed as an exact match for the Pentium processor.

Intel chipsets are designated in numbered series: the 420 for 486 chipsets, the 430 for Pentium chipsets, the 440 series for Pentium II, and the 450 series for Pentium Pro chipsets (along with the 440FX). The newer 460 and 800 series chipsets just being announced are designed to support the IA-64 (Intel Architecture—64 bits) processors, such as the Itanium, now emerging.

Here are some of the more common Intel Pentium and above chipsets:

- ▼ **430LX (Mercury)** The 430LX was the first Pentium chipset developed to support the 60MHz and 66MHz 5V processors. The Mercury chipset included the PCI bus and supported up to 128MB of RAM. This chipset was made obsolete by the chipsets that supported the 90MHz and 100MHz 3.3V processors.
- **430NX (Neptune)** The 430NX was developed to support Intel's second-generation Pentium chips. It supported Pentium processors running at 90MHz to 133MHz. Some of the improvements offered over the 430LX chipset are support for dual processors, 512MB of RAM, and 512 KB of L2 cache.
- **430FX (Triton I)** This was the first of the Triton chipsets. It featured support for EDO RAM, pipelined burst and synchronous cache, Plug-and-Play, and PCI level 2.0 compliance. However, it only supported 128MB of RAM (down from

the 512MB supported by the Neptune chipset) and did not have dual processor capabilities.

- **430MX (Mobile Triton)** This is a version of the 430FX designed for laptop, notebook, and other portable PCs.
- **430HX (Triton II)** This chipset supported EDO RAM and concurrent PCI buses and was designed for use in business-level servers. It was the next generation of the 430NX and included support for 512MB of RAM and L2 cache.
- **430VX (Triton III)** This chipset was developed to support the home PC market. It featured support for USB, SDRAM, and PCI interfaces.
- **430TX** With this chipset, Intel dropped the Triton label for its chipsets. The 430TX was adaptable for both desktop and mobile use and provided PCI, USB, DMA, and other interfaces.
- **440LX** Designed for the Pentium II, this AGPset chipset provides support for the LS-120 “superdisk,” Ultra DMA, AGP, USB, SDRAM, ECC RAM, and the PC97 power management specification. Figure 5-5 shows this chipset.
- **440LXR** A low-end version of the 440LX chipset.
- **440BX** Another Pentium II chipset that supports 100MHz bus, dual processors, FireWire, and up to 1GB of RAM.

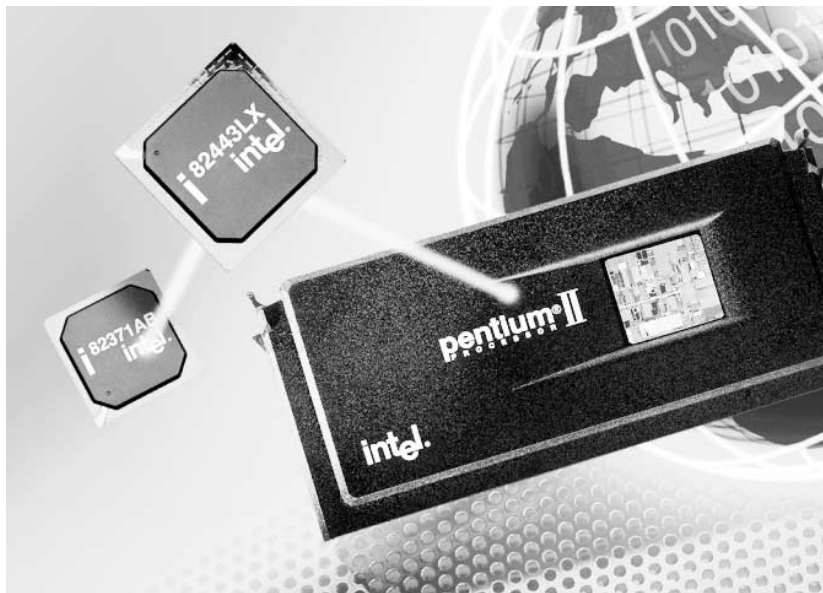


Figure 5-5. The Intel 440LX AGPset and the Pentium II processor. Photo courtesy of Intel Corporation

- **440GX** This chipset, shown in Figure 5-6, is designed for midrange workstations and supports dual CPUs and up to 2GB of SDRAM, along with dual AGP interfaces. This is an AGPset.
- **440FX (Natoma)** This chipset supported both the Pentium II and the Pentium Pro processors with USB, EDO RAM, ECC memory, dual processors, and PCI.
- **450GX (Orion server)** The 450GX chipset and the 450KX share the same basic design. However, the GX version is optimized for the Pentium Pro and supports four processors and 8GB of RAM but FPM memory only.
- **450KX (Orion workstation)** The workstation version of the Orion chipset supports dual processors and 1GB of RAM.
- **450NX** This is a high-powered chipset designed for Xeon workstations and servers. It supports up to four CPUs, 2MB of L2 cache, 8GB of EDO memory, and two 32-bit or one 64-bit PCI interface. Figure 5-7 shows the group of chips that make up this chipset.
- **460GX (Merced)** This chipset supports very high-end servers and workstations with supports for four CPUs and other high-performance features. You will see this chipset linked to the new high-powered Itanium processor.
- **810** This chipset is designed for value-priced PCs. It includes support for integrated 3-D graphics (AGP) with MPEG-2, 100MHz system bus, two USB



Figure 5-6. The Intel 440GX AGPset. Photo courtesy of Intel Corporation

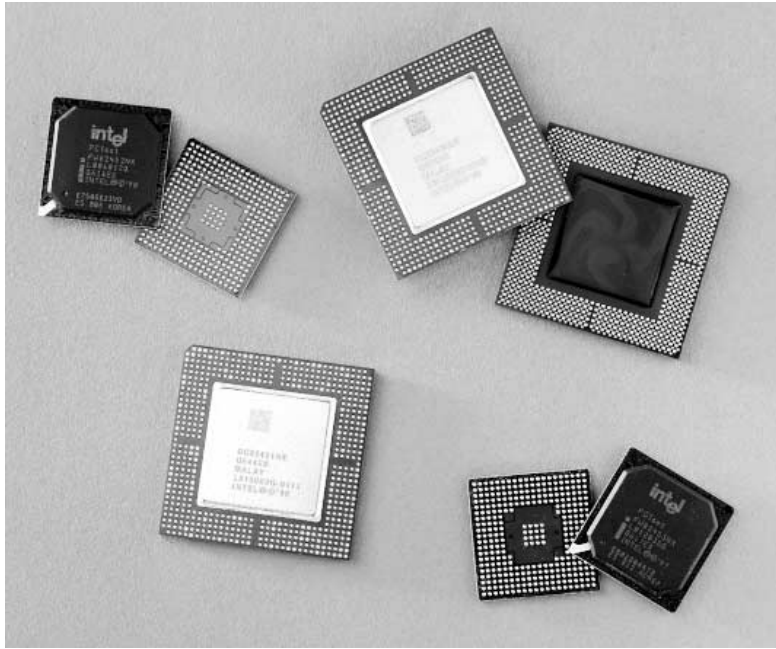


Figure 5-7. The Intel 450NX chipset. Photo courtesy of Intel Corporation

ports, and the Intel Accelerated Hub, which features a 266MB per second bus speed between memory and peripherals.

- **810e** This chipset, shown in Figure 5-8, is an extended version of the 810 chipset based on the 440BX chipset and intended for home market and office PCs. Its features are the same as the 810 chipset, with added support for 133MHz system bus and the ATA-66 interface.
- **815** The Intel 815 chipset is specifically designed to work with the Pentium III processor, but it also provides backward compatibility to other Intel processors.
- **820** Another extension of the 810 chipset designed to support high-end desktops and workstations.
- ▲ **850** The Intel 850 chipset was designed in tandem with the Pentium 4 processor and supports, among many high-performance innovations and features, a 400 MHz system bus that provides over 3 times the bandwidth of previous chipset and processor technologies.

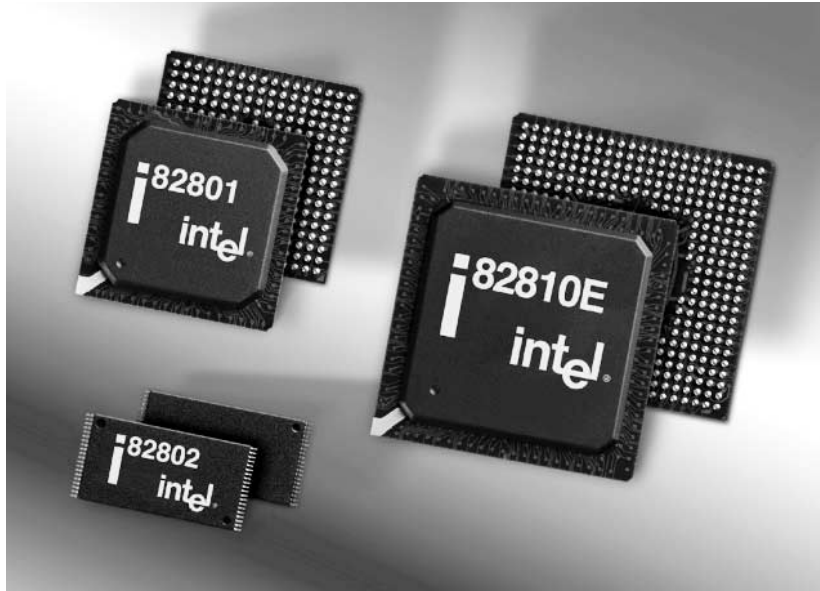


Figure 5-8. The Intel 810e chipset. Photo courtesy of Intel Corporation

Non-Intel Chipsets

Besides Intel, ALi (Acer Labs), Via Technologies, and Silicon Integrated Systems (SiS) manufacture Pentium-class chipsets.

ALi (Acer Laboratories, Inc.)

Acer Laboratories is a small part of Acer (the PC manufacturer) that manufactures chipsets for the Acer AcerOpen motherboards. The Aladdin III and Aladdin IV chipsets are comparable to the Intel 430VX and 430TX chipsets. The Aladdin V, also known as the M1541 chipset, supports higher CPU bus frequency (up to 100MHz), internal tag bits and tag RAM, high performance RAM controller, 64-bit ECC/parity memory bus interface, an AGP interface, and it includes device controllers for IDE, USB, and PS/2, as well as a Super I/O controller.

SiS

SiS (Silicon Integrated Systems Corporation) manufactures chipsets that combine the functions of the north bridge and south bridge into a single chip. SiS chipsets are available

for nearly all sockets since the Socket 7 and feature a shared memory architecture and *UMA (Unified Memory Architecture)* type of video adapter.

Popular SiS chipsets are as follows:

- ▼ **730S** This single-chip chipset, shown in Figure 5-9, is designed to support the AMD Athlon Slot A/Socket A CPU.
- **630/630E/630S** These single chipsets are designed for Slot 1 and Socket 370 CPUs that integrate the north bridge, an advanced 2D/3D GUI engine, and a Super-South bridge.
- **600/620** These two-chip chipsets integrate a high-performance host bus interface, a DRAM controller, an IDE controller, a PCI interface, a 2D/3D graphics accelerator, and a video playback accelerator for Slot 1 and Socket 370 processor-based systems.
- ▲ **540** This single chipset is designed to support AMD K6 CPU based systems with Super Socket 7 sockets with highly integrated PCI devices.

VIA

VIA Technologies, Inc. is perhaps the third-largest chipset manufacturer, after Intel and SiS. VIA produces chipsets for Slot 1, Socket 7, and Socket 370 legacy systems. However,



Figure 5-9. The SiS 730S single-chip chipset. Photo courtesy of Silicon Integrated Systems Corporation

their more recent chipsets concentrate on the Cyrix and AMD processors. VIA now produces the Cyrix processor, having purchased that company a few years back.

A few of the VIA chipsets are as follows:

- ▼ **Apollo KT266** This two chip chipset is designed for use with the AMD Athlon processor and features a 266MHz bus and a new high-bandwidth architecture Socket A motherboards.
- **Apollo KX133/KT133** These single chipsets (the KX133 is shown in Figure 5-10) are designed to provide support to the AMD Duron, Thunderbird, and Athlon processors and feature a AGP4X graphics bus, up to 2GB of RAM, a 200MHz processor bus, and an ATA-66 IDE hard disk interface.
- **Apollo PM601** This single chipset provides support for the latest Intel Pentium III processors and the Cyrix III processor. It features advanced 2D/3D (two-dimensional/three-dimensional) graphics, a scalable processor bus, and a full set of integrated controllers and other features (see Figure 5-11).
- **Apollo MVP3** This Super Socket 7 chipset provides support for the AMD K-6 and Cyrix MII processors with speeds of up to 533MHz and features a flexible processor bus that scales from 66 to 100MHz along with advanced AGP graphics, power managements, and other integrated features. This is a high



Figure 5-10. The VIA Apollo KX133 chipset. Photo courtesy of VIA Technologies, Inc.



Figure 5-11. The VIA Apollo PM601 chipset. Photo courtesy of VIA Technologies, Inc.

performance, energy efficient chipset that supports AGP, PCI, and ISA bus on desktop and notebook PCs ranging from 66MHz to 100MHz. It features support for EIDE, USB, and keyboard/PS2-mouse interfaces, a 64-bit CPU and system memory, 32-bit PCI and AGP interfaces, 3.3V and sub-3.3V power.

- **Apollo MVP4** This Super Socket 7 chipset, shown in Figure 5-12, combines the Apollo MVP3 chipset with a high-end Trident Blade3D graphics engine for value PCs, Internet appliances, and notebook PCs.
- ▲ **Pro Savage PM133** This two-chip chipset supports Intel Pentium III and Celeron processors as well as the VIA Cyrix processor. It features high-performance graphics support, an integrated 10/100 Ethernet adapter, audio support, a built-in modem, Super I/O controller, flat panel monitor support, advanced power management, and support for four USB ports.

NEW DEVELOPMENTS

Intel now includes a bus architecture, called *Intel Hub Architecture*, to enhance the interface between the elements of the chipset. Before this, chipsets used the PCI bus as the interface between the north bridge (host, memory, and AGP) and the south bridge (PCI and



Figure 5-12. The VIA Apollo MVP4 chipset. Photo courtesy of VIA Technologies, Inc.

IDE controllers). Because the south bridge was a PCI device and the PCI controller at the same time, some efficiency (and one PCI slot) was lost. Its latest chipset, the 850 series, is built on IHA technology.

The hub architecture dedicates a high-speed data bus between redesigned north and south bridges, now designated as the Memory Controller Hub (MCH) and the I/O Controller Hub (ICH). The ICH is not a PCI device and a PCI slot is freed up. The dedicated link allows these two hubs to transfer data much faster, as much as 266MBps over 8 bits.

Acer Labs has recently announced its ALiMAGiK 1 chipset to support the AMD Slot A/Socket A processor family. A parallel chipset family, the AladdinPro 5, supports the Intel Slot 1/Socket 370 processor family. What is remarkable about these chipset families is that they are designed to handle DDR (Double Data Rate DRAM) and SDR (Single Data Rate) memory architectures on desktop and mobile platforms, both of which were not previously supported together. DDR has a relatively small market share at present, but many experts expect it to grow to about half of the motherboard market in the next five years. In fact, VIA has also committed to using only DDR in its emerging chipsets and its newest chipset, the Apollo KT266, provides support for DDR SDRAM.

The Apollo KT266 also features a new architecture enhancement, similar to Intel's IHA, which it calls *V-Link Architecture*. The V-Link architecture has replaced the PCI link that is used to connect the north and south bridges of many chipsets.