

# Your PC, Inside and Out

## PART I: Chassis, Power Supply and Motherboard



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# YOUR PC, INSIDE AND OUT: PART 1



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# Introduction

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Why would you want to read this guide? There might be a few different reasons. You might be a budding computer buff, wanting to pad out your knowledge about all things hardware so that you can be the go-to guide for all your friends and family. It's a dark, busy and sometimes very frustrating path to take, but one that is ultimately very satisfying.

You might be a hardware expert on your coffee break, taking a flick through to see if you find something particularly interesting. If that's the case, I've certainly got my work cut out for me!

On the other hand, you might be a complete beginner when it comes to computers, and you're the reader I welcome most of all. I'll try to explain everything in such a way that you can get as much information as you wish, whether it's just the basics or if you want to understand anything in a bit more detail.

This guide is written a little more towards the budding computer buff than the expert or the complete beginner, but there should be something for everybody.

In this guide I'll be breaking the computer down into its different components. For each component I'll describe its function, explain the different specifications to look out for and provide a bit of history, too. I'll also provide the names of a few brands which I personally find to be the best – be it quality, performance, value, or all three.

More for the absolute beginners than anybody else, I'll be using a sort of body part metaphor to make things a little easier to understand.

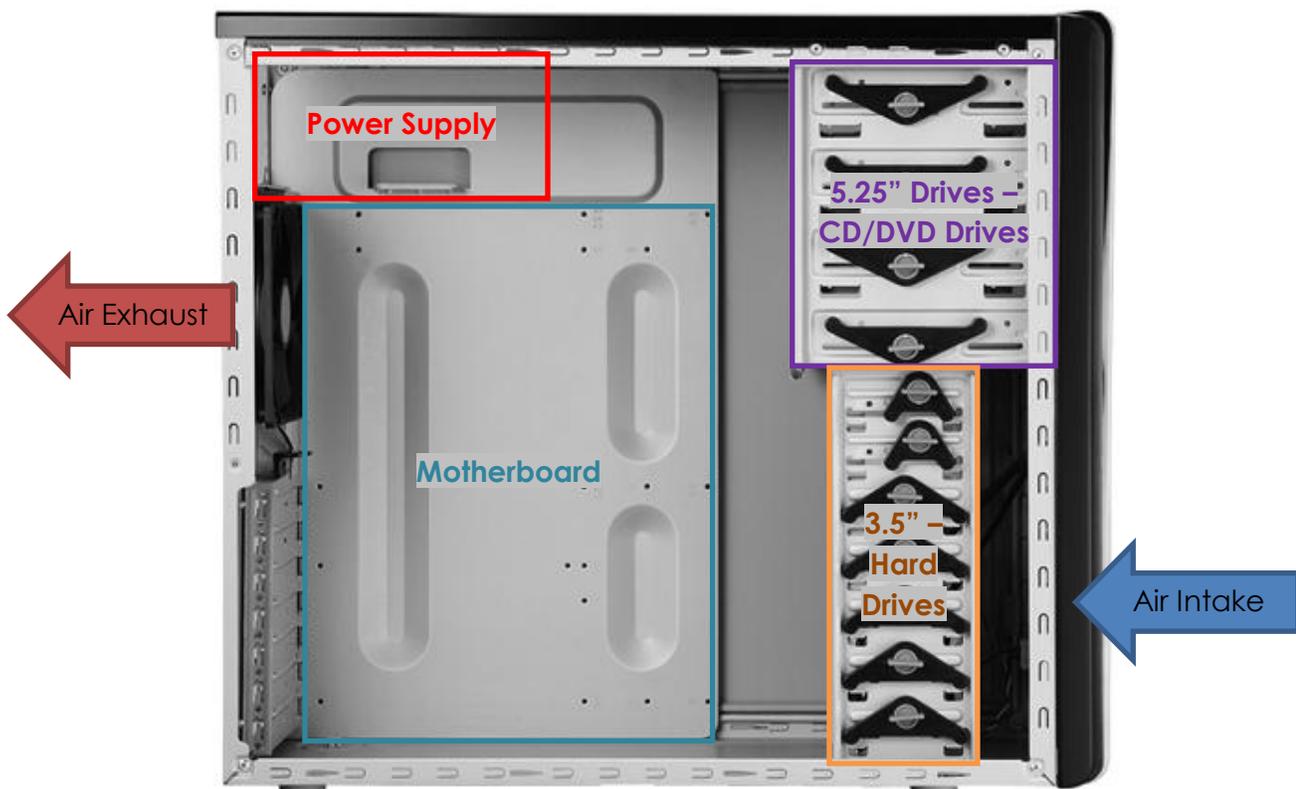
So, without further ado, I'll get started. This first guide covers the chassis, power supply and motherboard; stay tuned to learn about the rest of the computer in part two. Enjoy!

# Chapter 1: The Case (Chassis)

The most obvious part of the computer is often overlooked. As the **skeleton** of the computer, many people think of it as nothing more than something to bolt the components to keep them protected. The case is also instrumental in providing airflow and noise insulation.

## Layout

The layout of the case is quite important, although largely standardised. Until relatively recently, nearly all cases had identical layouts to that in the picture below:



Indeed, most budget cases still use this design, and for good reason – it's a conventional, solid design which works well for a basic computer. However, in the mid-range and high end market a few changes are becoming commonplace.

For example, you may begin to see the power supply being placed at the bottom of the case, below the motherboard instead of above it. This is a sensible idea, as it lowers the centre of gravity significantly. Another possible perk is removable hard drive cages,

sometimes turned sideways (in larger cases) so that the hard drives are facing you as you remove the side panel. This gives you easier access to your hard drives as well as providing more space for longer graphics cards.

There are also some cases that throw convention out the window to great effect. Examples include the [Silverstone Fortress](#) and the [Thermaltake Level 10](#) cases. They provide amazing layouts, although they do so at a great price premium.

## Airflow

Airflow is possibly the most important job of a good case. Components can get very hot, and good airflow is needed to get that heat away from the components. Without sufficient cooling, they can become less reliable over time and degrade faster.

Many cases that you buy yourself may come with only one or two fans but have mounting holes for more, allowing you to add extra ones. The most common fan size is *140mm*, followed closely by *120mm*. *80mm* fans are also relatively common, but usually on smaller computers. Finally, you can also get *92mm*, *60mm* and *40mm* fans, but these aren't used as often.

There are three main airflow models, each having its advantages and disadvantages:

1. **Negative Pressure** – when exhaust exceeds intake. The idea behind this is that a negative pressure gradient is formed, sucking all the hot air out of the case.
2. **Equalised Airflow** – when you have equal air intake and exhaust. This is the most common, and works by creating a wind tunnel.
3. **Positive Pressure** – when, you guessed it, intake exceeds exhaust. The idea behind this is that new air is constantly fed in, pushing hot air out of the case and replacing it with cool air.

The biggest problem with getting a good airflow is the amount of noise generated by the fans, particularly by many small fans. There are usually two solutions to reducing noise:

1. Isolate the fans from the case to prevent noise-creating vibrations to be passed to the main chassis. This does not make the fan itself quieter, but can significantly reduce overall noise. Many higher end cases provide rubber grommets for the fans in their cases for this purpose.
2. Buy better fans – These tend to use *ball bearings* or *fluid bearings* rather than the cheaper *sleeve bearings*. They have the extra bonus of lasting a lot longer, too.

The other alternative is to buy a case with one or more larger fans. These are great because they can generate the same CFM (cubic feet per minute of air, the standard measurement for air throughput for fans) while spinning with fewer RPM (revolutions per minute) and thus creating less noise.

When you go to buy fans, it's much better to get the fans from a well-known brand. You'll pay a bit of a premium, but it's worth it for the lower noise and longer fan life. Some good brands to look out for are *Akasa*, *Antec*, *Noctua*, *Scythe*, and *Zalman*. There are some other good brands out there, but these are *the* ones to get.

If you want to keep your computer as cool as possible, there are a few companies who will be happy to sell you cases designed for airflow. Examples include *Cooler Master's HAF* line (HAF stands for high air flow, funnily enough) or *Antec's Gaming Series* (including the 300, 902 and 1200 cases).

On the other end of the spectrum, for reviews and buying advice for keeping your computer as quiet as possible while still maintaining enough airflow, there's lots of information over at [www.silentpcreview.com](http://www.silentpcreview.com). They've got plenty of reviews on pretty much everything involved in keeping your computer as quiet as possible.

## Noise Insulation

The computer case itself also helps to keep your computer quiet. Computer parts can make a surprising amount of noise (the *processor's heatsink fan* and *hard drives* are the main culprits; *discrete graphics cards* can be very loud, too), and the case can be instrumental in making sure most of it doesn't reach your ears.

Unfortunately, while fairly good at blocking direct noise, cases can sometimes be susceptible to absorbing vibrations from other components, blocking the high pitched noises but generating its own low hum.



The first (and most common) noise reduction technique involves isolating the case from any vibrating parts using rubber or silicon. This can be something as simple as putting a thin layer of insulation between the component and the case or as elaborate as suspending it in its own bracket, using insulation at multiple points.

Some cases sometimes use noise reduction panels fixed to the chassis like the Cooler Master Sileo 500, pictured here. This foam-like material “absorbs” sound from inside the case, making things a lot quieter. These cases aren’t without their downsides, though. For noise insulation to work properly, you need to have the case as sealed as possible, which can seriously affect thermal performance if there isn’t sufficient airflow from the fans. It’s very difficult to keep a computer extremely cool *and* quiet. It’s usually one or the other without getting water cooling involved, which we won’t be covering in this guide.



Some cases take particularly novel approaches to noise reduction. Some examples that come to mind are the [Fractal Design Define R2](#), with its internals coated in *bitumen* for noise reduction, and the [Antec P180](#) series, which has side panels made with three layers; a layer of plastic sandwiched between two layers of aluminium, acting a bit like double glazed windows for sound. Again, [www.silentpcreview.com](#) has a lot of information on this subject – after all, that’s why it was originally started!

## Things to Look Out For When Buying a New Case

So, you’re looking to upgrade your case, or find the perfect one to build a new computer into. Apart from all the things we’ve discussed above, there are a few other things you need to watch out for to make sure you get exactly what you’re looking for:

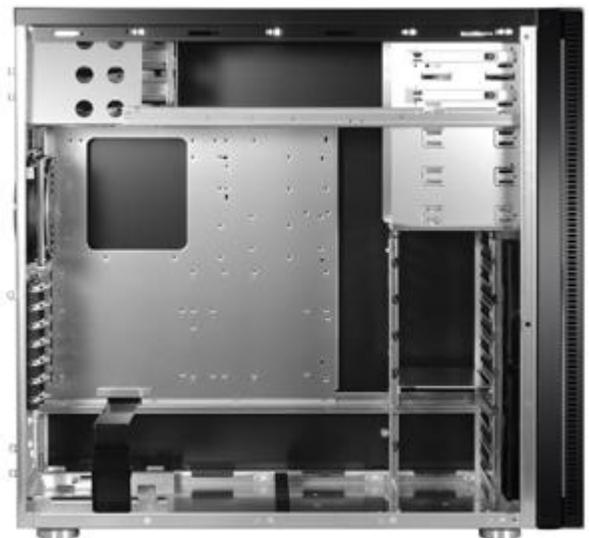
### Size



A Mini-ITX case



A midi case, although slightly longer than usual



A full tower case

There are many different sizes of cases, made to fit all sorts of uses. The right size all depends on what you want to do with your computer, and therefore what you're likely to be putting into your computer. For example, the case you'll need if you want to build a top of the range gaming computer is going to be completely different to what you'd need for a cheap computer made for nothing more than browsing the web. Just make sure your case is big enough to fit all of your components – your graphics card and processor's cooler in particular.

The most common size is the *midi* case. They're good for squeezing a full sized ATX or smaller Micro-ATX motherboard in, and (usually) have room for 2-3 optical drives and 3-4 hard drives. If you're looking to build a computer as cheaply as possible, this is probably the size to go for.

I wouldn't advise building a gaming rig into a standard MIDI case, as you'll usually run into problems with space, particularly with the graphics card. Some tailor-made gaming midi cases are made to be longer than usual to cater for this, though.

*If you want to build a very powerful computer, it's usually advisable to go for a full tower case. These are usually much larger than a standard midi case, giving plenty of room for a full sized ATX motherboard and sometimes providing support for the even larger (but much less common) Extended ATX (E-ATX) motherboard class. Full towers tend to be more expensive (as they cater for "power users" more than casual users), but gain much more flexibility because of it. You're much more likely to see flexible drive management (allowing you to choose to have more 5.25" bays or 3.5" bays), and will have plenty of space for even the longest graphics and expansion cards.*

Swapping now to the other side of the scale, smaller than the midi case is the *Micro ATX* case. As the name suggests, you'll only be able to fit a Micro ATX motherboard or smaller in here. There's usually much less space than in a midi case, so you usually have to be a bit more selective with the components you choose to put in here. You'll usually only fit a single optical drive in one of these, and 2-3 hard drives depending on the design.

Having said that, some people have made some quite powerful Micro ATX PCs, so they aren't necessarily an option to be discarded lightly! Just bear in mind that the smaller size comes at a fairly significant price premium.

Finally you have the smallest cases, the *Mini ITX* cases. These cases will only take... you guessed it – a Mini ITX motherboard, and not much else. These are designed (with few exceptions) specifically to take *low power components*. Most cases don't have enough room for a standard optical drive (they're really that small!), instead letting you use a

slim line drive like the ones you'd find in a laptop, and will usually give you enough room for one 3.5" drive or two 2.5" (laptop) hard drives.

## Expansion Bays

When looking to buy a new case, you'll need to make sure that there are enough *expansion bays* to hold all of your components. These are usually split into two categories: 5.25" and 3.5" bays.

### 5.25" Bays

These bays are the largest ones, usually found at the top of the case (see the diagram in the [Layout](#) section); although in some cases they may go all the way from the top to the bottom. The most common use is optical drives (such as DVD or Blu-Ray drives), but they may also hold specialised parts such as fan controllers, small LCD panels (for system information), or even a smaller auxiliary power supply.

They can also be repurposed to hold 3.5" drives that can be easily removed (i.e. they are *hot-swappable*). There are two main types of converters:

1. A 5.25" bay converter that holds just one hard drive. These usually completely enclose the hard drive, keeping it cool and blocking most of the noise it makes.
2. Three 5.25" bays can be used to house five 3.5" drives turned on their sides. These are often used in DIY home servers to hold lots of hard drives and greatly increase storage capacity.

### 3.5" Bays

These bays usually sit underneath the 5.25" bays (again, refer to the diagram in the *Layout* section for an example); however, in larger cases where the 5.25" bays go from the top to the bottom (such as the *Antec Twelve Hundred*), the 3.5" bays are usually stored in a *removable bay* which can then be placed in any two or three 5.25" bays, making it much more flexible.

When looking at cases you'll often see reference to *external* and *internal* 3.5" bays. The bays themselves are identical and can hold the same drives. However, *external* bays have a hole cut for them at the front of the computer. These are used for devices such as *card readers* and the now largely defunct *floppy disk drives*. *Internal* drive bays are therefore designed almost exclusively for holding hard drives. Some of the more expensive cases now provide a bracket for a 2.5" drive, usually made for a *Solid State Drive*, although there's nothing stopping you from using it for any other 2.5" drive you may have laying around (such as a laptop hard drive).

### Material

The materials used to make your case can also be important. What materials you choose will depend on a few things; how often do you plan to move your case? Does it need to be light enough for you to carry easily? How strong does it need to be?

Cheaper cases are invariably made using SECC (Steel that has been ElectroGalvanised, Cold-rolled and Coiled) with plastic fascia. SECC is *very cheap to make* and quite a good thermal conductor, but it does have a few disadvantages. Firstly, it's not particularly durable and can be accidentally bent quite easily. Secondly, it tends to be quite heavy. The plastic fascia can be accidentally broken quite easily, too.

Aluminium cases answer most of these problems. They're *stronger and lighter* than SECC cases. They're also pretty good at absorbing heat. However, because they're much lighter they're more susceptible to low-level vibration (making them not so great for noise reduction). They're usually significantly more expensive, too.

### Brands

When you finally go to buy a case, buying from a good manufacturer is more important than you'd think. Unless you really want to spend as little as possible on a case, you'll probably want to buy from a trusted brand of some description.

For *ultra-budget* cases, I'd suggest Asus' Vento series. For about the same price as a no name "Extra Value" case you can get one of these. They're still cheap and cheerful, but they get the job done. All budget cases tend to be quite hot and noisy, though.

If you're happy to spend a *little* bit more (around £25/\$40), the Cooler Master Elite range is great. The build quality is significantly higher; you get much better airflow and a few other little perks like tool-less hard drive and optical drive brackets.

For computers intended for *normal use*, I'd probably recommend an Antec or a Cooler Master. They tend to have a great balance between cooling and noise reduction, and a power supply bundled with one of their cases is usually one of theirs, meaning it can be trusted.

There are a lot of gaming cases out there, both good and bad. If you're building a gaming PC, don't skimp on the case. Layout and airflow are important, and it'd be a shame to have amazing components housed in a tacky case which just falls apart straight away.

If you're strapped for space, the *Antec Three Hundred* is a great case to get started. If you have the room, the *Antec Nine-* or *Twelve Hundred* cases are brilliant. Other cases to look out for are the *Cooler Master Storm* or *Sniper* cases, or if you've got really hot components, a *Cooler Master HAF 932*. Other good brands are *Silverstone* or *NZXT*. If you want a particularly *quiet* case, you may want to consider the *Fractal Design Define R2*, or the *Cooler Master Sileo 500*. Other good brands for quiet cases include *Akasa* and *Zalman*, or *Antec's Performance One* series.

If you've got some cash burning a hole in your pocket or money's simply not an issue, *Lian-Li* makes some really nice cases of all sizes. All of their cases are entirely made of aluminium. Most of their cases tend to be quite minimalist (unlike most gamers cases, which seem to be designed using pure testosterone), so they might be a bit bland for some peoples' tastes. For something equally luxurious but a bit more exciting, *Corsair*, *Zalman* and *Silverstone* make some ultra-high quality gaming cases.

For smaller cases, *Silverstone* is probably your best bet with their *Sugo* series. Both *Antec* and *Akasa* make good Micro-ATX and Mini-ITX cases, too.

Basically, whatever your budget, if you stick to one of the brands I've mentioned above it's quite difficult to go wrong.

Here's the list again.

- Akasa
- Antec
- Asus
- Cooler Master
- Corsair
- Fractal Design
- Lian-Li
- NZXT
- Silverstone
- Zalman

# Chapter 2: Power Supply (PSU)

## An introduction to Power Supplies

The power supply is probably best described as being the **heart** of the computer. It provides all of the other components in the computer with... well, power. It's responsible for converting AC electricity from the mains into the more usable, lower power DC before distributing it to the other components.



The most common type of power supply is the ATX power supply, which uses standardised connectors compatible with the vast majority of motherboards of any size. PSUs come in two varieties: Modular and Non-Modular. I'll be talking about both later.



*Inside the Enermax Modu87+ 900W – One of the best PSUs you can buy!*

## Power Rating

The *power rating* of a power supply is most often referred to as its *wattage*. You can usually tell the power rating of a PSU just by looking at its model number; for example, the power supply above is a *Corsair VX550W* which has a power rating of – you guessed it – 550W.

This 550W is broken up into a number of rails running at different voltages: +3.3V, +5V, +12V (which is often split into multiple rails), -12V and +5VSB.

By far, in a modern system, *the +12V power rating is the most important number*, followed by the +3.3V/+5V rating. +5VSB is 5V Stand By – used for powering the motherboard to keep monitoring for events such as your computer being woken up by your mouse or network card, for example.

Here's the *continuous power rating* breakdown for the Corsair VX550W shown above:

AC Input Rating	90 - 264VAC				
DC Output	+3.3V	+5V	+12V	-12V	+5VSB
Max Load	30A	28A	41A	0.8A	3A
Max Load	140W		492W	9.6W	15W
TOTAL POWER: 550W					

These numbers aren't as complicated as you'd think. To simplify things, let's have a quick refresh to dust off the electronics topic of your physics lessons back at school:

$$\text{Power (W)} = \text{Voltage (V)} \times \text{Current (A)}$$

In the case of +12V, the overall power is  $12V \times 41A = 492W$ . Simple, right? Well, not quite, but I'll talk about that more in [The Dangers of Cheap Unbranded Power Supplies](#).

When you turn a computer on, many of the components start up at once. On top of this, many of these components use far more power to start up than they use once they're running (hard drives in particular can use up to four times as much power while they spin up).

Luckily, almost all PSUs have extra capacity built in to handle this extra power requirement for short periods of time. This is referred to as the *peak power rating*. As the +12V rail is the most important, most manufacturers will provide both *peak* and

continuous ratings for this rail; it's less important on the +3.3V/+5V rails, so this information is less common.

When you go to build a computer or upgrade your PSU and you want to know quite how much power to use, there's a [great power calculator you can use](#). You just put in the components you want to use and it'll tell you the minimum and recommended power rating for your PC.

## Efficiency

Efficiency is another very important factor to think about when it comes to power supplies. When AC is converted to DC, some energy is wasted and released as heat. The more efficient the power supply, the less power is lost as heat.

Here's a simple example. A PSU requires 100W of AC power to output 75W of DC power. This means that 25W is being lost as heat. In this case, the PSU would be said to be 75% efficient.

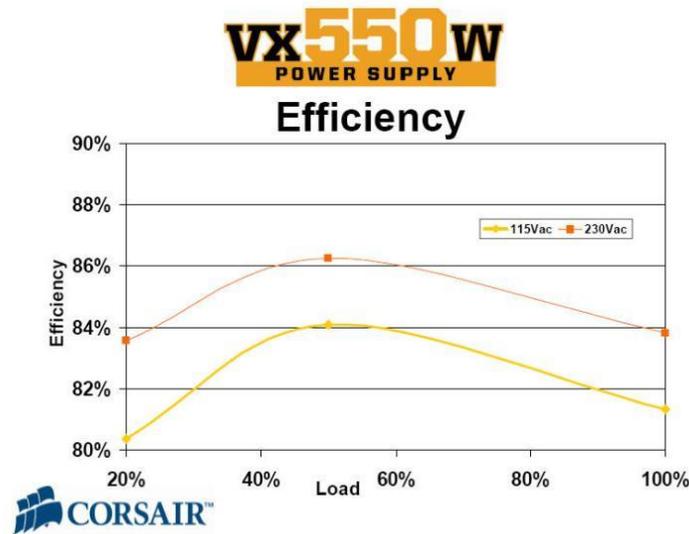
Why do you want an efficient power supply? Well, the main reason is simple; the more efficient the power supply, the less heat it produces. The less heat it produces, the less forced airflow it requires to stay cool. Less airflow means less noise, and less noise is always a good thing.

Furthermore, the more efficient the power supply is the less AC power it requires to provide sufficient DC power, meaning lower overall power consumption from the mains and a smaller power bill. The earth will thank you for it, too.

The [80 Plus program](#) is a good specification to look out for when buying a new PSU. The more efficient a power supply is, the higher the rating it can obtain. Most power supplies from well-known manufacturers will have reviews from multiple websites that measure and graph the efficiency of a power supply.



Here's the efficiency graph for the Corsair VX550W we were talking about earlier:



As you can see, a power supply is most efficient at around 50% load; that is to say, this power supply is at its most efficient when providing 275W of power to components. The vast majority of power supplies follow this efficiency pattern.

Higher quality PSUs tend to have higher efficiency across the board, but more importantly the *efficiency curve is flatter*. This means that no matter what percentage load the power supply is under it will still perform with similar efficiency.

## Connectors

Every power supply you buy nowadays will use the same standardised connectors for the various components you'll find in your computer. Here's a list of the different connectors with a picture and a quick description of what it's used for.

### Molex

This is largely considered to be the "standard" connector from your power supply. Its most common use was originally for older hard drives. However, it is now more commonly used as a "wildcard" connector; pretty much anything can be connected using molex, such as chassis fans.



PCI-E connectors can also be powered using 2 molex connectors if one isn't available from the PSU itself, and molex to SATA power connectors are also quite common.

### SATA

This connector is used exclusively for the more recent SATA hard drives. They're not particularly common on older power supplies, but as mentioned above it is possible to get a converter cable.



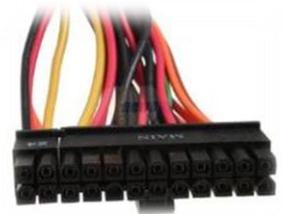
### Floppy

As the name suggests, this power connector was originally used to power a floppy disk drive. However, even though the floppy disk drive is now all but extinct, it is still often used to power internal card readers. You may also see it used as a modular connector for "Pico PSUs" – very small, very low power PSUs used in mini-ITX computers.



### 20+4 Pin (Motherboard)

This is the connector which provides power to the motherboard itself as well as the expansion cards. Graphics cards draw power from this connector too, but more often than not there isn't anywhere near enough, requiring them to have their own power connectors as well. It's called a 20+4 pin connector because the last four pins (shown here on the left) aren't always required, with the motherboard only taking 20 pins. The extra 4 pins are often made to be detachable.



### 4+4 Pin (CPU)

You'll usually find the socket for this connector right next to the processor, and there's a good reason for that – this connector provides the processor with all the juice it needs. Up until recently the CPU required the most power out of any component, although recently the graphics card has taken first place. Most processors require only one of the four pin connectors, but some motherboards provide an 8-pin socket, so plug them both in and it'll take only what it needs.



### PCIe (6+2 pin)

The last common connector, this provides power for your graphics card. Recently graphics cards have needed more and more power – the GTX 480 (the highest power nVidia graphics card) can take up to 250W by itself! The most common requirement is now two 6 pin connectors, but some cards require a connector with 8 pins (hence the 6+2 for compatibility). As mentioned earlier, 2 molex connectors can be converted to a single 6 pin connector.



## The Dangers of Cheap Unbranded Power Supplies

When you go shopping for power supplies you may notice that there are a lot of unbranded power supplies which offer much higher capacities for much lower prices than you'll find any reputed brand for. On paper and at a glance they look like an amazing deal, so you're probably thinking "Why pay twice as much for a 500W Corsair when I could get this 600W 'Extra Value' PSU?"

The reason why is simple; chances are that the power supply *isn't actually going to supply 600W*.

To make a power supply unit seem more competitive, some manufacturers use dirty tactics to make their processor appear to have much higher specifications than it actually does. Here are a few examples:

- Outright lying about power ratings – they may say that it's rated at 500W, for example, but if you added up the current on each voltage rail you'd find that it came up 20 or 30W short.
- Some manufacturers label the *peak* power rating as its *continuous* power rating. That can be particularly dangerous for your components!
- Another common tactic is to state a theoretical power rating at room temperature, rather than at a temperature more likely to be found inside a computer case (say, 40-50°C). As the temperature increases, the PSU is unable to provide as much power, so what is advertised as a 500W PSU *may actually only provide around 350W* when it's in your computer. There's a slightly more [in-depth explanation](#) you can look at over at Silent PC Review.

To cut down on costs, these manufacturers often use *low-quality internal components* in their power supplies. This has two main downsides.

Firstly, they generate a lot more heat and therefore need far more cooling to remain effective. That means multiple high-powered fans, which means far more noise. Secondly, and much more importantly, these cheaper components are *far more susceptible to catastrophic failure*. Depending on the kind of failure it's possible for a failing power supply to *permanently damage components connected to it*; motherboards (sometimes the most expensive component in the case and the most time-consuming to replace) and hard drives (containing all your precious, often irreplaceable data) are susceptible to damage. Thankfully in the case of hard drives the data itself is almost always unaffected but when the hard drive's circuitry becomes damaged the data becomes totally inaccessible without forensic recovery or a replacement circuit board.

So yes, you *could* save some money by buying a cheap power supply, but why take the risk? Personally, I wouldn't touch them with a barge pole.

While it's obviously a bit hard to do this while shopping for power supplies online, a rough rule of thumb for the quality of a power supply is *how heavy it feels*. Generally speaking, *the heavier the power supply, the higher quality its components*. If you get a 400W PSU and it feels like it weighs half a ton, chances are you've got yourself a good one.

## Power Supply Varieties

As I mentioned in the introduction, there are two main varieties of power supply: *Modular* and *Non-Modular* (which is more common). They're very similar and have the same connectors, but with one major difference. Read on to find out more!

### Standard Power Supplies

The standard power supply is usually a good deal cheaper than a modular supply. They're also a lot more common. In a standard power supply, all of the cables are hardwired into the main unit. While this is cheaper and debatably gives slightly better performance than a modular power supply (due to lower resistance), you're inevitably stuck with the cables that you don't use. This makes cable routing extra painful, looks messy and can affect airflow within the case.



### Modular Power Supplies

Modular power supplies, on the other hand, have *detachable power connectors*. This has the added benefit that you can have exactly the connectors you need, and nothing else. This makes cable routing and storage much easier and obviously looks much neater, but you'll have to pay a significant premium for the privilege.

## Brands to Look For

As you can probably tell, I'm a pretty big fan of *Corsair* power supplies – both their standard and modular power supplies have always received rave reviews all over the internet.

Decent case manufacturers also tend to produce good power supplies, too – *Antec*, *Silverstone*, *Fractal Design* and *Cooler Master* all make very high quality power supplies.

Other good brands to look out for are *Hiper* and *Nexus*.

If money isn't an issue, the best power supplies money can buy are generally considered to be made by *Enermax* and *Seasonic*. Most of their power supplies are rated at *80 Plus Silver* or *Gold*, and are about as quiet and reliable as a power supply can get.

There are plenty of brands which are better off avoided, too. There are far, far too many to list here, but there's a pretty comprehensive list over on the [eggxpert.com](http://eggxpert.com) forums.

# Chapter 3: Motherboard

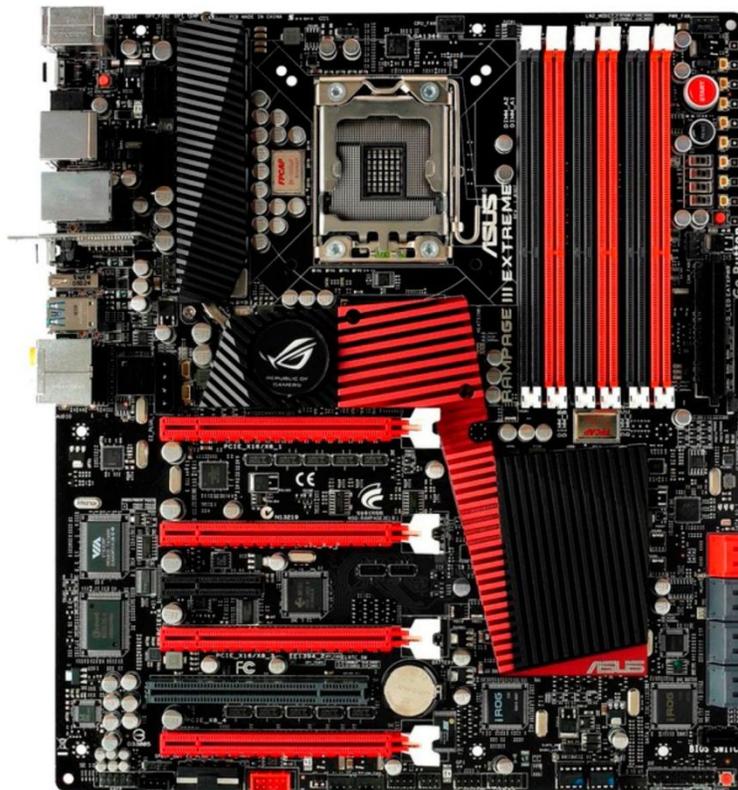
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The motherboard is the most obvious component inside a computer. Although this one is slightly harder to fit into our body metaphor, the closest thing I can think of is the **forso** of the computer. That's because everything is connected to the motherboard, whether it's by slotting into it directly or via cables; all the parts communicate through the motherboard, too.

Motherboards are generally split into two different groups; those for AMD processors and those for Intel processors. However, they are almost entirely the same – the only difference is the *CPU socket* and therefore the processors which are compatible.

## Motherboard Sizes

There are many different motherboard sizes, ranging from *Mobile-ITX* (measuring just 60 x 60mm) to *WTX* (which is a crazy 356 x 425mm). We'll be covering the three most common ones in this guide – the vast majority of motherboards you'll come across will be either *ATX* or *Micro-ATX*, but *Mini-ITX* is becoming increasingly more common.



## ATX

This is the larger of the two most common sizes, and offers the most upgradability. They almost invariably have *six or seven* expansion slots and often have more *SATA and IDE* ports than on a Micro-ATX motherboard.

With more room on the motherboard and more slots, these are usually the choice for somebody building a gaming PC as quite a few ATX motherboards have multiple slots for graphics cards, making it possible to use two or more graphics cards at the same time for greater power.



## Micro-ATX

This motherboard is much more common for less powerful machines such as those you'd find in an office or in a budget PC from Dell or HP. They offer a great balance between power and size, most often providing *four* expansion slots rather than ATX's seven.

The only *real* difference between ATX and Micro-ATX motherboards is the number of expansion slots and the amount of space on the boards. Some people prefer to use ATX simply because things aren't quite so cramped, even though they don't use more than what a Micro-ATX motherboard can provide.



## Mini-ITX

These motherboards have really only become particularly common within the last year or two with the introduction of *net tops*; the desktop equivalent of *netbooks*, although they have been used for industrial and commercial use for a bit longer than that.

The *raison d'être* for Mini-ITX computers is simple – a very small, low power computer used for the basic tasks which we use a computer for 90% of the time: browsing the internet, reading/writing emails, watching the occasional video and maybe doing a bit of word processing.



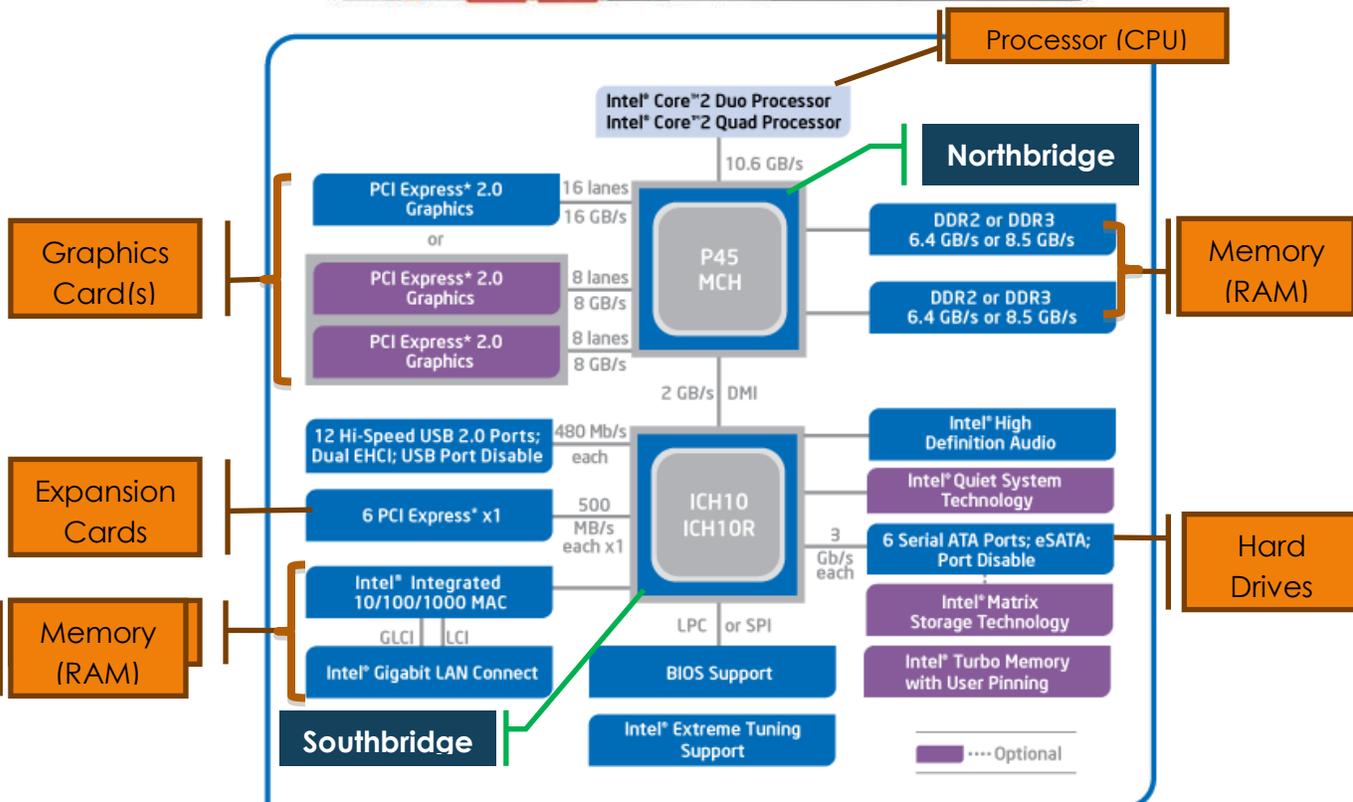
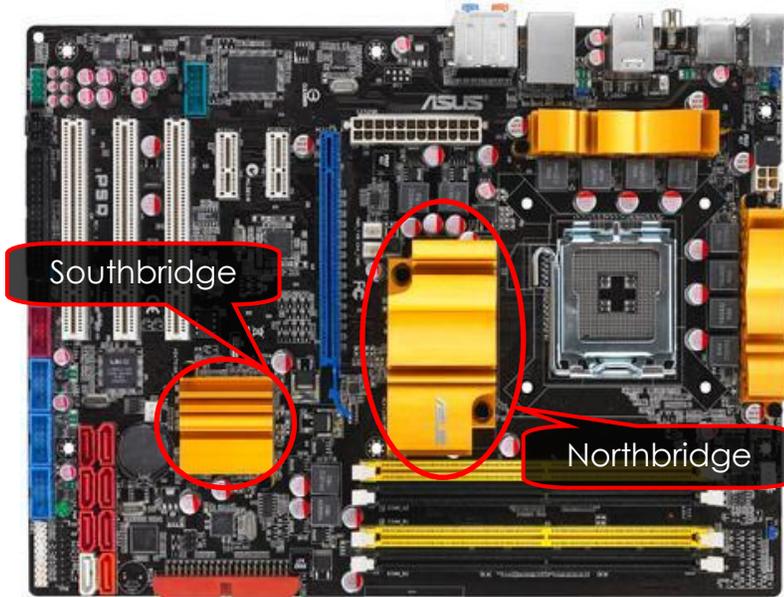
The Mini-ITX motherboard is different from the other two in that it *usually* has the processor integrated into the motherboard itself. Furthermore, Mini-ITX motherboards usually have very few SATA ports, rarely have an IDE port, and typically only one expansion slot. As such they're the least flexible and upgradable of all the common motherboard types, but more than make up for it with their diminutive size, relatively low cost and power consumption.

On the other hand, there are a few Mini-ITX motherboards designed with gamers in mind. These have a socket for a full-size processor and provide a slot to add a powerful graphics card. A good example is the [DFI LanParty MI P55-T36](#).

## Chipsets

Components which are connected to the motherboard are controlled and connected by the *chipset*. This usually comprises of a *northbridge* chip and a *southbridge* chip. I'll be talking about them in a little more detail later.

Here's a picture showing the location of the northbridge and southbridge chips with a corresponding chipset map from Intel's website which shows what each chip controls:



Intel® P45 Express Chipset Block Diagram



## Manufacturers

Although there are many different companies that manufacture *motherboards*, the chipsets themselves are almost always manufactured by the CPU manufacturer; that is, an AMD motherboard will almost always have a chipset made by AMD themselves, and Intel makes the chipsets for Intel motherboards.

There are a few exceptions, though – nVidia makes chipsets for both groups of motherboards which tend to be more aimed at gamers and multimedia users. Companies like VIA and SiS also used to make motherboard chipsets for both processor types, but haven't been in the mainstream desktop market for a very long time.

## Parts of the Chipset

### Northbridge

The *northbridge* chip allows the *CPU*, *RAM* and *Graphics Card(s)* (via *PCIExpress* lanes or, before that, *AGP* lanes) to communicate between each other as well as connecting with the *southbridge*. You might also see it referred to as an *MCH* (Memory Controller Hub) in Intel systems.

On newer systems (such as those based on Intel's i3/i5 processors), the northbridge no longer exists as a chip on the motherboard; instead the *PCIExpress* and *RAM* controllers have been incorporated into the processor itself. This has the benefit of reducing *latency* between the CPU and the memory (which basically means that it doesn't take as long for the processor and memory to talk to each other), but unfortunately makes big gaming rigs with multiple graphics cards unviable due to the amount of *PCIe lanes* that are able to be controlled.

In motherboards with *integrated graphics* (which don't require an external graphics card) the graphics chip is usually incorporated within the northbridge, too. In cheaper motherboards this is done by taking up *PCIe lanes* (which means that even a single external graphics card added later won't perform anywhere near as well as it would usually perform), but usually it's possible to disable the *IGP* (integrated graphics processor) to regain access to these lanes.

### Southbridge

The *southbridge* is responsible for the communication between the other components, external devices, audio and the network with the *northbridge*.

### Other Chips

Motherboard manufacturers may sometimes include extra chips to add extra functionality. For example, a motherboard may have an extra SATA controller chip to add more SATA ports to the motherboard, or more recently an extra chip to handle the

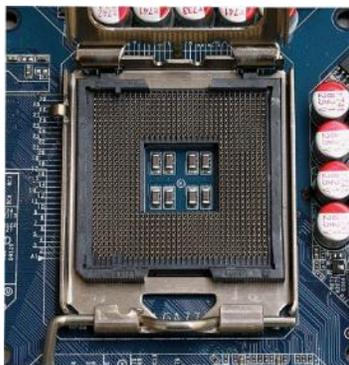


new USB 3.0 standard. They act very similarly to expansion cards that you might add to gain extra functionality yourself, except they are integrated into the motherboard itself. Cheaper motherboards which add extra chips usually do this by using *PCIe lanes* (the same way that integrated graphics may).

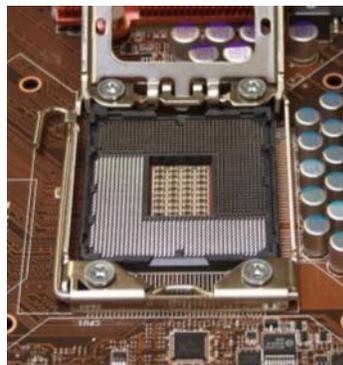
## Main Slots

### CPU

This is where the processor is installed. All modern CPU sockets use some form of lever to lock the processor down against the motherboard to ensure that there is a good connection between the pins and contacts of the motherboard and processor. There are quite a few common socket designs but they all look relatively similar, as you can see below.



Intel Socket 775



Intel Socket 1366



AMD Socket AM3

### RAM

This is where the computer's memory is installed. Most modern motherboards have two *channels* and either two or four slots (one or two for each channel). An exception is Intel's Socket 1366 chipset, which has *three* channels and six slots.

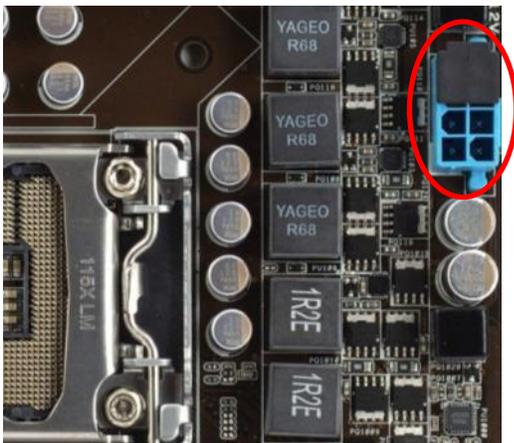


As you can see in the picture above, it mentions *DIMM\_A1*, *DIMM\_A2*, *DIMM\_B1* and *DIMM\_B2*. This shows the order in which RAM should be inserted. The letter shows which *channel* the slot belongs to, while the number shows which slot is recognised first *within* the channel.

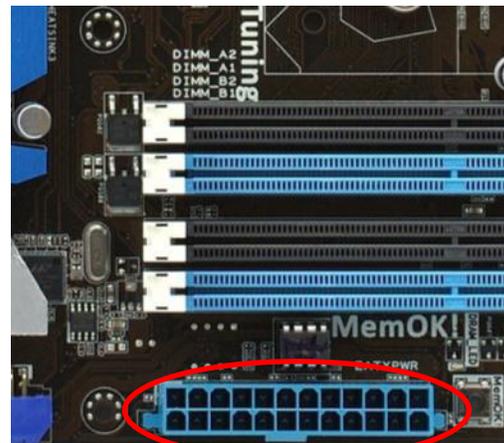
In this example, *A1* must always be filled first – no RAM is recognised if this isn't occupied. After that, it's a little more flexible; you could choose to either fill the first channel by placing a second stick in *A2*, or use the second channel by placing it in *B1*. It doesn't really matter either way, although if you have identical sticks you can get a small performance boost by placing them in different channels (i.e. *A1* and *B1*) as each stick is able to hold completely different memory and allows for greater multitasking.

### Power

Remember the *20+4 Pin* and *4+4 Pin* connectors on the power supply? Well, this is where they go. The 4+4 pin socket is always right near the CPU socket (see below). There are a few places where you may find the 20+4 Pin socket, but more often than not it's right on the edge furthest from the back of the case, near the RAM slots.



4+4 Pin Socket



20+4 Pin Socket

### Expansion Slots

#### PCI

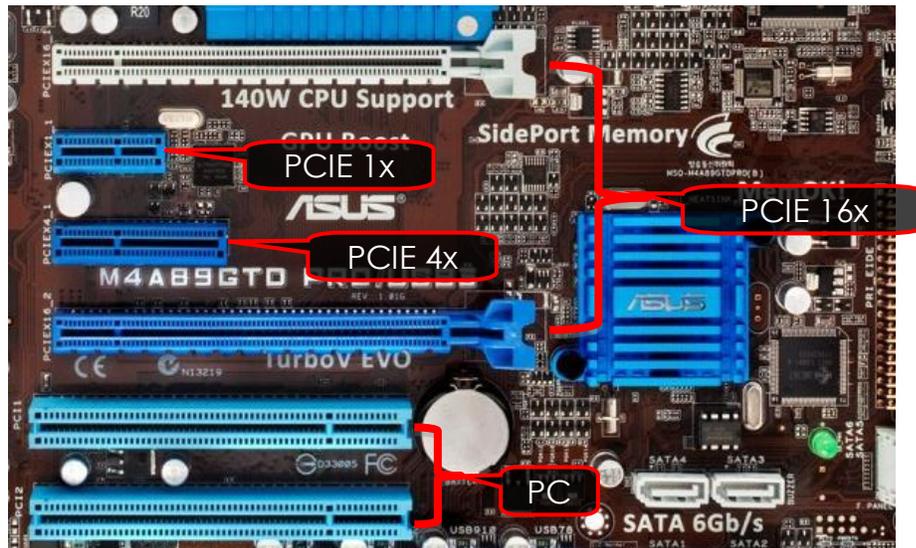
This is the most common slot for expansion cards. It has been superseded to an extent by the *PCIExpress 1x* slot, but many manufacturers still use the PCI slot for compatibility with older motherboards which don't have any PCI Express slots.

#### PCI Express (PCIE)

This is a new standardised connector which has begun to slowly replace the PCI slot. As you can see from the diagram above, it's available in a few different forms. The most

common one (and the one you may already be familiar with) is the PCIE 16x slot, which replaced the AGP slot a few years ago.

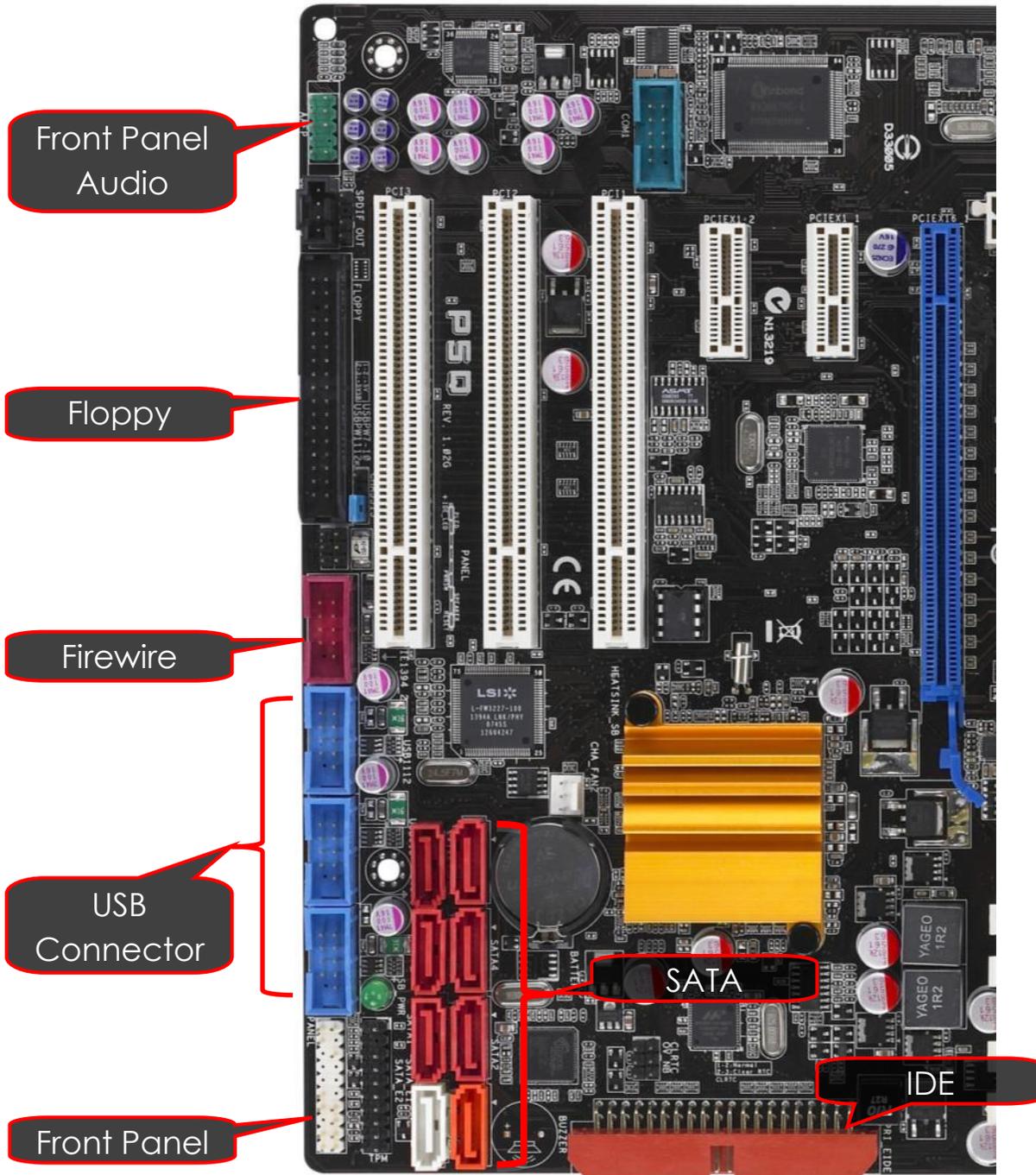
The other common form is the PCIE 1x slot. This is currently *mainly* used for network and sound cards, although the other standard expansion cards are beginning to become available on the PCIE interface.



The expansion slots – PCI, PCI Express 1x, 4x and 16x

The interesting thing about the PCI Express slot is that any PCIE device can work in any PCIE slot as long as it fits. For example, a graphics card with a PCIE 16x connector can work in a 1x slot if you were to cut out the plastic back of the slot. Likewise, a PCI Express 1x device will work perfectly in a 16x slot. The only real difference between the slots is the number of *lanes* which the slot has, and therefore the amount of *bandwidth* between the device and the motherboard (that is, the amount of data which can be sent between the two at the same time). So while yes, you *could* use a graphics card in a 1x slot, it probably wouldn't be a very enjoyable experience.

Connectors



### Front Panel

This is a series of pins which you use to connect the various parts of the front panel: The power and reset buttons, the power and HDD LEDs and the chassis speaker (for those beeps that you may hear when you turn your computer on, for example). It's not, however, for connecting the USB ports or similar ports to the motherboard – they have their own connectors.

### IDE (Parallel ATA)

This was the connector of choice for connecting hard drives and optical drives until the introduction of SATA connectors (which I'll come to in a minute). In the example picture the connector has been placed at a 90° angle to make cables easier to manage.



More often than not the connector will point straight up.

Each IDE connector (or *channel*) was able to support "daisy-chaining", which is basically jargon for being able to connect two devices using a single IDE cable and connector. For this to work, one device needed to be assigned as *master*, the other as a *slave* device, which basically decides which device appears to the computer first.

As IDE devices become less common (and less relevant) the connector will also eventually become less common on motherboards, similar to the *floppy* connector (more on that later). There are already some motherboards which don't have any IDE connectors.

### SATA (Serial ATA)



This was introduced in 2003 and eventually replaced the IDE port as the standard connector for first hard drives and then optical drives. Unlike IDE connectors each SATA port can only accommodate one device, but it has other advantages; it is much faster, for one (most SATA connectors today are able to transfer 3 *gigabits/second*, or 3000 *megabits/second*, while the latest IDE connector could only handle 133 *megabits/second*), and the cables are much thinner and more manageable.

SATA also has the benefit of being *hot-swappable*; that is, it is possible to disconnect a SATA device and connect a different SATA device using the same cable while the computer is still switched on (although it's often the case that you would have to manually rescan for it in the operating system). IDE devices on the other hand need to be plugged in before the computer switched on.

## USB

These connectors are used to add extra external USB ports (such as USB ports on the front panel of the PC), or to connect internal USB devices (such as internal card readers).

Each connector supports either two USB ports or a single device. Most new motherboards have at least two internal USB *headers* (connectors), with some having as many as four.

## FireWire (IEEE 1394 or FW)

Even though a motherboard may not have a FireWire port on its I/O (Input/Output) panel, it doesn't mean that it doesn't have FireWire. Many recent motherboards have at least one FireWire 400 header (FireWire 400 being the most common FW connector). Unlike USB headers, each FireWire header can only support one FireWire port.

## Floppy

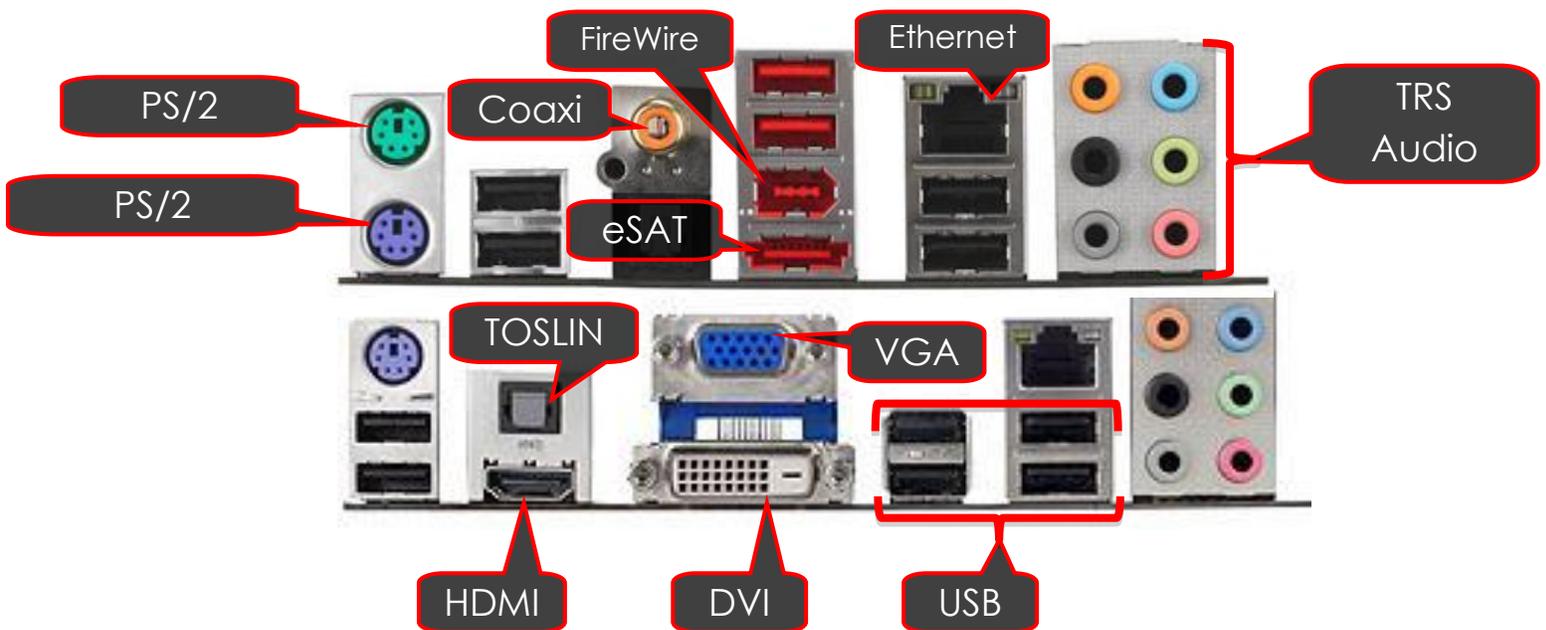
The floppy connector is for... well... connecting a floppy disk drive. While the floppy *power connector* has been repurposed for card readers, the motherboard connector hasn't been so lucky – it simply doesn't provide enough *bandwidth* for modern usage.

As very few people still use floppy disks most modern motherboards no longer have a floppy connector at all.

## Front Panel Audio

This is the header to connect the microphone and headphone jacks on the front panel of your PC to the motherboard. Most cases have two audio connectors inline on the same cable, one labelled AC97 and the other as *HD AUDIO*. Both will fit on the same header on the motherboard, but only one will work. Generally speaking, older motherboards will only support AC97 while newer motherboards will support both. It will usually say on the motherboard next to the header.

## The I/O Panel



### What you may find

#### PS/2 Connectors

Before the introduction and widespread use of USB ports, PS/2 was the standard connector for mice and keyboards. Their major advantage is guaranteed compatibility with older (and most new) hardware, particularly where there is only partial USB support. This is because PS/2 devices are reported to the computer as soon as the computer starts up, which is not always the case with USB devices. However, this comes with a major caveat – the devices must be plugged into the computer before it is turned on otherwise they are not recognised and won't work.

As PS/2 devices become less common in the face of new USB ones, it becomes rarer to see two PS/2 ports on the I/O panel. However, most manufacturers leave one either just for the keyboard or a hybrid port which can take either a keyboard or a mouse. This aids in situations where a USB device may not be recognised for various reasons, or if all other USB ports are used by non-PS/2 devices.

#### USB Ports

These ports are used for pretty much everything now – they don't call it the *Universal Serial Bus* for nothing! Whether it's for keyboards and mice to memory sticks, card readers to mobile phones, external hard drives to wireless dongles to novelty fuzzy hamburger mousepad/ hand warmer combinations (such a thing exists!), you'll find most things have some form of USB connectivity.

In general, USB devices are *hot-swappable*, which means that they can be unplugged and plugged into any USB slot at any time and will usually be recognised by the computer quickly. The other major advantage is that USB slots are so common – most computers now will have *at least* six USB ports, with new ones often having support for *twelve* or *fourteen* ports.

### **Ethernet Port**

This is the standard networking port which you use to connect the computer to the internet using an *ethernet* cable. There isn't a whole lot more to it than that (at least, not when it comes to motherboards).

### **eSATA**

eSATA is a relatively new connector which allows a hard drive in an external enclosure to perform and act like an internal drive; in fact, an eSATA connector usually requires sacrificing one of the SATA ports provided by the motherboard's southbridge.

As far as the computer is concerned, the external hard drive is an internal drive, which makes it perfect for backups and things which take a lot of bandwidth like video editing.

### **FireWire 400 (IEEE 1394a)**

FireWire is similar to eSATA in that it's great for hard drives and video-related file operations. It's been around for significantly longer than eSATA, though, and doesn't have the same level of performance that eSATA has. On the upside it is still significantly more common than eSATA. It also has the advantage of being able to *daisy chain*; similar to the way that *daisy-chaining* works with IDE devices. In fact, a single FireWire bus (i.e. a single FireWire port on your computer) can support up to *sixty-three* FireWire devices with negligible performance loss (provided that multiple devices aren't used at the same time).

### **Video Connectors**

These are the connectors you would use to connect your *monitor* (screen) to your computer. You would connect the monitor to your motherboard's *I/O Panel* only if you don't have a separate graphics card.

The three most common video connectors are *VGA*, *DVI* and *HDMI*. I'll cover these in more depth under the [Graphics Cards](#) section.

## Audio Connectors

These are what you use to connect or *speakers* or *sound system* to your computer. There are three main types of audio connectors: *TRS*, *TOSLINK* and *Coaxial*.

### TRS (Analogue)

You will have almost certainly seen these ports before – they're the same sockets that you'll find on an MP3 player like an iPod, or an older player like a Sony Discman. In fact, you can easily plug headphones into the green port. *TRS* stands for *Tip*, *Ring*, *Sleeve*, which is the design of a standard jack connector:



Most TRS sockets on a motherboard I/O panel will support 8 *output channels*:

- The *green* socket supports stereo output for two front speakers (or headphones)
- The *black* socket supports stereo output for two rear speakers
- The *grey* socket supports stereo output for two side speakers
- The *yellow* socket supports dual output for a centre speaker and a *subwoofer*

As well as having 8 *output channels*, they also support 2 *input channels*:

- The *blue* socket supports stereo input for line in
- The *pink* socket supports mono or stereo microphone input

Some older or cheaper motherboards only have the *green*, *blue* and *pink* sockets.

### TOSLINK (Digital - Optical)

This connector is mainly for connecting a home theatre sound system to your computer. It uses optical fibre to send large amounts of data through a single cable.



### Coaxial (Digital)

This is very similar to the TOSLINK connector, but it relies on alternating electrical current to transfer data as opposed to the rapid blinking of light. They're both used for the same application, so it just depends on what connector your speaker system has.

### Some Legacy Ports

There are some other ports which you may find on the I/O panel which you don't recognise and that haven't been covered in this guide so far. These connectors are very rarely used with the introduction of USB ports.



#### *Serial Port*

This handled many of the connections which the USB port now performs, such as the connection of modems, printers and consoles.

#### *Parallel Port*

This was used almost exclusively for printers. Parallel to USB adapters are fairly common for connecting older printers which only have a parallel connector to a USB-only system.



### Brands to Look Out For

There are many different motherboard manufacturers, and favourites seem to come down to personal preference. However, there are a few brands which seem to be recommended more than others. The two brands which are arguably the highest quality are *Asus* and *Gigabyte*. Other brands which have mixed recommendations are *MSI*, *DFI* and *ASRock*.

Some brands which are generally recommended to stay away from are *ECS* and *BioStar*.

For gaming purposes, *DFI LanParty* and *XFx* motherboards tend to get good reviews. *eVGA* always used to get very high praises but recently seem to be having some quality issues. However, any of the standard motherboards can be just as good for gaming – gaming motherboards are generally made to be able to handle overclocking.

Of course, every manufacturer makes a couple of different boards which get particularly bad reviews or high failure rates. You'll also come across people talking about how bad a certain manufacturer is because of a particularly bad experience that they've had. Take these with a grain of salt – people are much more likely to speak up about a bad experience than to take the time to praise a product – but at the same time, don't completely ignore them.

The only thing you can really do is do the research online – read professional reviews from review websites as well as customer reviews on websites such as [NewEgg](#). That'll

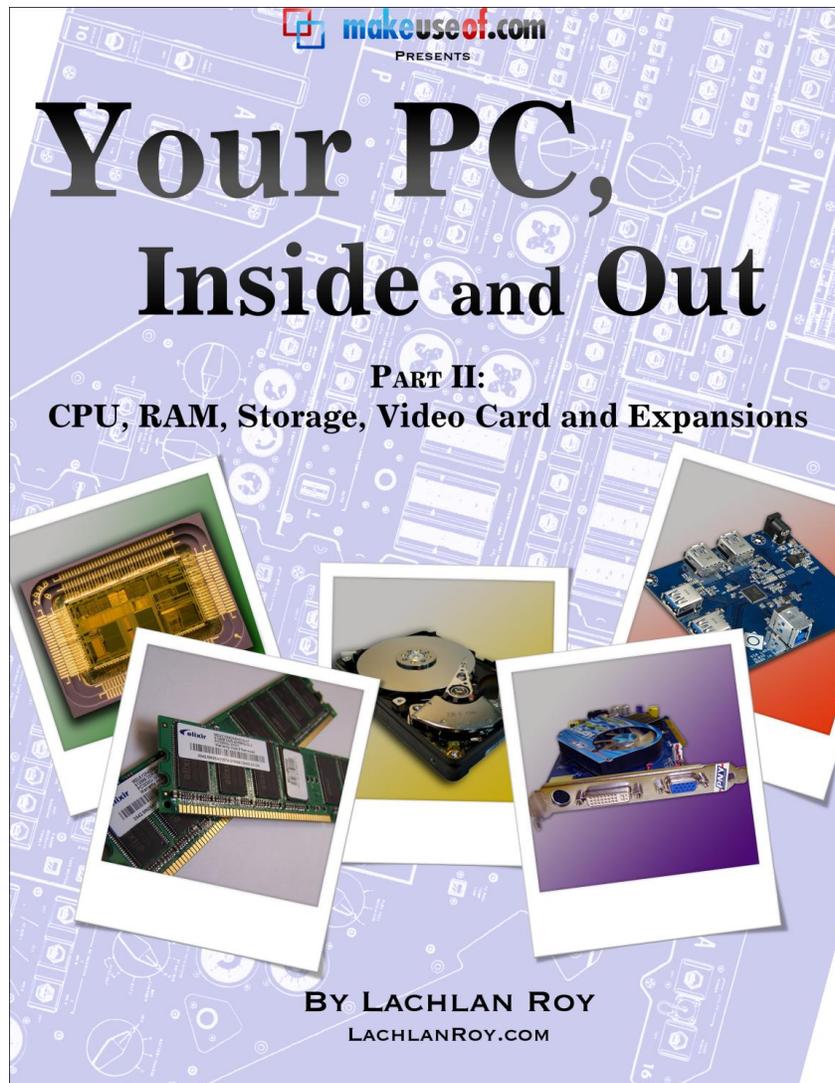
give you a better idea of whether it's just a few people making a lot of noise or whether the product in question does really have a problem.

## Download Part II

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That's it for this half of "Your PC: Inside and Out." I hope you learned something, and perhaps even feel confident enough to start working on your PC! Please check MakeUseOf.com for the second half of this manual, which will highlight the CPU, RAM, storage, video cards and other expansions.

**Coming soon to MakeUseOf.com:**



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- Cooler Master Elite 334 Side View – <http://coolermaster.com>
- Lian-Li HD-01A Bracket w/ HDD – <http://lian-li.com>
- Cooler Master Sileo 500 Panel View – <http://coolermaster.com>
- Lian-Li PC-Q07 Side View – <http://lian-li.com>
- Lian-Li PC-8N Side View – <http://lian-li.com>
- Lian-Li PC-A71F Side View – <http://lian-li.com>
- Corsair VX550W PSU – <http://corsair.com>
- Enermax MODU87+ 900W Internals – <http://pcper.com>
- Corsair VX550W Efficiency Graph – <http://corsair.com>
- Corsair VX450W With Cables – <http://prohardver.hu>
- Corsair HX550W Without Cables – <http://hexus.net>
- Asus Rampage III EXTREME – <http://odoc.dk>
- Asus P6T – <http://asus.com>
- Asus P7H55D-M EVO – <http://asus.com>
- Asus AT3N7A-I – <http://asus.com>
- Asus P5Q – <http://asus.com>
- Asus P7P55D Deluxe RAM Slots – <http://clunk.org.uk>
- Asus P7H57D-V EVO 4+4 Pin Socket – <http://ixbtlabs.com>
- Asus P7H57D-V EVO 20+4 Pin Socket – <http://ixbtlabs.com>
- Asus M4A89GTD PRO/USB3 Expansion Slots – <http://indiaprwire.com>
- Asus P5Q Motherboard Connectors – <http://raovat.xalo.vn>
- IDE Cable – <http://wpclipart.com>
- SATA Connectors – <http://7shop.co.uk>
- Asus P5Q-E I/O panel – <http://asus.com>
- Asus P7H55-M PRO I/O panel – <http://asus.com>
- Standard 3.5" TRS connector – <http://maplin.com>
- Standard TOSLINK connectors – <http://ruby-electronics.com>
- Standard Coaxial connectors – <http://tvcables.co.uk>



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