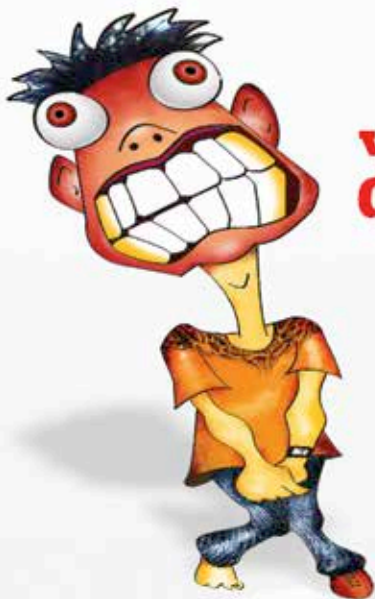# digit FastTrack
YOUR HANDY GUIDE TO EVERYDAY TECHNOLOGY

To
BUILDING A PC
(2017)

- A rite of passage - Which component does what
- CPU + CPU cooler - Motherboard
- Memory - Storage - Graphics Card - Case
- Power Supply - Monitor - Keyboard and Mouse
- Peripherals and accessories
- DIY Cable Management - DIY Water Cooling
- Assembling your machine - Where to buy

FAST TRACK to

BUILDING A PC
(2017)

CHAPTERS

COVER DESIGN: PETERSON PJ

di9it.in

A rite of passage

Building your own PC has become a rite of passage for those born in the digital age, or as they're referred to these days – Digital Natives. Some would argue that the PC market is dying and they wouldn't be wrong from a purely numbers perspective. While the overall market has been on a steady decline thanks to the fact that mobile phones have begun to replace some of the tasks traditionally performed by a PC, there still exists and will continue to exist a strong market as the sheer performance provided by PCs is way ahead of anything that phones of the same generation can provide.

Over the last couple of years, there has been a shift in the PC community as more people who only needed the PC for casual needs moved away from building systems and got themselves pre-made systems or laptops or any of the million variants therein. Hence, the PC building scene has now become dominated by enthusiasts who want more. More customisability, more power, more performance, more control, more flexibility ... more everything! The very act of building your own machine is a very personal affair, at least we, the members of the PCMasterRace, would like to believe so. It's the act that has brought many a PC enthusiast together. Something that we like to reminisce about when we meet other members of the PCMasterRace.

In this FastTrack, we start you off with a simple overview of the functions of each component. We hope that this cursory information will hook you into the world of PC building. After that, we take you through a more in-depth look at the same components but each chapter looks at multiple suggestions for PC configurations. We've labelled them according to different price points. So, if you want a Basic Rig, all you need to read are just the

portions under the label 'Basic Rig'. Go through each chapter and look for the same label to figure out your configuration. And if you want something a little 'Outrageous', there's a label for that as well.

A PC isn't just about the accessories, there are numerous peripherals that can not only add a certain flair to your rig but also give you added functionality. So we've gathered some of those for you. And then we move into the more complex domain of water cooling which works out as a primer that will get you familiarised with the concepts of water cooling.

By this point, you should have everything that you need to build your very first machine. And that's where the chapter on assembling will come in handy. Do remember that, this is a generic guide and different components may require a certain re-ordering of the steps mentioned in the guide. So don't be afraid to mix things up. After all, most of the fun lies in the assembling.

And lastly we tell you where you can buy the different components for your PC for the right price in India. We don't want you to be at the mercy of your local dealer. It's always good to know your options are and where you can get your components for the best price. After all, a few thousand bucks saved will help you get a better graphics card, or perhaps even more RAM.

So what are you waiting for? Your rite of passage awaits!
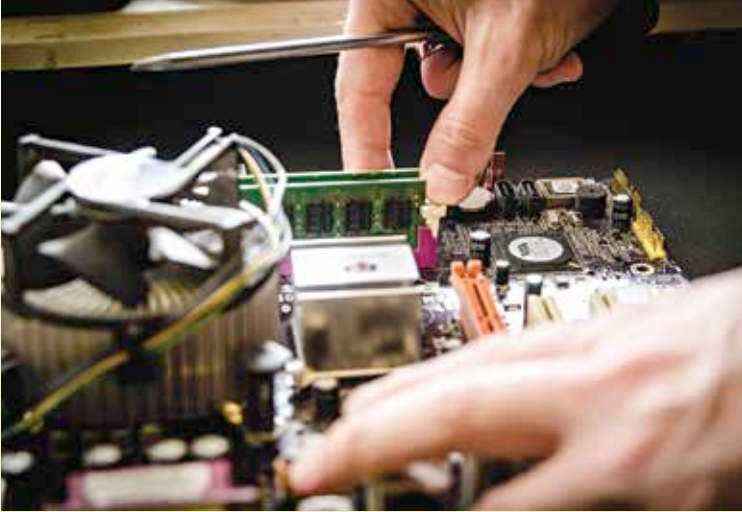
WHICH COMPONENT DOES WHAT

The humble PC is made up of many different components. Here's a brief overview of what each component does.

If you would like to build a desktop PC, you will have to assemble all the relevant components in the proper and correct way. If you are a beginner, the whole process will look complicated. If you approach a computer shop for PC Building, they will probably dump a whole bunch of components onto you which your PC might not require. Hence, it is vital for you to understand the core function of each component before venturing to assemble a PC. In this chapter, we will provide a list of all the important components required for PC Building.

Processor

The processor will perform all the required work such as word processing, calculations, video rendering and much more. Higher the clock speed and threads speed up work. Hence, if you want to perform video editing, you need to buy a processor with many threads.

CPU Cooler

When you purchase a processor, the product package will ship with a small cooler. The main functionality of the cooler is to decrease the amount of heat generated by the processor. If you want enhanced cooling performance, you should purchase coolers manufactured by third-party companies which are way better at the job.

Water Cooler

If you build a PC and overclock it, it will generate quite a lot of heat. While air coolers can do a good job, they're no match for a custom liquid colling system. You can get pre-made All-in-One coolers or build your own system for a little extra money should you need all that cooling.

Thermal paste

The thermal paste is a chemical compound, which plays a pivotal role in the cooling of the processor. A thermal compound is used to ensure maximum heat transfer from the CPU to the CPU cooler. And we simply cannot stress its importance.

Motherboard

Think of the motherboard as the foundation for your computer. Every component is seated into the motherboard. And it's the motherboard's job to ensure that they all communicate and work

with each other in the most optimal manner. They come in different sizes and feature sets. You should pick the one that meets all your needs.

RAM

RAM stands for Random Access Memory and is used to store data needed by the CPU or graphics card. The higher the capacity of RAM, the more applications you will be able to work with on the PC. There are many types of RAM and the most popular one these days is DDR4.

RAM Cooler

RAM generates heat during usage. But never enough to warrant its own cooler. But should you want more performance from your RAM then you can overclock it. And doing so will cause it to heat up a lot more and require its own cooling.

Hard drive

Hard drive is used to store data. They're cheap, offer lots of storage space but aren't as fast as SSDs. So the optimal thing to do is use a mix of hard drives and SSDs. The stuff you need frequently goes on SSDs while everything else can go on the hard drives.

SSD drive

SSD stands for Solid State Drive and are a much faster medium of storage compared to hard drives since all the data is store on silicon NAND chips similar to what RAM uses. Current gen NVMe SSDs are way faster than anything before.

Graphics card

Graphics card are required to render visuals and graphics. Current processors include graphics as well but they simply can't compete with the performance of a discrete graphics card. A must need for any gamer.

Cabinet

A cabinet is an important item which houses all the components required to build a PC. You need to pick a cabinet that can fit all your components and that which provides a good number of intreface ports like USB. Also, cooling is one of the most important aspects of a cabinet, so choose wisely.

Power Supply Unit (PSU)

The power supply unit or SMPS (switching mode power supply) takes AC power from the wall socket and converts it into DC power for your computer's hardware. You need to get an SMPS that supplies the right amount of power needed.

Case Fans

The case fans are inserted onto the relevant positions inside the cabinet for cooling purpose. You can either attach a normal case fan or fans with fancy LED bulbs. The standard size of the fan is 120mm but you can get bigger fans for enhanced cooling.

Monitor

A monitor is used to enjoy visual content generated from the PC. Nowadays, widescreen LED monitors are available in various sizes starting from 15-inch. If you are looking for better color reproduction, you should buy a monitor with an IPS panel.

DVD drive

A DVD drive is required for your PC so that you can read and write data stored on DVD-ROMs. If you would like to view the contents of the DVD included with the Digit magazine, then you need to build a PC with a DVD drive.

External DVD Drive

You can also buy an external DVD drive so that you can use it with both your assembled PC or laptop. They often come with a USB connector and don't need any extra power so they're portable.

Keyboard & Mouse

The Keyboard and Mouse are required to interact with your PC. You can either buy a wired USB or wireless depending upon your needs. If you want your work place to be free of wire clutter, you can invest for a wireless keyboard.

Printer

A Printer is required to generate hard copy of your documents. Nowadays, you can easily buy a printer which will not only print documents but also provides an ability to perform scan and copy operations.

Scanner

A scanner is used to generate soft copy from the hard copy. Unless you need to perform a lot of fast scanning, a normal multi-functional printer will be sufficient for your needs.

UPS

A UPS supplies the required power for your PC during power failures. Based on it's capacity you can get anywhere from 5 minutes to more than a few hours of back up power. Use it wisely.

Surge Protector

Your valuable PC components will be damaged by voltage fluctuations or because of spikes during a lightning storm. A good quality surge protector will be able to prevent damages to your equipment.

Speaker

A speaker is used to listen to the audio output produced by the PC. A 2.1 or stereo speaker setup is sufficient for a basic rig but you can always go for a 5.1 setup for a proper surround sound system.

Headphone

A headphone is used to listen to the audio output without causing disturbance to others. You can get wired as well as wireless headphones which use Bluetooth. If you're into multiplayer games then get a headset with a mic.

Modem

A modem is used to establish connectivity with the Internet. Modem's generally tend to have built-in routers as well but sometimes you might have to get one separately. A good Wi-Fi router has become absolutely essential these days.

LAN card

With a LAN card (or Ethernet adapter), you will be able to attach an Ethernet cable from your modem. Every motherboard these days ship with at least one Ethernet port, so you'll not need one.

TV Tuner

A TV Tuner is an add-on card which slots into the Motherboard. It will help you to watch television channels directly from your PC. You can either buy an internal or external card depending upon your requirement.

Conclusion

In this article, we have made an attempt to list all the components that are required for building a PC. Some of these are optional such as the TV Tuner card. In the forthcoming chapters, you will learn more information about the above components in detail. Without any further discussion, let's get started. **d**

CPU AND CPU COOLER

The brain of your machine puts the hot in hot-head. And it needs a good cooler to keep running things optimally.

As the norm has it, sporting high GigaHertz is like flexing your muscles, showing off power. It is not uncommon to compare two CPUs based on their clock speeds and core counts. We believe a digit reader like yourself might already know what a CPU is. So, we are not going to bore you with the definition once again.

Beginning this chapter, we will also highlight components you might want to use for building your PC, according to your budget.

What makes a CPU better than the other?

Details matter when it comes to technology and the CPU is the brain behind most electronic gadgets. While the clock speed is the thing most people compare, it is not the only factor that matters. It is possible for a CPU with more cache to beat another CPU with slightly higher clock speeds but lower cache. This is because of how the CPU accesses data demanded by the program currently running and the nature of that particular program. A program that uses very less memory but does a lot of calculation in a serial manner would need higher clock speeds while a program which does less computation but needs more data could benefit from a larger cache size.
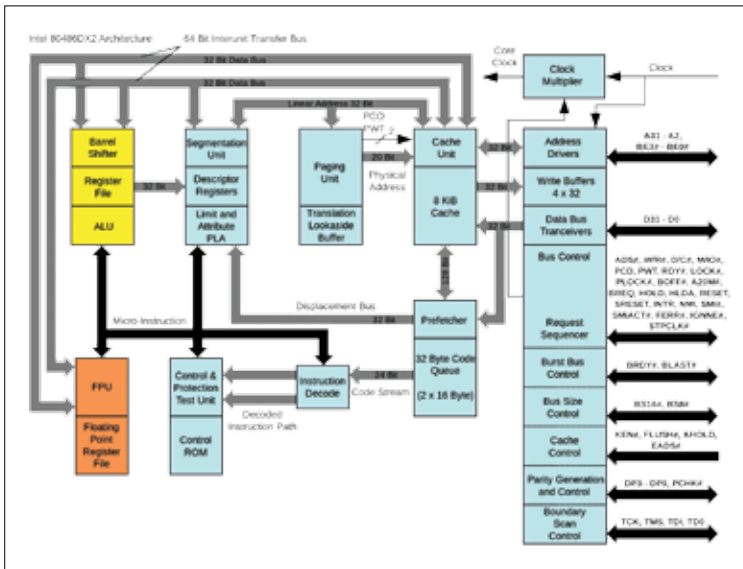
Processors are complex, yet sophisticated pieces. The sophistication is inevitable

1. **Clock Speeds:** These govern the number of instructions a CPU can execute every second. A CPU with 1 GHz of clock speed can execute 1 billion of them per second. This number does not tell what kind of instruction the CPU is executing. Normally, processing happens with operations being handled one step per clock cycle. Also, many-a-times, the CPU has the instruction (i.e. the what to do part) but ends up waiting for data to arrive from RAM so that it could process

the data and thus, a fast CPU with slow RAM would not make an impressive pair.

2. **Instruction Sets:** depending on what you want to run on the CPU, the instruction set matters. There are main instruction sets like the x86 (32-bit instruction set) or amd64/x86_64 (the 64-bit instruction set) and then there are others like SSE4.1 (the SIMD instruction set implemented on Intel chips). There may be dedicated instruction sets for encryption and decryption too (e.g. the AES Instruction Set on Intel and AMD CPUs), so that encrypted data can be read and processed as fast as possible.

3. **Speed and Energy balance:** The faster the processor works, the more energy it consumes. However, we do not use that much power most of the time. For example, web-browsing or document editing is not very compute-intensive. Many modern CPUs come with speed enhancement technologies. One with such a technology would be better than another which cannot increase or decrease the frequency on demand.

4. **Cache Size and Levels:** Cache is the fastest memory there is in a computer system. This memory is packaged into the CPU and resides very close to the compute cores. It is also very expensive and cannot be upgraded or changed because it is inside the processor chip. No matter what the CPU is executing, it brings the data (and the instructions) into the cache before working on it. This is so because cache is the only memory accessible to the CPU. Every time the CPU wants to fetch some data, whether it be an instruction or data, it looks for the same in the cache. If the data is there (called a cache hit), it loads the data into an appropriate register (or instruction pipeline, if it is an instruction) and then executes it. If the data is not present in the cache (cache miss), it looks for it in the RAM and loads it from there. It is noteworthy that caches are very fast memory units designed to be at par with the processing speed of the CPU itself. RAM modules on the other hand are much slower than CPUs. A cache miss usually triggers data transfer from RAM. While the data is being loaded into the cache, the CPU cannot perform that task and thus may stay idle for that duration. It goes without saying that bigger the cache, faster your computer is going to feel!

5. **Threading and Cores:** If there's anything that gets compared as much as a processor's clock frequency, it's the number of cores. It might sound funny but your OS might be deceiving you a little. The Task Manager of your OS might show 8 cores, while there are only 4 (as you can see

in the picture). This is because there are only 4 actual compute cores available but to make sure that cache misses have as less an impact as possible, modern processors use SMT (Simultaneous Multi-Threading, HyperThreading in Intel's terminology) and keep 2 states for every compute core. This way when the processor is waiting for some other resource (e.g. while a cache miss is being dealt with), the other state can be resumed on the core. This way, a Hyper-Threaded CPU mentioned as example will perform better in a multi-tasking environment but you cannot expect it to work just as fast as another CPU with 8 physical cores under most conditions. If, however, you put a more compute-intensive and less memory-intensive job, the performance will not be the same as you would expect from an octa-core.
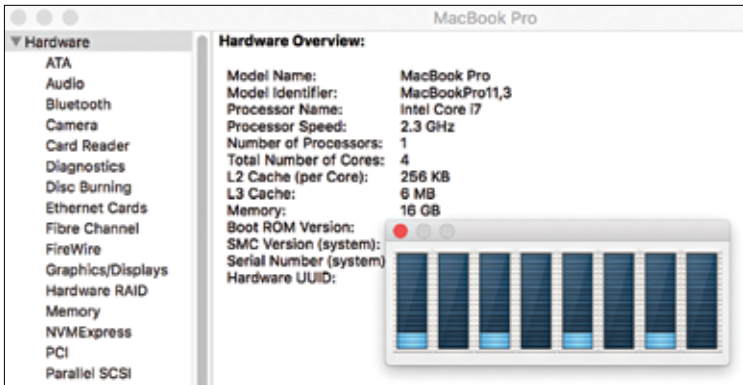
Notice that the number of cores mentioned in the specification is 4 while activity monitor on the Mac shows 8 cores being used.

Having said all of that, you should be able to recognize the ones meant for you by their names. The older Core Duo/Core 2 Duo series from Intel were meant for the desktop and so are the new i3/i5/i7 series processors. AMD on the other hand, has the FX series, APUs and the new RYZEN 3/5/7 chips for desktops. At the same time, if the packaging reads Xeon or EPYC, then you should stay away from them unless you know what you are doing – they are meant for the servers and are both extremely powerful as well as pricey! They can have up to 32 cores which can run up to 64 threads. They also have a higher cache/core ratio than desktop lineups. However, if you want such a beast to live in your house though, who are we to complain?

We've seen workstations being built by enthusiasts who prefer to have a lot of cores on hand for video and 3D rendering work.

What choice do I have?

While tech is supposed to be definitive, ironically, the answer to this question is "it depends". Fortunately, we can be more definitive about what it depends on. If you search online, you might be able to spots gems like these: *http://bit.ly/Flipkart775* . Please do not fall for such components. Although they were good performers, the problem with such components is that they are old and you might not find other components that are compatible. E.g. It is difficult to find a motherboard that goes with LGA775 socket. Also the processor itself has reached End of Interactive Support status from its manufacturer Intel.

Basic Rig

You are looking for a basic processor, possibly with a built-in graphics unit as you do not want to use a discreet graphics card. Also, we believe you are not looking for a lot of gaming.

You can go for AMD A8-7600 APU with 4 processing cores clocking between 3.1 to 3.8 GHz and 4 MB of L2 shared cache.

Entry Level Gaming

You need a decent punch with multi-threaded processing in this case with a higher single core performance. You could go for a Intel Core i3 – 7100 for your CPU which can deliver good speeds with 2 cores / 4 threads and 3MB of smartcache and supports the latest hardware developments on the multimedia end.

Mid-Range

You need a machine which can do more than just basic tasks. You need more cache and more computation power. AMD Ryzen 5 1400 is priced well and comes with 4 cores and 8MB cache. It supports DDR4 on 2 channels and can address up to 64 GB of memory. A neat performer at an affordable price.

High-end

Intel Core i5 – 7600 has 4 processors that can run 4 threads at a time (no SMT/HT here). The processor also supports most technologies developed

by Intel for good multimedia experience and robust security. Since we are going for high-end gaming, you should pair this CPU with a good heatsink named H45 from the Corsair family to keep it cool.

Video-Editing / Gaming Glory

We think if you are planning to make a monster, you give it a hot head. You are better off with more cores and an AMD RYZEN 7 1800X is a pretty good bet. Or an i7 would suffice here and i7-7700K being one of the absolute best processors available justifies its place here. To make sure these monster CPUs don't burn the house down, you need to provide them with ample cooling. Something like the Antec Kuhler H2O 600 can take care of that.

Outrageous

When sky is the limit and you are ready to break barrier, stepping back a little might not seem like a bad move for a very long run. With 10 cores and 20 threads supported and a better cache/core ratio than almost any processor out there, nothing beats Intel Core i7 - 6950X (Extreme Edition) in performance. While it might not have a couple new technologies in the 7XXX series, you simply cannot get the performance from any other processor out there. By the time you read this, Intel's x299 or AMD's Threadripper might be out. So be on the lookout for those.

What to look for in the spec sheet

Specifications matter when it comes to any product. Typically, the full spec-sheet of any PC component would be a lot bigger than what you can find on their website. On top of that, there are only a few things that are focused upon by manufacturers. Unless you are a member of a hardware forum with passionate members, chances are that you would not get to know a huge deal about what matters on the specification sheet. Starting this chapter we are going to tell you exactly that.

When it comes to the specification sheet, we have already told you most of what matters. While the clock frequency obviously matters, it is not the most paramount thing to look for. If there are two of processors with close frequencies but one of them have a higher-cache, then you should go for the one with higher cache. Such a processor will waste less of its power waiting to get data from the RAM and thus, will end up working faster.

Make sure you pay attention to the number of cores there are in the processor and whether HyperThreading (in case of Intel CPUs) has been men-

Keeping the head cool

CPUs, often called the brains of a PC can heat up to the point where they can boil water (~100 degrees). But it is nearly guaranteed that they will kill themselves at that temperature by burning out and if the thermal sensing units are working well, the machine will halt well before you bring in eggs to boil over your CPU (strongly, not-recommended). To counter that heat, you will have to get a great heatsink with large surface area and a large fan to blow the heat away. If you are going to tax your CPU with lots of work for long hours (like rendering a 3D scene, video editing, audio format conversions or as a server that stays busy), we recommend you get yourself a liquid cooled heatsink. A liquid cooling solution works better than simply installing fans because the specific heat capacity (rate at which heat is transferred) of water is about 4 times more than that of air. Also, water can be easily channeled in and out of the system while air turbulence caused by different moving fans can obstruct the heat flow and end up causing more trouble.

Example of a liquid cooling heatsink

tioned. Normally, if the number of processing cores is less than the number of threads it can run simultaneously (it is clearly mentioned on the spec sheet), the chip comes with SMT (Simultaneous Multi-Threading) and you should be able to get more juice out of the processor than if there were none.

Also, you do not want to make a monster which overheats even when doing the minutest of tasks (like web browsing) and set the fans whirring. Power optimizations are just as important for that reason.

Many users do not take 'security' into consideration many-a-times. It is important to remember that if your PC is not secure, it can be very dangerous. The WannaCry ransomware which was recently in news only reinforces the importance of security. Though the mentioned ransomware was not because of lack of any hardware features, it is always good to look out of some extra protection. Higher end CPUs from Intel come with built in protection from multiple attacks that can be launched against your system right from the boot-up to when your system is properly working. **d**

MOTHERBOARD / MAINBOARD

It's the underlying fabric that holds the entire machine together. Motherboard comes in all shapes and sizes.

I f the CPU is the brains of the system, the motherboard must be the backbone to which everything else is connected. MotherBoard, sometimes also referred to as MainBoard and sometimes simply, the Board is the largest component inside the CPU cabinet to which your processor, RAM modules, graphics card etc. are connected. It has the system buses, chipsets and power lines for components attached to it.

Key points of a motherboard

With the number of components they house, chances are, you will never find two motherboards identical to each other. Keeping that in mind, it is important to understand what all functions are carried out by the motherboard.

The power distribution: A motherboard is the primary source of power for all components attached to it. It receives the energy from the Power Supply Unit installed inside the casing using power input connectors, the most important of which is a (20+4)-pin connector. However, it may not be sufficient to power everything you connect to the board. For example, a powerful CPU demands more. For such cases, the board has extra power input points in the form of 8-pin or 4-pin connectors.
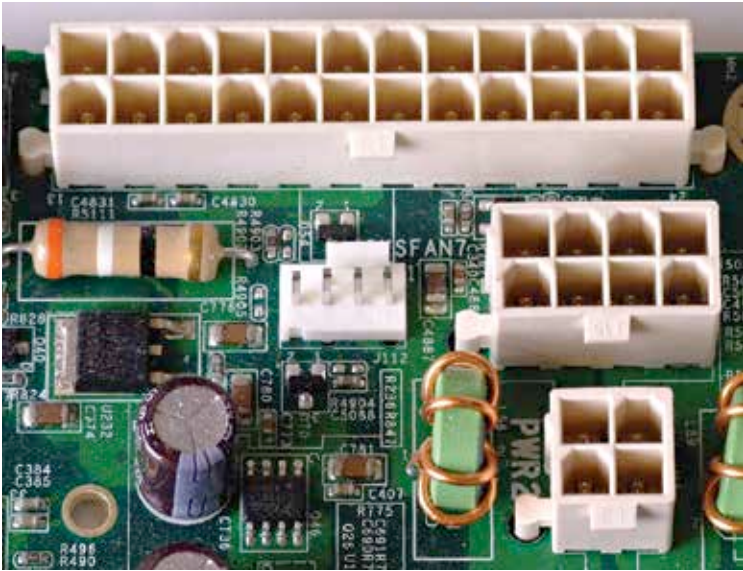
24-pin, 8-pin and 4-pin Power connectors on a motherboard

Data distribution and management: Apart from distributing power amongst the components, it also distributes and manages the data flow. This is the most crucial part of what a motherboard does. The physical data bus(es) are part of the motherboard. There responsibilities of data flow management are normally carried out by the chipset installed on the motherboard. This used to include the Northbridge (Memory Controller

CPU

Clock
Generator

Graphics
card slot

Front-side
bus

Chipset

High-speed
graphics bus
(AGP or PCI
Express)

Northbridge

(memory
controller hub)

Memory Slots

Memory
bus

Internal
Bus

PCI
Bus

Southbridge

(I/O controller
hub)

IDE
SATA
USB
Ethernet
Audio Codec
CMOS Memory

Cables and
ports leading
off-board

PCI Slots

LPC
Bus

Super I/O

Serial Port
Parallel Port
Floppy Disk
Keyboard
Mouse

Flash ROM
(BIOS)

Motherboard Controller Layout Block Diagram

Hub or MCH for short) and the Southbridge (I/O Hub or IOH for short). However, these two have been since merged into the PCH or Platform Controller Hub. Or you can just call it a chipset, a more generic term that gets the message across. This chipset decides which all I/O ports exist and what speeds they operate at. It acts as an intermediary between I/O ports and the CPU.

Housing the CPU and RAM: CPU is the single most important component of the system and affects the motherboard's design in a significant way. Like all other components, the CPU goes in its own slot. In case of motherboards built for use by servers, there can be more than one CPU slots but for sake of simplicity and the lack of availability in normal mar-
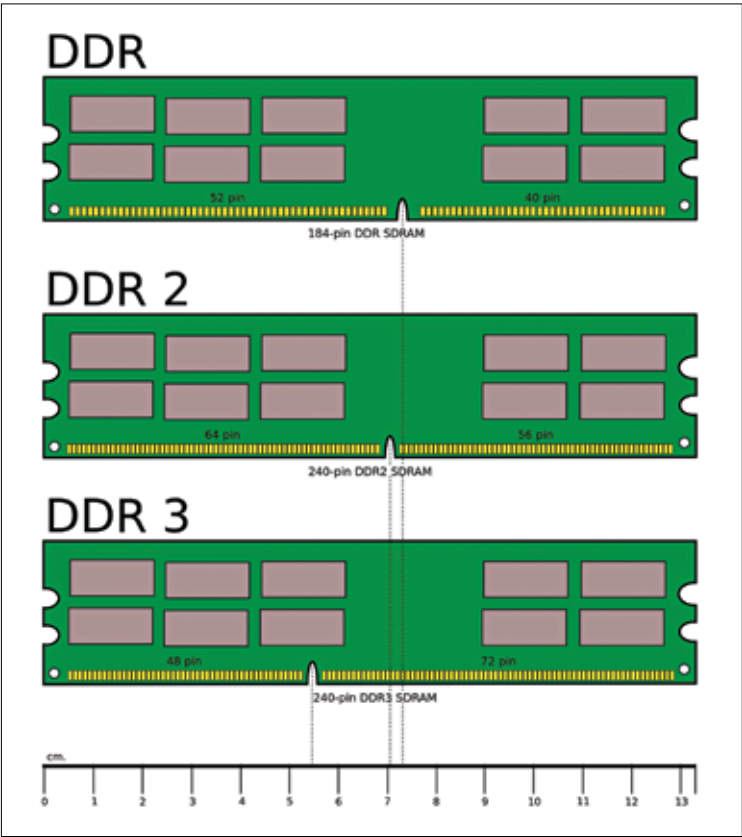
The cut in the RAM module does not allow it to be used with an incompatible board

kets, we will skip them in this FastTrack. The CPU has pins coming out of its body at the bottom or there are pins in the CPU socket. The former is called PGA(Pin Grid Array) and the latter is called LGA(Land Grid Array). Intel uses LGA while AMD has PGA. The two are not compatible with each other. It is common sense that if the number of pins and their layout on the CPU differs from that on the motherboard, they are not going to fit together.

Very similarly, every motherboard is designed to house a particular type of memory module. This is determined by both its DDR type and the clock frequency. It is not possible to shove a different kind of DDR memory into a motherboard than what it was designed for. It is so because of how RAM modules are designed physically. Have a look at the picture above and you can understand why one module type won't fit in a motherboard with a slot for another type.

Providing connection points to other components: Graphics Cards mostly go into the PCIe slots with x16 width. These slots are placed parallel to each other and are perpendicular to the edge on which all built-in I/O ports (like USB, Ethernet, Display port, Audio ports etc.) are placed. These slots must be marked on the board.

The motherboard also provides the ports for connecting SATA, PATA devices, connectors to front-panel USB and audio jacks as well as the Power/Reset buttons. You should be able to see them marked on the motherboard. You might get confused with smaller names and numbers labelled on the motherboard. If you have a doubt, take a picture ready and head to the digit forum to get all your answers.

Which motherboard is right for me?

You need to select a motherboard keeping other components' compatibility in mind, especially CPU and RAM modules

Basic Rig

Asus A68HM-K works well with AMD A8-7600 and comes with 2 DIMMs supporting up to 32 GB, three SATA ports, support for USB 3.0 and has built-in support for DVI and D-SUB.

Entry Level Gaming

Gigabyte GA-B250M-DS3H is a good motherboard with support for up to 64 GB DDR4 RAM over 4 slots (almost all motherboards support

this) and a PCIe-x16 slot for the graphics card for future. It has a DVI-D (remember they are different from DVI-I) and a HDMI output port for 4K output. With protection against over and under voltage detection, it is a good bet.

Mid-Range

ASUS PRIME B350-PLUS goes well with the selected processor (Ryzen 1400). You can put in as much as 64 GB of RAM in it with the Ryzen. It has a PCIe-x16 v3 Port and supports CrossFire with another AMD card plugged into another PCIe-x16 v2 port. There are enough ports to satiate your need for storage.

High-end

Having a certified Ready for Windows 10 tag should boost your confidence when buying MSI Z170A PC Mate. Basically any Z170 board is sufficient for this budget. Don't opt for boards that advertise about overclocking unless you know what you're trying out. You can opt for an H170 board too if overclocking isn't on your mind despite getting an 7700K. Also, you can get the 200-series boards for Kabylake processors as that's the only way you can get support for Optane memory.

Video-Editing / Gaming Glory

If 3200 MHz sounds cool, support for 4266 MHz should blow your mind. ASUS MAXIMUM IX APEX is nothing short of a marvel. With 4 PCIe-x16s, LEDs built on board to make it look like a warrior, 8 USB 3.0 ports, 1 USB 3.1 port, 1 USB-C port, 7-channel Audio, two BIOSes, a button to reset memory overclocking to guarantee booting (if your experiment to overclock failed) and some other mind-blowing tech on it, you will skip a heartbeat when you see this one. The GIGABYTE AX370-Gaming 5 and the ASRock Taichi X370 are pretty good boards for the Ryzen 7 1800X.

Outrageous

For a processor like 6950X with outrageous performance, you need a board that can keep up. Gigabyte GA-X99-SLI delivers. Being a generation older, it supports overclocking the RAM to 3400 MHz which is still crazy! It comes at par with MAXIMUM IX APEX with 4 PCIe-x16 slots, better sensing, support for USB 3.0, Thunderbolt 3.0 (via a card sold separately) and a cool looking design.

What to look for in the spec-sheet

Being the most sophisticated part of the PC, you will need to be extra careful when selecting a motherboard. Remember the rule: "when in doubt about the configuration of a board, you should always refer to the manufacturer's website and not an e-commerce site".

We have already established the fact that Processor's slot and RAM specifications are important because you cannot use a kind which wasn't built for the board. Make sure that they are compatible before you buy. Motherboards mention the supported slots in the spec-sheet and so do the CPU manufacturers. Remember that the match must be exact – e.g. LGA1155 and LGA1156 are different. A processor which supports LGA1155 will NOT FIT in a LGA1156. Do not be tricked into thinking that the numbering you saw on the spec-sheet was probably a mistake or that you can somehow make them work together (you just can't). We recommend you go to the manufacturer's website and check for yourself when in doubt rather than trusting any random blog post you find on the web.

It is also important to remember that you must never try to force the CPU into the motherboard. The CPU does not fit from all sides. It has a specific orientation with which it goes into the board. Refer to manual when in doubt. Trying to force the CPU into the socket on the motherboard is the easiest way to bend or break one or more pins on the CPU's rear. Such a damage is normally not covered under warranty and you will end up wasting the money you spent on the processor

Just like with CPU, make sure you have the right kind of RAM. Again, RAM modules go into their slots only in a single orientation. Never try to shove them in forcefully. You might break the RAM or the board or both. Read the specs carefully before buying and stay attentive when assembling.

Take notice for the display ports available at the back. If you do not want to buy a discreet graphics card, choose one which already has a display port (VGA/HDMI). We warn you, for it is easy to commit this mistake in greed of building a upgradeable CPU with a good motherboard (which does not have a built-in display port) but failing in the first step of building one.

If you want to have a truly upgradeable machine on the graphics front, make sure the board has more than one PCIe-x16 slot allowing you to SLI/CrossFire two cards later. The card too will have to support those technologies too. Look out for the number of SATA/USB ports and on-board extension pins supported for front panel. They will matter when you need to attach more devices. While most motherboards come with USB 3 support,

spec-sheet is where you should pay attention. Looking out for USB-C might make sense too if you have a device which works on USB-C.

Though sometimes neglected, you should keep an eye on the number of pins provided for attaching fans to the system – they matter when you want a monster that needs lots of cooling. Also, if you are going to use a power-hungry CPU and Graphics Card, there should be extra 8-pin or 4-pin power input connectors too.

Broadly speaking, the form factor of the motherboard helps you pick either a compact mini-ITX system or completely set up system can cost your quite the money. For more on this, check with your local retailer to eg

Since motherboards are at the center-stage and almost every component attaches itself to the board directly or via wires, each of them have certain protocols which play a role in the complete PC integration. We will talk more about the factors as we get into detail about those component in subsequent chapters. **d**

MEMORY / RAM

The more you have, the better it is. Memory helps you run a lot of things at the same time.

R AM or Random Access Memory is named as such because once upon a time, we had 'Tapes' as storage medium. To access data on those tapes, one had to wind them continuously to reach the point where data resided – much like an audio cassette. Electronic, volatile memory was easier to access – you could just ask for data at any address and it would deliver. Therefore, they were named as such.
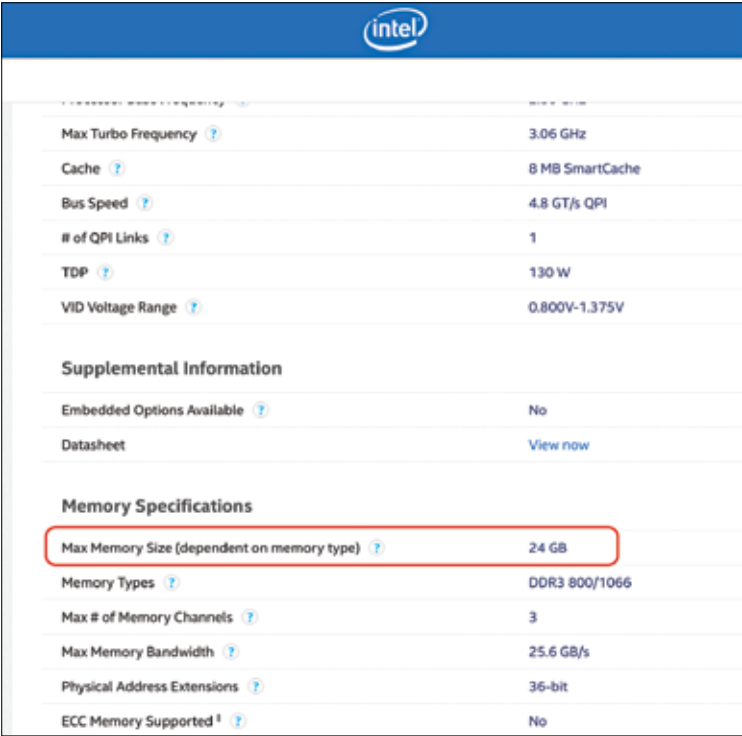
RAM is also called the Primary Memory and most of the times just "Memory". The name of "primary memory" is attributed to the fact that

RAM is the first place the CPU looks into for data before it tries to load anything from the storage media, which are not-so-surprisingly also known as secondary memory.

RAM holds the data in "active use" by processes running on the system and the OS itself. Like everything else that makes up a PC, you will be spoiled by choices when it comes to RAM modules. But first, let's see what makes up a good RAM module.

Key points of RAM

What are the two most important things to look for in the RAM when we read about them? DDR rating and size. It is so because they are the most important ones affecting the performance of a PC. In case you were unaware, DDR stands for "Double Data Rate" indicating that they can transfer at twice the speed. You may ask "twice the speed of what?" And the answer would

CPUs also determine the max amount of memory that they can address

be "SDRAM". DDR is short for DDRSDRAM (Double Data Rate Synchronous Dynamic Random-Access Memory). The original SDRAM is now, sometimes referred to as 'DDR1' but DDR actually began with DDR2. If you are building a new PC, you might not have to worry about those naming conventions because both DDR1 and DDR2 modules are almost obsolete from the market. DDR4 is where all the action is right now.

DDR specifications technically deal with timings on which the chip operates. Each module has a range of operating frequencies within which it can operate with ease and it can go higher if you overclock the RAM module. The frequency determines the speed at which the RAM module can transfer data. Since RAM is the primary place the CPU looks for data after searching its own cache, speed of RAM affects the overall performance.

Then there are also RAM channels, Dual-Channel is the most popular configuration while Quad-Channel is only found on enthusiast boards. Between Dual-Channel and Single-Channel, there is a lot of performance difference but as you move to Triple Channel, that comes down a little and with Quad-Channel, the benefits are only applicable to very few applications. Simply put, the channel type dictates how many modules (or their multiple) you should have connected to ensure higher throughput. For dual channel, you need two RAM modules to be connected, for Triple-channel you need to have three modules and so on. Also, they should be of a compatible spec, it's best if they are the same. Apart from just the frequency, latency also affects the performance. Latency is the time taken to respond to a request for data from an address within RAM. The lower the latency, the faster the RAM would work.

What RAM modules are available?
Basic Rig
HyperX FURY 4GB (HX318C1OF/4) is a good performer. It is a DDR3 RAM module rated for 1866 MHz with a capacity of 4GB. Basic rigs don't need a lot of RAM and of late, RAM has been getting a bit expensive. However, should you have surplus budget then feel free to bump this up to 8 GB.

Entry Level Gaming
HyperX FURY 4 GB 2133 MHz module from Kingston is great for a basic gaming rig. With automated overclocking, low power consumption and cool looks, it's a pretty good module. Again, you can bump this up to 8 GB since games have become more resource heavy of late.

Mid-Range

We recommend a pair of Corsair Value Select DDR4 (2x 4 GB) RAM modules from this configuration onwards so that you get the most of dual-channel performance.

High-end

We remember so fondly the days, when games used to come on CDs. Though nostalgic, long gone are those days. Modern games refuse to fit on dual layer DVDs. With such large games, having more memory is as essential as having a high-performance graphics card. Kingston DDR4 2133 MHz HX421C14FB/8 16 GB (2x 8 GB) should be good enough to handle AAA titles with huge levels.

Video-Editing / Gaming Glory

Videos are what consume your disk space the most amongst all other files. No wonder video editing would need working with a lot of data at a very fast speed. Clocking at 3200 MHz, Corsair Vengeance (2x 8 GB) CMK8GX-4M1A2400C14R should let you work with your videos and play games while letting the hardware takes care of the complexities behind data speeds. If you're into some serious video editing then you'll need a lot more RAM. Large format videos can do with as much memory that you can throw at your system.

Outrageous

Corsair Dominator 3200 MHz 32 GB (4x 8 GB) or G.Skill TridentZ make for excellent kits at this range. Both are known to have B-die NAND from Samsung which are very high quality memory chips so not only are they highly clocked and low latency but they can be pushed further.

What to look for in the spec-sheet

Physical Size is the first thing you should look at. RAM modules are also referred to as DIMM (standing for Dual In-line Memory Module). Remember that they are different from SO-DIMM (standing for Small Outline DIMM). The SO-DIMM is Laptop RAM in layman terms. They are smaller in size and are not used in desktops but sometimes are used in Mini-PCs as well. We have seen and heard cases of wrong orders via ecommerce sites as the consumer didn't know the difference.

DDR rating is the second most important one because if they are not compatible with the motherboard, the module simply cannot be installed

SO-DIMM and DIMM are different

on the motherboard as the notch on the connecting sides are positioned differently. Also, if you have two modules with same DDR rating but different frequencies, the motherboard will make them both operate at the frequency of the lower-frequency module. Hence, if you plan to upgrade, get the one with matching frequencies.

Memory capacity is the third most important (and often neglected) part of the spec-sheet. Each motherboard can address only a limited amount of memory in each of its slots. In addition, both Motherboard and CPU have a limitation of how much memory it can address in total. It is futile to install more memory than the lower supported size between the two. E.g. If the CPU supports 24 GB of memory and the Motherboard supports up to 32 GB on 4 available slots, then you will not be able to use a RAM module with size more than 8 GB or more than 24 GB in total. Do not worry, almost every processor and motherboard now support as much as 64 GB of RAM. So you need not worry about this pointer any more.

Latency is the fourth important point we want to mention but it is one of the finest and probably the most neglected part of the compatibility matrix. While two RAM modules may have the same DDR rating and frequency, latencies might make them incompatible. If you were to put two RAM modules in a single channel with same DDR and frequency ratings but different latencies, they might not work. The funny part is: the motherboard may not even show an error. It can simply reject the RAM module; all you will just notice is the total available memory being less than what is physically installed. You might end up thinking that your motherboard has gone rogue and needs replacement while that might not be the case. We have seen this happening and thus recommend that you pay attention to those numbers.

If you are well-versed with overclocking, it goes without saying, the module of your choice must be overclockable! Of course, as always, read the fine print before attempting overclocking. **d**

STORAGE – HDDs AND SSDs

This is where all your sitcoms and anime are stored and you have a plethora of storage options these days.

While the RAM is called memory, permanent memory is normally referred to as 'storage'. Hard disk drives (HDDs) have been the norm in the industry for a long time. Before they came into fashion, storage tapes were used. Hard disks used read/write heads which could move to access any track on a spinning disk. This allowed for faster access to a block of the storage without

having the user wait for the disc to wind or rewind. While tapes are still in use today as data centre backup storage, their use is gradually coming to an end. SSDs or Solid State Disks are relatively newer and a lot faster than traditional spinning hard disks.

Key points to consider for HDDs and SSDs

We are going to skip storage tapes because they no longer exist in the normal consumer landscape. The remaining two classes are HDDs and SSDs. Due to their design differences, we will address them separately.

HDDs

Hard Disk Drives or HDDs use spinning magnetic disks which store data. Typically, a hard disk has multiple disks stacked one atop another with gaps in between to allow access to the read/write heads. The speed of the hard disk depends on two factors – the speed at which the disks rotate and the time it takes for the read/write head to move from one track to another.

The figure below shows an opened up HDD. It has 3 stacked disks and the read/write heads go in the gaps between them. Normally, the read/write heads move together. But when the disk becomes fragmented, the access times spike. This happens because the heads have to move a lot more. For example, if there is a file with 100 pieces and it takes an average of 8ms to move the head, you can expect a delay of 0.8 seconds (8ms x 100) when accessing those files. Also, the slower a disk spins, the slower its data transfer rates.

Internal View of HDD

Fragmentation and how it affects performance

When we create a file, it takes some space on the disk and when we delete it completely (even from the Recycle Bin), the space that the file was sitting on is marked as empty. When we do this frequently (which is a given in today's day and age), logical gaps appear where files used to be previously. When a new file is added but there is no empty space large enough to accommodate the whole file, the OS splits the file into multiple pieces and stores them wherever it can find empty space. It links the pieces together with markers which indicates where the next chunk of the file is present. This is called fragmentation.

Fragmentation decreases the performance of an HDD by increasing the time it takes to move the read/write head to go to different chunks to read the file. When you defragment the file, the OS rearranges files on disk in a manner that all files are allocated in continuous (contiguous in file system terminology) spaces. Now you know why you should defragment your disk from time to time.

SSDs

SSDs or Solid State Disks behave like RAM in terms of data access methodology. The pieces of data are stored in whatever space is available and can be accessed at the same speed no matter what part of the storage space they're located on. Much like how USB pendrives behave, only faster.

SSDs are typically very energy efficient because they do not have moving parts. This eliminates the need to power a motor for spinning the disks. They are also not affected by fragmentation because of negligible seek times – after all, there are no heads to be moved.

What storage device should I use for my PC?

For the most part, HDDs should suffice. However, if you measure time in milliseconds instead of minutes, then an SSD might be more your calibre.

Basic Rig

The Toshiba 1 TB DT01ACA100 with 1 TB storage @ 7200 RPM and a 32 MB cache on board delivers a decent performance. We do think 1 TB is essential to a digital life, especially when it comes at about ₹3100.

Entry Level Gaming

The Seagate Barracuda ST1000DM003 (1TB) has nearly the same specs as the Toshiba 1 TB DT01ACA100 except that it has a 64 MB cache built into it and thus delivers better performance. It should only cost you about ₹300 more.

Mid-Range

We once again recommend the Seagate Barracuda ST1000DM003 (1TB) in this segment. We can be a little less frugal at the mid-range point so go ahead and pair it with a ZOTAC 120GB SSD to install your OS and whatever you want loading lightning fast.

High-end

The Western Digital WD20EZRZ 2 TB plus the Kingston UV300 SSD 240 GB combo should cost you about ₹8300. We're pretty sure you won't feel short of either space or speed with this combo.

Video-Editing / Gaming Glory

The Western Digital WD30EZRX 3TB and Samsung 960 Pro 512GB SSD combo is suitable for very high speeds and good space.

Outrageous

The Western Digital WD40EFRX comes with 4 TB of space but you can always opt for more. As for the SSD, you can either go with a pair of the Samsung 960 Pro SSDs in RAID for some really outlandish speeds. RAID 0 benchmarks have produced read speeds of around 3,000 Mbps.

What to look for in the spec-sheet?

For HDDs, we've already established the fact that the two most important factors are the rotation speeds (mentioned in RPMs or Rounds Per Minute) and the seek-time. The higher the RPM, the faster the disk. The lower the seek-time, the faster it will operate when the disk is fragmented. In addition to these two important factors, you should also look at the power consumption by the disk in its idle and spinning states. Also, the more the number of physical disks inside the casing, the more power it will require to both start and stop operating. HDDs consume a high amount of power when they start up. The power consumption in the first second can reach up to about twice the power required for its normal operation (if you have read

about inertia in your physics class, this should make sense to you). So it is important to look at the power consumption of each disk you want to add and the rating of your power supply unit. Also, look for the interface of the HDD. SATA is the new interface while IDE/PATA is the old one. Nowadays, it would be hard to come across a PATA/IDE interface, but we advise you to pay attention regardless. It's also worth remembering that an E-SATA is not the same as SATA. E-SATA stands for External SATA and is not a compatible interface with SATA. E-SATA disks are meant to be used as external disks (given there is a port on the motherboard or front panel of the cabinet). Also, do not underestimate the power of a decent amount of cache within the hard disk. They can affect the performance to a good
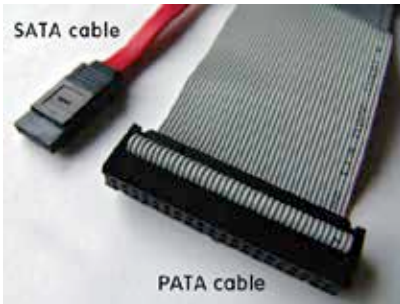
SATA-vs-PATA

extent for certain types of workloads, especially when you need to read fragmented files back-and-forth. The hard disk can serve those blocks right from the cache, if the space allows it.

In case it wasn't obvious, you should also check for the size of the hard-disk (2.5 or 3.5-inch). The larger ones (3.5-inches) are meant for desktops while the smaller ones (2.5-inches) are made for laptops.

Why SSDs are fast

SSDs employ flash technology (mostly NAND flash) to achieve high speeds. It is worth remembering that each flash memory chip has a limited number of write operations that it can take. Let's call it the write threshold. After you have written more than that many number of times on a single area i.e. after you've crossed the write threshold, that particular area on the flash memory degrades and the data stored on it may get corrupted. Hence, it is recommended to keep data which is written less often as compared to the number of times it's read on SSDs.

Also, filling the disk with data up to its upper limit will reduce the physical area available for writing while the already resident data covers most of the storage area. Don't let this piece of information drive you para-noid though. Most SSDs have enough read-write cycles to last you for years.

The amount of data you can safely transfer is normally mentioned on the spec-sheet. In addition to that, manufacturers provide drivers and additional tools to keep track of how much data has been written already. Samsung Magician is one such tool released by Samsung to help you monitor their disks, and in a similar vein Corsair has SSD Toolkit to perform the same task. Also, current gen SSDs have the feature to automatically optimise storage block allocation to maximize the life of the SSD.

Hybrid Disks

Part of a hybrid disk is an SSD while the rest is a normal HDD. Mapping is done internally by a controller chip. The first few GBs are mapped to the SSD while the later parts are mapped to the HDD. When you install the OS on the first partition of the disk, it gets installed on the SSD, thus allowing for a super-fast OS startup. They are a win-win when it comes to performance/price ratio.

Most SSDs are 2.5-inch in size but there's an entirely new form factor called M.2 which has a much smaller footprint. These are commonly used in laptops but desktop motherboards also have M.2 slots to support them. Another recent addition is NVMe, which is a protocol that does away with the existing 600 Mbps limit that SATA III has. So you now have NVMe SSDs with transfer speeds of over 3,000 Mbps. However, they carry a similarly monstrous price tag as well. So depending on form factor, you should ensure that either your motherboard has an M.2 slot for M.2 SSDs or your cabinet has a 2.5-inch drive bay should you go with the classic 2.5-inch SSD. **d**

GRAPHICS CARDS

This is what you need to run Crysis on max settings at 60 fps.

We're sure some of you skipped a few chapters and jumped directly to this one. We don't blame you. After all, gaming is one of the things we enjoy the most on a PC. Graphics Cards enable us to game with quality graphics and acceptable frame rates. But how do they work? We'll give you a primer.

Key points of a Graphics Card

Modern processors house a decent-enough graphics system within their package. Normally these built-in graphics systems can deliver a great audio-visual experience by packing in hardware logics to encode/decode media

formats and bitmapping technologies to display pictures on the screen. But they are not well-equipped to deal with heavyweight 3D rendering. That's where a graphics card comes in.
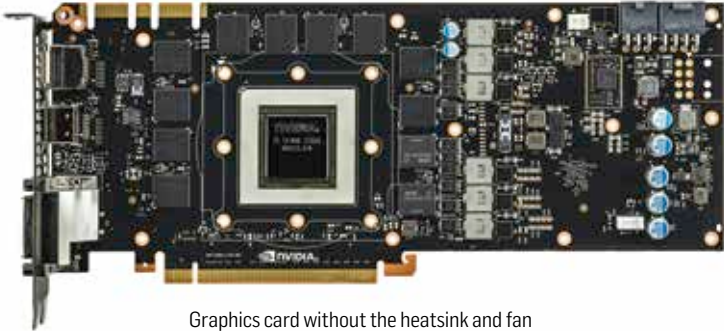
Graphics card without the heatsink and fan

A discreet graphics card is a module that can process a lot of 3D information. Calculating vertices, their colour, tracing rays and their reflections, effects of shadows, dust and liquid in a scene are a few things that a graphics card can do really well. Along with this, calculation changes and stitching data together to form a complete scene is also done faster on a discreet graphics processing unit. The reason a graphics card works fast on these tasks can be attributed to three features of its architecture:

1. **Hardware for doing a task:** Many of the algorithms used for producing a 3D scene are not done by running mathematical instructions one after another on a general purpose processor (like your CPU). Instead, there are dedicated cores called streaming multiprocessors designed for such work. For example, Ray Tracing is typically done via hardware, than by software. You can read more about this on *https://en.wikipedia.org/wiki/Ray-tracing_hardware* (if you want to get into details, study the references at the bottom of the article). A graphics card packs many such dedicated streaming multiprocessors to enable faster graphics data processing.

2. **Parallelism by using very high number of processors:** The CPU is a general purpose processor that can run billions of instructions per second. A graphics processor on the other hard is dumb. It cannot do scheduling, memory management, intelligent interrupt handling etc. However, they have a large number of registers available and the number of processors is high and they work at a very fast rate. For example, the Nvidia GTX 1080 Ti has 3500+ processors, each of which can run at 1.5

GHz. Simple math would tell you that amounts to 5000+ GHz or more than 5 trillion instructions per second! That's a staggering number. Considering that a lot of tasks can be done by other hardware chips, the processing power of a graphic cards is too high. However, they work on a SIMD pattern and have to work in parallel. Game design principals and standards (like DirectX and Metal) ensure that the processing patterns utilize this architecture to its max.

3. **Types of memory:** You might have heard some people saying something like "XYZ graphics card has 6 GB of RAM". Well, such a statement would be wrong and if you're guilty of it yourself, please correct yourself. Graphics cards do not have normal RAM. They instead have GDDR RAM. The extra 'G' stands for 'graphics' (quite obviously). Graphics RAM is divided into multiple chunks. There are just as many divisions as the number of processors available. When the graphics card is running, all its processors try to access the memory. Each processor can simultaneously access the memory from a division of memory. So if there are 2048 processors and each wants to read a 1 MB of data, the GDDR RAM will deliver 1MB to the 2048 processors in parallel (a total of 2 GB). This parallel access pattern is what sets GDDRRAM apart from normal RAM which works serially (processing one request after another). An upcoming type is HBM or High Bandwidth Memory.

There is another type of memory available to a graphics card which is called 'Texture memory'. This type of memory allows the processor to read data in "surrounding memory units" of an address much faster.

Which graphics card is good for me?

If gaming is fun, graphics cards are the humour. They are also ridiculous when it comes to sheer computational output with over 12 Billion (with a capital 'B') transistors in the latest models. While those might be very costly, there is one for everyone.

Basic Rig

If you are building a basic PC, we do not think you have many options (or need) here. It would be best to settle with the one built into your processor.

Entry Level Gaming

With 2 GB of GDDR5 memory, a 1345 MHz clock and 640 processing cores, the Zotac GTX 1050 is a good piece to make some noise in the box.

Mid-Range

With 4 GB of GDDR5 memory and 2000+ cores working at 1290 MHz, you shouldn't have any complaints. The MSI RX 480 ARMOR 4G OC can handle most games with grace (and acceptable frame rates at high settings). With room for crossfire, you can add more power later on, as and when you need it. You might want to explore the GTX 1060 as well.

High-end

If you hate FPS drops as much as we do and are willing to shell out a little more on a good gaming experience, we suggest the ZOTAC GTX1070 Mini. It has 1920 cores, 8 GB of GDDR5 memory and a base frequency of 1518 MHz (which can go up to 1708 MHz).

Video-Editing / Gaming Glory

For the ones who can differentiate between 59 FPS and 60 FPS and are not okay with 59 FPS at max settings, the Zotac GTX 1080 Ti AMP Extreme should more than suffice. It's a mean number crunching graphics power-house with 3584 cores working between 1644 to 1759 MHz backed by a 11 GB of GDDR5 memory. Enough said.

Outrageous

What's better than one graphics card? Two of them. Even better if they're both 1080 Ti's. The bad news is that Nvidia doesn't want you to SLI more than two of them and has decided to go against 3-way and 4-way SLIs. Also, some games and certain drivers refuse to make use of multiple cards. You could easily make do with just one of them; they're powerful enough already! Though, keep a look out for any news confirming games/drivers supporting SLI modes.

What to look for in the spec-sheet?

Graphics cards are simpler when it comes to "which one is faster". There are less number of hidden performance points. The greater the number of processors, memory, and memory interface width, the better the performance.

However, that's only computation power. There are other factors you should consider:

1. **DirectX version support** – if you want better support for future, make sure the latest DirectX, OpenGL and Vulkan versions are supported.

Two or more cards can be connected using SLI (2) or CrossFireX (2+) technology

2. **Support for VR** – By support, we mean that the card might be capable of driving Virtual Reality headsets like the HTC Vive and the Oculus Rift.

3. **SLI/Crossfire support** – If you plan on using an extra GPU later on, make sure the graphics card supports SLI (Nvidia) or CrossFireX (AMD) technologies. Also, remember that only the same model of graphics cards can work together. So if you have a GTX 970, you can only SLI it with another GTX 970. You can look for the number of cards supported (2-way, 3-way or 4-way) in parallel. AMD is more accommodating with CrossFireX as you can have slightly different GPUs of the same family and each card doesn't need x8 PCIe lanes. Even x4 will do. To know about PCIe lanes, refer to the motherboard chapter.

4. **Power consumption** – Graphics cards are power hungry devices which can ask for more than 100 watts of power on average and at peak, this can go all the way up to 300 watts. This means you're going to need a suitable power supply unit and you're going to need a cooling solution – fans should suffice for a single high-end graphics card. However, if you have more than one card, we suggest you learn how to install liquid cooling solutions and ensure that the model you are trying to get allows liquid cooling modules to be installed as well. **d**

CASE / CABINET

Your PC cabinet buying queries end now. Here's all you need to know about them.

A case or cabinet or chassis is not always the component that comes to mind first when one sets out to build a new PC. The cabinet is as important as any other component going inside it. It's the container of all the components that make up the computational part of the PC – the motherboard, CPU, RAM, graphics cards, optical drives, HDDs and SSDs. Here's a daily reminder that a CPU and PC cabinet aren't the same, so stop calling them a CPU.

Key points that make a good cabinet

While most cabinets you find in the market are adequate to house most

components, a good cabinet makes the process of assembling and upgradation easy. While not apparent, the first compatibility issue with a cabinet is the number of bays available for hard drives. Some cabinets support only two or three bays for hard drives. If you want to add more than one hard drive, make sure the cabinet has the adequate number of bays available. Also, some bays are built for 2.5-inch SSDs and HDDs which are used in laptops. If you are planning to add an SSD later, do ensure you have an appropriate number of 2.5-inch bays. We do recommend you get yourself a DVD reader/writer to enjoy the stuff we send you out every month in the Digit DVDs. For that you are going to need a bay for an optical drive too. Make sure there is one available since newer cabinets have stopped supporting optical drives. Cabinets are loosely divided into different sizes including mid-tower, full-tower and super-tower being the most common ones. We say loosely since the definition keeps on changing since it isn't
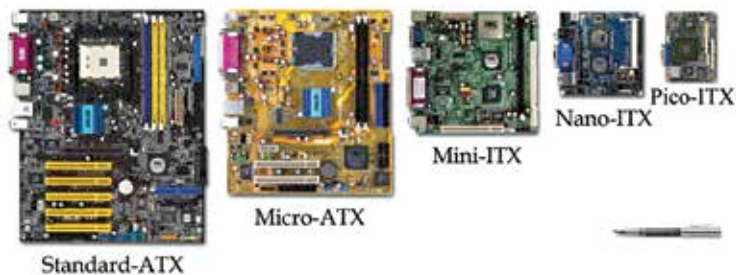
Make sure you are buying the case for the right motherboard size

a standard. The distinct differences are the number of storage bays and expansion slots, along with the motherboard size. Mid-tower is the most common size in cabinets and normally they have ample space to house components. If you plan to include a graphics card into the configuration, you have to make sure there is enough space left in the cabinet for proper air flow. If you plan on using a liquid cooling system, make sure there are holes available to allow liquid intake and outflow in case you use an external liquid reservoir. If you're planning on installing an AIO cooling system, then you need to verify whether the cabinet supports the different sizes including 120, 140, 240, 280, 360mm, etc. Custom water cooling systems with reservoirs placed inside the cabinet will require a lot of space, so ensure they fit in the cabinet.

Size of the motherboard matters too. You cannot put an ATX motherboard into a cabinet built for micro-ATX or mini-ITX motherboards. In addition, when you connect all the components together, you are going to have a mess of cables inside the cabinet. Certain features which help manage cables (clips and cutouts available at the right places) demand consideration.

Zip ties are cheap and they make cable management much simpler

Don't forget to keep some zip ties handy when doing cable management.

Inadequate or under-optimised airflow can cause your system to abnormally heat up. Few cabinets sport ventilation at the top with options to attach exhaust fans. Also, some of them ship with fans near the hard drive bay to keep them cool while you push them to the limits (yes, hard drives do heat up). More the number of fan mounts, the cooler your system can potentially run. Remember though, you need to incorporate some amount of air intake as you increase the number of fans. In case you have missed the downside of all those fans, here it is – they let your internal components collect dust a lot faster. Hence, you should also look for cabinets that have dust filters installed over the fan mounts.

Which case is good for me?
Basic rig
The basic PC contains minimal components with low heat-dissipation requirements. Most cabinets available in the local market should be good enough. You need to verify the motherboard sizes supported by the cabinet before buying these OEM cabinets.

Entry level gaming
Corsair Carbide SPEC-01 coming at approximately INR 3K is a good fit for the needs here. It comes with enough fan-mounting options, support for up to four HDDs and two optical drives, large side window panel, cable management features and a cool-looking build.

Mid-range gaming
Corsair Carbide SPEC-01 would serve the purpose well in this segment too. We couldn't find any better at the price for the features it includes.

High-end gaming

Cooler Master MasterBox 5 is the one to hit the sweet spot. It can house three 120 mm fans and up to two 140 mm fans. All drive bays are fully modular and cable management is a breeze. You should have no problem with SLI or CrossFire-d graphics cards either because space is not a problem with the MasterBox 5.

Ultra high-end gaming glory

Go for the Corsair Crystal 570X. If you think, the name 'Crystal' is just another product line-up name, go check the looks. It looks like a house of glass and qualifies to have a "drooling not allowed" label to prevent viewers from spoiling things around. Apart from the brilliant aesthetics and of course, RGB support, it can house a liquid cooling solution inside itself easily and looks futuristic. Though the bays are a little unconventionally placed, the looks are just worth the hassle. It can accommodate beefy graphics cards and AIO cooling systems easily.

Outrageous

Behold, we present to you the Corsair Obsidian Series 900D. If there were anything like "a brute hidden in plain sight", this case would come on top. It looks like a plain regular box. Only the owner of this thing would ever be able to appreciate the true grandeur of its inner beauty. With three 120 mm fans, one 140 mm fan built-in and a crazy total capacity of 15 fans, five radiator mounts and dust filters, it is a "cool" (literally) cabinet. There is enough space to put in four optical drives and up to 15 hard drives or SSDs. There is simply not enough we can talk about here.

What to look for in the spec-sheet?

Number and type of bays, number and size of mounts for installing fans and AIO radiators, and dimensions are the most crucial points to look for. Let us explain why:

1. **Type of bays:** Lower-end cabinets allow you to fix the hard disks in place by using screws. Better ones allow you to slide them into the fixture which clicks into a locked state without using screws. Detaching your drives is much easier with such cabinets and you do not have to worry about misplacing screws either. Some cabinets provide you hybrid bays which can house both 3.5-inch or 2.5-inch hard drives – great if you have a SSD on mind or if you want to use the hard disk from your old laptop!

2. **Number of fan installation mounts:** More the number of fans, better the cooling. But you cannot install a fan if there's no support. Cabinets can have dust filters and cutouts on all sides to let you install fans. With those, you can skip a liquid cooling system if you're low on budget.

3. **Dimensions:** You just bought the world's most powerful graphics card but then you discover that it doesn't fit in the cabinet. Always make sure that the components being attached to the motherboard directly (PCIe cards, CPU coolers, etc.) are not bigger than what your cabinet can accommodate. Look for the length of these cards, height of CPU coolers and the clearance in their particular areas in the cabinet.

A good cabinet allows you to reduce clutter

Two rather significant attributes which can skip your attention are build quality and cable management. If the case is of low build quality and can accumulate rust over time, you are in for some trouble. At the same time, if it is heavy, you are going to have a tough time moving the cabinet. A sturdy cabinet full of high-end components can go upwards of 20 kg). That's a heavy thing to move around. Though a PC is supposed to stay where it is placed for long time, you might need to move it around for cleaning dust, adding/removing components etc.

If the case allows you to open both left and right side panels, there is a good chance, it allows you to manage cables efficiently. Cable management leads to cleaner installation and easy upgradation and maintenance. Such cases allow you to hide the extra cable lengths underneath the motherboard thus ensuring near-perfect airflow. You can read about cable management in more detail in Chapter 14.

Last but not the least, a beautiful looking case wouldn't hurt anyone. A good-looking case is always better than a vanilla rectangular box sitting atop your table or on the ground. You might need to add RGB LED fans or light strips to make it look even better but the case itself looking sexy is a bonus point any day. **d**

POWER SUPPLY

Picking the right power supply unit for your rig could possibly be the most important step of all.

Getting the latest CPU and Graphics Card is all well and good but remember, they need power to run. Undermining the importance of a good power supply unit (alternatively known as SMPS) is one way to fry up your system. If you are housing a couple of hard disks, a powerful CPU and two of the latest and greatest GPUs, you can't do without a decent power supply unit. Why? Let's do the math:

- TDP of a Core i7 7700K = 91 W

- Power requirement of 2 HDDs = 2 x 10 W (approx.) = 20 W
- Power requirement of a GTX 1080 Ti = 260 W

Add them up and you get 371 W. If you were to use a Power Supply unit with a 500W (or VA) rating, you're left with 129W, right? Wrong! That 500W you have would operate at about 80-90% efficiency. Let's assume it's working at ~85% efficiency. This means the power it can provide to your components comes to (500W * 85/100) = 425W. So in a practical world, your SMPS has only around 55 watts of energy to spare. If you were to add one more component which happens to use that much energy, you will have pushed your SMPS to its limit. While it feels good to utilise your components to the max, you don't want to do that with a power supply unit.

Key points of a power supply unit

Power supply units (PSU) are central to a computer's operation. Right from when you hit the power-on button and all the components start up. The notable power draw amongst them are the devices which utilize motors – hard disk drives and all the fans mounted at various places (cabinet, CPU cooler, graphics card heatsink etc.). Power drawn from the power supply unit in the first second can go up to twice the power rating of all devices. At the same time, voltage fluctuations are pretty much a norm in India. A good power supply unit takes care of this and prevents itself and other components from failing and getting damaged.

We must stress on the importance of a good PSU – if the PSU fails or gets damaged, it can potentially damage any (all) components of a PC. All devices have their own voltage and power ratings. Extra voltage or current on any of the lines can fry up a component while a drop in either will either shut down the device or put them in an irrecoverable state for that session. It's the PSU's job to ensure that these things do not happen.

PSUs are marked with their operational voltage ratings, total power output, efficiency and number of cables and ports provided. A PSU is supposed to have:

1. 24 (20+4) pin connector – they go into the power input socket on the motherboard.
2. CPU (4+4) pin connector – they supply power to the CPU and go into the input socket normally located close to the CPU socket on the board.
3. PCI-e (6+2) pin connector – these power graphics cards and go into them.
4. SATA power connectors – these go into your hard disks and SATA based Optical Drives.

5. MOLEX connectors – these are traditional 4-pin connectors also known as peripheral connectors. Older hard disks and optical drives might have them. You can also find MOLEX to SATA/Floppy converters in your PSU's packaging.

6. Floppy connectors – Although floppies are long gone, you can still find connectors for them.

When we write the pin configurations in the (X+Y) format above, it means the connector can be used with an input socket that can accept X number of input pins OR X+Y number of input pins. For example, you can find 6-pin power input sockets on graphics cards; a (6+2) pin power connector can be used with the 6-pin socket as well as an 8-pin PCI-e input socket, depending on the need.

Which PSU is good for me?

Basic Rig

We do not believe you are going to need too much power for there are few components here demanding power. A Corsair VS450 can handle a basic rig pretty well and leaves ample room for expansions.

Entry Level Gaming

The Corsair VS450 can serve this segment well too.

Mid-Range

We recommend a Cooler Master V650 for this segment – modular cabling, safe operations and high efficiency are the attributes that make it a great fit here.
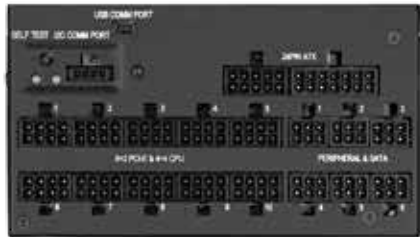
Modular PSUs allow you to put cables as required while leaving the rest

High-end

The Seasonic M12II-750 EVO is a 750 W rating PSU. It has a power efficiency of 80%+ even at full load. That's great because this one is built for mean machines that can draw power. The PSU is modular and boasts a lot of safety certifications.

Video-Editing / Gaming Glory

Here, we recommend the Corsair RM1000i. This one boasts staying quiet when undisturbed and managing a load like a pro. 80%+ power efficiency

at 100% load speaks for itself. Along with the modular cable design, you will feel safe installing just about anything inside the cabinet.

Outrageous

The Corsair RM1000i works well for this segment too. You can use the Corsair RM1000x as a replacement as it has similar specs and ratings. If however, 1000 watts is not enough for you, the Corsair AX1500i or Cooler Master MASTERWATT MAKER 1500 should more than suffice.

What to look for in the spec-sheet
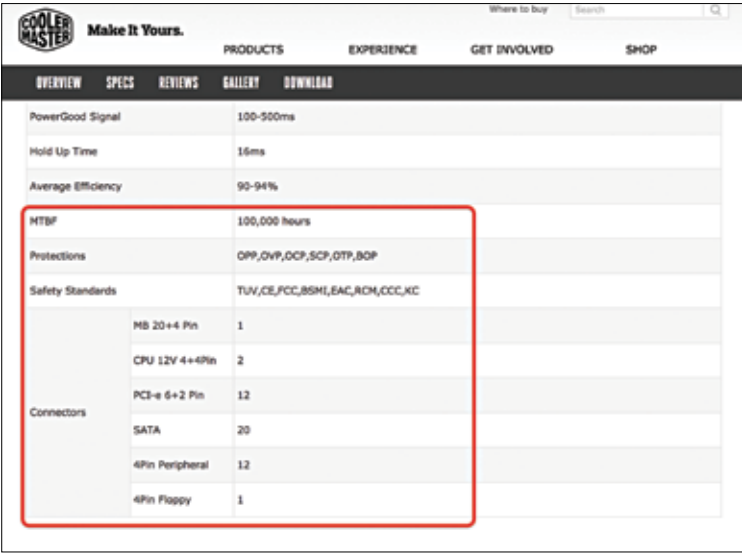
First things first – the power rating. Make a calculation of how much power your system will draw when under full load. Since most PSUs operate between 80%-90% efficiency (check this on the spec-sheet), multiply the number with 1.2. You should keep a buffer of about 30% for when you might want to add more components in the future and to make sure that the PSU itself doesn't operate under a full load and can handle the startup power draw with ease. So, if all components are going to draw 400 watts of energy together, you should get ((400 watts X 1.2) + (30% of 400 watts)) = (480+120) watts = 600 watts of power supply just to be on the safe side.

We have already told you about the types of cables that a PSU provides for powering various components. Make sure your PSU has enough of them. For example, if your PSU has only 2 SATA power cables but you plan on having more than 2 SATA devices, you would need to find alternate ways (like converting a MOLEX output to a SATA power output pin by using an adapter) and it may not always be possible.

The most important thing to look out for is safety. PSUs are marked with protection ratings. Some that you can find are:
1. OVP – Over Voltage Protection
2. UVP – Under Voltage Protection
3. OPP/OLP – Over Power Protection / Over Load Protection (they are basically the same)
4. OTP – Over Temperature Protection
5. SCP – Short Circuit Protection

All of the above immediately cut the power supply to the PSU itself and/or rest of the components when any parameter crosses defined limits. Look for these in the spec-sheet. Steer clear from products without these protection technologies mentioned clearly. MTBF, which stands for Mean

PowerGood Signal		100-500ms	
Hold Up Time		16ms	
Average Efficiency		90-94%	
MTBF		100,000 hours	
Protections		OPP,OVP,OCP,SCP,OTP,BOP	
Safety Standards		TUV,CE,FCC,BSMI,EAC,RCM,CCC,KC	
Connectors	MB 20+4 Pin	1	
	CPU 12V 4+4Pin	2	
	PCI-e 6+2 Pin	12	
	SATA	20	
	4Pin Peripheral	12	
	4Pin Floppy	1	

Important points to look for in the Spec-Sheet

Time Before Failure, is an estimate of the PSU's operational lifespan. The more the better. This should also be mentioned on the spec-sheet.

Another feature you might look for in a PSU is "modular cables". This allows you to do away with unnecessary cables. So, if you need only one hard disk, there is no need for 4 connectors sitting inside the case. Modular cables allow you to attach and remove cables to and from the PSU as and when required. This helps with air-flow and cooling while keeping things clean and clutter-free inside the case.

Since we are talking about power, we also recommend you get a power backup (UPS) which can handle spikes and surges well and allow you to operate the computer for some time after a power cut. At the very least, they should allow you to shut down your PC normally. However, there's an important factor to consider while getting a UPS for current gen PSUs. There's a parameter called PFC (Power Factor Correction) and for the PSU to do it's job properly, it's power source should only be of pure sinewave. Stepped up approximation or anything other than pure sine wave is not recommended as it will mess up your PSU over time. True sinewave UPS tend to be a little expensive but price should be the last thing on your mind while getting a PSU and UPS. **d**

MONITOR / DISPLAY

It might not be the most important components but you simply can't do without a display.

A great and powerful CPU is all well and fine if there is a monitor to watch what it can do. Monitors or Displays are what convert performance to pleasure. A powerful PC with a bad display is no fun. In this chapter, we will tell you how to select a good one.

Key points to consider for a display

Display size is the biggest factor when choosing a monitor. While there are smaller displays, sized below 19-inch, we would not recommend you

that. You must understand that a smaller display is not going to make your video-watching and browsing/reading experience good. If you want to play games, less than 19-inch is truly small by today's standards.

Aspect ratio is the ratio of width with height and determines how wide the display would be. A wider display allows more content horizontally then vertically and is good for tasks that require horizontal space; software development and watching videos naturally are more pleasurable on such displays provided the content is made for that aspect ratio. In addition, some higher end displays can have a curved screen and are good for viewing from a distance. Such displays also sport built-in TV functionality.

Technology used for manufacturing the display (TN/IPS/VA/MVA/PVA/AMOLED) make an impact. For example, a TN panel is going to restrict the viewing angle significantly. You might have witnessed the artefacts of this limitation in several low-end displays where you start getting altered colors when viewing from the side. At the same time, AMOLED/OLED displays produce much more vibrant colors than LED displays.

Contrast Ratio and Color Reproduction – Contrast ratio refers to the difference between colors that can be produced by the display. Same image when looked at on a display with higher contrast ratio is going to look more vivid and lively.

Compatibility across output types makes a difference too. Some monitors come with single input type while others come with support for multiple types. A TV which supports multiple input types and has more than one port available of a certain type can be used in more ways than another which does not have all those options.

Which display is good for me?
Basic Rig
BenQ G615HDPL (15.6-inch) comes with a resolution of 1366x768 – standard resolution for an entry-level monitor. It is LED backlit and does a decent job for casual work.

Entry Level Gaming
You cannot enjoy a game unless you have gone HD. BenQ GW2470H takes you there without burning a hole in your pocket. It is a full HD (1920 X 1080) monitor with D-SUB and HDMI connectivity option. Adding to that a 3000:1 contrast ratio and a flicker-free experience makes it good for gaming.

Mid-Range

With 22-inches of real estate, full HD support, built-in speakers, IPS panel display, support for HDMI and standard display port (D-SUB) and a thin design, there are few contenders to ViewSonic VX2263Smhl.

High-end

We would recommend BENQ GL2460HM for its fast response times, high contrast ratio, connectivity options (D-SUB, HDMI and DVI) and the ability to be wall mounted.

Video-Editing / Gaming Glory

Acer XB270HU is our selection for this segment. It's got a 27-inch WQHD (2560 x 1440) IPS panel so you have a lot of real estate with great viewing angles. A contrast ratio of 1000:1, 144 Hz refresh rate and support for NVIDIA G-Sync. And lastly, it has a 4 ms refresh rate so you'll experience no ghosting at all.

Outrageous

The LG 29UC97C is a good monitor to go with but since we are not looking at price limits we're going to go with something much larger. The SONY X8200E looks good with a 43-inch, 4K display and amazing colour reproduction. If you are ready to spend an insane amount, you very well can take a demo and see what can be only be "experienced".

What to look for in the spec-sheet

The first thing to look at is the display size – make sure that you are going to get the right sized display. Display sizes are mentioned diagonally, end to end. The height and width of the display should be mentioned too.

The closer the aspect ratio is to 1, the more square-like the display is going to look, the further it is from 1, the wider the screen will be.

Resolution of the display: Or appropriately known as pixel dimensions is a metric that tells you how many vertical and horizontal pixels there are. You've no doubt heard of numbers such as 1280x720, 1920x1080, 4K, UHD, etc. these refer to resolutions. 1920x1080 is the most common resolution you can get these days.

Pixel density: It may or may not be exclusively mentioned on the spec-sheet. If it's mentioned, it's well and fine. In case it is not mentioned, you can calculate it yourself. Take the resolution of the display and divide the

number of pixels on any edge with number of inches on that same edge. E.g. if the width of a display is 16 inches and the number of pixels it fits horizontally is 1920, then the pixel density is 1920/16 = 120 PPI (Pixels Per Inch). Human eye cannot differentiate between pixels when the density is higher than 300 PPI. When looked at from ~10 inches away, a display with 300+ PPI will look superfine.

Connection options: If you are getting yourself a larger monitor which you want to triple up as a TV and an external display for your laptop, the monitor must have the ports available to plug into these devices. You should pay attention to these points:

1. **Number of ports:** If you want to use both your laptop and your DTH Set-top box with the same monitor, the display needs to have at least 3 ports available or you will have to plug/unplug wires from devices again and again.

2. **Types of inputs:** A graphics card can have DVI, Mini HDMI and DP ports while the monitor can have support for HDMI and ThunderBolt input types. See the problem? These are all standard ports which are widely used among devices and yet, you will not be attach the display to the graphics card. The same holds true for other devices you want to connect to the display.

3. **Cables included in box:** You get your fascinating display at the end of day and when you start setting it up, you discover that they did not provide an HDMI cable – not a good experience. Make sure you check which cables and adapters are included in the box. This is usually mentioned on the spec-sheet.

We have already talked about contrast ratio. Remember to compare them when choosing one.

In the end, we would like to recommend that you see the product for yourself. Reading a specification sheet does not do justice to what the display might look like. Since displays are meant to be looked at, it only makes sense to see how they look firsthand. Also, remember that most displays have settings to adjust colors, contrast, brightness etc. When testing displays, remember to adjust various setting and presets before picking one up. Patience is the key! **d**

KEYBOARD AND MOUSE

Gaming or typing, we tell you what to consider while you're out buying them.

Unless you want to convert your PC into a server, you are going to need input devices to interact with it. While they may seem trivial, having a keyboard whose keys get jammed halfway is not a good thing when your project deadlines are closing in fast. The same frustration can be brought to you by a mouse which makes the pointer move in unpredictable ways. Yes, they are as essential as anything else, or maybe more.

Once the PC has been assembled and the display has been connected, it is keyboard and mouse you would interact with regularly. You will hold them, move them and maybe spill coffee over them too.

Key points for input devices
Keyboards

One of the most important parts of a keyboard or mouse is the quality of materials used. This plays a major role in deciding its durability.
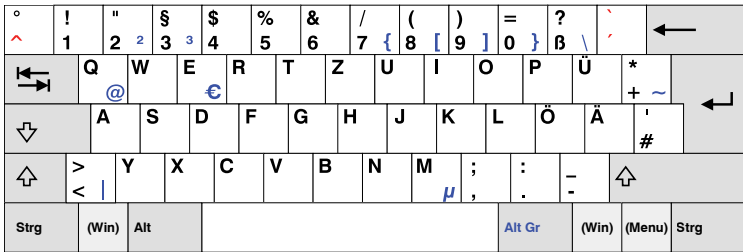
Membrane, mechanical, chiclet and hybrid are the common types of keyboards available currently. The difference is all about the switch type underneath the keys and the matrix or PCB underneath is almost the same in all of them.Membrane keyboards use a membrane between the keys and the circuit board. There are raised points near the keys and when they are pressed, they complete an electrical contact with the board and register the same key. They are quite basic and usually priced lower, and have lower durability since the membrane wears off.

Mechanical keyboards use an actual mechanical assembly to register your clicks while the underlying circuit board remains almost the same. Mechanical switches are made from mechanical parts which are more durable and can be easily identified because of the louder clicks. They are available in different flavours and by flavours we mean different travel distances, actuation points and feedback. The feedback or "feel" consists of

Backlights are gorgeous! A mechanical gaming keyboard with RGB backlighting.

essentially three types — linear, tactile and clicky. Cherry is the most popular mechanical switch manufacturers currently with knock off brands offering similar solutions at affordable prices. Because of high durability which is almost a life cycle of more than a decade for the switches, mechanical keyboards are expensive. There's just too much to cover about mechanical switches and keyboards, and we have already dedicated many articles to them in the past, including a comparison test in the previous month.

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Can you play spot-the-difference game with this keyboard layout and yours?

Chiclet keyboards are usually found on laptops. They have a scissor switch design beneath them and it varies among manufacturers whether the switch individually works as the membrane for electrical contact or through a common membrane below all the keys. They have low travel distances hence they are best used on laptops. Mechanical switch manufacturer TTC have come up with a low-travel mechanical switch for laptops where the Lenovo IdeaPad Y900 is the first laptop to use them.

Keyboards also vary in sizes dedicated for various use-cases. If your work includes more of gaming that covers several genres and also typing, you would prefer keyboards with extra keys for macros. For a perfect balance in gaming and typing, you would settle for a regular 104-key keyboard. If there's no typing at all, and your games don't require extra keys, you might opt for tenkeyless (TKL) keyboards that don't include the numpad.

Mouse

When it comes to mice (not the kind cats hunt), the build quality and ergonomics matters the most. While we can testify that there is no greater satisfaction than the feedback of a good click, their size makes a lot of difference too. If you have larger-than-normal hands, a small mouse can ruin your experience on the PC. Additionally, weight matters when it comes to precision work and even gaming. Heavier mice need a little greater force to move and feel stable. If you continuously need to lift and flick your mouse, then you would prefer a lightweight mouse. Accuracy is important as well and although laser sensors have more precision and reliability than optical sensors, they are highly prone to acceleration issues and sensitive to different surfaces. Essentially, you need to consider the shape, size, weight and accuracy of the sensor while considering a mouse.

Which keyboard and mouse is good for me?

Basic rig

Logitech MK120 USB 2.0 Keyboard-Mouse Combo has everything you need except the media keys and comes for about INR 900. For about 100 bucks more, you can have the Logitech MK200 Media Wired Keyboard and Mouse Combo with the media keys. We recommend the latter.

Entry level gaming

Logitech MK120 and MK200 bundles can be used for some basic gaming as well. After all, they do have all the standard keys and buttons.

Mid-range gaming

Logitech G100s is available online between INR 1,500 and 2,000. With an ergonomic design, good looks and sturdier-than-entry-level, it feels solid under your palms. Remember, it is a wired combo pack.

High-end gaming

When you're spending a lot on your PC components, it would be a shame to ignore your peripherals. We recommend the Cooler Master MasterKeys Lite L Combo RGB. You get a mem-chanical or hybrid keyboard with RGB backlighting support and a decent gaming mouse for its price.

Ultra high-end gaming glory

The HyperX Alloy FPS is a gimmick-free mechanical keyboard, focused on providing the basic requirements for typing and gaming. Sporting genuine Cherry MX switches, you also get a detachable cable and carry pouch, making it a portable solution for gamers on the go. It has a small footprint while maintaining a sturdy build quality.

You will have a wonderful overall experience using the Logitech G502 Proteus Core as it excels in almost every aspect. Talk about accuracy (the legendary PWM3366 optical sensor), build quality and features, you can get a lot from this mouse. The only concerns that people have presented are subjective such as its weight. The shape is ergonomic with a tank for a body. An updated version also supports RGB.

Outrageous

Nothing beats G.SKILL RIPJAWS MX780 for being the most outrageous gaming mouse ever. Ambidextrous design (all you left-handed people,

pay attention), interchangeable side grips, height-adjustable palm rest, on-board profile storage (storing it within the mouse), adjustable weights, eight programmable buttons and customisable RGB backlighting on four zones. Phew! It's also the top rated mouse in our labs currently.

The keyboard department is also conquered by G.SKILL with a model number very close to the best mouse they have – RIPJAWS KM780 RGB. Right when you start thinking gaming keyboards are all about being mechanical and sturdy, the company created a tank. It supports full RGB backlighting underneath, controlled by the software. A built-in volume display, all the regular multimedia buttons, programmable keys and detachable palm rest. This keyboard is also the top rated keyboard in our test lab.

What to look for in the spec-sheet?

Not the first and most important thing to look for, but still a useful feature is multimedia buttons. Increasing and decreasing the volume and even muting can be quite handy with dedicated buttons. If the keyboard is backlit, buttons to increase or decrease the backlight brightness is going to make a difference too. Extra buttons are also favourable for macros. If you're a gamer, disabling the Windows key can be quite useful to avoid accidental presses. Other features such as 100% anti-ghosting and N-key rollover is something you should look at especially if you want one for gaming.

Specifications matter. Just not always.

While having multimedia keys is a great thing, it is important to focus on the more important aspects – ergonomics. Here at Digit, fun involves a lot of typing and way more gaming.

Trust us when we say, "ergonomics matter". How good it feels in your hand is directly proportional to how fast you will be able to work with them. Remember, the focus of "ergonomics" is not on the extra buttons in the mouse for flipping web pages or reloading your weapon in a game. The first factor is "how well does the device fit in your palm". You won't be able to move the mouse if it doesn't fit well in your hands. You cannot determine a device's ergo factor by staring at a sheet because one cannot experience the feedback of a click or smoothness of the scroll wheel by looking. We recommend you step out and use them at places where a demo is available. The same goes for keyboards.

PS: You can always trust our reviews when you can't have a demo. Always.

Backlight: This one's a must-have feature for night-owls, the late-night fighters in RPGs and programmers, who love the darkness for they need to focus on the task! .

Connectivity: Wired is normally cheaper than wireless devices. In case your display is a large one, you would probably want to work from a distance and need a wireless one. For ones who do not mind staying close to their cabinets, wired ones are great too. Although PS/2 keyboard and mice are almost obsolete from the market and USB is the norm, double check before buying. It never hurts.

Palm rest: Keyboards may or may not have palm rests. Palm rests elevate your hand to a level where pressing keys is more convenient; worth checking.

Split layout or not: Split keyboards look nerdy. While one can justify the benefits of the design, it is not always great to use them. Most keyboards are not split-layout by design and you should be able to spot the difference right away, have a look at images of the keyboard before ordering.

You sure about this?

Additional buttons on a mouse by the side and gesture support can be helpful for several tasks in and outside of gaming. Being able to program them per your need is a bonus. For instance, an image editor can program the extra button to map an action, like cropping or rasterising, to ensure they can work faster. **d**

PERIPHERALS AND ACCESSORIES

There's more to PC components than just your graphics cards and keyboards.

A PC might be a monster computing device but it lacks quite a few things from smaller form factors like laptops and tablets. Fret not, for there are peripherals and accessories to make sure the monster does not lag behind any of its weaker siblings. Which accessories are we talking about? We are talking about the ones most people are accustomed to when using laptops and tablets. Let's list them down.

Webcam / Camera

Every laptop has a built-in cam at the top. For PCs, you need to get one externally. The camera is useful for recording video but mostly useful when you need to video chat.

The key points to consider when buying one are:

1. **Input resolution:** Some cameras are low-resolution and cannot produce high-quality video while others can see the world in 720p or better. It is always better to get one with a higher resolution.

2. **Frame rates:** If the frame rates are low, the other party will see your video lagging. Most of the time it is not the case but drivers bundled with the camera can play evil.

3. **Mounting options:** Some cameras can be made to sit atop a flat surface, while others can be clipped onto the edge of a monitor. This factor can limit your placement options significantly.

4. **Compatibility:** You might be planning to use Linux with your system while the camera does not get detected by the OS.

Webcams are essential for livestreaming

A similar situation might come up with Windows too where the driver software might not be compatible with your version of Windows. Always double check.

You may not need a camera most of the times. If video chatting is not something you need to do frequently from your desk, you can do without one.

Wi-Fi dongle / adapter

PCs are supposed to be sitting at one place and you would normally get an Ethernet cable from your router to plug it to the network. Although, you might need a Wi-Fi dongle if you want one less cable to manage. The need of this one is also subjective. If you connect to the Internet via an Ethernet cable coming out of a router that can double up as a Wi-Fi Access Point. However, if you need to use the Internet via your phone, we would recommend a Wi-Fi Dongle over USB tethering.

Tethering can be a little messy and does not allow you to move your phone. It can be unstable depending on software installed in either your phone or your PC. Wi-Fi hotspots do not cause as much trouble.

Most dongles have USB 2.0 and above support and are good to go with the hardware but can be troublesome with the software. Windows as well as Linux can automatically detect most Wi-Fi devices; however, some cannot be used without installing the driver first (e.g. D-Link DWA 131). Linux becomes a trouble because driver installations are not easy on Linux. This can be a problem if you are unable to locate the driver disk and you cannot locate one online either.

Wi-Fi dongles also enable you to connect to your home network if your router is too far from your PC

You may also want to go for the latest standards – while still not widely in use, 802.11 ac is catching up. There are dongles which support the ac standard – they come at a higher price and you might not need them if your access point does not. We recommend you to go for an adapter that at least supports 802.11 n standard.

Bluetooth dongle / adapter

Bluetooth, though slower than Wi-Fi is more useful in some ways. Certain capabilities of Bluetooth are:

1. It allows you to transfer files to the system.
2. Audio playback on Bluetooth enabled headsets and speaker systems.
3. Connect to Bluetooth enabled wireless keyboard and mouse.
4. Connect to your phone's Bluetooth PAN (Personal Area Network) to share the internet connection.
5. A printer that can use Bluetooth can be used without much hassle.

While there are devices which can get all this done over Wi-Fi, they are more expensive.

Some adapters might need driver software. If it needs the driver and won't function without it, try avoiding them. We have known Bluetooth adapter drivers to corrupt networking drivers, audio playback drivers and more. At the same time, many drivers get installed without a hint of a trouble. Some adapters just do not need any driver software – true plug and play – how Bluetooth is supposed to be in this age.

If you are considering to buy a Wi-Fi adapter just to connect to your phone's data connection, try getting a Bluetooth adapter instead and see if it delivers on what you need. Bluetooth can give you decent speeds over PAN and can be used for many other purposes. If it does not deliver, you can reconsider Wi-Fi.

Most adapters can serve many profiles (capabilities of Bluetooth enabled system services are called profiles – file transfer is a profile and so is audio playback) while some cannot. In addition, Bluetooth adapters may have a hard limit on how many devices you can connect to it. Do your research before buying one. Also, ensure you are buying an adapter with support for more recent versions (Bluetooth 4.x is best). Most adapters only cost a couple hundred bucks or so and can be tempting. Do not fall for prices alone; we repeat – do your research.

Note: Many high-end motherboards come with Wi-Fi and Bluetooth modules built into them. As always, keep the eyes open and mind alert when going through the spec-sheet.

Speakers

We believe every PC has the right to voice its opinion about what you are doing. PCs are known to express their gratitude by playing soothing music and their excitement via loud explosive noises when we play games. Apart from entertainment, the OS may playback small warning sounds via the speaker. A PC without a speaker is dumb.

Ranging from small stereo speakers to complete home-theater systems, everything is available in the market. We recommend you to stick to a price range and features which you are looking for in the speaker. While specs matter, the best way to judge a speaker system is to listen to it. The second best way is to go through our reviews.

When deciding on a model, apart from price point, look for number of speakers, Bluetooth support, inclusion of a subwoofer, connectivity options (AUX, Bluetooth, Wi-Fi). We do not recommend you to go for portable Bluetooth speakers, even if the design is tempting and has dancing LEDs, for they do not do justice to the experience a PC can give you. At least a stereo system is recommended.

Printer

As the world is going paperless, you probably don't need them as much as you would have needed them 10 years ago but if you deal with school or

college projects, a small home, office or anything else that needs frequent printing, getting a printer will only help.

Printers come in all sizes. Their purpose defines their form factor, speed and price. Here are the points you can look out for:

1. **Size:** Availability of the space is important. Remember not to put the printer on an unstable surface. We have seen people placing their printers atop their cabinet – and that's a horrible thing to do; not only there is a risk of the printer falling, the heat coming from the cabinet can affect the printer as well. Make sure you have enough space to place the printer before deciding on one.

A printer at home turns out quite useful for projects and assignments

2. **Speed:** The number of pages a printer can print in a minute can be an important factor when you have to deliver a whole lot of printed material. You would need a laser printer for such purposes. Laser printers can print 15-20 pages per minute while inkjets can produce up to 15 pages per minute.
3. **DPI:** If you want photo printing, the printing speed matters less and the printing DPI (Dots Per Inch) is more important. For a picture to appear very clear, a DPI of 300+ is necessary (just like a PPI of 300+ is good for displays because individual pixels cannot be seen with naked eyes). For normal text, a lower DPI setting can work well though.
4. **MFD:** If you find yourself in a position where you need to scan documents every now and then, an MFD is a better option. MFD or Multi-Function

Devices include a scanner alongside a printer. This enables them to act as a printer, a scanner and a photo-copy machine which can read a document via the scanner and print a copy using the printer. When choosing an MFD, getting one with a flat-bed scanner is better than getting one with a paper-feeder scanner. Flatbeds can be used to scan/copy thick document sets and books while the paper-feeder can accept only a single page for scanning.

Sound cards

The same music track sounds different when played on different machines using the same media playback software with same output settings. Audio processing on hardware level matters. If it matters enough to you, get a sound card. They can go into both PCI (conventional) or PCIe slots. Check the specifications and see if you have an empty slot on the board.

Optical drives

You might wonder why we are placing this component as an accessory and not an essential component. It's because they are coming of age. While on one end the Blu-ray and HD-DVD format wars were coming to an end, the average speed of internet was increasing with broadband access penetrating most of India and the world. Today, it is not difficult to get a 4Mbps connection in most parts of our country. You could download content worth a dual-layer DVD in a matter of hours. With various ISPs providing unlimited 10Mbps connections for as little as ₹800 per month, Internet connectivity has indeed become cheap. Optical discs are less and less in use (you must have noticed that now we ship only one DVD instead of two) and are no longer the preferred way of distributing software and media content. OS installations are increasingly being done using USB drives than DVDs and CD-ROMs. Cloud backups are becoming easier and faster than writing DVDs.

If however you do want to remain backward compatible, you can go for a good DVD-RW drive. Not just internal ones, but you also get external DVD drives that can be connected to the PC through a USB port. While Blu-Ray discs may be available (though only rarely seen anywhere), it makes more sense to get a DVD-RW drive than a Blu-Ray reader. It looks like Steve Jobs was right, after all. **d**

CABLE MANAGEMENT

That untidy mess of dangling cables isn't going to impress anyone. It's time to take responsibility and clean up your cabinet.

Y ou've beefed up a monster PC which might just summon an army of demons from another dimension. You were even able to make the monstrosity look beautifully intimidating. Then you step back to marvel your creation and notice it. A slacking mass of wires crashing down the celestial dominance of your machine back to the mortal realm.

Cable management is often the last item on the checklist. Nestling in the less lively parts of our consciousness. No matter how much we detest it, we can

all agree that the lack of this management can sabotage the whole rig, not just aesthetically. We spend our passion and love in handpicking the best hardware, meticulously bringing everything together into something we make sure looks as amazing as it performs. By the time we reach the cable management, all our love and passion is spent. So here's a primer to make cable management less messy than your cables so that you'll be able to save up some love.

Before going forward. Let's settle this. Why do you need cable management? Well, for starters, it makes the rig that you spent so much money on, tidy. It also organises everything so that you have easy access when needed to move. Inside the cabinet, there's another very important reason. If cables are haphazardly done, they might create walls which will obstruct the flow of air, your cooling system is pumping. And it is well known what happens when the cooling system faces a jeopardy.

Lastly, cable management is a time consuming process. Plan ahead to spend almost half a day on this. Your rig will thank for it.

Useful products

Cable ties (a) - These are one of the best inventions ever made for organising things, especially cables. They're cheap, easy-to-use and do a wonderful job. Just wrap a bunch of cables together and tuck it somewhere. Done. You can even purchase tie mounts. They provide a flat surface to attach the ties and therefore the cables can be tucked in. Gear and twist ties can also be used to make adjustments easier.

Cable clips (b) - They hold cables in a place allowing you to channel them as desired. They have a reusable variant and also a nail variant if you want to stick an annoying bit for all eternity. The reusable ones are extremely useful for cables which keep moving around, like headphone and charging cables. You can fit them in the gap of a clip and pull them out when moving.

Cable box (c) - Remember the tucking away of wires mentioned earlier? So, if you aren't into fixing your cables to your desk or wall, cable box should sound genius to you. It's a box which holds your cables and the bricks attached to them. It has two slits on either side for cables to travel through. Simple and efficient.

Cable sleeve (d) - Okay, let's say you hate boxes. Something about the flat faces of a three-dimensional structure causes you discomfort. Well, you've been covered. A cable sleeve is basically a fabric with many holes and velcro running along its length. Wrap it around a bunch of cables and you have one cable which holds many.
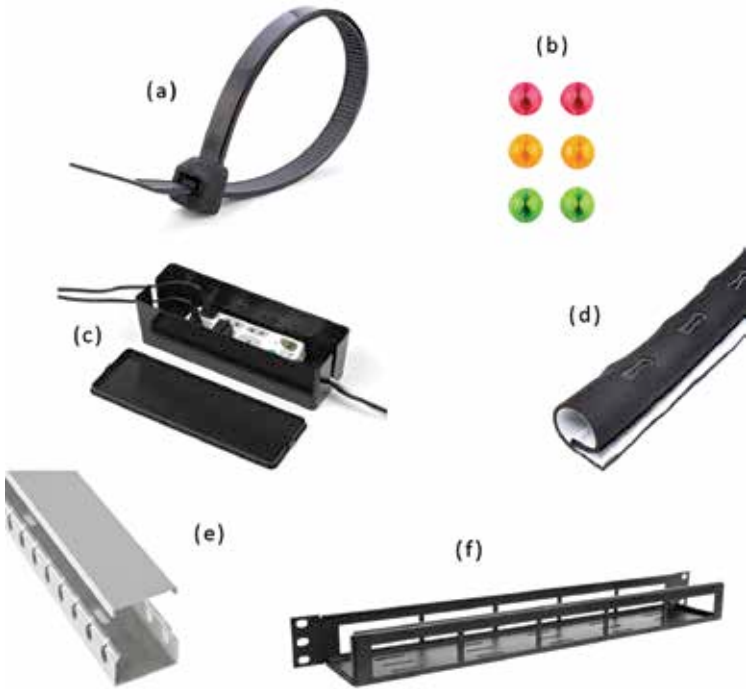
Handy tools to tidy up the cabling mess

Cable raceway (e) - Take the ideology of a sleeve, make it out of a rigid material and fix it on surfaces. A good way to use this is to fix it under your desk. The only drawback is the mild headache of reorganising the cables.

Cable tray (f) - Very similar to a raceway, with only difference being that this looks like it can be used to hang plant pots. Tons of openings for you to easily reorganise. The problem you face here is, because it is so open, cables can become a mess inside the tray because of you constant rearranging.

Managing the inside of the cabinet

Admit it, the reason why you spent some extra money on your current cabinet was because it looked swankier than the cheaper option. Now why would you bail out from maintaining that swank by managing the spaghetti that resides inside your machine.

A little side note, when buying a case, do check its cable management facilities. Then plan on what products you'd need to buy. Also, before

starting to assemble the PC, consider every place where you'll be putting a component and the paths of all the cables. If you think a component would restrict flow of the cable of another component, fit that other component and its cable first. Same goes for vice versa.

Cases usually have routing holes on one side. Use them to tuck away the cables behind prying eyes. Make sure that the thicker cables don't overlap each other. You should try to make the cabling as flat and spread apart as possible. After flattening, in case a cable or two gets excess remaining, instead of rerouting that cable to spread more, coil it and place it in a corner. Putting the coil in a corner will keep it away from getting into a mess with other cables. Use ties to hold together the cables which have to travel together. Often times there would be openings which would allow you to lock your ties to a spot. If they aren't present, use tie mounts. Bear in mind that you might have to change or move some cables more often than others. Use simple cable ties for those you wouldn't be changing often and twist ties or any reusable alternative, for those you'd be changing often. Each cable should be running through the holes closest to its connectors. And don't forget to leave a little slack in the cables near the connectors so that they don't

An example of an average attempt at cable management

experience strain. Finally, you should be able to see clear defined paths that each of the cables or groups is taking and they should be flat on the wall.

Managing the desk

Now that you have a tidy cabinet, it's time to make your desk the same. Before you start, undo all the cabling and start from scratch.

As with the cable management inside, thoroughly plan this one too. You would want the cables or their groups travelling in well-defined paths. If you're planning to achieve aesthetic superiority, figure out places you can hide your cables.

Once you have thought of the path each cable would be taking, start placing the mounts and clips. If you wish to use a tray or a raceway, mount it now as well. Use the tie mounts and cable clips to sustain the paths of cables. This would prevent them from intertwining with each other. Use the double-sided mounting tape to stick power bricks, charging hub or anything bulky to the table. Or pack them inside a cable box if you desire so. Once you've hooked up all the cables, tie the ones which seem to be together. A sleeve would do a great job too. You can even pack the cables with sleeve or ties and place them inside cable racks if you want easy access.

Homebrewed techniques

The products used for cable management are so simple, that you can make most of them at home. If you can get a PVC or an ABS pipe, cut them in rings. Now make an opening on each of the rings. To stay on the safe side, the opening should not be more than 30 degrees. Now fix the rings in a line on the roof of your desk or the back with the openings facing upwards. That's your alternative for cable raceways and trays. As an alternate for ties, drill holes on each end of a cork bottle stopper. Slide each end of a bungie cord through the respective holes and tie knots. Now take the end opposite to the stopper and wrap it around a bunch of cables and lock the end on the bottle stopper.

Conclusion

Organising your cables is not only important for aesthetics, but also helps in managing or moving them. At times it even helps with longevity of a cabinet. Basically, it is all about routing the cables in well-defined paths. Ultimately, it is a long and arduous process and there are no shortcuts for neatness, but going through this hell has great rewards. **d**

DIY-WATER COOLING

For overclocking the system, nothing's as effective as having water cooling in place. Here's how to go about it

There are times when you might need to push the computer into overdrive, to derive the highest performance from it. If you're a tech geek, or a game aficionado (or both!) chances are you would encounter such scenarios more often than not. Thankfully, for such scenarios a water cooling mechanism is an excellent way to keep the system running quietly even if it's running furiously!

It then stands to reason that you should learn to assemble and install a water cooling system, don't you think? After looking at some of the basics, we would get right to it.

Why should you have water cooling?

A cursory answer to the question is already provided in the opening paragraph of this article. But still, it's worth knowing the science that makes water cooling such an efficient mechanism.

The thing is, water has a pretty high thermal conductivity. This means that the liquid can absorb heat rather easily. It does way better a job of this than air. This makes water a great element to cool the system.

With water cooling, water is run over all the components. This transfers heat from each one of those parts to a radiator. The radiator then dissipates the heat which helps keep the water cool. It wouldn't do to have the water boiling within the system, now, would it? This mechanism, in fact, is pretty similar to how the car radiator works. This helps cool down parts including the graphics card, processor and other hardware.

The components you'll require

If you're buying an all-in-one kit for water cooling, you need just follow the instructions that come with it. On the other hand, if you're getting the parts yourself, these are the things that you'd require:

Waterblock

The waterblock refers to the block which you mount on the hardware that has to be cooled. Waterblocks are available for processors, chipset, graphic cards and other components. Though waterblocks for RAM and hard drives are available, they won't contribute much to boosting the performance. Water cooling, in fact is most effective for graphics card and processors.
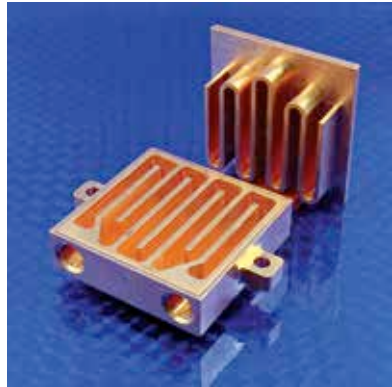
Go ahead, mount them!

Radiator and fans

The radiator along with the fans attached to it keeps the water cool even as if flows through the loop.

Radiators are available in different sizes. They are usually designed for a particular number of fans. The larger and thicker the radiator is, it

Radiator- channeling energy where it matters!

will dissipate heat more effectively. To give you some idea of the fans that could be attached to a radiator, if a radiator is a 240mm fan, it means you could attach two 120mm fans. You do have the option to get smaller single-fan radiator or even a larger radiator that could accommodate four fans.

If the casing is large enough, you should be able to mount them within your computer itself. However, smaller cases would need you to mount them outside.

Reservoir

The reservoir holds the liquid within the loop. It also makes easy the bleeding out of bubbles. Most reservoirs would need to be mounted within the case. Usually, the hardware for this would be provided along with it. But then, there are some which are explicitly designed to be mounted within your 5.25" external drive bays.

The source of cooling

Pump

As the name evidently refers, this is the part that actually pumps water in the loop. You could either buy an external pump or one which attaches to reservoirs.

Pump it up, for pumped-up performance!

Fittings

You're gonna need two fittings – one for each component in the loop – the radiator(s) and the waterblock(s). The fittings enable you to connect them with each other. Usually, this is made possible with the aid of tubing.

Barb fittings is one option you could use. These are just a spout, actually. Or you could consider compression fittings. These consist of a second piece

that you can screw on, giving you an extremely tight fit. They look better than the others too, but the catch is that they're considerably more expensive.

Tubing

The tubing connects all the components together. It's available in different shapes and colours. While buying the tubing, do ensure that its inner diameter or ID is the same as the outer diameter or OD of the fittings. In certain cases the tubing could be (very slightly) smaller compared to your fittings, that is, if you wish for a tight fit.

However, generally speaking, it's a good idea to go for the same size always.

Coolant and additives

A coolant is something that you should buy separately even if you have brought an all-in-one kit.

There is a plethora of coolants available, each with its own distinct properties. which could flummox you somewhat. If that's the case,

Fit it right, keep it cool!

Tubing for a cooler system!

Choose the right ones for you!

you could simply use distilled water. Not only is it as effective as any of the commercial coolants, it's also cheaper compared to the rest, not to mention the fact that it's available in most grocery shops. Then, there's also the fact that there's lesser chance of it causing problems.

You're also gonna need additives for the coolant. Some of the ones you could consider are given here:

A biocide

A biocide would prevent algae and other gunk from growing within the

loop. You could use as an alternative – a small silver piece called kill coil. This is because silver could act as a natural biocide. It's a pretty good idea since you won't have to add extra liquid to the coolant.

An anti-corrosive

This is necessary only if there are multiple metals in the loop. For instance, if the loop has copper waterblock and copper radiator, you don't have to use this. But on the other hand, say, you used a copper block with an aluminium radiator, an anti-corrosive would be needed in the coolant.

Dish soap(just a drop or two)

This would act as a surfactant. It can also help rid of the bubbles that may generate in the loop. Behold the immense potential of the humble dish soap!

Colouring

Colouring is another additive that you may use but one which is not actually recommended. This is because color additives tend to gum up the works. So, if you do want color, it's best to opt for colored tubing instead.

If you're buying the different parts separately, ensure that all the parts are compatible.

How to put together the components

Once all the parts are procured, you can then proceed to put everything together. The process is a bit complex but if you take it slow and follow the instructions, the water loop should be up and running without incident. So, take a deep breath and follow these steps:

1. Planning out the loop

First of all, look within the case and plan how the loop would work. Find out where the reservoir and the pump could be mounted with the included hardware. Also, figure out where the radiator would fit and the order in which you're gonna connect the parts.

The perfect loop starts at the drawing board!

The reservoir should come right before the pump inside the loop, so that the pump never actually runs dry. If the reservoir isn't built for a drive bay, you'll need to either mount it on

the case with the included hardware, or you can find a spot where you could velcro it in place. Usually, the hard drive cage would turn out to be a good candidate for the purpose.

After deciding on where the parts would go, you should then decide how you'll run the tubing. Starting from the pump, you could lead to the radiator and then the waterblock, before looping it back to the reservoir. Or else, you could first go to the waterblock, then the radiator and back. There isn't much of a difference between the two in terms of performance, so go for whichever fits easily.

Rinse. Dry. Repeat.

2. Rinsing out the components

This is the part where you get all the hardware and then rinse it.

For the reservoir, tubing and waterblock, this amounts to just running distilled water through it. For the radiator, it can be complicated. Since radiators often come with some debris left over from the manufacturing within, you should rinse it thoroughly.

You can do this by heating up some distilled water before pouring it in the radiator. You can fill it some two thirds of the way up. After plugging the holes up, shake it well for a couple of minutes. Then drain the water. Debris would be mixed with it. Repeat the process until you get clear water coming out.

3. Installing the hardware

To mount the waterblock on the CPU, do this: Add a little thermal paste on the CPU before setting the cooler on top of it. Then, attach the backplate to the motherboard's backside and then screw the plate in place. While screwing it in, ensure that you give each screw just a few twists at a time. You should also move in the star pat-

The perfect loop starts at the drawing board!

tern – so that the pressure comes across evenly on the processor.

If the case is big enough, the radiator could be mounted on the vent the fans go to. Then, you could screw the fan to the radiator. If the case is larger, you'd probably mount it in the bottom. If such options are unavailable, you would have to mount it externally. Use the brackets that come with it for this.

The pump and reservoir could be mounted with Velcro or the mounting hardware which come along with them. If you've a bay reservoir, you could simply slide it into place and screw it into the side, just as with a DVD drive.

Get the connections right!

4. Connecting the tubing

Start with screwing the fittings into all the components. After that, start connecting the tubing. One end of the tubing could be slid over a fitting. After that, you should measure how much of tubing you'd need to connect the thing to the next component in the loop. After marking it using your finger, the tube should be cut with a pair of scissors, as straight as you possibly can.

Then, the tubing's end should be connected to the next component. This process should be repeated with every piece of hardware.

If you find that the tube makes too sharp a turn and kinks, it's bad for the water flow. If this is the case, go back to the planning stage and figure out how you could make the bend without the kink.

Also, if barb fittings are used, to secure them use zip ties or hose clams, even of the tubing looks like it's well-fit.

5. Filling up the loop

Before you do this, have some paper down within the computer. In case a leak springs, plug it up and empty the loop. Give the system some 24 hours to dry.

Fill it up the right way!

Before filling up, you should jump the power supply. This would help you test the pump and also the fans without turning the computer on. The 24-pin cable has to be disconnected from the motherboard. The green wire should be connected to the black wire with a paper clip.

After this, add the liquid additive if needed. For this, put a funnel on the reservoir's fill port. Pour the water in. The reservoir should be filled nearly to the top. If some empties into the tubing, it's fine. After the reservoir gets filled up, the power switch in the computer's back should be flipped on. Allow it to run for a second.

Once the reservoir is halfway down, turn the computer off before the pump is dry. It's crucial that the pump never runs dry since this could damage the pump for good in mere seconds. After letting some water out of the reservoir, fill it to the top yet again. The process should be repeated until the water level in the reservoir stays constant. Check the loop for leaks.

6. Testing for leaks and bleeding the air bubbles out

The final step involves letting the whole loop leak-test for 24 hours. Allow it to run but check frequently to ensure there is no leaking. Also, during these hours, a lot of the bubbles in the loop will bleed out. To aid this process, you may have to shake the case or maybe tap the tubing. If a very few small bubbles are left over, it's no reason to worry. They will drain away in time.

Once it's ensured that the system is completely leak-free, turn it off before reconnecting the 24-pin motherboard cable. Closing everything, you can use the computer.

You would find that the computer's temperatures have come down significantly. Also, you'd find that you could run the fans at significantly lower speeds and still keep everything much quieter. About every six months or so, you should empty the loop and rinse out the hardware. **d**

BUILDING A PC 101

You have everything you need. Now it's time to put it all together. Here's all you need to know about building your PC.

So. After all your part picking agonisation and bargain hunting, you finally have all the components you need to build the PC you've always wanted (Or atleast, the one you can afford) and you're all set to assemble it but don't know how? Here's an easy step-by-step guide to get your rig up and running in no time!

Before building: Ensure that all your components are compatible. Your motherboard must support your processor and your RAM, check if your CPU cooler meets the height requirements of your case and doesn't inter-fere with your RAM's heatspreaders (Google your specific combination to

make sure or look for a YouTube video), make sure your GPU can fit inside your case and you have enough mounting brackets for your storage, both 3.5 and 2.5-inches (all of this can be found on the motherboard and case manufacturer's website). And please don't pair a CPU with an unlocked multiplier (Usually signified by a K suffix in Intel processors which effectively means that you can vary the voltage supplied to the chip to overclock it) with a board incapable of overclocking. Right now, a big problem is that the 100 series motherboards from Intel, i.e. Z170, H170, B150, H110 chipset boards are not compatible with Kabylake processors unless they have had their BIOSs updated. Make sure that your motherboard was produced recently or your vendor has updated the BIOS themselves with a Skylake CPU. You can NOT update the BIOS with a Kabylake processor in there. Or, you could just purchase a 200 series motherboard to ensure compatibility. On the AMD side of things, do note that you can't use aftermarket coolers without special AM4 mounting brackets. You'll have to request these from your cooler manufacturer and they'll usually ship it to you for free. *https://in.pcpartpicker.com/* is your saviour here. It'll automatically warn you of any incompatibilities. Oh, and if you are building a small form factor or SFF case, we recommend getting a blower style GPU (one that exhausts it's air outside the case) because you'll get cooler temperatures this way and not heat up the inside of your case. For a regular mATX or ATX build where cooling doesn't come at a premium due to space, normal aftermarket cards with factory overclocks beat the reference blower cards both in temperatures and performance and are worth paying the premium for over the latter.

Prep for the build: The build itself can take quite a while so make sure you do it when you are least likely to be interrupted. Having a good (and preferably long) Phillips head screwdriver and a designated screw and other small part holders is a must. There will be a lot of them, so if you can somehow mark which screws are which, it'll really help you out. First things first, ground yourself before you handle any of the components. Static electricity may not seem like a huge problem until you end up frying a component. Wear rubber sandals (no socks please!) or go barefoot and touch a 'grounded' piece of metal, something like a window grill for example. Anti Electrostatic Discharge Bracelets and Mats are a thing but you usually won't need to go to that extreme although it's always better to err on the side of caution. If you can afford the extra cost or you are building a lot of components, AESD bracelets are always a welcome addition. Clear your

Double check all your components to make sure nothing is damaged

workspace, preferably one that's well lit and on a non-conducting surface like a wooden table. Okay, you're all set! On to the build!

Unbox allll the things: Unbox all your components and double check that none of them were damaged in transit. If they were, return them and wait to complete your build. Unless it's your graphics card that is broken and you have an integrated GPU (most Intel Chips do. Ryzen chips right now don't), in that case, you can just build your PC now and add the graphics card later once you RMA it. Also make sure that the product matches the box (There are some sellers who switch items inside boxes. Never hurts to be too careful!)

Motherboards can be complicated, always keep a manual handy!

Get your Motherboard or MoBo out of its electrostatic packaging and place it on top of the box. Also make sure to remove the IO shield from the MoBo box. Keep the motherboard manual handy for referencing. It's very important for a lot of stuff

Outside the case :

MoBo JoJo time!: Disengage the locking tension arm of the CPU socket by pushing on it and opening

it. It'll have a black socket cover, don't try to remove this. Unpack your processor and orient the golden triangle on one of it's corners with the imprinted triangle on one of the socket edges and the notches on the side of the chip with the socket. Very gently place the processor in the socket (seriously, doesn't matter if you have a Land Grid Array or an LGA chip [i.e, your motherboard socket has the pins and your chip has bumps] or a Pin Grid array or PGA chip [i.e, your motherboard has holes and your chip has the pins]. DO NOT USE FORCE WHEN DROPPING THE CHIP INTO PLACE). Bring the locking arm down and engage it. The black cover should pop right off and you should hear a solid thunk signifying the CPU is seated correctly.

Installing a cooler: Even though your cooling hardware might be different (you might go for an aftermarket cooler or maybe AIO/Custom Water Cooling), mounting them is similar. For Intel processors, the stock coolers will come with push pins. Just align them with the sockets around the CPU and push them with a good amount of force until you hear a satisfying click (We can confirm. It's extremely satisfying). For AMD processors, you'll have to screw the cooler into those sockets instead of pushing. Both are pretty easy to mount. Stock coolers have the Thermal Interface Material or TIM preapplied. If you are going for an aftermarket cooler or want a different one for some reason, clean the chip and the cooler with 90% isopropyl alcohol and squeeze a pea sized amount of a TIM of your choice in the centre of the processor and install the cooler over it. The pressure and the heat once the computer starts working will spread the TIM in a nice thin layer that

Beating the heat

provides best thermal conductivity. Make sure not too use too little TIM or too much, both can have highly negative effect on your temperatures. Take the wire from the cooler and plug it into the CPU Fan header on the MoBo (It'll be nearby). Make sure you peel off the protective sticker from below the cooler before you install it! Not doing so can have some nasty results. For AIOs, read the manual that came with it and install the backplate as required for your processor. Then flip it over and install the stand-offs into the backplate. Carefully orient the cooler and screw it down into the stand-offs and make sure it's tight. Take the radiator and depending on whether you want your fans to push or pull, stick it and install the radiator using the provided screws in the computer cabinet when you install the motherboard in it. Quick tip, the manufacturer logo sticker indicates the side where the fan pulls its air from. But there are exceptions so use a piece of tissue paper when it's spinning to figure out what direction it's blowing in. This is true for cabinet fans as well. We do not recommend novice builders starting out with custom water cooling as there are many ways it can go catastrophically wrong and one leak can ruin your whole PC. Once you have some experience under your belt and hopefully a friend who has prior knowledge of water cooling, it's a great mod to your PC that brings both function and form in the form of lower temps and that industrial futuristic bling.

Time to install the RAM!

Installing Memory: Install your RAM SODIMMS by pulling back the tabs on the ends of the slots. Align the notch in the middle of the RAM stick with the nob on the socket and push it down firmly till the tabs click back up. Wiggle your installed sticks lightly to ensure they've been seated well. Remember, RAM goes in pairs in the same coloured slots for dual channel (We highly recommend you do this. Two 8 Gigs sticks of RAM in Dual Channel is faster than one 16 Gig stick of RAM in Single Channel). RAM slots are usually named A1, B1, A2, B2, in that order so try to fill A1+A2 or B1+B2. If you have more than 4 slots refer your motherboard's manual and if you just have two slots, stick it in there. If you are installing an Intel Optane or a M2 SSD, first unscrew the socket protector if it has one (Yes we know it looks cool. And yes, it HAS to go. At least, if you want your SSD in there). Align and fix the SSD in place and using that same screw, fix it in place. Make

sure that your M2 slot CAN support NVME if you are installing an NVME drive. If it only supports SATA, the SSD will still work but at lower speeds, at which point, paying the premium for NVME becomes meaningless.

Inside the Case:

Now, onto the biggest part of your rig! The case. Open the side panel up by removing the screws on the back of the case and if required, push on the grooves indicated. If you're having trouble, check the case manual or a YouTube video!

Preliminary Fitting : Install the IO shield that came with your MoBo. Then install your PSU behind the included shroud (if there is one) and visualize how you want your cables to be routed. Unless you have sleeved PSU cables, you don't want to expose the mustard and ketchup nightmare of wires through your side window so hide your cables in the shroud as much as possible. We recommend getting extensions as they are cheaper than full sized sleeved cables and a modular PSU (But please don't skimp on the PSU, it's looks unassuming but it's actually one of the most important parts of your build. Get a good quality one with preferably good efficiency). Next, using the case's manual, figure out where the storage brackets are and install your drives in the ones closest to the PSU (if applicable) using the provided screws. A new trend in cases is toolless storage bays (which we wholeheartedly support) in which all you have to do is slide the drives inside. If you are installing extra case fans, screw them into the provided brackets in the case (Make sure you got your intakes and exhausts right!) and stick those RGB LED strips along the side. Come on, it's 2017. You've GOT to have RGB in your build. Get RGB fans for extra bling too!

Joining Brain and Brawn: Now install the MoBo in the stand-offs provided in the case (some older cases require you to install these standoffs yourself. Please ensure that you are installing the motherboard on what essentially is some brass risers that'll keep the board from touching the metal in the bottom of the case. Not having standoffs will short circuit and fry your PC the first time you turn it on) and align it with the IO shield which you installed earlier so that the ports match up. (Please don't forget it. Taking apart the whole build just to install the shield is a very sad and sombre experience. Not that we're talking from experience or anything...) and screw it down tight. Depending on the size of your motherboard, it's anywhere between 4-9 screws.

Installing the Crown Jewel a.k.a. Your Graphics Card: Remove the (usually) perforated expansion brackets on the backside of your case that

align with your PCIE socket (a long rectangular thin slot not unlike a RAM slot. Make sure it's PCI Express x16 slot, it's usually the one closest to the CPU. Check the motherboard manual just in case). It'll be held together with screws. Depending on the size of your card you might have to remove up to 3 of those slots. Place your graphics card in the slot and push down on it like it's humongous RAM stick with fans and lights and stuff and secure it in the hole(s) the metal slot brackets you removed was in. If you have any expansion cards (like Wi-Fi) plug them into the respective PCI sockets as well. Make sure they're well seated by wiggling them slightly.

Finish it!: Plug it all up! If you have ever played LEGO (Mega Bloks is an abomination. We do NOT talk about Mega Bloks) this is child's play for you. First, take the biggest plug that's coming out from your power supply, the 24 pin connector. This is the one that'll power your motherboard and it fits into the... You guessed it, 24-pin socket (Usually found on the right side of the CPU). Then, there should be an 8-pin connector, labelled CPU power. This goes into the 8-pin CPU Power header that's usually found above the CPU. Make sure you carefully align each connector to the header before pushing it down but it's pretty hard to mess this up so don't worry too much. Then you take the L shaped connectors that are labelled SATA and plug them into your hard drives and SSDs. Then take the SATA cables that came with your motherboard and plug one end into the MoBo and the other into your drive(s). If you have an RGB header on your motherboard, plug your LED strip into it, if applicable and finally, plug your cabinet fans into the fan headers. If you have more fans than headers, you can either buy a splitter for the header or plug them into the PSU MOLEX (it'll be a big 4 pin connector) - Do note that this'll cause the fan to run at 100% RPM all the time and you don't have any control over it). If you have space to cable manage, try plugging in everything without creating tangles and

You'll need one of these if you plan on gaming

PROBLEM	SOLUTION
My computer doesn't turn on!	i) Check if you have all your power cables plugged in securely. ii) Check if you have your RAM seated correctly. Reseat them in different slots too, to see if that helps. iii) Check if you have the power socket turned on. Check if you have the switch on the back of the PSU turned on.
My computer turns on but I can't see anything	i) Check if you have your data cable plugged into the correct port, both on the monitor and the CPU ii) Verify the monitor is actually on - if you have a physical power button on it, press it. Make sure the power socket the monitor is connected to is also turned on. iv) Make sure your processor is seated correctly and none of the pins on it or the motherboard are bent.
My computer is a stuttery, jittery mess!	i) Go to your motherboard manufacturer's website and download all the latest versions of the drivers and BIOS updates. ii) Update your graphics card drivers. iii) Monitor your resource usage and temperatures to find if something is behaving abnormally
I have low FPS in games	i) Make sure your graphic card drivers are up-to-date. ii) Double check that you have plugged your monitor into the graphics card's socket instead of the MoBo socket. (Seriously, check it)
My computer is keeps starting and restarting or stuck in a 'bootloop'	i) This is a sign of a defective motherboard. Try another and replace it if possible ii) Check if your PSU is of a high enough wattage. Your system can bootloop if not enough power is being supplied to it.
My computer shuts down in a little while	i) Make sure your CPU fan is plugged in correctly. ii) Make sure you have your case fans oriented right and they are cooling your system well by monitoring temperatures. Did you peel off the plastic from the cooler? iii) If it throws up a Blue/Black Screen of Death before turning off, try to find the log file. Probable culprits are corrupted drivers, corrupted windows install or a program that you installed. Try running the computer in safe mode or even better doing a clean install correctly.
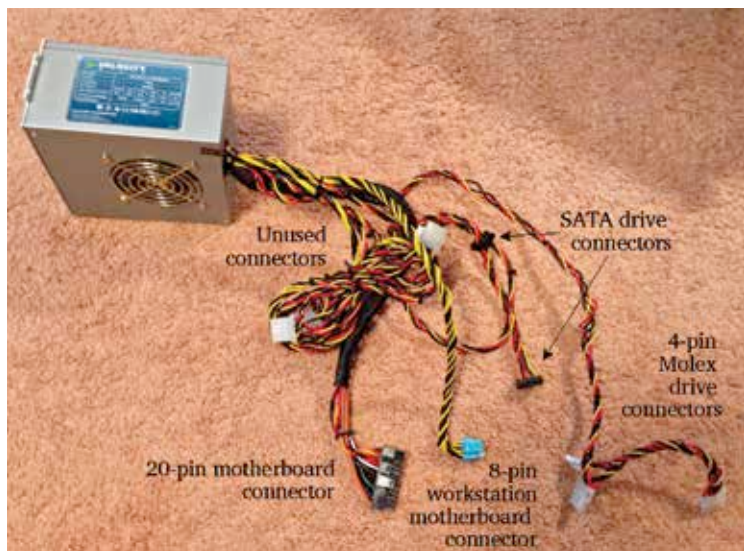
It's as easy as playing with LEGOs

ugly crisscrosses. When it's in a state you like, use a ziptie to hold it all in one place to make it look clean and tidy. Proper cable management makes your build look super neat and while it's a chore and a pain to do it, the end results are worth it.

Last thing: Plug in the your OS USB and turn on your Computer and hit F2 or Delete to get into BIOS (check if the processor and RAM and storage all show correctly). Navigate to the Boot devices tab and set the primary boot device to USB and install your OS. We also recommend disconnecting the other HDDs and SSDs except your boot device if you have several. Make sure to set up your SSD in AHCI and not IDE when you are setting up Windows! This setting will be in the drive properties. You're almost done!

Now don't put the side panel back on! You need to verify that you got your computer all set up correctly. Having the side panel off makes it easier to troubleshoot and fix things.

Use Ninite.com (or an alternative) to download common, free programs all together easily and just in case, run Driver Booster to check if all your drivers are the latest versions. Oh and don't forget to put your side panel back on once you're finally done. **d**

WHERE TO BUY

Offline or online, building your PC is always about getting the right components at the right prices.

Y ou now have a basic idea about the various aspects involved with PC building. The next step is to fill your pockets or wallets with cash to purchase the components as per your requirements. In this article, we will explore the various ways by which you can buy all the components at best prices whether it's at retail stores or online.

Offline purchase

You can approach a computer dealer and assemble the PC straight away. You just need to inform your requirements to the shop owner and they will suggest a suitable configuration for you. However, you will not be able to

compare the prices of each components. You will have to pay the amount which will be billed to you.

Sometimes, you will get the same component for a better price from another retailer. Hence, before you decide to buy, you have to approach multiple dealers and ask for a quote for all the components. You will have to analyse the cost and the reputation of the dealer including after sales support. If you are a beginner or student with negligible knowledge in computer assembling, you should build your PC through a dealer for trouble-free computing.

Buy online

Gone are the days where you need to approach a dealer for to assemble a PC. You can now buy all the required components after reading the complete specifications from the comforts of your home via e-commerce websites.

Most online retailers will take care of RMA and other customer related support

The advantage of online purchase is that you can compare the price from multiple online dealers easily. Moreover, there are specialised price comparison websites using which you can keep track of the cost.

Flipkart, Amazon, Snapdeal and eBay

Like all other tech enthusiasts, you should navigate to Flipkart, Amazon, and Snapdeal for the best possible deals. If you are not in a hurry, you can wait for Big Billion Day or Great Indian Shopping Festival or similar sale

periods to grab all the required components at unbeatable prices. While shopping on eBay, you have to search for the product and you should buy from a seller with excellent rating.

Prime ABGB

Prime ABGB, based in Mumbai sells a wide range of PC hardware. In addition to computer components, the company also sells servers, gaming solution and enterprise storage solutions. The retailer has listed products manufactured by premium companies such as Deepcool and Noctua. You can also contact them for customised solutions.

http://dgit.in/primeabgb

The IT Depot

The IT Depot is a popular online retailer dealing with all kinds of computer components, accessories including gaming desktops, laptops, software and mobile devices.

http://dgit.in/theitdepot-com

If you visit Lamington Road (Mumbai), Nehru Place (New Delhi), and Burma Bazar (Chennai) you can purchase computer and electronic items at cheap prices from various shops.

Deltapage

Deltapage is based in Chennai and sells a wide range of computer hardware components, peripherals and accessories at excellent prices. The company ships all over India.

http://dgit.in/deltapage

MD Computers

If you have a list of products to buy and are very particular about the specifications, MD Computers is a great place to explore. The website has incorporated really good filters and categorisation that makes it easier to shortlist your desired product easily.

http://dgit.in/md-comp

Hardwire

You can purchase a wide range of computer hardware items and accessories from Hardwire. The company also sells items via Amazon, which gives you peace of mind with good service.

http://dgit.in/hardwirein

Some of the other popular international e-commerce retailers selling computer hardware components with shipping to India are Newegg (*http://dgit.in/newegg-in),* Gearbest (*http://dgit.in/gearbest-store), banggood.com*, and *Aliexpress.com*.

If you prefer an online tool to build your PC, you can try *Rigassembler.com*, *ant-pc.com*, *assembleyourpc.net*. You can also try originpc.asia/in and in.pcpartpicker.com.

Water-cooling components

If you are a PC building enthusiast and overclocker, you need advanced solutions such as water cooling. However, you need to buy each specific item and assemble to prepare water cooling solutions. It is possible to buy branded liquid coolers but it would be interesting if you can build your own.

Individual water cooling components can be easily found online

You can buy individual components for water cooling in India such as radiators, water blocks, pumps, tubing, clamps and reservoirs from eBay.in and Amazon.in. Acro distributes EK Water Blocks all over India. You will have to establish contact with them to obtain the details of the authorised dealer.

You can buy a wide range of components required for PC liquid cooling from *FrozenCPU.com*. The retailer sells coolants, adapters, rings, plugs, barbs,

connectors, pumps, radiators and all kinds of spares. *Performance-pcs.com* also sells a huge selection of water cooling components.

Buying second hand/used products

You can save a substantial amount of hard earned money by buying all the components required for PC building from online forums. The discussion forums focusing on technology have separate sub forums for buying and selling used IT products. The popular sites in India through which you can buy and sell computer hardware items are *Techenclave.com*, *Erodov.com* and *digit.in/forum*.

You can navigate through the listings under the relevant section and post a reply to the thread. Moreover, you can interact through the seller and obtain payment related information via private message. You should transfer the payment manually due to absence of an automated payment system. Before transferring payment, you need to clear all the doubts with the seller.

Buying second hand items can save you a lot of money

Comparison sites

You can also refer to price comparison sites but most of them are oriented towards smartphones and laptops. However, *Comparometer.in* has listed a special category for computer hardware components. A Google search with the keyword "price comparison sites" provides you with a detailed list of all the sites.

The advantage of comparison sites is that you will be able to view the variation in the price for the same product. Hence, you can decide the cheapest

selling e-commerce retailers for the product you are searching for.

Building a PC the smart way

You should buy computer hardware items via online sellers if you have experience in assembling a PC. You require intermediate knowledge in connecting the various components while building a PC.

If you are a beginner who doesn't have any prior experience in PC assembly, you should approach a computer dealer. The shop will have qualified staff who will be able to assemble the PC. You should prepare a detailed checklist of all the items and write down the online prices. After that, you should visit various offline retailers and enquire about the prices. Once you have gathered the price of all the components, you should sit and select the best available shop.

You can visit *nehru-placeonline.com* for a complete list of dealers for the various PC building components. If you select the Dealers E-shop link, you will be able to select an item and a dealer of your choice to fetch the relevant contact and payment related information. Alternatively, check out *nehruplacemarket.com* as well.

You should also visit the assembling facility inside the shop as part of your assessment and verification about whether the desired components are being installed. Peripherals and accessories such as printers, keyboard, mouse, speakers and headphones can also be bought online and you might even end up saving money.

Conclusion

As you can see, there are several options available at your disposal for buying PC components. We can't tell you to adopt a particular purchase method. It's your personal choice. With plenty of retailers setting up exclusive shops, you can purchase an assembled PC without any hassle. Moreover, the Internet is wide open and you have complete freedom in your quest to build your dream PC. **d**