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Computer Hardware: Building a High Spec Desktop for Gaming

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**Higher Cert/Bachelor of Technology – DT036A
Computer Systems**

Computer Hardware - Building a High Spec Desktop for Gaming

This section aims to describe in detail how to spec a desktop for gaming taking into account the various considerations for Graphics Card, Processor, Power Supply, RAM, MotherBoard, bandwidth of internal connections, long term storage and the case and outlines in a step wise fashion how one would put the build together.

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1. An outline of the Desktop Spec:

1. Intel Motherboard Z77 Chipset with PCI express 3.0 is the latest iteration of the PCI Express Bus and offers fantastic performance in particular for video cards and other components that will be plugged into the PCI Express Bus on the board. It also has fully integrated USB 3.0 (built into the chipset).

Previous motherboards had USB 3.0 via an add-on chip.

2. To go along with a high performance motherboard you need a high performance processor. The Intel core i5 Processor is a 3.4GHz quad core chip from the Ivy Bridge family of processors. This is not the highest end processor you can buy but when purchasing a processor, you will pay an exorbitant price for the highest end processor. It is better to step down a notch or two, where the price drops dramatically, and match its performance to the higher end performance by overclocking it. We will overclock this particular chip.

3. When you overclock a processor you have to be concerned about the heat that the chip generates. When you buy the box processor this also includes a heat sink. Since we are overclocking we need to use a much larger heat sink - it has more mass and features a heat pipe design. This contains a liquid that draws heat away from the processor and cools it via its cooling tower assembly.

4. DDR3 memory is the fastest type of memory on the market at the moment, but there are different speed grades of DDR3. Just like the processor you should buy a grade a little lower than the highest from a price point of view but also because a higher speed will be higher than the processor and chipset or motherboard will allow, so would only be fully exploited in a fully clocked state. Four memory modules will be included, 16GB total of DDR3 memory and i recommend to use nearly the highest speed grade.

5. Even though the processor has built in video circuitry that would be fine for normal desktop/business type operations - it is not adequate for gaming. The video card selected is based on an Nvidia GTX 680 GPU. This draws an enormous amount of power, up to 300 W. Thus you will need to choose a power supply accordingly. The documentation for this video card specifies you need to spec your power supply unit with a minimum of 650W and with 38A or more of 12 volt power.

6. The Case (full sized ATX) comes with a 400 W power supply which is not up to the task for our spec and will be discarded for this build. A Corsair 750W power supply will be used. This should fulfill all of the power requirements to power the video card, overclocked processor, memory, motherboard, drives etc.

7. Intel 480 GB SSD from 520 Series. You will notice that the System boots up faster and that programs load faster.

8. A Standard DVD burner/ Optical drive is included to load programs mainly.

2. Block Diagram of the Intel Z77 Express Chipset:

This Block Diagram explains how the motherboard works, it shows how the chipset, processor and other parts of the board are all interconnected. The Intel Z77 Express Chipset is the central feature in the Block Diagram and connects to all the main components of the system. It used to be a set of chips working together that formed the core of the motherboard circuitry, but in modern motherboards it has been consolidated down into one large chip but still retains the name "chipset".

The main thing connected to the chipset is the processor, one of Intel's core i-series of processors most of which are quad cores and some of them, not all of them contain integrated graphics as you can see on the Block Diagram.

Years ago when we had multiple chip chipsets, one chip was called the Northbridge and another chip was called the Southbridge. The Northbridge had the memory controller (circuitry that connected to the main memory) and the Bus Controller (circuitry that connected to the bus slots (such as PCI, PCIe).

The Northbridge these days has been integrated into the processor - the processor has absorbed those functions. Instead of having the Processor connected to the Northbridge which was connected to the Southbridge we now have the Northbridge circuitry built into the Processor.

Thus you will see e.g. the bus circuitry (PCI Express) is now connected directly to the processor, unlike previously where it was connected to the Northbridge which was connected to the processor.

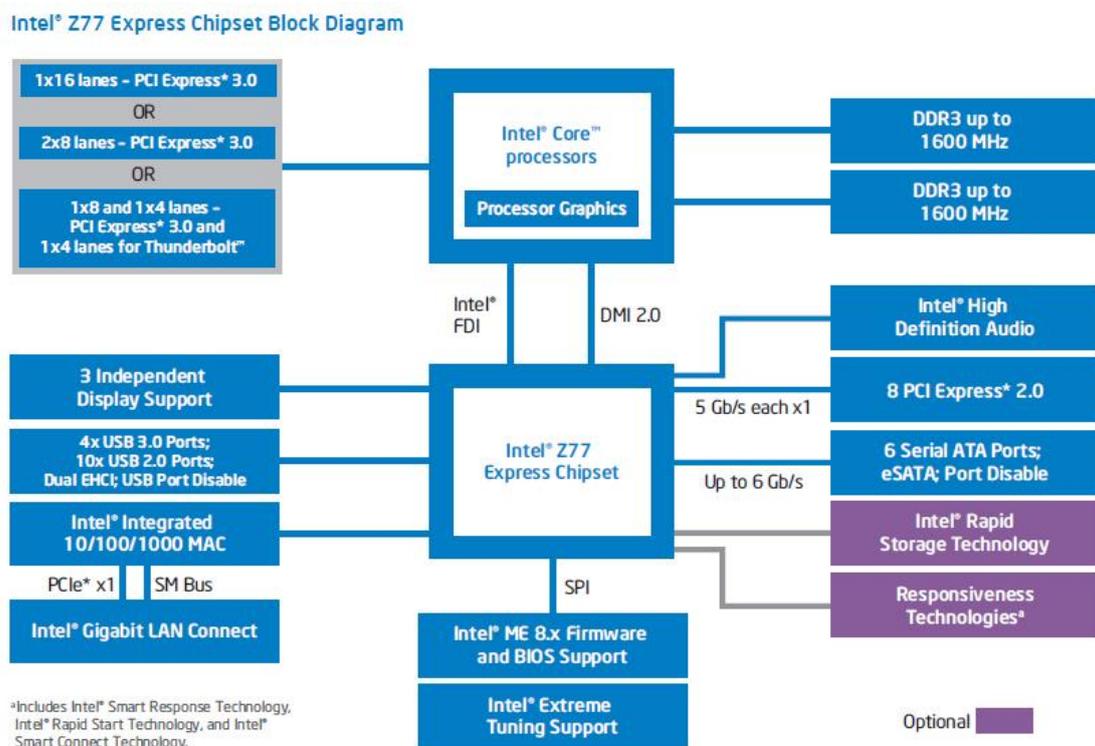


Figure: Intel z77 Express Chipset Block Diagram

PCI express 3.0:

The Block Diagram shows the PCI express 3.0 bus emanating from the processor can have a number of configurations or ways it can be used:

1 x16 lanes slot of PCIe 3.0 or
2 x8 lanes slots PCIe 3.0 or
3 slots: 1 x PCIe 3.0 slot with x8 lanes, 2 x PCIe 3.0 slots each with x4 lanes.

Possible uses of these PCI express is to slot in a high performance video card to connect to all 16 lanes, or use 2 video cards with both using 8 lanes each.

The PCI Express 3.0 controller is built into the processor.

DDR3 memory:

Also built into the processor is the memory controller to control DDR3 memory. The diagram shows 2 banks of DDR memory connected to the processor. This is dual channel memory with each of these banks with 2 modules, so you have up to 4 modules in total. 1600MHz is the maximum speed supported by the memory controller of this processor.

Previously the Northbridge contained the PCI express and Memory functionality.

We also used to have a separate Graphics Card chip but that has also been absorbed into modern processors.

Z77 Express Chipset:

The chipset has support for up to 3 independent displays. This depends on the processor you use. The processor contains Processor Graphics circuitry that connects via the Flexible Display Interface (FDI) within the integrated graphics of the processor to the Z77 chipset, which routes the video signals from the processor to up to 3 displays/monitors. Actually being able to run 3 displays depends on the processor you have in place, its graphics capabilities and the capabilities of the motherboard. This motherboard only supports 2 displays.

The USB controller:

The USB controller is also built into this chipset.

Intel calls this chipset the Platform Controller Hub (PCH) a.k.a. Z77 chipset a.k.a. the South Bridge in older chipsets. The chipset connects to up to 4 x USB 3.0 ports or 10 x USB 2.0 ports. These ports will be routed to connectors on the motherboard for the front panel and some on the back part of the motherboard and the IO ports on the back panel.

A Gigabit Ethernet connection is also built into the chipset.

The Serial Peripheral Interface:

The Serial Peripheral Interface (SPI) connection is the main connection between the South Bridge chipset and the BIOS on the motherboard. The configuration of the motherboard settings is stored on the ROM BIOS flash memory chip and can be changed in the Setup program.

PCI express 2.0:

The Block Diagram on the right hand side shows the PCI express 2.0 built into the chipset with 8 lanes. Each lane has a 5 Gbits/s performance giving a total performance of ~500 MBytes/s per lane.

Contrast this with 3.0 where each lane has 1 Gbit/s performance. Thus PCI express 2.0 has half the throughput of 3.0 and there is only half as many of them (8 vs 16).

SATA ports:

Up to 6 Serial ATA ports are available. 2 of these SATA can be the 6Gb/s version which is 600MB/s. This could be used by the latest SSD drives as they require this amount of bandwidth.

Intel Rapid Storage Technology:

The SATA ports can function in a RAID configuration as well.

Identify the processor, the chipset/Platform Controller Hub (PCH), RAM with 2 modules on each of the 2 memory banks, so 4 DIMM modules in total.

3. Detailed Motherboard Tour:

PCI express 3.0 bus connection:

The processor contains the PCI express 3.0 bus connection with 16 lanes each. The bus connection goes to each of the 3 long blue slots for cards.

Switch Multiplexer chips control the lane configuration.

- (i) if you had just 1 card in 1 of the slots then all 16 lanes would go to that slot.
- (ii) If you had 2 cards in 2 slots then each would have 8 lanes per slot.
- (iii) If you had 3 cards in all 3 slots then the slot closest to the processor would have 8 lanes per slot, while the other 2 would have 4 lanes each per slot.

Power to the Processor:

The Processor draws a lot of power, and can draw a lot of power very quickly.

The following components are important in providing power to the processor:

(i) Voltage Regulator Module (VRM): A chip can go from idling on 1 W to instantaneously drawing ~125W very quickly. This requires power delivery circuitry that delivers power to the processor called a VRM. There are 12 VRMs here tucked under the heat sinks close to the processor, so they are also denoted as 12 phase VRM. Each VRM has 3 main components:

(ii) a Choke or coil: denoted by square blocks with SFC on them (super ferrite choke). This is essentially a small transformer. also known as the “Alloy Choke”, it is made of a compound of various types of metal instead of standard iron, and enables the support of up to a massive 40A of rated current.

(iii) Voltage regulator chip: This produces a lot of heat and thus is located under the heat sink.

(iv) Solid state capacitors: which are located under the heat sink. They don't physically get hot, they are just tucked away under the heat sink. They look like tiny metal tin cans. They don't have the liquid electrolyte used previously, thus there are no issues with leaks.

Compare these VRMs with those on an older motherboard, older capacitors suffered from leaks, problems with the electrolyte formula - it not charging after a passing a certain number of heating/cooling cycles (Bad Capacitor Plague)

(v) 8 pin 12volt power connector (to power all this circuitry) where power enters the motherboard from the power supply. Older motherboards had just a 4pin 12volt connector, so it can supply more 12volt power to power all the various voltage regulator modules which then in turn power the processor.

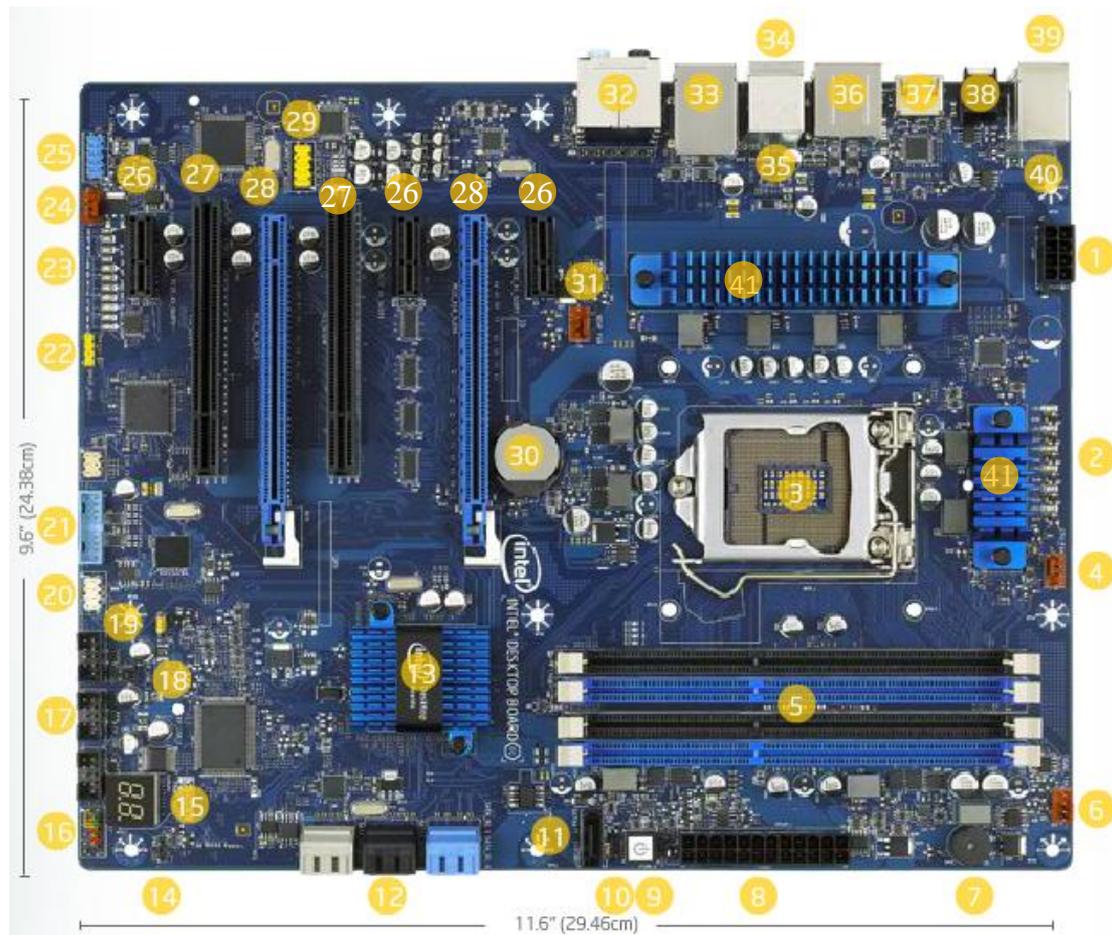


Figure: the Intel Z77 motherboard (Plan View). (Intel, 2014b)

1. 12V Processor Core Voltage Connector (8 pin)	15. POST Code LED Display	29. High Definition (HD) Audio AC97 Front Panel Header
2. Voltage Regulator status LEDs	16. Front Panel Header	30. CMOS RAM Battery
3. Processor Socket (LGA1155)	17. USB 2.0 Dual-Port Header (black)	31. Rear Chassis Fan Header (4 pin)
4. Processor Fan Header (4 pin)	18. Chassis Intrusion Header	32. 5 port audio with S/PDIF
5. Memory Slots	19. BIOS Configuration Jumper	33. Intel Gigabit (10/100/1000 Mb/s) Ethernet LAN
6. Front Chassis Fan Header (4 pin)	20. Consumer IR (CIR) headers	34. IEEE 1394a port
7. Onboard Speaker	21. USB 3.0 Front Panel Connector (blue)	35. External Serial ATA (eSATA) port (3 Gb/s)
8. Main Power Connector (2x12 pin)	22. S/PDIF out Header (4 pin)	36. USB ports: 4 USB 3.0 ports (blue) 2 USB 2.0 ports (black)
9. Onboard Power Button	23. Diagnostic Status LEDs	37. Graphics ports
10. +5V Standby Power Indicator LED	24. Auxiliary chassis fan header (4 pin)	38. Back to BIOS button
11. SATA 3.0 Connector (black)	25. IEEE 1394a front panel header	39. PS/2 port
12. SATA Ports: (4 SATA 6.0 ports (blue & grey) 2 SATA 3.0 ports (black)	26. PCI Express 2.0 x1 connector	40. USB 2.0 ports (yellow) 2 high current/ fast charging ports
13. Intel z77 Express Chipset	27. Conventional PCI bus connector	41. Voltage Regulator modules with heat sinks
14. Alternate Front Panel Power LED Header	28. PCI Express 3.0 x16 connector	

Back Panel - Various Output Ports:

Observe the following on the Back Panel: keyboard connector, several USB ports, digital audio interconnect, HDMI video (digital), Gigabit Ethernet slot, USB 3.0 slots (coloured blue), VGA connector (analog video), DVI connector (digital video interface). Only 2 of the video connectors can work at any one time. e.g. DVI & HDMI (don't use VGA)

In our case we are going to be installing our own video card so we won't be using any of these ports. Finally we see the Audio out ports on the I/O panel- there are 6 coloured coded ports.

Intel Gigabit Ethernet Chip:

1 x Gigabit LAN Controller(s)

The chip, silver crystal and other circuitry acts basically as a Gigabit Ethernet card which you would plug into a slot. Here it is built into the motherboard.

The Super I/O chip:

This is manufactured by Fintek. It contains keyboard and mouse controller, serial port, parallel port, floppy controller. Only the keyboard and mouse controller on this chip are connected to their respective interface ports on the back panel.

The Super IO chip also contains temperature sensors and a fan controller. This provides the ability to control all of the fans connected to the motherboard as well as the ability to monitor the temperature of the board and other features. You can see these readings in the BIOS setup as well as in various custom software apps. that come with the motherboard. They take the readings that the Super IO chip provide and can be used to automatically adjust fan speeds for better system stability.

The Sound Card:

This is based on the RealTek audio chip. Nearby you see the front panel audio connector (JAUD 1) which would be plugged into the microphone jack and headphone jack on the front of the case.

The Front panel connectors, power switch, reset buttons, Hard drive and power LEDs are all in this area of the MotherBoard.

The FireWire port (blue with 1394 printed on it) and above it the FireWire chip (VIA brand) with a crystal or FireWire card that connects to the port.

USB 2.0 connectors:

3 sets of USB 2.0 connectors (USB printed on it) each providing 2 Ports giving a total of 6 USB ports on the front of the case. One of the connectors is color coded with a red interior background to indicate this is also a charging port. Usually USB devices draw about 0.5 amps, however iDevices (iPhone, iPad) can draw 1 amp or more). These devices can be plugged in here and the system can be configured that so as to charge even when the PC is powered off, in sleep or hibernation modes.

4 x USB 3.0 port(s) (2 at back panel, blue, 2 at mid-board)

Intel® Z77 chipset:

10 x USB 2.0 port(s) (4 at back panel, black, 6 at mid-board)

POST Code 2 digit diagnostic display:

This display outputs various codes at each point of the boot process. Rather than think there is an error with the entire motherboard on boot up, this display displays the error at the point of failure.

e.g. Faulty memory on boot up, the system locks up and outputs the corresponding error code. You look up the Motherboard manual for the meanings of the POST codes.

BIOS chips:

Dual BIOS chips are located side by side with pink dots on them and with a switch nearby to alternate between BIOS chips. You only need one, but as a Safety feature you have 2 chips e.g. if you were updating your flash BIOS to a newer version and a power cut occurred. You can flip the switch to the older working flash BIOS.

SATA ports:

This is where you connect the harddrives and optical drives to the motherboard. Total of 8 ports, 2 per set.

white ports: 6 Gbit/s or 600MB/s, black ports: 3 Gbit/s or 300MB/s

e.g. we want to install a SSD capable of 550MB/s performance.

It should not be plugged into the black SATA port as you would be limiting the performance to 300MB/s or less. It should be plugged into the white port.

Why are there 2 sets of white ones?

Intel Z77 chipset can supply 4 ports that are 3 Gbit/s and 2 ports of the 6 Gbit/s, the white ports on the top.

There is also an Asmedia serial ATA chip that supplies 2 more 6 Gbit/s ports.

http://www.asmedia.com.tw/eng/e_show_products.php?item=118

This external chip connects to the chipset via a PCI express slot. The problem is a PCIe 2.0 slot only provides a 5 Gbit/s (500MB/s) so there is bottleneck here and these two 6 Gbit/s ports are not as fast as the upper ones that are connected directly to the z77 chipset. Thus you should use it to connect to an eSATA port via a cable to connect to an external harddrive out the back. This reserves the high performance boot drive to one of the 6 Gbit/s ports connected to the chipset for maximum performance.

One of the white ports (6Gbit/s) is connected directly to the z77 chipset while the other is attached via a chip to a PCI Express 2.0 1x lane slot (the smaller black slot) and which only provides about 500MB/s so this acts as a bottle neck. Thus these ports are bottlenecked to 5Gbit/s or less. Thus use these set of ports for something slower e.g. connect via a cable to an eSATA port connected to an external hard drive.

Each lane of PCIe 3.0 has 1 Gigabit/s performance.

2 x PCIe 3.0/2.0 x16 (x16 or dual x8) *2
1 x PCIe 2.0 x16 (x4 mode, black) *3
3 x PCIe 2.0 x1

5000 Mbit/s 622MB/s

External SATA docks:

External SATA docks allow you to put 1 or 2 hard drives in at the same time: Intel ports lack Port multiplier Capability (PMC) so plugging in 2 harddrives into these docks will result in only one of them being recognised. The AS media port does have PMC and so would be ideal for External Serial ATA applications.

2 x SATA 6Gb/s port(s), brown
4 x SATA 3Gb/s port(s), black
Support Raid 0, 1, 5, 10

Power Connector:

The Main 24pin power connector to power the motherboard. Cable from power supply will plug in here.

7 Voltage taps: for enthusiasts, especially if overclocking the processor, memory and adjusting voltages to various components.

Switches:

power and reset switches when testing the motherboard and working with the case taken off. Exact same as pressing buttons on the front of the case, when the motherboard is attached to the closed case.

OC Genie button:

Depressed and locked down the system is in overclocking (OC) mode. The next time the PC is switched on, it examines which processor you have installed, which memory and other components, looks up a table what the safe overclocking settings are for those components and sets a safe overclocked configuration. It may increase performance by 30% and does it safely.

CMOS RAM Battery:

a standard CR2032 Lithium coin/button shaped battery. It is rated for 5 years but can last 10 years or more, it powers the real time clock (RTC) and the BIOS setup information which is stored in the CMOS RAM. As long as the system is plugged in this battery is not being depleted. The Clock and CMOS RAM are now part of the Z77 chipset, they used to be separate chips. CMOS stands for complementary Metal-Oxide-semiconductor.

4. Selecting a Case and Power Supply:

Case:

Removing the case side cover you see what Intel calls the Thermally Advantaged Chassis attached to the side cover. This has a special cooling duct for the processor. This is placed close to the fan allowing it to draw cool air directly from the outside. This is fine for a stock PC but our build will need a tall heat pipe based heat sink so the cooling duct will be removed and discarded in our build.

This is a full sized ATX case with 3.5 inch Bays for drives, 4 for HDDs / SSDs, 2 for additional HDDs or SSDs, 4 optical drive bays which could be used as additionally HDDs using adaptors. If you do mount 3 or more drives you should consider mounting a front fan to blow air across the drives. As this build will only have 2 HDDs, a front fan is not needed.

The usual configuration is for a front fan (small or none) to draw in air and back fan (larger) to exhaust air, exhaust fan has larger CFM (cubic feet per min).

Fans:

Fans: 120mm (at back), smaller or no fan at front e.g. 92mm, 80mm.
Dimension is not diameter, it measures across the side.

In sizing fans you don't want to pressurize the case, you don't want to pull in more air than you exhaust out the back. This would disturb the normal cross airflow (improper cooling).

Toolless drive installation assemblies Vs Bolted:

with toolless the bays for the drives are not as secure so HDs can vibrate, there is not as much strength in the case. These can be discarded and the bolts put in, making the case stronger and quieter.

Vent Holes:

Hexagonal vent hole is a better cooling design than round hole ('more hole than metal'). Less metal blocking the air-flow means lower air resistance so less noise and a fan does not have to work harder. This vent feature will be at the back of the case both towards the centre of the back and in the upper area beside the power supply.

Both sides of the case are removable as they are screwed in rather than riveted. You can secure or screw in drives from both sides making them more secure, allowing easier access to cables for routing them.

Sizing the Power supply:

Existing power supply that comes with the case is 400W.

The i5 Processor requires 77W at max power, 30-50W to power the motherboard, we plan to install 1 or 2 drives, and a top end video graphics card.

The graphics card has 2 x 8 pin PCI express power connectors, and requires 38A of 12volt power, resulting in 456W. Thus the existing power supply will have to be replaced.

Power supply depth:

ATX standard power supply, it allows for up to 140mm of depth (measured from the back of the system).

EPS power supply, same dimensions of width and height and screw holes, just extended. The replacement power supply (corsair HX 750W) extends to 180mm which is a deeper power supply but it will fit in the case without interfering with the optical drives.

If you needed to have 2 high performance graphics cards then 750W would not be adequate. A 1 KW power supply would be needed. This extends to 230mm deep, the maximum depth under the eps standard. This would still fit in this case.

The number of pins in the power supply output:

The power input to the Graphics card has two 8 pin PCI express power connectors. The PCI Express connector on the power supply has only 6 pins. In the official 6 pin connector standard there are only 2 x 12 volt wires - this power supply output however has 3x12 volt wires. This means you can use a clip on adaptor cable to convert this to an 8 pin connector and be able to power the graphics card. The 8 pin connector has only 3x12 volt wires.

5. CPU and RAM Installation:

1. Install processor into motherboard socket
2. Install RAM
3. Install the Heat Sink

Electrostatic Discharge Protection:

Wear a Wrist-strap for protection against static, tied to the mat via a wire
Board and all of the components would be on the Anti static mat

Work on non-conductive surface - no metal tables or workbenches, use plastic table
Motherboard comes with an anti-static bag, put that on the table and place the motherboard on top

The installer must be electrically grounded to the board i.e. to a grounded portion of the board. The best portion is the metal shields around all of the connectors.

Touching this means you are at the same charge as the board so no dissipation.

Try to handle the board via the edges.

If you handle memory modules, again handle them by the edges and not the gold contacts.

The processor is in the protective case it came in. Don't touch the gold lands on the processor.

Installing the processor:

LGA1155 come with a plastic cover on the socket to prevent the pins being bent. Very fine pins under the cover. Leave cover on until you are ready to install the processor.

Pop the cover off to expose the socket.

press down and a little to the side to release the lever and lift up the latch.

Remove processor from its protective package and handle it by the edges.

Examine the processor - it has 2 notches, these will align with notches in the socket.

That's how you know it is oriented properly. Place it in the socket and close the latch.

It has a notch that tucks underneath a screw to hold the processor in under pressure.

Pull the lever back down to hold the processor and you have installed the processor.

Installing RAM:

4 memory modules are to be placed in all 4 slots on the motherboard. If you had 2 then you would install them in slot 1 and slot 3, the odd slots or matching banks. This is because this is Dual channel memory, so install modules in matched pairs in order that they work together in an interleaved fashion.

Flip all of the latches down and insert the DDR3 modules.

The modules have an alignment notch on them that needs to match the notch in the socket. If you get it work you can burn up the motherboard when you switch it on. Press them down on both ends with pressure and the latches should pop up by themselves.

Install the Heat Sink:

We are not going to install the factory heat sink as we will be overclocking the processor. Instead use a 3rd party Heat Sink

First install the base that came with the Heat Sink.
Turn the motherboard over to see the base of the cpu socket.
Stick the base over the cpu socket using its sticky tape.
The 4 studs on the base should pass through their corresponding holes, and press down on the base.
Turn the motherboard back over.

How to orient it? The Fan facing RAM will draw air over the RAM modules, exhaust side exhausts air over one of heatsinks on top of one of the VRMs.

One benefit of the cooler that comes with the processor is that it is omni-directional. It blows ambient air down and out in all directions, so it will pass cooling air over both Heat Sinks on the 2 VRMs and the RAM as well. The VRMS are connected by a heat pipe so the heat will be evened out between them.

The heatsink has a protective film that needs to be removed and you also need to apply a thermal interface paste to the top of the processor.
The heatsink is made of copper and has a highly polished base when exposed.

Applying the thermal interface paste:

add the paste to the middle of the top of the processor. You can spread it using a credit card. Place the heatsink on top of the processor. Align the screws to the holes on the motherboard and tighten them. You could use a long handled screwdriver for access.

Take the power cable for the heatsink fan and route it around behind the heatsink and plug it into the cpu fan connector tucked between the VRM and the RAM. This is a 4pin fan connector.

With the processor, RAM and the Heat Sink all installed on the motherboard, the motherboard can now go into the system case.

6. Case Preparation:

- Remove fan

bend tabs on the bracket and take fan out

- Remove Power Supply

remove 4 screws at back and slide Power supply forward and remove

- Remove quick release tabs
- Remove back panel
- Remove front bezel and cables

Now have bare chassis

The wires on the front panel connections are the most problematic. Plug individual wires, each with 1 or 2 pins, careful with the polarity, into a single 10 pin connector on the motherboard. Power LED, Harddrive LED, Reset Switch, Power Switch.

MSI Motherboards which comes with an M connector. Insert wires into this outside of the motherboard. It is keyed, with one of the pins blocked to match with connector on the motherboard.

Frontex.com also sells a 10 pin hetero connector. Engage tabs and pull the terminal out of their tabs. Align the wires properly with the 10 pin connector so that you have a single front panel motherboard connector. Refer to pin out codes diagram.

7. Motherboard Installation:

Full size ATX installs with 9 screws that come with the case

Install IO shield:

IO shield comes with the motherboard

bend tabs up out of the way so as not to impinge use of USB connectors.

Add the Motherboard to the case:

Advice using Power screw driver - Intel have returned motherboards sent in damaged under warranty as traces had been scratched.

Start the screws by hand, you don't want them to be cross threaded, once you are sure the threading is perfect then use the power.

Torque screwdriver, it ratchets in the screw when they are tightened so as not to overtighten. Tip does not work its way out of the screwhead and damage the motherboard.

8. Drive and Video Installation:

1. SSD Drive Installation:

This has a 2.5 inch form factor. First has to be mounted into a 2.5inch to 3.5inch Bracket Adapter as the desktop chassis are designed to accept 3.5 inch drives.

This case has 6 positions for 3.5 inch drive and 4 positions for 5.25 inch drives.

If installing 3 harddrives then skip every second bay to allow space between drives to allow cooling air to circulate. Do not out them in adjacent positions.

Slide the SSD into the lower position and install the 4 screws, 2 on either side. Screws are better than no tool as it makes the whole chassis stronger, like a cross brace, with less noise from vibration.

2. Optical Drive Installation:

There are multiple screw hole positions for the drive. Ensure you have the right depth. Install 4 screws.

3. Video Card Installation:

uses 2 bracket positions, so check the back of the case to ensure that 2 brackets have been removed.

take bracket plate off before you can install the card.

use the topmost PCIe x16 slot and slide in the card.

Latching assembly on PCIe slot that will engage and lock the card in place.

Remove the protective cover that is protecting the gold connector on the video card.

Turn PC on its side and install the card.

The external eSATA passes out the bottom back of the case

9. Power Supply Installation and Cabling:

At this stage the motherboard is installed, the drives are installed and the video card is installed. The cables and power supply now need to be installed. The power supply is modular meaning the cables can be installed/connected first (cabling up) without the power supply being in place and in the way.

Connect the Data Cables:

Cabling the SATA drives:

connect the data cables first. The SATA cable is available with an angled and a straight connector. The angled end plugs into the SSD drive, the straight end plugs into the motherboard.

Cabling the optical drive:

Again the angled end plugs into the drive, the straight end goes into the motherboard.

Attaching the cables to the Motherboard serial ATA:

The top two ports are the 6 Gbit/s that go to the Intel z77 chipset.

Plug the Solid State Drive into the Intel chipset 6 Gbit/s port, i.e. Port Number 1.

The bottom two ports (white) are the 6 Gbit/s that go to the Asmedia chipset.

There is no need to waste a 6 Gbit/s port for the optical drive as it can't take advantage of this bandwidth, so leave it free for another SSD or another harddrive.

Plug the optical drive into one of the 3 Gbit/s port, the black ones.

Plug the eSATA bracket cable into the Asmedia 6 Gbit/s port as you could possibly take advantage of a 6 Gbit/s eSATA port in the future.

Connect individual Power Cables to the devices:

(i) SSD boot drive (ii) Optical Drive (iii) Video Card

Data cables have been connected. Now connect the power cabling to the SSD drive and to the Optical drive.

Connect a power cable to the Video card:

It has 2 x 8 pin PCI express power connectors.

Attach the Power Supply:

Attach the power supply to the case as all cables are in place.

Add the screws to secure it to the case.

Connect the power supply to the motherboard:

Take both of the main power connectors: 24pin main power connector and the 8pin cpu power connector, and connect them to the motherboard.

Finally connect all the modular power cables from the SSD, optical drive etc. to the power supply.

Dress up all the cables with cable-ties, some are zip-tied to parts of the case to keep them out of the way. This helps to maximize air-flow and also makes future servicing a lot easier. e.g. if you have to replace the video card or processor.

Front of the Case:

Take off the front panel of the case and feed the USB front panel switch connector and front panel audio connector in through the holes in the front of the case and attach them to their proper connectors at the base of the motherboard.

Back of the Case:

Replaced the missing bracket.

Removed the little caps from the video card connectors.

We can connect 4 different monitors into this video card.

The 6 Gbit/s eSATA port is ready to go.

Reinstalled the chassis fan

Reinstalled the back side cover, then the front side cover - the one with the CPU air duct installed on it. This would sit over the conventional factory installed CPU heat sink and help it draw in external air.

With this massive high performance heat sink in here that's not going to work so just simply remove the two screws that was holding the CPU air-duct to the front cover.

Power On the PC:

First thing to do is to enter the BIOS setup and check the BIOS date and ensure that you have the latest version. If you don't then download it from the motherboard manufacturer, copy it onto a flash drive that is in a FAT32 format and plug it into any of the USB ports on the system. Then restart the system going into the BIOS setup again. This time in the setup program you can perform a flash ROM upgrade by reading directly from the flash drive.

Once you have performed the BIOS update, restart the system, boot from your operating system installation disk to install the OS.

Once the OS is installed you want to install the latest drivers which you can download from the motherboard manufacturer as well as any application programs you will run.

Overclocking:

Remove the case, hit the Genie button. See a performance boost of 30 - 40%.

You could also go back into the BIOS setup and tweak the processor multiplier, voltage settings, bus speed settings. Using this method you could get up to a 50% increase in performance.

References:

1. Asus (2014) *Thermal Armor Total Airflow-Boosting Circulation Test*
http://www.asus.com/Motherboards/SABERTOOTH_Z77
2. Eastaugh, Matthew, (2004) *Micro processor Tutorial*:
<http://www.eastaughs.fsnet.co.uk/cpu/structure-reg.htm>
3. HowStuffWorks (2014) A useful site for various computer articles, images and video. <http://computer.howstuffworks.com>
4. Intel (2014a) *Desktop Boards Power supply considerations for building a computer*, <http://www.intel.com/support/motherboards/desktop/sb/CS-008646.htm>
5. Intel (2014b) Intel® Desktop Board DZ77BH Interactive Layout
<http://www.intel.com/content/www/us/en/desktops/desktop-board-dz77bh-55k-interactive-layout-demo-video.html>
Mouse over the 40 numbered items to see feature descriptions.
6. Intel (2014c) For a 360° view of the z77 motherboard
<http://www.intel.com/content/www/us/en/desktops/desktop-board-dz77bh-55k-360view-demo-video.html>
Move your mouse across the board image to rotate it.
7. Intel (2014d) Block Diagram of the Intel Z77 Express Chipset
<http://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/z75-z77-express-chipset-brief.pdf>
8. Intel (2014e) Port 80h POST Codes Ranges, the operation that corresponds to the code and the POST sequence <http://www.intel.com/support/motherboards/desktop/sb/CS-025434.htm>
9. Mueller, Scott (2013) *Upgrading and Repairing PCs*, 21th Edition, Que Publishing, Indianapolis.
10. Nvidia (2014) Technology demos from Nvidia used to showcase the rendering power of the chip. See YouTube and <http://www.nvidia.com/coolstuff/demos>
11. Tweaktown (2014) This link has some good images of the z77 motherboard:
<http://www.tweaktown.com/reviews/5259/gigabyte-z77-hd4-intel-z77-motherboard-review/index2.html>
12. Tennis, Caleb (2009) *A Peek At Computer Electronics*, The Pragmatic Programmers LLC.
13. White, Ron (2008) *How Computers Work*, 9th Edition, Que Publishing, Indianapolis.
14. HowStuffWorks (2014) A useful site for various computer articles, images and video.
15. PCI Express SIG site. <https://www.pcisig.com/home>
16. Serial ATA website. www.serialata.org