ICT Lab 1

Computer Hardware – Hardware Components & Internal PC Connections:

You might see a specification for a PC [1] such as "*containing an Intel i7 Hexa core processor - 3.46GHz, 3200MHz Bus, 384 KB L1 cache, 1.5MB L2 cache, 12 MB L3 cache, 32nm process technology; 4* ***gigabytes*** *of RAM, ATX motherboard, Windows 7 Home Premium* ***64-bit*** *operating system, an Intel® GMA HD graphics card, a 500* ***gigabytes*** *SATA hard drive (5400rpm), and WiFi 802.11 bgn*". This section aims to discuss a selection of hardware parts, outline common metrics and specifications used to describe them, what they measure as well as their operation.

POWER SUPPLY

HEAT SINKS/FANS

CASE

MANUFACTURERS: ASUS, Intel **MOTHERBOARD**

MOTHERBOARD

EXPANSION CARDS

RAM MEMORY

CACHE MEMORY

REGISTERS

BOOT-UP PROCESS

CHIPSET

PCI BUS

AGP BUS

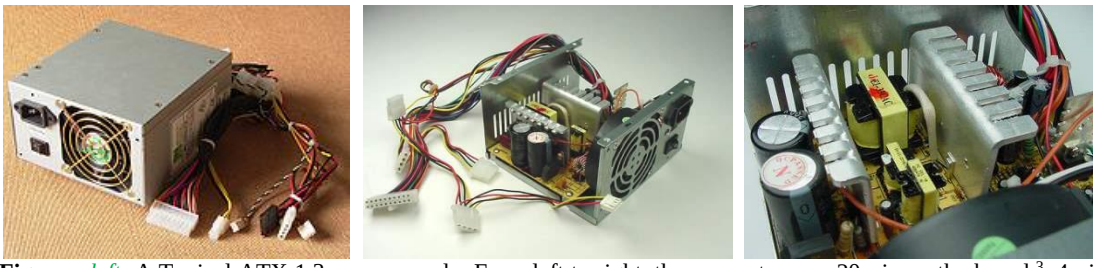
PCI EXPRESS 1.0 BUS

(IDE) ATA INTERFACE

SERIAL ATA (SATA)

Power Supply:

The power supply converts the **alternating current** (AC) from your mains (110V input or 220V input) to the **direct current** (DC) needed by the computer [2]. In a PC, the power supply is the metal box usually found in a corner of the case. The power supply is visible from the back of many systems because it contains the power-cord receptacle and the cooling fan. Power supplies - often referred to as **switching power supplies**, use switcher technology to convert the AC input to lower DC voltages. The typical voltages produced are: •3.3 volts, •5 volts, •12 volts



Figures: *left:* A Typical ATX 1.3 power supply. From left to right, the connectors are 20-pin motherboard [3], 4-pin "P4 connector", fan RPM monitor (note the lack of a power wire), SATA power connector (black), "Molex connector", and floppy connector; *middle* and *right*: shows the power supply with three small transformers (yellow) in the center. To the left are two cylindrical capacitors. The large finned pieces of aluminum are heat sinks. The left heat sink has transistors attached to it. These are the transistors in charge of doing the switching -- they provide high-frequency power to the transformers. Attached to the right heat sink are diodes that rectify AC signals and turn them into DC signals.

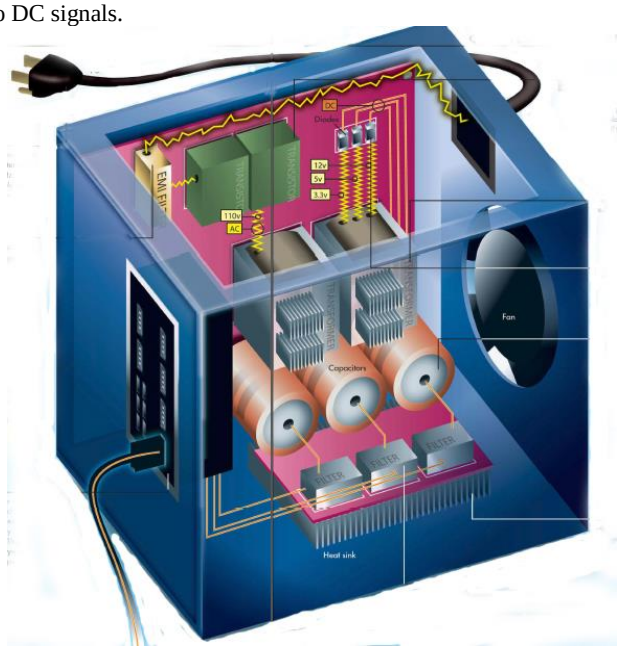


Figure: A power supply schematic showing the AC input, fan, EMI filter (yellow), transformers, cylindrical capacitors, filters, aluminum heat sink, rectifying diodes, and 3 outgoing DC voltage lines. (White, 2008)

The 3.3-volts and 5-volts are typically used by digital circuits, while the 12-volt is used to power fans and motors in disk drives. The main specification of a power supply is in **watts**. A watt is the product of the voltage in volts and the current in amperes or **amps**.

[2] In a laptop the conversion is done by the AC adapter in the power cable.
[3] In current ATX this has changed from 20 pin to 24 pin (2 x12) to support PCI-Express* requirements

The *form factor* of the power supply refers to its general shape and dimensions. The form factor of the power supply must match that of the case that it is supposed to go into, and the motherboard it is to power.

Power Supply Wattage:
A 400-watt switching power supply will not necessarily use more power than a 250-watt supply. A larger supply may be needed if you use every available slot on the motherboard or every available drive bay in the personal computer case. It is not a good idea to have a 250-watt supply if you have 250 watts total in devices, since the supply should not be loaded to 100 percent of its capacity.

According to *PC Power & Cooling, Inc.*, some power consumption values (in watts) for common items in a personal computer are:

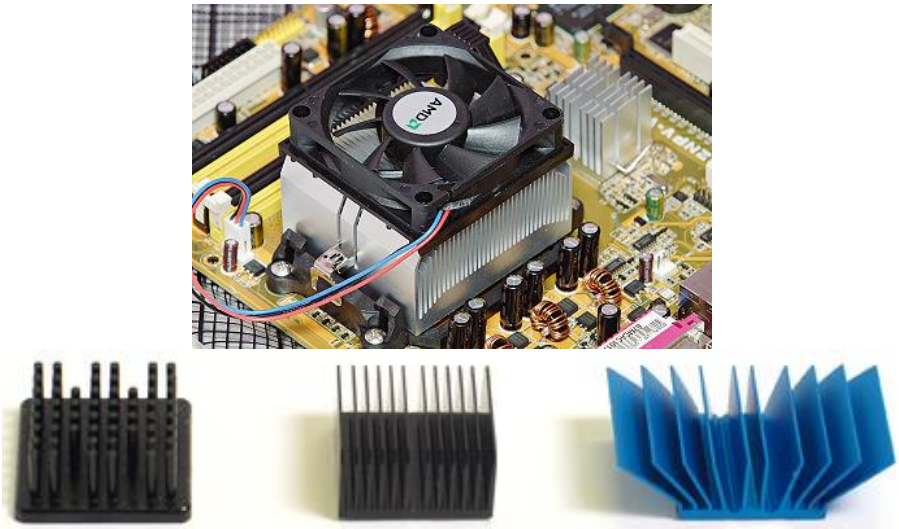
Component	Requirement
AGP Video Card	30W - 50W
PCI Express Video	100W - 250W
Average PCI Card	5W - 10W
DVD/CD	20W - 30W
Hard Drive	15W - 30W
Case/CPU Fans	3W (ea.)
Motherboard (w/o CPU or RAM)	50W - 150W
RAM	15W per 1GB
Processor	80W - 140W

If you use a PSU that does not supply enough power for the system, any of the following symptoms might occur:
(i) System does not boot,
(ii) System randomly shuts down,
(iii) Add-in devices do not work properly. *Intel (2014a)*

For overall power supply wattage, add the requirement for each device in your system, then multiply by 1.5. The multiplier takes into account that today's systems draw disproportionally on the +12V output. Furthermore, power supplies are more efficient and reliable when loaded to 30% - 70% of maximum capacity.
Source: http://www.pcpower.com/technology/power_usage

Heat Sinks/Fans:
As processors, graphics cards, RAM and other components in computers have increased in speed and power consumption, the amount of heat produced by these components as a side-effect of normal operation has also increased. These components need to be kept within a specified temperature range to prevent overheating, instability, malfunction and damage leading to a shortened component lifespan. Other devices which need to be cooled include the power supply unit, optoelectronic devices such as higher-power lasers and light emitting diodes (LEDs) and hard disks.

A heat sink is a heat exchanger component attached to a device used for **passive cooling**. It is designed to increase the surface area in contact with the cooling fluid surrounding it, such as the air thus allowing it to remove more heat per unit time. Other factors which improve the thermal performance of a heat sink are the approach air velocity, choice of material – usually an aluminum alloy due to its high thermal conductivity values (229 W/m^{o}K), fin (or other protrusion) design and surface treatment.



Figures: Above A fan-cooled heat sink on the processor of a PC. To the right of it is a smaller heat sink cooling another integrated circuit of the motherboard. Below 3 types of Heat-sink design: *Pin*, *Straight* (running the entire length of the heat sink), *Flared*.

The approach air velocity depends on the attached or nearby fan. When there is no air flow around the heat sink, energy cannot be transferred. A computer fan is any fan inside, or attached to, a computer case used for **active cooling**, and may refer to fans that draw cooler air into the case from the outside, expel warm air from inside, or move air across a heat sink to cool a particular component.

Case:
A computer case (also known as a computer chassis, cabinet, box, tower, enclosure, housing, system unit or simply case) is the enclosure that contains most of the components of a computer (usually excluding the display, keyboard and mouse). If you are building your own computer selecting the case will be one of your first choices to make: the type of case, its size, orientation, the number of bays you will need etc.

Figure: shows a stripped ATX desktop case. The motherboard will lie flat on the bottom, against the right panel, with peripheral connectors protruding through the rear panel, drive bays at the top and front, and the power supply at the top and rear.

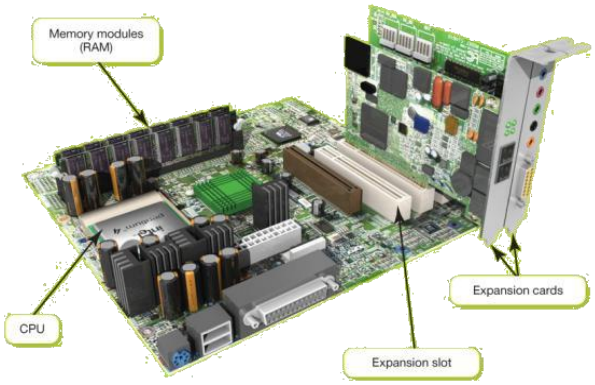
Sizes
Cases can come in many different sizes (known as **form factors**). The size and shape of a computer case is usually determined by the form factor of the motherboard, since it is the largest component of most computers. Consequently, personal computer form factors typically specify only the internal dimensions and layout of the case.

For example, a case designed for an ATX motherboard and power supply may take on several external forms, such as a *vertical tower* (designed to sit on the floor, height > width) or a *flat desktop* (height < width) or *pizza box* (height ≤ 2 inches, designed to sit on the desk under the computer's monitor). Full-size tower cases are typically larger in volume than desktop cases, with more room for drive bays and expansion slots. *Desktop cases*—and *mini-tower* cases designed for the reduced microATX form factor—are popular in business environments where space is at a premium.

Major Component Locations:
1. The motherboard is usually screwed to the case along its largest face, which could be the bottom or the side of the case depending on the form factor and orientation.
2. Form factors such as ATX provide a back panel with cut-out holes to expose I/O ports provided by integrated peripherals, as well as expansion slots which may optionally expose additional ports provided by expansion cards.
3. The power supply unit is often housed at the top rear of the case; it is usually attached with four screws to support its weight.
4. Most cases include drive bays on the front of the case; a typical ATX case includes a 5.25" bay (used mainly for optical drives) and 3.5" bays used for hard drives, floppy drives, and card readers.
5. Buttons and LEDs are typically located on the front of the case; some cases include additional I/O ports, temperature and/or processor speed monitors in the same area.
6. Vents are often found on the front, back, and sometimes on the side of the case to allow cooling fans to be mounted via surrounding threaded screw holes.

Manufacturers: Asus, Intel

Motherboard:
The motherboard is the key circuit board holding the essential processing parts of a computer. It allows all the parts of your computer to **receive power and communicate with one another**. It is usually screwed to the case along its largest face, which could be the bottom or the side of the case depending on the form factor and orientation. The **form factor** describes the shape and layout of the motherboard. It affects where individual components go and the shape of the computer's case. Attached directly to the motherboard are the CPU, RAM, expansion cards, networking, video, and audio components.



Figures: *Above:* An older motherboard, *Below*: the Intel Z77 motherboard.

ATX (**A**dvanced **T**echnology e**X**tended) is a motherboard form factor specification developed by Intel in 1995. A full-size ATX board is 12 × 9.6 in (305 × 244 mm). It was the first big change in computer case, motherboard, and power supply design in many years, improving standardization and interchangeability of parts. The specification defines the key mechanical dimensions, mounting point, I/O panel, power and connector interfaces between a computer case, a motherboard, and a power supply. The specification has been revised numerous times since 1995, the most recent being version 2.3, released in 2007.

Standards: ATX, standards for smaller boards: microATX, FlexATX and mini-ITX.

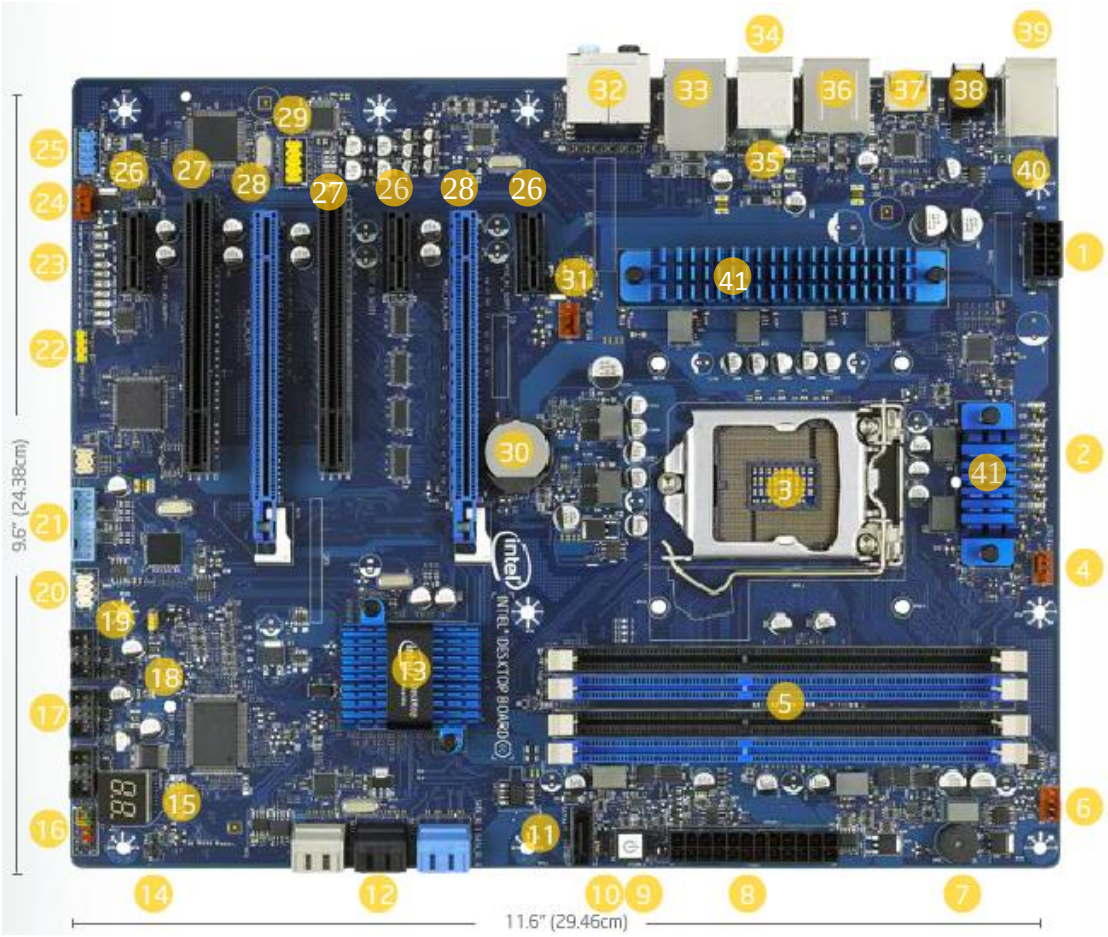


Figure: the Intel Z77 motherboard (Plan View). (Intel, 2014b)

1. 12V Processor Core Voltage Connector (8 pin)	15. POST Code LED Display	29. High Definition (HD) Audio AC97 Front Panel Header
2. Voltage Regulator status LEDs	16. Front Panel Header	30. CMOS RAM Battery
3. Processor Socket (LGA1155)	17. USB 2.0 Dual-Port Header (black)	31. Rear Chassis Fan Header (4 pin)
4. Processor Fan Header (4 pin)	18. Chassis Intrusion Header	32. 5 port audio with S/PDIF
5. Memory Slots	19. BIOS Configuration Jumper	33. Intel Gigabit (10/100/1000 Mb/s) Ethernet LAN
6. Front Chassis Fan Header (4 pin)	20. Consumer IR (CIR) headers	34. IEEE 1394a port
7. Onboard Speaker	21. USB 3.0 Front Panel Connector (blue)	35. External Serial ATA (eSATA) port (3 Gb/s)
8. Main Power Connector (2x12 pin)	22. S/PDIF out Header (4 pin)	36. USB ports: 4 USB 3.0 ports (blue) 2 USB 2.0 ports (black)
9. Onboard Power Button	23. Diagnostic Status LEDs	37. Graphics ports
10. +5V Standby Power Indicator LED	24. Auxiliary chassis fan header (4 pin)	38. Back to BIOS button
11. SATA 3.0 Connector (black)	25. IEEE 1394a front panel header	39. PS/2 port
12. SATA Ports: (4 SATA 6.0 ports (blue & grey) (2 SATA 3.0 ports (black)	26. PCI Express 2.0 x1 connector	40. USB 2.0 ports (yellow) 2 high current/ fast charging ports
13. Intel z77 Express Chipset	27. Conventional PCI bus connector	41. Voltage Regulator modules with heat sinks
14. Alternate Front Panel Power LED Header	28. PCI Express 3.0 x16 connector	

Figure: the Intel Z77 Motherboard (North View).

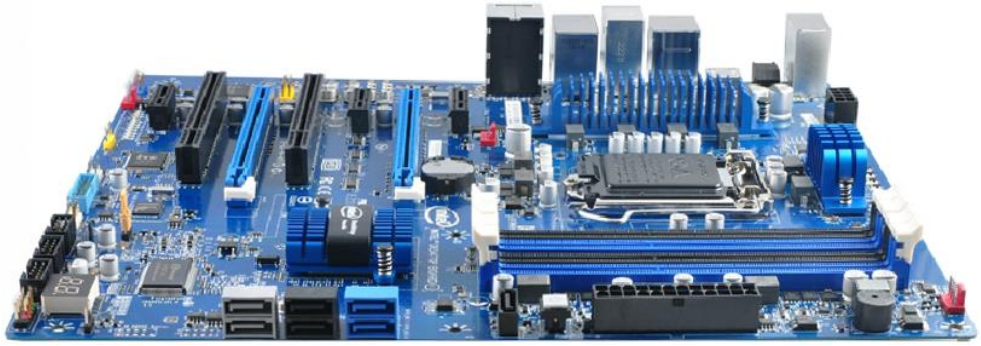


Figure: the Intel Z77 Motherboard (South View).

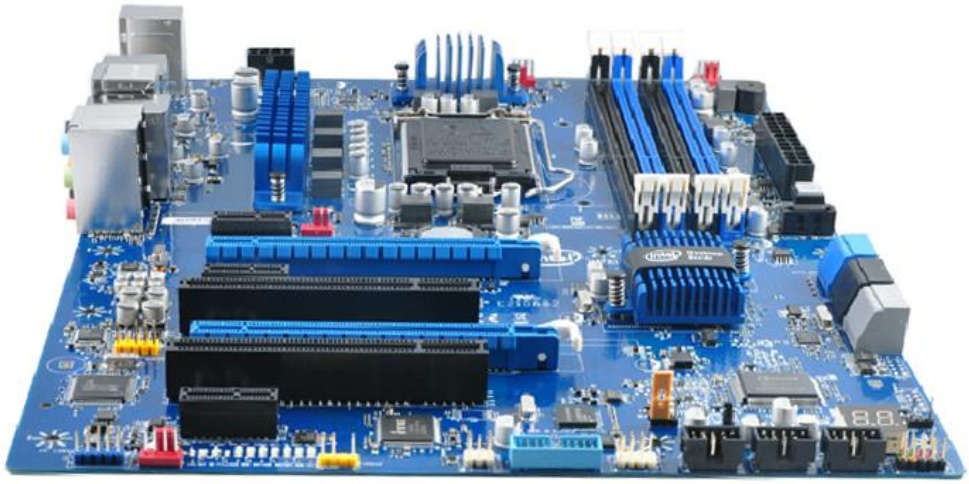


Figure: the Intel Z77 Motherboard (West View).

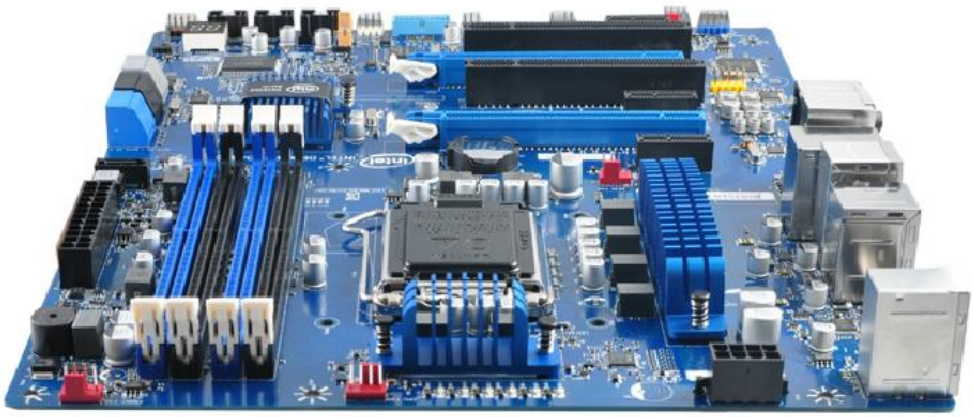


Figure: the Intel Z77 Motherboard (East View).

Expansion Cards:

Special expansion cards are one way to add new types of ports to an older computer or to expand the number of ports on your computer. Like other expansion cards, these cards clip into an open **expansion slot** on the motherboard.

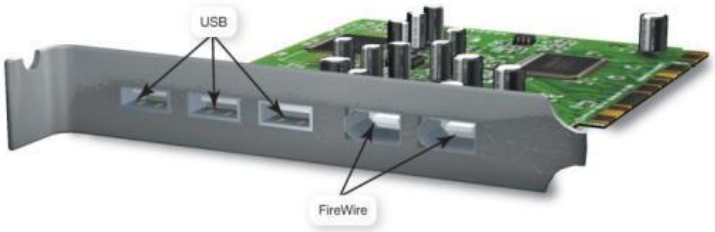


Figure: An expansion card with 3 USB ports and 2 Firewire ports.

Video (Graphics) Card:

A **dedicated** video card (or video adapter) is an expansion card installed inside your system unit to translate binary data received from the CPU or GPU into the images you view on your monitor. It is an alternative to the **integrated** graphics chip.

Modern video cards include ports allowing you to connect to different video equipment; also they contain their own RAM, called **video memory**.

Video cards also come with their own **processors** or **GPUs**. Calls to the CPU for graphics processing are redirected to the processor on the video card, significantly speeding up graphics processing. Updating to a dedicated graphics card offloads work from the CPU and system RAM, so not only will graphics processing be faster, but the system's overall performance will improve.

The video card also controls the number of colors your monitor can display. The number of bits the video card uses to represent each pixel on the monitor (referred to as the **bit depth**) determines the color quality of the image displayed. The more bits available, the better the color detail of the image.

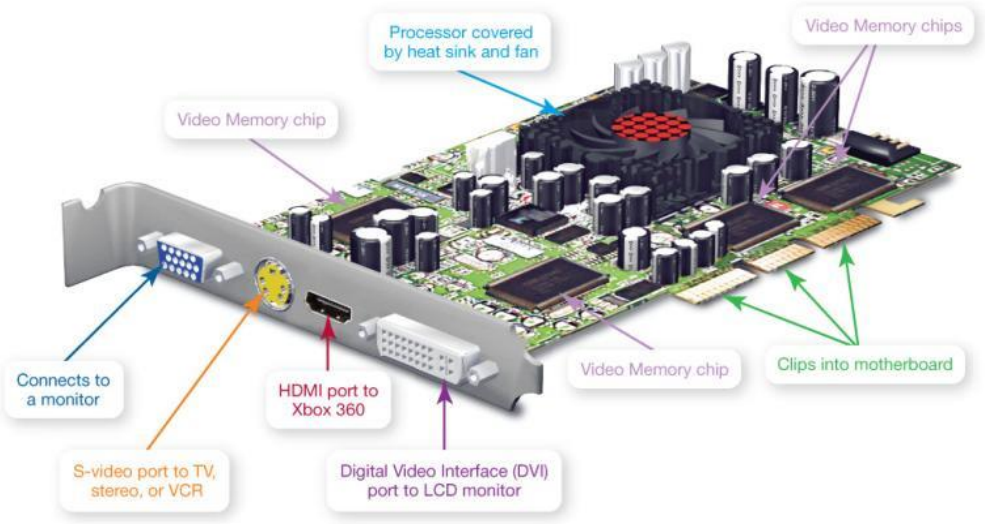


Figure: A Graphics card with output ports for both digital and analog video. The GPU sits under the fan (red) and heatsink.

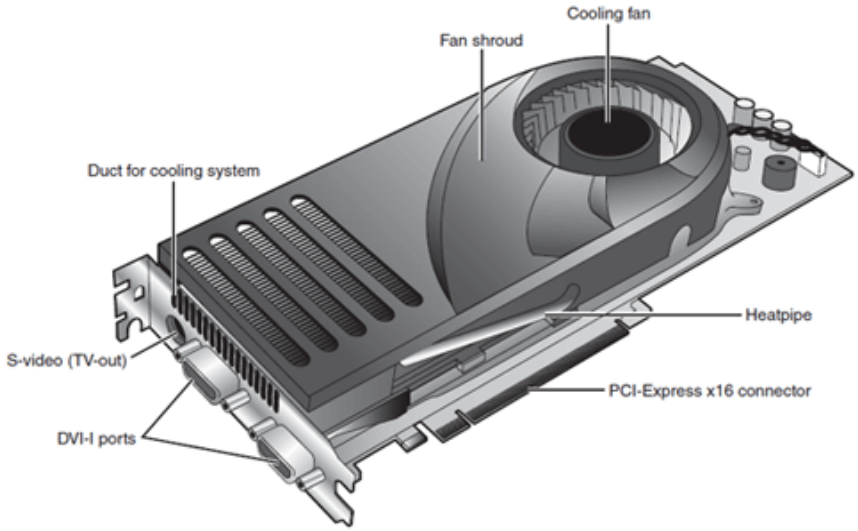


Figure: A mid-range video card optimized for dual-GPU gaming (NVIDIA SLI)

Manufacturers: Nvidia (GeForce [4]), AMD (Radeon).

Sound Card

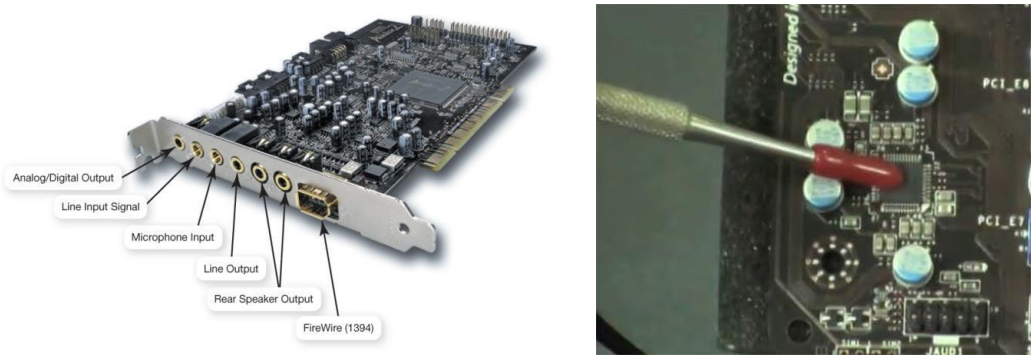


Figure: Left An older sound card expansion card. Right Sound card module as an integrated circuit on the Z77 motherboard. Indicator is showing the RealTek audio chip. In the bottom right you see the front panel audio connector which would be plugged into the microphone jack and headphone jack on the front of the case.

- Sound cards attached to the motherboard and enabled your computer to record and reproduce sounds.
- Most computers ship with a basic sound card, most often a 3D sound card. 3D sound is better than stereo sound at convincing the human ear that sound is omnidirectional, meaning that you can't tell what direction the sound is coming from. This tends to produce a fuller, richer sound than stereo sound.
- To set up surround sound on your computer, you need two things: a set of surround-sound speakers and a sound card that is Dolby Digital compatible. There are many formats to choose from such as Dolby Digital EX, Dolby Digital Plus, and Dolby TrueHD.

The ports on the sound card allow you to connect additional audio devices such as amplified speakers, headphones, microphones etc.

[4] The technology demos from Nvidia used to showcase the rendering power of the chip. See YouTube and http://www.nvidia.com/coolstuff/demos

Network Card:

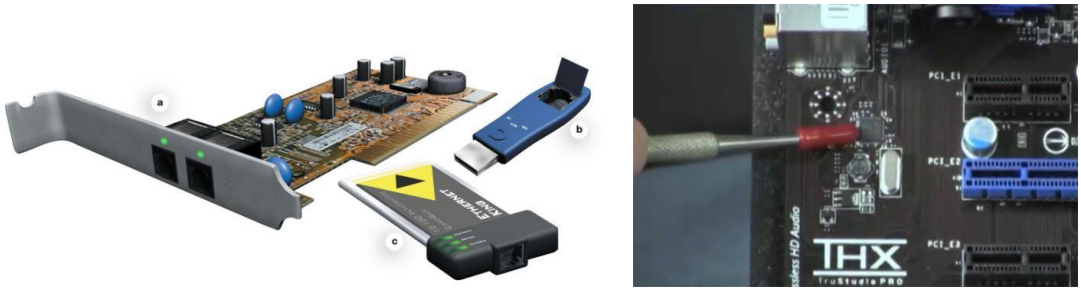


Figure: Left An older Network card expansion card. Right The Gigabit Ethernet Card as a integrated circuit on the Z77 motherboard. The indicator is pointing to the Gigabit Ethernet chip, while just below it is a crystal.

An Ethernet network requires that you install or attach network adapters to each computer or peripheral you want to connect to the network. Most computers come with Ethernet adapters preinstalled as **network interface cards** (NICs).
If your computer doesn't have a NIC, your options are: (i) buy one and install it, or (ii) use a USB adapter, which you plug into any open USB port on the system unit.

RAM Memory:
Random access memory (RAM) is a series of small cards or modules plugged into slots on the motherboard. The CPU can request any data in RAM. It is then located, opened, and delivered to the CPU for processing in a few billionths of a second. Since all the contents of RAM are erased when you turn off the computer, RAM is the temporary or **volatile** storage location for the computer.

Figure: A RAM Memory Module.

Operation:
Similar to a microprocessor, a memory chip is an integrated circuit (IC) made of millions of **transistors** and **capacitors**. In the most common form of computer memory, **dynamic random access memory** (DRAM), a transistor and a capacitor are paired to create a **memory cell**, which represents a single bit of data. The capacitor holds the bit of information - a 0 or a 1. The transistor acts as a switch that lets the control circuitry on the memory chip read the capacitor or change its state.

A capacitor is like a small bucket that is able to store electrons. To store a 1 in the memory cell, the bucket is filled with electrons. To store a 0, it is emptied. The problem with the capacitor's bucket is that it has a leak. In a matter of a few milliseconds a full bucket becomes empty. Therefore, for dynamic memory to work, either the CPU or the memory controller has to come along and recharge all of the capacitors holding a 1 before they discharge. The capacitors must to be energized every 15ms or so (hundreds of times per second) to maintain their charge. To do this, the **memory controller** reads the memory and then writes it right back. This is **refresh operation** happens automatically and is how dynamic RAM got its name. Dynamic RAM has to be dynamically refreshed all of the time or it forgets what it is holding. The downside of all of this refreshing compared to SRAM is that it takes time and slows down the memory.

How Much RAM do you need?

The amount of RAM actually sitting on memory modules in your computer is your computer's **physical memory**. The memory that your operating system uses is referred to as **kernel memory**. To determine how much RAM your computer needs, look at the memory requirements for each program and add them up.

- You need RAM for the operating system, application software, and data. If your system responds slowly or accesses the hard drive constantly, then you need to add more RAM

Table: Sample RAM requirements:

Application	**Minimum RAM Required**
Windows 7	1000 MB
Microsoft Office Professional 2007	256 MB
Internet Explorer 8	128 MB
iTunes	256 MB
Adobe Photoshop Elements	512 MB
Total RAM required to run all programs simultaneously	*2,152 MB or 2.15 GB*

To save data more permanently, you need to save it to the hard drive or to another permanent storage device such as a CD or flash drive.

Read-only memory (ROM) holds all the instructions the computer needs when it is powered on. The data does not get erased when the power is turned off.

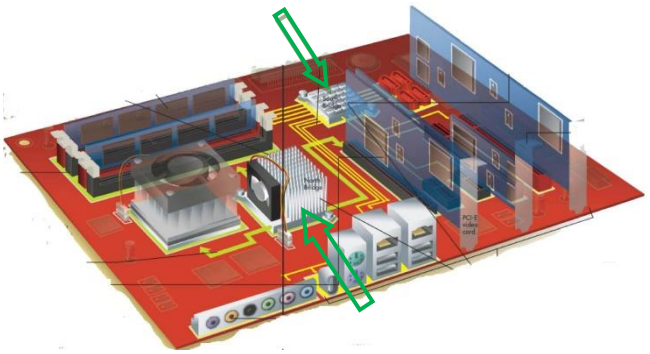


Figure: the Motherboard with the North Bridge and South Bridge highlighted on an older motherboard

Figure: the Z77 Motherboard – the i-series CPU has made the NorthBridge chip obsolete.

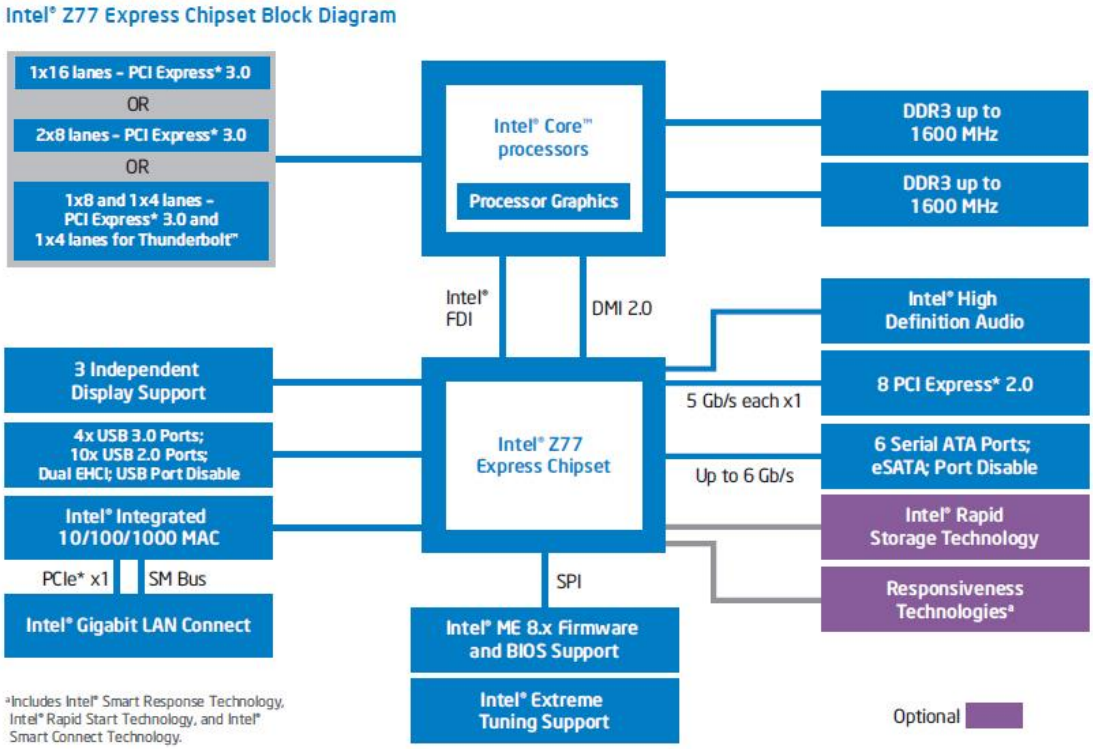


Figure: Intel z77 Express Chipset Block Diagram

PCI Bus:

The **Peripheral Component Interconnect** (PCI) bus produced by Intel in 1992 provided direct access to system memory for any connected hardware devices.

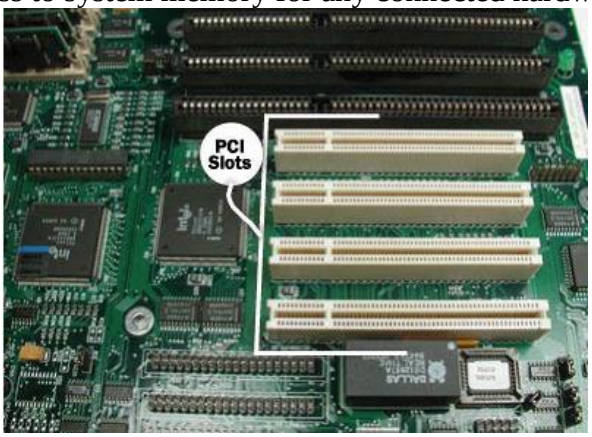


Figure: PCI slots on a motherboard.

This bus allowed multiple packets of information from different sources to travel down it simultaneously. Previously it was used to connect to the graphics card and this setup meant that information from the graphics card travelled through the bus along with any other information coming from a device connected to the PCI. When all the information arrived at the CPU, it had to wait in line to get time with the CPU. This system worked well for many years, but eventually the PCI bus could not keep up. The Internet and most software were more and more graphically oriented, and the demands of the graphics card needed priority over all other PCI devices.

This is now a **legacy** technology and is used for functions that do not require great quantities or speed in data transmissions. PCI slots were mainly used for network, graphics and sound cards.

Figure: PCI card showing the pins (4+2+24+10+8+2) and PCI bridge chip.

PCI cards use 47 pins to attach to a PCI slot. Pins are thin metal feet that allow computer chips to be attached to a circuit board. AGP replaced the PCI as the standard way to connect a graphics card to the motherboard.

Operation:
A PCI-Express bus breaks all data (payload) it handles into pieces and wraps the pieces in a **packet**. The packet includes other binary codes that identify where the information has come from, its destination, its sequence among all the other packets being sent, and the results of a **cyclic redundancy check** (CRC). A CRC is a mathematical operation that detects transmission errors in the data. [7]
e.g. 8b/10b means **8 bits of data transferred for every 10 bits sent**

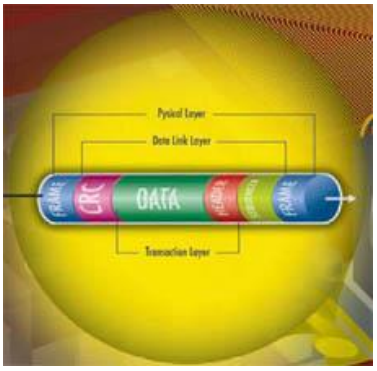


Figure: A Packet and its constituents: Frame Number, CRC, Data (Payload), Header, Footer.

After subtracting the overhead for packet packaging, the basic PCI-Express x1 slot has a top bandwidth of 250 Megabytes a second (MB/s). But PCI-E is scalable. Devoting two or more lanes to send data to and from a single component - called **channel bonding** - increases the bandwidth for each lane added to the channel. PCI-E transfers data at 250 MB/s in each direction per lane. A lane is composed of two differential signalling pairs: one pair for receiving data, the other for transmitting. Thus, each lane is composed of four wires or signal traces.

With a maximum of 32 lanes, PCI-E 1.0 allows for a total combined transfer rate of 8 GB/s in each direction. That gives a single channel nearly twice the bandwidth of the older PCI and an eight lane slot a data rate comparable to the fastest version of AGP. You can identify the expansion slots with the increased bandwidth by comparing the slots' lengths. The basic PCIe **x1** slot is about 24.5mm long. Each 13.5mm added to other slots represents another 250MB added to their bandwidth.

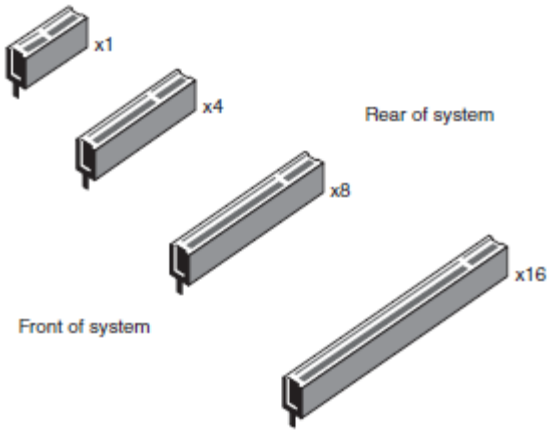


Figure: PCI express x1, x4, x8 and x16 connector slots. x4 and x8 appear mainly in servers.

[7] Checksum (summation check) – a technique for determining whether a package of data is valid. The package, a string of binary digits, is added up and compared with the expected number.

1. The chipset sends packets serially over two lines. Another pair of lines is responsible for packets going in the opposite directions. Taken together, the two pairs are called a **lane**. One of the lines in each pair carries the original signal. The other line carries a negative image of the signal; each 0 becomes a 1 and each 1 becomes a 0 (**differential signalling**). The lines are laid out so that any electrical noise, or static, that affects one line should also affect the other.
2. When packets reach their destination, the receiver restores the negative packet to its positive version. That same operation reverses the values of any junk signals introduced by electrical interference. The bus combines the two paired packets, and any interference in the original packet is cancelled by its negative image in the matching packet.
3. It also performs the same CRC operation that was performed on the packet before its journey and compares its result to the earlier one bundled into the packet. If CRCs differ, the bus orders the packet be re-sent. Since the sequence of the data in each packet is included in the packet, the bus doesn't have to wait for the corrected packet. It can continue to accept other packets and then put them all back in the correct order when all the packets have been received.

PCI Express Version	Bandwidth *	Bandwidth ǂ	Encoding	Year Released
1.0	250MB/s	(2 GB/s)	8b/10b	2002
2.0	500MB/s	(4 GB/s)	8b/10b	2007
3.0	1000MB/s	(~ 8 GB/s)	128b/130b	2010

*** Per lane, in each direction ǂ Per 8 lanes, in each direction**

(IDE) ATA Interface:

Usually, these devices connect to the computer through an **Integrated Drive Electronics** (**IDE**) interface. Essentially, an IDE interface is a standard way for a storage device to connect to a computer. IDE is actually not the true technical name for the interface standard. The original name, **AT Attachment** (ATA) or parallel ATA, signified that the interface was initially developed for the IBM AT computer. We will learn about the evolution of IDE/ATA, what the pinouts are and exactly what "slave" and "master" mean in IDE.

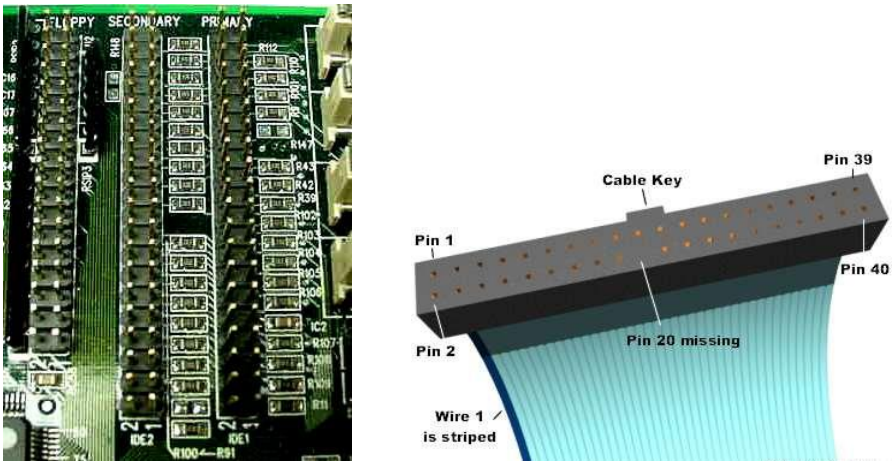


Figure: *Left* A close-up of the primary and secondary IDE interfaces on a motherboard; *Right* The connector on an IDE cable, the stripe denotes where to align with Pin 1.

IDE quoted upper transfer rates of 133MB/s. Above that, crosstalk, or electrical interference, from their 40-wire parallel cables drowns out meaningful communication.

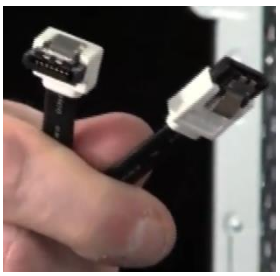
Serial ATA (SATA):
Serial ATA was designed to replace the older parallel ATA (PATA) standard (often called by the old name IDE), offering several advantages over the older interface:

1. reduced cable size (7 conductors compared to 40 with the wider PATA ribbon cable) – which facilitates a more efficient airflow inside a form factor and also allows for smaller chassis designs as well as a reduced cost,
2. native hot swapping,
3. faster data transfer through higher signalling rates, and
4. more efficient transfer through an (optional) I/O queuing protocol.

The SATA standard defines a data cable with seven conductors (3 grounds and 4 active data lines in two pairs of conductors) and 8 mm wide wafer connectors on each end. The three grounding wires dampen any crosstalk. A SATA cable can have a length up to 1 metre (3.3 ft), and connects one motherboard socket to one hard drive.

SATA revision	Bandwidth (Coded)	Bandwidth (Actual)	Year
1.0	1.5 Gbit/s	1.2 Gbit/s (150MB/s) *	2003
2.0	3 Gbit/s	2.4 Gbit/s (300MB/s) *	2005
3.0	6 Gbit/s	4.8 Gbit/s (600MB/s) *	2009

* 8b/10b encoding


Pin #	Mating	Function
1	1st	Ground
2	2nd	A+ (Transmit)
3	2nd	A− (Transmit)
4	1st	Ground
5	2nd	B− (Receive)
6	2nd	B+ (Receive)
7	1st	Ground

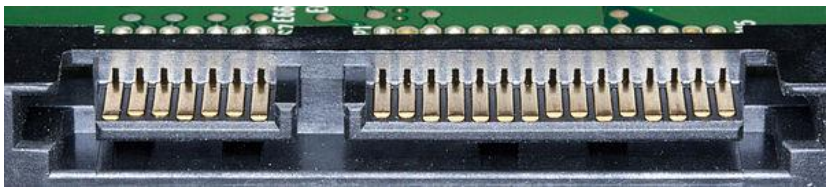
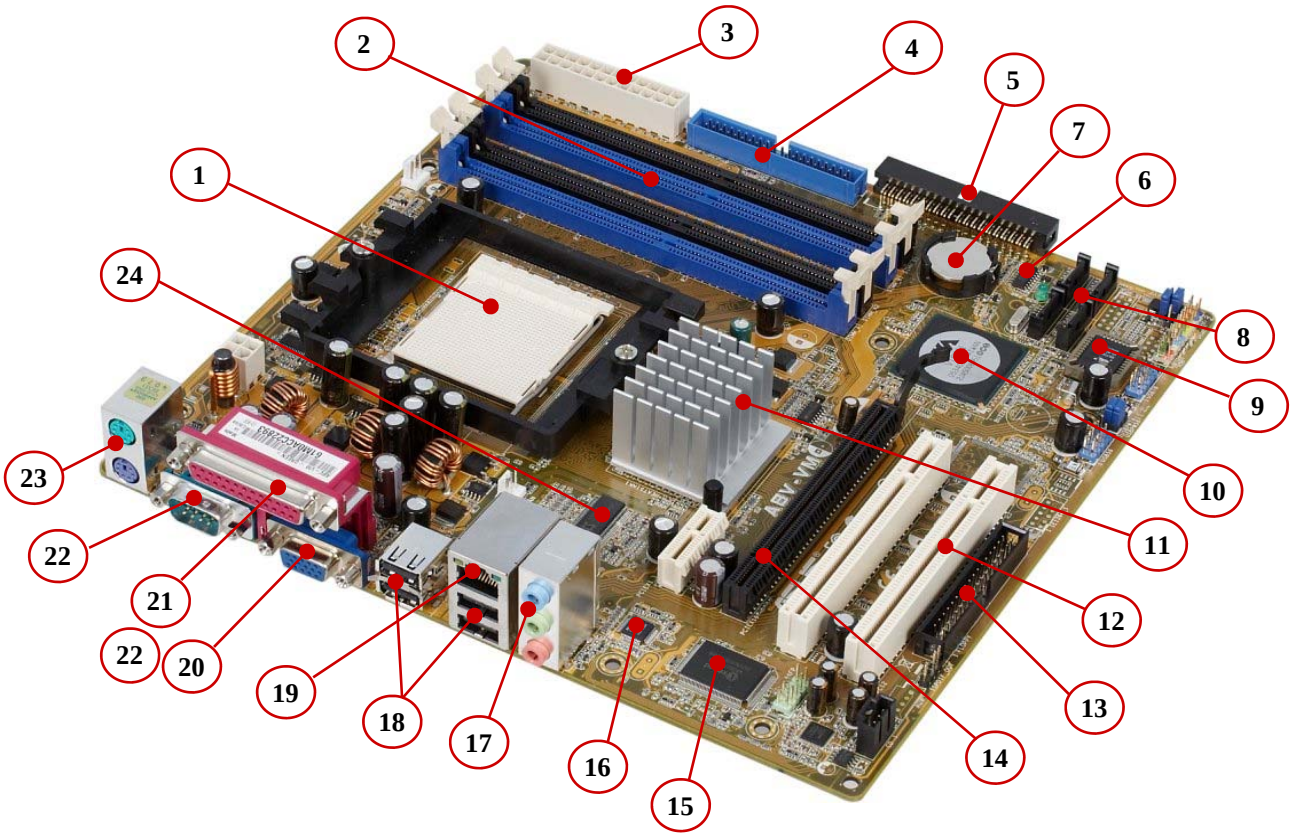


Figure: *Left* The 7-Pin SATA data cable (angled end); *Middle* The SATA data cable (angled and straight ends); *Right* The SATA connectors on the motherboard (straight);
Below Left The SATA Data connector Pinout; *Below Right* The SATA connector on a hard drive (7 pin data connector on the left and 15 pin power connector on the right). Pins are spaced 1.27mm apart.

The Motherboard

Often called the **mainboard** or **system board**, it is the main circuit board for the computer system. Every device in the computer system will either be part of the motherboard or connected to it.



The motherboard shown above is an **Asus A8V-VM**. This board is designed for **AMD** processors. The main parts of the motherboard are:

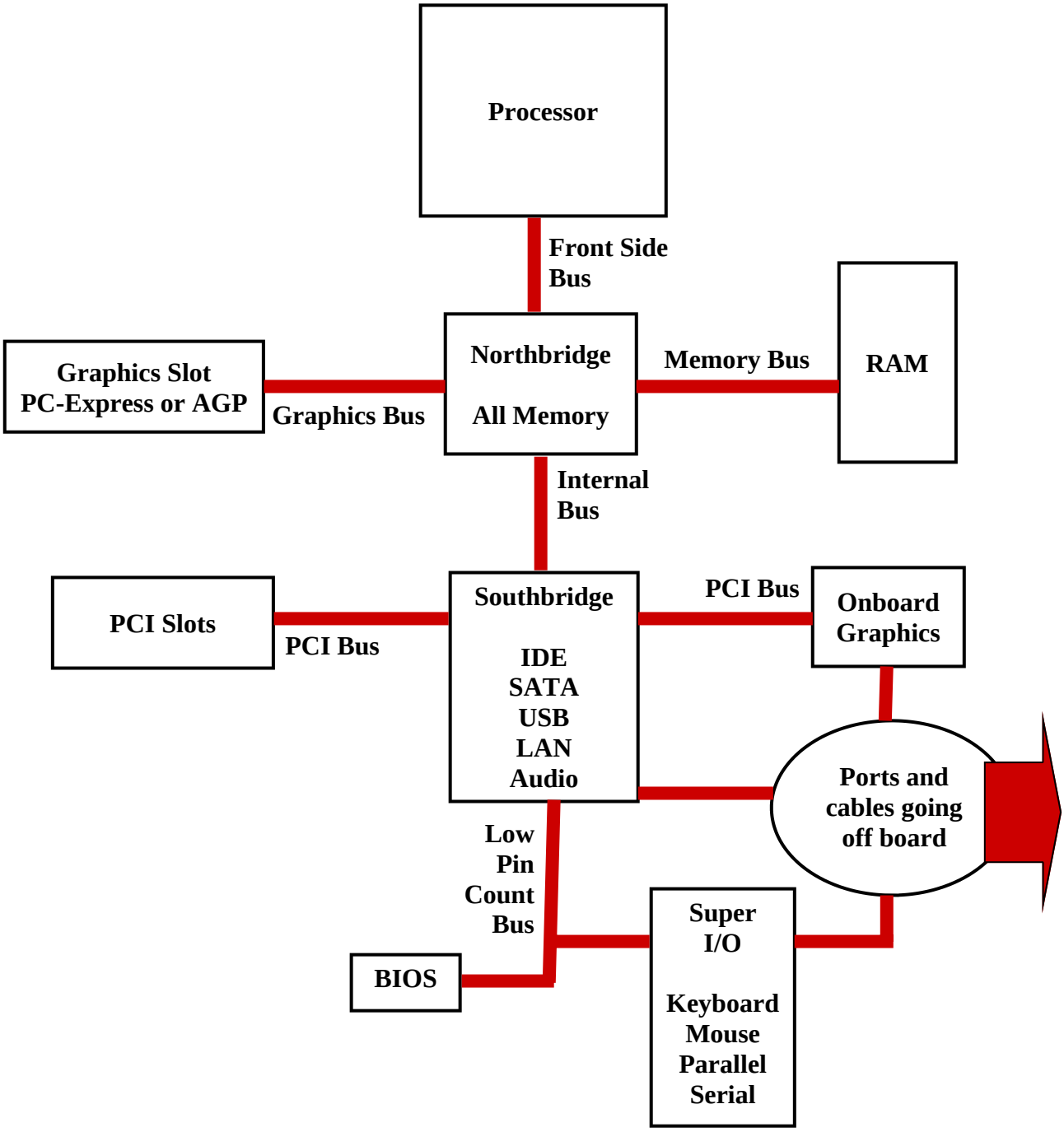
1	**Processor socket**	This socket is an AMD 939 pin socket. It is designed for the Athlon X2 processor. Different processors require different sockets and a motherboard must be chosen to suit the processor intended for use.
2	**Memory sockets**	The board has four memory sockets and accepts DDR 266/333/400MHz memory up to a total of 4GB
3	**Power connector**	The power supply connects here and supplies appropriate power to the different components on the motherboard.
4	**Primary IDE**	Hard drives can be either IDE (Integrated Drive Electronics) or SATA (Serial Advanced Technology Attachment). If an IDE hard drive is being used, it should connect to this socket.
5	**Secondary IDE**	This could be used to connect a second IDE drive. This could be a second hard drive or an Optical drive - DVD or CD drive.
6	**CMOS RAM chip**	A DRAM chip used to store the date and time and any user settings added to the setup screen. Complementary metal oxide semiconductor is the material the chip is made from.

7	**CMOS battery**	Because the CMOS chip is a DRAM chip, it is volatile and would loose data when the computer is switched off. The battery preserves the data in the CMOS RAM chip when the computer is powered down.
8	**SATA connectors**	Used to connect SATA hard drives and optical drives
9	**BIOS chip**	Basic Input/Output System. A chip holding the start-up routine for the computer system. It runs a program to test the hardware of the system. It the test is successful, a single beep is sounded. If not, a series of beeps are sounded and these beep patterns can be used to identify the failing component.
10	**Southbridge chip**	Forms the chipset with the northbridge. Between them they control the buses on the motherboard. Buses are the data pathways between the motherboard components. The southbridge controls the slower buses like the IDE bus, SATA bus, USB bus etc.
11	**Northbridge chip**	Controls the faster buses on the motherboard. These include the front side bus (between the processor and main memory) and the graphics bus.
12	**PCI sockets**	Peripheral Component Interconnect sockets used to connect expansion cards like modems, network cards, TV tuner cards etc.
13	**FDD connector**	For connecting a floppy disk drive.
14	**PCI-Express**	The graphics card connects here. Other motherboards have an AGP (accelerated graphics port) slot.
15	**Super I/O chip**	Controls the serial, parallel, mouse and keyboard ports at the back of the computer system.
16	**Network chip**	Controls the network port at the back of the computer
17	**Audio ports**	For connecting speakers, microphones etc.
18	**USB ports**	The current standard for connecting peripherals.
19	**Network port**	Used to connect the computer to a network
20	**Video port**	Connect the monitor to this port if a PCI-Express graphics card is not being used.
21	**Parallel port**	Largely obsolete. Used to connect printers and scanners.
22	**Serial port**	Largely obsolete. Used to connect external modem etc.
23	**PS2 ports**	The keyboard connects to the purple port and the mouse connects to the green port. Largely replaced by USB.
24	**Audio chip**	Controls the onboard audio system.

Chipset

The flow of data around the computer is controlled by the **Chipset**. This consists of two chips:

- **Northbridge**: This chip controls the flow of data between memory and the processor. It also controls the flow of data between the processor and the graphic's card.
- **Southbridge**: This chip controls the flow of data to the slower devices. These include USB, IDE, SATA, LAN and Audio devices. It controls the PCI slots and the onboard graphics chip. It delegates control of the keyboard, mouse, parallel and serial ports to the Super I/O chip.



Buses

A bus is a set of wires through which data can be sent to the different parts of the computer system. Buses connect the major computer derives to each other. The chipset uses the buses to send data around the motherboard. The main buses are:

- **Front side bus**: Connects the processor to the northbridge.
- **Memory bus**: Connects the northbridge to the main memory.
- **Graphics bus**: Connects the northbridge to the PCI-Express or AGP graphics slot.
- **Internal bus**: Connects the northbridge to the southbridge
- **PCI bus**: Connects the PCI slots and the onboard graphics to the southbridge
- **LPC bus**: Connects low bandwidth devices to the southbridge. These include the BIOS chip and the Super I/O chip which controls the keyboard, mouse, parallel, serial ports etc.

Motherboards are processor specific. The main types available are:

- **Socket 478**: Intel Pentium IV processors
- **Socket 775**: Intel Dual Core and Core Duo processors
- **Socket 754**: AMD Athlon processors
- **Socket 939**: AMD Athlon 64 processors
- **Socket AM2**: AMD Athlon X2 processors

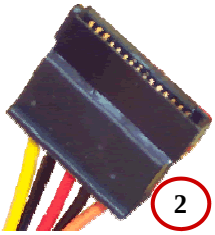
The Power Supply

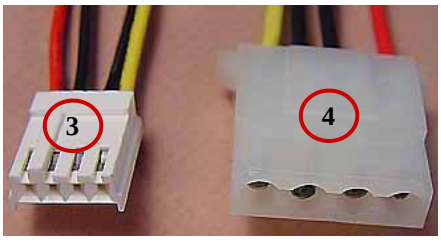
The power supply can be seen from the back of the system unit. The mains cable is plugged into the power supply. A computer power supply has a number of functions:

- It converts the power from **Alternating current** (AC) as supplied by the electric supplier to **Direct current** (DC) as required by the computer system.
- It transforms the 240 Volts supplied by the electric supplier into the voltages required by the computer system. The main voltages are:
    - **12 volts** for the disk drives as they have motors
    - **3.3** and **5 volts** for the circuit boards in the computer.
- It uses advances power management (**APM**) to allow the computer go into a standby mode.
- Some have a switch to toggle between 240 volt supplies and 110 volt supplies.

The power supple has a number of connectors to connect to the motherboard, drives etc. The main connectors are:

1	**Main connector**	Connects to the motherboard and supplies the 3.3 and 5 volt supply for the board.
2	**Molex connector**	Connects IDE hard drives and optical drives.
3	**Berg connector**	Connects floppy disk drives
4	**SATA connector**	Connects SATA drives





Power supply

Power supplies are rated in watts. The vary in size from 350 watts to 1000 watts. Using too small a power supply of a low quality one can lead to serious computer problems. Below is shown typical power usage for a number of computer devices:

- Motherboard: 60 watts
- Processor: 90 watts
- Memory: 10 watts/128MB
- Processor fan: 5 watts
- Graphics card: 40 watts
- Hard disk: 25 watts
- Optical drive: 30 watts

As can be seen, a large power supply (at least 400 Watts) is preferable and does not use more energy as it only supplies power on demand.

Ports

Computer ports are interfaces between peripheral devices and the computer system. They are hardware devices built into the motherboard or on expansion cards. They are often built into the front of the computer chassis for easy access but will be cabled back to the motherboard.

Ports at the rear of the computer

Ports at the front of the computer

Serial port

Although more or less obsolete, they are still included in new systems. The serial port is a 9-pin port. Windows calls them Com ports - Com1, Com2 etc. Mice and external modems were connected to these ports. They are **turquoise** in colour.

Parallel port

This 25-pin port is used to connect printers, scanners, external hard disks, zip drives etc. to the computer. It is **burgundy** in colour and windows refers to them as LPT ports - LPT1, LPT2 etc. The original port only supported single direction communication but the modern parallel ports can support bi-directional communications. This is essential for reporting ink levels etc. in printers.

Video port

Used to connect a monitor to the computer system. There are two types:

- **VGA port**: This is a 15-pin port and is **blue** in colour. It is an analogue port and is being replaced by the DVI port.

- **DVI port**: This is **white** in colour and is a digital port. This means that no conversion is necessary between the computer and the monitor and that means that images can be produced more quickly on the monitor.

PS/2 port

PS/2 ports are used to connect keyboards and mice to the computer. The keyboard port is **purple** and the mouse port is **green**.

USB port

The universal serial bus was intended to replace Serial, Parallel and PS/2 ports with a single standard. 127 devices can be connected to a single USB port and computers are often supplied with six to ten ports. USB is **hot swappable** which means that devices can be connected and disconnected without turning off the computer system, something that should never be attempted with parallel or serial devices.

There are different USB standards in use:

- **USB 1**: This is the original standard and can transfer data at **1.5MBps**. This is too slow for external hard disks with capacities of 500GB or more.
- **USB 2**: This is forty times faster than USB1 and has a data transfer rate of **60MBps**. This is the current standard.
- **USB3**: this is tem times faster than USB2 and 400 times faster than the original USB1. it has a data transfer rate of **600MBps** and will be common on new computer systems in 2009.

Firewire port

FireWire (IEEE 1394) is a technology introduced to the computer world by Apple. There are two versions available and a third is planned:

- **FW 400**: This can transfer data at 400Mbps which is **50MBps**. This makes it similar in speed to USB2.
- **FW 800**: This can transfer data at 800Mbps which is **100MBps** making it considerably faster than USB2.
- **FW S3200**: This will transfer data at 3200Mbps which is **400MBps**. It is intended to compete with USB3.

The main difference between USB and FireWire is that USB is **host based** and FireWire is not. USB devices must be connected to a host computer while FireWire devices can be connected to each other without using a computer.

Modem port

Technically known as an **RJ11** port, it is the common telephone socket used in Ireland. Modems will usually have 2 ports side by side. The port marked **Line** should be connected to the wall socket while the port marked **Phone** can be used to connect a telephone. The phone can then be used he when computer is offline or if a V92 modem is used, the Internet can be put on hold while the **incoming** call is taken.

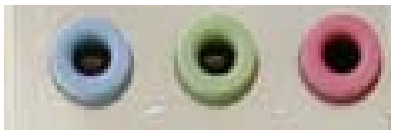
Ethernet port

This port is used to connect to a network. Technically known as RJ45, it is physically bigger than the modem port. They can either be part of the motherboard or on an expansion card.

Audio ports

These ports are used to input and output audio from the computer system. The standard is three mini jack ports but there may be more. The three ports are:

- **Light blue**: Line in - this is used for connecting stereo systems, tape cassette players, record players, radios etc. You can record what is being played on the connected device.
- **Lime**: Connect the speakers to this port.
- **Pink**: Connect a microphone to this port.

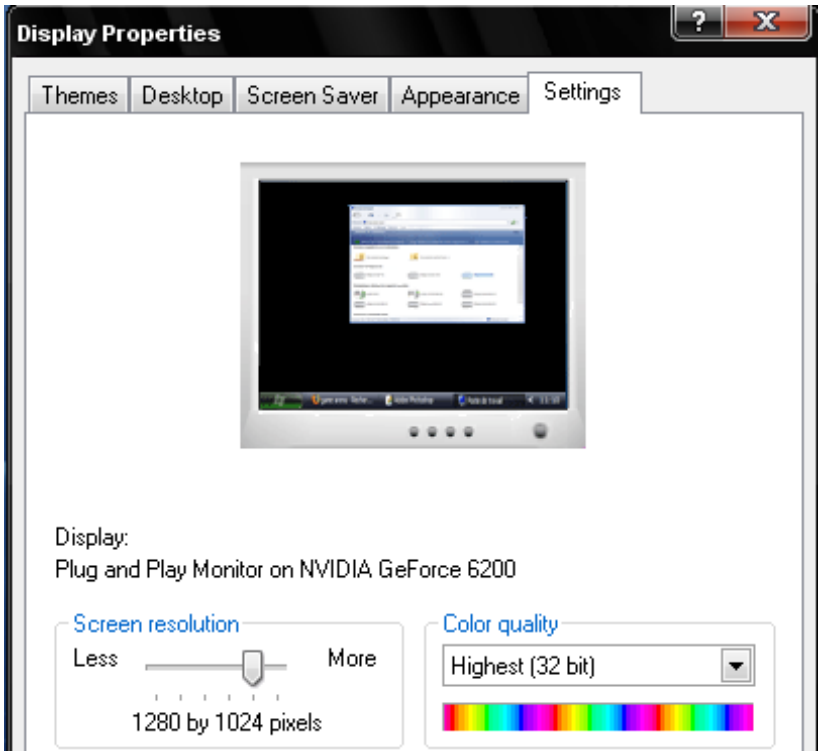


Graphic card

Images displayed on a monitor are made up of dots called **pixels** (picture elements). The graphics card has to decide what to do with each one of these pixels in order to create the required image. In the case of a moving image as in a video file or a game, the task becomes more complex.

The resolution of a screen is the number of pixels being displayed. Typical resolutions include:

- **800 x 600**: 480,000 pixels
- **1024 x 768**: 786,432 pixels
- **1280 x 1024**: 1,310,720 pixels
- **1600 x 1200:** 1,920,000 pixels

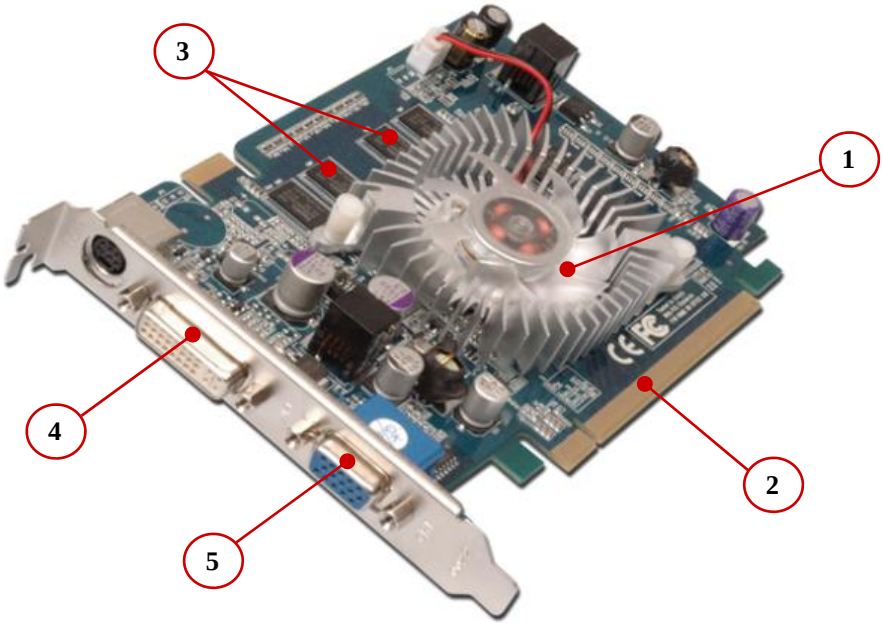


The graphics card must handle each pixel to maintain the image and refresh each pixel 60 to 100 times every second. There are two types of graphic card available:

- **AGP** (accelerated graphics port). This is the older technology but is still available. Depending on the card, it can output in analogue or digital or both.
- **PCI-Express.** This is the newer technology and is faster than AGP. It also allows for the use of two graphics cards working in tandem to improve the performance. This is called **Scalable Link Interface** (SLI) and it allows the two graphics cards to produce a single output. PCI-Express can also output in analogue or digital or both.

These cards are mutually exclusive and the choice is made according to the graphics slot on the motherboard.

A graphics card will have it's own processor and memory built in. The faster the processor and the more memory a graphics card has, the faster and more even the display will be. If the on screen image is jerky or blurred, the graphics card is not good enough for the job. The main parts of a graphics card are:

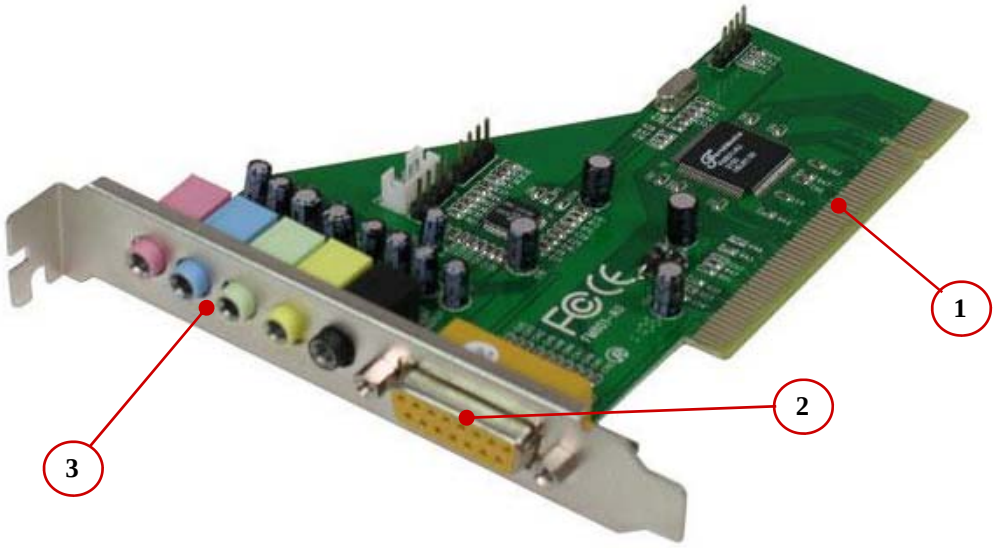


1	**Processor and fan**	This allows the graphics card to manage it's own processing and makes it almost independent of the main computer processor.
2	**Board connector**	This will be either AGP or PCI-Express
3	**Memory**	The graphics card does not need to use any main memory as it has it's own. This makes it much faster. Most new graphics cards use DDR3 memory. Up to 1GB of DDR3 memory is now available on graphics cards although this makes them as expensive as most computer systems.
4	**DVI connector**	Digital output is supplied through this port. If a digital monitor is present, this is the best option as no conversion is required.
5	**VGA connector**	Analogue output is provided through this port. If you have an analogue monitor, you must use this port. If you have a digital monitor, it is best to use the DVI port as the graphics card works in digital and must convert to analogue to use the VGA port.

Computers are often supplied with **integrated graphics cards**. This means that the main memory must be used to control the graphics system and the main processor must supply most of the processing power. This is perfectly OK on an office computer where word-processing etc ate the main activities. Introduce CAD etc. and the system becomes unusable.

Sound card

In recent years, computers have become entertainment centres with media centre operating systems controlling TV and video. The need for good quality sound and even surround sound has made it almost standard on most computers. Most computers are supplied with an integrated sound system and this is sufficient for most applications. A sound card can be fitted to an empty PCI slot and the integrated chip turned off if the extra features of a card are required.



1	**PCI connector**	Used to connect the sound card to a PCI slot on the computer motherboard.
2	**MIDI socket**	Musical Instrument Digital Interface port is used to connect digital musical instruments to the computer. This port is no longer supplied on integrated systems and if one is needed, the only option is to fit a sound card to the computer system.
3	**Audio jacks**	These are used to connect microphones, speakers, stereo systems etc to the computer.

The main functions of a sound card are:

- To use a **DAC** (digital to analogue converter) to prepare audio for speakers etc.
- To use an **ADC** (analogue to digital converter) to convert the audio coming into the computer.

A sound card can be connected to the following:

- Analogue input devices - Microphone, Radio, Tape deck, Record player etc
- Headphones and speakers
- Output to tape etc.