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EN2031 - Fundamentals of Computer Organization and Design
Motherboard Dissection Report
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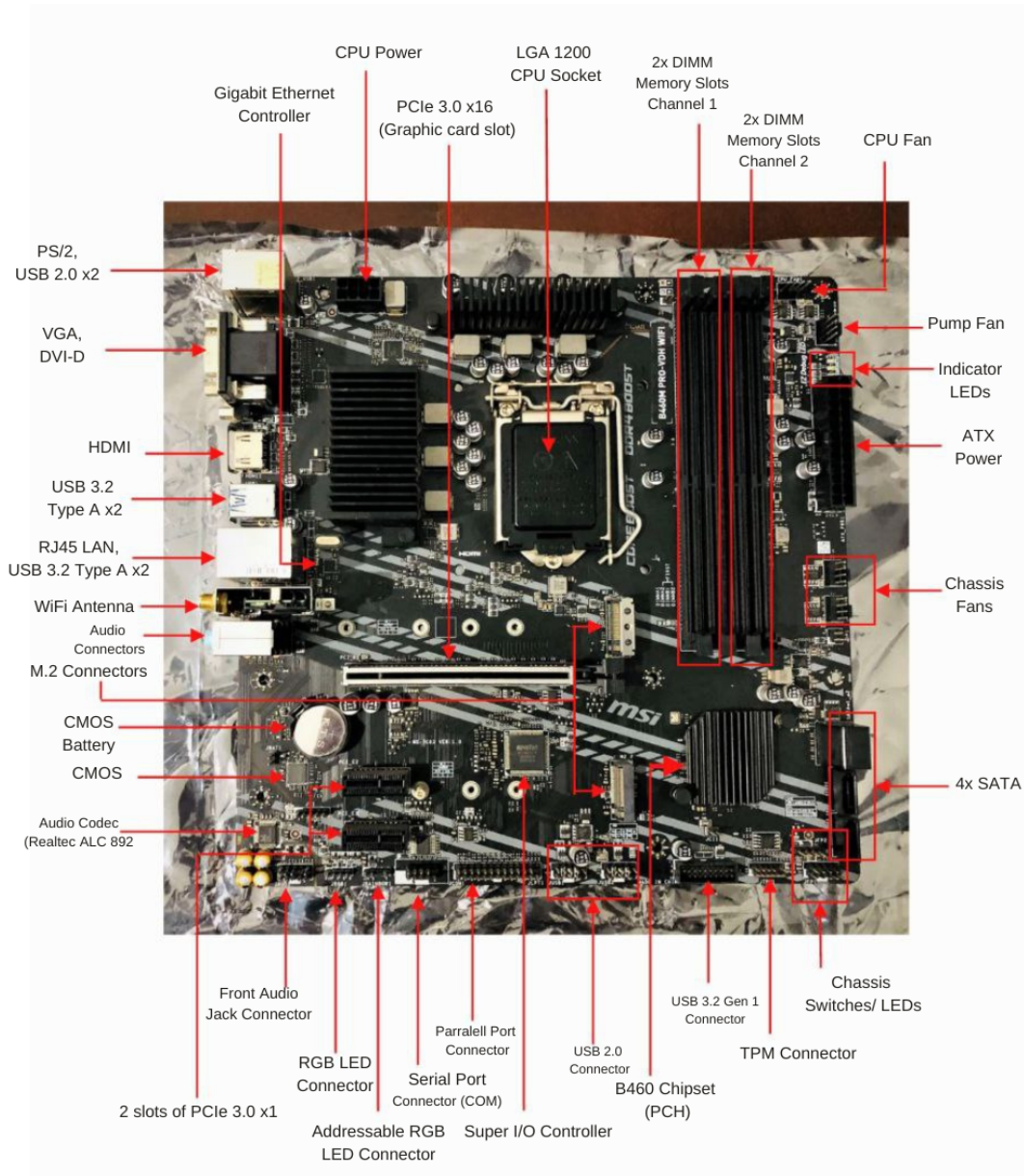
1 Abstract

Our dissection report is based on the MSI B460M PRO-VDH WIFI motherboard and the main inceptions are Identification of main components and their key specifications, Cooling Options, Connectivity options with their key specifications, IO component classification based on their access speeds, and Functional Block Diagram indicating all the main components and their inter-connectivity.

2 Introduction

One of the standout features of this motherboard is its integrated Wi-Fi 6 technology, which offers faster and more reliable wireless connectivity compared to previous generations. This makes it an excellent choice for users who require stable internet connections for gaming, streaming, or professional work. Also this motherboard emphasizes cooling and thermal management, featuring multiple fan headers and comprehensive controls via the MSI Dragon Center software. This allows users to optimize their cooling setup to maintain optimal temperatures under various workloads. The motherboard layout is designed to facilitate easy installation and upgrades, with ample space for memory modules, storage devices, and expansion cards. Furthermore, the motherboard supports dual-channel DDR4 memory, with speeds up to 2933 MHz, providing ample bandwidth for multitasking and demanding applications.

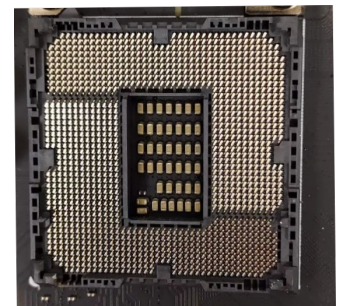
3 Motherboard Layout



4 Main Components

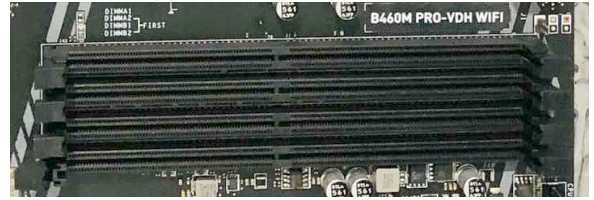
4.1 Processor

MSI B460M PRO-VDH WIFI motherboard supports 10th Gen Intel Core (i3, i5, i7, i9) and Pentium Gold / Celeron processors for the LGA 1200 socket (Socket H5). Unfortunately, this motherboard does not support overclocking (for Intel, we need a Z or X series motherboard) and the dissected computer had an Intel i5-10600K, which is a unlocked processor. The processor socket allows the CPU to be mounted on the motherboard with the locking mechanism. The socket is designed for variety of cooling solutions to be mounted on the processor such as full fan heat sinks or custom pump fan cooling solutions with a dedicated header pin. MSI software allows the user to monitor the temperature and control the fan speed at different levels.



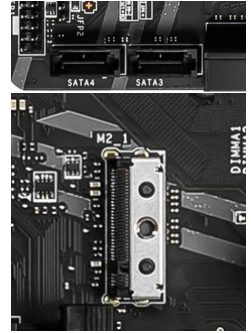
4.2 Memory (RAM)

This motherboard features four DDR4 memory slots and a maximum of 128GB memory. It is compatible with Intel i7 and i9 processors, which support 2933 MHz bus speed and with Intel i5 and below, supporting 2666 MHz bus speed. The motherboard supports dual-channel mode, non-ECC (Error Correcting Code), unbuffered memory, and Intel Extreme Memory profile enabled. (XMP is a memory profile that allows the user to overclock the memory to higher speeds).



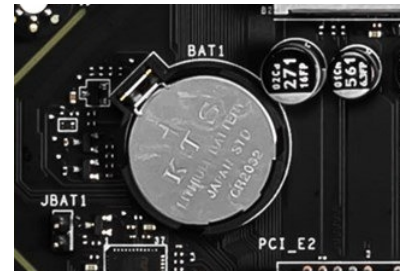
4.3 Storage

MSI B460M PRO-VDH WIFI motherboard supports 4 SATA ports and 2 M.2 slots for storage. The SATA ports are used to connect traditional hard drives and solid-state drives to the motherboard. The M.2 slots are used to connect high-speed NVMe solid-state drives, which offer faster data transfer speeds compared to traditional SATA drives. The motherboard also supports RAID 0, RAID 1, RAID 5, and RAID 10 configurations. The M.2 slots support both PCIe and SATA-based M.2 drives, and it is very important to mention that the M.2 SATA SSD will disable the SATA 1 port. The maximum speed of SATA is 6Gb/s and M.2 is 32Gb/s.



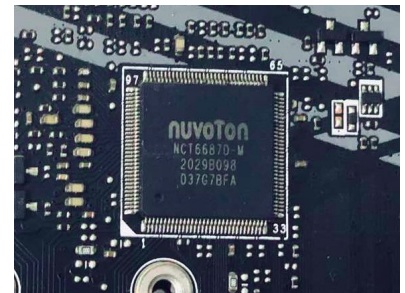
4.4 CMOS and Battery

CMOS stands for Complementary Metal-Oxide-Semiconductor and the main purpose is to store system settings, boot order and date and time. The CMOS battery is about 3V and The CMOS battery is used to power the CMOS chip when the computer is turned off, allowing it to retain the system settings and other information. If we remove it and put it back, the system will reset to default settings.



4.5 Super I/O Controller

The motherboard includes an super I/O controller (NUVOTON NCT6687D Controller Chip), which manages legacy input and output connections like Serial, Parallel a range of connectivity options, including USB ports, audio jacks, and network connections. It also includes features such as fan control and temperature monitoring to help manage the system's cooling and performance.



4.6 Platform Controller Hub (Intel B460M)

The MSI B460M PRO-VDH WIFI motherboard uses the Intel B460 chipset as the PCH, which is part of Intel's mid-range offering for 10th Gen Intel Core processors. This supports up to six SATA ports, PCIe 3.0 lanes for expansion, and 12 USB ports. Although it lacks overclocking capabilities (which are only available in Intel's Z series chipsets), the B460 chipset offers dual-channel memory support and the ability to connect various peripherals. It also integrates functions such as gigabit Ethernet in conjunction with a dedicated Ethernet controller (Realtek RTL8111H) and other I/O management features to enhance system connectivity. Additionally, the chipset handles audio I/O with the support of a dedicated audio codec like Realtek ALC892.

5 Other Integrated Circuits

5.1 Ethernet Controller

The Realtek RTL8111H IC is used to provide Gigabit LAN ethernet connection to this motherboard. This supports 10/100/1000 Mbps high speed networking with low latency. This also includes Green Ethernet for power-saving modes and support features like Wake-on-LAN(WoL), jumbo frame support, and hardware checksum offloading.

5.2 Audio Codec

The Realtek ALC892 is a High Definition Audio (HDA) codec chip, introduce 8-channel audio support, for 7.1 sound setup. It features a 96kHz/24-bit DAC with 97db SNR and ADC with 90dB SNR for all channels. Also this includes line-in, line-out, mic-in, and SPDIF output options. Also ALC892 supports jack detection and stereo input and output re-tasking, along with technologies such as EAX, Dolby, and DTS for enhanced sound quality. This IC communicates with the PCH (Intel B460M) to provide inputs and outputs to both the front and back panel audio jacks.



6 Interface Standards

6.1 PCI (Peripheral Component Interconnect)

Newer motherboards have PCI Express slots, which are faster than the older PCI slots. It is a high speed serial computer expansion bus standard. It can be used to add network cards, sound cards and graphics cards. This motherboard has 1 PCIe 3.0 x16 slots and 2 PCIe 3.0 x1 slot. The x16 slot is used for the graphics cards (Dissected computer had a Nvidia GTX 1660 Super graphics card.) and controlled by the CPU, and the x1 slots are used for other expansion cards and controlled by the PCH(Platform Controller Hub).



1x PCI-e x16 slot and 2x PCI-e x1 slots

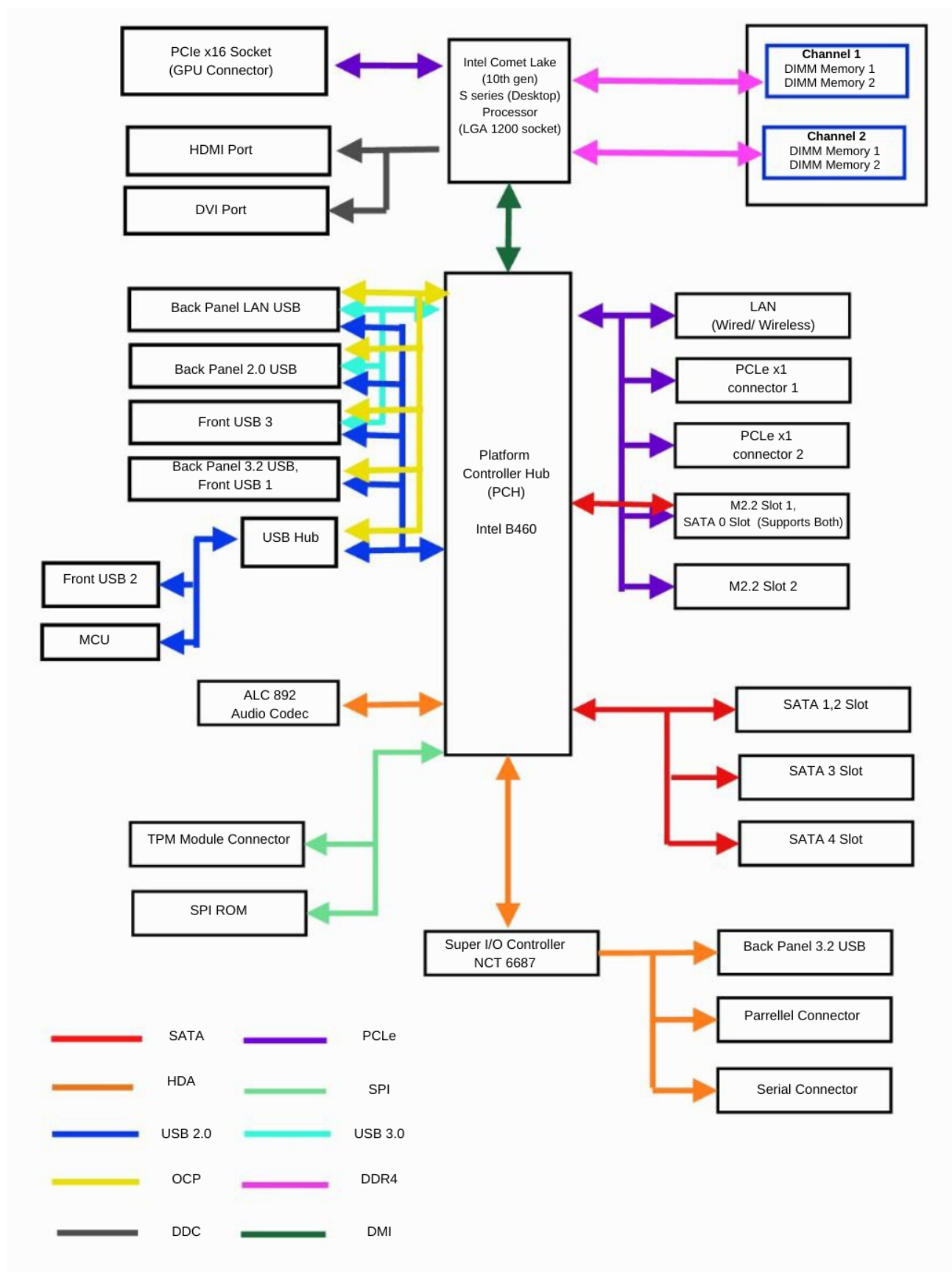
6.2 SATA

SATA (Serial Advanced Technology Attachment) is a standard for connecting hard drives and solid-state drives to the motherboard. It is a serial bus interface standard that transfers data between the motherboard and storage devices. SATA 3.0 has a maximum of 600 MB/s data transfer rate.

6.3 DMI 3.0

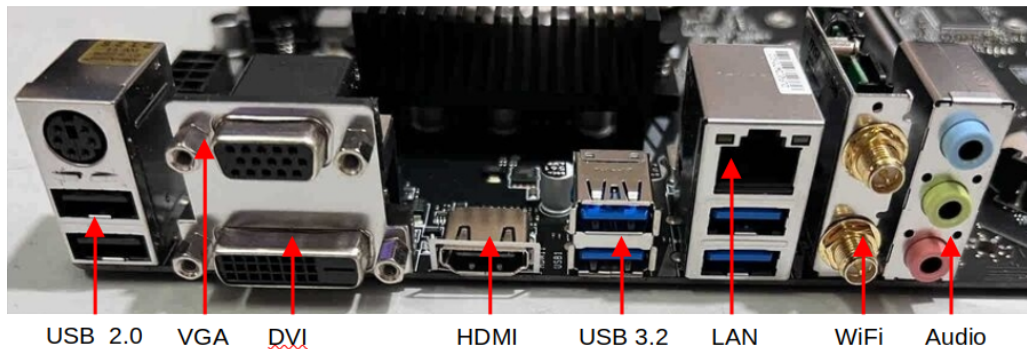
DMI (Direct Media Interface) is a proprietary interconnect that connects the PCH to the CPU and innovated by Intel in 2004. This motherboard has DIM 3.0 and it is capable of transferring data at a rate of 3.93 GB/s with a total of four lanes (8 GT/s) and DMI 4.0 support up-to 16GB/s with eight lanes which is introduced with 600 series chipsets.

7 Functional Block Diagram



8 I/O Components

8.1 Back Panel I/O Ports



USB (Universal Serial Bus)

USB ports are used to connect various peripherals to the motherboard such as a mouse, keyboard, flash drives, and printers. This motherboard support both USB 2.0 and USB 3.2 connectivity.

VGA

VGA ports are used to provide display output from the motherboard or graphics card. Shown VGA output will give onboard graphics and whenever an external graphics card is connected it will be disabled.

DVI

DVI ports are used for connecting digital displays, providing a higher-quality video output compared to VGA. This motherboard has a DVI-D port (Single Link).

HDMI

HDMI ports are used for transferring high-definition video and audio signals to monitors, TVs, or projectors. Newer motherboards have display ports which are more advanced than these ports.

LAN

LAN ports connect the motherboard to wired networks, providing reliable internet and local network access. RJ45 ports are controlled by 8111H Gigabit LAN controller and provides maximum speed of 1.0 Gbp/s

WiFi

Manufacturer provide 2 WiFi antennas with the motherboard and 433Mbps of data transfer rate is supported by the Intel AC 3168 wireless adapter

8.2 Internal Connectors

24 Pin ATX power connector

This port is used to deliver power from the computer's power supply unit to the motherboard.

Front panel connectors

As shown in the overview there is a series of front panel connector pins such as front panel audio, USB and chassis switches connectors.

Fan connectors

This headers allows to connect CPU cooling fans and Chassis fans.

TPM connector

This is header on the motherboard that allows for the connection of a TPM module, a hardware-based security component used for various security functions.

9 Cooling Options

Cooling options are essential for maintaining consistent performance of the motherboard under various operating conditions. The primary heat sources on the motherboard are the CPU and the Intel B460 chipset.

9.1 CPU Cooling

The motherboard we dissected included a Noctua NH-U12A air cooler, which is a fan dedicated for CPU cooling which features a heat-sink with 7 heat pipes and an increased fin surface area for efficient heat dissipation. Furthermore it has a maximum speed of 2000 RPM and has a low operating noise(22.5dB). The motherboard includes a dedicated 4-pin CPU fan connector for this. The functions of the 4 pins are listed below.

- Pin 1- **Ground** (Provides the ground connection for the fan)
- Pin 2- **Power** (Supplies the power to the fan. Usually this is a 12V power supply)
- Pin 3- **Tachometer** (Provides a signal to the motherboard to indicate the speed of the fan)
- Pin 4- **PWM Control** (Allows the motherboard to adjust the fan speed using Pulse Width Modulation)

The motherboard also has a integrated sensor to monitor the CPU temperature, which is crucial for ensuring that the processor is not overheating and is operating within safe limits.

9.2 Chipset Cooling

The Intel B460 chipset generates less heat than the CPU. Due to this passive cooling is used. A heat sink is used for this purpose. It is made out of Aluminium or Copper which conducts heat effectively. The heat sink usually has a fin like design which increases the surface area for better heat dissipation. Also to increase the thermal connection between the chipset and the heat sink, thermal paste has been applied. The motherboard does not have a dedicated sensor to monitor the temperature of the chipset.

9.3 System Cooling

The motherboard comprises of two 4-pin fan connectors for system cooling. The motherboard we dissected included Noctua NF-F12 fans which were fixed to the casing. These fans have a maximum speed of 1500 RPM and also operate at a low noise level (22.4 dB). These fans indirectly help in dissipating the heat from the motherboard by creating an airflow within the system.

9.4 Other Options

- **Liquid Cooling** - This technology uses a special water block to conduct heat away from the processor as well as the chipset. A pump is then used to circulate the liquid coolant through the system and the radiator dissipates the heat in the liquid coolant into the air. Though the motherboard we dissected included a separate 4-pin water pump connector there wasn't any component connected to it.

- **MSI Dragon Center** - This is a software suite developed specifically for MSI motherboards which displays real time information about CPU and GPU temperatures and fan speeds. Also it allows users to manually control fan speeds or set automatic fan curves based on system temperatures. This ensures efficient and customizable cooling of the system.

10 Connectivity Options

Category	Interface Type	Peripheral	Specifications
Network	Wi-Fi	Intel AC 3168 wireless adapter	Protocol: IEEE 802.11a/b/g/n/ac <ul style="list-style-type: none"> • 2.4 GHz and 5 GHz dual-band support for better signal coverage and data rates • Supports advanced security standards like WPA/WPA2
	LAN	Realtek RTL8111H Gigabit LAN Controller	Protocol: IEEE 802.3, 802.3u, 802.3ab <ul style="list-style-type: none"> • Supports Wake-on-LAN (WoL) • Auto-Negotiation for speed and duplex
PrimaryStorage	Random Access Memory	DDR4-2666 Memory	Protocol: JEDEC DDR4 standard <ul style="list-style-type: none"> • Supports Dual-Channel mode • Data Rate: 21.3 GB/s
	Read Only Memory	Flash Memory	Protocol: UEFI,PCIe <ul style="list-style-type: none"> • Non-volatile memory • Capacity: 128 Mb • Stores firmware (BIOS/UEFI)
	Cache	12 MB Intel Smart Cache	Protocol: MESI <ul style="list-style-type: none"> • Allows all cores to dynamically share access to the last level cache
Secondary Storage	Hard Disk Drive/Solid State Drive	4x SATA ports 2x M.2 slots	Protocol: SATA 3,PCIe <ul style="list-style-type: none"> • SATA port has a data rate of 6Gb/s • M.2 slots supports PCIe 3.0, which has a data rate of 32Gb/s
External Storage	USB	6x USB 3.2 Gen 1 ports 6x USB 2.0 ports	Protocol: USB 2.0, USB 3.2 <ul style="list-style-type: none"> • USB 3.2 ports have a data rate of 5Gb/s and can deliver power upto 900mA at 5v (4.5W) • USB 2.0 ports have a data rate 400Mb/s and can deliver power upto 500mA at 5V (2.5W) • Uses PCIe bus to communicate with the CPU
Graphics	Video Output	HDMI port	Protocol: TDMS <ul style="list-style-type: none"> • Supports a maximum resolution of 4096x2160 @ 30Hz, 2560x1600 @ 60Hz
	Video Output	DVI-D port	Protocol: TDMS <ul style="list-style-type: none"> • Supports a maximum resolution of 1920x1200 @ 60Hz
	Video Output	VGA port	Protocol: Analog signalling <ul style="list-style-type: none"> • Supports a maximum resolution of 2048x1536 @ 50Hz, 2048x1280 @ 60Hz, 1920x1200 @ 60Hz
	Graphical Processing	GPU	Protocol: PCIe <ul style="list-style-type: none"> • Responsible for processing the video data from the CPU and converting it into a form suitable for each video output interface. • PCIe is the communication pathway between the CPU and GPU

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