Inside the computer case

Some people get a little excited when they look inside a computer and see all the different electrical components and circuit boards. All the wires, connectors and data cables inside tend to be a little intimidating. Yet, all of today's computer repairs, replacements, upgrades and installations are getting easier and easier.

A technician could spend hours (at outrageous prices) to search for a specific chip or failed solder connection that's causing a particular problem. Repairs aren't done at the chip level anymore. Everything is very modular. It's quicker, easier, and much more economical to have the technician pop in a whole new video card or motherboard.

It's still important to know some of the different components and what they do. It can give you an insight as to which particular module may need replacement, and aids in the troubleshooting process.

It may only take 5 minutes to replace a particular FRU (Field Replaceable Unit), but it might require a lot more time to troubleshoot the problem and discover which module needs replacement.

Even if you don't plan on becoming A+ (A Plus) Certified, if you've come this far you must have an interest in computers. This is a great place to learn about what's inside that case.

Start this section with ESD (Electrostatic Discharge) precautions and work your way through in order. Once you understand ESD and the precautions you should take, go ahead and open the case. See if you can find the different components, connectors, and devices discussed. When you do, try and discover everything you can about it. What kind of chip is it? What does it do? What kind of socket does it fit into? How much data can it move at once? How fast is it?

If you have room on your desk, you can run your computer with the cover off * so you can look inside as you read (keep your hands out).

*Note: Only run your system with the cover off for a short period of time. Contrary to popular belief, leaving the cover off can interrupt the airflow, actually contributing to overheating in some cases. For short periods of time it should be OK. In fact, its often necessary when troubleshooting hardware. Its also a good time to make sure the CPU fan is working properly!

By the time you're done, you'll be removing and reinstalling some of the devices inside.

Look around for an old 286 or 386 computer. They can be picked up for less than 50 dollars, in working condition. Whether it's working, or not, you can learn an awful lot by taking it apart and putting it back together.

Please Remember: **Do Not** take apart a monitor or power supply, there is enough stored electricity inside to cause you serious injury!

ESD - Electrostatic Discharge

ESD is simply the discharge of built up static electricity. Electrostatic discharge however, should not be taken lightly when working with computers. ESD has the capability of causing enough damage to the components inside your computer to render it completely inoperable. It's important to use an anti-static strap and/or a grounding mat whenever working on the inside of your computer. Being aware of ESD precautions can significantly reduce the chance of damage to your computer due to static electricity.

Static electricity is a fact of Life. You're producing it and discharging it constantly. Moisture in the air can help it to dissipate, and raising the humidity in your workplace is another very good measure you can take to reduce the chance of damage caused by ESD. ESD is bad for computers and electronic components. If you are opening the case or working inside a computer, always take **ESD precautions.**

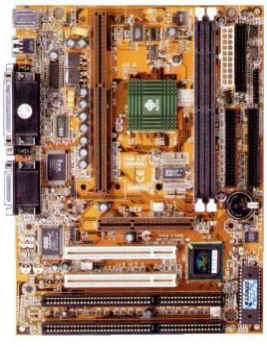
WARNING:
There are capacitors inside a computer's **monitor** and **power supply** that store enough electricity to stop your heart, even when they are unplugged. You **should not be grounded** if you are working inside a monitor or a power supply.
But then, you shouldn't even open a monitor or a power supply unless you know what you're doing.

How Much is Too Much?
Have you ever walked across a carpet on a dry winter day, touched somebody, and heard the snap of electricity as a small blue spark jumped from your fingertip to the edge of your victims ear?

If the discharge was felt, it was probably more than 2000 volts. If you heard it, then it could have been between 3000 - 5000 volts. If you actually saw a small blue spark, it was more than likely in excess of 10,000 volts.

So do I have to walk on a shag rug? Does it have to be a dry winter day? No! Your body is building up and discharging static electricity all the time. Just shifting in your chair can produce up to 150 - 200 volts! You can't completely eliminate this problem but it can be controlled.

ESD and Your Computer
The ICs (Integrated Circuit chips) on the various circuit boards in your computer use between 2 - 5 volts. They can be **damaged by less than 200 volts**. Some may be damaged by as little as 30 volts.



This means that ESD can cause damage to the various components inside your computer and you won't feel it, hear it, or see it. In fact, the discharge voltage could be 1000 times less than what the human body can feel!

When they started replacing the tubes in radios with transistors, people were amazed at how small radios were getting. You could get a **transistor radio** that boasted 7 transistors and was about the size of a brick! …Today, some of the individual chips on your computer's circuit boards contain **millions of transistors**. Advancements in technology allowed for entire circuits to be etched onto a single chip. These are called Integrated Circuit Chips.

One technology for producing ICs is called **TTL (Transistor Transistor Logic)**. These chips are actually more tolerant of ESD and even faster than the newer technology. However, they're also larger, use more electricity or power, and their resistance causes them to run very hot. As computer technology advanced and the number of transistors in the chips increased, heat and power consumption became a huge problem.

TTL ICs are still used in computers today, but the newer **CMOS chips (Complimentary Metal-Oxide Semiconductor)** have all but replaced them entirely. These chips have a semi-conductive metal oxide layer that allows for less resistance, reducing the power consumption and the generated heat. Unfortunately, the very technology that makes these CMOS chips more efficient also makes them very susceptible to electrostatic discharge.

Wait a minute! If you can discharge 10,000 volts of static electricity into somebody's ear, how come it doesn't kill them? Well, the amperage is very low. The human body is very tolerant of voltage, it's the amperage, or a current's strength, that will kill you. The chips inside your computer however, are highly sensitive to any kind of voltage, even at very low amperages. ...By the way, all of today's CPUs (Central Processing Units) and system memory chips on your RAM SIMMs or DIMMs are CMOS chips.

ESD Damage

So what kind of damage can be caused by ESD? Anything from a simple system interruption, causing your computer to reboot with no further problems, to complete destruction of a chip that will make your system unusable until the chip is replaced. Also, you won't find any discoloration, burn mark or physical indication whatsoever as to which chip has been damaged.

There are 2 types of damage that can occur:

Immediate Failures (Direct Failures, Catastrophic Failures) - These are failures that occur immediately after the chip has been damaged and usually aren't recoverable until the chip has been replaced. Say you open your computer (or worse yet, someone else's) to install more memory. Without using an anti-static strap or a grounding mat (you've done it lots of times before and never had a problem), you take a brand new DIMM from its anti-static tube, install it, and now the computer won't even finish its boot sequence. Not a good situation, but you do know the computer worked before you installed the RAM, so you should have an idea where to start looking for the problem.

Latent Failures (Upset Failures, Delayed Failures) - Sometimes a chip can be damaged by electrostatic discharge and the results aren't immediately noticeable. Months later the chip could finally fail completely, or you may end up with intermittent failures that occur sporadically. These are usually difficult to attribute to any specific cause, and very hard to track down.

Although static buildup can't be completely eliminated, there are precautions you can take to reduce the possibility of damaging components due to electrostatic discharge. You should always ground yourself to discharge any static buildup before touching anything inside your computer's case.

Warning: You should never open the case on a power supply or monitor unless you are qualified to do so and know exactly what you're doing. You **do not** want to be grounded if you're working inside a power supply or a monitor. There are capacitors inside these units that store enough electricity to stop your heart (even when unplugged). You should not open the case on a monitor or a power supply. Please note that this is important enough to tell you twice.

Antistatic Wrist Straps

An excellent way to prevent ESD damage to your computer is to use an anti-static wrist strap. It's a conductive strap that fits on your wrist as you're working. It has a wire attached to it with an alligator clip on the end to connect to your case or to an anti-static mat. Some can be plugged right into the wall socket. Only the ground receptacle makes contact. But make sure the cord is long enough, unless you have a receptacle right at table level. If you're working inside a computer's case, the most important tool you should have is an anti-static wrist strap.

Note: A piece of wire wrapped around your wrist and attached to the case does not work the same. Anti-static wrist straps have a resistor inside and are designed to slowly and safely bleed charges away.

At the very least, you should use an anti-static wrist strap
connected to the bare, unpainted metal of your case's frame. There are two schools of thought on this subject:
One is to leave your computer plugged in. Any static buildup is discharged along your wrist strap to the computer's case, then through the power cord into the ground receptacle of your electrical outlet.
The second is to unplug your computer. With the wrist strap attached, this should put you and your computer at the same potential charge and no transfer of electrons should take place.
This becomes a decision you have to make for yourself. A lot of books will suggest that the computer remain plugged in, and in fact, the A+ Certification exam considers this the correct choice at this time (which is probably why these books suggest it). However, when you leave the computer plugged in, it's a little too easy to turn it on when you're working inside; or forget it's on and plug in an expansion card or drop a screw onto the motherboard. Also, you have full AC power going to the remote power switch on the front of your computer. If there is a bared wire, or open contacts on the back of the switch, you could get quite a shock. Remember too, that today's ATX motherboards have power to them even when the switch is off.

A very good alternative is to plug your wrist strap right into the ground receptacle of a wall socket, or into a grounded antistatic mat.

Antistatic Mats
Antistatic mats provide a grounded surface on which to work or place components as you remove them. They also have a cord that can be plugged into a wall outlet to slowly remove any static charges. Some come with another cord and a clip that attaches to your computer's case. The computer does not necessarily have to be on the anti-static mat when you're working on it. If the mat is plugged into a wall socket then it's grounded. Attach an alligator clip from the mat to the case, and now the case is grounded. Attach your wrist strap to the case, and now any static buildup can be safely discharged from your body. As you are working, any parts you remove or plan to install, can be safely placed on the anti-static mat.

If you find yourself in a situation where you don't have a grounding mat or anti-static wrist strap, then you should keep one hand on a bare, unpainted portion of the chassis as you're working inside the case. This method is not that reliable and you'll soon find it to be a little awkward. The ten or twelve dollars spent on a good wrist strap is a wise investment.

What else?
Don't work on a computer or components when they are cold. Allow them to warm up to room temperature first. Cold, dry conditions promote static electricity. In the

winter, when it's very dry, static can build up very quickly. Raising the humidity in your workplace can help to dissipate this buildup. Humidity at 50% to 60% is ideal.

Keep components and expansion cards inside their anti-static bags until you are ready to use them. Remember to handle them carefully, by their edges and as little as possible. Anti-static bags are treated to be conductive so that they draw static away from the components inside. It's always a good idea to keep a supply of anti-static bags to put expansion cards and components into when working on a computer.

It's better to have a tile floor in your work area than rug or carpet, which promotes static buildup. Also, think about what you wear. You don't want to be working inside your computer while wearing a wool sweater or a nylon jacket.

You may not be able to take every ESD precaution all of the time, but use your head and do what you can. The components and hardware inside your computer are subject to electrical fluctuations, spikes, surges, power losses, temperature extremes and, I suppose, even physical abuse. But, the number one cause of damage to internal components is Elecrostatic Discharge.