

# **How To Build Your Own Computer**

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It is increasingly popular to build your own computer. In most cases, it saves money, lots of it, and it guarantees you get what you want. It also assures you avoid proprietary designs many companies use to keep you coming to them for new parts. Best of all, having built the system yourself, you become very familiar with that system and with computers in general.

Should you tackle the project of building your own computer? Well, there is no reason not to. Even if you know nothing about computers, if you have a desire to learn them, then you can. And once you know the basics, you can build! You can learn as you go. In my opinion, it is best to do this at least once. If you go to buy a pre-built PC by HP or Compaq, they are fine. But, keep in mind that, often, PC manufacturers reduce price by using lesser quality parts. Also, if you do not know you're arse from a PC, you can be certain the salesman will pick up on that and really take advantage of it. I'm not saying all computer salesmen are dishonest, but you wouldn't believe some of the stories I've heard and being a salesman myself believe me I know. In short, you need to know what you're talking about. I help you do this and I think you will find this tutorial in particular quite helpful.

In the following pages, you will find the steps to building your own PC. Enjoy!

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# Part 1 : Selecting your components

Often this is the one part that takes the most time and consideration. Which parts do I buy? Which are best?

There are many good places to buy computer parts. You can go to a computer shop in your area. Although they often provide good warranties, the trade off may be that you will pay a little more than you would in other places. Quite often a lot more. Also, due to the sheer volume of people they see every day, some of the so called specialists don't always listen to your concerns and start jumping to conclusions on what you need or what the problem is. Some of them take pride that they can give you a technical answer in two seconds and make themselves look smart, even though what they just said is probably wrong. If you walk in and say your computer keeps crashing and he insists you need a new motherboard and CPU to fix it, go somewhere else.

Most towns have smaller shops that sell and repair computer equipment. These may be office and stationary suppliers in a shopping centre. Regardless of location, such shops are often cheaper and can provide individual attention. The hardware they sell is often retail packaged from the manufacturer. They may also sell OEM hardware, which usually comes wrapped in nothing but a static bag and is accompanied with very little documentation. You will need to be the judge on this type of hardware. If you feel you need the documentation, you should not buy OEM hardware. Also, not to stereotype certain businesses, but I have to tell you this so you'll be informed: the smaller computer stores are sometimes a little more questionable as to their honesty, I've found. This is not always the case, but since they are a smaller business and don't have the large sale volumes of the larger retail stores, they are often under more pressure to make the sale just to stay solvent. Be aware of this when you walk in.

The bottom line here is to know your stuff. There are many who WILL take advantage of your lack of knowledge to make a sale.

Now, let us go through each type of hardware:

**Case** : Make sure you buy a case which will fit into the space you intend to place it. This is where you decide between a desktop or a tower case. Allow room for expandability; spare drive bays, ample room to work inside. Make sure it has a power supply. Is the case clean? Pay attention to the form factor: AT or ATX. Almost all newer motherboards are using the ATX form factor, so if you have an old case lying around, chances are a new board won't fit in it. If you do a lot of upgrading, you should get a case that is designed with this in mind, such as easily removed motherboard mounting plates, drive racks, etc. Things like the turbo switch and keylock are ancient technology, so pay no mind to having them. Try to have the buttons such as power and reset recessed, so that if you keep the case under the desk you won't accidentally

kick the thing and reset it. Also, check the sturdiness of the case. Some cheaper cases are actually quite flimsy inside. Pay attention to how the case comes apart. Depending on the design, the screwless type is very user friendly. It's easier to work with a case that does not come apart in many pieces.

If you will be running a high-end processor in the case, pay attention to the cooling aspects of the box. It's nice when cases come with case fans included, but if they do not, you should make sure the case is designed to allow them. You should have an unobstructed air hole in the front of the case for a front-mounted case fan, with some method of air flow from the rear of the case as well. Many power supplies also aid in cooling by having bottom-mounted fans that suck air from the inside of the case and blow it out the back through the power unit. And, along this line, pay attention to the wattage rating of the power supply included with the case. If you will be running either a large amount of hardware or fairly high-end hardware in this case, get a good strong power supply. I, not too long ago, upgraded my own PC and shortly thereafter had this mysterious odor of burning plastic in the office. Using the good old' sniffer, I found that it was the power supply burning up. Right about the time I tracked it down, the whole PC went *poof!* Gone and could not turn it on again. I took out the 250W power supply and installed a solid 400W power supply and the PC has been running strong ever since. The PC ran great fairly loaded with a Pentium 3 450 MHz, but putting a new board and an AMD 1.3 GHz Thunderbird in there drove it batty. So, keep this in mind.

As far as brands go, there are many good manufacturers out there I use unbranded ones from my local supplier. Many shops have very sturdy cases that are easy to work with that are unbranded. Many other brands can be just as good. We've even seen some I-MAC looking cases that are semi-translucent. If you want a futuristic look, these may interest you. All aluminum cases are now started to catch on as have black ones (funky!). If you don't mind spending a little more, you may want to take a look at the quality cases made by Lian-Li. If you're into modified cases, you can get them pre-modified with viewing holes and everything. Or, if you're so inclined, you can grab a nice case and do your own mods to it. For some reason, though, I've never been keen on tearing huge holes into my PCs, but maybe it's just me. I would advise you to keep away from the ones with plastic cases – they are crap and fall apart unless kept in the cupboard and never taken out to add anything.

**Motherboard** : Almost everyone knows that the motherboard is the most important component of your computer. At one point or another, every other component connects to the motherboard. Keep in mind that your motherboard choice controls your future upgrade paths. Want to upgrade you RAM? You first have to check and see what type your motherboard will take, and how much it will support. Want that new video card? Your motherboard will need an AGP slot. Get the point? If you choose the wrong motherboard in the beginning, you may find yourself having to buy a different one down the road to support some other upgrade. Today's motherboards are a lot more sophisticated than the one's in the 486 days. If you are used to these older systems, you will

need to come up to speed on the latest boards. Where you once needed an IDE controller card, the connectors are now built right on the motherboard. USB was once an option - now it is integrated on every board. Some boards go all the way, offering built on SCSI controllers, 10/100 Ethernet support, onboard video and sound, etc. Buying a motherboard is a tradeoff - you need to know what you want and then pick that board which has the best combination of features for you. Bear in mind the old adage - sometimes it is better to buy what you will eventually end up with anyway.

There are really three levels of motherboards. Of course this is a generalization, but it's accurate enough.

- Bare-bone boards. These are the types of boards you usually get if you are not into PC hardware and don't want to deal with frustrations. You just want to build it and turn it on. These boards have built in sound and video, and sometimes other gizmos too, like a modem. They don't usually overclock well and don't have a wide range of CPU support. These boards are comparatively inexpensive. Many times, pre-built PCs come with these types of boards, and this is one of the reasons you should be following this tutorial. If you're going to bother building your own PC, get a board that's worth your time. This isn't it.

- Secondly, we have the level of board most commonly used. These boards come with a single CPU slot, EIDE controller, etc. Most don't have built in video, although more of them have built-in sound. This is fine, as long as it is easily disabled. They support a wide range of processors, and with more voltage and multiplier settings, they are more overclocking friendly. Some of these boards offer RAID capability. With the proper amount of PCI slots, these boards are great.

- Thirdly, you have the beasts which most of us cannot afford. These are the dual processor boards, often with built on NIC and SCSI, a shipload of PCI slots. These are more for NT workstations than your desktop PC.

Some things you want to bear in mind:

● **Board Layout** - A lot of people don't consider where everything is placed on the motherboard, but it is important. Is there a big capacitor right near the CPU slot, blocking where your CPU fan will go? Is there a bunch of crap that will block your full-length PCI card from fitting? Are the memory slots in a position where you'd need to remove the floppy drive to get at them? You need to know roughly what you will be plugging into this board and know if anything will get in the way. This also depends to a degree on the size of the case you are using. Trying to cram a larger board, like an Abit board, into a mini-tower is asking for trouble.

● **Slots** - If we had our way, we'd have a motherboard with 20 PCI slots so we could run everything in the world. Unfortunately, this doesn't exist. So, you need to pay attention to how many PCI slots a motherboard has. For most of us the standard 4 or 5 PCI slots will be fine. Be careful, you can easily fill all your slots. Make sure the board has an AGP slot and if necessary, ISA or CNR slots.

● **Manuals** - Believe me, you'll regret it if you don't think ahead and get a board with a good manual. If you purchase a no-name board, you'll probably get stuck with a manual that was written in Taiwanese or English you think a third grader would write. A lot of times, you'll find a pile of addendums added to the manual. They couldn't get it right the first time! Make sure to look at the manual for your board and make sure you can understand it. Most well known brands have decent manuals. Asus, Abit, FIC, Tyan, Shuttle and a few others come with nice manuals. Another thing to keep in mind is that the better-known manufacturers often have nice web sites, and you can get support info there, too. If you don't know who the manufacturer is, or their website is utterly useless, think twice about using the board. Otherwise, you'll be trying to email people like me asking who made it and I'll probably not even reply.

● **Form Factor** - Unless you would die without that older server case you are using, I would recommend going with the ATX form factor. ATX integrates all of the connectors, whereas with AT, you have to plug all of that crap in. AT boards use that big DIN keyboard connector which is a relic.

● **Chipset** - The chipset is the hub of your motherboard. You need to pay strong attention to what chipset a motherboard has before you purchase it. The chipset is fully responsible for what hardware your motherboard will support now and in the future. It controls everything. If your motherboard won't support ATA-100, AGP 4x, etc. blame the chipset. There are many chipsets out there, and this tutorial is not the place to address them all. But, doing your research on this site and others, as well as observing the specs of the chipset itself before you buy it, will be beneficial.

● **Hardware Support** - This one is really a no-brainer, but bears mentioning anyway due to its obvious importance. Pay attention to the specs to make sure that the board will support the hardware you would like to use. If possible, allow room for expandability beyond what you will be using as this will ensure you can use the board for awhile. If there are embedded components such as sound or video, this is fine as long as you are able to disable it easily. Unless you like that all-in-one thing, you'll find you want to eventually put something better in there and you don't want it conflicting with the built-in components.

● **Reviews** - Finally, before purchasing any motherboard, find out what others think of it. You can rest assured that if there is any nagging annoyance with any motherboard you are thinking about buying that several people have noticed it and have posted all over the internet about it. Check out hardware review sites. I'm sure you all know where to go for those. Also check out Usenet Newsgroups.

## **Processor :**

Processors come in three basic levels:

● **Low End** - This group is made up of the people that may be starting just starting their own business, and need a computer to print letters, invoices, and other business related things. Most standard business software will run just fine on these processors. Here, we are talking about anything from the old 486 to 3-400MHz processors now days. This can include the original Pentium processors, Pentium II's, AMD K6's, the old Cyrix 6x86's and the like. They used to be mainstream, but now they are old school, face it.

● **Average** - This group of processors encompasses the bulk of the chips being sold right now. These processors zip at business software, but, depending on the speed and other things, also zip reasonably well at image editing or gaming. These include the Pentium 3's and the Athlon T-Birds, and most processors ranging from the 800MHz range up to over a gigahertz. It's amazing that over 1 gig is not considered average, but given that you can buy chips of these speeds so cheap now days, it'd be dumb not to get one.

● **High End** - This group is the usually the company that's very competitive, on the leading edge of profitability, needs a high end processor for CAD, or just has a lot of money to burn. If you're in this group, you should be looking Intel Pentium 4 processors, or an AMD XP processor ranging upwards of 2 Ghz. These processors are the top of the line. They have the most onboard memory, and they are the best at crunching numbers that are needed for CAD and other CPU intensive programs.

Which CPU you need for a new system is a matter of personal choice. And, on this note, keep in mind that all processors need cooling. Most retail-boxed processors come with fans included or already attached. But, if not, or if you're getting an OEM processor, make sure to get a good fan. Make sure the fan is of the ball bearing variety and not one of those cheap sleeve bearing fans. Make sure it is rated for your processor, as some fans look fine when you look at them, but wouldn't help a high speed processor do anything but boil itself to death. Also, and this is not usually an issue, it is nice when the fan gets its power from the CPU\_FAN power 3-pin plug on the motherboard rather than take up a plug from your power supply. If you are dealing with older hardware here, you may have the heat sink separate from the fan. In this case, you'll want to make sure the heat sink has a way of attaching to the processor, either by clips or with heat sink compound.

### **Memory:**

Memory is a big part of your machine, so get the good stuff. A lot of people get really confused when it comes to memory, and it's really not necessary. Some memory manufacturers will help you find compatible memory for your motherboard on their websites. One such company is Crucial Technology. In most cases, standard non-parity, non-ECC memory will work just fine. Most boards today are still using SDRAM, although DDR-DRAM has really caught on and is a lot faster. In short, though, memory is not a huge issue and just buy what your motherboard requires. And, with today's prices, buy lots of it. Operating systems themselves require large amounts of memory. Windows XP's bare minimum requirement is 128MB of RAM. So, give yourself ample breathing room and don't try to save a few measly bucks by not getting enough memory.

### **Video Card:**

There are just tons of video cards out there to choose from, all saying they're the best and sporting snazzy graphics on the boxes to grab your attention in the store. Let me give you some general pointers:

Where it used to be we all used 2 MB cards and thought you were a gaming nerd if using a 4 MB card, all graphics cards today have a lot more- usually 64 MB or higher. Get it. It won't cost that much. Likewise, AGP is now the standard, so unless you're using a relic motherboard without an AGP slot, get an AGP video card. As for power, consider what you'll be doing with the PC. If you're doing mostly business and Internet and the occasional game, then you don't need a super-duper gaming card. A card with decent 3D and good 2D power is better for you. Most video cards on the market today are pretty decent at 3D and kick-ass at 2D. 2D really does not require all that much out of a video card. Watch the reviews to get viewpoints on different manufacturers.



Some cards come with TV-out channels, video-in, or even TV tuners. This is great stuff, and if you can afford it, go for it. I would say, in general, though, that do-everything cards usually sacrifice performance tweaks, so if you're trying to build an all-around kick-ass system here that pumps pixels so hard you'll drool, get a card that does that with authority and don't worry about the TV. Hell, you can buy a TV cheaper than some of those video cards. Make sure whatever you get is matched to your monitor. There is no sense in buying a cutting edge video card with killer refresh rates if you're using a clunker monitor that can't do it.

### **Removable Storage:**

All PC's have some form of removable storage, even if it's only a floppy disk drive. In the case of a floppy, there's really nothing much to know about them. Just buy one that looks alright and works. And, don't even think about putting a 5.25 floppy drive in your PC. A lot of PCs now boast more advanced media such as ZIP drives or maybe an LS-120. These can be useful, given that 1.44MB for a floppy is really barely anything. Plus, they are slow as hell. Beyond these drives, though, the CD-R/CD-RW drives are the real craze right now...and for good reason. If you want a drive where you can perform backups and share data with friends without really worrying about capacity issues, invest in a CD burner. They are pretty fast now, and most drives offer drives with Smart-Burn technology that will virtually guarantee you never mess up a burning session by doing something else on the PC at the same time.

### **Hard Drive:**

Make sure it looks good. Always buy new, in my opinion. And make sure it has a manual, or at the very least, a jumper diagram imprinted on the drive itself. For price and compatibility, I'd stick with IDE. With IDE, though, make sure the drive is UDMA. Most likely, your motherboard supports ATA-33,66 or 100. So, you may want to get a drive that can pump that hard. Get a drive with a decent rotation speed. 5400 RPM drives are slow. 7200 RPM is better, and higher RPM drives even better. The really fast drives, though, may require a hard drive cooler, so unless you are willing to mess with that, get a drive with a good balance of speed and temperature. If speed is your biggest concern, go for the SCSI interface. Keep in mind that with SCSI you will have to purchase the additional hardware necessary for the SCSI bus. Also, get the largest drive you can afford. You'll be surprised how fast you can fill up a hard drive, depending on what you do with your PC. Large volume drives are dirt cheap now, so get yourself a biggie.

**Sound Card** : An absolute necessity in today's PC world. There are tons of available cards out there, but I recommend the name brand again. I've tried some of the various cheaper clones and had my share of driver issues with them. Read the reviews, as there are a lot of sound cards out there with special features. Some cards pimp special sound algorithms that are supposed to enhance the sound. Some of these suck, but others really improve the

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sound. Some cards, like the upper-end Creative Labs cards, have extensions with all sorts of inputs and things that attach to the sound card and expand the capabilities. These are not usually important unless you're into sound mixing or audio-video editing. Make sure the card has 4-channel support, because this really makes the PC sound great if you have enough speakers. With the card, you must get speakers. You can spend a lot on speakers, but I recommend at least a 3-piece system (with a sub). You'll appreciate the deeper base response and overall sound. Altec Lansing makes good stuff, as well as others. Labtec makes good speakers, although their sound doesn't really impress me. For true top of the line check out the Klipsch Pro-Media speakers or Boston Acoustics.

**CD-ROM/DVD** : Make sure it has a driver installation disk (almost all retail units do). You will need to get this drive working so that you can install the operating system. These drives are very inexpensive now, get a fast one: 40X or faster. Make sure it is ATAPI compatible IDE. Some drives look like IDE drives, although they really use a proprietary interface, such as that used on some older Creative multimedia kits. If you're buying new, you won't find this in the stores anymore, so don't worry. If you want more than a simple CD-ROM, get yourself a DVD player. These drives are not much more than a regular CD-ROM and are backward-compatible with CD-ROMS, so they serve all purposes. Then, with a good DVD software player like PowerDVD or WinDVD you can watch movies or use DVD software on your PC.

**Keyboard & Mouse** : Rather self-explanatory. Make sure the keyboard connector fits into the plug on the motherboard, otherwise you may need an adapter. Most new boards use a PS/2 connector for the keyboard. Make sure the mouse works. And choose the right kind for your system: serial or PS/2. If you like, you can get fancy "Natural Keyboards", which are basically regular keyboards that are bent in the middle. It takes a while to get used to them, but they are nice. You can also get mice with various gizmos such as scroll wheels, roller-balls, etc. If you like feminine mice (without balls =| ) , then you can check out optical mice, such as the Intellimouse Explorer from Microsoft. When it comes to the mouse get an optical one – you will soon get sick of removing fluff from the ball of your ordinary mouse – optical mice use a light source and an encoder which recognises when the mouse is moved on any surface – they cost a little more than a standard mouse but you will only ever need one!

**Drive cables** : Make sure you have all cables for connecting the hard drive, floppy drive, and CD-ROM to the I/O on the motherboard or I/O card. These cables usually are supplied with the motherboard or drive itself, but not always, and sometimes not in the quantity you need. Make sure they are long enough. Inspect for damage, such as ripped wires or something. Also, keep in mind that ATA/66-100 drives must have an 80-wire IDE cable. It's the same width as the norm, but each wire is thinner, so they cram more wires into the cable. If you're paying special attention to cooling issues, you may choose to get rounded data cables. These are nice as they tidy up the inside of your case and allow cleaner air flow than would a case crammed with a bunch of wide, gray ribbon cables that often get in the way.

**Audio Cable** : Usually supplied with the CD-ROM, it connects your CD-ROM to your sound card directly.

**Screws** : Makes sure you have enough screws. Usually an ample amount is supplied with your case. Make sure the screws are the right size. There are different sizes used for connecting card than for connecting drives, and if you try using a large screw on the drive, you'll crack the drive.

**System Disk**: Make sure you have a system disk setup and ready to use. You can make one for whatever operating system you plan on using. If you have another machine already running, use it to make a system disk. Hopefully you are using Windows 98 or better, since it makes CD-ROM setup later in this tutorial much easier.

That was a brief overview of the hardware scene for you and hopefully it serves as some advice for collecting parts to build your PC. There is no way I can cover all brands of make any solid recommendations as to manufacturer in this tutorial, so much of that research would need to be done separately.

Now, we will move into some actual assembly steps...

## STEP 2 : Remove Case Cover

This is a very easy step. Basically, you are just taking the cover off your new case. If you have a plain jane case, you take a screwdriver and remove the four or six screws located around the edge on the back of your case. Hang on to these screws and put them in a place where they will not be scattered and can be easily found. Once they are removed, the entire case cover comes off in one piece. With this design, the front of the case does not move. Only the top and sides come off as a cover. In some newer cases, you may have to yank the front cover off and then unscrew the case sides from the front.

If you have a newer, more expensive case, it may come apart differently. The manufacturers of better made cases have gone to a "screwless" design. With this design, you usually take hold of the bottom of the front bezel of the case and give it a nice solid yank. The front then pulls off. It is my experience that this usually requires a few tries and some muscle. These cases are usually pretty durable. The sides then lift and slide off as does the top. Your case, in essence, comes apart in four pieces. Other cases come apart in a similar way, but after you take the front off, the top and sides come off together.

Each case is a little different in how it comes apart. There are almost as many designs as there are companies that make them. You may find some where you don't even have to remove the front, and rather you just slide the sides off. With others, you can remove the whole motherboard mounting plate and card rack combo from the case by sliding it out the back. This is convenient for making quick changes to the system, although you still have to disconnect the various cables to get it out all the way. Whatever case style you have, remember to look it all over before you attempt to gain entry. You don't want to force it and break anything - take your time.

Now that this is done, you are ready to move on.

## STEP 3 : Case Preparation

At this point, you should have the new case in front of you with the cover removed. Before you can use it for a new system, you must prepare it for use. Go through the following checklist to make sure it is prepared. Not all of this may be necessary on your case, and if you're using a case you already had, much or all it has likely been done already. Nonetheless, this is a useful guideline.

Now that the case is open, now is a good time to go through the screw supply provided with the case. These are usually held in a small plastic bag nestled inside the case. Inside this bag you should find:

- Chassis screws - this is the type used to tighten down cards, etc.
- Smaller screws - just like the chassis screws, just with a smaller diameter. It is used to fasten the motherboard in.
- Standoffs - these are screws that are used to hold the motherboard about 1/8" from the motherboard mounting plate. Their ends have a threaded opening in them that accept the smaller chassis screws. If you have an AT case, you may find small white standoffs. These serve the same function as the metal standoff, but are simply punched through the board and slid into slots on the case. They are rather clumsy to use compared to the metal standoffs, but they get the job done. Lastly, some cases use small metal clip-looking stand-offs. They are pinched together and slipped into small rectangular holes in the motherboard mounting plate and they snap in. These are, too, a bit awkward.
- Washers. These are typically small, loose washers, not the metal kind you've seen in your toolbox. These will be used to cushion your motherboard from the screws you will be using to hold it in. Some motherboards have metal plates around the holes to keep the screws from shorting the circuitry, and in this case, washers are not necessary and may not be included.

Now, verify a few things have been done, if they need to be done.

1. **Clean Case** - If the case is new, this should be no big deal. But, if the case has been used before, it could probably stand a cleaning. Clean out the inside with a rag or compressed air. Make sure the fan in the power supply is free of furry dust. Also take a rag and wipe it off.
2. **Inspect the Power Supply** - Make sure it is tightly attached to the case, make sure it is free of dust, and make sure it is set to the proper voltage of your area- 110V for U.S. and 220V (I think) for outside countries.

3. **Inspect Power Switch** - Make sure the power switch is securely tightened and correctly connected to the power supply. With most AT cases, the power switch is already connected to the power supply by four wires. In ATX cases, the power switch will have one loose wire coming off of it. This wire will then connect to the Power Switch connector on the motherboard. The power supply should be attached to the power switch already and the connectors should be covered with electrical tape.
4. **Install Feet** - These are little tabs inserted into holes at the bottom of the case. The case sits on these tabs when on your desk. If the case has been used before or it is a more expensive case, this may not need to be done.
5. **Install Case Fan** - Sometimes, you may want to install a separate fan that screws onto a rack next to the vent on the front of the case. This helps increase circulation of air through the system. Make sure the fan is set to draw air into the case, not blow out. Many cases already have this installed, so you may not need to worry about it. Some like to put a little filter over the hole so as to prevent dust from being drawn in.
6. **Configure the LED** - The LED on the case operates completely separate from the actual speed of the system, so you can set that now. It is done with jumpers on the back of the LED. You will need the little manual that came with the case to do this right. Many newer cases don't even have LED's, so don't worry about it.
7. **Free Up the Drive Bays** - Brand new (cheaper) cases sometimes have the drive bays sealed with metal plates. It's the most annoying thing. If you want to install any drives, and you probably do, you'll need to remove these. Choose the drive bays you want to use (usually the ones at the top on tower cases) and remove the metal plates. These are attached by metal, so they take some cutting, prying and twisting to break them free. Be careful not to hurt the case or yourself. The plate will likely have sharp edges once removed. Better cases have these bays covered with plastic, replaceable plates which are a lot easier and make infinitely more sense.

## STEP 4 : Configure Your Motherboard

It's time to get your motherboard ready to install. The next few steps of the tutorial will walk you through how to do this. This step as well as the installation of the memory and CPU is much easier to do before installing the motherboard in the case. It can be done while the motherboard is in the case, and if you were working on a PC after it has been built, you would likely be doing so. But, when building a PC from scratch, it is easier to perform the configuration and setup of the motherboard from the outset.

Motherboards tend to be the most daunting obstacle in a first time builder's mind. But, they should not be. They are actually pretty easy to configure and set up, as long as you can do a few basic things. The first thing is to be able to read the manual and understand what it is saying. If there are any words or concepts in the manual which you do not understand, look them up. This is very important, as not really understanding what is going on can lead to dumb mistakes.

Second, you need to know how to manipulate a jumper. First understand that a motherboard is very configurable. This is done so that it can work with a variety of different hardware configurations. The settings the board uses are governed by which circuits are carrying electricity. Now, we have the jumper, which is nothing more than a pair of pins, each carrying an electric current. When these pins are left in a non-connected state, then the small plastic cap is not placed over them and the circuit is broken. Thus, whatever setting that particular jumper controls is off. This state is called "uncapped" or simply "off". Now, if you place the cap over the two pins, then the circuit is complete, and the configuration of the board changes accordingly. That is the theory behind a jumper.

Now, in the real world, jumpers can be more than two pins. Sometimes a particular jumper, labelled JP1 or something similar, can consist of three or more pins. In this case, the manual will tell you which pins to uncap and which to cap in order to set a particular setting. As long as you understand the manual, you're in good shape.

Configuring your motherboard usually requires setting jumpers on the motherboard according to the CPU you plan on putting on it. I say "usually" because not all boards use jumpers for this. Some make use of DIP Switches, although these are not commonly seen these days. Other newer boards are jumperless, making use of a system in which the settings that are normally set with jumpers or DIPs are set in a special CMOS type program. If the motherboard you are installing is jumperless, you can basically skip this step because it will have to be done later. You might want to read through it, though, because even the "jumperless" design has a few jumpers and you will need to know what you are doing even with the jumperless design.

You need to have the manual for your board available. If you do not have the manual, log on to the manufacturer's web site and see if you can find this info there. You can also try their tech support via phone. In some cases, too, some of the jumper settings are printed onto the surface of the motherboard. If you don't have any of this info, you are just out of luck. Unfortunately, you must have some form of documentation available simply because motherboards have so many settings to adjust. If you're dealing with an older board, you may need to spend some time trying to identify the manufacturer so that you can see if they do support it. You can many times use the BIOS ID numbers to identify the board online.

Motherboard manuals come in two main formats. Some are friendly for hardware buffs by listing a separate jumper or DIP switch for CPU core voltage, I/O voltage, multiplier, and system bus speed. They then tell you the settings for each of these. This format is better because of the increased control. Other manuals list the settings next to a list of commonly used CPU's, showing the common settings for each. While this format is easier for the end user for easy setup, it is tougher if you like increased control of the settings, for overclocking for example. The best manuals do both: list the jumper setting individually as well as provide a list of processors and the jumper settings for each.

There are few things to be careful of. When setting the processor speed via the jumpers, use the processor's TRUE speed. If your chip is rated with the P-rating system, it does not run at this speed. The P-rating is simply a comparison to the Intel chip. Such an example is the Cyrix 6x86MX-233. This chip has a P-rating of 233MHz, but actually runs at 187.5MHz. The good news is that most CPU manufacturers no longer use the P-rating system and any modern or semi-modern processor does not use it.

When playing with the board, be careful with it. It is usually best to place it on the static bag it was in when setting the jumpers. Always place the board on a flat surface, not carpet or anything like that. And always ground yourself before handling the board. When handling the board, handle it by the edges only when at all possible.

**A NOTE ON GROUNDING:** It is important that you ground your body before handling computer components. Your body can accumulate huge amounts of static charge just by walking. You may not feel it, and most certainly do not, but the charge can be sufficient to fry a computer component. It's the same effect as rubbing your feet on carpet and touching a doorknob. So, before handling electronics in this tutorial, ground yourself by touching the frame of your PC's case with both hands. You can also use a filing cabinet or anything conductive attached to the ground in some fashion.

Now, here is the basic procedure for motherboard configuration:



● **Read the Manual.** Always. Read the listings for settings and locate all jumpers on the motherboard itself and what settings they control.

● **Set the voltage settings.** Most older chips use one single voltage. The newer chips we use today use a split voltage. Most newer motherboards provide jumpers for the core voltage and I/O voltage. Set them to match your intended CPU. If you are using an older chip with one voltage, just set both voltages to be the same. Your best bet to choose the correct voltage is to see what is printed on the CPU itself. Most CPUs will have "core voltage" printed somewhere on it. That is your voltage. Many newer boards are designed to detect the voltage automatically and then use the correct voltage. In this case, you will not have to worry about it.

● **Set the processor speed.** This is not usually done with a single jumper. It is, instead, done by setting the system bus speed and a multiplier. The multiplier is the number which when multiplied by the system bus speed gives the processor speed. There is a separate jumper for each of these settings. Configure these to match the intended CPU. If you know what you're doing and would like to overclock the chip a tad, set these jumpers a little differently. Generally, though, I would recommend actually getting the system working before trying to overclock it. If your manual lists settings by CPU, just do what it says. You can sometimes infer from the manual which switches control voltage, multiplier, etc. Also, watch for chips that use different multiplier settings than they actually use. For example, many 233MHz chips use a 3.5x multiplier, but since some boards don't offer this option, they interpret the 1.5x multiplier to be 3.5x. So, set the bus speed first. Most CPU's are designed to operate on the 66MHz or 100MHz bus, although many choose to operate higher than this or at various speeds in between. After this, set the multiplier. This will depend on the CPU you are using. For example, let's say you are installing a Pentium II-266. You set a bus speed of 66MHz. In order to run the processor at its intended speed of 266MHz, you must set a 4.0x multiplier.  $66\text{MHz} \times 4.0 = 266\text{MHz}$ .

Generally, if your board is jumper-controlled, you will need to consult the manual for the proper jumper arrangement, use the motherboard layout in the manual to find the jumper on the board itself, and use either your finger or tweezers to adjust the jumper to look like the diagram in your manual. When the jumpers in question look like they should in the diagrams, then you're set. And,, again, if your CPU settings are NOT jumper-controlled, you will be taking bare of all this later on.

Some boards make use of a jumper to set the cache size and type. Set this now, if need be. If you have internal cache, which most do, you won't need to bother. Likewise, some boards give you the ability to use either AT or ATX power supplies. Depending on which type you will be using, you may need to set a jumper to tell the board what type of power to use.

If your board supports the asynchronous SDRAM clock speed, as most boards with Via chipsets do, you need to set the jumpers properly for this as well. This capability allows you to run the memory at a different clock speed than the rest of the system. This comes in handy, for example, when you want to use older memory yet run the rest of the system at the higher bus speed. You can set the system bus speed at 100MHz and then set the memory to run at 66MHz or 75MHz, for example. The instructions for properly setting this up are in your board's manual.

If you've done that, most of the configuring is done. Now you want to double-check the other settings that were set by the manufacturer to make sure they are correct. Make sure the CMOS-clear jumper is set to normal so that you can change the BIOS settings later. Make sure the battery jumper is set to onboard battery instead of external battery. If you have a jumper enabling FLASH BIOS, make sure this is disabled. Also, check to see if all jumpers enabling or disabling onboard controllers are set correctly. All these settings are usually set correctly by default, but you need to make sure. Keep in mind that many boards control these feature via their CMOS and you will be setting them after the PC is up and running, not now with jumpers.

Double-Check all of your own work. Better safe than sorry.

## STEP 5 : Install the Processor (CPU)

Installing the CPU is a pretty straight-forward process. The real risk is to the CPU. Doing this step too fast or carelessly can result in damage to the processor. Therefore, don't get nervous. It is an easy step, but do it with care.

There are several common interfaces for CPU's today: Socket 7, Slot 1, Socket 370, Slot A and Socket A. Socket 7, Socket 370 and Socket A look very similar, only differing by number of pins and various voltages. Older processors such as the Pentiums, K6's, 6x86's use the Socket 7. Socket 370, as I said, looks similar but is only used by Intel Celerons and the Cyrix Joshua chips, since they have a license to use the design by Intel. Socket A is used by all current higher end processors by AMD. Slot 1 is used for most Intel Pentium II's, III's, and certain Celerons. Slot A looks like Slot 1, but is electrically different and is used for the older Athlon processors before they switched to Socket A. Intel would not license their design to AMD. Therefore, depending on the processor you will be using, the CPU installation will be different. Therefore, this step will be divided into two sections.

Almost all Socket 7, and all Socket 370 and A systems make use of the zero-insertion force (ZIF) socket. Therefore, this procedure is relevant with that setup.

To install a processor using this type of interface, follow this procedure:

1. **Check the pins.** Turn the chip over and inspect the pins. Are they bent? They should all stick straight up. If many of them are bent, then it is best to request a replacement processor. If only a couple are bent and the bend is not that much, then you may be able to use a screwdriver to gently bend the pins back into place. Do so VERY carefully.
2. **Open ZIF Socket.** This is done by grabbing the lever on one side of the socket and opening it. Pull the lever from the closed, level position, to the open, vertical position. You may need to pull the lever out a bit before it will open. Do this slowly and don't force it. You don't want to break the socket. On the way up, you may experience a little more force. This is normal. The top part of the ZIF socket will slide over a bit.
3. **Orient The Chip.** This involves locating Pin 1 on both the chip and the socket. This is easy to do. The chip is always marked at Pin 1. The mark may be a little dot on one corner, a slightly notched corner, or a mark at one of the pins under the chip. On the socket, there is usually a notch on one corner, or a big "1". These corners will be matched up for correct installation.

4. **Insert Processor.** Bearing in mind the orientation determined in Step 3, insert the chip into the socket. With a ZIF socket, the chip should install very easily. It should almost fall into the socket with all pins lining up. That's why they call it the *Zero* Insertion Force socket. If not, the socket is probably not open all the way. If you do not have a ZIF socket (God forbid!), you need to exercise extreme care. Lay the chip on the socket. Make sure all pins line up. Then, slowly push the chip into the socket. Use your thumb and push on one side of the chip until it starts to go in. Then proceed to another side and repeat. Do this around the chip several times until it is completely installed.
5. When done, there should be basically no gap between the bottom of the processor and the socket.
6. **Close ZIF Socket.** Just close the lever. You will probably feel some resistance. This is normal and it should close anyway. If you really need to lean on it, though, check to be sure the chip is installed correctly. When down, make sure the lever snaps into place. You're done.

Slotted processors are installed different because the interface is completely different. The slot is basically like a long PCI slot, although it is usually brown, not white. It runs parallel to the memory slots. Now that we have it spotted, let's install the chip.

1. Basically, this rack serves as a guide-rail and support for the CPU to rest in. Since this type of processor sticks up high off the board and is rather slim, it would simply be too loose in the slot without the rails. The rails usually come with the motherboard. They will be about the height of the processor and have two built-in screws on one end. Position a rail on each end of the Slot. Use a screw to tighten it into place onto the motherboard receptors. Do this for each side of the Slot. Some racks have each side attached by a plastic frame, and this frame goes around the entire slot. When done, you should have one rail on each end of the slot. Some boards already have them installed so that all you have to do is "unfold" them for use. This is really convenient.
2. **Install the Cooler onto the Processor.** It is much easier to do this, usually, before you push the chip into its slot. All coolers are a little different in the way they attach to the CPU, but most use the little holes on the metal side of the processor to lock into place. With some coolers, you may need to use a support to keep it off the motherboard. This support comes with the rack setup, and you only use it when needed.

3. **Insert the Processor.** It is time to insert the processor into the Slot. The processor has one card-like edge at the bottom of the black cartridge. This edge is keyed so that it can only insert into the slot the correct way. So, push the processor into the guide rails and down all the way to the surface of the slot. Make sure the cooler(or fan) is facing the side near the motherboard's chipset. When you get to the bottom, you will feel some resistance. This is normal. Work the processor in until the little levers at the top of the guide rails click into place, locking the chip in

## STEP 6 : Install Heat Sink/Fan

As mentioned in the previous step, slotted processors usually have the heat sink/fan combo installed before the CPU is actually installed onto the motherboard. But, with socket processors, this cannot be done because the fan is actually clipped to the motherboard.

Well, I'll get right to it. Some of these steps are unnecessary on modern machines, but are here for the sake of covering all setups. I will highlight these legacy steps in red.

1. **Attach the fan to the heat sink.** This step is almost always already done for you, but if not, you must do it yourself. This is done using the four screws that came with the CPU fan.
2. **Apply the Heat Sink Compound.** Heat sink compound is something that many do not use anymore, myself included. But, in some older systems, it will be necessary. Or you may wish to in order to increase the conductivity of the heat from the processor into the heat sink. To do this, apply just enough to cover the surface of the chip. If you have portions of the chip higher than others, apply compound only to the raised areas. The layer should be thin. More won't hurt anything, but will be a mess when you press the heat sink down.
3. **Attach The Heat Sink.** Place the heat sink/fan combo squarely on top of the processor, pressing down lightly. Most newer heat sinks use a set of clips on each side to fasten itself down. These clips attach to a pair of tabs on each side of the socket. It will probably take a little bit of force to bend the clip down over the tab. Other heat sinks wrap around the processor, then just sit on top, the compound being the only real attachment.
4. **Double-Check Contact.** If you are using heat sink compound, you need to make sure all areas of the chip are in contact with the heat sink. The best way to do this is to temporarily remove the heat sink again and see if there are any areas of compound that remain smooth because it didn't touch the chip. Apply a little more compound to any such areas, then refasten the heat sink. Repeat this until all areas are in contact with the processor.
5. **Clean The Mess.** If you applied too much compound, some will have oozed out the sides. Wipe this up. After that, you're done.
6. **Attack fan to power source.** Unless your CPU fan is powered via a standard power supply plug, it is probably powered by a wire attached to a 3-pin power lead on the motherboard itself. You can attach this now. The CPU\_FAN power lead is located near the CPU interface somewhere. The lead will have two small pins on each side, and these pins surround the power plug and the pins are inserted into the holes in the plug. It should be pretty easy and obvious.

## STEP 7 : Install the Cache Module

On many late-486's and early Pentiums, external cache, or Level 2 cache, was installed in a slot. This was later abandoned in favour of on-board cache or on-chip cache, which is mostly used today. If you are installing a newer board with on-board cache, you can skip this step. Likewise, if you're using a Pentium II or newer processor or almost any manufacturer, the L2 cache is built into the chip, so the motherboards for these chips have no cache at all and this step can again be ignored.

The cache module is usually called the COAST module. It is not universal. Like RAM, there are different types, and you need to make sure you are installing the right type.

Follow this simple procedure to install your COAST module, if you have one:

1. **Line It Up.** This is pretty easy. COAST modules are keyed to prevent incorrect installation. This is done by placing an indent on some point other than the halfway point, thereby leaving a different amount of contacts on one side of the indent than another.
2. **Insert The Module.** Again, easy. Once lined up, push the module into the slot. This may require a bit of pressure, but don't force it. Make sure the motherboard is on a flat surface so that you don't flex the board. Like a card, it may be easier to rock the module, installing one side, then the other.
3. **Check Your Work.** You're pretty much done. Just make sure that the contacts are almost all the way into the slot, and that, obviously, the module sticks straight off the motherboard.=)

## STEP 8 : Install Memory

You should now install your memory modules. You need to make sure you have the right kind of memory for your motherboard, but you should have taken care of this already.

On older machines, there are a few installation guidelines to follow. Make sure the memory banks are full on your board. The memory banks will be outlined in your manual. On a Pentium system, 72-pin SIMMs must be installed in pairs. DIMMs can be installed alone. On 486 class machines, 72-pin SIMMs can be installed alone while 30-pin SIMMs must be installed in groups of four.

Most systems use 168-pin SDRAM or memory of newer formats such as DDR-DRAM. On these systems, memory can be installed in just about any combination and can be installed alone. So, this is the good news for those of you using modern technology. I assume most people using this tutorial will have hardware new enough to not worry about memory banks and all that crap.

Let's get on with it:

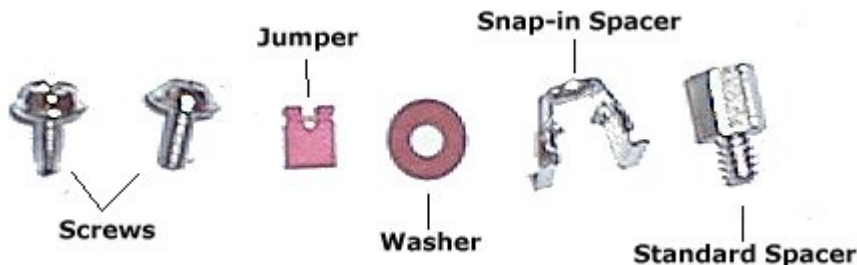
1. **Decide which slots you are going to use and orient the memory module over it.** The module will be keyed in such a way that it will only go in the correct way. So, find the small notch in the memory slot and align the module so that that notch will be inserted into the gap in the module itself. Easy.
2. **Install the Module.** With SIMMs (30-pin or 72-pin), you need to stick it in at an angle, about 45 degrees. With DIMMs (anything newer than a SIMM), they go straight in.
3. **Lock the module in place.** Obviously, SIMMs don't sit in the motherboard at a 45 degree angle. Rotate it to the vertical position. This may require a bit of muscle, but do not force it. If it is too hard, it is probably installed backwards. When it is vertical, you should see the little plastic or metal clips snap into place, thereby holding the SIMM in place. With DIMMs, all you have to do is close the levers on either side of the DIMM. If they do not close, it is because the DIMM is not inserted all the way into the slot. A lot of times, you can just keep pushing the DIMM into the slot and the levers will close automatically.
4. **Done.** Now just repeat these steps for each of your memory modules. When you are done, double-check your work.



## STEP 9 : Install the Motherboard

Now you need to install the motherboard into the case. If you're following this tutorial, the CPU, fan and memory will already be installed onto the motherboard, so you will be installing this whole setup into the case now.

1. Once the case is positioned correctly for work, locate the holes on the motherboard and the holes on the case or motherboard mounting plate. You might want to hold the board just above the case motherboard plate and see which holes on the case line up with holes on the motherboard. You might need to place some components of the case out of the way so that you can do this, including the power leads and motherboard hook-ups. But, the point here is to find out which holes out of the many holes on the motherboard mounting plate will need to be used for your particular motherboard. All motherboards have mounting holes in different places.
2. Now gather your spacers, pictured below. Screw them in to the holes in the case or mounting plate that line up with holes on the motherboard. You can tighten them with a 3/16" nut driver or by hand. Some cases have small spacers that snap into place. With these, you push them through the mounting plate from the back side and they will snap into place.



3. For the holes on the motherboard that line up with an eyelet hole on the case (a hole that is very long so that you can slide things in it), install a plastic stand-off on the motherboard. The stand-offs should poke through the motherboard and expand to keep them in place. The little disk on the other end of the stand-off will later be used to slide into the eyelet holes. If your case does not provide eyelet holes, do not worry about this step. Most cases use only the metal spacer screws to hold the motherboard. In fact, if your case doesn't have them, good.



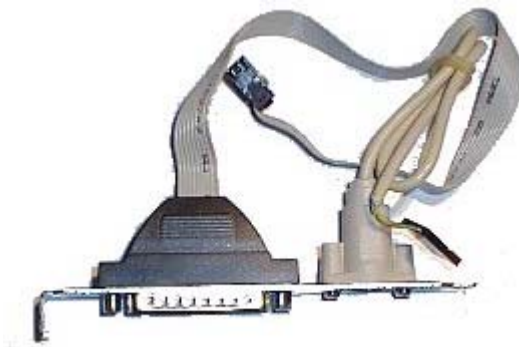
4. Now slide the board into the case. Make sure it sits on the spacers and that all the spacers line up with an available hole on the motherboard. If you have any stand-offs installed, make sure the little disks on them are placed into the wide end of the eyelet hole, then slid over to the narrow part, thus locking them in. Once the stand-offs are locked in, all spacers should line up. If you have a case with a detachable motherboard mounting plate, simply place the board over the previously placed spacer screws on the plate, and make sure they all line up with holes through the motherboard. As you do this, you will need to make sure that the I/O connectors (parallel, keyboard and mouse ports) face backwards and properly align and go through the holes in the back of the case. Some cases have a flimsy removable plate in this back area, and you can easily poke out the holes you need to use so that the motherboard's corresponding parts can poke through. Other cases have this rear portion as part of the chassis, and you will need to use a flat head screwdriver to pry the metal covers out of the holes. When this step is complete, you should have a motherboard sitting in your case, with the screw holes lining up with the spacers beneath it and the I/O connectors should be sticking out of the holes at the back of the case properly.
5. Inspect the screws you will use to tighten the board down. If the head of the screws are too wide, and you think they might contact any circuitry on the motherboard, place a plastic washer over each hole. I've had some ATX boards refuse to start up later because they were grounded somewhere to the case, probably by a screw.
6. Tighten the board down. Install the screws into each of the spacers underneath, through the board and the washers if you used them. Tighten them down by hand first, then finish them with a screwdriver. Make sure you do not tighten them too much. You don't want to crack your board. Just make them snug so that the board doesn't wiggle around in the case.
7. If you were installing the board to a removable mounting plate, install the motherboard mounting plate back into the case. On some cases, the plate is installed from the side. On these, you insert the bottom edge of the plate into a guide rail on the bottom of the case and then rotate upward. The top edge of the plate will contact the case, at which point you can screw it in or a spring loaded handle will lock it in. On other cases, the plate may slide in a different way, as from the rear. These plates are then easily removed later if you ever need to remove the motherboard.
8. Double Check your work. Check to be sure that the back of the motherboard is not touching any part of the case or mounting plate. Make sure the slots and connectors line up with the holes on the back of the case. And definitely be sure that the board is rigid and tight. If you press down on the board at any point, it should not bend down.

## STEP 10 : Install the I/O Connectors & Mouse

Now that the motherboard is in place, you can start connecting all the parts of the computer to it. The first step is to install the I/O connectors, such as your parallel and serial ports.

**Note that if you are installing an ATX motherboard, these connectors are built into the motherboard, and you do not have to do this step.**

1. Study the setup and determine mounting technique. AT style boards almost always come with slot inserts that have the parallel and serial ports mounted on them. These are just screwed onto a couple of your expansion slot bays on the back of the case. While this is easy, it steals the slots away from the motherboard slots, keeping you from using those slots later for expansion cards. To get around tying up these slots, you can remove the actual ports from the metal plate and install them into the dedicated port holes on the back of the case, if your case has them. These holes are located above the regular card slot bays and are usually covered with a metal cap that will need to be pried out with a screwdriver.



2. If you are installing ports on the metal insert, you can now screw these inserts into one of the available slots on the back of the case. It is best to choose a slot near the top that will not be used for anything else and provides a short enough distance so that the I/O cables can reach the motherboard.
3. If you are installing the ports into the dedicated slots on the case, you should now choose which slots you will use, making sure you choose those that fit your I/O ports, such as 9-pin or 25-pin. Then remove the cover from these slots. Some cases hold these covers on with a screw. With others, the cover is a metal punch, where you can remove it with a screwdriver and bending it until it snaps off.
4. If the ports are installed in a metal insert, un-install them now. Then install them into the appropriate case slot. You can tighten them in with hexagonal nuts, just like those used on the metal insert.

5. Either way you installed the ports, they are installed now. All you need to do is connect them to the motherboard. Using the board's manual, determine which connectors are for the ports, usually labeled PRNT, for printer or LPT1, then COM1 and COM2. Most likely, the 9-pin connector connects to the COM 1 connector on the motherboard. Pay attention to pin 1 on the connectors. Make sure the red side of the ribbon cable is lined up with pin 1.

If you are using a serial mouse, it will simply plug into the 9-pin connector you just installed. If you will be using a PS/2 mouse with this system, then this connector is attached the same way. Install the insert near the PS/2 connector on the motherboard. Then connect the PS/2 cable to the connector, usually consisting of a few pins sticking straight up off the board.

## STEP 11: Hook the Motherboard to the Case

In this step, you will connect the motherboard up to the power supply and all of the various case connections.

**NOTE:** If you have been working on a removed motherboard mounting plate, you will need to install the plate back into the case in order to be able to make the connections below.

1. **Connect the power to the motherboard.** On an AT system, find the two large 6-wire leads from the power supply labeled P8 and P9. These two connectors will connect to the large 12-pin power connector on the motherboard, usually right behind the keyboard connector. **MAKE SURE THE BLACK WIRES ARE IN THE MIDDLE, RIGHT NEXT TO EACH OTHER.** This is very important, because forgetting it has fried many motherboards. You may need to play with them to get them in, due to the funny little tabs placed on one side. But, they do fit, trust me. On an ATX board, the power connector is one large 20-wire plug. It is keyed for correct installation. Just plug it in. If your motherboard provides both kinds of connectors, then choose, but I recommend ATX.
2. **Connect the CPU fan to the power.** Many CPU fans connect to one of the power supply leads. They often, then, provide a pass-through so that you have a connector free for a drive, thereby placing the CPU fan on the circuit to a particular drive. Others have a little 3-pin lead that connects to a small connector on the motherboard itself. Just plug it into the motherboard. The connector is usually labeled CPU\_FAN 1, or something to that effect.
3. **Study the case connectors** on the motherboard and match them up with case connector wires. The connectors are usually a big block of pins located in the lower section of the board. Some boards label the pins, but it is best to have your manual since it can sometimes be difficult to determine which label goes to which set of pins. If you have a good case, each connector will be labeled to tell you what case feature it leads to. If this isn't the case, you may have to physically trace the wires back to see what feature it goes to. When connecting, consult the manual for pin 1's, to make sure each connector is plugged in the right way. Remember, if the particular case feature is not working later, you may only have to turn the connector around on the motherboard. The following steps will outline each wire:
4. **Connect Turbo Switch.** If your case has one. If not, you can simply roll up the wire and stuff it aside or tie it up with a garbage bag tie.
5. **Connect the power switch** - ATX form factor only. On ATX machines, the power switch is connected to the motherboard instead of the power supply itself. Consult your manual. The connector is usually labeled PWR\_SW, or maybe just PWR, but you must make this connection. Doing this wrong could cause your system not to start later.

6. **Connect the reset switch.** It can be plugged in any way, just make sure you connect it to the right pins. The pins may be labeled RST or RESET, but it is best to also consult the manual.
7. **Connect Power LED/ Keylock Switch.** Many system cases put these two devices on one 5-pin plug, but if your case does not have a keylock, it will be alone. The motherboard will probably be labeled accordingly. Just plug in the plug. If your system has separate plugs for each, connect them separately.
8. **Connect the Turbo LED.** Like the turbo switch, this is a relic. You can connect it if you wish, although many boards just light it and don't really do anything with it at all. If you wish, you can skip it. Some also connect it to a different part, such as a SCSI adapter, and use it for SCSI drive activity instead.
9. **Connect the hard drive activity LED.** Some come on a 2-pin plug. Others come on a four-pin plug, sometimes only two of the pins actually doing anything. Consult your manual, or play with it until it works. It is usually labeled HDD, HDD\_LED, or something like that. If this is attached wrongly, the light may either never come on later or will stay on all the time when the PC is running.
10. **Connect the PC speaker.** Most cases put this onto a 4-wire plug. Just plug it in to the 4 pins on the motherboard. Other cases put the speaker connector on two 1-wire plugs. In this case, plug them into pins 1 and 4. I never could figure out why they did that...
11. **Double-Check your work,** as always.

## STEP 12 : Install Floppy Drive

1. Choose which drive bay you want to install the drive to and remove the face plate off of that bay. Save the face plate for future use. Pick a bay that will fit the drive. If you have to install a 3.5" drive in a 5.25" bay, you'll have to use a special front panel to adapt it. This panel usually comes with a new floppy drive.
2. Now, slide the drive into the bay from the front. If your particular case has a drive rack, then you may need to remove the rack from the system and then screw the drive into the rack separately from the actual case. Otherwise, screw the drive into the case itself. Before doing so, make sure the front of the drive is flush with the front of the PC.
3. If you are using brackets to hold the drive in place, secure them now. You may need to temporarily disconnect the cables. Once in, tighten the drive in place. Double-check the connections, also checking the connections for other drives to make sure you didn't bump one out of place.
4. Now, the floppy disk drive should be installed properly.
5. **OPTIONAL** : If you are installing a 3.5" internal ZIP drive, you install it the same way and into the second floppy drive bay of your case.

## STEP 13 : Configure the Hard Drive & CD-ROM

It is much easier to configure these drives before you actually install them in the case. If you install them first, having enough room to actually set the jumpers can be a problem.

Before doing this, you must decide what type of drives and how many you want in your system. Then you will need to decide how to configure them to make them all work together. Here is some data to help you out:

Your motherboard has two IDE channels, each supporting two devices. So, if you want two hard drives, for example, you should have one be the "master" and the other be the "slave". Have your main hard drive (the one with your operating system) be your "master" and the other one will be your slave. If you will only have one hard drive, then you will have it configured as the "master", or on some drives, you would choose "single" or "cable select" to tell the IDE bus that it is the only drive on that chain.

The same procedure goes for your secondary IDE channel, where you will be running your CD drives, tape backups, or if you have a crapload of hard drives, other hard drives.

Configuring these drives is very easy. Often the jumper settings are printed on the top of the drive itself. On CD drives, the settings are described right above the jumper pins. On hard drives, the information is printed on the top of the hard drive, if it is printed at all. If not, then consult the manual for it or go online to try finding the specs. The manuals will also outline any special jumper settings such as use of the limiter jumper on Maxtor hard drives.

In general, have hard drives on a separate channel than the CD drives. If you have a second hard drive, set it as slave on IDE 1. Likewise, if you have a second CD drive, such as a CD-RW drive or a DVD, then install it as a slave on IDE 2. Keep in mind you can use a CD-RW or a DVD drive as a CD-ROM drive, although it won't be as fast in some cases (usually older ones).

If a particular drive does not need to be jumpered at all, it is best to hang the jumper over one pin. This is the same as being unjumpered, but make sure the jumper is there for future use if needed.



## STEP 14 : Mount Hard Drive

Before simply following the directions below on mounting the hard drive, pay attention to where you put it. Technically, you can put the hard drive in any free bay of your case, but there are a few considerations. Hard drives generate heat, especially the newer 7200 and 10000 RPM drives. Therefore, it is best to place these drive as far from other hardware as possible. Give them room to breathe. If it is necessary to install a drive cooler, make sure you have room. Also, some cases give room under the power supply to install a hard drive. Bad idea. A power supply is like a magnet, and magnets and your data do not go together. Don't install a hard drive anywhere near the power supply. Keep your hard drive near the front of the case.

That said, move on:

1. **Slide the hard drive** into an available drive rail of the case. All cases have a space (maybe two) for a hard drive that is below the floppy drive bay and has no access to the front of the case. This is fine, since who needs to see their hard drive from the front? If the drive is smaller than the drive bay (if you are installing a 3.5" drive into a 5.25" drive bay), you may need to add rails or a mounting bracket to make it fit (these are included with most hard drives). Screw the drive into place, making sure not to force anything. And, uhhh, power connectors face the back. Good!

In some cases, tightening down screws on the far side of the hard drive can be a problem, because the screws are not highly visible and thus it is hard to get to them with a screwdriver. It can take a little creativity to get at them. Most cases which have this problem have little holes where you can stick the screwdriver through and tighten the screw beneath. If the screw is not in there, I've even had to do a controlled fall of the screw onto the hole and then use the screwdriver to position it into the hole. It's a pain in the ass. If you have a magnetic screwdriver that can hold the screw, this might be less of a problem.

2. Repeat Step 1 for any slave drives you might be installing.
3. **To double-check**, you should have an installed hard drive, securely fastened. The power lead is connected and the IDE ribbon cable leads from the IDE 1 connector on the motherboard to the IDE connection on the hard drive itself.

### SCSI Drives

If you are opting for a SCSI drive setup, then there are a few minor variations from the procedure above. First, you need to install a SCSI controller into one of your expansion slots (unless your motherboard has an integrated SCSI controller). Then proceed:

1. You need to set any switches or jumpers that need setting on the new drive. In SCSI setups, each device gets its own SCSI ID, numbered 1-7. #7 is usually given to the adapter card. You may pick, then, any other unused address. You may need to take into account any little quirks in your adapter, such as special likings to other addresses that could cause problems a little later. You'll need the manual for this one.
2. Check for the correct termination. In SCSI setups, the adapter can hold up to seven SCSI devices. These devices are hooked up in a chain, usually with the adapter at one end and another device at the other end. This ending device must be set to be the terminating device, therefore ending the SCSI chain and making a complete electric circuit. In some cases, the adapter is in the middle of the chain, therefore you must terminate at both ends of the chain. You may need to consult the manual for any special termination techniques particular to your brand of drive. In general, a certain jumper setting will enable internal termination on the drive itself, eliminating the need for a special terminating plug.
3. Slide the drive in and connect the cables. Make sure that pin #1 on the ribbon matches up with pin #1 on the drive. Yada yada...same as above.

When performing this physical installation, you'll find that it differs from case to case. With some cases, the drive rack is simply part of the case. With this setup, you simply push the drive into the case and screw it in. In other cases, the drive rack may be removable. Some have many separate racks, and some have one removable rack that can hold many drives. With this setup, remove the drive rack. This is usually done by squeezing two metal tabs together to release it, or you might need to use a screwdriver. Then slide the rack out. Screw the drive into the rack per above. Then, slide the rack back into place where it was.

When you are done, you should have a hard drive properly screwed into the case and the ribbon cable attaching it to the IDE controller and the power cable attached.

## STEP 15 : Install the CD-ROM(s)

Now, you need to install the CD drive(s) into your drive bays.

If you have not yet removed the drive bay cover, do so now. This is usually done by pushing two tabs together and pushing the plate out from the front of the case. As I mentioned in the case preparation step, if you have metal plates in the drive holes that have not been removed, you will need to pry these things out before you can install the drive. Once the cover is removed, you can slide the drive in from the front.

You can now screw the drive into place. You might want to just place the screws in but not tighten them. This is done so that you can slide the drive out again later. When installing the cables later, you may need to slide the drive out a few inches so that you have enough room to work behind the drive. In many cases, especially mini-towers, one can have a hard time working behind the CD-ROM because it is pinned up against the front of the power supply.

Just like in the previous step, the physical installation depends on the case. Some cases come with a bunch of drive rails. What you do is screw a drive rail in the correct direction to each side of the CD-ROM drive. Then, you slide the CD-ROM into the case from the front and the drive rails follow a guide until they click into place. This design, once you get used to it, is really much easier, and leads to very quick installations in the future. The only trick is to make sure you screw the rails to the drive in the right position, otherwise your drive could be set too far out or too far in even when the drive rails click into place.

When tightened into place, make sure the front of the drive is flush with the front of the case. If the front bezel is off the case on installation, make sure you don't make the mistake of making the drive flush with the case frame. It needs to stick out a little so it will be flush with the bezel when you re-attach it. Also make sure it appears straight. While this doesn't really affect functionality, it's a matter of aesthetics.

## STEP 16 : Connect the Floppy Drive

Assuming you have already installed the floppy drive into the case, it is now time to actually connect it to the motherboard and power supply.

1. **Connect the power supply to the floppy drive.** On the 3.5" drives, the plug is very small...the smallest coming out of the power supply. On the larger 5.25" drives, the connector is a large 4-wire connector, just like the hard drive power connectors. These are a little harder to plug in, and may take some rocking. The mini-plugs are much easier to plug in to the 3.5" drives. It is designed so that it is obvious which way to attach it.
2. **Attach the Ribbon Cable.**  
Floppy cables have a twist in the cable. A: drive goes after the twist. If you have a second B: drive, this goes before the twist. You do not need to mess with master/slave jumpers. If you choose not to mess with the twist, you can, with later BIOS versions, swap the order of the drives in the BIOS. 3.5" drives use a set of pins for the connection to the ribbon cable. 5.25" drives use a card-edge connector, just like the typical edge of an expansion card. You need to use a cable with the proper connectors for each type you use. Many floppy cables come with connectors for each type on each side of the twist. Always check Pin 1 on the ribbon cable connector. The red edge of the cable is connected to Pin 1. If you accidentally reverse this, your drive won't be damaged, it just won't work, and the floppy drive light will stay on all the time until fixed. The connector on the far end of the ribbon cable connects to the floppy controller on the motherboard or I/O card. Consult your motherboard's manual to determine which is your floppy controller.
3. **You're done.** Double Check your work.

## STEP 17 : Connect the Hard Drive

Assuming your hard drive(s) has already been physically installed in the system case, you must now connect it up to the power supply and motherboard.

1. **Attach the power cable.** Choose an unused power lead from the power supply and plug it into the power plug on the hard drive. The plug will be keyed so that it will only go in the correct way.
2. **Attach the ribbon cable to the hard drive.** The ribbon cable goes from the primary IDE controller of the motherboard to the drive. Make sure the red edge of the ribbon cable is in line with Pin 1 on the drive. If you can't see Pin 1 marked, then it is the pin closest to the power connector. If you place the cable on backwards, you may get strange errors that make your new drive sound like it has died already. If you are adding a second drive, simply choose a connector on the same ribbon cable that is not used. Most ribbon cables come with two connectors: one on the end and one mid-way. In this case, it doesn't matter which plug goes in what drive. The computer looks at the master/slave jumpers to see which one is "C". Make sure to connect the other end of the ribbon cable to the primary IDE connector on the motherboard. Pin 1 will be labeled on the motherboard, and align the red edge of the cable with it. Also, ATA-66/100 drives must have an 80-wire cable instead of the older 40-wire's. The ribbon cable will generally be included with the hard drive.
3. **Double-Check your work.** Make sure everything is tight.

## STEP 18 : Connect the CD Drive(s)

Assuming your CD-ROM is already installed in the case, you can now connect it to the motherboard and power supply. This same procedure will be used for installing any other drives such as tape backups and the like.

1. **Attach the power supply to the drive.** Just like a hard drive, just find a free 4-wire power plug and plug it into the power connector on the CD-ROM.
2. **Attach the ribbon cable.** Connect one of the two available plugs on the ribbon cable to the CD drive. Just choose the plug which can reach the drive best. If you have two CD drives, use the plug on the end of the ribbon cable for the top most drive, and the middle plug for the next lowest CD drive. Attach the other end of the ribbon cable to the secondary IDE port on the motherboard. Like that of the hard drive, Pin 1 will be labeled on the motherboard, and align the red edge of the cable with it.
3. **Attach the Audio Cable.** This small 3-wire connector goes from an "Audio" plug on the back of the CD-ROM to a 3-pin plug on the sound card. If you happen to have on-board audio circuitry on your motherboard, the CD-IN plug will be on your motherboard and you can connect this now. Otherwise, you can attach it after you install the sound card. Some CD drives have both an analog and a digital audio out. Most of the time, people just use the standard analog audio, but if you wish, go ahead and use the digital. Your drive should come with audio cables for both options.
4. **Double-check your work.**

## STEP 19 : Install The Video Card

This is a very easy step.

1. **Find an expansion slot** ideal for your video card. The slot must be the correct type, and it should be as far as possible from other hardware in the system. In most cases, you will be using the brown AGP slot which is furthest up, next to the processor.
2. **Remove the case insert** that corresponds to the slot on the motherboard. This is usually done by unscrewing, but some cases have punch out inserts.
3. **Insert the video card** in the slot. You might need to rock the card in, inserting one end first, then rocking the rest of the pins into place. The old ISA cards may be tougher because of their length. You might not be able to rock them. Most, though, will not be dealing with ISA video cards anymore. When pushing down, make sure the motherboard does not flex. If the board tends to bend, it may be necessary to place one hand underneath the board to hold it up. Also, in some cases, you may have a problem with the leading edge of the video card's metal plate hitting the case behind the motherboard. The result is that it keeps you from being able to push the card in all the way. I've tried all sorts of weird crap to fix this problem, including taking pliers to the card and actually bending it. Sometimes, you can grab a flat-head screwdriver and pry the hole wider than the card's lip protrudes into. But, in most cases, just playing with it for a bit will do the trick.
4. **Screw the card into place.**
5. **Double-check** your work.

## STEP 20 : Post-Assembly

Your new PC is now pretty much ready to roll for the first time. The PC is rather bare-bone at this point and lacks a lot of the hardware you will eventually want to put in it. It is generally best to keep the PC as simple as possible during initial setup and operating system installation, which is why this tutorial has stopped with only the video card installed. Some may choose to install the sound card at this point, and this is fine. If you want to install a network card, you can do this now as well, as your OS will probably do a great job of sensing and automatically setting this up during installation. Just follow the same procedure you would for any expansion card. But, I would keep the system at that point until after the operating system is installed. If you want to install TV tuners or any other optional hardware, I would do so afterward.

Before jumping right into booting, though, I recommend taking a minute, and with a flashlight, check all of your work. It is better to "waste" the time than to engage in wasted time trying to track down why the system will not boot.

Pay attention to the following list:

- Drives properly connected to power
- CPU fan attached to power
- If an AT machine, P8 and P9 are connected properly, with black wires in middle.
- The 110/220 volt switch is configured properly for your area
- Ribbon cables attached correctly, red edge on pin 1
- All connections tight, no connectors off by one set of pins
- CPU settings correct for bus speed, voltage, and multipliers. If you have jumperless motherboard, you can forget this, since you will take care of it when you turn the thing on.
- Cards fully in slots
- No wires or ribbon cables protruding into fans.



## STEP 21 : Initial Boot-Up

It is time for the moment of truth. To see if this thing works!!

Before doing it, connect all of the external peripherals to the system. This includes the mouse, the keyboard, and the monitor as well as the main power cords for the monitor and main PC. You don't need to connect anything else yet. Besides, if you are following this procedure, you won't have too many added parts installed yet. You can go ahead and attach the speakers and things, if you have the hardware installed, but the sound card will not be doing anything at this point.

Also, you need to have a valid system boot disk. Your system disk should have been ahead of time, as noted previously in this tutorial.

**>> For more information, read System Disk Creation.**

1. Stick your system disk into the A: drive.
2. Turn your monitor on and let it heat up a few seconds before proceeding.
3. Keep in mind what to expect. You may need to act quickly. The power LED should turn on, then fans should start spinning, the hard drive should power up. You will see the video BIOS screen first, then you will see the BIOS screen and it will proceed to count the memory. You may hear one beep from the PC speaker. You may also get a "CMOS checksum error" or another error saying the CMOS or time isn't set. Know what key(s) to hit to enter setup. This will be shown on the bottom of the screen. You will want to do this quickly. If you hear any weird sounds such as grinding, scraping, or loud whining, be ready to turn the system off immediately. Keep in mind that if you miss the stated sequence to enter the BIOS before the boot sequence moves on, there is nothing wrong with just hitting the reset button and rebooting until you do catch what it is.
4. Press the power switch. If it powers up, observe the system closely. As soon as the BIOS screen appears, press the appropriate key(s) and enter BIOS setup. The correct key combination should be visible at the bottom of the screen. Sometimes it pops by too quickly for you to see which keys to press. No problem. Don't hesitate to just hit reset and try again, as stated above. A lot of times, the key will do the trick.
5. After you are sitting in the CMOS area, just let it sit there while you take out a flash light and inspect the system. Make sure all the fans are running. Make sure all the fans are operating smoothly and not generating any strange noises. Make sure the case power LED is on. Make sure the floppy drive light is not stuck on. If it is, the ribbon cable is likely not properly aligned with Pin 1. If any of the fans are not spinning, turn the PC back off and plug the fan in. You do not want to run the PC for long without fans running, especially the CPU fan.

## Basic troubleshooting:

Sometimes things do not work exactly as planned at this point. Sometimes the system will not power on at all. Sometimes it will power on, but you get no video. Sometimes you will get beep codes. Sometimes you hear the fans, but the rest of the PC just sits there and does nothing.

If things didn't go according to plan, troubleshoot the system. Walk mentally through the boot process and check all hardware as it goes. Think like the computer thinks, if you know what I mean. Here is a list of some of the more common problems.

- The power does not even turn on. This sometimes happens on ATX machines and it usually tracks down to the fact that the power switch is not properly connected to the motherboard or it is not connected at all. Find the power switch lead and make sure it is connected to the motherboard, as described in Step 11. It's a possibility that simply reversing the lead will do the trick. If this is not the case, then make sure the motherboard is not grounded somehow. Make sure that the board is not touching the case (this is what the spacers are for). Make sure that none of the screws that hold the board in place are touching anything metal or any of the electrical pathways on the motherboard. If you have any doubt on this, you can remove each screw one at a time and place a washer on them. You do not need to remove the motherboard to do this.

- The PC boots, but it is giving beep codes. This is actually better than having to track everything down on your own, because at least the PC is giving you a hint as to what is wrong. Often, these beep codes will not tell you exactly what the problem is, but will point you at the trouble device. This information will then get you pointed in the correct direction.

- The fans come on, but you get no video or beeps. Sometimes, this is because some key component may not be plugged in well or may not be operational. Check the memory modules and the processor to be sure they are firmly installed. You might want to make sure the processor is actually working. One way that I have used to see if a processor is working is to remove or unplug the CPU fan and place your fingers on the CPU to see if it heats up real fast. If it does, it's OK and don't let it run this way for long. If it remains at room temperature for awhile, then there is no juice going through the processor and it may need replacing. Sometimes, you may need to track down a problem component through a process of elimination. You may need to replace parts one by one and then use that gray matter in your head to narrow down the problem. Also be sure you have the CPU jumper settings done properly and are not trying to run the processor on settings too high or too low.

- The keyboard doesn't seem to work. This one doesn't happen too often, but if it does, your two trouble sources will be the keyboard itself or the keyboard controller on the motherboard. Hope it isn't the second one.



## STEP 22 : Configure The BIOS

Now, your new PC should be up and running and you should be staring at the BIOS setup screen.

Your next step is to make sure your BIOS is using the proper settings. While some users like to use the BIOS to tweak the system into running like greased soap, during an initial build, it is best to keep settings conservative, which usually means leaving them at their defaults. In this case, not a whole lot really needs to be done in the BIOS for sake of completing this process. I will, though, go through some of the common settings and point out what needs to be done and some common settings for them, at least to serve out purposes here. Please bear in mind that this serves as an outline. Your actual settings and names may vary for different BIOS versions.

When you first enter the BIOS, and where you probably are at this point in the tutorial, you will see the main menu. It will list two columns (usually) of sections of your BIOS which have different settings in them, an example of which is to the right.



### Standard CMOS Setup

This section just controls some of the basic stuff. Make sure the time and date is correct. Make sure your floppy drive setup is correct (usually 1.44M, 3.5 in.). Video will stay set at VGA/EGA. The HALT ON settings controls what the PC will stop booting on, and it does not usually need to be changed. Some BIOS versions contain the IDE auto-detection in this section, and it is important for you to do this before you move on. If this section does not have it, then it will be its own menu item in the BIOS. Regardless, go ahead and perform your auto-detection now. An auto-detection will scan all four IDE drive positions whether there is a drive there or not. If there is a drive there and that drive is properly connected, the BIOS will offer you three choices to choose from. Usually the one offered by the BIOS is correct, but you can choose one of the other two. As the BIOS tries to detect non-existent drives, you can just wait for it or pressing to skip it. In the very rare cases, you may need to manually enter the hard drive information to make it work. Usually, you would put the drive specification into USER mode and then specify each field based on the information given to you about the drive.

## Advanced BIOS Features

This section controls some of basic operating settings of your PC. For example, you will enable/disable things such as on-board cache, determine the boot device, etc. Here are some of the common settings:

- Virus Protection/Warning: Will scan your hard drive boot sector on startup for viruses and alarm you if anything attempts to write to the boot sector. Enable for increased security, but disable to avoid the annoyance.
- Cache Settings: These settings control L1 and L2 cache, which in most newer systems resides on the processor itself. In almost all cases, this is enabled and should be. If there is an option to have ECC error checking on the L2 cache, go ahead and have it enabled.
- Quick POST: This will allow the BIOS to skip some tests such as the memory test on boot-up, thus allowing the PC to boot faster. You can enable it for the sake of thoroughness, and this is fine if you leave your PC on most of the time. But, if you turn it on a lot, this is an annoyance and I'd recommend enabling Quick POST.
- Boot Sequence: This controls the order in which the PC looks at the drives for bootable information. Sometimes the BIOS will have one field for this and you scroll through the options. Other versions have separate settings for "First Boot Device", "Second Boot Device" and so on. I recommend having the A drive be first, and you will need it to be so for this tutorial. The hard drive is second. If you will be using your CD-ROM as a boot device, you can set that up here.
- Swap Floppy Drive: Allows you to control the assigning of the A and B drive letters to your floppy drives by swapping the order that is dictated by the twist in the floppy drive ribbon cable. Most of the time this is disabled.
- Fast A20 Gate: The gate A20 is a device used for addressing memory above the 1 MByte mark (don't really want to get into that here). This used to be controlled by the keyboard via a pin. Keyboards still play a role in this today, but you control it via the BIOS. Some BIOS have enable/disable, some have Normal/Fast. I would go ahead and leave it at the default.
- Typematic Rate Settings: These options control the rate at which holding down a key on the keyboard will produce characters on screen. Just leave it disabled as it isn't very important.
- Boot Numlock: Enable to have Numlock on when you start the computer.
- CPU Serial Number: Enables or disables the serial number thingie in Intel CPUs. Privacy buffs, disable it.
- Security Option: - Some systems have an option to require a password every time the system boots up. You'll probably want this disabled.

- Video BIOS Shadow: - Disable or default.

## Advanced Chipset Features

This area of the BIOS allows you to control certain aspects of your motherboard which are specific to the chipset on your board. This would include bus speeds and memory issues. Most of the time, you don't need to worry about anything in here for the sake of this tutorial. But, a general outline:

- Chipset Special Features: Disable. Not all BIOS have this.
- L2 Cache size: If this option exists, set it to match the size of your external cache.
- DRAM Parity Checking: Enable only if using parity memory
- Dram parity/ECC mode: "Parity" if using parity memory, "ECC" if using ECC memory
- DRAM Clock Control: This area allows you to control the speed of the memory. On Via chipsets, it will usually also display the processor bus speed and the DRAM bus speed, allowing you to set the memory to operate on the Host Clock or BY SPEED. You can set the memory speed manually or have it run at the same speed as the system bus. If you are using SDRAM, you can also control the CAS latency, which is usually best left at default unless you're a real tweaker.
- AGP Mode: Controls the AGP Mode, such as 1X, 2X or 4X. Set to Auto if available, or whatever it is set to already.
- AGP Aperture: Controls how much of the PCI memory address range will be dedicated to graphics memory space. Usually, 64MB is fine, but you can set it to whatever you want.
- DRAM Frequency: Set to the speed of your memory (66, 100, 133, etc.)
- You will likely have many other options in this section such as cacheable RAM options, PCI wait states and bus control options. This stuff is usually left alone and should not need to be adjusted to get a PC working well.

## Power Management

This section should be fairly straight-forward to even the novice user, and you should be able to use your manual to best describe the settings. I typically disable almost everything in this section, and you should for now, too. You're

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just trying to get the PC working at this point, not fine-tuning every little aspect of the BIOS.

## Integrated Peripherals

In this section, the important part for now will be to enable or disable the various ports you may be using. Make sure the IDE ports are enabled if you are using both. For the IDE devices, your BIOS may offer various speed options such as setting the PIO mode of the hard drives or enabling IDE pre-fetch or UDMA-100. Set these options to AUTO where possible. You can enable pre-fetch on IDE only if your IDE interface supports it, which if you have the option, it likely does. It will speed up data access some. If your board has integrated hardware such as video, sound or networking hardware, you will enable or disable here if it is not controlled by a jumper. Enable if you wish. If you're using expansion card hardware and your board has these options, disable them to allow usage of the cards. You can also enable/disable things such as your USB port, serial/parallel ports. You'll probably want them enabled. Set the parallel port mode to ECP or EPP or both. If you have an IDE HDD Block Mode settings, enable this if your hard drive supports it (most newer drives do). For the other settings, just leave them at their default values.

## PnP/PCI Configuration

This section controls some of the various aspects of plug and play and the PCI bus. Much of it will not need to be touched at this point, but a couple items bear mentioning:

- **PnP OS Installed:** Since most likely you will be running an operating system that is plug-n-play compatible, set this option to Yes.

- **Reset Configuration Data:** This field should normally be set to disabled. But, you can enable it to reset your Extended System Configuration Data (ESCD) when you exit BIOS setup. This may be useful to you if you add new hardware or software and the system reconfiguration caused a serious error that rendered your OS un-bootable.

- Your other options should be left at default.

## PC Health

This might be caused by a bunch of different names, but it is the section of the BIOS (if it has it) that monitors things like fan speed, CPU temperature, voltage levels, etc. You may also be able to set a shut down temperature, so if the CPU gets way too hot, the system would shut itself down for safety.

## SoftMenu / Frequency-Voltage Control

If you are using a "jumperless" motherboard, you will have a section of this nature which allows you to control the CPU settings and maybe a few other things. It will allow you to set the minute voltages to the processor, select the CPU multiplier, voltages to your DDR memory (if you are using it) and the system bus speed. Most of these options have an AUTO or default value, and

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this is fine for most people. The settings may already be set fine. But, you can use this to overclock the system if you choose (not recommended right now).

## **Defaults**

Many BIOS versions have pre-set sets of default values which you can pre-load. Some have "fail-safe" defaults and "optimized" defaults. If you don't wish to mess with any of the above, you can use these options to set the BIOS info up to certain sets of settings in one or two button clicks.

## **Passwords**

Most BIOS versions have security options to allow for user or supervisor passwords. Most people do not use them. But, if you do, just make sure you record the password. If you lose it, you'll have to reset your whole BIOS to get your system back.

Save and Exit the BIOS setup program. This will reboot the machine. Make sure your system disk is still in Drive A:.

## STEP 23 : Test The System

Now that the system is on and operating, you can make a few tests to ensure all is working as it should. Let's check the following items:

1. Check the LED's on the front of the case. During boot-up, the HDD LED should light. If it does, it is connected properly to the motherboard. If not, try reversing the leads on the LED plug, or just turning it around. You can also check that the power LED lights and that the turbo LED lights, if it is connected.
2. Check the hard drive. Make sure it is spinning.
3. Check the fans. Make sure the CPU fan, power supply fan, and case fan(if you have one) are all spinning without any wires in the way. If your video card happens to have a fan, make sure it spins freely as well.
4. Make sure the CD-ROM has power by hitting the eject button and seeing if it opens.
5. Hit the reset button to be sure it works. Make sure the system disk is still in Drive A:. While it reboots, check to be sure all the data on the BIOS splash screen is correct to your system.
6. If you have a keylock, test it now.
7. Let the system run for 10-15 minutes.
8. Now, turn it off, ground yourself on the case, and carefully touch the CPU and hard drive. You are checking the temperature to be sure they are being properly cooled. Both will be warm, especially the CPU, but it should never be too hot to touch. If it is, then you should get a better fan. You can also use your BIOS PC Health specs to monitor the temperature.

## STEP 24 : Prepare the Hard Drive

In order to use your hard drive, it must be partitioned and formatted. If you are building a system and putting a previously used hard drive into it, you may not need to perform this step. But, on any new hard drive or one you are just trying to start over with, you will need to do this.

Partitioning a hard drive means that you are creating the boot sector (necessary to boot the machine) as well as dividing the hard drive into actual drive volumes (C,D,E, etc). This action is done using the FDISK command. FDISK should be included on your system disk and when you use it, it will actually be run off of the floppy drive. If, for some reason, your system disk does not have FDISK.EXE on it, get one that does.

Take a little time to plan your partitions. Do you want one large partition for the entire drive? Or do you want to separate it into different drive volumes? If you have FAT32, it is very popular to create one partition for the entire drive. Otherwise, if you are using a drive larger than 2G, you will have to separate it into more than one partition. Also, keep in mind that smaller partitions lead to smaller clusters, thus less slack or wasted disk space. With almost any modern operating system (I'm thinking Windows here) you will want to use the FAT32 file system. When you go into FDISK, it will ask if you want to enable "Large Disk Support", and you do if you're using any OS Windows 98 or newer.

So, start.

1. Type "fdisk" at the command prompt. If it does not work, it is because your hard drive is not attached properly or you may be missing FDISK.EXE on your system disk.
2. It will ask if you wish to enable Large Disk Support, and in most cases, you will. Type "Y" and proceed.
3. Next, you will see 4 menu options. If you already have partitions on this hard drive, you can choose option 4 to view the current partition setup and decide if you want to change it. For a brand new drive (which I'm assuming for the purpose of this tutorial), you'll need to start from scratch.  
Some information: The first partition is your primary DOS partition. This is your C: drive and can't be divided. This is also called the active partition. You can only have one active partition. The second partition is optional. It is called an extended partition. This is the space left over after the primary partition. Then, logical DOS drives are created within the extended partition, each having a letter by which you will refer to it.
4. First you have to setup a primary DOS partition. Choose Option 1 (Create DOS partition or Logical DOS drive).
5. Choose Option 1 in the next menu.
6. Now you can make your entire hard drive the primary partition or only a part of it. Many people just make the entire drive one partition just to stay simple. If you want to break from this norm, specify the amount of

drive you want to partition in either megabytes or percentage of total drive. If you are using a percentage, be sure to follow the number by a "%" or the computer will think you're talking MB's. As a tip, I generally like to have my operating system(s) stay on their own partition, so I like to assign 2 GIG or so to the primary DOS partition, allowing ample room for a few versions of Windows. That's just me.

7. Next, you'll need to make this partition active. Return to the main FDISK menu and choose Option 2 (Set Active Partition). Follow the prompts.
8. If you're going to create an extended partition (and you probably will unless you're only going to use C), choose Option 1 again, but this time choose Option 2 in the next menu (Create Extended DOS partition).
9. Plug in the percentage of drive to partition for this one. You can use the remaining amount for simplicity. Do not make this partition active. Only one can be active.
10. After you create an extended partition, you will be given the Create Logical Drives option in the extended partition menu. Follow the on-screen instructions to assign drive letters to your partitions D: through Z:.
11. After all this is done, you can choose Option 4 (Display Partition Information) and check your work.
12. After the drive has been partitioned and all looks fine to you, press to exit FDISK. You'll be told you need to restart the machine and that's what you're about to do.
13. Reboot the machine with the system disk in Drive A: . If you try to do anything on the C: drive, you may get an error about Invalid Media Type. Don't worry about it. It's because you haven't formatted it yet.

Now you must format the new C: drive. At the A> prompt, type "format c: /s". The "/s" tells it to make the disk bootable by copying some elementary system files to the C drive. You will get a warning saying that this action will erase all data on the drive. This is normal, and since there is no data on the drive, just press "Y" and move on. It will show the status as it happens. As a note, if you will be installing the OS right away and have a system disk that provides CD-ROM support, then you don't need to copy any system files over to the C drive, as the OS installation will do this for you.

If you created additional partitions on this drive, format those volumes now. Type "format d:" or "format e:", where the letter corresponds to the volume you wish to format. Do not type the "/s" since you only want the C: drive bootable. Do this for all remaining partitions you created during the partitioning process. When you are complete, you should be able to do a directory listing to be sure it is formatted by typing "DIR" at the command prompt. You'll likely get a FILE NOT FOUND message, but that's normal. At least the drive is set up.

Reboot the system. If you copied the system files over you can do so without the system disk. If not, you'll need to leave the system disk in Drive A. If using the C drive, it is supposed to boot normally and go to the C: prompt. If you get an error like "No boot device found" or "No ROM Basic", you probably forgot to make the primary partition active. Run FDISK again and fix that. If you get an error like "No Operating System", you probably forgot to make the disk bootable. Make sure you typed "/s" at the format command.

## STEP 25 : Install The CD-ROM Driver

Most operating systems come on CD, which requires you to have your CD-ROM working in order to install the operating system. This is usually a pretty easy thing to do. Your CD-ROM comes with an install disk that, if properly programmed, will install your CD-ROM drivers very quickly. Unfortunately, many manufacturers make lame installation disks, requiring you to do some of the work manually. For this reason, I recommend you have a copy of EDIT.COM on your hard drive or system disk in case you have to manually edit the CONFIG.SYS or AUTOEXEC.BAT. Also have a copy of MSCDEX.EXE on your disk in case your CD-ROM installation does not include it. If necessary, use the command "copy mscdexe.exe c:" to copy the file from your system disk to your hard drive.

Some installation programs are very particular as to what they expect. Some will stop unless MSCDEX.EXE is not already installed on the drive C: Some go so far as to expect this file in C:DOS, and it might not tell you this. You can just put the file in a directory called C:DOS and try again. Other installations cannot properly configure CONFIG.SYS or AUTOEXEC.BAT. Some will halt if these files aren't already present on the hard drive. If you run into problem, keep this in mind.

The good thing is that, very often, you can use a system disk that offers CD-ROM support. When I build a PC, I never have to worry about setting up DOS-mode CD-ROM drivers manually. I use a system disk that offers support for CD-ROMs. Then, you just boot with CD-ROM support and install your operating system right away. If you have access to a Windows machine, make a system disk with it and use it. You can also see if you can download a pre-set system disk on the internet.

Below, I will outline a general procedure for installing DOS-mode CD-ROM drivers. This obviously changes on a per-drive basis:

1. Make sure EDIT.COM is on your hard drive. It may be found on your system disk, your installation disk, or you may need to get it from another system. Copy this file to the new computer's C: drive.
2. Install the CD-ROM Installation disk in Drive A:.
3. To be safe, you might want to create a AUTOEXEC.BAT and CONFIG.SYS if they are not already there. You can do this by typing "EDIT CONFIG.SYS" then saving it empty. This will create the file, although it will be empty. Do the same for AUTOEXEC.BAT.
4. Run the Install program. Usually you type either "a:install" or "a:setup". It will copy necessary files, and modify your CONFIG.SYS and AUTOEXEC.BAT. Just follow the prompts. All install programs are different. When this is done, reboot.
5. Check the system files. You can EDIT them or type "type config.sys". The line will look something like "DEVICE=C:CDPROVIDE-CDD.SYS /D:MSCD001". In the AUTOEXEC.BAT file, it may look like

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"C:WINDOWSCOMMANDMSCDEX /D:MSCD001 /V". The parameter after "/D" should be the same in both files. These lines will vary depending on your CD-ROM and files locations.

6. If you want to change the drive letter of the CD drive, add "/L:F" at the end of the line referencing the CD-ROM in the AUTOEXEC.BAT file. Change "F" to the drive letter you wish the CD-ROM to be.
7. Test your work. Reboot. The CD-ROM should activate. Then stick a CD in the drive and try to read it by switching to the appropriate drive just as you would to read a floppy diskette. If it didn't work, then first check your AUTOEXEC.BAT and make sure it is leading to the correct location for the file MSCDEX.EXE. This file is necessary on all systems to make a CD-ROM operate in DOS.

## STEP 26: Install The Operating System

At this point, the CD-ROM drivers are installed. So, you are ready to install the operating system. You can choose whatever operating system you wish. I generally use Windows, as do most people. For the sake of this tutorial, I will assume you are installing Windows. I will offer a broad outline of the installation processes to each version of Windows I think you have any chance of using.

As a note, as we all know, a lot of the Microsoft operating systems out there are "upgrades". This means that it will ask for and check to make sure you have a previous version of the OS before installing. In some cases, if you only have upgrades, you may need to install more than one operating system on a machine to eventually get the one you want. For example, my version of Windows XP is an upgrade. To get it installed, I typically install Windows 98 first. Since it itself is an upgrade, I have it detect some old Windows for Workgroup diskettes I have. The reason I use Windows 98 as a start is because you can run its setup directly from DOS, whereas you cannot run Windows 2000 or XP setup programs directly in DOS Mode. Once 98 is installed, I turn around and install Windows XP (or Windows 2000 if you wish) as a "New Installation" rather than upgrade (although that's my personal preference). This is described below. When you are done, you can use the built-in OS Loader to choose which operating system you want to use when you boot.

### Windows 95 Installation:

1. **Begin Setup.** At the DOS prompt, type "D:setup". If your CD-ROM is a letter other than D:, type in that drive letter instead.
2. **SCANDISK.** Once begun, the setup program will begin to run a SCANDISK on your hard drive. This will proceed automatically and, hopefully, without error. If you get an immediate error stating that you have no extended memory manager, don't fret. This is probably because this drive is brand new and you don't have DOS installed on it. Simply hit ESC and move on.
3. **Welcome Screen.** At this point, you will see the graphical interface of Windows 95 and a Welcome screen. You should see a mouse cursor. Makes sure your mouse works. If not, double-check its connections. You can setup Win95 without a mouse, but I wouldn't recommend it. Now, hit "Continue".
4. **License Agreement.** You should see the Setup Wizard load, then a license agreement. Read it, if you want, then click Yes.
5. **Setup Start.** Setup will tell you all about the three phases of this install process. How nice of Microsoft to warn us.=) Click Next.
6. **Choose Install Directory.** You will be prompted to tell the computer what directory to install Windows to. The default is C:WINDOWS, and I strongly recommend leaving this value at default.



7. **Options.** Upon continuation, setup will run some routine tests on your system. After this, you will be offered four options for a setup routine, "Typical", "Portable", "Compact", and "Custom". Pick the options that best suits you. For most people, I recommend choosing "Typical". If you wish to have more control over what Microsoft would like to install on your machine, choose "Custom".
8. **Authentication Code.** Setup will prompt you for a long string of numbers and letters that proves you indeed bought this software. This code should be available with a Certificate of Authenticity.
9. **Hardware Search.** At this point, setup will analyze your computer to see what components are installed. When asked if it has a MIDI or sound card, or video capture card, check the appropriate boxes. This search may take several minutes, and expect your hard drive to be very loud and active.
10. **Select Components.** Windows will ask you which components you would like to install. Simply click on those you want. I recommend choosing at least Accessories, Communications, Multimedia, and Disk Tools.
11. **Network Configuration.** Even if you don't have a network, Windows will want to add a network card. Just accept the defaults and move on. This can be fixed later.
12. **ID.** You will be asked for your network identification. Just type something in for each line just to make Windows happy. You can always change these names later.
13. **Double-Check Settings.** Change any settings that aren't right. Some drivers will have to be installed later.
14. **StartUp Disk.** Windows will ask you if you want to make a startup disk. Make one if you would like. You can always make one later as well.
15. **Copy Files.** Setup will now copy all of the files to your computer's hard drive. This may take awhile depending on the speed of your system. When it is finished, click "Finished".
16. **First Boot.** Well, first Windows 95 boot. You will see a nice blue screen. At the bottom, it will say "Getting Ready To Run Windows 95 For The First Time". It will do some thinking, and it might take a while. Just let it go.
17. **Password.** You might be prompted for a password. Just hit "Cancel".
18. **Hardware Setup.** Windows will now detect all plug-and-play devices and configure them automatically.
19. **Time Zone.** You will see a lovely world map. If you are installing OSR1, you can click on the map on your location and set the time zone. In OSR2, Microsoft made the map unclickable (to be politically correct with regards to border disputes) so you will have to chose it manually below.
20. **Add Printer.** The Add Printer Wizard will appear. You can install your printer now, if you like, or later if you want. If you'd like to wait, just hit "Cancel".
21. **SetUp Finished.** You will see a dialog saying setup is done. Click OK and the system will reboot.

22. **Check Settings.** Upon reboot, you should see basic Windows 95. At this point, you can check a few things to just to make sure setup did its job and that there are no problems. Right-click on "My Computer" and choose "Properties". Then, just double-check everything. Is the correct CPU detected? Right amount of memory? All of your hardware listed?
23. **Optimize the OS.** At this point, you might as well optimize the system a tad from the start. Follow the procedures in the section on OS optimization. This includes optimizing your swap file and disk cache settings, integral components of performance that Microsoft configured poorly.
24. **Install Additional Drivers.** If you're like most, you have additional hardware that is not yet set up. This probably includes your video card, sound card, modem, etc. Install these drivers now. Follow the procedures outlined in their documentation. You may have to reboot a few times.
25. **Last-minute changes.** At this point, reboot your machine and make sure all parts work. Then, change your wallpaper, screensaver, etc to match your innermost desires. Then, YOUR DONE!

### **Windows 98 Installation:**

1. Your CD-ROM drive should already be set up. If you had the luxury of a Windows 98 system disk, you can get the CD-ROM going easily by using this disk to boot the system and choosing to boot with CD-ROM support when asked.
2. Type "Setup" at the command prompt to start the process. It will warn you that setup is going to do a routine check on your system. This is fine. Press Enter.
3. It will do its thing. When its done, you'll be presented with the Windows 98 setup screen, with the Welcome box. Here it says this could take from 30-60 minutes. Choose Continue.
4. It'll load the wizard and present the license agreement. If you are feeling weird, you can read through it. Otherwise, hit "I accept this Agreement."
5. It will then ask for the product key. You can find this on the CD-slip that help the Windows CD when you bought it. Type it into the blank boxes. The key is quite cryptic, so you need to be careful that you are hitting the right keys.
6. If you are using an Upgrade CD, then you will be shown the Upgrade Compliance Check window. Find your disks or CD that contains a previous Microsoft OS. It could be that you have Windows 95 on your hard disk already. In my case, I used my old Windows for Workgroup diskettes. Choose the drive that contains the old OS. Follow the prompts. It will ask for several disks, if you are using floppies. Once it is happy that you are indeed upgrading, it will move on.
7. Select the directory to which you want to install Windows. For most people, the default of C:WINDOWS will do just fine. Hit Next.
8. Setup will "prepare the directory". Just wait.
9. You will be presented with your setup options. You are given four options: Typical, Portable, Compact, and Custom. The explanations for

- them are given. Choose the one you want. For the regular user, Typical will do just fine. If you want more control, and don't necessarily want everything Microsoft thinks should be on your computer, choose Custom.
10. Type in your name and company name in the provided spaces.
  11. If you chose custom, you will be given a window to select those components you want installed. Go ahead and do that now.
  12. You will be shown an Identification window, where you can choose your computer's network ID. Even if you will not be on a network, make up a name.
  13. Computer Settings: Most likely, these are right. If not, hit Change and change them to the suitable settings.
  14. Choose your location from the Scroll Box and hit next.
  15. The next window informs you that setup will make a startup disk for you. If this is your first install and you do not already have a Win98 system disk, I recommend you do this. Just follow the prompts. If you don't want to make one, Microsoft doesn't really give you an easy out. Just hit next. It will start compiling the data. When it pops up with a window saying to put a floppy in drive A:, just hit cancel and you will get away with not making a startup disk. Sneaky, huh.
  16. The next window just says that Windows is ready to start copying files. Hit next.
  17. Now you can sit back for a bit, watch the little Microsoft messages flash across the screen, watch the Estimated time remaining get smaller, or just leave and go get coffee. Windows will sort of take care of things from here, but I'll walk you through the rest anyway.
  18. When the system needs to re-start, Windows will do it automatically for you.
  19. The hard drive will click away for a few minutes while setup does its thing. When the blue screen comes back, you will see a window saying Setting up Hardware. This is where setup is detecting your plug-n-play hardware and other components and installing the drivers for it. Just be patient. When its done, it will re-start again.
  20. After it has finalized the settings, it will first give you a window to set your time zone and date. Go ahead and do this.
  21. It will continue to coast for a few minutes.
  22. When it re-starts this time, it will go into Windows and you are done.

Windows will install some of the drivers for you, but these are stock drivers and may be old. It is probably a good idea to grab the latest drivers for all of your hardware and update the drivers yourself. Some hardware you will outright have to install yourself. After the drivers are installed, you can customize the video settings, get that nagging "Welcome" window to go away along with that stupid web menu.

## Windows 2000 Installation

Windows 2000 is a great OS, but I recommend being able to test your hardware first under the OS. Some hardware has problems under Win2000, or at the least, settings disabled. I'd recommend sticking to Win98 unless you'd had a chance to mess with Win2000 with your hardware.

1. When starting setup, you will first see a "Windows 2000 Setup Wizard". Here you can select an upgrade or a clean install.
2. Plug in the product key when asked. It is every bit as cryptic as the Win98 codes.
3. It will then ask you if you feel like hopping over to the Microsoft site to check out the Hardware Compatibility list. Whatever. Not much of a point.
4. A window will ask if you have an upgrade packs. These are small patches to make certain programs work under Win2000. You probably don't have any, so move on.
5. It will then ask whether you want to upgrade your file system to NTFS. If you want increased compatibility or simply want to dual-boot with Win98, then leave your file system as FAT32. If, after understanding the ins and outs of NTFS, you still want to go with it, then go ahead.
6. It will start to wind and grind, detect things, and otherwise make noise. It will then spit out an upgrade report.
7. The upgrade report may show a few issues. Probably not a big deal. You can handle them later.
8. It then gives you a message that you're ready to install, that it will take 75 to 90 minutes, and that it will restart 3 times. Yes, good, whatever....hit next.
9. Sit back and watch the pretty pictures. You're pretty much done, other than the wait.

## Windows XP Installation

1. Insert the CD into the CD-ROM. Click Install Windows. If your CD doesn't automatically run when inserted, then run setup.exe manually on the CD.
2. Choose the type of installation you want: Upgrade or New Installation. Upgrade is recommended if you just want one OS on your machine, but choose New Installation for an easier process. I've had problems trying to do an upgrade to XP.
3. Agree to the license agreement.
4. Enter the product key.
5. Choose whether or not to do Dynamic Update. This will download the latest setup files from Microsoft before continuing. You must have an active internet connection, and obviously a modem, set up to do this.
6. Skip 7-10 if you are doing an upgrade.
7. You will have the option to control some "Advanced Options". In here, the important things to set are the location of the setup files, the folder name of Windows (which you might want to define if you are putting

- more than one version of Windows on this machine) and whether or not to copy the install files to the hard drive.
8. After continuing, you will have a slight difference in that that PC will boot into a DOS setup area.
  9. You will be asked which file system to use. You can convert to an NTFS file system or use FAT 32 or, the default, which is to leave the file system as is, which I recommend.
  10. You will be asked to select which partition to install Windows XP to. It is best to install it to a different partition than any other version of Windows, as Microsoft recommends it. But, you have full control.
  11. Once these steps are done, you will sit back and watch it copy all your files over and do its thing.

## STEP 27: Tweak Your Creation

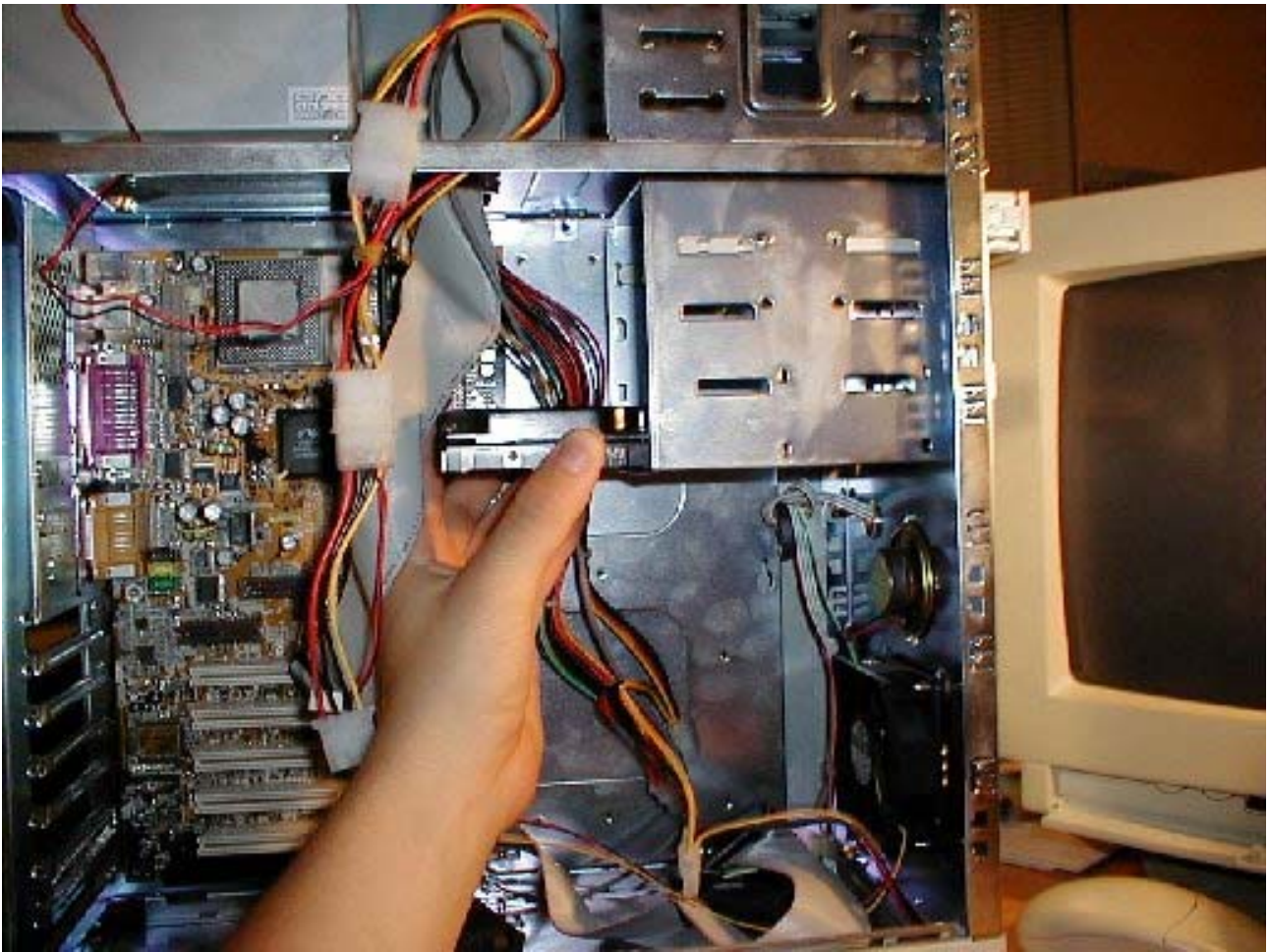
Now you have a PC which you built and it is now running with a newly installed operating system. Great job! Now you are ready to get the PC set up as you want it. This will include installing any additional hardware and software, adjusting any default Windows settings you don't like, upgrading drivers. If you installed an older Windows version, you might want to use Windows Update to upgrade some of the core components as well as basics like Internet Explorer. You'll definitely want to get a modem installed (if you have not done so already) and hook the PC up to the internet. This is your prime way of updating software and is highly important.

I leave the rest up to you. I hope you found this tutorial useful, as I'm sure you can tell from the length of it that it is very long and very in-depth. Enjoy your new PC

## ***Illustrations***

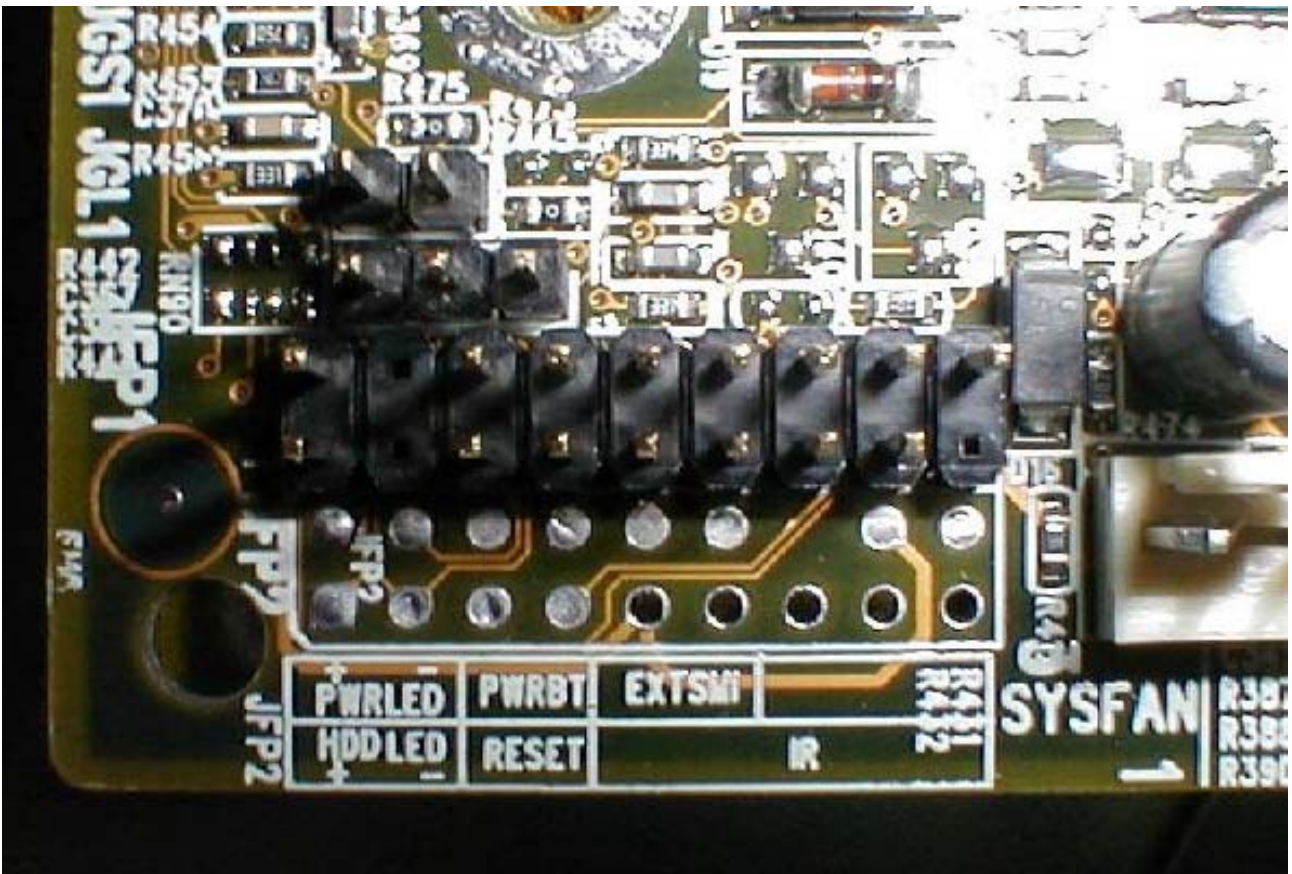


1. Installing the floppy disc drive

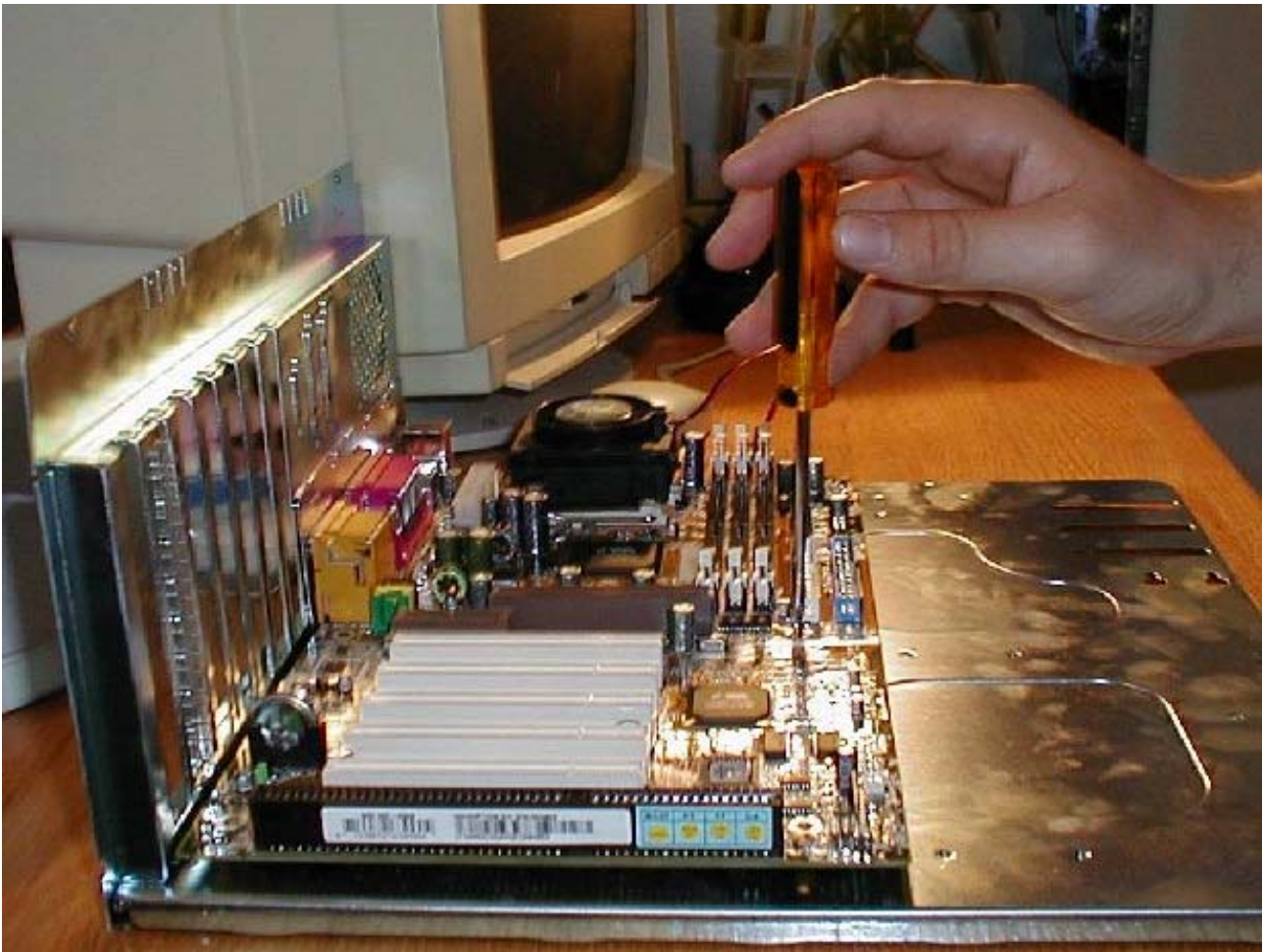


## 2. Installing the Hard Disc Drive





### 3. Motherboard jumper Block



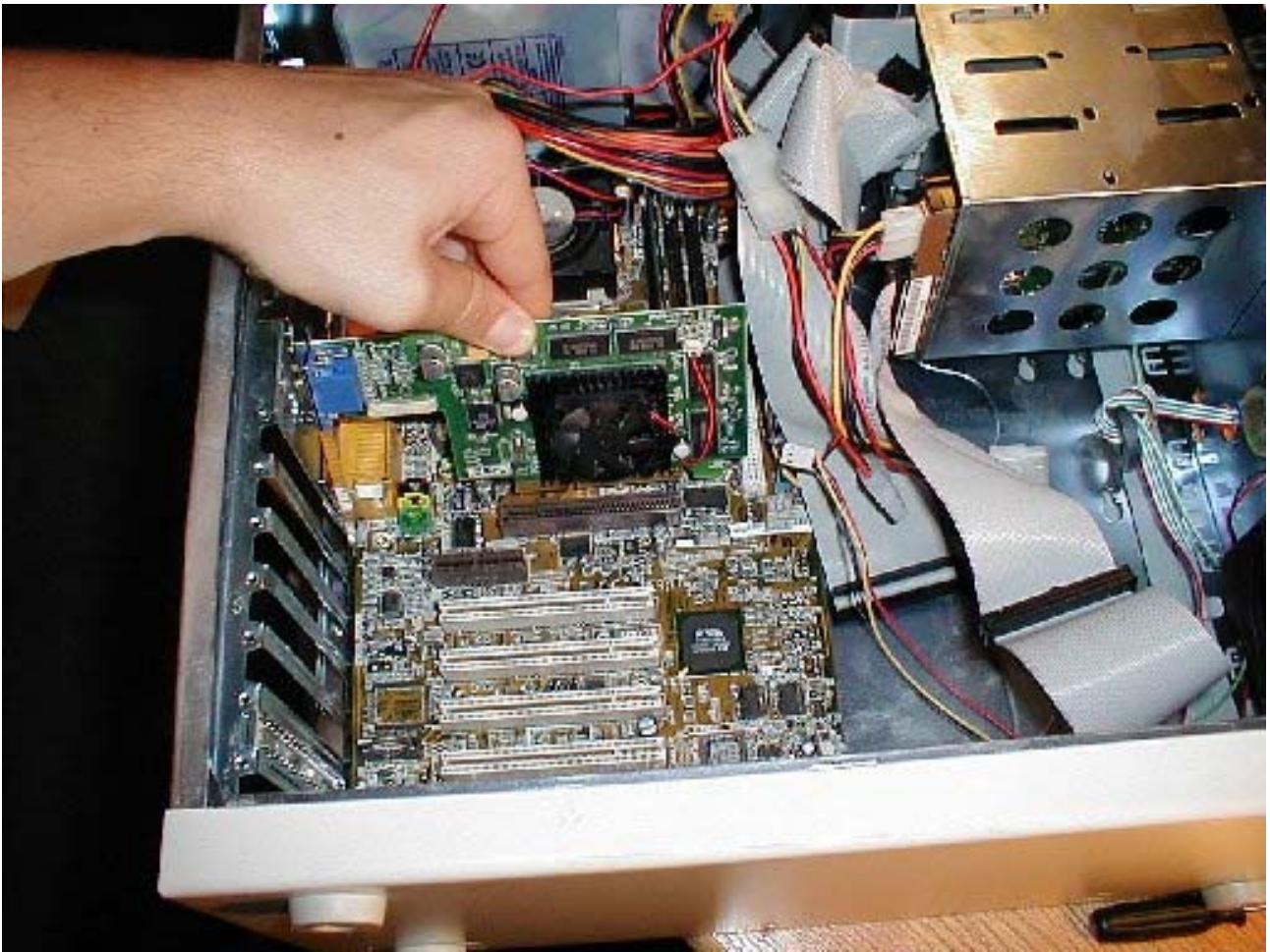
#### 4. Installing the Motherboard



## 5. Installing the memory modules



## 6. Zif Socket (zero insertion force)



## 7. Installing The Video Card (or modem or any other card)