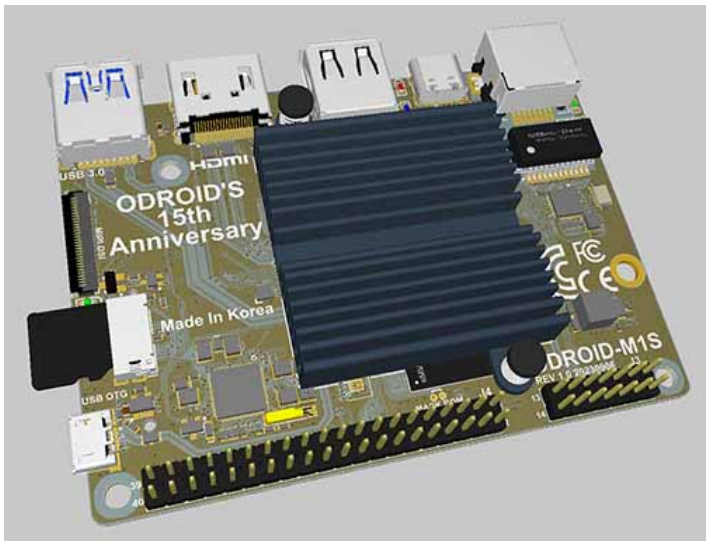
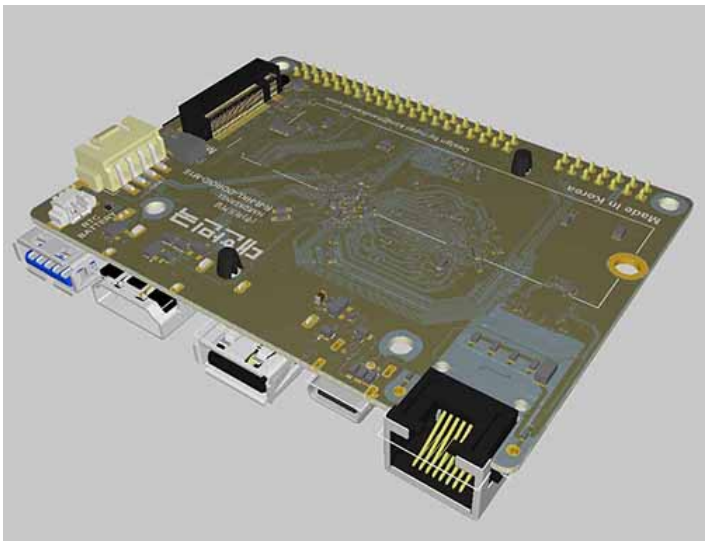
We launched ODROID-M1 about 20 months ago and have supplied it to many B2B and B2C customers. Feedback from many customers requested a lo wer price, more GPIO ports, lower power consumption, a slimmer form factor, and a variety of practical peripherals.

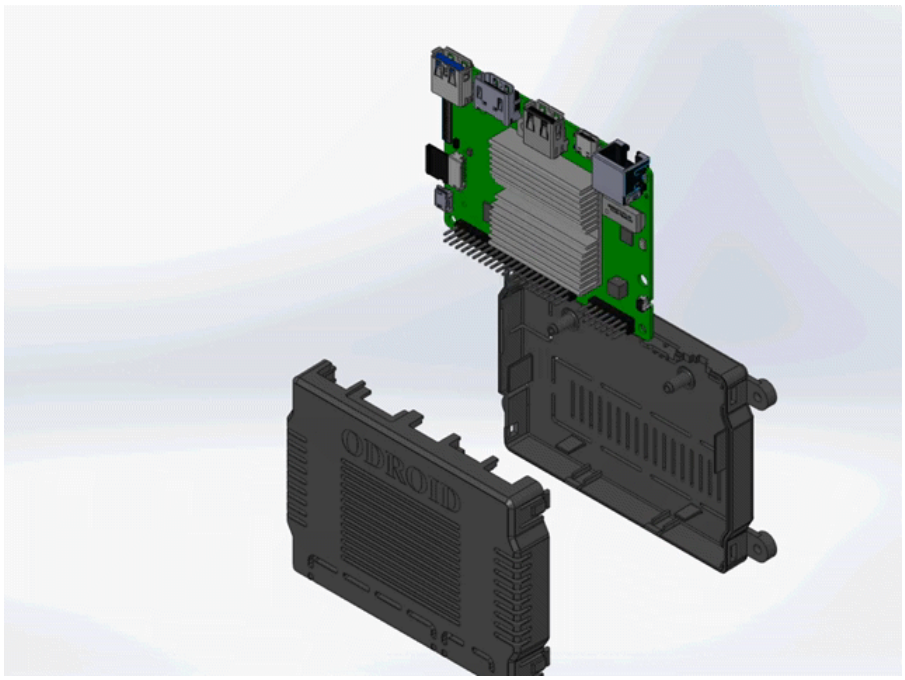
We would like to introduce you to the ODROID-M1S which was developed over the past six months to respond to market demands.
We made the board about 20% thinner, reduced power consumption by about 20%, added 14 header pins, and a built-in 64GB eMMC chip on the board. We have lowered the price to only $49 including a case, heatsink, and power adapter. We believe this will help significantly reduce the c ost of building your own affordable and sustainable embedded systems. To ensure longevity, which is important to customers using it for indus trial purposes, we will supply this product until at least 2036.

By utilizing 3D modeling from the early PCB design stage, we were able to complete case development relatively precisely and rapidly.
It will be remembered for a long time as a novel development project in which collaboration between circuit design & mechanical design proceeded quite s moothly.

M1S PCB 3D model

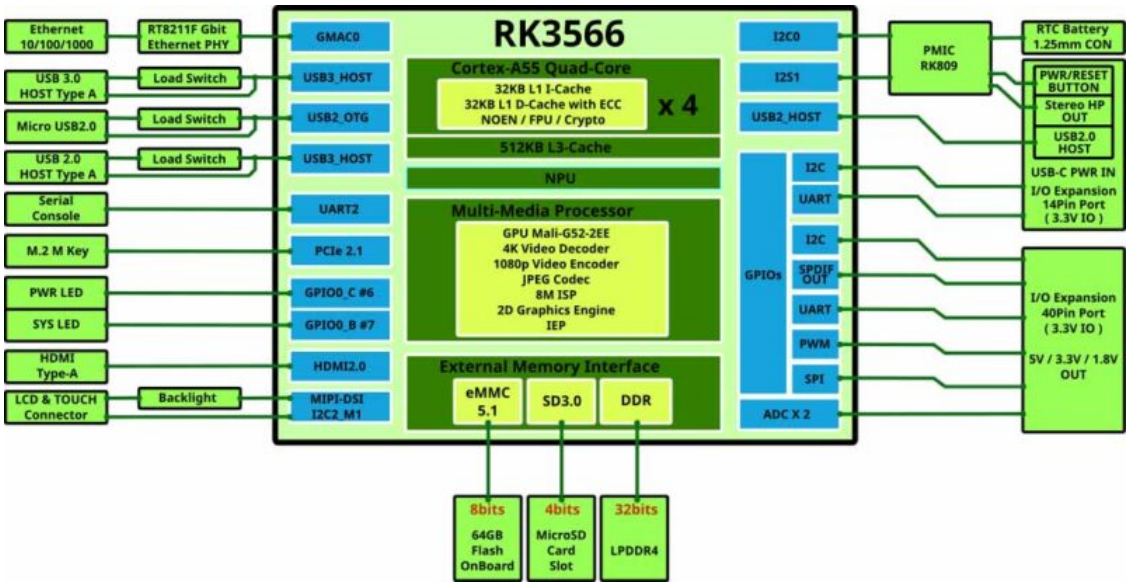






The SOC in the M1S is the RK3566, which is the younger sister of the RK3568 used in the original M1. This allows most of the software development to be reuse d. Because the bootloader and kernel settings are different, existing OS images for M1 cannot be used as-is, but porting is quickly possible through a simple proces s.

For detailed internal configuration, please refer to the block diagram below.



On-board eMMC storage

For the first time in the ODROID board series, an eMMC chip was soldered to the PCB by default instead of using a removable eMMC module. We think 64GB cap acity is sufficient for building most embedded systems.
The speed of eMMC measured with the ***fio*** command is approximately 180MiB/s, which is about 3~5 times faster than typical microSD cards.

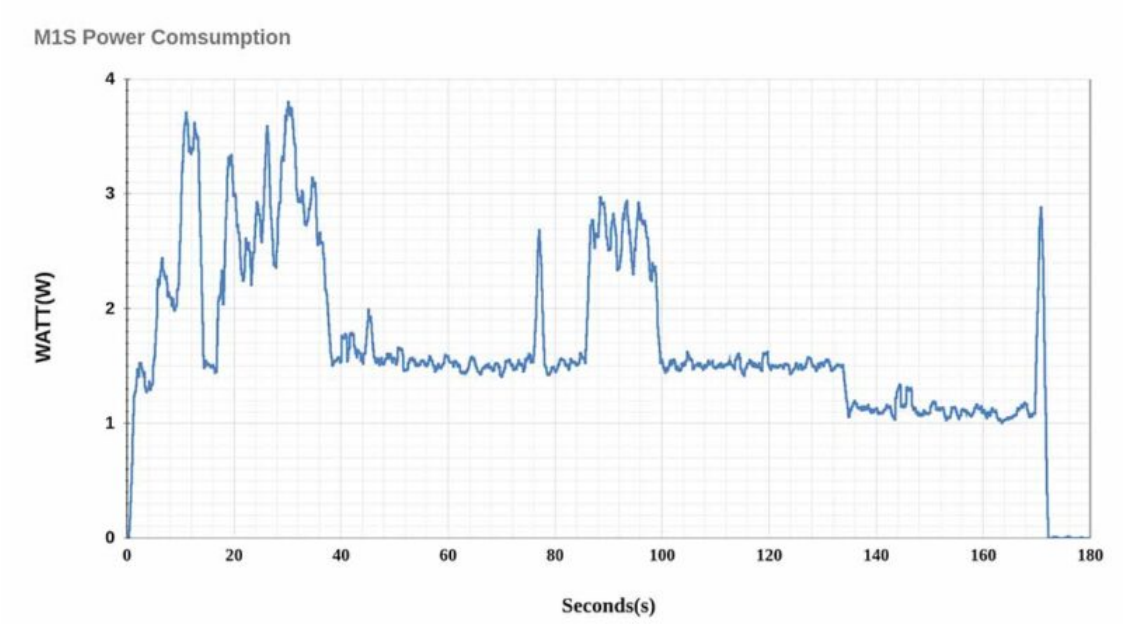
On-board M.2 NVMe slot

In case the 64GB storage space of the soldered eMMC memory is insufficient, consider using an industry standard 2280 form factor NVMe SSD. An on-board M.2 NVMe slot is provided to access large amounts of data storage.
Unlike the original M1 model's PCIe 3.0 x 2 lanes configuration, M1S has PCIe 2.1 x 1 lane. The NVMe transfer speed of the M1S has been reduced by about 1/4. However, we still believe that ~400 MiB/s of storage access speed is sufficient for building various high-end embedded systems.
Note that M.2 SATA storage devices can not be used. The M.2 slot supports only a PCIe interface (M-Key).

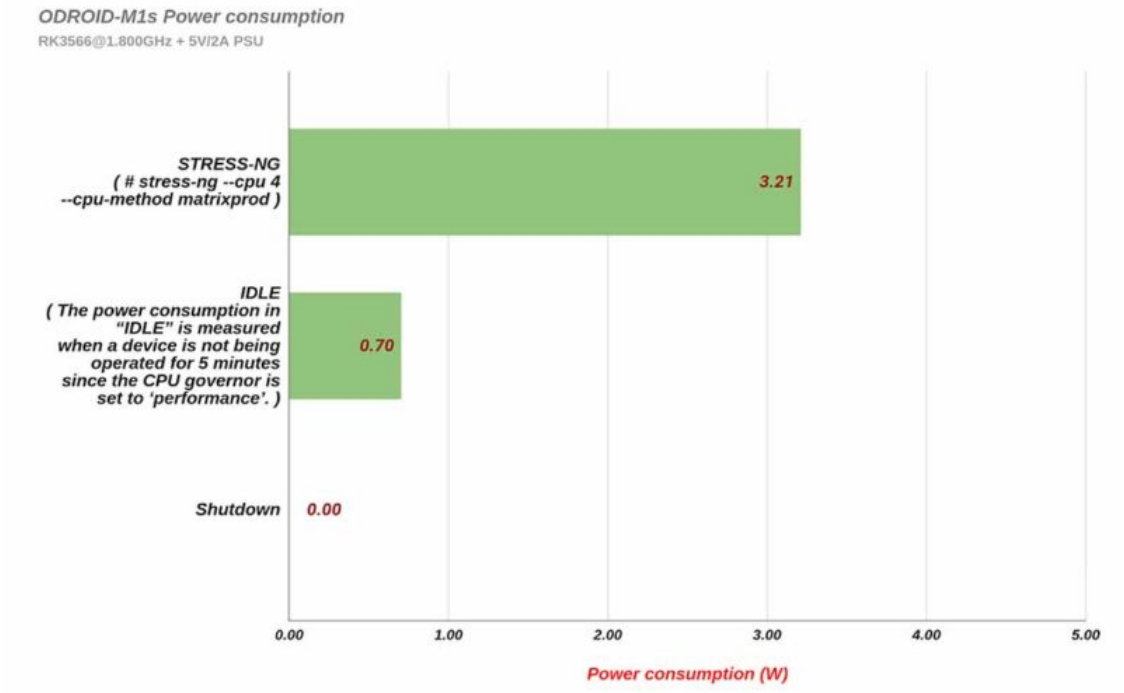
Power consumption

To create the graph below, we turned on the M1S and recorded the power consumption until the Ubuntu Desktop OS boots and enters Idle mode. We used the SmartPower3 device to examine power characteristics.
-With Ethernet and HDMI monitor connected, the peak power consumption is close to 3.7 Watts during booting, but drops to 1.5 Watts in desktop GUI idle state.

-If you remove the HDMI monitor for a headless system, power consumption in idle mode drops to near 1.0 Watt. Additionally, please note that when the Ethernet c able is unplugged, the power drops to 0.7 Watt.

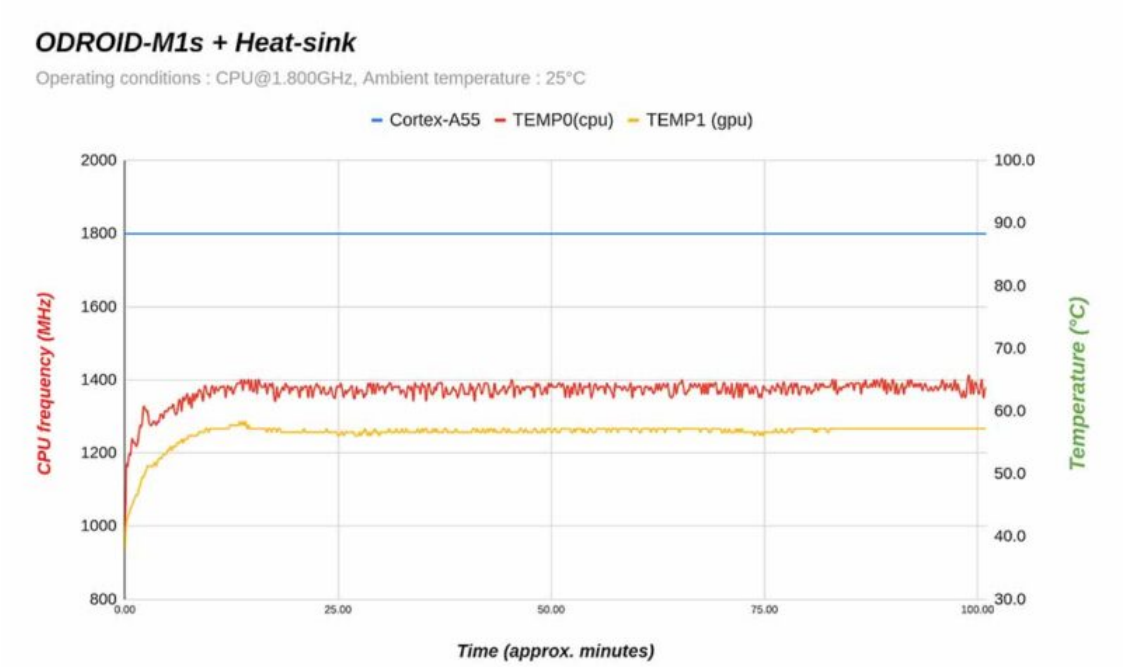


When performing a CPU stress test without either HDMI output or Ethernet connection, the power consumption is about 3.2 Watts. This shows an energy savings of about 25% compared to the 4.3 Watts of the original ODROID-M1 under the same test conditions. Note that the computing power of ODROID-M1S has been m easured to be 5-10% lower than that of M1.

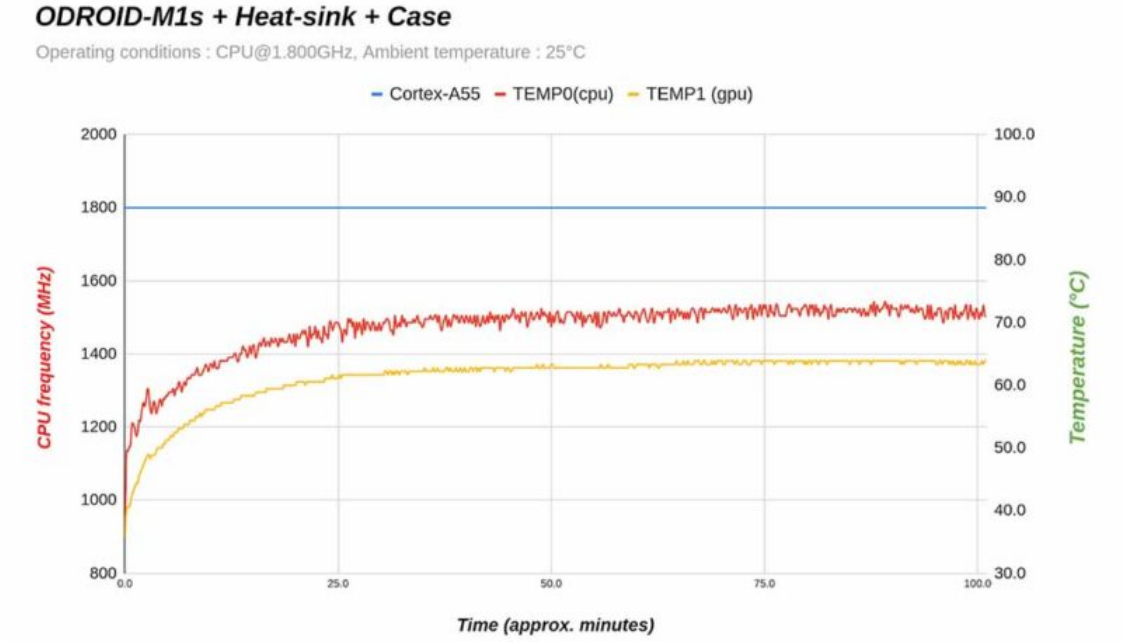


Thermal Characteristics

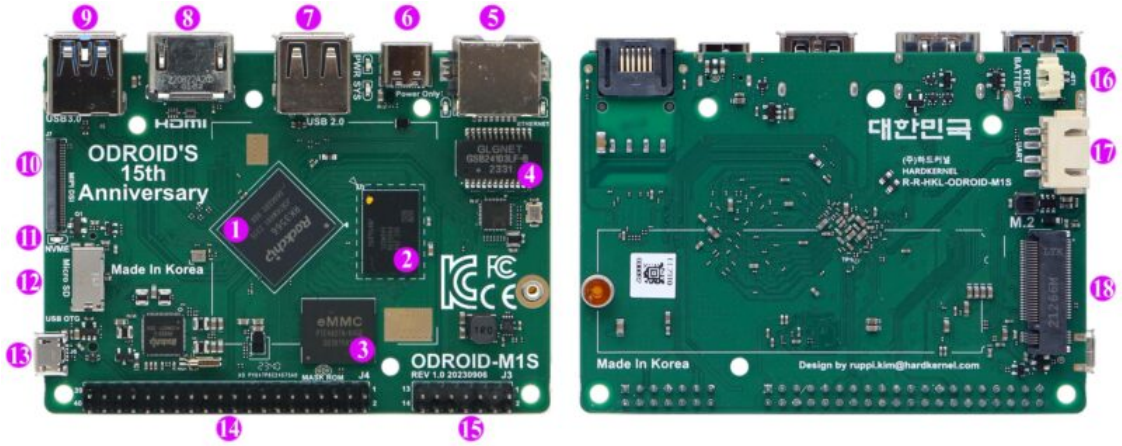
Thermal throttling does not occur even when performing a CPU stress test while mounted in a case. Because system power consumption is low, less heat is gene rated. Cooling is sufficient with just the stock heatsink.
As shown in the graph below, when a stress test was performed on ODROID-M1S with a stock heatsink under room temperature conditions of 25°C, the CPU temp erature did not exceed 65°C and maintained the maximum clock frequency.



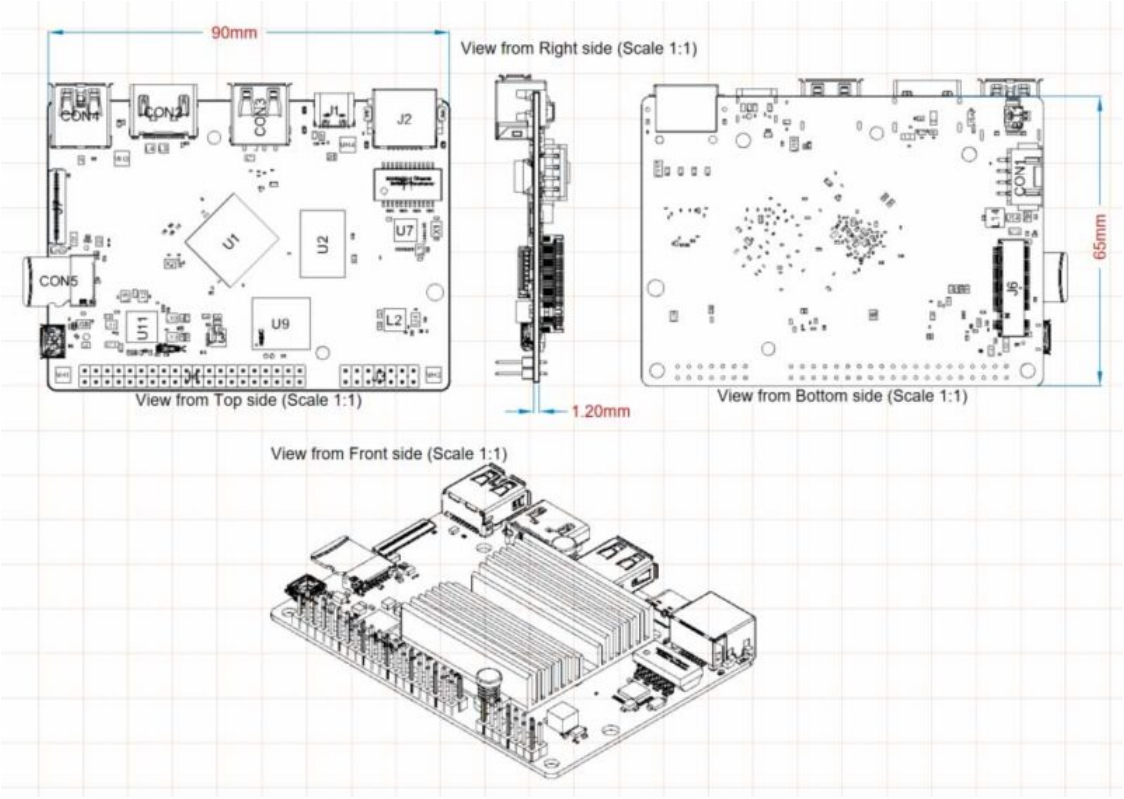
Even when assembled in the case, the CPU temperature did not exceed 75°C and thermal throttling did not occur.



Board Detail



1	Rockchip RK3566 CPU	**10**	1 x MIPI DSI 4Lane
2	LPDDR4 RAM	**11**	1 x M.2 LED Indicator
3	1 x 64GB eMMC embedded	**12**	1 x Micro SD Slot
4	1 x Ethernet Transformer	**13**	1 x Micro USB2.0 OTG
5	1 x RJ45 Ethernet Port (10/100/1000)	**14**	40 x GPIO Pins **Optional**
6	1 x USB Type C Power Connector	**15**	14 x GPIO Pins **Optional**
7	1 x USB 2.0	**16**	1 x RTC Backup Battery Connector
8	1 x HDMI 2.0	**17**	1 x UART for System Console
9	1 x USB 3.0	**18**	1 x M.2. M-KEY PCIe2.1 1Lane



Specifications

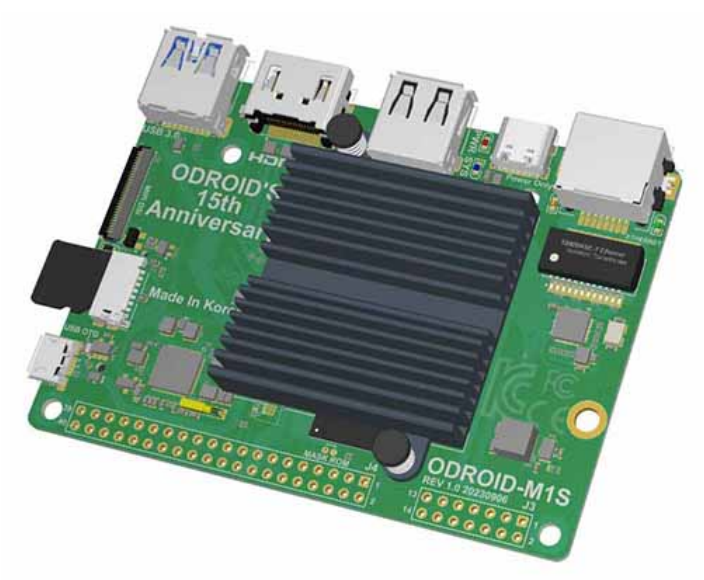
FORM FACTOR	Board Dimensions: 90mm x 65mm x 16mm Weight: 52g including heatsink
PROCESSOR	Rockchip RK3566 Processor L1 instruction cache: 32 KB, 4-way set associative (128 sets), 64 byte lines, shared by 1 processor L1 data cache: 32 KB, 4-way set associative (128 sets), 64 byte lines, shared by 1 processor L3 data cache: 512KB , 16-way set associative (512 sets), 64 byte lines, shared by 4 processorsQuad-Core Cortex-A55 (1.8GHz) ARMv8-A architecture with Neon and Crypto extensions Mali-G52 MP2 GPU with 4 x Execution Engines (800Mhz)
NPU	0.8 TOPS@INT8, Integrated AI accelerator RKNN NPU Supports one-click switching of Caffe/TensorFlow/TFLite/ONNX/PyTorch/Keras/Darknet
MEMORY	LPDDR4 4 or 8GiB with 32-bit bus width, Data rate: 2112 MT/s, up to 1,055MHz
STORAGE	1 x 64GB eMMC embedded (soldered to the PCB) 1 x Micro SD slot (UHS-I SDR104, Boot priority is always higher than eMMC) 1 x NVME M.2 SSD (PCIe 2.1 x 1 lane)
NETWORKING	1 x GbE LAN ports (RJ45, supports 10/100/1000 Mbps) – Realtek RTL8211F Ethernet transceiver – LED indicators * Green LED: Flashing by data traffics at 100Mbps connection * Amber LED: Flashing by data traffics at 1000Mbps connection
VIDEO	1 x HDMI 2.0 (up to 4K@60Hz with HDR, EDID) 1 x MIPI DSI Interface (30pin connector which is different from 31pin of the original ODROID-M1)
EXTERNAL I/O	1 x USB 2.0 host port 1 x USB 3.0 host port 1 x USB 2.0 micro OTG port 1 x Debug serial console (UART) 1 x 40 pin GPIO and 1 x 14 pin GPIO
OTHER FEATURES	RTC backup battery connector (to keep time and date for several months without main power input) System LED Indicators: – Red (POWER) – Solid light when DC power is connected – Blue (ALIVE) – Flashing like heartbeat while Kernel is running. Solid On in the u-boot stage.
POWER	1 x USB Type C for Power only DC input : 4.9V ~ 5.3V – USB Type C 5V/3A power adapter is recommended – IDLE : ≃ 1.1W – CPU Stress : ≃ 3.52W (Performance governor) – Power Off : ≃ 0W

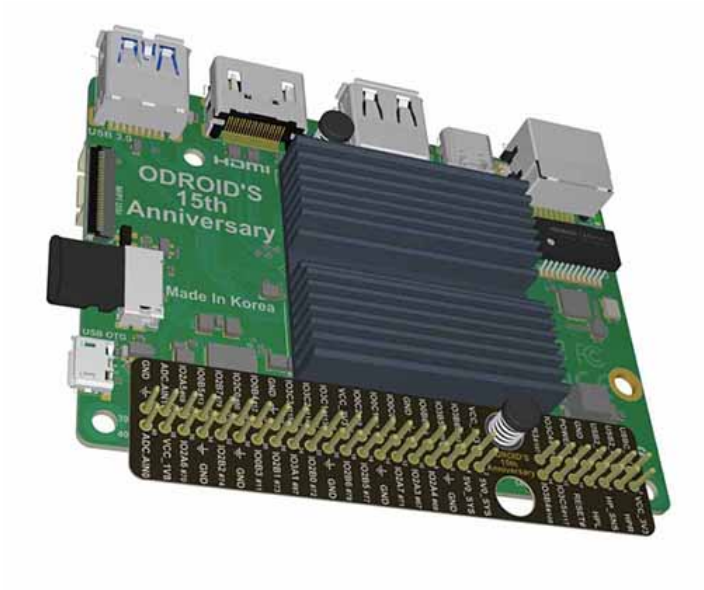
- We recommend powering the ODROID-M1S with a bundle Type C 5V/3A power adapter.

-The CPU has four ARM Cortex-A55 processors with low power consumption & high efficiency operation at 1.8Ghz. A larger 8GB of LPDDR4 DRAM memory is ava ilable in addition to a 4GB model for reduced cost.

GPIO Header

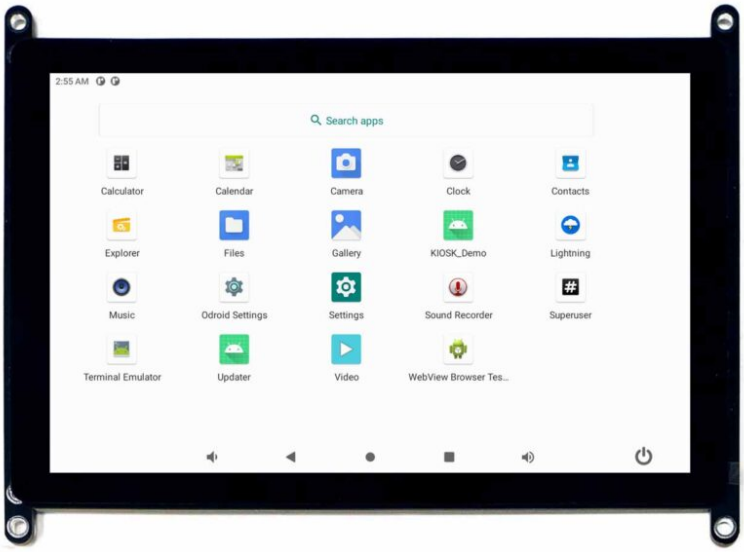
There are 40-pin and 14-pin header pin connectors for general purpose input and output functions. Digital IOs, UARTs, I2Cs, PWMs, ADCs, SPI, USB 2.0 host, Ana log audio output, Power-on and Reset signals are available.
What we heard from many B2B and B2C customers is that they often didn't use the actual GPIO functionality. Therefore, to lower production costs and product pric e, we decided to make GPIO header pin installation an option. If you choose the option to install 40-pin and 14-pin GPIO headers, $3 will be added to the price. An I O-labels board for easier DIY tinkering will also be provided.





MIPI-DSI

-The four-lane MIPI-DSI port can be directly connected to an LCD panel.
-The ODROID-Vu8S kit with an 8 inch, 800×1280 wide viewing angle LCD and capacitive multi-touch screen is an available option. Note that LCD connector is diffe rent from the one on the ODROID-M1.
-If you assemble the ODROID-M1S single board computer on the rear side of the Vu8S kit, you can easily implement a Human-Machine-Interface (HMI) device with Android as well as Linux.



NPU

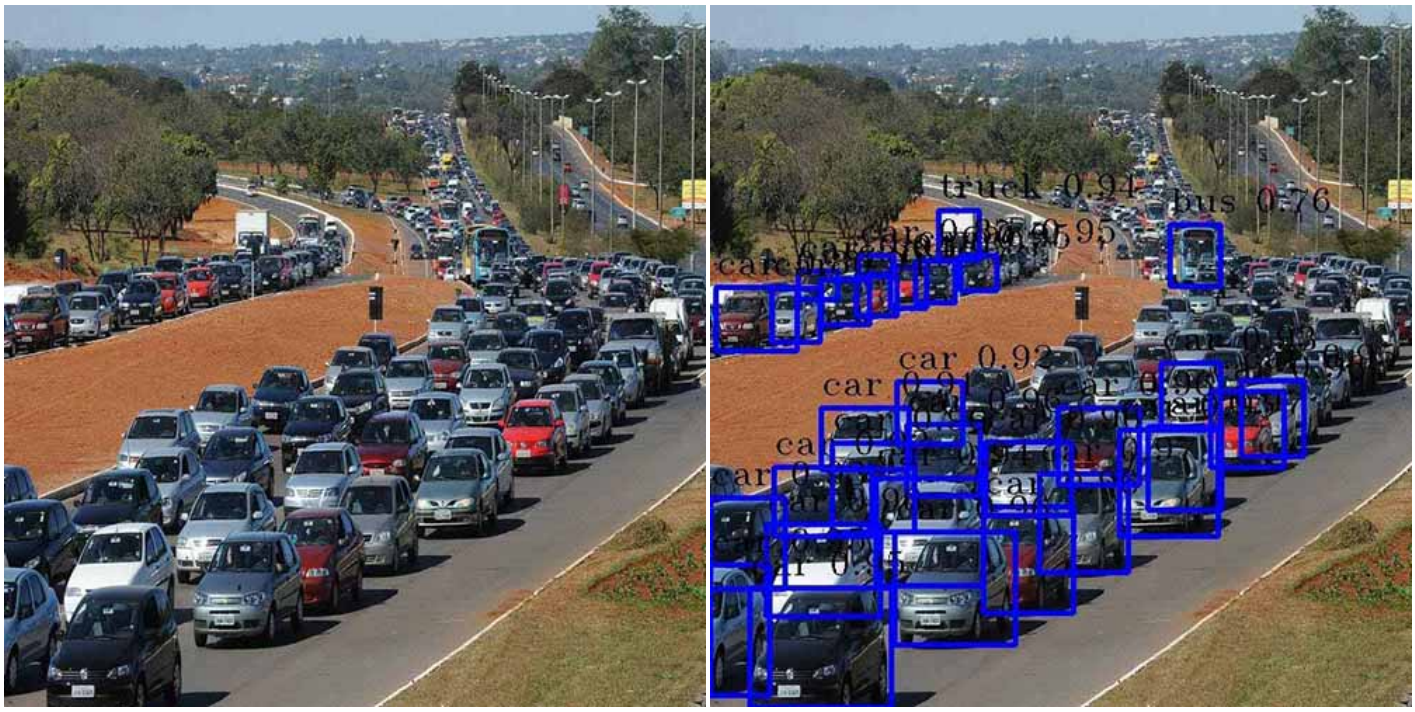
Since Machine Learning has been a trend in this industry, there is a neural network processing unit (NPU) which can deliver up to 0.8 TOPS on the M1S single boar d computer.
We could run various TensorFlow Lite and ONNX models on Ubuntu Linux OS. Here is an example of object detection.

– Input image and Output image (The input image source : https://commons.wikimedia.org/wiki/File:Traffic_in_Brasilia_before_Brazil_%26_Chile_match_at_World_Cup_2010-06-28_1.jpg)

As shown in the test results below, the object detection speed of the NPU is nearly 20 times faster than that of the CPU. For reference,
the NPU performance of M1S is about 10% lower than that of M1. We believe this is due to the difference in DRAM clocks.

Conf=0.25	CPU (ms)	NPU (ms)	NPU: Cam (fps)
M1S	1288.3	70	11.8
M1	1225.7	64.3	13

CPU governor = performance
AI model = yolov5s.onnx(cpu) / yolov5s.rknn(npu)
Confidence threshold = 0.25
USB Camera = Logitech BRIO



Software support

- Android 11
    - AOSP based on Rockchip BSP
    - Customized raw GPIO access framework : Android Things with various examples https://wiki.odroid.com/common/android_things
        - GPIO toggling
        - Rotary encoder with GPIO IRQ
        - PWM outputs
        - I2C (Color sensor, Temperature, Humidity, OLED, RTC)
        - SPI (CAN receiver, LED strip lights, IO expander)
        - UART (Loopback test, Barcode scanner, Thermal printer)
- Ubuntu 20.04 LTS
    - Kernel 5.10.160
    - Wayland based GNOME desktop
    - ARM Mali Bifrost GPU OpenGL-ES / EGL driver
    - MIPI DSI driver
    - GPIO drivers and WiringPi library
    - NPU driver and Neural Network APIs
    - VPU driver with MPP/Gstreamer APIs
- Ubuntu 22.04 LTS
    - Kernel 6.1.60
    - Wayland based Gnome/KDE desktop
    - ARM Mali Panfrost GPU driver for desktop OpenGL 3.x
    - MIPI DSI driver
    - GPIO drivers and WiringPi library