Build your own PC Guide

Picking parts and making your own computer can be a very challenging endeavor, especially for the ones who are new to this field. Choosing every component wisely is of the essence, since even a single wrong placed item can cause instability, crashes, or it can prevent your system from actually booting. This guide is being made with an intention of educating people who are just buying their first PC or for the ones who are already into the PC world but need to fill in the few blanks.

CPU

CPU or Central Processing Unit has been widely known as the brain of the computer and therefore, one of the most essential components. The CPU is responsible for executing instructions of a computer program using mathematical and logical operations based on user's inputs. In today's time, there are two manufacturers of CPU chips, Intel and AMD. Intel has been considered as the leader when it comes to high end with its i7 processors, while both manufacturers (Intel with Pentiums, i3s and i5s and AMD with its dual, quad, six and eight core processors) are fighting for the mid and low segment of the market leaving no clear winner.

Intel's i7 and i3 processors use HT (Hyper threading) technology. This enables the CPU core on those CPUs to create an additional virtual core in order for it to create one more thread within the pipeline, and this is the reason why operating systems see them as physical cores, although they are not. i7 CPU has 4 or 6 physical cores (depending on the model), but with HT enabled in BIOS, OS system can see and use (if the software is optimized for it), 8 or 12 threads. In theory, that HT provides huge benefits, but as it was stated this solely depends on the software optimization.

Today's CPUs are usually multi core, so when choosing a CPU for your system you will first need to inform yourself of how many CPU cores or threads the applications or games that you intend to run actually use. With that in mind make sure to thoroughly check on line benchmarks for the particular processor you intend to purchase.

Even the most expensive CPU on the market can have equally good (or bad) performance in the same application, if the software has not been properly optimized by the developer.

Both manufacturers have their own platforms and sockets, so once you choose a CPU from one of those two, make sure that you buy a motherboard based on the same platform. Within those platforms, there are different types of sockets, which serve as a physical and electrical connection between the CPU and motherboards PCB. If there weren't for sockets, CPUs would have to be soldered directly to the motherboards. Sockets provide flexibility to an end user, since he can swap CPUs on the motherboard without any particular issues.

CPUs can be also be overclocked, but only the who have "K" in their name (i7 4770k f.e.) while in AMD's case overclocking feature is available for all of its CPUs.

Motherboard

If a CPU has been considered as the computer's brain, most fitting metaphor for the motherboard would be the spinal cord. Motherboard connects all the peripherals and additional components within the system and it is equally important as the CPU. When choosing a motherboard for your system, there are several things you will be required to look out for, of course based on your needs and the budget.

Motherboard Form Factor

If you already have a case for your new computer make sure that the motherboard you intend to purchase can actually fit into it. The most common form factor on the market is ATX and it is highly unlikely that you can go wrong with this choice. Of course, there are other, smaller form factors such as Micro-ATX or Mini-ITX as well as the bigger, Extended E-ATX motherboards. Certainly greater motherboards provide more connectivity options as well as the other features, and it is up to you to decide whether you need them all.

Chipset

Chipset is responsible for communication between motherboard's components, and as AMD and Intel platforms have different chipsets, there are also differences between chipsets within these platforms themselves. Both AMD and Intel have a Premium chipset for the more expensive motherboards, which brings some additional features for the most demanding users, such as Quad GPU SLI/Crossfire support, more power phases for overclocking, Smart Response Technology (Intel), etc.

Power Phases

This is essential for anyone who wants to do overclocking.

Besides connecting all the components, motherboard has also one more very important function-voltage regulation. In order for CPU to receive the same out-put voltage. This voltage filtering is being conducted by power circuits working together but not at the same time; therefore, they are working "out of phase" which is the reason they were named power phases.

The more power phases your motherboard has, the less those power phases are individually pressured, which extends their life cycle and provides additional stability for the system. For example, if your motherboard has 8 power phases, each of those phases will work only 12.5% of the time, while with 4 phases each of them will work 25% of the time.

Now let's explore one more thing, what does 8+2 power design mean? In this case, eight power phases are dedicated for the CPU while the other two power phases are dedicated for VRAM.

In another example, we have 8+4+2 power design. This type of design is characteristic for Intel platform since Intel's CPUs have integrated GPU (iGPU) which requires voltage regulation as well. Therefore, this means that power phases are distributed accordingly: 8 for the CPU, 4 for the iGPU and 2 for the VRAM.

Motherboards that have 4+1 phase power design should not be considered for purchase if you intend to overclock your CPU.

PCI- E Slots

PCI-E slots are dedicated for video cards. If you use only one video card, which is plugged into the first PCI-E slot, that slot on your motherboard will work in 16x (16 lanes). However if you plug into the second PCI-E slot one more video card, those two PCI-E slots will work in 8x. In most cases there will be no degradation of performance; nevertheless, with some motherboards the second slot will start working at 4x where slower performance is to be expected from the second card.

Number of PCI-E slots is something you should consider if you want to make a multi GPU setup (Crossfire/SLI). At present, PCI-E 2.0 Standard slots are prevalent on most of the motherboards while PCI-E 3.0 Standard (provides around 60% faster speeds) is still making its way. There is no difference in terms of performance between these two standards just because the limits of 2.0 Standard haven't been reached by the modern GPUs, however if you are building a PC with an intention for it to last for the next few years, you should go for the motherboards that support PCI-E 3.0 Standard.

Internal and External Ports

When we say internal ports, we mainly refer to SATA ports. These ports are dedicated for Hard Disk Drives (HDD) and Solid State Drives. Unless you have a crazy amount of HDDs and SSDs almost any motherboards will fulfill your needs in that department, but always make sure to buy the motherboard which supports currently the fastest SATA 6 standard, especially if you plan to add SSD later.

RAM slots

These are the slots where RAM sticks plug into. Most of the motherboards (ATX) have 4 RAM slots and support 32 GB of memory, while other bigger and expensive ones can have 8 RAM slots and can go up to 64 GB and even 128 GB.

Smaller Micro-ATX and Mini-ITX motherboards usually have 2 slots (although there are exceptions which have 4 slots) and if you intend to buy such a motherboard buy a biggest stick of RAM that your motherboard can support, since you want to have room for a future upgrade.

Ram (Memory)

Random Access Memory (RAM) is the place where a system accumulates data that is about to be processed or are being used by the system frequently. This enables the PC to respond much faster instead of reaching for those sets of data on the HDD every time it needs it.

DDR3 standard is currently prevalent, and although DDR4 standard and modules are already on the market, there will be quite some time before DDR4 takes DDR3's place.

When it comes to memory frequency and what you should choose the answer may depend on solely what you need. If you intend to buy AMD's APU FM platform, you will have better performance in games if you buy RAM modules with higher frequencies since APUs use system memory. On the mainstream platforms higher frequencies on RAM modules do not necessarily mean better performance in games or any other application since as the frequencies go up (speeds of the clock cycle), the latencies (number of clock cycles) go up as well, where benefits (if there are any) are purely marginal.

HDD

Hard Disk Drive (HDD) is a device for storing and retrieving data. HDDs store data magnetically using rapid rotating disks. HDD have greatly evolved in terms of capacity and speeds over the last decade, reaching today's maximum storage capacity of 6 TB and rotations per minute (RPM) to up to 10 000. HDDs are still No. 1 factor when it for storing and installing operating systems and applications simply due to their low price per GB. SSDs although much faster are still rather expensive for the general public since their price per GB is a lot higher compared to HDDs price per GB.

If you are on the market for the new HDD for your operating system, you should go for at least 7200 RPM HDDs. Greater speeds guaranty that your system will boot faster and your applications will load faster as well. If you need a HDD for storage, 5400 RPM HDD is a sweet spot since you will not have any software installed on it.

Capacity is one more thing to look after. In today's time 500 GB HDD is considered to be a bare minimum, although we strongly advise to go for at least 1 TB. One more thing worth pointing out is that when you buy a 1TB HDD you do not actually get 1 TB of storage as the manufacturer marketed it. Why, you may ask? Simply because they calculate 1 MB as 1000 KB and 1KB as 1000 Bytes, instead of 1 MB= 1024 KB and 1 KB= 1024 bytes . Once you reach 1TB with this way of thinking you actually get 931 GB instead of 1024 GB, so you should always expect around 8% less storage than you were hoping for. The reason why they get away with this without being sued is that, because it has been accepted that Mega is 1000 times bigger than Kilo, Giga is 1000 times bigger than Mega, etc. So strictly legally speaking, they are not falsely marketing their own product.

As we mentioned previously, SATA 6 Standard has been widely accepted by all of the motherboard manufacturers, however most of the current hard drives cannot fully utilize even the previous SATA 2 Standard and let alone SATA current SATA 6.

There is also some kind of confusion that needs to be explained when it comes to names of SATA Standards.

SATA 1 – 1,5 Gb/s= 150 MB/s

SATA 2- 3 Gb/s= 300 MB/s

SATA 3- 6 Gb/s= 600 MB/s

When SATA 3 was announced, manufacturers agreed to call it SATA 6 since it was causing confusion between the users about what its speeds actually are since they mixed them the with SATA 2 Standard.

Maximum throughput of modern HDD is around 210 MB/s, which means that they are not even limited by the SATA 2 Standard.

HDD are being made in sizes: 2,5“and 3,5“

2,5“ HDD are mainly used in laptops and are considered slower than their desktop counterparts since they run at 5400 RPM.

3,5“HDD are mainly used in desktop environment, and as we mentioned their speed range from 5400 RPM to 10000 RPM.

SSD

Solid State drives use completely different type of technology compared to HDD. SSDs use integrated circuit as memory instead of HDD’s rotating disks. This enables SSDs to consume less power, but most of all it enables them to achieve much higher read/write speeds than HDDs, as well as much lower random access time which enables operating systems to react much faster than they would under a HDD.

SSDs have had their ups and downs since they first came to market, mostly because of bad controllers and firmware that deprived them of their full potential or. In some cases bad controllers and firmware managed to kill large amounts of SSDs. Fortunately those times are behind us, but whatever you do make sure that you buy SSD with the newest controller which will guaranty you its stability.

In most cases, modern SSDs use full potential of SATA 6 Standard. Eventually they have managed to surpass SATA 6 Standard by using external PCI-E SSDs, which enabled them to reach almost 1000 MB/s speeds.

Video Card

Video Card is responsible for creating and outputting images to a display. Video card is one for the most important piece of hardware for gaming, however it has other uses as well, such as 3D modeling, encoding, rendering and even for mining crypto currencies. There are two manufacturers of discrete GPU chips on the market AMD and NVidia, while AMD and Intel produce CPUs with integrated GPUs (iGPUs).

GPU (graphical processing unit) chip is the most essential part of the video card, since it is doing all the heavy calculations in order to display complex forms, effects and images.

When choosing a video card, you first need to understand the naming nomenclature. GPU chips (or video cards) with higher numbers within the same series have better performance. AMD's R9 290x will have better performance than R9 280x, which again has better performance than R9 270x etc. Same thing can be said for Nvidia's GTX 780ti->GTX 770-> GTX 760. Make sure to check on line benchmarks in order to find out which card performs better for your budget before making a final decision.

Video card memory stores data that is about to be processed by the GPU or it has already been processed. Amount of needed VRAM does not only depend on the game's settings and its complexity, it also depends the resolution you are playing at. 2GB of VRAM is perfectly enough for 1080p gaming. However, if you have 1440p monitor or plan to upgrade to one, 2GB of VRAM might prove to be insufficient, but you will need a GPU with a larger amount of horsepower as well.

Video Card cooling is one more thing to worry about. Video cards consume a lot of power and therefore release a lot of heat. Once GPU new video cards are launched they usually come with reference cooling solution signed by the GPU manufacturer. Video cards with reference cooling solution are notorious cause of their low thermal dissipation and noise as loud that it might make you think you have a jet in your case. This is way Video card manufacturers create their own solutions in order to provide better cooling and performance for the card, better overclocking ability and less noise.

Make sure that your PSU can handle your new video card together with the rest of the system, not only in terms of wattage but also in terms of PCI-E connectors your future video card will require.

PSU

Power Station Unit (PSU) is a device in charge of converting main AC current from the wall socket to lower DC voltages for computer components. PSU has never received the full intention it deserves mainly because understanding it is not quite easy and users have always focused more on the CPU, GPU and motherboard than on anything else.

Rails and Wattages

Rails are single voltage suppliers, and modern computers use 3 types of rails: +3.3V, +5V and +12V. Rails such +3.3V and +5V are there mainly to power motherboard and some lesser power hungry components such as HDDs, fans, PCI cards. The truth is that almost any PSU can deliver enough power to +3.3V and +5V rails. The most important rail in terms of power that delivers is the +12V rail. This rail supplies two main power consumers in the PC- the GPU and the CPU. With that in mind we will turn out attention to only +12V rail. In order to determine how many Watts can your PSU deliver to your PC you will need to multiply +12v with the number of Amps on that rail provided by the PSU.

If you have 50 Amps on your +12V rail your PSU can deliver clean 600W in its peak and these are the numbers that you need to consider once you deice to upgrade your PC. Also be weary of the usually very cheap “no name PSUs” that claim that they can deliver great wattages but in real life situation they can barely deliver 50% of their claims.

PSU 80+ efficiency

One more thing that has caused confusion, what is 80+ efficiency and what does it exactly mean?

If you have a PSU that delivers real 600W to your PC and it carries 80+ certificate, this mean that in peak load your PSU will draw 750W from your wall socket and deliver 600W to your PC components (mainly CPU and GPU) while the other 150W will be wasted on heat. When PSU is running at peak load over time there will come to degradation in performance which will lead to ripples in voltage regulation, causing instability for the whole system. The heat and working at max load is not the only reason why ripples occur but here are mentioning only the main ones.

Modularity

Modular PSU means that certain if not all of the power connectors can be unplugged from the PSU. With non-modular PSUs, power connectors are non-detachable. However there are good sides and bad sides for each choice. With modular PSUs, there is some loss in efficiency since the cables are not directly connected to the PSU. The loss in efficiency is minor but it still exists. Non- modular PSUs do not have any efficiency loss since they are directly connecting PSU with components, but on the other hand they are highly impractical since they interfere with the airflow within the case, increasing the temperature of the whole system.

Case

The case is there to protect your components from dust, secure them with better air flow and provide you with comfort of accessing various motherboard's ports and plugins with ease.

Cases have several form factors: full tower, midsize (ATX), micro and mini-ITX cases. Full tower cases are the only ones that support E-ATX motherboards. As we mentioned with CPU coolers, make sure that your case full supports it size and other features. If you are planning of buying a big graphics card make sure that it can actually fit inside the case. In some cases, disk cages can be removed in order for long graphics card to fit in. So if you are on the market for a case, this might be one more feature to look for.

When it comes to airflow inside the case, there are some basic things that case simply must support: it must have at least one intake fan on the front side and one out take fan on the back side in order for airflow to exist inside the case. In some cases, fans can be mounted on top of the case as well as on the bottom. It is preferable that the case comes with removable dust filters, making the case maintenance much easier.

Most of the mid-range cases support cable management. Cable management holes are stationed within the motherboard's proximity, enabling users to hide cables and connectors on the right side of the case enabling better airflow within the case.

CPU cooler

As the name says, CPU coolers are there to cool off your CPU in order for it to be stable and extend its longevity. Every CPU comes with a stock cooler, a small cooler which is usually enough to cool of your CPU when doing something not particularly demanding. The bad thing about stock coolers is that they are very loud and not exactly efficient when it comes to reducing temperatures of your CPU to an acceptable level. Therefore, sooner or later buying an aftermarket cooler becomes more than a reasonable solution.

There are 2 types of CPU coolers, air coolers and water coolers. While they differ in the way they work, some general guidelines apply to both.

When choosing a CPU cooler, the first thing that you should check is whether you can fit it into your case. Height of the cooler shouldn’t be larger than the width of the case. It is worth mentioning that if you decide to buy some water cooler (for example, example some 240 mm one) you need to make sure that the screws, which come with the cooler, are compatible with the screw holes in your case, otherwise you will not be able to mount it.

What you should also check is whether the cooler you intend to purchase actually supports your CPU’s socket, therefore make sure to visit manufacturer’s web site before engaging in any purchase.