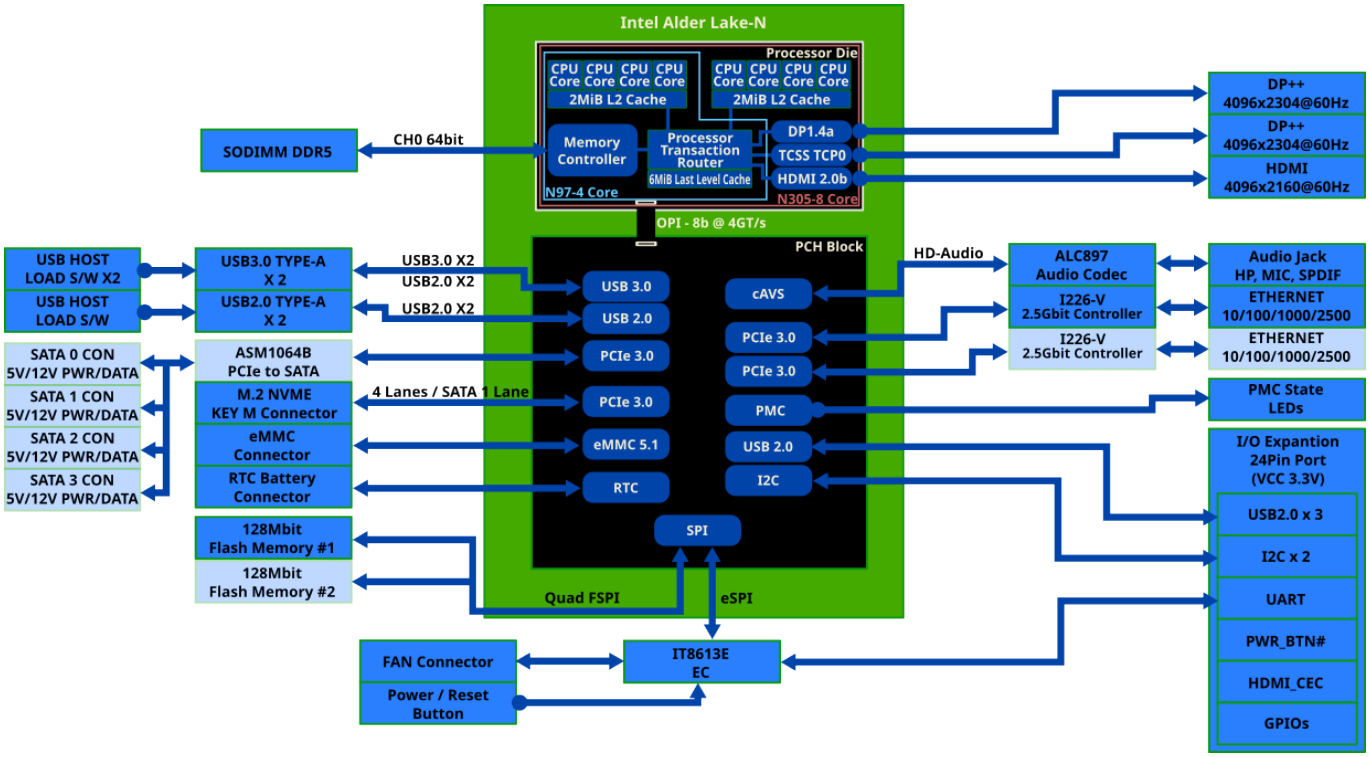
ODROID-H3

Hardware

Block diagram



Specifications

Item	Description
Form Factor	120mm x 120mm x 44mm Approx. Weight : H4 Ultra and H4+ 350g , H4 320g including heatsink
Processor	Intel i3 N305 Octa-Core or Intel N97 Quad-Core
Memory	1 x DDR5 SO-DIMM slots Single Channel, up to 4800 MT/s Max memory capacity 48GB DDR3/DDR4 are not supported
Storage	1 x eMMC connector (bootable and selectable on BIOS) Various eMMC modules can be purchased at Hardkernel store separately 4 x SATA3 6Gbps (The SATA Port-Multiplier doesn't work) 1 x M.2 slot (PCIe 3.0 x 4, supports NGFF-2280 cards)
Networking	2 x GbE LAN ports (RJ45, supports 10/100/1000/2500 Mbps) Intel I226-V Supports Wake-On-Lan LED indicators (Green: Link, Amber: Traffic)
Video	2 x DisplayPort 1.2 (up to 4K@60Hz) 1 x HDMI 2.0 (up to 4K@60Hz) Triple simultaneous display support

Item	Description
Audio	1 x Audio out (3.5mm jack) 1 x Audio in (3.5mm jack) 1 x SPDIF out (ALC662, HDA codec) * HDMI & DP have audio output too.
External I/O	2 x USB 3.0 Host ports 2 x USB 2.0 Host ports 1 x Peripheral Expansion Header (24-pin, 2.54mm pitch) – 1 x DC 5V, 1 x DC 3.3V, 5 x GND – 1 x UART (TXD/RXD/RTS/CTS : 3.3Volt IO level) – 2 x I2C (SCL/SDA : 3.3Volt IO level) – 1 x External Power Button – HDMI CEC, 5VA+ – 3 x USB 2.0 – All 3.3V I/O signal level
Other features	Passive Heatsink BIOS Backup Battery – Maintains system time and BIOS settings Power Button Reset Button System LEDS Indicators: – Red (PWR) - Solid light when DC power is supplied – Blue (left, SLEEP) - turns off only when the system enters into suspend mode – Blue (right, PMIC) - turns on only when the major power rails are working – Amber (SATA) - Flashes when SATA data transfers – Green (NVMe) - Flashes when NVMe data transfers Active Cooling Fan Connector (12V 4-pin, PWM input + TACHO output) – Active Cooling Fan is optional – Connector (4-pin, **2.54mm** pitch)
Power	DC jack : outer (ground) diameter 5.5mm, inner(positive) diameter 2.1mm DC 11V ~ 20V – DC 15V/4A power adapter is recommended if you don't use any 3.5“ HDDs – DC 19V/7A power adapter is recommended if you use more than one 3.5” SATA HDDs together Power consumption: – Headless Idle : ≃ 3.3W(H4), 4.4W(H4+), 4.5W(H4 Ultra) – Desktop GUI Idle : ≃ 4.5W(H4), 5.8W(H4+),5.9W(H4 Ultra) – CPU + GPU stress test : ≃19~22W – Power-off : ≃0.2W – Suspend : ≃0.9~1.3W

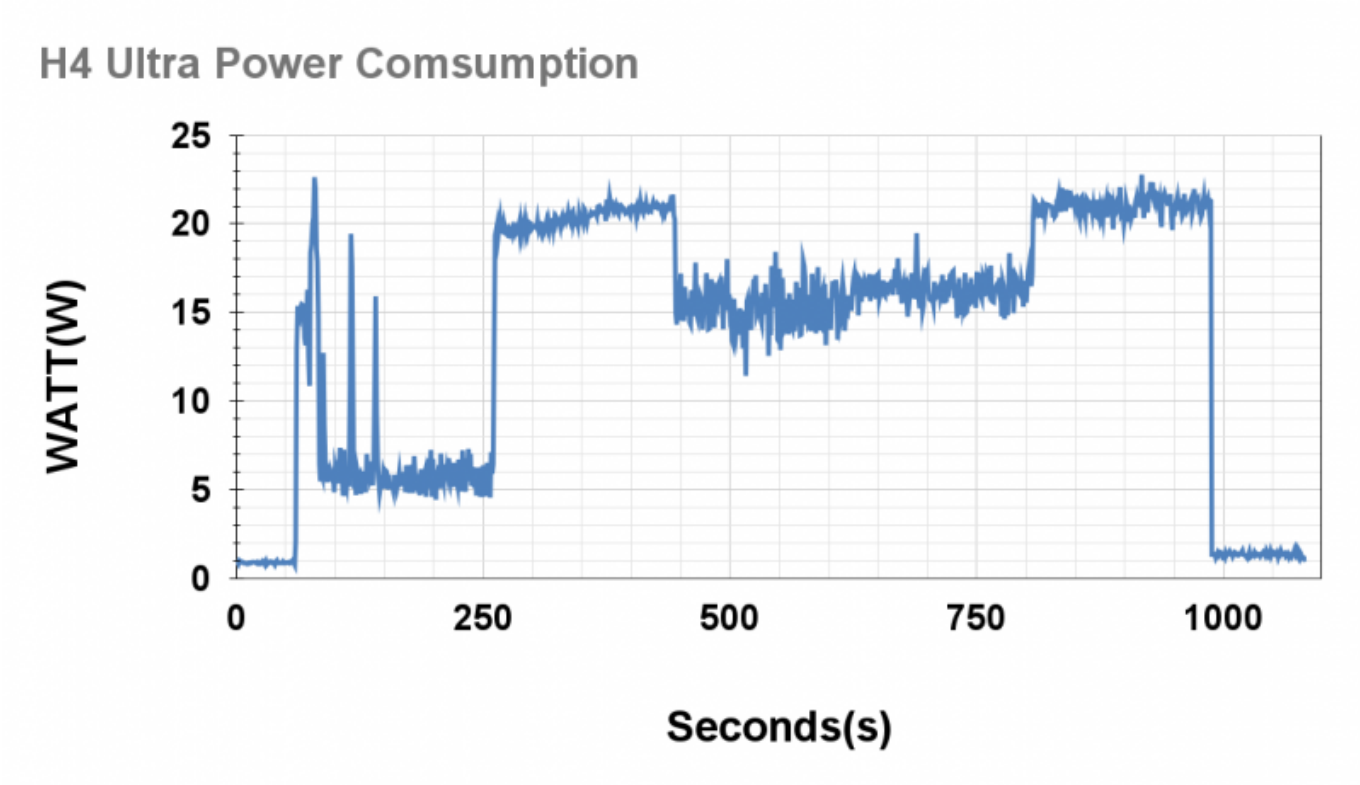
Note that you have to connect an HDMI-CEC adapter board to the 24-pin header to use the HDMI CEC function. The HDMI-CEC boards are sold by 3rd parties.

ODROID boards do not support the hotplug function of storage devices, and replacing SATA, eMMC, or NVMe while the system power is on will cause serious damage to the board and devices.

Power consumption

We used our SmartPower3 (see https://www.hardkernel.com/shop/smartpower-iii/) to test and measure the ODROID-H4 Ultra power consumption while performing specific activities.
We used an M.2 NVMe storage device, 4K HDMI monitor, Ethernet cable and USB combo keyboard + mouse while measuring the power consumption.
Note that Headless-Idle power was measured with all peripherals removed.
The table shown below and its corresponding chart detail the power consumption we witnessed:

Activity	Power Consumption in Watt
Ubuntu Desktop Booting	15.66
Desktop Idle	5.9
Headless Idle	4.4
CPU stress	20.49
4K YouTube play on Chrome Browser	15.33
WebGL aquarium demo on Chrome Browser	16.33
WebGL + CPU Stress	21.03
Power Off	0.20
Sleep (Suspend to RAM)	1.38



Idle Power Characteristics for Headless Server

If the idle period of the server you operate is relatively long, lowering the idle power to a minimum will save electricity bills and help improve the global environment.
So, we have always made continuous efforts to improve the low power characteristics of the H series. Efficiency has always been a top priority when selecting numerous power conversion components in hardware design.

As a result, the new H4 model also achieves idle state power as low as 2 watts. Since many users are very interested in idle power, we conducted more comprehensive in-depth tests for each model.

We started our testing by resetting all BIOS settings and then booting Ubuntu 22.04.4 based on Linux kernel 6.5. After confirming that the CPU's C10 (pc10) state occupancy rate was over 96%, we logged power data every second for more than 60 seconds using SmartPower3, and the average value is written in the table shown below.
Then, we disconnected the HDMI cable and measured it in the same way. In that state, we rebooted, entered the BIOS menu, changed the PL4 value, changed it to Unlimited Performance mode, and tested again. We were able to confirm that the Unlimited Performance setting had near zero effect on idle power.
Next, we changed the PCIe ASPM (Active State Power Management) setting from the default 'Disabled' to 'Auto'. A fairly dramatic reduction in idle power is observed in this area. Now we can see numbers closer to 2 watts. The reason we chose “Disabled” as the default BIOS ASPM setting is because we saw that some NVMe/PCIe devices have been experiencing instability with ASPM features. We let each user turn it on depending on the devices being used.
In addition, if you remove the Ethernet cable, the H4 model shows amazing idle state low power characteristics of 1.5 Watt. Of course, we know that in reality, it is unlikely to be used without an Ethernet cable unless there are special cases like standalone robots or drones.

Anyway, it's a blessing for all of us that anyone can build a very low idle power server that runs continuously 24/7, all year round.

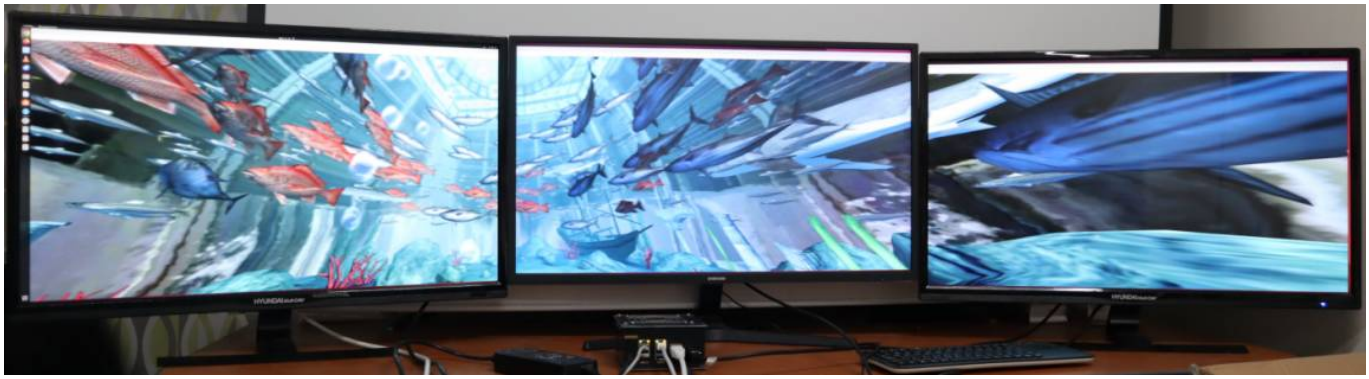
		H4	**H4+**	**H4 Ultra**
Ubuntu Desktop GUI (Power-Save Governor)	HDMI connected	4.6W	6.1W	6.2W
	HDMI disconnect	3.9W	5.3 W	5.4W
Unlimited Performance mode	On (PL4=0)	3.9W	5.3W	5.4W
	Off (PL4=30000, Default)	3.9W	5.2W	5.3W
PCIe ASPM option in BIOS settings	All Disabled (Defaut)	3.9W	5.2W	5.3W
	All Auto	2.0W	2.7W	2.8W
Ethernet connection	**Yes**	**2.0W**	**2.7W**	**2.8W**
	No	1.5W	2.4W	2.4W

Notes
* The idle power of the H4+ and H4 Ultra models is almost identical, well below the margin of error.
* Even when set to Unlimited Performance Mode (PL4=0), the power difference in idle state is negligible.
* If you change the PCIe ASPM option to Auto, idle power can be reduced by about 1~2 Watt even in the Desktop GUI environment.
* The difference in idle power between the H4 and H4+ models is approximately 0.7 to 1.5 Watt due to the external PCIe-to-SATA controller IC and the power circuitry for SATA devices.
* Only one Ethernet cable is connected.
* In this test, Ubuntu Desktop OS was used, and we think that power consumption could have been slightly reduced if Ubuntu Server OS had been used.

Triple 4K/60Hz display output is fantastic with HDMI 2.0 and DP 1.4 ports

- Three different 4K youtube playback flawlessly and simultaneously with Chrome browser on Ubuntu desktop.

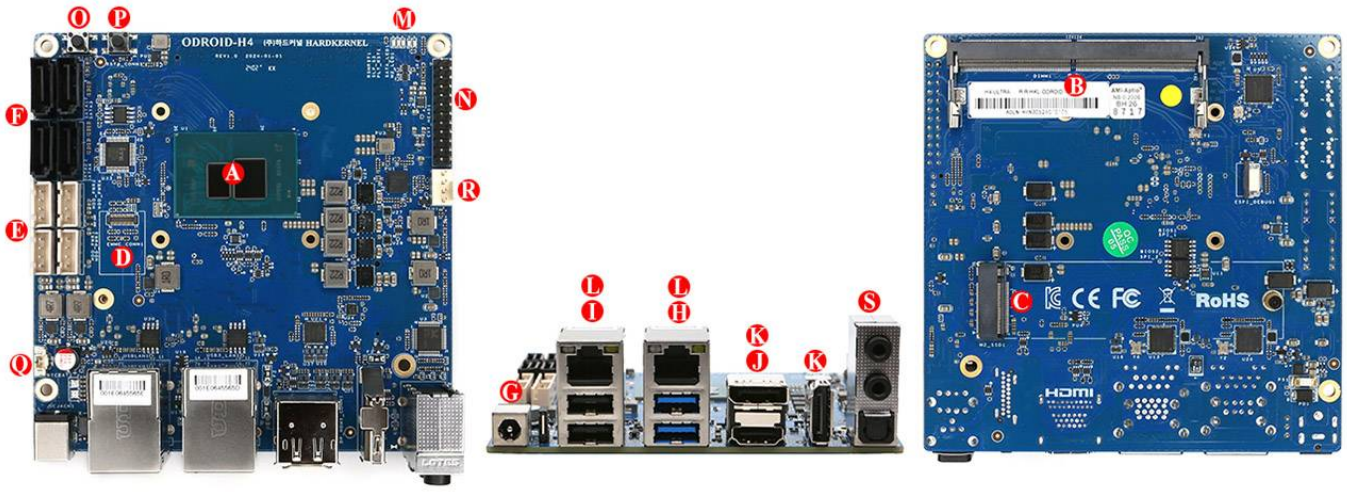
- Ultra wide WebGL Aquarium on Ubuntu Chromium browser.



- The monitor on the left shows Ubuntu Desktop host OS, the one on the middle shows Windows 11 running as a guest OS, the one on the right shows Debian 13 using the hardware virtualization VT-x technology.

Board Layout

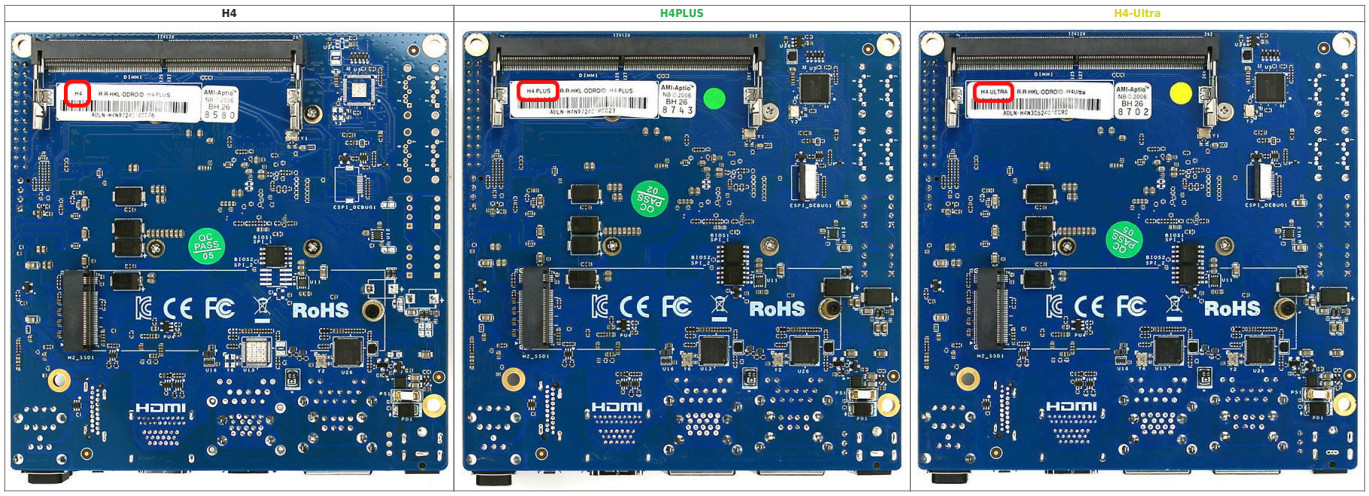
Revision V10 board(H4/H4+/H4 Ultra)



- A. CPU (Intel N97 or N305)
- B. 1 x DDR5 SO-DIMM slots (Single channel memory support)
- C. 1 x M.2 PCI Express Module Socket (NGFF-2280)
- D. 1 x eMMC (Embedded Multimedia-Card) Socket
- E. 4 x SATA Power Connectors (2.5mm pitch, JST-XH compatible connector)
- F. 4 x SATA3 6.0 Gb/s Data Connectors
- G. 1 x DC Power Jack
- H. 2 x USB 3.0
- I. 2 x USB 2.0
- J. 1 x HDMI 2.0
- K. 2 x DisplayPort 1.2
- L. 2 x RJ45 Ethernet Ports (10/100/1000/2500)
- M. 5 x System LED Indicators
- N. 1 x Peripheral Expansion Header (24-pin)
- O. 1 x Power Switch
- P. 1 x Reset Switch
- Q. 1 x Backup Battery Connector (2-pin)
- R. 1 x Active Cooling Fan Connector (4-pin)
- S. 1 x Audio out, 1 x Audio in, 1 x SPDIF out

For the distinction between ODROID-H4, H4+, and H4-Ultra refer to the figure below

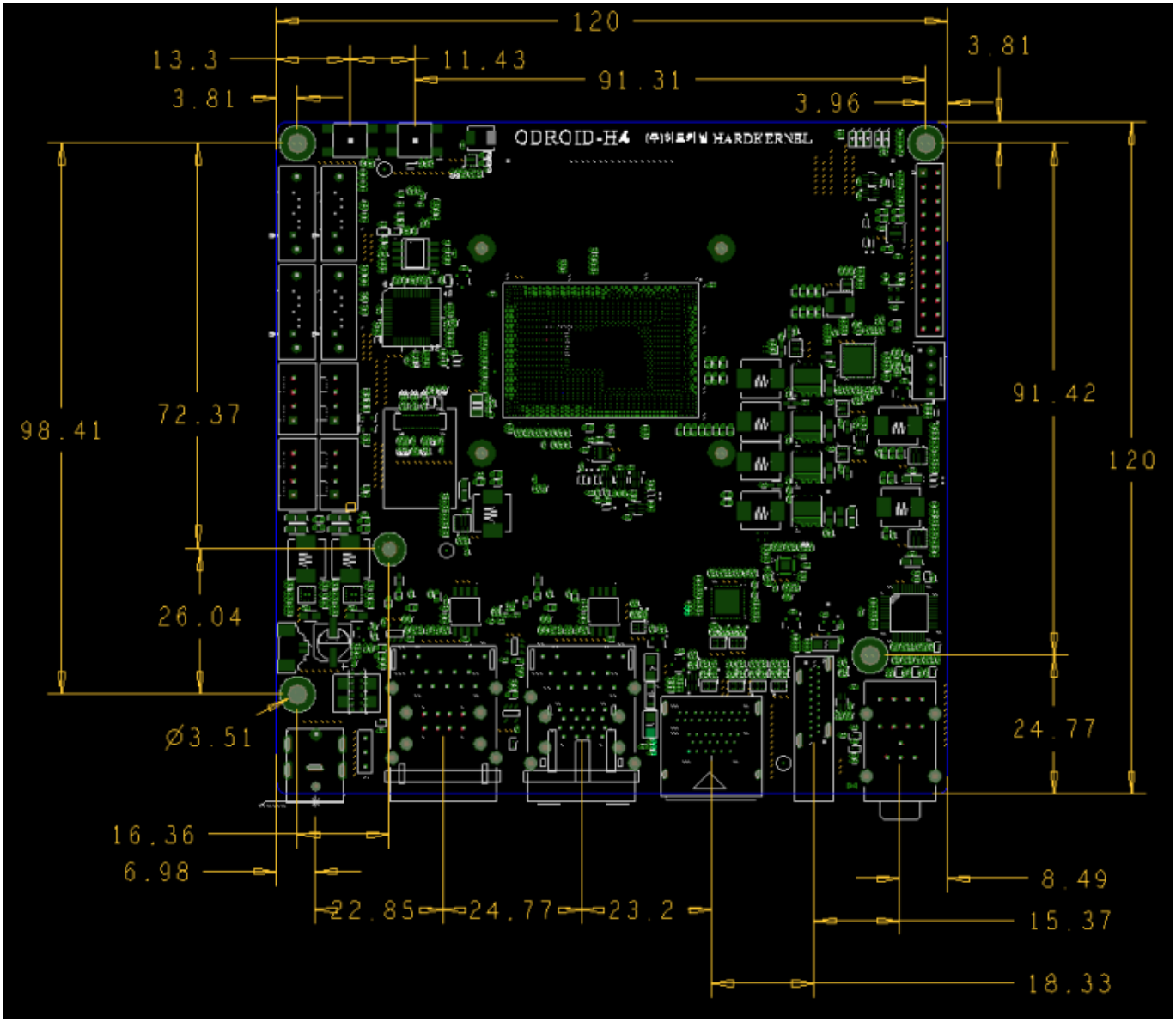
Have written H4, H4PLUS, and H4-ULTRA like in the red circle below pictures where on the bottom PCB inside SODIMM DDR5 Socket.



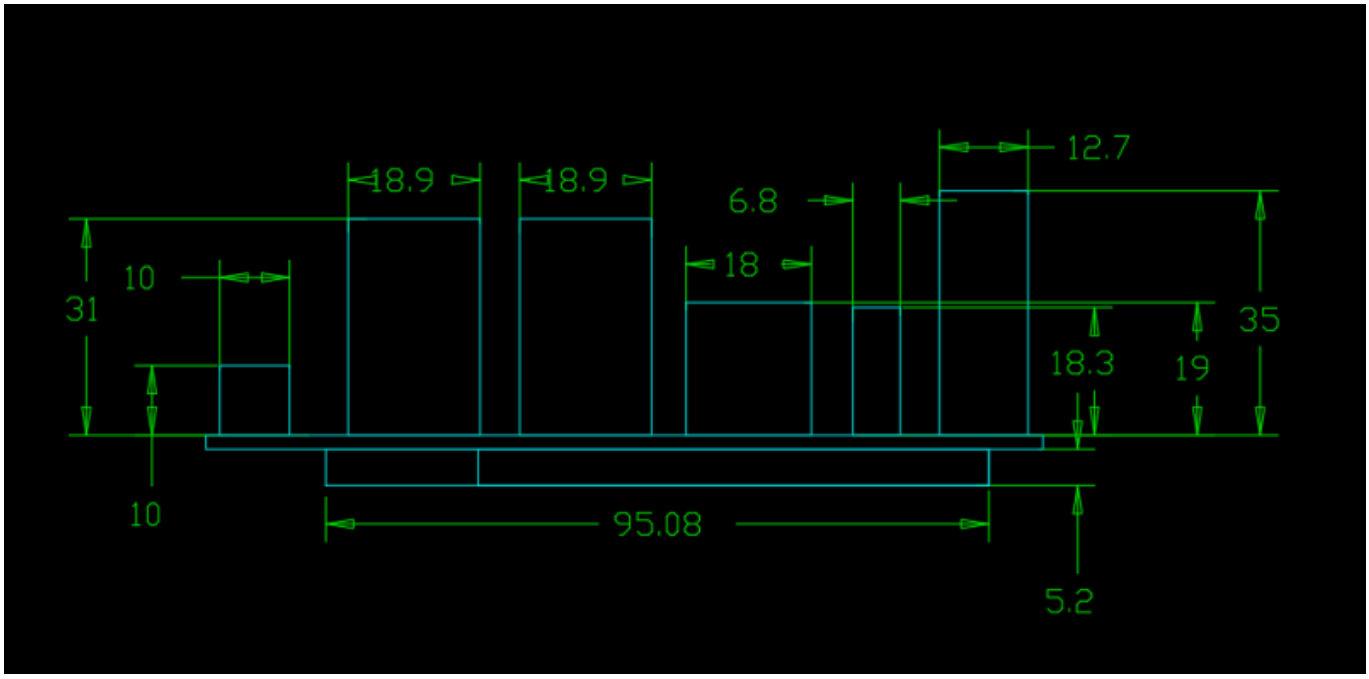
Board dimensions

- Top side
  - Download Top and Bottom dxf file format

H4 PCB Top and Bottom side

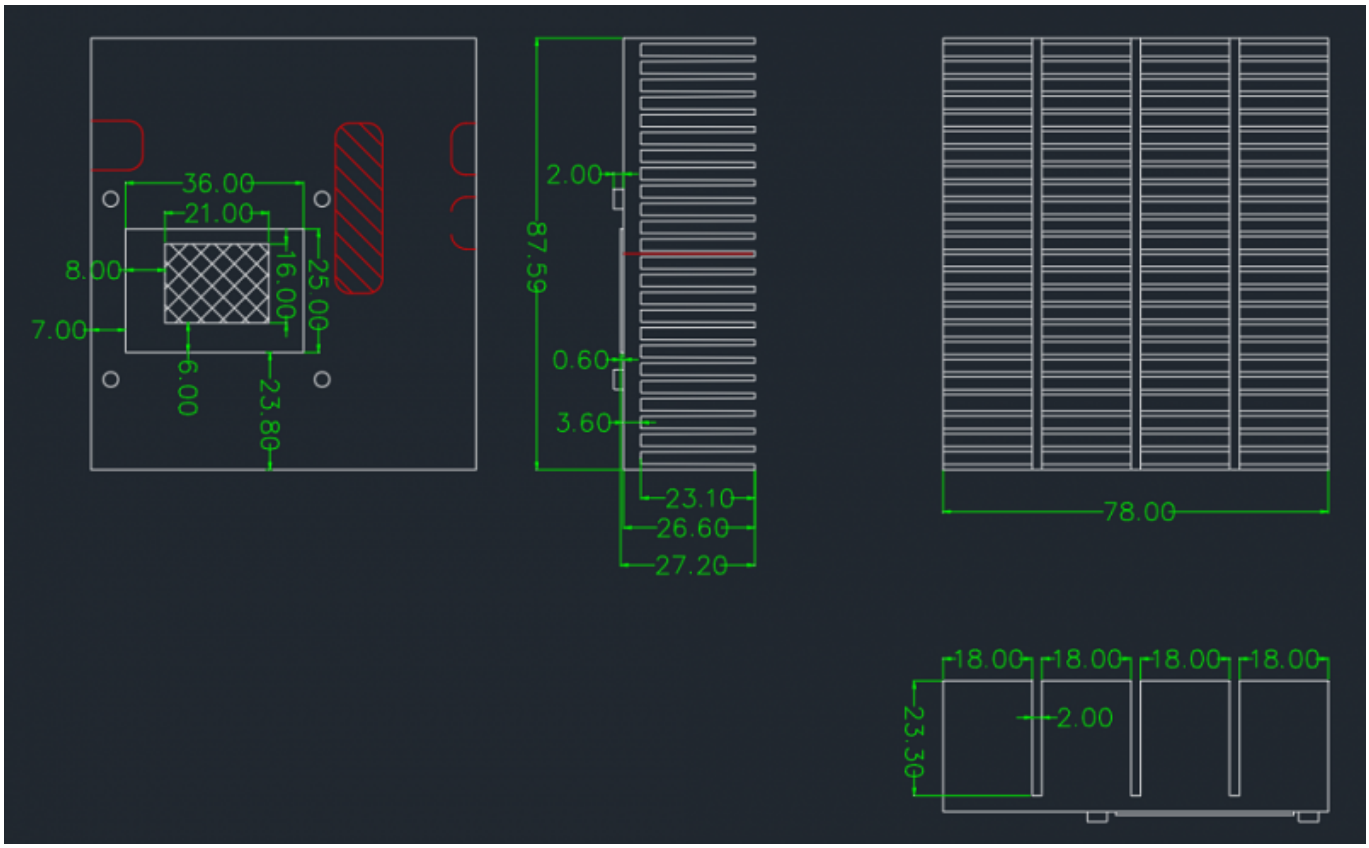


- Rear side



- Heat Sink
  - Download dxf format

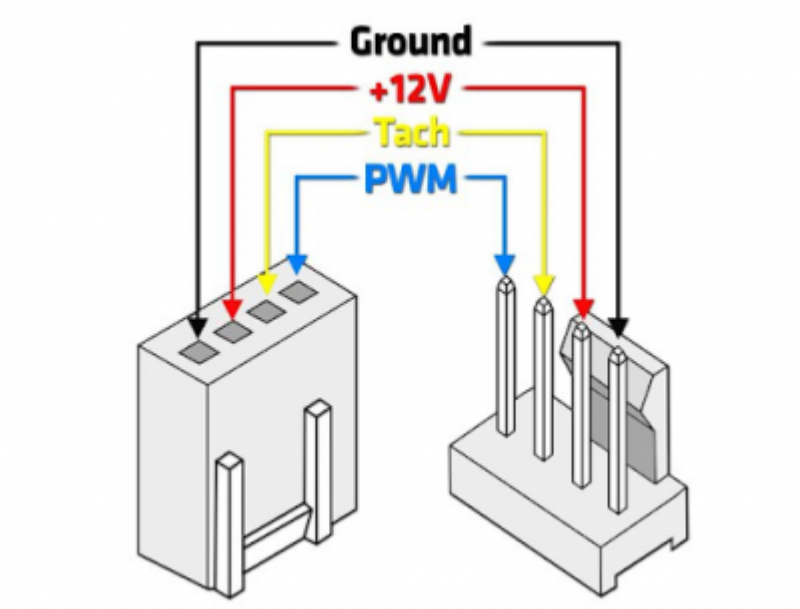
H4 Heat sink



Fan Connector

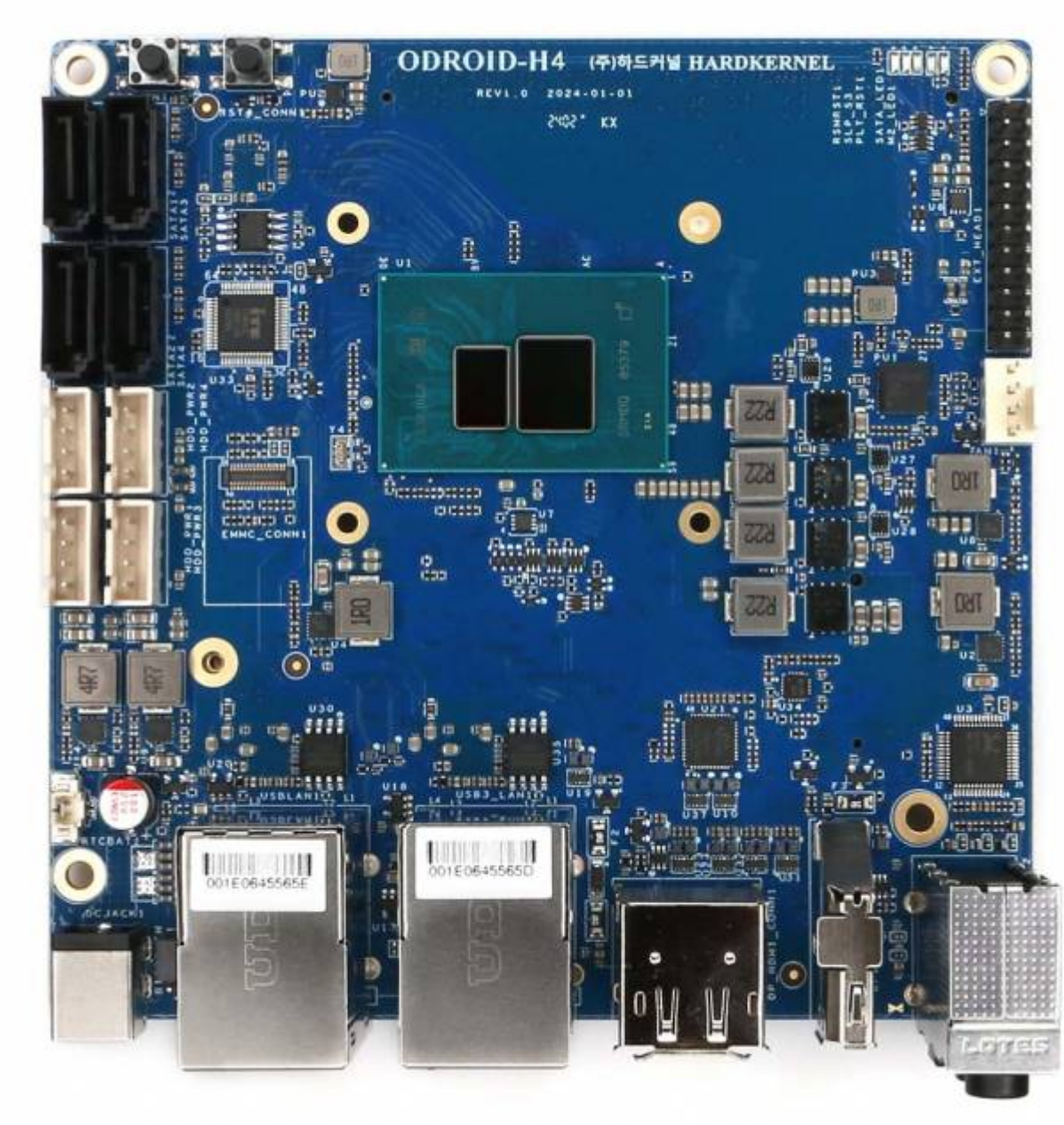
The ODROID-H4, H4+ and H4 Ultra use a PC standard 12V PWM 4-pin connector instead of the

proprietary 5V mini connector used on the H2/H2+.
Therefore, anyone can install a third-party cooling fan that can be easily purchased in the market.
However, if you want to mount a cooling fan inside our official H4 cases, you must choose a product with a thickness of 15mm or less.



ODROID-H4 Schematics

#	DATE	Release number	Description
1	2022/07/07	Rev 0.1	Initial release.



- ODROID-H4 Schematics (PDF format)
- ODROID-H4 Fritzing part (Breadboard view)

- Component layout (PDF format)
  - TOP layer :

    top.pdf
  - BOTTOM layer :

    bot.pdf

ODROID-H4 BIOS

- ODROID-H4 BIOS Release
- How to update ODROID-H4's BIOS
- eMMC Connection Check in BIOS
- Serial Port Console Redirection on ODROID-H4
- Restore H4 Bios firmware

Regulatory Compliance Documents

- ODROID-H4 KCC Certification
- ODROID-H4+ KCC Certification
- ODROID-H4 Ultra KCC Certification
- ODROID-H4+ CE Certification
- ODROID-H4 Ultra CE Certification
- ODROID-H4+ FCC Certification
- ODROID-H4 Ultra FCC Certification
- ODROID-H4+ RoHs Certification
- ODROID-H4 Ultra RoHs Certification

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