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## Report on Motherboard Dissection

EN2031: Fundamentals of Computer Organization and Design

Group: Neumann++

Index Number	Name	Contribution to the Project
210069F	B.Y.N. Basnayake	Processor, Memory, Cooling options, Annotations
210258J	R.M.K.C. Jayathissa	I/O Components, Peripherals and Classification of connectivity options
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# Overview

A motherboard can be considered as a Printed Circuit Board (PCB) which provides one place for all the relevant components in a computer system to connect to each other. It provides sockets for processor, RAM, graphic cards etc. while allowing peripheral devices such as monitors, USB devices, and network devices to connect and communicate with each other through I/O ports. Moreover, the BIOS chip and the Chipset can be seen directly mounted to the motherboard. The Central Processing Unit (CPU) acts as the *brain* of a computer and hence it is the main component of the system. The motherboard facilitates the operation of the CPU by providing a platform to access memory, interact with Input/ Output (I/O) devices, and managing requirements such as power supply and temperature control.

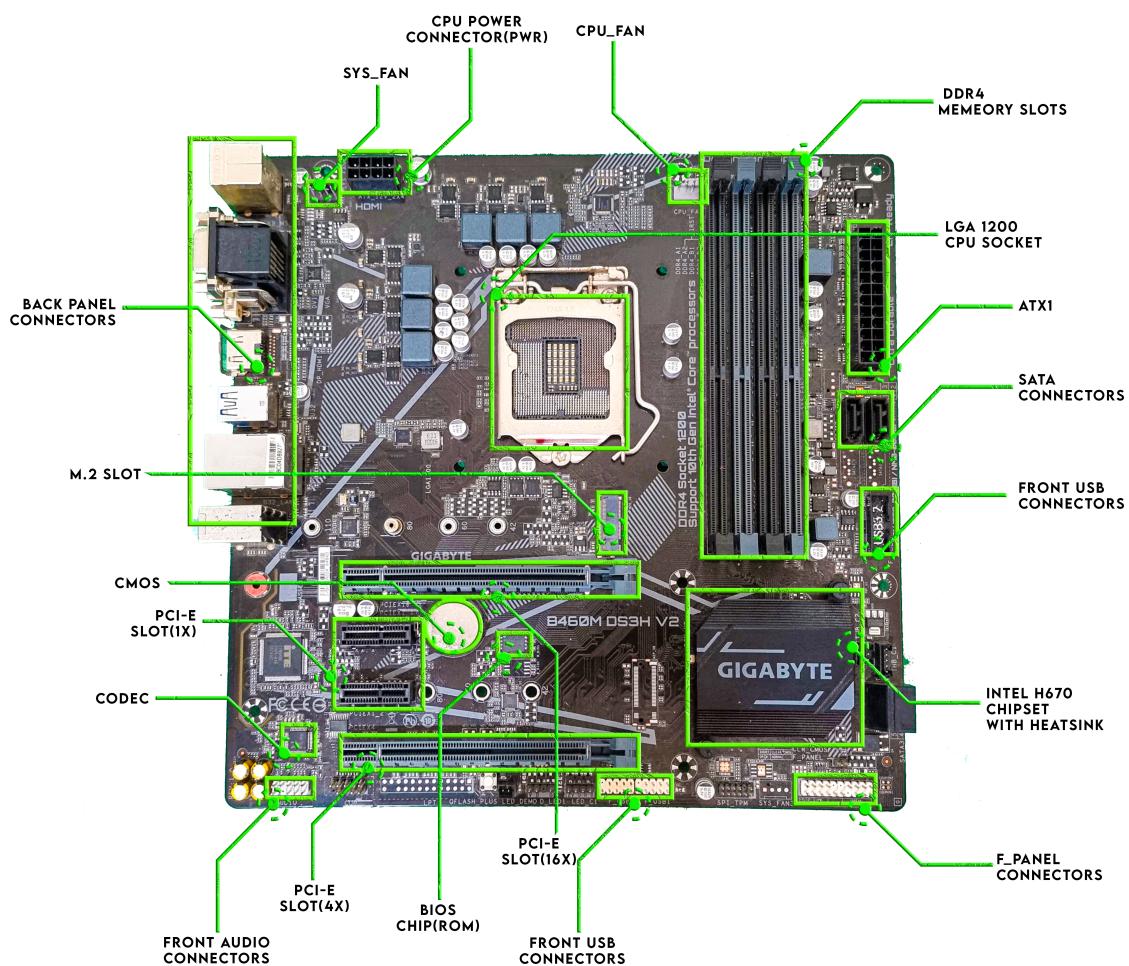


Figure 1.1: Components of a motherboard

# Basic Components of the Motherboard

## 2.1 Central Processing Unit (CPU)

The GIGABYTE B460M DS3H V2 motherboard features an LGA1200 socket, designed by Intel®, to accommodate a wide range of processors, including 10<sup>th</sup> generation Intel® Core™ i9, i7, i5, i3, Pentium®, and Celeron® processors. This socket design provides a profound electrical connection between the CPU and the motherboard, ensuring both performance and physical integrity. The LGA1200 socket employs a Flip-Chip Land Grid Array (FC-LGA) configuration, enhancing heat dissipation by exposing the CPU's hottest region to the heat-sink for optimal cooling.

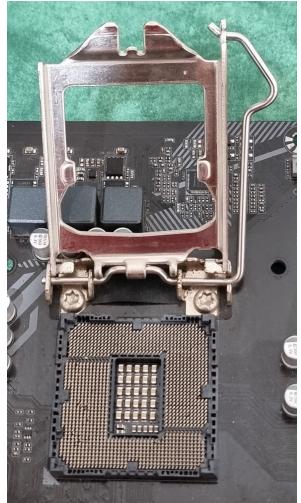


Figure 2.1: LGA1200 socket

Memory Speed (MHz)	Supported Processors
2933, 2666, 2400, 2133	Intel® Core™ i9 and i7 processors
2666, 2400, 2133	Intel® Core™ i5, i3, Pentium® and Celeron® processors

Table 2.1: Memory speeds and their supported processors

Each DIMM socket supports memory modules with capacities up to 32GB, totaling a maximum system memory capacity of 128GB.

Memory organization operates in two distinct modes, depending on the installed DIMM configuration:

**Dual Channel Mode:** Achieving peak performance by accessing both RAM modules at once, when two RAM modules of the same capacity (and preferably the same speed and brand) are connected.

**Single Channel Mode:** This mode is activated when memory capacities of the two or more RAM modules differ or only one RAM module is inserted.



Figure 2.2: DDR4 RAM slots

### 2.3 Chipset

An Intel H470 chipset is used in the motherboard and it serves as the coordinator between the CPU and the other peripherals. The traditional Northbridge and Southbridge functionalities are both handled by the newer chipset. It connects to the CPU via Direct Media Interface (DMI) and controls and facilitates the data flow between the CPU and the other peripherals such as network interfaces, storage devices, USB devices, and audio ports. It also facilitates connecting M.2 NVMe drives to the motherboard and manages RAID data storage virtualization.

However, RAM and some PCIe slots are directly connected to the CPU for better performance bypassing the traditional Northbridge behaviour. Additionally, the Intel UHD on-board graphics in the 10th and 11th generation processors also connect to display ports directly bypassing the chipset.

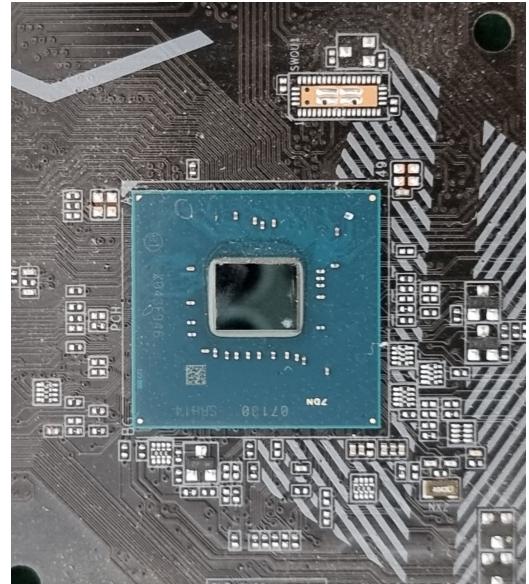


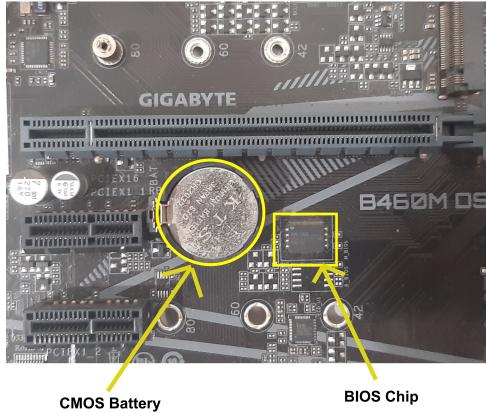
Figure 2.3: Intel H470 chipset

### 2.4 BIOS Chip and CMOS Battery

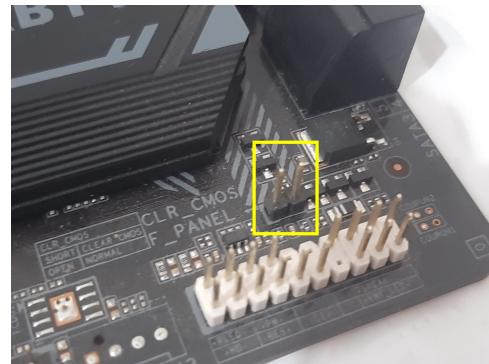
Basic Input Output System (BIOS) chip stores the firmware that needs to be run at every system boot-up. It simply checks for any abnormalities in the system and proceeds to the loading of the operating system if none found.

The CMOS (Complementary Metal Oxide Semiconductor) battery is used to get continuous power to the CMOS memory, a small memory in which the BIOS settings of the computer such as boot order of drives and system date and time etc. are stored, even when the computer is not connected to the main supply.

There is a special jumper on the motherboard which is used to reset the BIOS settings to their defaults. The jumper consists of two metal pins and when they are short-circuited for a given time, the settings will be reset.



(a) BIOS Chip and CMOS Battery



(b) Jumper to clear BIOS settings

Figure 2.4: BIOS chip, CMOS battery, and BIOS CLR jumper

## 2.5 Cooling Options

### 2.5.1 Heat Sinks

The GIGABYTE B460M DS3H V2 motherboard utilizes heat sinks to dissipate heat from specific components such as the CPU and the chipset. Heat sinks come in two main types: passive and active. Passive heat sinks don't require fans, relying solely on their design and material to dissipate heat. Active heat sinks, on the other hand, incorporate fans to enhance heat dissipation. Heat sinks contribute significantly to maintain stable temperatures, which is crucial for preventing overheating and ensuring optimal performance.

### 2.5.2 Fans

To further enhance cooling, the motherboard employs fans strategically placed to promote airflow and dissipate heat. Fans play a critical role in expelling hot air from the case and bringing in cooler air to regulate temperatures. The GIGABYTE B460M DS3H V2 motherboard may come with built-in fan headers to which case fans can be connected. These fans can be controlled manually or through automatic speed control mechanisms based on temperature readings.

### 2.5.3 Customization and Expansion

Users have the flexibility to customize their cooling solutions based on their system's requirements. Aftermarket cooling solutions, such as advanced heat sinks and high-performance fans, can be added to further enhance the cooling capabilities of the motherboard. Additionally, proper case ventilation and cable management contribute to effective overall cooling.



Figure 2.5: Heat sink on the chipset

# Functional Block Diagram of a Motherboard

A motherboard can be considered as a pinnacle of the development of Electronics and Computer Architecture which integrates the concepts in both domains to create a functioning computer system, which in turn makes many other fields and domains to function properly and efficiently. As GIGABYTE B460M DS3H V2 motherboard has been manufactured in the recent couple of years, it shows the latest technologies and approaches in motherboard designing. The following chart shows how the different functional blocks of the motherboard are inter-connected and inter-related.

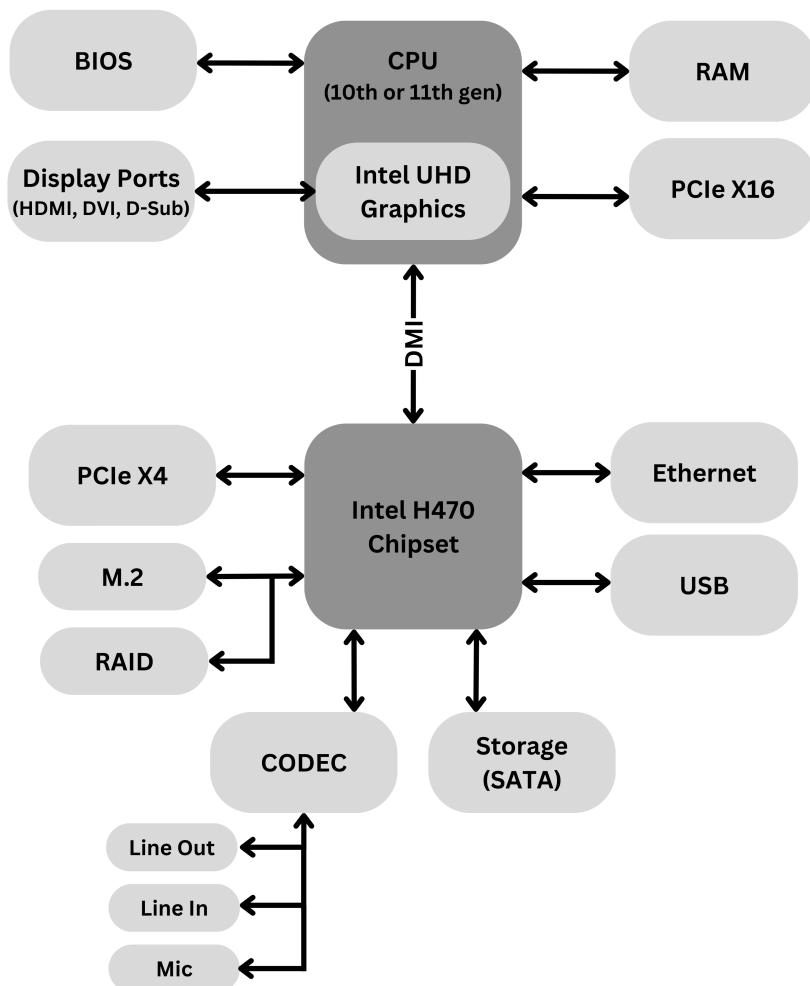


Figure 3.1: Functional Block Diagram of a Motherboard

# Input Output (I/O) Component Classification and Connectivity Options

## 4.1 Internal I/O Components

1. **24-pin ATX main power connector** - Supplying power to the motherboard.
2. **8-pin ATX 12V power connector** - Supplying power to the CPU.
3. **CPU fan header / System fan header** - Supplying power to the cooling fans.
4. **Addressable LED strip header / RGB LED strip header** - Supplying power to the decorating LEDs.
5. **M.2 Socket 3 connector** - Provides an interface for connecting M.2 SSDs.
6. **SATA 6Gb/s connectors** - Connecting high-speed serial ATA devices.
7. **Front panel header** - Connect the case's front panel components, such as power buttons, reset buttons, LED indicators, and audio jacks, to the motherboard.
8. **Front panel audio header** - Connect the audio ports on the front of the computer case (usually headphones and microphone jacks) to the motherboard.
9. **USB 3.2 Gen 1 header / USB 2.0/1.1 headers** - Connecting USB drives and peripherals.
10. **Thunderbolt™ add-in card connectors** - Serve as connection points for Thunderbolt™ add-in cards. (Thunderbolt is a high-speed interface technology that enables fast data transfer)
11. **Trusted Platform Module (TPM) header** (For the GC-TPM2.0 SPI/GC-TPM2.0 SPI 2.0 modules only) - Enhances the security of a computer system by providing features like encryption, secure boot, and hardware-based authentication.
12. **Serial port header** - Connects external devices, such as serial communication devices, to the motherboard.
13. **Clear CMOS jumper** - To clear the BIOS configuration and reset the CMOS values to factory defaults.
14. **Q-Flash Plus button** - Q-Flash Plus enables BIOS updates when the system is powered off (S5 shutdown state). By inserting a USB thumb drive that contains the updated BIOS into the dedicated port, we can then proceed to automatically flash the BIOS by pressing the Q-Flash Plus button.

## 4.2 Classification of External I/O Components/ Peripherals

Input-output peripherals are important parts of a motherboard. They help the computer take in different kinds of inputs. Below, there are different connecting options for IO components to the GIGABYTE B460M DS3H V2 motherboard.

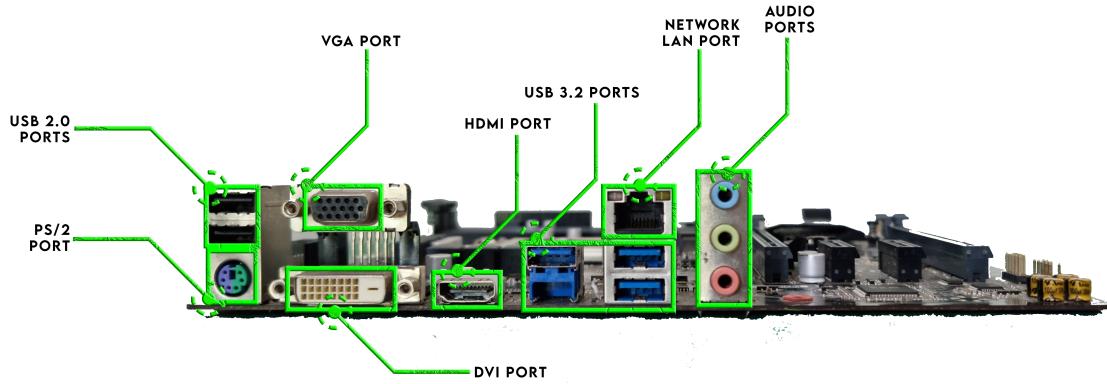


Figure 4.1: Ports and connectors in the back panel

**USB 2.0/1.1 Port (2)** - This USB port supports the USB 2.0/1.1 specifications and is capable of a data transfer rate of up to 480Mbps.

**USB 3.2 Gen 1 Port (2)** - The USB 3.2 Gen 1 port supports the USB 3.2 Gen 1 specification and is compatible with the USB 2.0 specification. It offers a data transfer rate of up to 5Gbps which is faster than that of the USB 2.0 ports.

**USB 3.2 Gen 1 Port (Q-Flash Plus Port) (1)** - Q-Flash is a BIOS flash utility integrated into the Flash ROM. With Q-Flash, we can update the system BIOS without having to enter operating systems like MS-DOS or Windows first. Before using Q-Flash Plus (Note), we need to make sure to insert the USB flash drive into this port first.

**PS/2 Keyboard/Mouse Port** - A 6-pin mini-DIN connector that can be used to connect a PS/2 (Personal System/2) keyboard or mouse. These 6 pins in this port have their own different functions. The PS/2 port operates with a serial communication frequency of 10-16.7 kHz, resulting in a bit rate of 7-12 kbps.

**D-Sub Port** - D-Sub ports, also known as VGA (Video Graphics Array) ports, are common connectors used to transmit video signals from a computer or device to a display, such as a monitor or projector. This D-Sub port supports a 15-pin D-Sub connector and supports a maximum resolution of 1920x1200@60 Hz.

**DVI-D Port** - DVI (Digital Visual Interface) is a video display interface used by common devices such as computer monitors and projectors. GIGABYTE B460M DS3H V2 motherboard featured with DVI-D (DVI - Digital) single link port that supports a maximum resolution of 1920x1200 while dual link ports support a maximum resolution of 2560x1600.

**HDMI Port** - HDMI (High-Definition Multimedia Interface) is a widely used audio and video interface that allows for the transmission of high-quality digital signals between devices. In GIGABYTE B460M DS3H V2 there is an HDMI port that supports HDCP 2.3 (High-bandwidth Digital Content Protection) Dolby TrueHD and DTS HD Master Audio formats. It also supports up to 192KHz/16bit 7.1-channel LPCM audio output. The maximum supported resolution is 4096x2160@30 Hz.

**RJ-45 LAN Port** - This port is the network port on a computer and connects the computer to a LAN via a wired connection. RJ-45 port in GIGABYTE B460M DS3H V2 provides an Internet connection at up to 1 Gbps data rate. Two LEDs are located at the top of the port: one indicates speed, while the other shows activity status.

**Line In/Rear Speaker Out (Blue)** - This audio jack serves as a line-in input. It can be used to connect line-in devices such as optical drives, Walkmans, and similar audio sources.

**Line Out/Front Speaker Out (Green)** - This audio jack functions as a line-out output and is suitable for speakers or headphones.

**Mic In/Center/Sub-woofer Speaker Out (Pink)** - This jack is dedicated to audio inputs like microphones.

### 4.3 Connectivity Options with Key Specifications

**USB** Universal Serial Bus (USB) ports facilitate data transfer, power delivery, and communication between devices, enhancing their versatility and functionality.

In the GIGABYTE B460M DS3H V2 motherboard, there is a total of 5 USB ports: 2 USB 2.0 ports with a maximum speed of 480 Mbps and an additional 3 USB 3.2 Gen 1 ports with a maximum speed of 5 Gbps. USB protocol is the standardized communication protocol that acts as the common interface for communication between peripheral devices. It defines the rules and procedures for data exchange, power distribution, and control between devices and hosts.

**Ethernet** Ethernet is a widely used networking technology for devices within a local area network (LAN). It employs packet-switching and supports speeds like 10/100 Mbps and 1 Gbps. Motherboards, like the GIGABYTE B460M DS3H V2, feature Ethernet ports for stable wired network connections.

**PCI/ PCIe** PCI stands for "Peripheral Components Interconnect." PCI is a serial expansion bus standard used to connect computers with one or more peripheral devices such as graphic cards. These slots are classified as 1x, 2x, 4x, or 16x to accommodate different types of PCI Cards. The GIGABYTE B460M DS3H V2 motherboard offers four PCI slots, comprising two PCI Express 2.0 x1 slots, one PCI Express 2.0 x4 slot, and one PCI Express 2.0 x16 slot.

Peripheral Component Interconnect Express (PCIe) offers superior data transfer rates and lower latency compared to PCI. When a device is connected to a motherboard via a PCIe link, it gains its own dedicated point-to-point connection. This means that devices do not share the same bus.

**SATA** Serial Advanced Technology Attachment (SATA) functions as a computer bus interface that connects host bus adapters to mass storage devices like hard disk drives (HDD), optical drives, and solid-state drives (SSD).

The GIGABYTE B460M DS3H V2 motherboard features four SATA connectors that adhere to the SATA 6Gb/s standard and are compatible with both the SATA 3Gb/s and SATA 1.5Gb/s standards. Each SATA connector supports a single SATA device.

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