

DIY Hero:
Build Your Computer

Why Are You Here?:

It sounds redundant, but it helps to have a Square Zero. You're here because you want to get the best out of your computer and the best way to do it is how you get the best out of your car, by knowing the ins and outs of it. As with every car manual, this manual is not the be all and end all for computer manuals. Building a computer is a meticulous marathon but a very enriching one and will allow the reader to later on pace their own journey whether it is to troubleshoot their own device or (as intended here) build their computer completely from scratch.

Get Started

What We're Building and What You Will Need

The following items are for the computer we are going to be building together:¹

- ATX System Case
- 1366 Socket Motherboard
- ATA 20+4 Power Supply
- i7-960, 3.20 GHz processor
- DDR3 memory
- SATA hard drive
- CD-DVD Drive
- Video Adapter
- DVI-I Adapter
- HDMI Adapter
- Crossfire
- PCIe video card

¹ Do not worry about learning in detail the items that you will be installing. We will explain each part while installing. This list is usually known as a computer's *specifications*.

Tools:

- Phillips screwdriver(Fig 1)
- IC insertion & extraction tool(Fig 2)
- Anti-static pad/wrist strap/mat(Fig 3)
- Multimeter(Fig 4)
- Motherboard POST card(Fig 5)



Figure 1



Figure 2

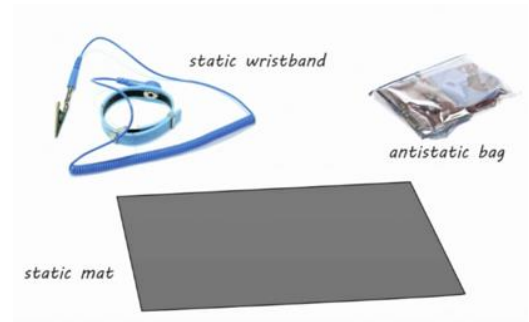


Figure 3



Figure 4



Figure 5

Your Surroundings:

You read that right, even your surroundings have to get ready in order for you to build your computer. Although you may think to build your computer in an environment as this:



You will probably end up here:



Regardless of where you work, you want to ensure that your surroundings are clear of litter and loose wiring. You do not want to risk your safety working in places where tripping can be of great concern. Avoid working in areas with wiring thrown about; it may sound ridiculous but carrying a computer and one that you spent hours building only to be done in by a piece of 2 ft long cable will be understandingly frustrating.



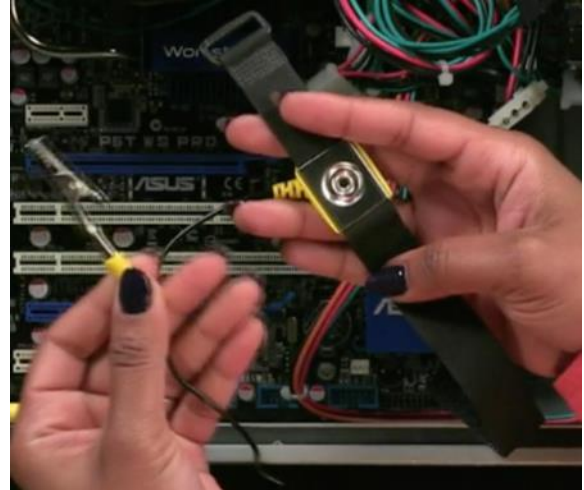
Again, this is ok as long as the proper precautions and steps are taken to avoid damaging your equipment, which can be done fairly easily and unexpectedly. The biggest threat of any piece of your PC build is the person building it and not because of how you will be handling the parts, it's because of *electrostatic discharge(ESD)*. You may have experienced it at one point or another. Rubbing your feet through carpeting and shocking someone or rubbing a balloon and seeing your hair rise. Yes, even the contact of any portion of your body including your hair, according to research, can cause sufficient ESD [1]. Although harmless to you, to the parts that will be going to your PC, they can be damaging to the point where they can be deemed useless before they even go inside your computer. This is why we must take the following precautions:

Step 1: Get your anti-static mat / pad ready:

In many offices, technicians are aware of the fact that they will end up working in a carpet setting, which if not prepared, can be a logistical nightmare. We will assume that your home office will have some moderate level of carpet coverage and throughout this manual we

will be working on a 'Safety First' approach. The anti-static mat and pad will be the two things that will be protecting your computer against ESD.

Their primary purpose is to constantly ground all items on top of it to avoid the building up of electrons that naturally builds up with conductive items such as the components itself or with objects



that build up said conductivity(us!). The mat will be under us to ground the PC builder while a mat will under the PC and any parts that will be installed will be on top of the mat to quickly dissipate ESD.

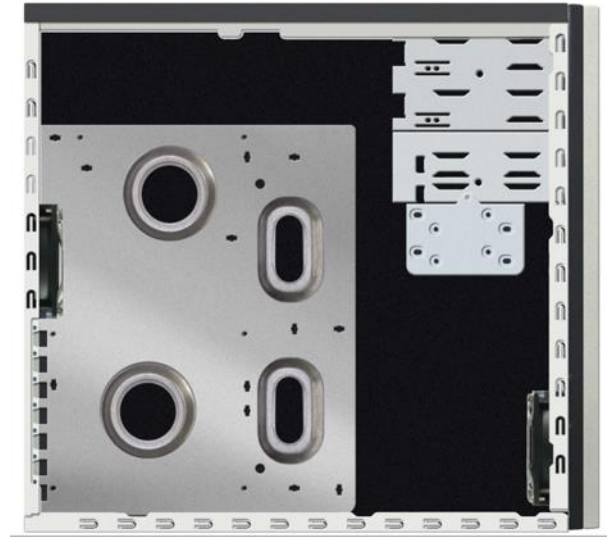
More experience PC technicians go even further in the prevention of ESD by strapping an anti-static wrist strap to further ground themselves. Also, being methodical, patient and organized is crucial as well. IF there is no need to work on a part, there is no need have it strewn about! Most PC parts come inside ant-static bags to avoid static buildup due to their conductive nature so keep them in there until they will be installed.

Section 1: The PC Case and Motherboard

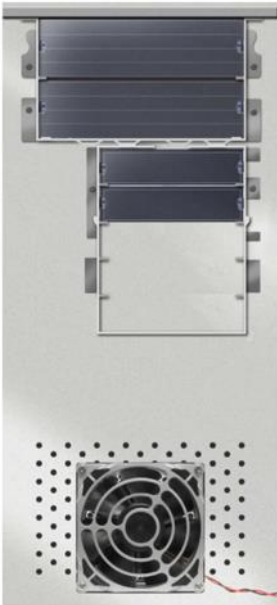
As you will see later on in your journey as a PC technician, you will see many cases for a variety of computer sizes. Many follow what is called the *ATX form factor* model. This form factor is dependent of the motherboard that will be installed on the case. For this manual we will be using a standard ATX (or also called a full tower) case.



Back View



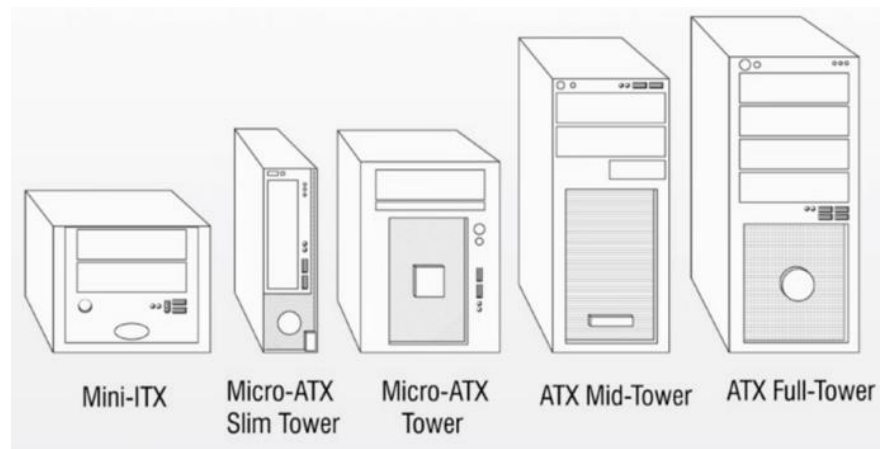
Inside View



Drive bays inside case

The following images should be able to provide a rough idea of how your ATX case should look like with little to no components.

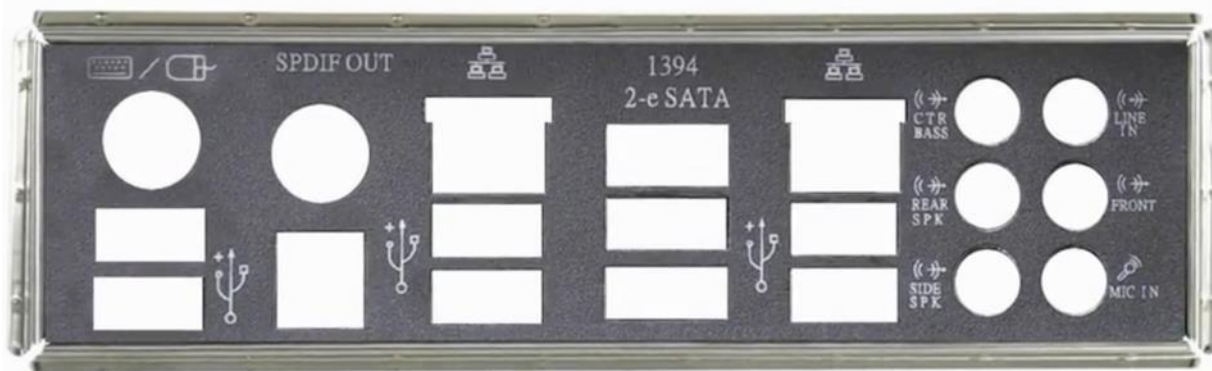
If you're curious of knowing other ATX factors, check these out:



Step 1: Connect your case to the anti-static mat.



Step 2: Let's find the I/O shield and attach it to the back of your computer:



Step 3: Fasten motherboard standoffs without additional torqueing. You do not want to add additional pressure as it is not needed and can damage the case.

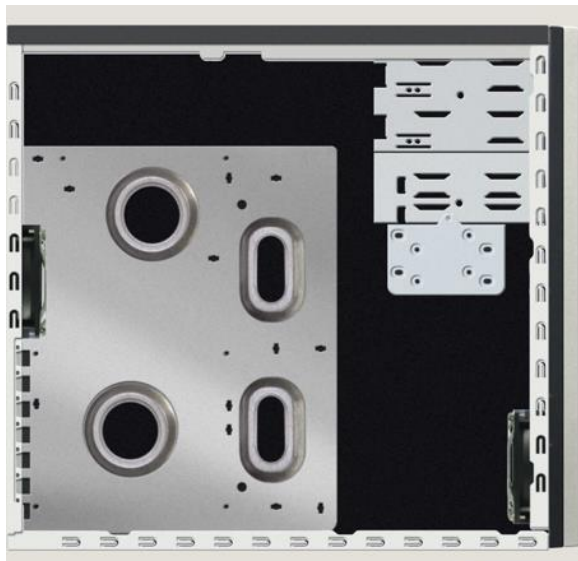


Step 4: Let us find the appropriate spots as to where the motherboard standoffs will be installed

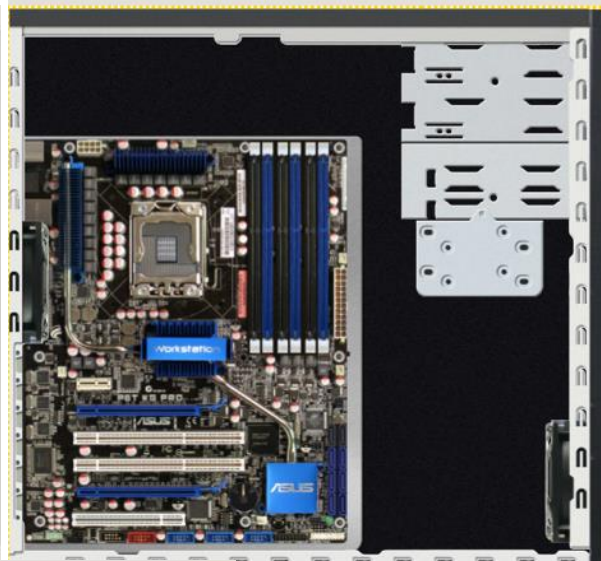


Step 5: Install the 1366 Socket Motherboard:

Case without motherboard



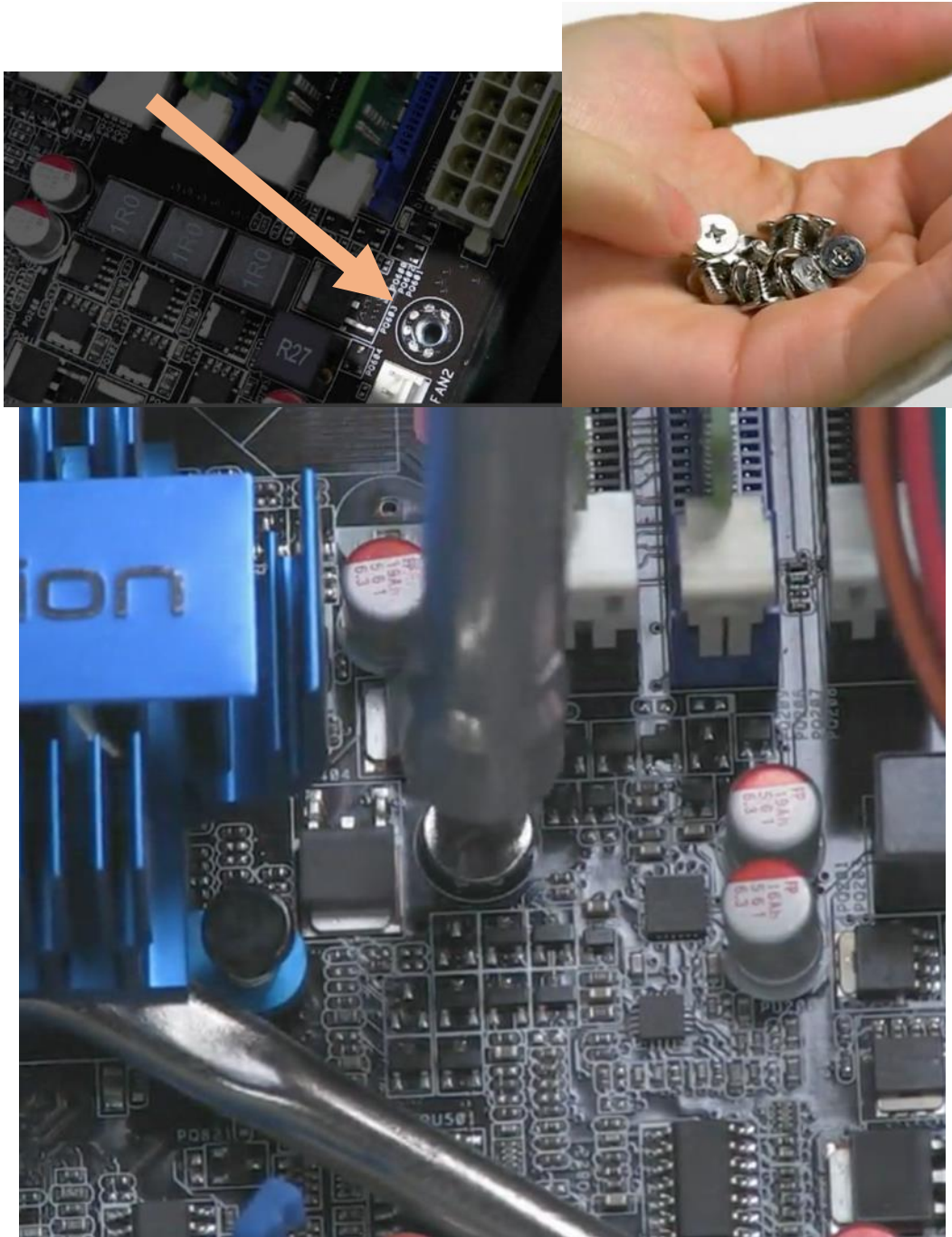
Case with motherboard



Back Case with I/O shield and motherboard

The above images show how the back and inside of your case should look like after the installation of the motherboard. Care must be taking when installing the motherboard to fit it correctly with the I/O shield

Step 6: Secure your motherboard and use the motherboard fine screws. You're not done yet! Find the motherboard fine screws that came with your motherboard and ensure that they are fastened to avoid any movement later on and potentially damage your motherboard.



Step 7: Check your work. We will do this often as it is crucial to be critical of your own work. Make sure that all standoffs were used and screws were fastened to avoid movement. Take a step back and pat yourself in the back, but we still have a lot more to do.

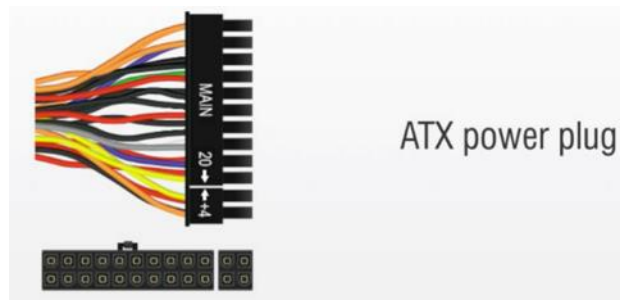
Section 2: Power Supply

The majority of the components inside your computer will need some sort of power in order to perform the necessary functions. However, not all components use the same type of power which is why with computer power supplies it should not surprise you. We will break down the PCIe 20+4 pin, ATX power supply that we will be using.

The ATX power supply is one of a variety of different power supplies available depending on the case's size and the needs your system will need as you start to add different components. Just to give you an idea the one we are using is on the left-hand side of the below image:

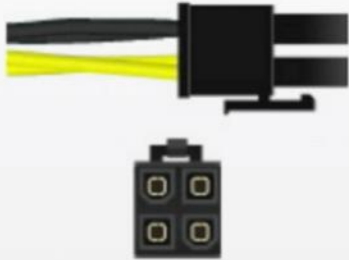


You will also see the following connections on your power supply as well.

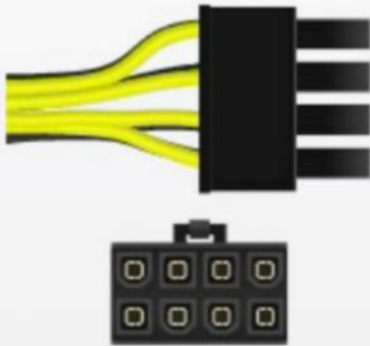


This power plug is used primarily the motherboard and comes with a 20 pin with a detachable 4 pin for older 20 pin motherboards.

ATX12V 4-pin connector

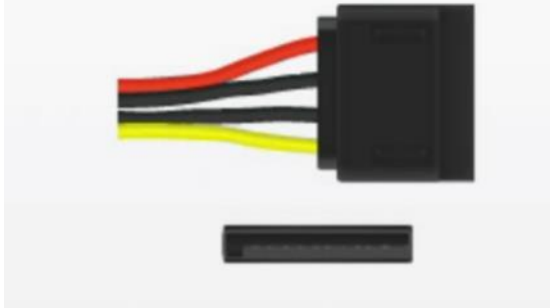


EPS12V connector



Both of these connections also connect to the motherboard, which we will install at a later time. They supply power to the processor usually at 12 volts

SATA power connector



These power connectors are primarily used for hard drives and CD/DVD drives. They carry different power voltages of 3.3, 5, and 12 volts.



Usually all the connectors will be on a power supply if enough research is made, but in the event this doesn't happen, there is a wide arrange of power adapters that quickly change the power supply setup to the connection that you need for the components that you will installing.

So now we're going to install the power supply to the case.

Step 1: Align the power supply to the case.

Usually as you will see in your back case, it will have fitting holes in place in order for you to align the parts that you will be installing. Make sure that once the power supply is connected that the screws that came with the power supply are tightened to avoid movement.

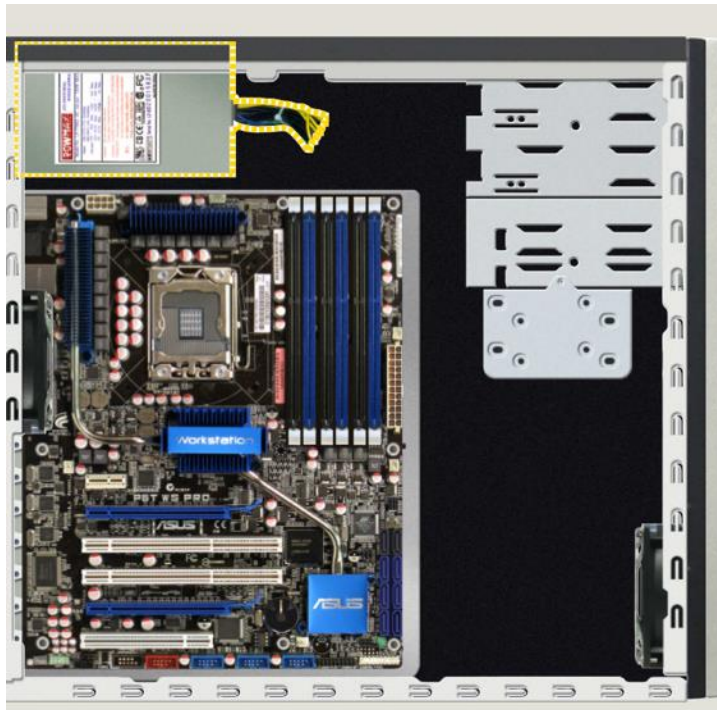


Image of power supply installed.



Image of installed power supply seen through the back with screws attached.

Step 2: Test your power supply

It's been taken out of the box and you have it installed. Good job so far but now we have to know if it works. You have probably seen the multitude of wires and each wire you will see will go into a connected device or to the motherboard itself. Using tools such as a multimeter and a motherboard POST card can allow you to see if the connector from the power supply are providing the required power to the components to work. Too much or too little power can result in either the computer not turning on or badly damaging parts that can be irreplaceable.



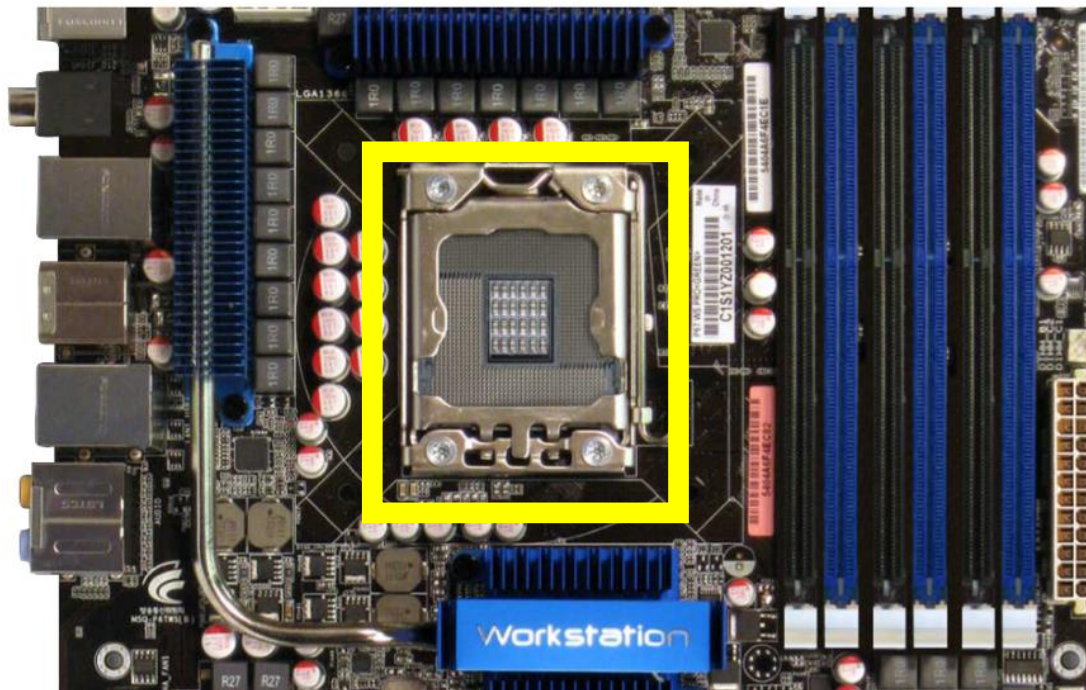
Note:

Care in the usage of electrical components is critical in the installation of computer. Your safety should be paramount at all times. Remember the human body has a low tolerance for electricity, usually between 5 and 18 milliamps [5]. Some power supplies have ratings of up to 650 watts, so extra care must be taken to void the risk of high voltage shock.

Section 3: CPU

The processor, or commonly known as the brain or CPU, is an integrated circuit chip, usually square in shape and small in size that is fitted in a special area of the motherboard[4].

With the motherboard we are installing it is in this area:



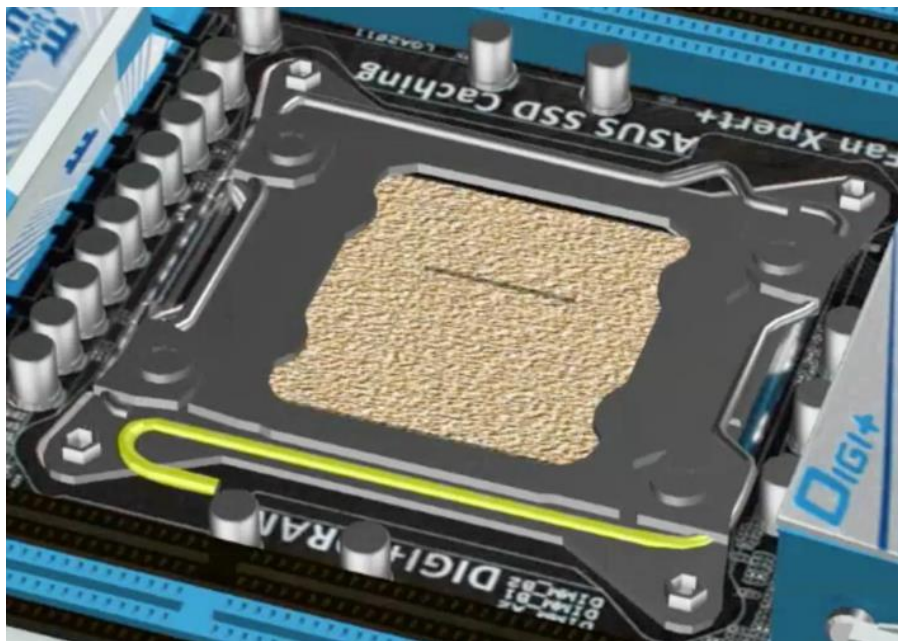
Reading the motherboard manual allows to know that the processor is an i7-960 3.20 GHz processor



This piece will be the most difficult to install on your computer which is why we will take extra care in this section to ensure that the motherboard is correctly installed.

Step 1: Find the CPU socket lever and pick it up to unhinge it.

This lever will keep your CPU in place when closed and will prevent movement(the yellow portion in the below image is but one type of a variety of levers. Check your motherboard manual).



Step 2: Install the CPU and place the thermal pad on top.

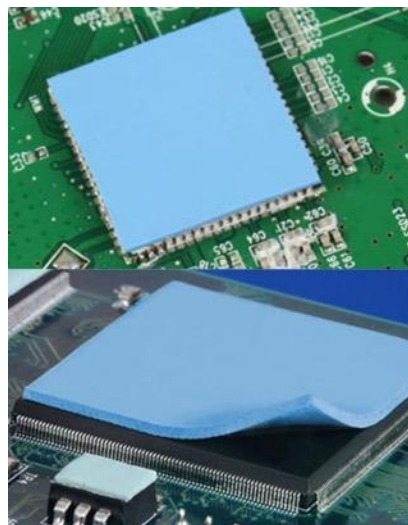
For your CPU, nowadays with new motherboards most CPU socket are *keyed*, which means that they can only be installed in one orientation only. Check the CPU that it has the circle or triangle(usually found in the corner of processor) in the same section of the socket.



How you will want to apply the pad will depend on your experience installing processors. More experience technicians will install the thermal pad on the processor outside the case but will take great care to avoid ESD. For the adventurous novice, do it inside the case once installed



Installed CPU



Installed thermal pad

Step 3: Install the CPU cooler fan.

It may seem like we are installing another component other than the processor with the thermal pad and now a CPU cooler fan. So before we go any further....



By now you may want to check if your processor is working and with the power supply available. Do not do it under any circumstances. The processor can burn up rapidly due to the high temperature. So, with that said...



Top View



Bottom View

processor:

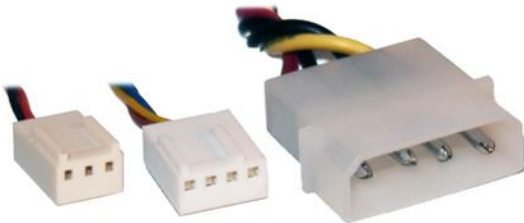
It be c



Installed cooler fan

Step 4: Connect the CPU cooler fan

Before attempting to turn on your motherboard, connect the cooling fan's 4 pin connector

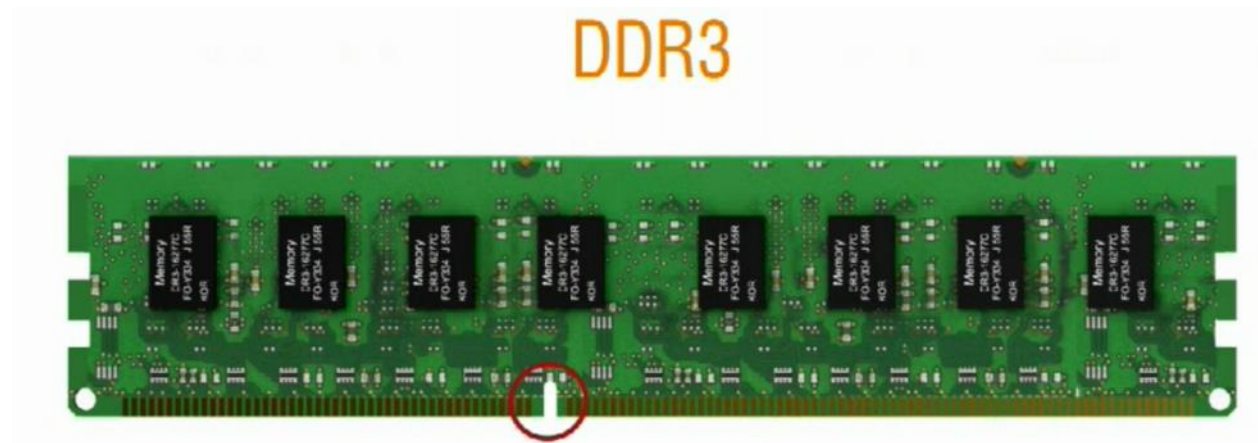


Make sure that this is connected prior to turning on your computer to ensure no damage to the processor can occur due to a rapid rise in temperature.

Section 4: Memory

Random access memory, or better known as RAM, are components that assist your CPU and can be accessed by your computer at any moment to store data. For this motherboard we will be installing a DDR3 DRAM memory.

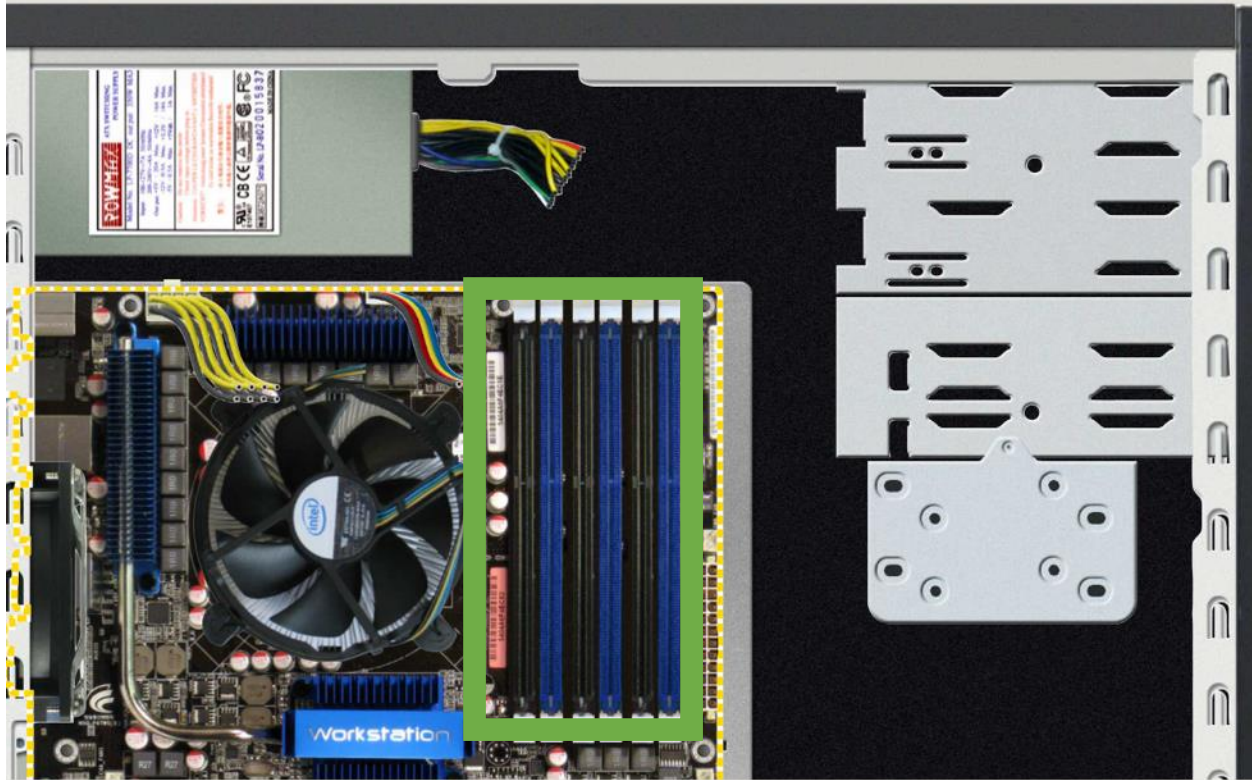
DRAM stands for *dynamic random access memory*, which is memory that is most frequently used for computers[3].



The above example is an image of the memory that will be installed to the computer in this manual. As your journey as a PC technician will show, there are many different types of DRAM available such as DDR, DDR2, DDR3 and DDR4. One way of knowing what type of memory you have is by seeing how many notches it has (red circle) and where that notch is located. As one can see it is located slightly left of center.

Step 1: Locate the memory slots on your motherboard

For the computer that we are currently building, these slots will be to the right of the CPU.



Notice that there 6 slots to add memory to the motherboard, 3 of them black and 3 of them blue. While inconspicuous at first, there is great importance to this.

Step 2: Read your motherboard documentation

Your motherboard documentation is important here due to the importance of adding the memory to the correct slots. Motherboard will prioritize the memory inserted and when done correctly can further help your computer's speeds. This is known as *triple-channel memory* for this particular motherboard, something that we will touch on later on in this manual.

According to our motherboard documentation:

1. ATX power connectors (24-pin EATXPWR, 8-pin EATX12V)
2. LGA1366 CPU socket
3. CPU, chassis, and power fan connectors (4-pin CPU fan (top), 3-pin for other fans)
4. DDR3 DIMM slots (left to right: DIMM_A2, DIMM_A1, DIMM_B2, DIMM_B1, DIMM_C2, DIMM_C1)
5. CPU overvoltage jumper
6. PCI-X speed setting
7. SAS RAID connector (left to right: SAS1, SAS2)
8. Clear RTC (CMOS) jumper
9. Serial ATA connectors (top to bottom, left to right: SATA1, SATA2; SATA3, SATA4, SATA5, SATA6)
10. Onboard power LED
11. Chassis intrusion detection connector
12. System panel connectors
13. TPM connector
14. USB connectors (right to left: USB78, USB910, USB1112)
15. IEEE 1394a (Firewire) connector
16. Optical drive audio connector
17. Front panel audio connector
18. Digital audio connector
19. PCI slot (PCI1)
20. PCI Express x16 slots (top to bottom: PCIEX16_1, PCIEX16_2)
21. PCI-X slots (top to bottom: PCIX_1, PCIX_2)
22. PCI Express x1 slot (PCIEX1_1)

System Memory

The motherboard comes with six Double Data Rate 3 (DDR3) Dual Inline Memory Modules (DIMM) sockets.

A DDR3 module has the same physical dimensions as a DDR2 DIMM but is notched differently to prevent installation on a DDR2 DIMM socket. DDR3 modules are developed for better performance with less power consumption.

Recommended memory configurations

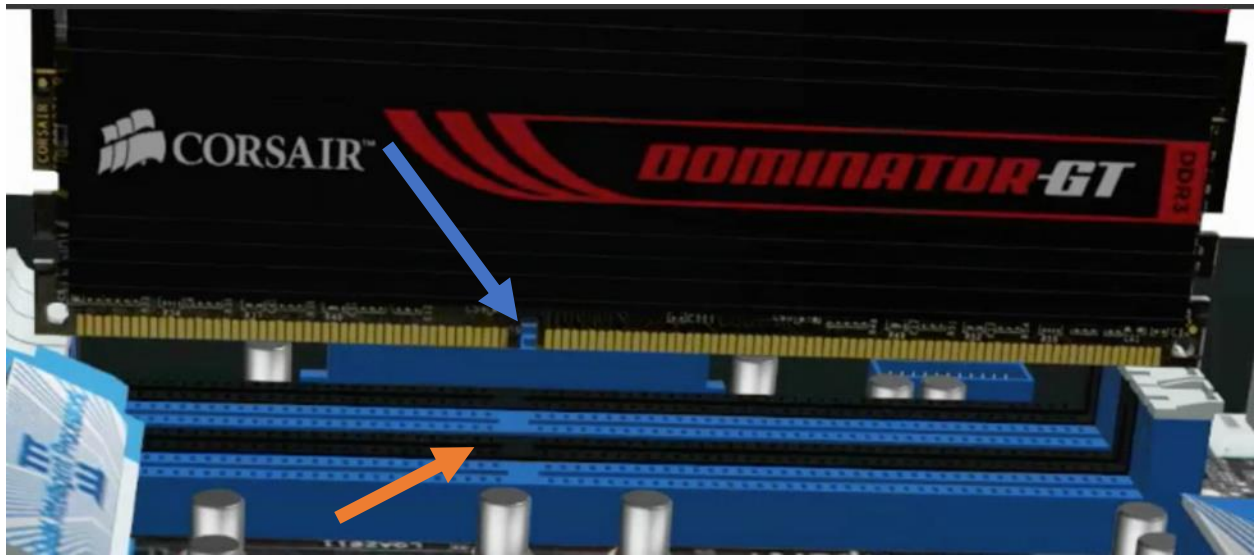
Mode	A2	A1	B2	B1	C2	C1
2 DIMMs (Dual Channel)		X		X		
3 DIMMs (Triple Channel)		X		X		X
4 DIMMs	X	X		X		X
6 DIMMs	X	X	X	X	X	X

Based on the documentation, it is letting us that the installation of the memory will occur on the blue slots.

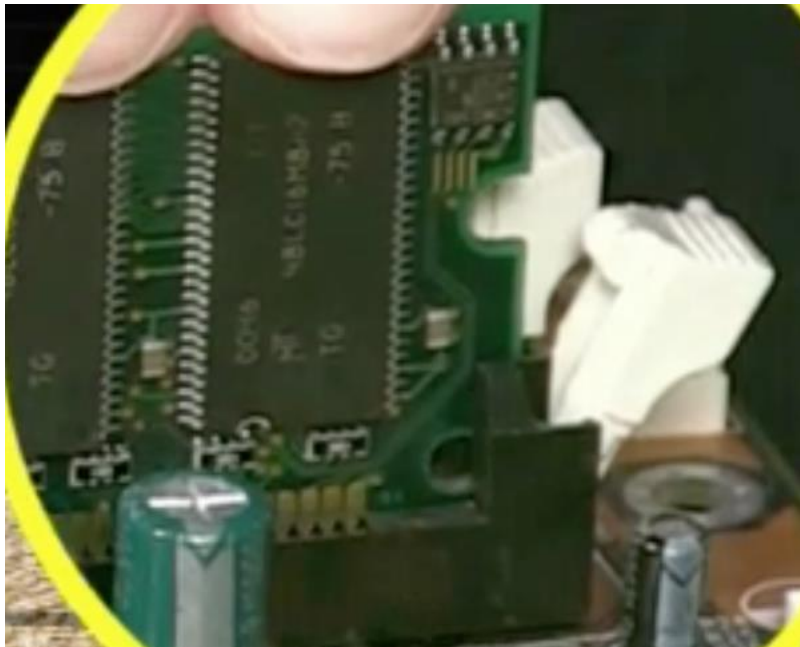
Step 3: Install memory modules into slots

Ensure that you are lining up the memory as how the modules have the notch lined up.

Attempting to install the memory in any other way is sure way to damage either memory, motherboard or both.



You will also notice that your memory slots have tabs on each side that will open as you are placing your memory module unto the slot. If installed correctly, the tabs will attach to the module side notch creating a perfect fit that will not allow the memory to move.



Step 4: Check your work

Again, as with every component installation we will step back and make sure that the installation is completed without issue.



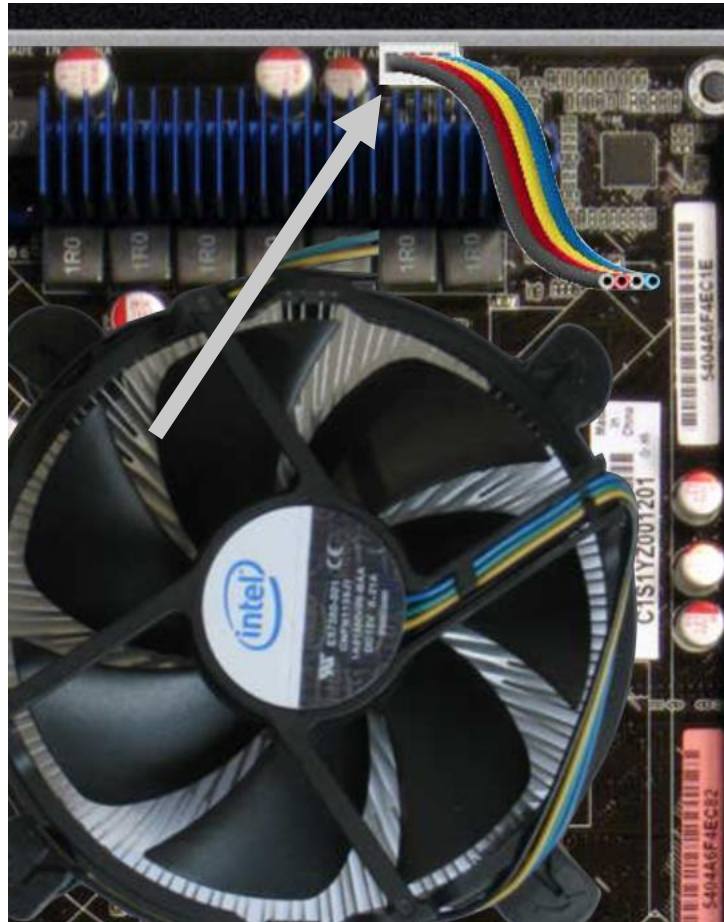
Review

At this point you have the necessary components to turn on your computer and you very well could. I would recommend in order to be able to troubleshoot adequately to not do it yet as breaking apart your computer for troubleshooting can become taxing after a while. We still to ensure that we have connected the rest of the power supply.

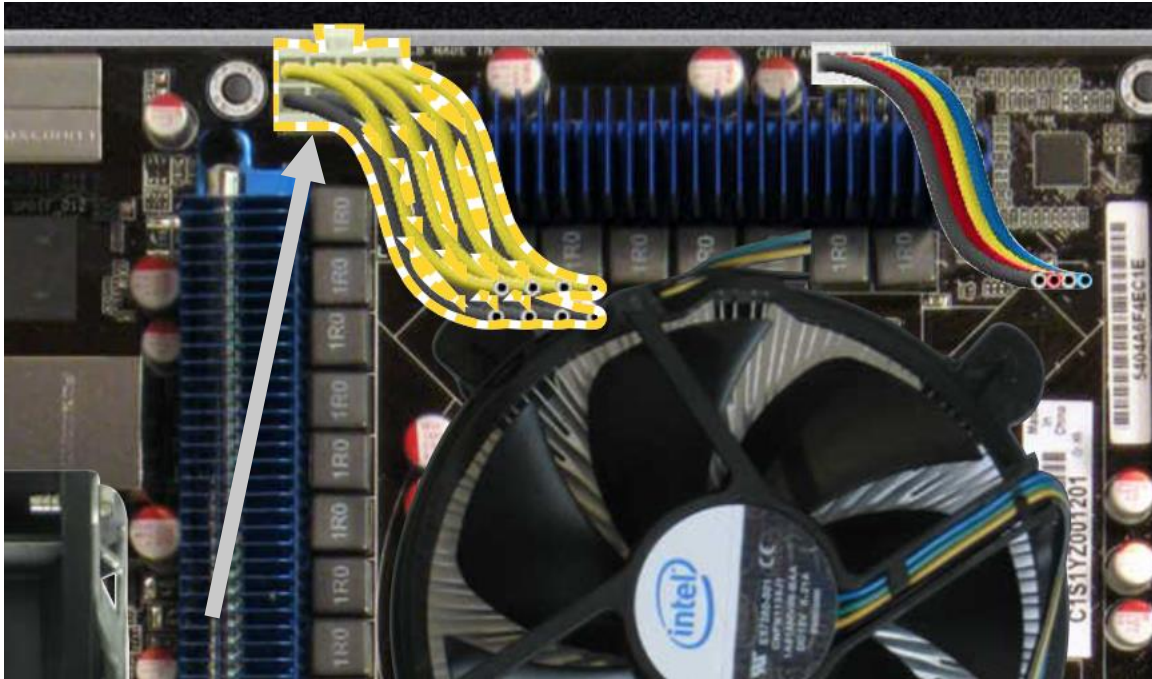
Step 1: Connect all component power supply

We will start connecting the critical components first starting with the CPU fan.

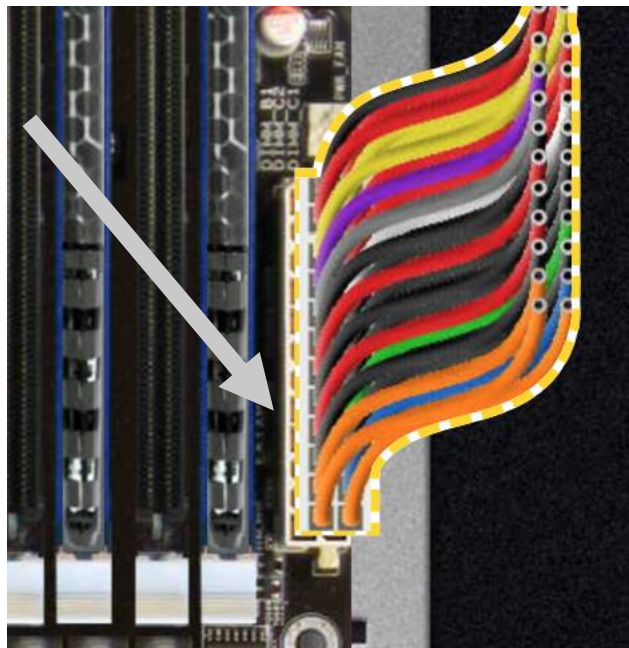
Remember, if the fan is not connected when the PC is turned on, serious damage to the processor will occur.



Step 2: Connect your CPU power supply. This will feed power to the processor.

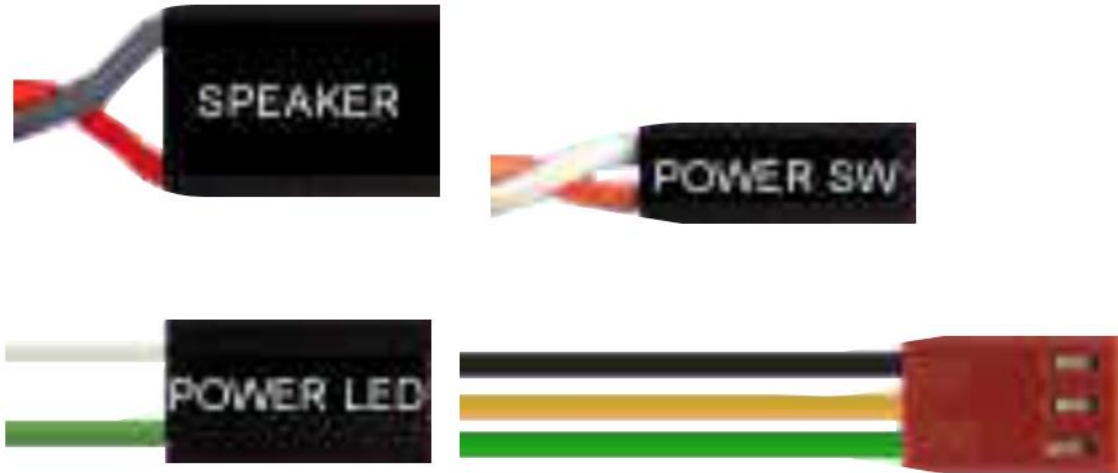


Step 3: Connect the motherboard power supply. This will supply power for memory modules and later on, additional components that will be installed as well.

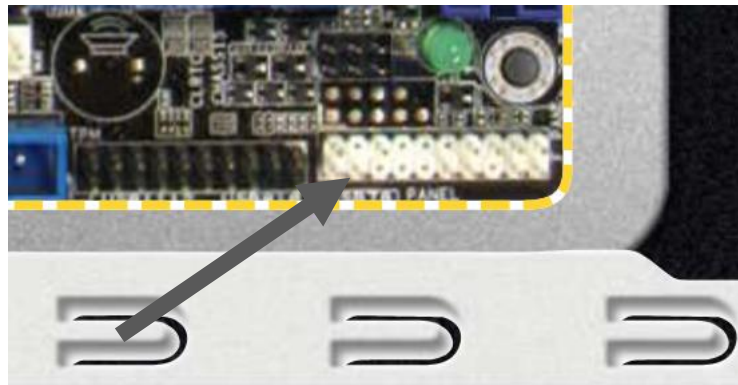


Step 4: Connect the additional motherboard system panel connections

By now you've probably notice that the motherboard has some additional cables to connect:



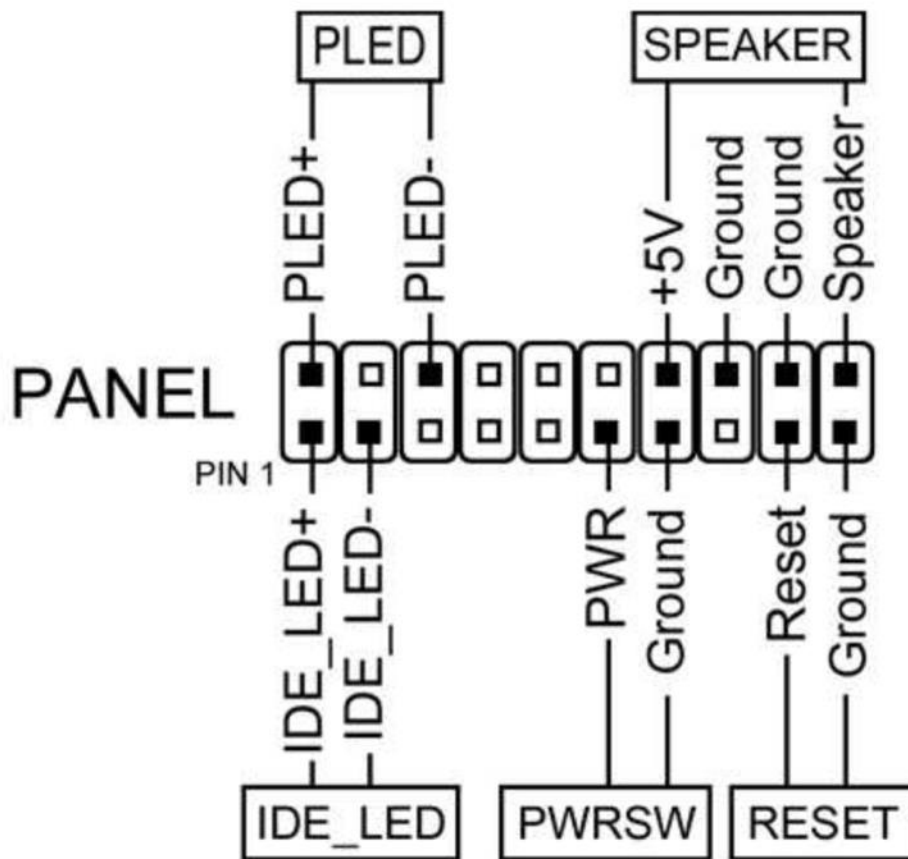
These connections will typically be installed in a section of the motherboard known as a system panel connector cluster. We would need to go back to motherboard documentation on this but a brief picture to know about its location:



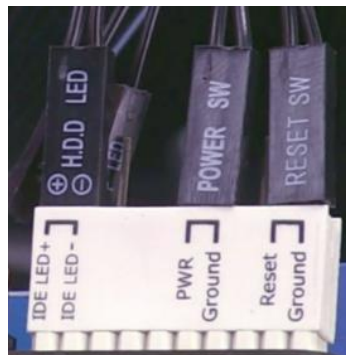
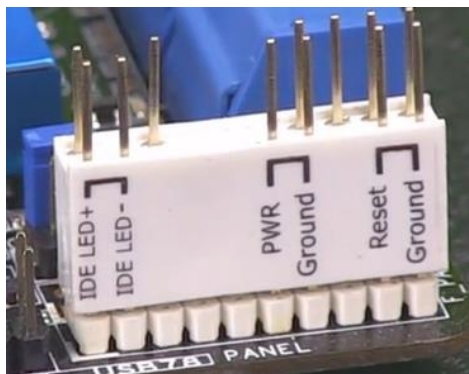
And for our motherboard in this manual the following documentation shows us the following

System Panel Connectors

Connect the cables for the case speaker, front panel switches, and front panel LEDs as follows:



The diagram will show how you will be connecting the above connectors for options such as the power switch, reset button, internal speaker and LED lights. Since the orientation of the cable being connected does not matter, we will be connecting them as the documentation details:



References

- [1] A. M. Nicuta, P. Biclenanu, O. Beniuga, and A. Salceanu, “Modeling Devices Sensitivity Associated to the Susceptibility of ESD Phenomena,” Jun-2013. [Online]. Available:
<http://eds.a.ebscohost.com.ezproxy.umuc.edu/eds/detail/detail?vid=2&sid=2598170d-e411-4701-9a13-6b8611889348@sessionmgr4009&bdata=JnNpdGU9ZWRzLWxpdmUmc2NvcGU9c2l0ZQ==#AN=91567915&db=eih>. [Accessed: 08-Aug-2018].
- [2] Testout.com. (2017). *IT Certification Training / MOS Certification Training*. [online] Available at: <http://www.testout.com> [Accessed 01-Aug-2018].
- [3] Testout.com. (2017). *IT Certification Training / MOS Certification Training*. [online] Available at: <http://www.testout.com> [Accessed 01-Aug-2018].
- [4] Testout.com. (2017). *IT Certification Training / MOS Certification Training*. [online] Available at: <http://www.testout.com> [Accessed 01-Aug-2018].
- [5] G.P. Plitnik, “Electric Shock,” 2013 [Online] Available at:
<http://eds.b.ebscohost.com.ezproxy.umuc.edu/eds/detail/detail?vid=3&sid=5fe08153-446e-4f4c-9cfc-bc104a820c31%40sessionmgr120&bdata=JnNpdGU9ZWRzLWxpdmUmc2NvcGU9c2l0ZQ%3d%3d#AN=89093394&db=ers> [Accessed 02-August-2018].

