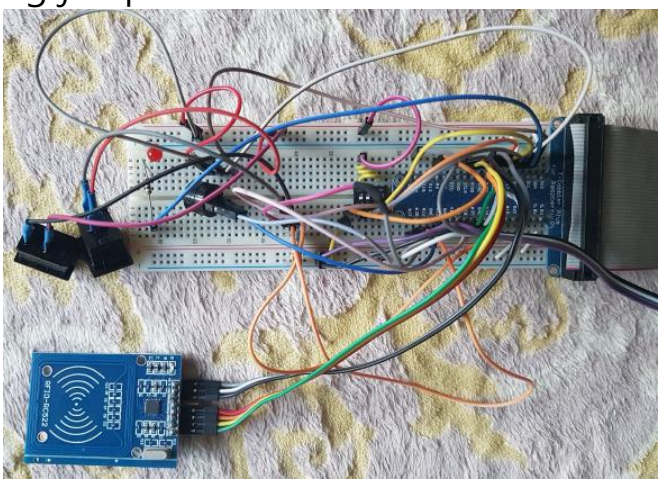
Introduction to MLS (Multi Layer Stackable) Hat Series

MLS Hat series developed by **AESLAB** are released at Dec. 2021.

Many makers use breadboard. But just create only, not long time use and most displeasing jumper cables.



Raspberry Pi 2x20 GPIO prototyping with breadboard and devices

Make own PCB work is not complex things nowadays, But its not simple to novices, makers and hobbyist, still many huddles remains.

PCB from prototype test result

For example, find foot print and cross check between device and foot print, modern CAD tools has very advanced and support 3D assemble views, but finding exact device from online market need time consuming and efforts.

Situation considering :

Many MCU boards and module boards available now
but we need still jumper wires.

Uncountable resources are available in internet and videos
lead by open hardware and software trends.

Experts can make nice electronics boards simply with low cost.

If a maker wish to get nice PCB result for various need without jumper cables and breadboard…

option 1. Out-sourcing … Nonsense.
option 2. Studying PCB works … Spend time.

Someone think like "*I want to get nice PCB board like expert result, But I don't want to spend my time to make PCB*." excluding option 1 and option 2…….No ways.

And soldering also required detail skills.

HLS Hat series will be another solution for this simple hope.

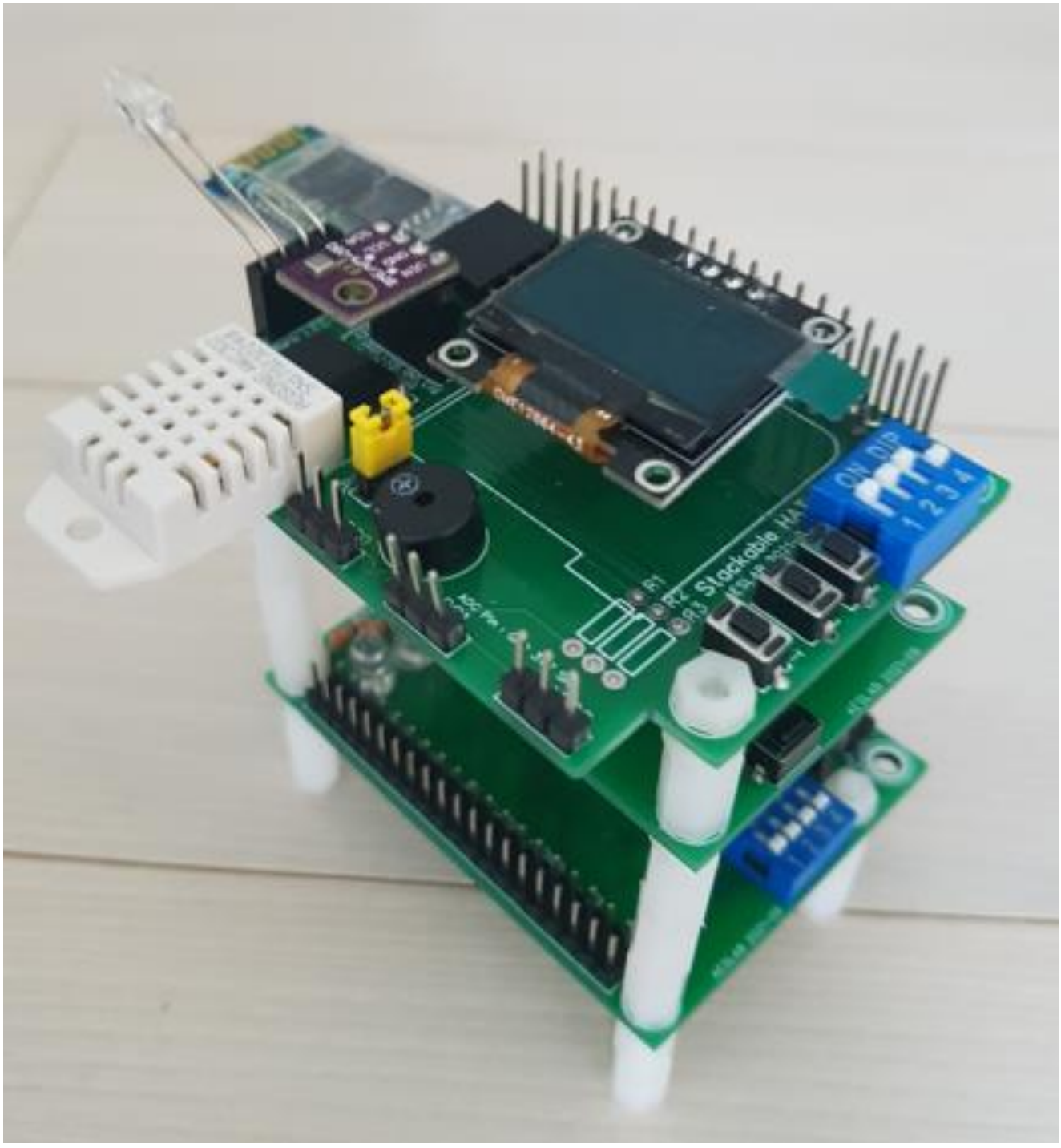
MCU hardware GPIO worlds are consist by only 7 things.

GPIO Input, output
PWM
ADC
UART
I2C
SPI

Exactly can not support all kind need, But a little availabilities are possible with pre-worked PCB for novices, makers and hobbyist.

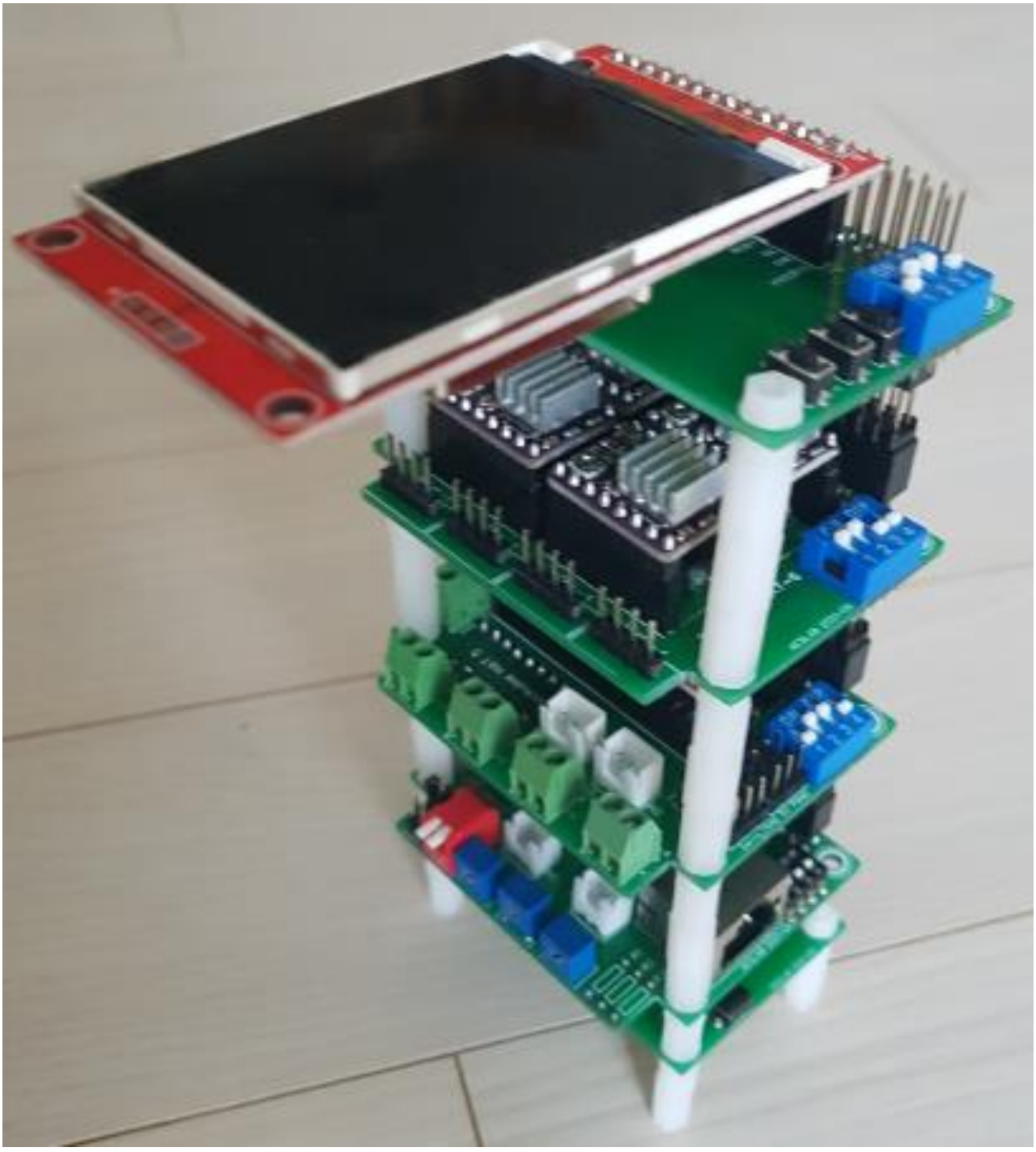
HLS Hat series can help this!

MLS Hat Configuration Example



Hat-0 + Pico Base A1 + Hat-1

MLS Hat Configuration Example



Pico Base A1 + Hat-4 + Hat-5 + Hat-6 + Hat-3

MLS Hat series support :

Multi layer stacking availability

May 3~5 layers can achieve a little complex results.
Between the hats height gap is 32mm, plastic supports (2/10mm, M3 screw) are included.

Each hat has specific purpose

with long time embedded system design experience

First release (Nov. 2021)

Raspberry Pi Pico Base A1
Hat-0 : Dual Raspberry Pi 3/4 2x20 GPIO Use
Hat-1 : Flowerpot (LED/Buzzer/OLED/ADC/DHT22/Bluetooth)
Hat-3 : Display (I2C/SPI)
Hat-4 : IO Combo (TR-Out/In/SPI-RJ45)
Hat-5 : Motor (x4 DC Motor, 6 Servo Motor)
Hat-6 : Motor (x4 NEMA17 Stepping Motor)

Under ready, 2nd release (Dec. 2021)

Raspberry Pi Pico Base A2 : Add ESP-01 WiFi, Bluetooth
Hat-2 : 10 Buzzers MIDI Player with SD Card module
Hat-7 : IMU, Various I2C/SPI Acceleration/Gyro/Magnet Module
Hat-8 : MCP Combo (GPIO Expander/ADC)
Hat-12 : 4 Gas Sensor support (include MCP3004)

Under development, 3rd release (Jan. 2022)

STM32F Bluepill/Blackpill Base A1
Hat-9 : Wire Communication Combo
Hat-10 : Wireless Communication Combo
Hat-11 : Opto-coupling 2xIN, 2xRelay Out

Up to total 24~30 MLS hats release plan till end of 2022.

Each hat has DIPSW(x4)

for enable and disable for each sub function
Thus user just DIPSW on/off for need
Each hat has 4 functions normally

Reasonable small form factor (41x65mm, 49x65mm)

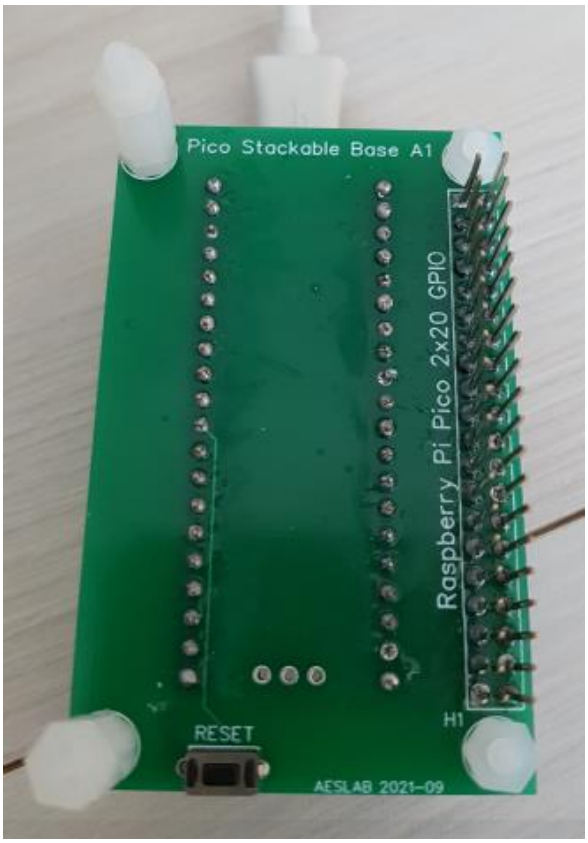
No Soldering, Just insert your module, Just stacking MLS Hats

All tested MicroPython library and test code supports

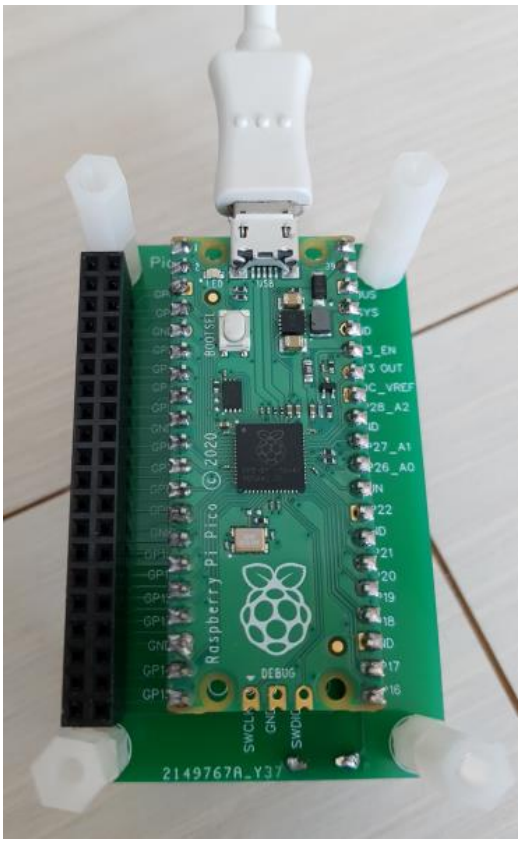
Pico Base A1 :

Pico Base A1 for Raspberry Pi Pico.
2x20 GPIO header for top side and bottom side.
A hardware RESET button, 41x65mm.

Product : MLS Pico Base A1 PCBA (PCB Assembled)
MLS Pico Base A1 Set (include Raspberry Pi Pico and soldered two 1x20 Male header)



Top View

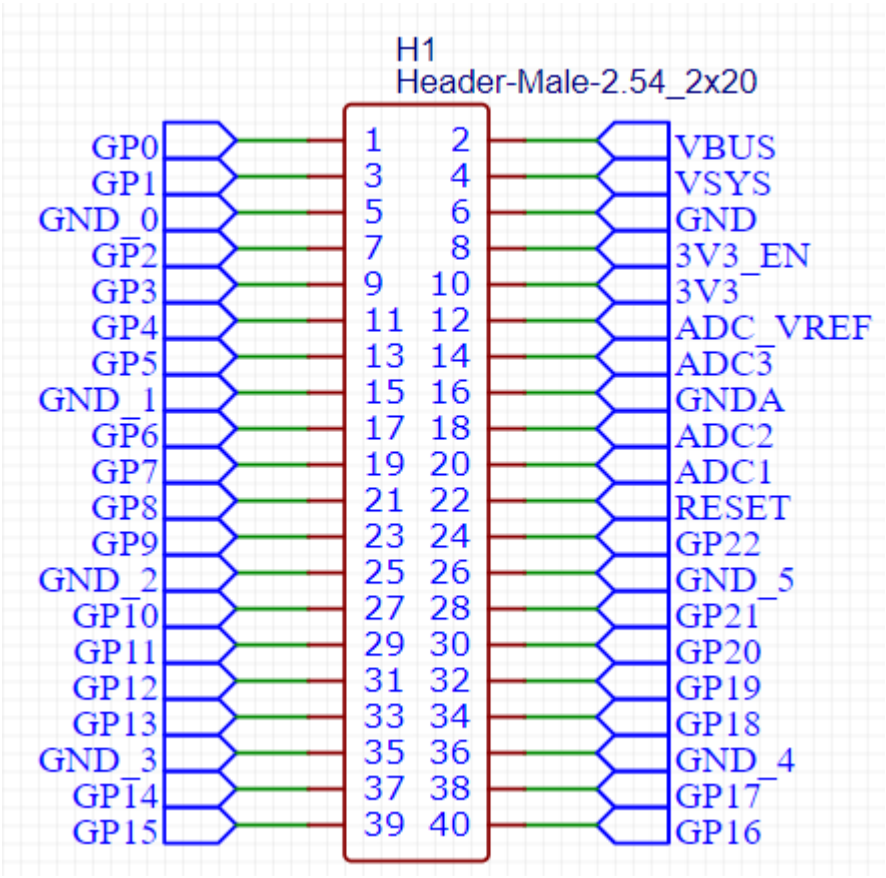


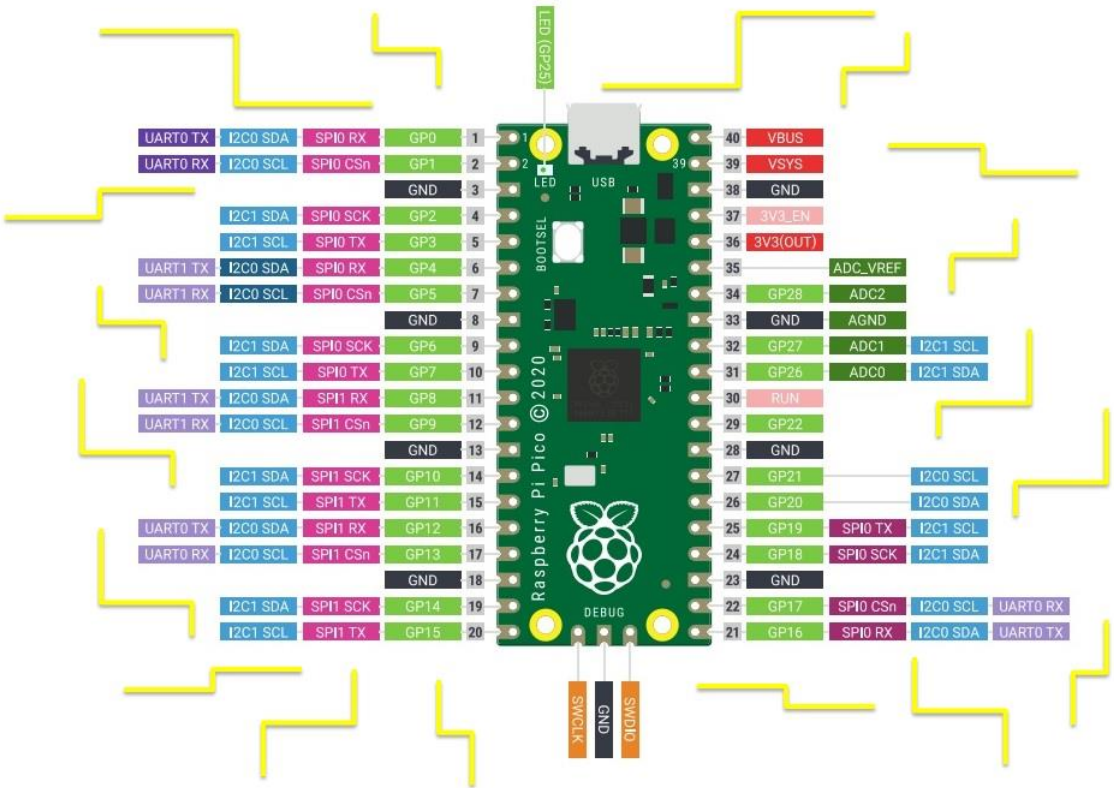
Bottom View

Pico Base A1 is for MLS Hat base for Pico MCU users.

MLS Hat interconnected 2x20 GPIO header.
Raspberry Pi Pico has Two 1x20 headers both side of board.
Pico board size is 20x50mm.
Pico board form factor is too small to practical functionality.

Left side : 2x20 GPIO header
Right side : IO Connector
Top side : Various device, for example Bluetooth or WiFi modules
Bottom side : Buttons and DIPSW

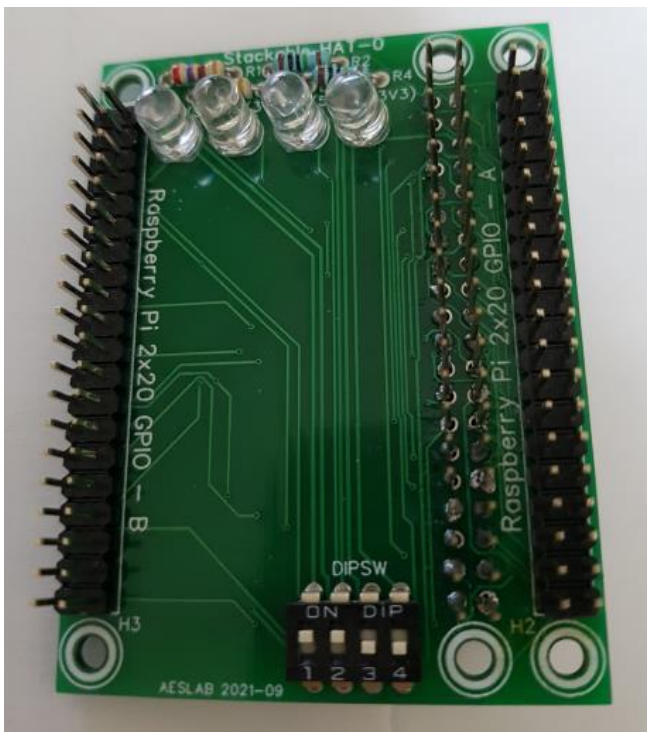

H1
Header-Male-2.54_2x20
GP0 1 2 VBUS
GP1 3 4 VSYS
GND_0 5 6 GND
GP2 7 8 3V3_EN
GP3 9 10 3V3
GP4 11 12 ADC_VREF
GP5 13 14 ADC3
GND_1 15 16 GNDA
GP6 17 18 ADC2
GP7 19 20 ADC1
GP8 21 22 RESET
GP9 23 24 GP22
GND_2 25 26 GND_5
GP10 27 28 GP21
GP11 29 30 GP20
GP12 31 32 GP19
GP13 33 34 GP18
GND_3 35 36 GND_4
GP14 37 38 GP17
GP15 39 40 GP16


LED(GP25)
Raspberry Pi Pico © 2020
BOOTSEL
USB
LED
DEBUG
SWCLK
GND
SWDIO
UART0 TX I2C0 SDA SPI0 RX GP0 1
UART0 RX I2C0 SCL SPI0 CSn GP1 2
GND 3
I2C1 SDA SPI0 SCK GP2 4
I2C1 SCL SPI0 TX GP3 5
UART1 TX I2C0 SDA SPI0 RX GP4 6
UART1 RX I2C0 SCL SPI0 CSn GP5 7
GND 8
I2C1 SDA SPI0 SCK GP6 9
I2C1 SCL SPI0 TX GP7 10
UART1 TX I2C0 SDA SPI1 RX GP8 11
UART1 RX I2C0 SCL SPI1 CSn GP9 12
GND 13
I2C1 SDA SPI1 SCK GP10 14
I2C1 SCL SPI1 TX GP11 15
UART0 TX I2C0 SDA SPI1 RX GP12 16
UART0 RX I2C0 SCL SPI1 CSn GP13 17
GND 18
I2C1 SDA SPI1 SCK GP14 19
I2C1 SCL SPI1 TX GP15 20
40 VBUS
39 VSYS
38 GND
37 3V3_EN
36 3V3(OUT)
35 ADC_VREF
34 GP28 ADC2
33 GND AGND
32 GP27 ADC1 I2C1 SCL
31 GP26 ADC0 I2C1 SDA
30 RUN
29 GP22
28 GND
27 GP21 I2C0 SCL
26 GP20 I2C0 SDA
25 GP19 SPI0 TX I2C1 SCL
24 GP18 SPI0 SCK I2C1 SDA
23 GND
22 GP17 SPI0 CSn I2C0 SCL UART0 RX
21 GP16 SPI0 RX I2C0 SDA UART0 TX

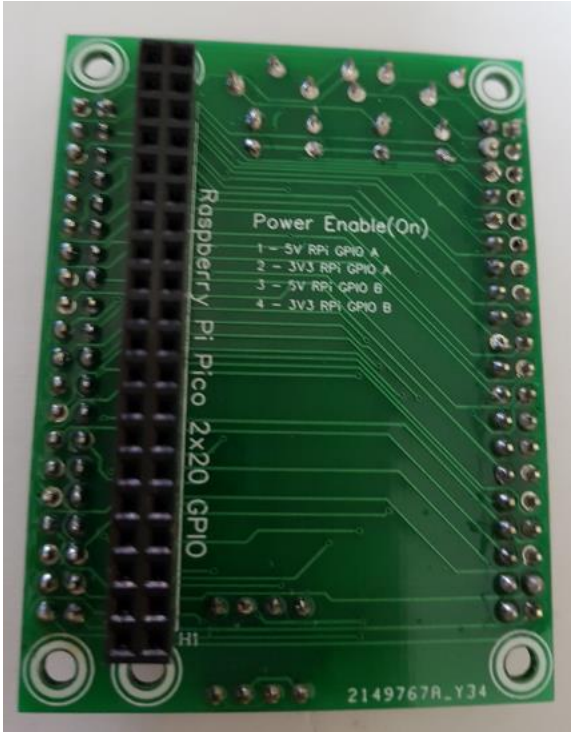
MLS Hat-0 :

MLS Hat-0 for Raspberry Pi 3/4 2x20 GPIO.
2x20 GPIO header for left and right side.
Left and right 5V, 3.3V LEDs, 49x65mm.

Product : MLS Hat-0 PCBA (PCB Assembled)



Top Side

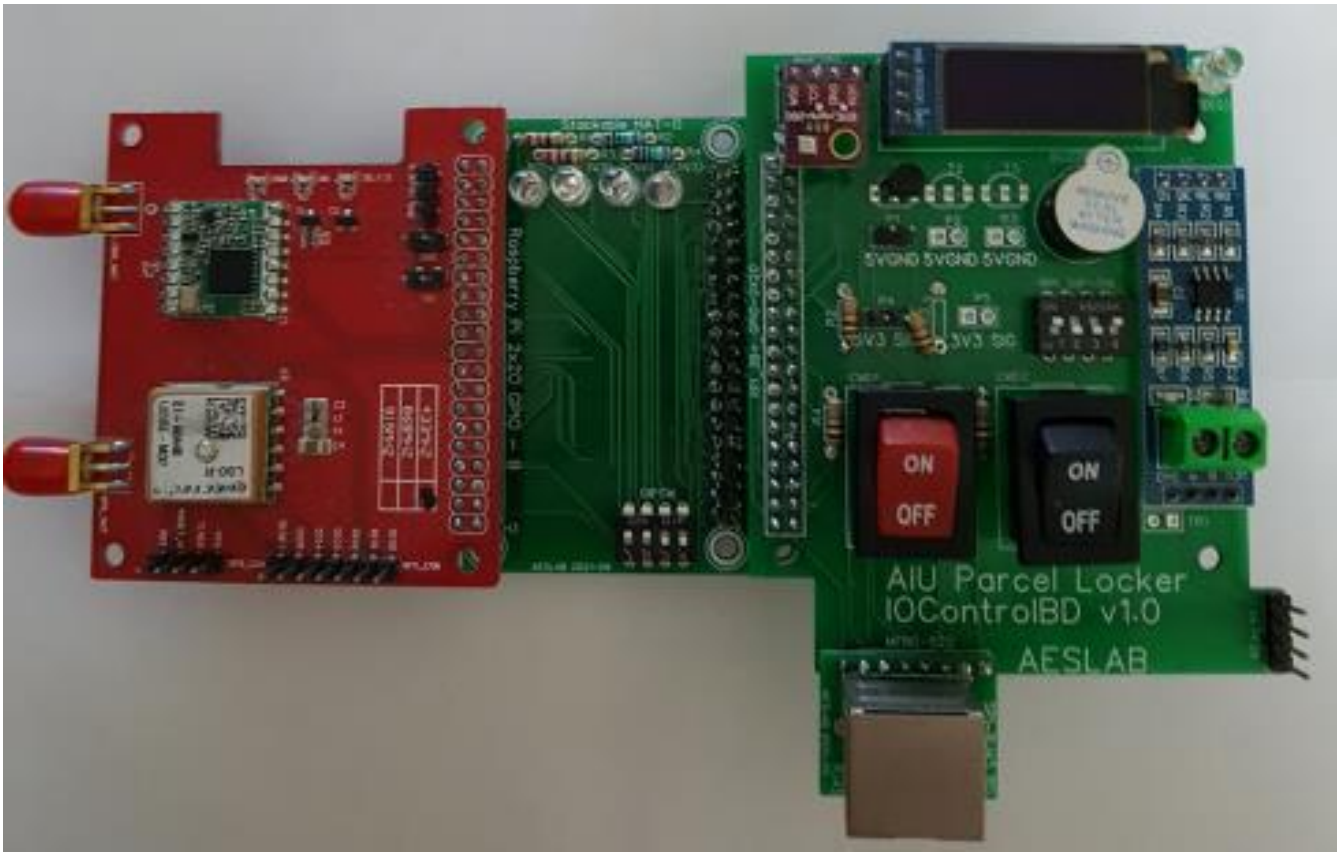


Bottom Side

DIPSW Usage :

1 : GPIO A (Left) 5V Enable & LED A(5V) On
2 : GPIO A (Left) 3V3 Enable & LED A(3V3) On
3 : GPIO B (Right) 5V Enable & LED B(5V) On
4 : GPIO B (Right) 3V3 Enable & LED B(3V3) On

MLS Hat-0 use example



Left side RPi GPIO board RPi means Raspberry Pi.

I2C 0.91" 128x32 OLED
I2C BME280 Temperature and Humidity sensor
LED, Buzzer, TR-Output, Digital Input, DIPSW(x4), Command SW
RS-485 Wire Communication module
SPI RC522 RFID Card Reader with SPI-RJ45 LAN Connector

Right side RPi GPIO board

UART GPS Module
SPI LoRa Wireless Communication module

All these previous RPi GPIO Board functionality works on Pico Base A1 and MLS Hat-0.

RPi 2x20 GPIO Portmap, BCM Type, MicroPython define code is available.

MLS Hat-1 :

MLS Hat-1 for Flowerpot
- 2x20 GPIO header for left side
- LED, Buzzer with 2.54mm jumper for enable and disable
- UP/DOWN/SELECT Buttons
- DHT22 Temperature & Humidity Sensor
- I2C 0.96" 128x64 OLED
- ADC for three Capacitive Soil Moisture Sensors
- UART HC-06 Bluetooth Wireless module
- I2C BM280/AHT10 Temperature & Humidity Sensor (Option)
- 49x65mm.

Product : MLS Hat-0 PCBA (PCB Assembled)
MLS Hat-0 Set (exclude BME280/AHT10)

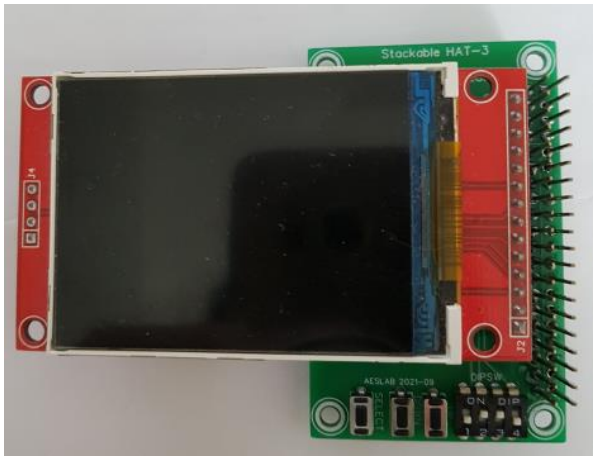
DIPSW Usage :
- 1 : 5V (UART0/BT)
- 2 : 3V3 (I2C0/DHT22/BTN)
- 3 : 3V3 (I2C1)
- 4 : 3V3 (ADC)

More detail information is available in each MLS hat user guide documents.

MLS Hat-3 :

MLS Hat-3 for OLED/TFT Display
2x20 GPIO header
SPI 1x14 header, I2C 1x4 header (1.3" and 0.96" OLED VCC/GND pin position is different)
41x65mm.

Product : MLS Hat-0 PCBA (PCB Assembled)



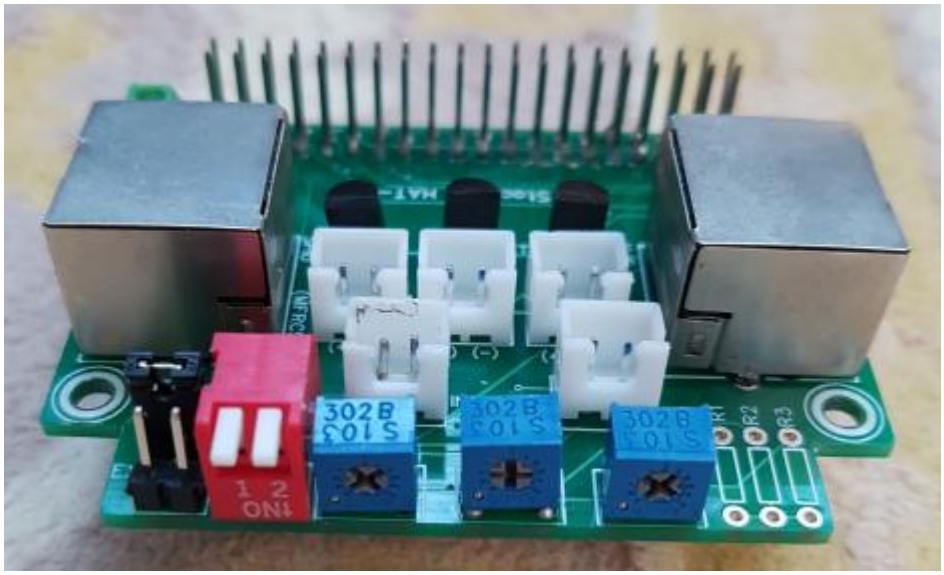
DIPSW Usage :
1 : None
2 : for SPI 2.2/2.4/2.8" 320x240 ILI9341 TFT module
Also can support 1.44/1.77/1.8" ST7735 TFT
3 : for UP/DOWN/SELECT buttons
4 : for I2C0 I2C SSD1306 1.3" and 0.96" 128x64 OLED

More detail information is available in each MLS hat user guide documents.

MLS Hat-4 :

MLS Hat-4 for Various IO interfaces
- 2x20 GPIO header
- SPI0, SPI1 with RJ45 LAN Port
- Three TR switching output
- (Pico internal 5V and external 5~12V KF350-3.5 Connector with 2.54mm jumper for enable and disable)
- two digital 3.3V input
- DIPSW(x2) Function select
- ADC three potentiometers
- 49x65mm.

Product : MLS Hat-4 PCBA (PCB Assembled)



SPI-RJ45 : UTP cable up to 10M, STP cable up to double length, cable length depends on SPI Clock speed. RC522 use 1MHz.

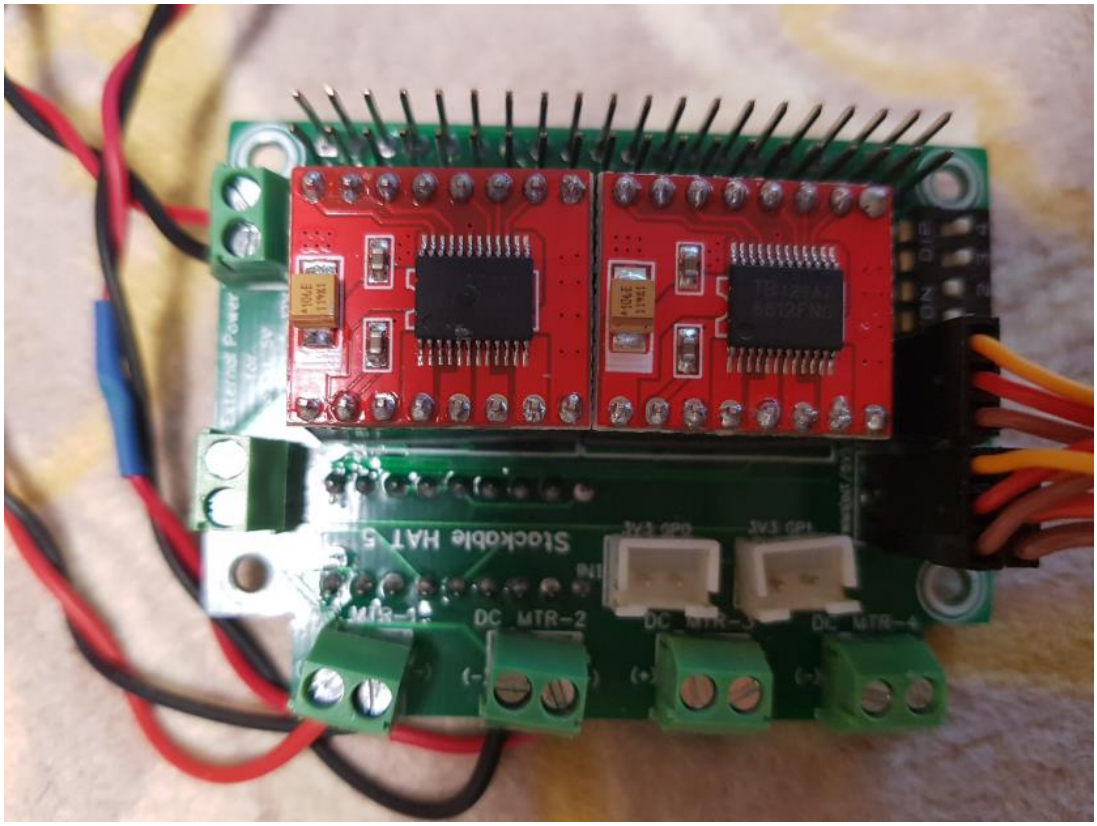
DIPSW Usage :
- 1 : 5V for TR switching output
- 2 : 3.3V for SPI0, SPI1
- 3 : 3.3V for DIPSW(x2), two digital 3.3V input
- 4 : 3.3V for ADC for three potentiometers

More detail information is available in each MLS hat user guide documents.

MLS Hat-5 :

MLS Hat-0 for 4 DC Motors, 6 Servo Motors
2x20 GPIO header
External power 12V KF350-3.5 Connector for DC motor
External power 5V KF350-3.5 Connector for Servo motor
Two TB6612FNG DC Motor driver (two 1x8) header
49x65mm.

Product : MLS Hat-5 PCBA (PCB Assembled)
MLS Hat-5 Set (2 TB6612FNG DC Motor Driver modules)
TB6612FNG can driver two DC motors.



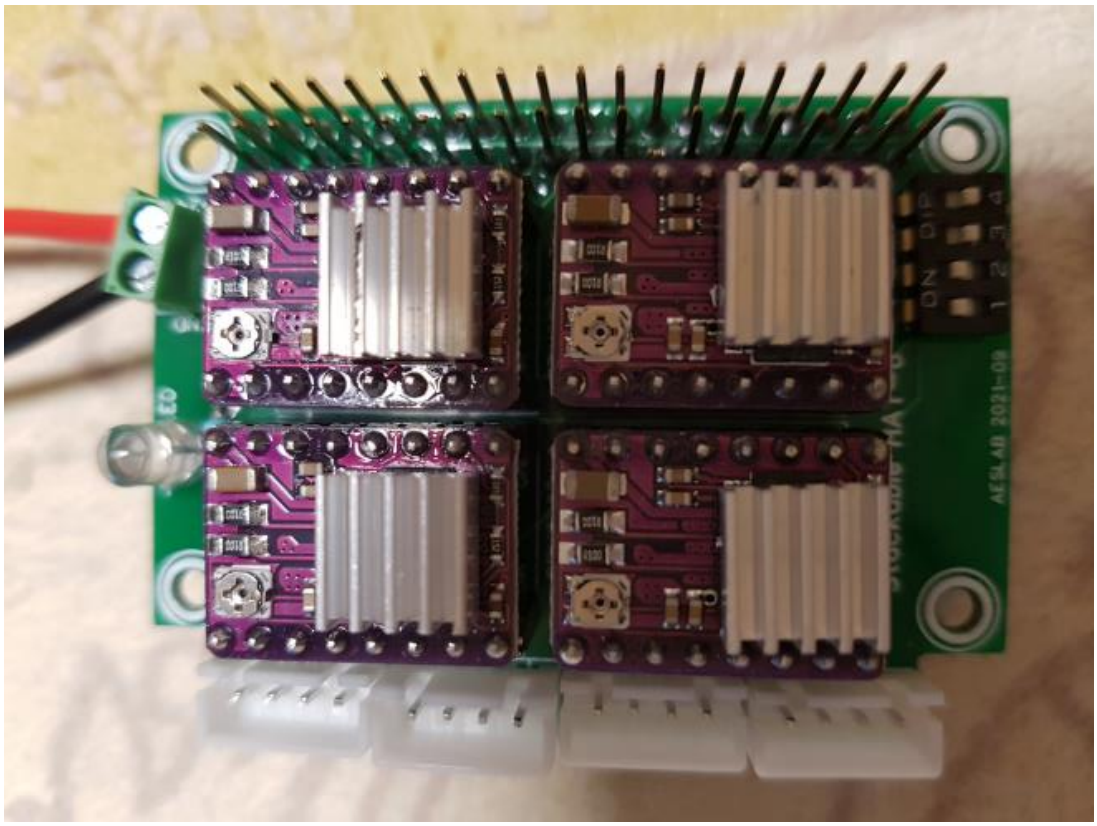
DIPSW Usage :
1 : 5V Servo PWM1/2 (use Internal 5V)
2 : 3V3 I2C MCP23008 (for TB6612FNG direction control)
3 : 3V3 for TB6612FNG1, 2 module
4 : 3V3 for digital input

More detail information is available in each MLS hat user guide documents.

MLS Hat-6 :

MLS Hat-0 for 4 Stepping Motor (NEMA17) drivers.
External power 12V KF350-3.5 Connector
LED, 4 DRV8825 driver (two 1x8) header
49x65mm.

Product : MLS Hat-6 PCBA (PCB Assembled)
MLS Hat-6 Set (DRV8825 Stepping Motor Driver modules)



DIPSW Usage :
1 : 3.3V for 1st DRV8825
2 : 3.3V for 2nd DRV8825
3 : 3.3V for 3rd DRV8825
4 : 3.3V for 4th DRV8825

More detail information is available in each MLS hat user guide documents.

MLS Hat-X Policy :

First, customer may request dedicated Hat-X that keep MLS Hat form factor and design style development also possible with reasonable cost.

AESLAB always listen to customer's need carefully and find some possibilities.

Second, also possible custom MLS Hat suggestions. AESLAB will share profit within royalty sharing policy.

Contact : aeslab@naver.com

Thanks!