Internal use only

Infonique
iSEB Expansion Board 1200 0012 V1.1

Prepared by	Date	Version
Bing Ran	15/7/2023	1.0

Abstract

This document provides detailed of Infonique iSEB Expansion Board 1200 0012 V1.1 specification.

Document History

Date	Rev	Modifier	Changes
15-July-2023	1.0	Bing Ran	First Draft
10-Sept-2023	1.1	Bing Ran	Further elaboratoin about WiFi and servo motor

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1 Introduction

This document will discuss the details of the iSEB Expansion Board 1200 0012 V1.0. iSEB Expansion Board 1200 0012 V1.0 is design for a spider robot. It provide 8 rgb leds (red green blue leds) and 16 pwm output to control the servo motors. The following figure is one of the robot that control with iSEB Expansion Board 1200 0012 V1.0.

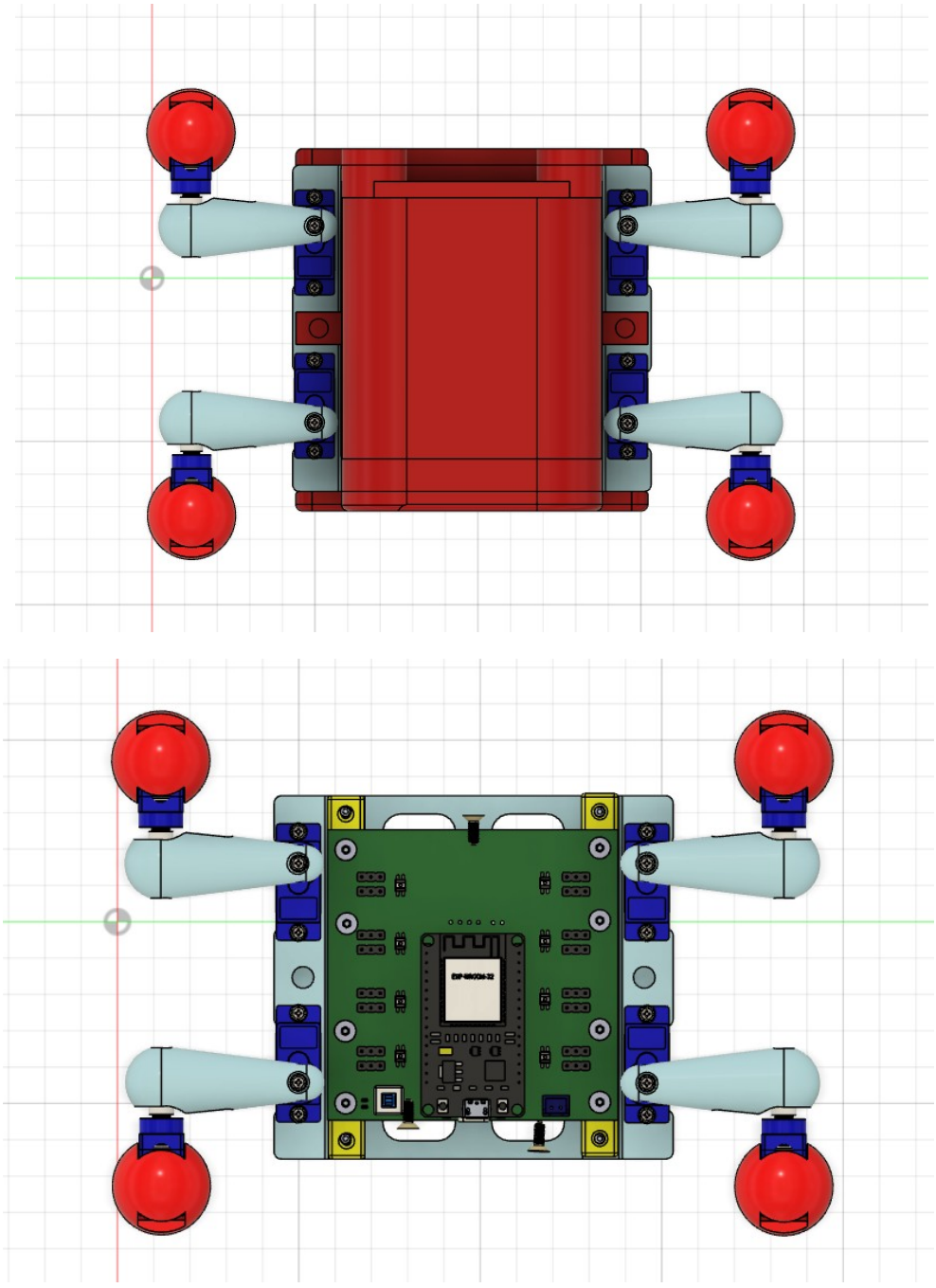


Figure 1: Robot that controlled by iSEB Expansion Board 1200 0012 V1.0.

2 Hardware

2.1 Schematic

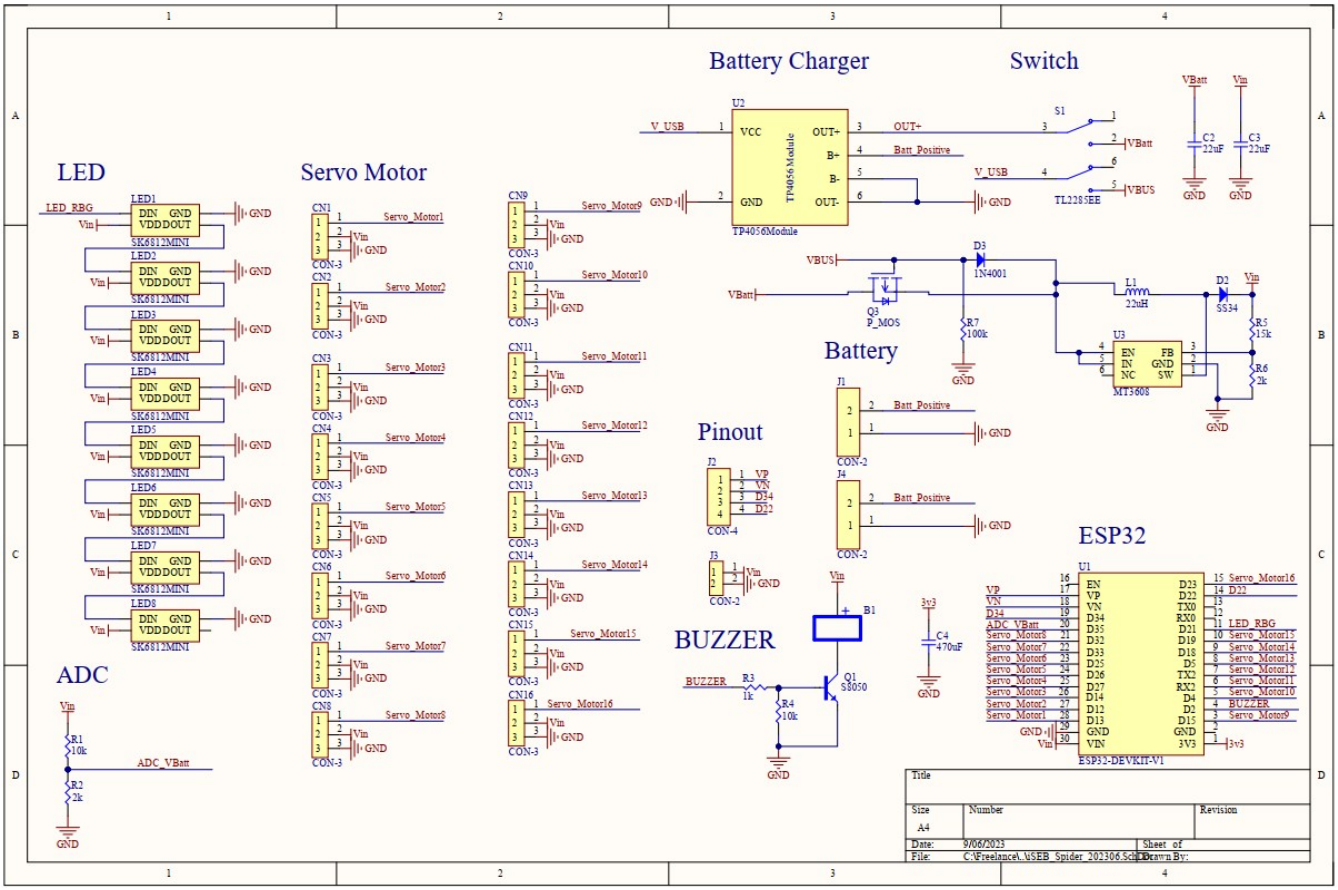


Figure 2: Schemaitc of iSEB Expansion Board 1200 0012 V1.0

2.2 Pinout

Pin	Function	Pin	Function
EN	Enable Pin	D23	PWM16
VP	Unused	D22	Unused
VN	Unused	TX0	TX0
D34	Unused	RX0	RX0
D35	ADC Vbatt	D21	RGB Led
D32	PWM8	D19	PWM15
D33	PWM7	D18	PWM14
D25	PWM6	D05	PWM13
D26	PWM5	D17	PWM12
D27	PWM4	D16	PWM11
D14	PWM3	D04	PWM10
D12	PWM2	D02	Buzzer
D13	PWM1	D15	PWM9

Table 1: Pinout

2.2 PCB Layout

The following is the figure of the iSEB Expansion Board 1200 0012 V1.0

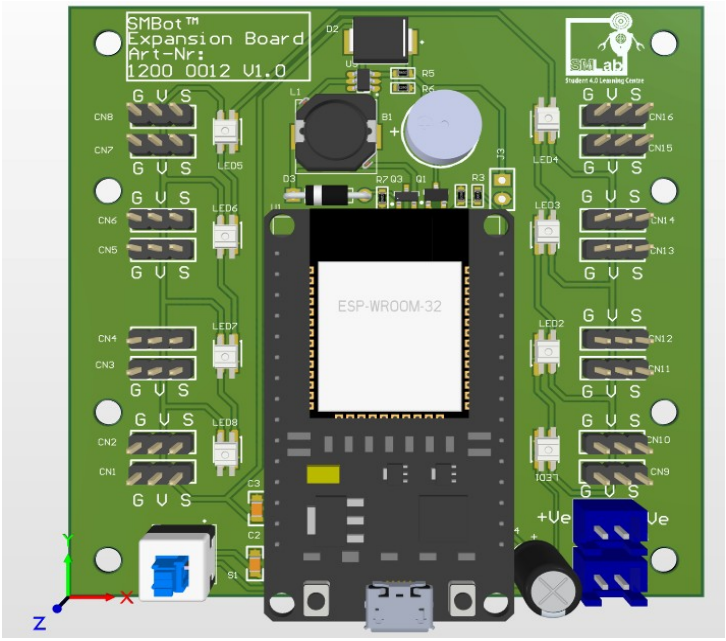


Figure 3: iSEB Expansion Board 1200 0012 V1.0 with ESP32 Module

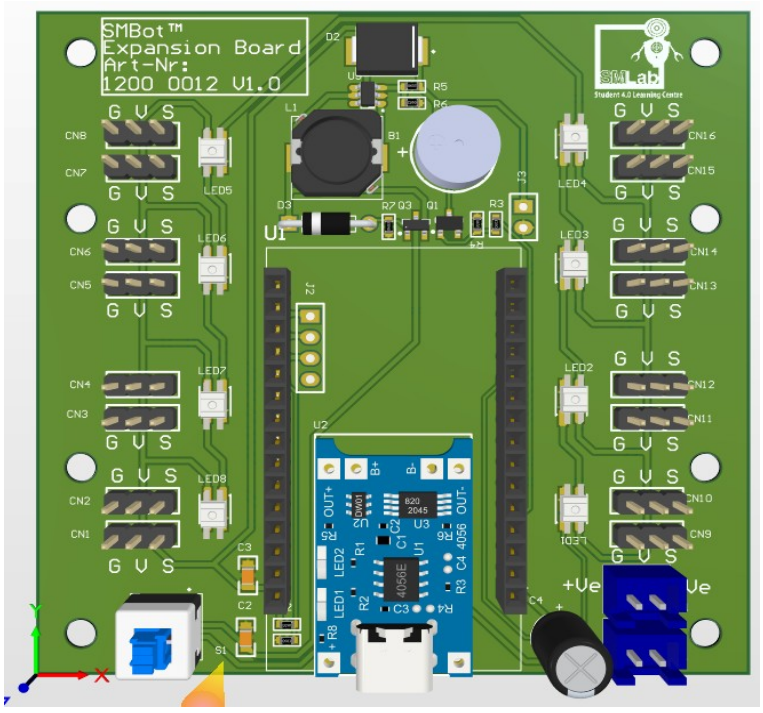
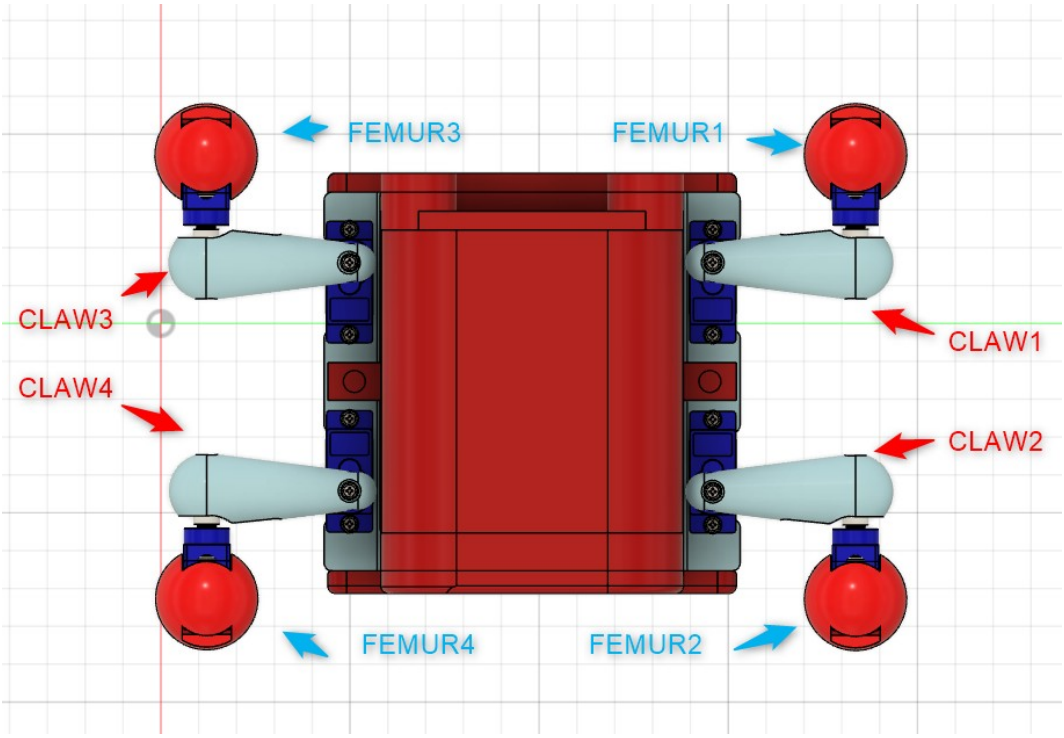


Figure 4: iSEB Expansion Board 1200 0012 V1.0 without ESP32 Module

2.2.1 Label of legs

The following figure is labeling the leg of the robot.



2.2.2 PWM control

There are 16 PWM control port in iSEB Expansion Board 1200 0012 V1.0. The figure below is showing the locaiton of the 16 PWM control port.

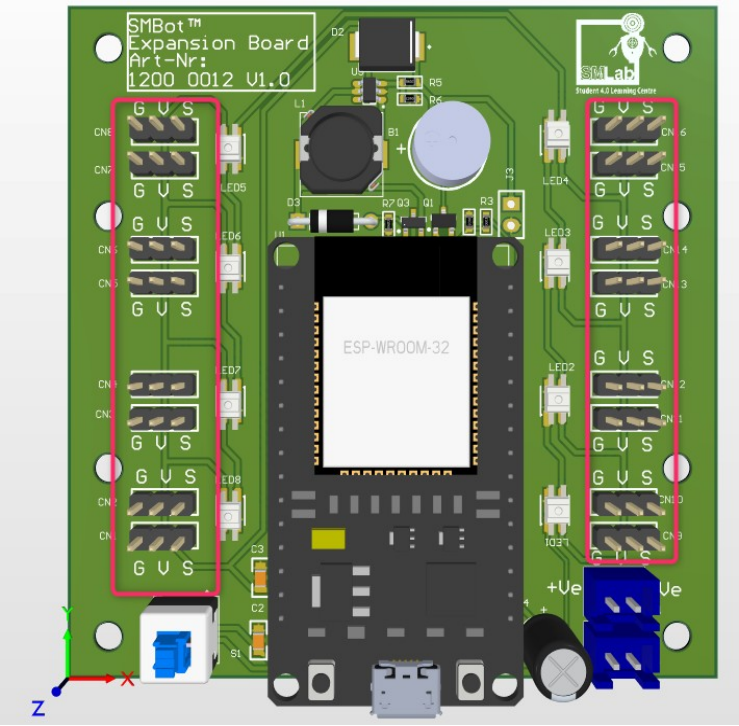
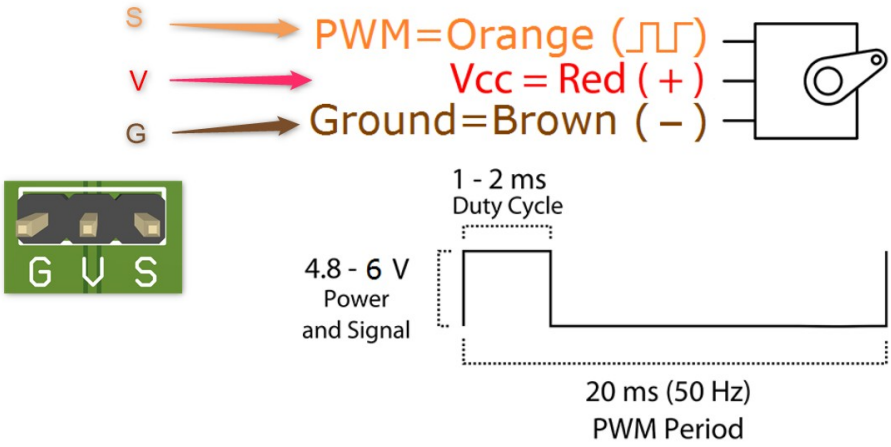


Figure 6: PWM control port

2.2.2.1 PWM Control Servo Motor Connection



Position "0" (1.5 ms pulse) is middle, "90" (~2 ms pulse) is all the way to the right, "-90" (~1 ms pulse) is all the way to the left.

The figure below is specifying the port for each robot's claw.

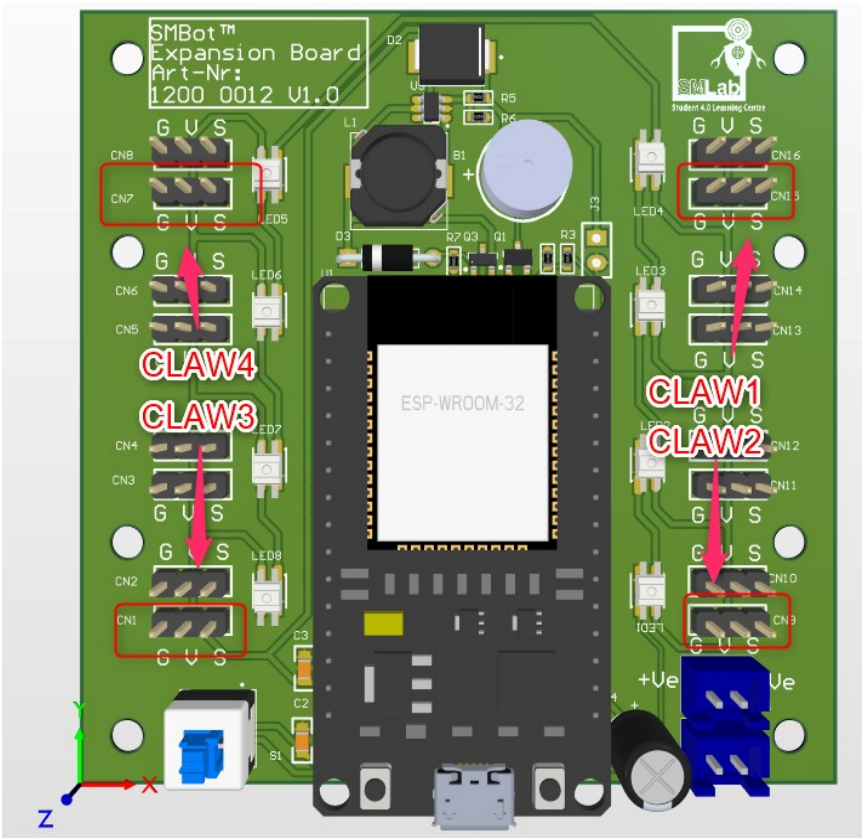


Figure 7: ports for robot's claws

The figure below is specifying the port for each robot's femur.

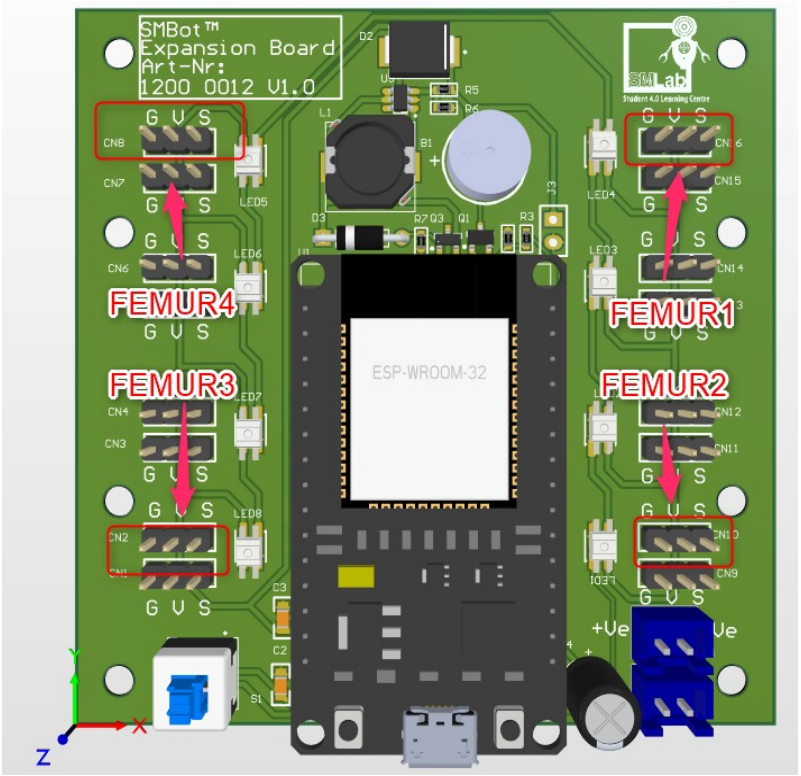


Figure 8: Robot's femur

2.2.3 Switch , Battery Connector & RGB Led

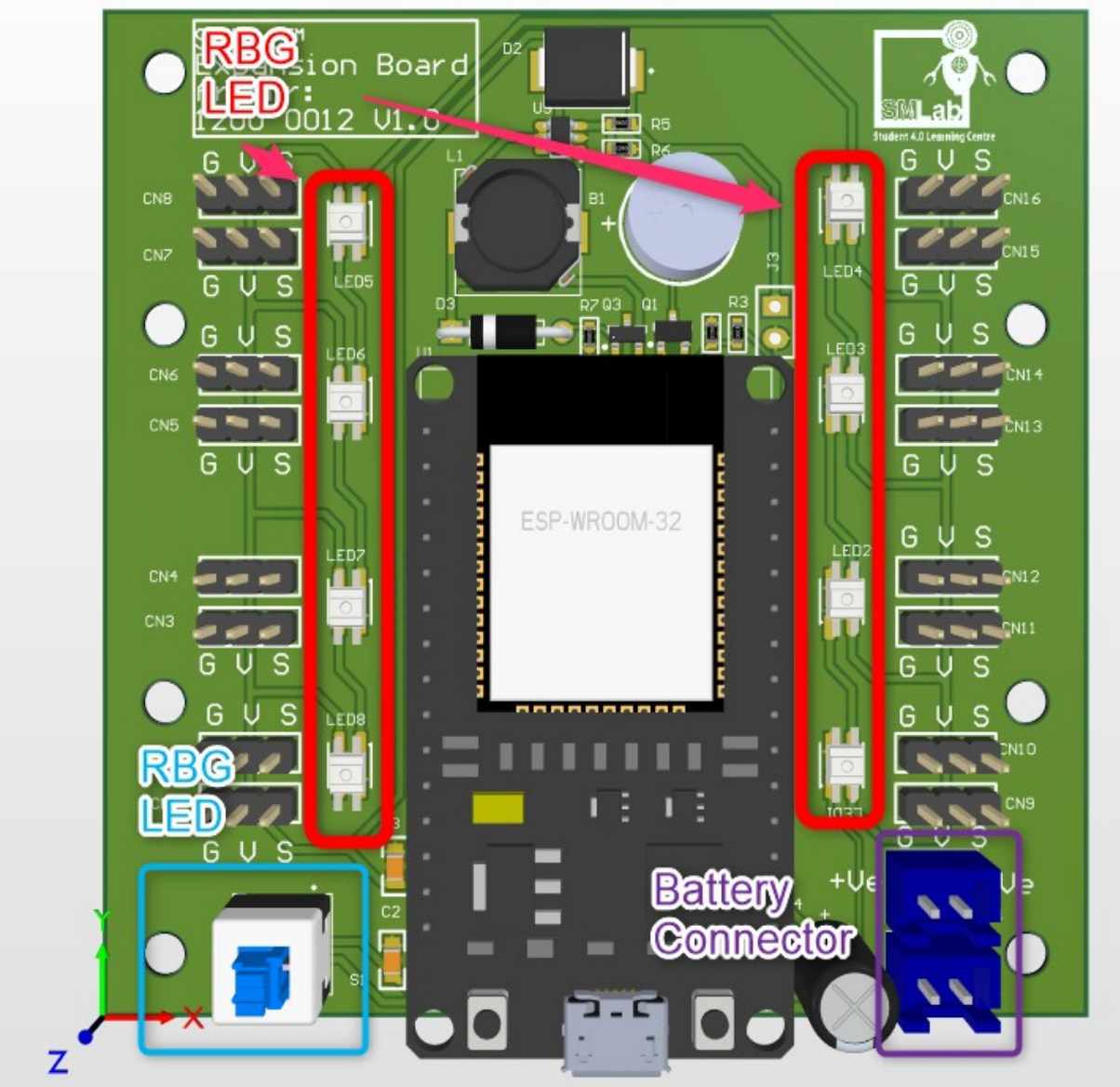


Figure 9: Switch , Battery connector & RGB led

2.3 Bom list

- *iSEB Expansion Board 1200 0012 V1.0 with ESP32 Module x 1*
- *18650 Battery x 2*
- *ESP32-DEVKIT-V1 x 1*
- *Spider chassis set x 1*

3 Firmware

The iSEB Expansion Board 1200 0012 V1.0 is using ESP32 DevKit V1. The figure is showing the pinout of ESP32 DevKit V1.The microcontroller is esp-wroom-32 module.

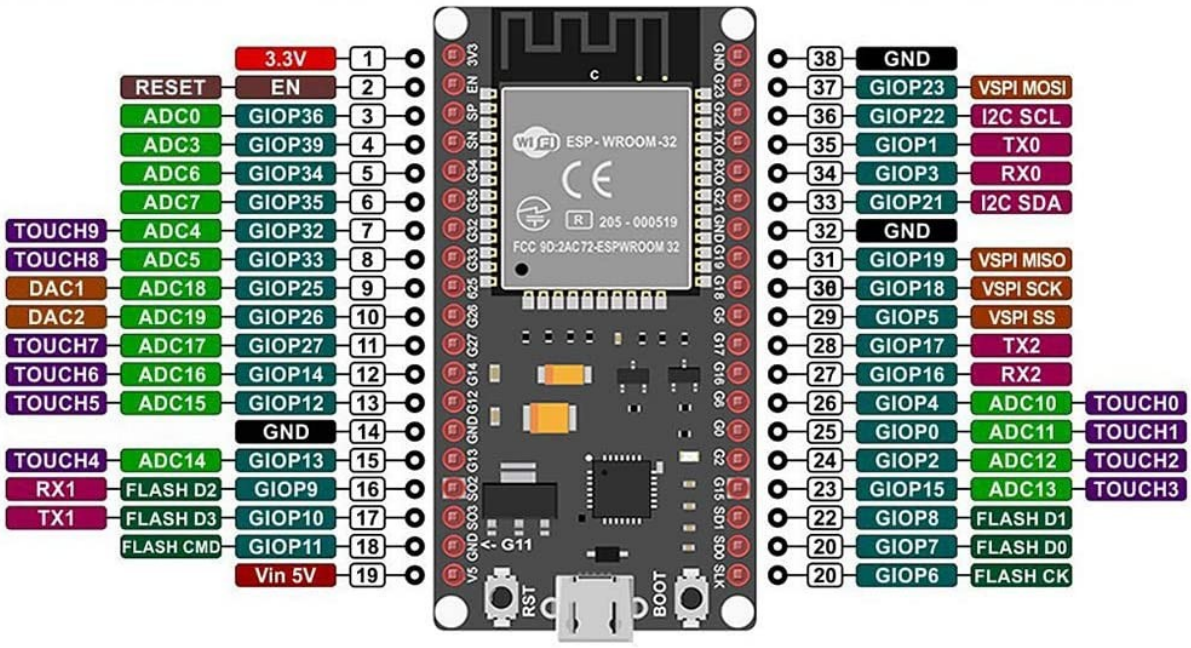


Figure 10: Pinout of ESP32 DevKit V1

3.1 Specification of the ESP32 DevKit V1

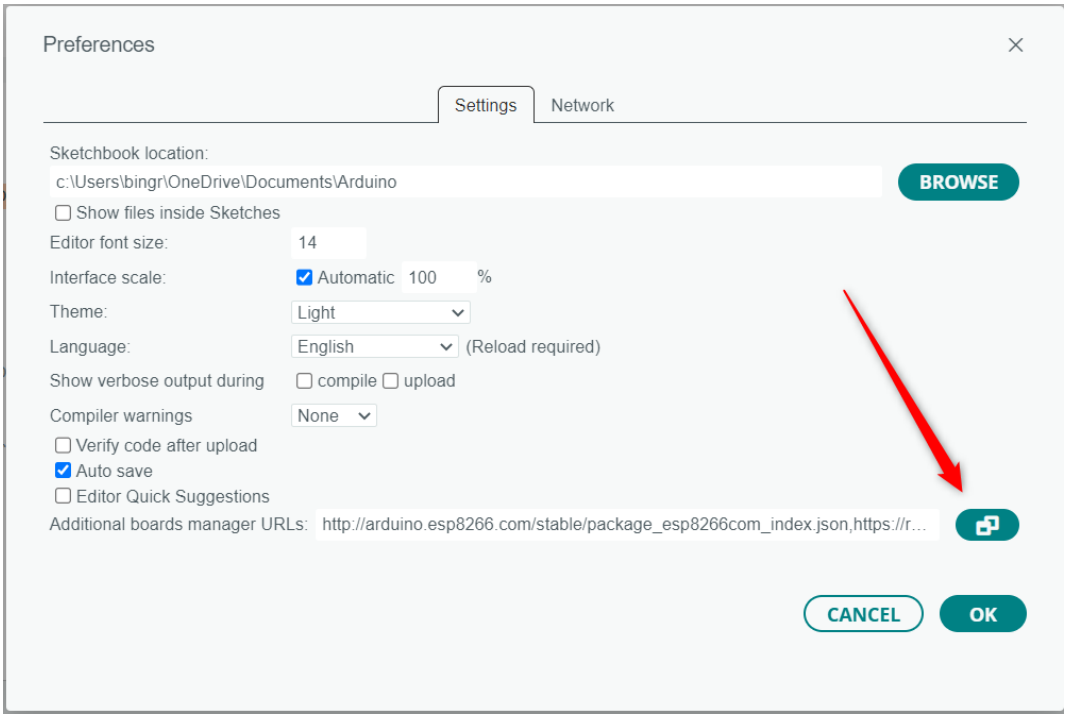
Microcontroller: Tensilica 32-bit Single-/Dual-core CPU Xtensa LX6

- Operating Voltage: 3.3V
- Input Voltage: 7-12V
- Digital I/O Pins (DIO): 25
- Analog Input Pins (ADC): 6
- Analog Outputs Pins (DAC): 2
- UARTs: 3
- SPIs: 2
- I2Cs: 3
- Flash Memory: 4 MB
- SRAM: 520 KB
- Clock Speed: 240 Mhz
- Wi-Fi: IEEE 802.11 b/g/n/e/i:
    - Integrated TR switch, balun, LNA, power amplifier and matching network
    - WEP or WPA/WPA2 authentication, or open networks
- Dimensions: 51.5x29x5mm

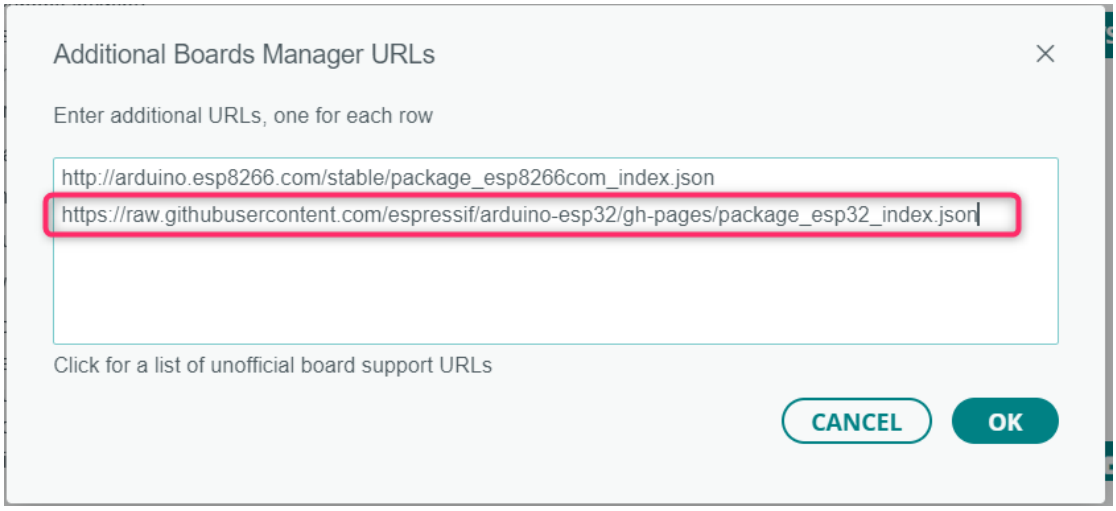
3.2 Environment set up

We need to set up the environment to flash the binary to ESP32 DevKit V1.

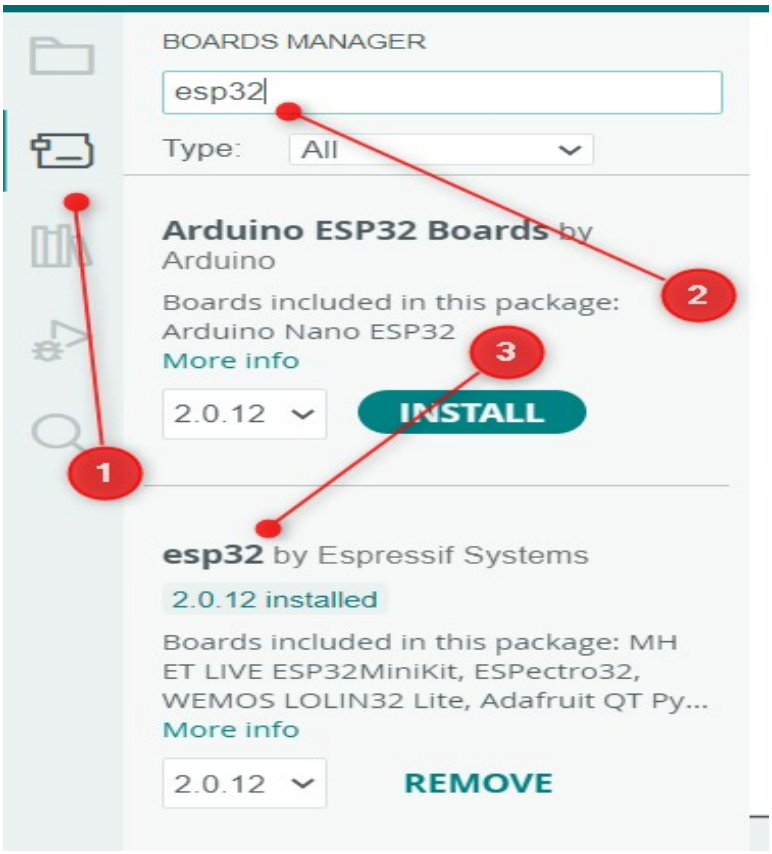
- Install Arduino IDE is requried to install. (Snapshot is base on Arduino IDE 2.2.0)
- Add https://raw.githubusercontent.com/espressif/arduino-esp32/gh-pages/package_esp32_index.json to Board Managers and install ESP32 libary.
    - Select Files-> Preferences and click on the icon



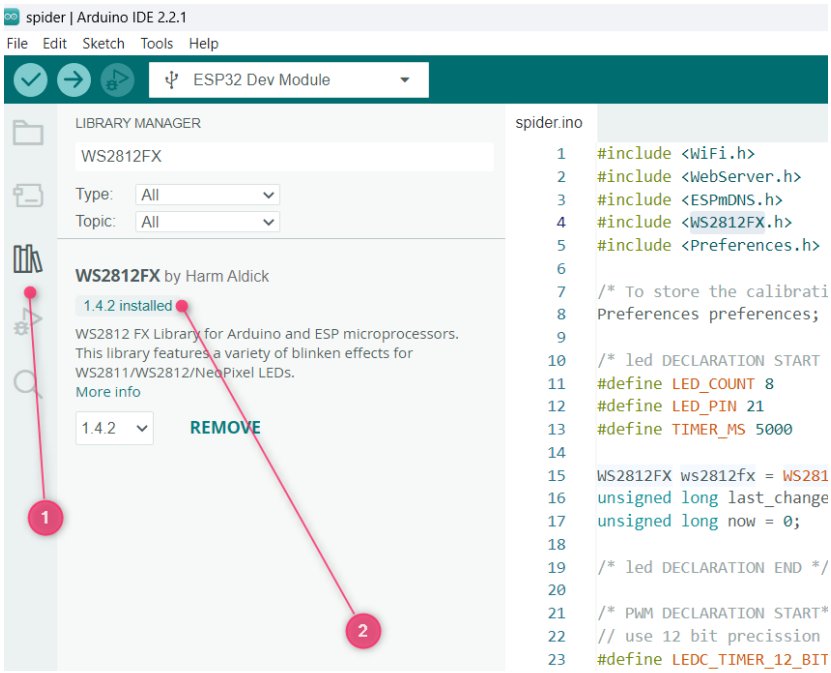
- Add Boards Manager URLs



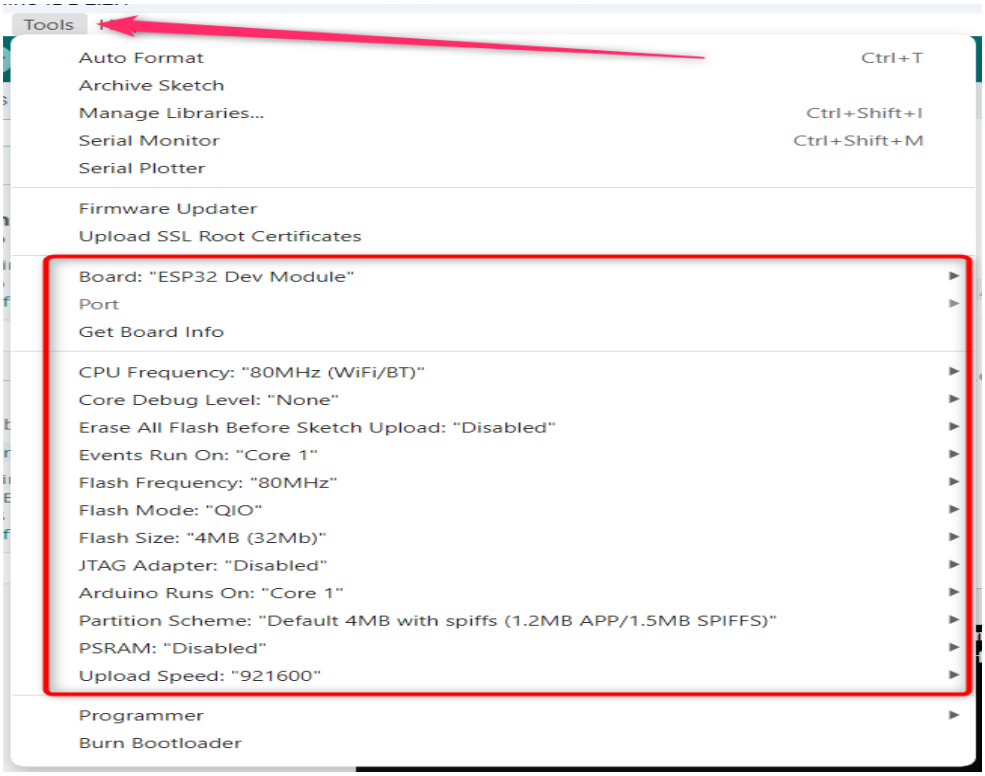
- Install ESP32 by Espressif Systems at Board Manager.



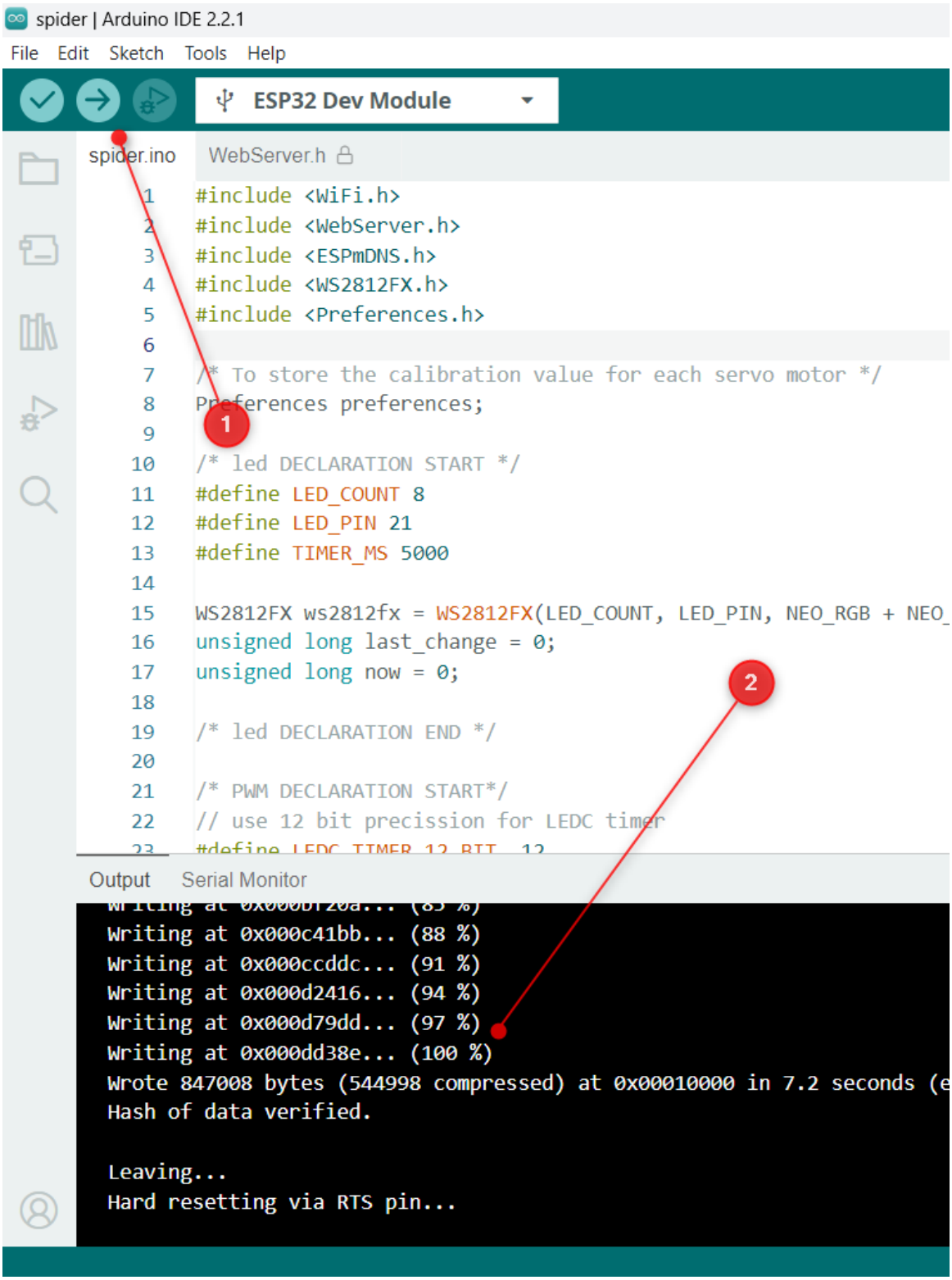
- Install WS2812FX by Harm Aldick (version 1.4.2) library.
  - Snapshot of install libary



- Update the upload setting



- Click upload button and the firmware will be flashed successfully if the snapshot below is seen.



- The environment set up is done if the binary able to flash to ESP32 DevKit V1..

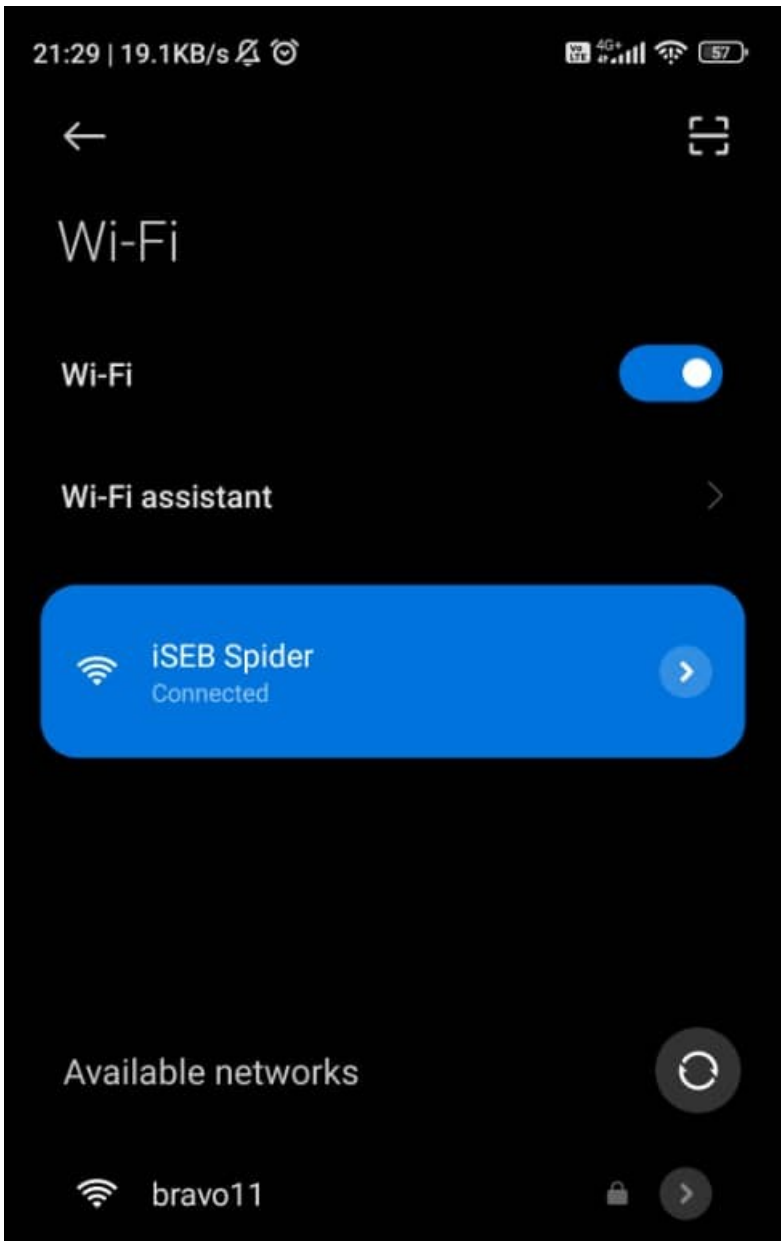
3.3 WiFi

3.3.1 How the WiFi Code works

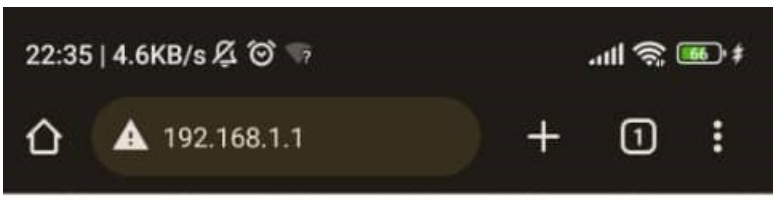
- Firstly we need to include WiFi and WebServer library
  - `#include <WiFi.h>`
    - `WiFi.h - esp32 Wifi support.`
  - `#include <WebServer.h>`
    - WebServer.h - Dead simple web-server. Supports only one simultaneous client, knows how to handle GET and POST.
- Secondly we need to insert our ssid and password
  - `const char* ssid = "iSEB Crab";  // Enter SSID here`
  - `const char* password = "12345678";  //Enter Password here`
- Then we set our web server to port 80
  - `WebServer server(80);`
- We have to setup the WiFi in setup function
  - To start the Wi-Fi as an Access Point.
    - `WiFi.softAP(ssid);/* without password */`
    - `WiFi.softAP(ssid,password);/* with password */`
  - Function used to configure the IP as static (fixed) as well as the gateway and subnet.
    - `WiFi.softAPConfig(local_ip, gateway, subnet); /* to add exception to server */`
  - Set up handling of web page
    - `server.on("/",handleIndex);`
    - `server.on("/editor", handleEditor);`
    - `server.on("/controller", handleController);`
    - `server.on("/zero", handleZero);`
    - `server.on("/setting",handleSetting);`
    - `server.on("/save", handleSave);`
  - Enable the server
    - `server.begin();`
- We have to handle the user request in loop funtion
    - `server.handleClient();`

3.3.2 WiFi server and control UI

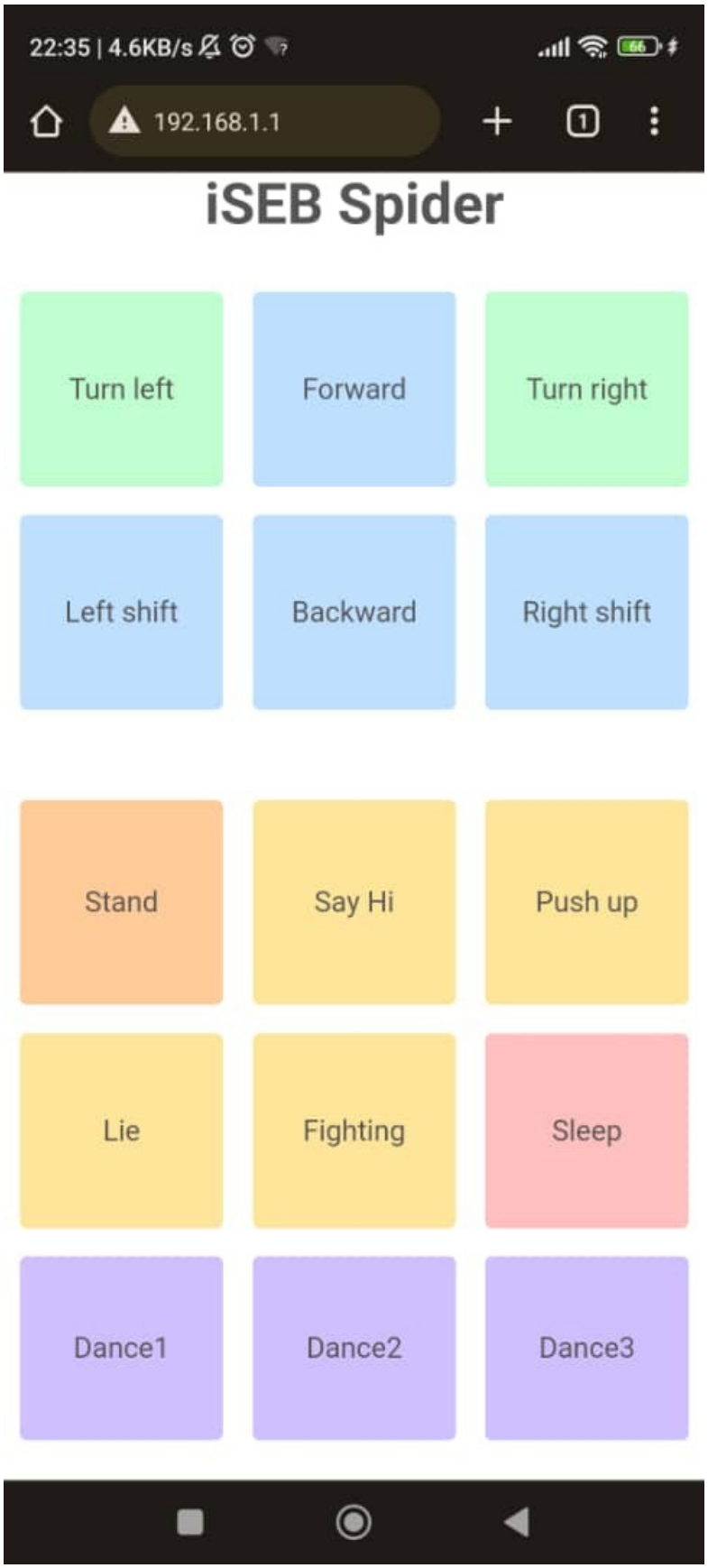
- After flash succesfully, the iSEB Spider should be appear in the WiFi list. The figure below is showing the iSEB spider is appeared in the WiFi list.



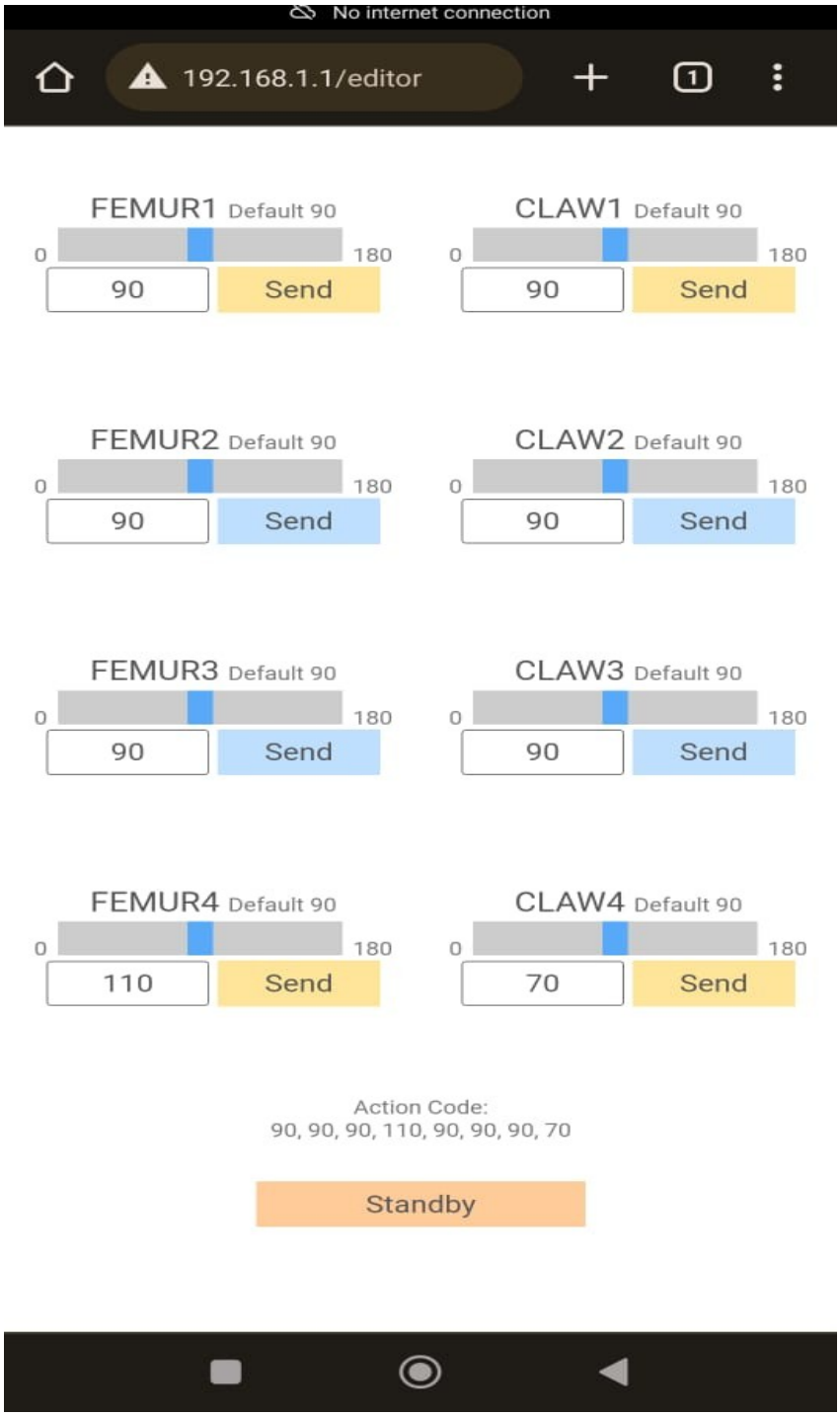
- Connect to the ISEB Spider and access 192.168.1.1



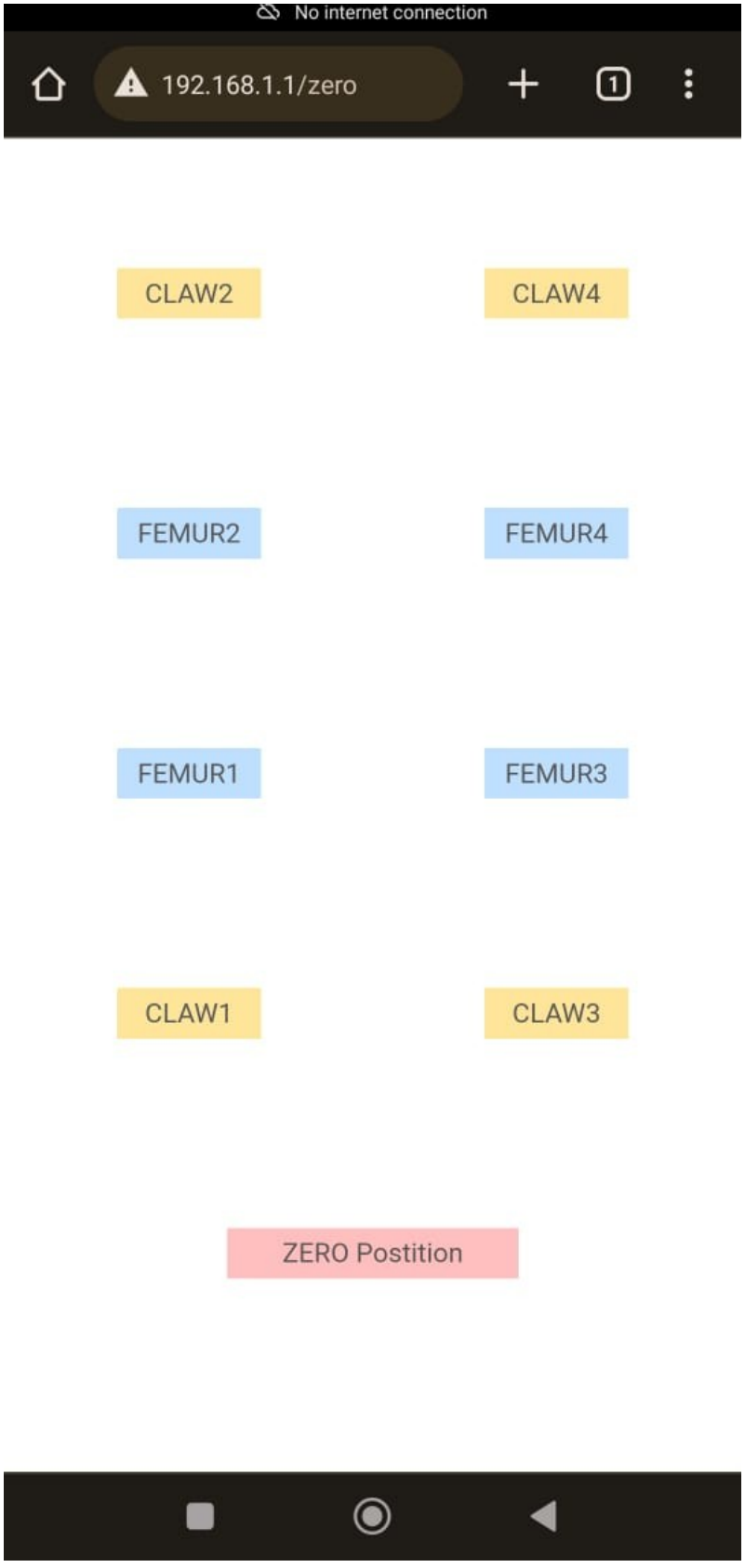
- The control page will be show as below



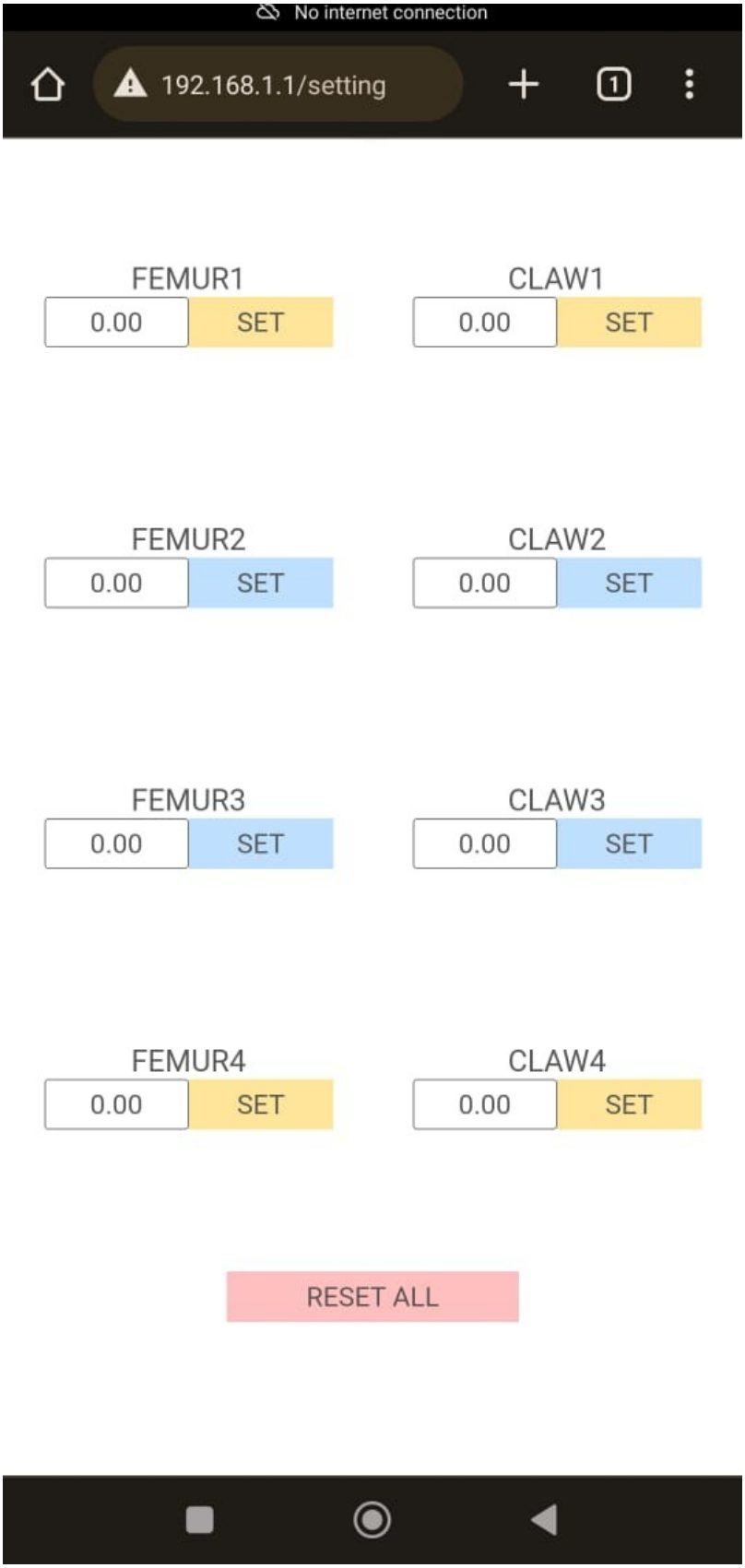
- The Motion Editor Page



- The Zero Page



- The Setting page



3.4 Servo Motor

- The servo motor used in the iSEB Crab is TowerPro SG90 servo .
- The wire colors are Red = Battery(+) Brown = Battery(-) Orange = Signal
- The figure below show how the servo motor angle control by pwm
- Servo motor control with 50 Hz pulse width modulated (PWM) signal, which produces a pulse every 20ms.
-

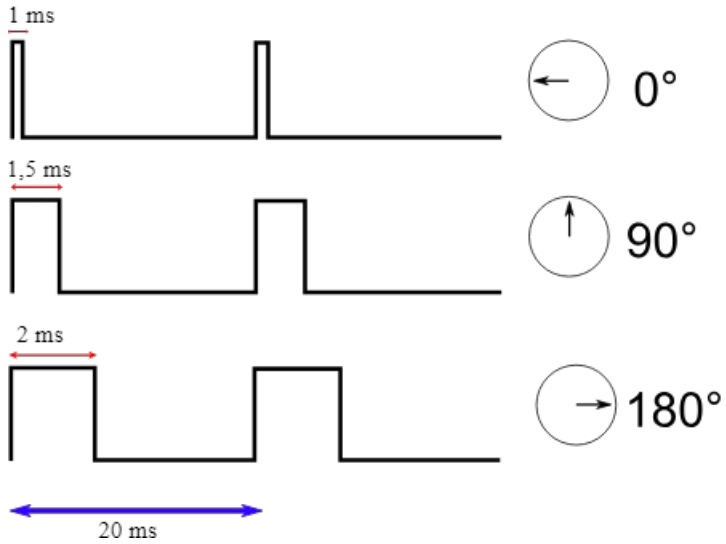


Figure 11: How servo's position controlled by PWM signal

3.4.1 How the Servo Motor Code works

3.4.1.1 Setup

- We are using the LED Control library from ESP32 hal library to control servo motor.
- The LED control (LEDC) peripheral is primarly designed to control the intensity of LEDs, although it can also be used to generate PWM signals for other purposes. .
- For more details of the LEDC library can refer to the link
  - https://espressif-docs.readthedocs-hosted.com/projects/arduino-esp32/en/latest/api/ledc.html
- We able to generate PWM signals to control the servo motor.
- We have a motorInit funciton in the setup function to call the setup.
- We are calling funcition ledcSetupledc and ledcAttachPin in function motorInit.
- Function ledcSetupledc is used to setup the LEDC channel frequency and resolution.
  - uint32_t ledcSetup(uint8_t channel, uint32_t freq, uint8_t resolution_bits);
    - channel select LEDC channel to config.
      - ESP32 have 16 channels
    - freq select frequency of pwm.
    - resolution_bits select resolution for ledc channel.
      - range is 1-14 bits (1-20 bits for ESP32)
- Function ledcAttachPin is used to attach the pin to the LEDC channel.
  - void ledcAttachPin(uint8_t pin, uint8_t chan);
    - pin select GPIO pin.
    - chan select LEDC channel.
- The follow table is showing the GPIO vs Channel vs Connector in the example code

FEMUR/CLAW	GPIO	Channel	Connector
FEMUR1	19	1	CN15
FEMUR1	15	2	CN9
FEMUR1	33	3	CN7
FEMUR1	13	4	CN1
CLAW1	23	5	CN16
CLAW2	4	6	CN10
CLAW3	32	7	CN8
CLAW4	12	8	CN2

Table 2: Position vs GPIO vs Channel vs Connector matrix

3.4.1.2 Code of motorInit function

```
// use 12 bit precission for LEDC timer
#define LEDC_TIMER_12_BIT  12

// use 50 Hz as a LEDC base frequency
#define LEDC_BASE_FREQ     50

#define FEMUR_1 0 /* Chanel 0 */
#define FEMUR_2 1 /* Chanel 1 */
#define FEMUR_3 2 /* Chanel 2 */
#define FEMUR_4 3 /* Chanel 3 */
#define CLAW_1 4 /* Chanel 4 */
#define CLAW_2 5 /* Chanel 5 */
#define CLAW_3 6 /* Chanel 6 */
#define CLAW_4 7 /* Chanel 7 */

void motorInit()

{
 // Setup timer
 ledcSetup(FEMUR_1, LEDC_BASE_FREQ, LEDC_TIMER_12_BIT);
 ledcSetup(FEMUR_2, LEDC_BASE_FREQ, LEDC_TIMER_12_BIT);
 ledcSetup(FEMUR_3, LEDC_BASE_FREQ, LEDC_TIMER_12_BIT);
 ledcSetup(FEMUR_4, LEDC_BASE_FREQ, LEDC_TIMER_12_BIT);
 ledcSetup(CLAW_1, LEDC_BASE_FREQ, LEDC_TIMER_12_BIT);
 ledcSetup(CLAW_2, LEDC_BASE_FREQ, LEDC_TIMER_12_BIT);
 ledcSetup(CLAW_3, LEDC_BASE_FREQ, LEDC_TIMER_12_BIT);
 ledcSetup(CLAW_4, LEDC_BASE_FREQ, LEDC_TIMER_12_BIT);

 // Attach timer to a led pin
 ledcAttachPin(19, FEMUR_1);  /* FEMUR_1 *//* CN15 *//* PIN 19*/
 ledcAttachPin(15, FEMUR_2);  /* FEMUR_2 *//* CN9  *//* PIN 15*/
 ledcAttachPin(33, FEMUR_3);  /* FEMUR_3 *//* CN7  *//* PIN 33*/
 ledcAttachPin(13, FEMUR_4);  /* FEMUR_4*//* CN1  *//* PIN 13*/
 ledcAttachPin(23, CLAW_1);  /* CLAW_1 *//* CN16 *//* PIN 23*/
 ledcAttachPin( 4, CLAW_2);  /* CLAW_2 *//* CN10 *//* PIN  4*/
 ledcAttachPin(32, CLAW_3);  /* CLAW_3 *//* CN8  *//* PIN 32*/
 ledcAttachPin(12, CLAW_4);  /* CLAW_4 *//* CN2  *//* PIN 12*/
 delay(50);
}
```

- From the code above we have set up pwm channel 0 to 7 to 50hz frequeny with resolution 12 bit with function ledcSetup
- We have assign GPIO pin to the pwm channel accordingly with function ledcAttachPin.

3.4.1.3 Update duty cycle during runtime

- ESP32 will output pwm signal after we configure the frequenc , resolutoin to the pwm channel and assign the GPIO pin to each pwm channel.
- We can call LEDCWrite to update the duty cycle of the particular pwm channel.
- By updating duty cycle we can control the positoin of servo motor mention chalter 3.4
- Functoin ledcWrite is used to set duty for the LEDC channel.
  - void ledcWrite(uint8_t chan, uint32_t duty);
    - chan select the LEDC channel for writing duty.
    - duty select duty to be set for selected channel.
- In the example code, we have set the resolution bit to 12 bit hence there are 4095 steps for the reoslution.
- By calculation we set 409 to acheive 1ms duty cycle and 819 to achieve 2ms duty cycle.
- However the example we set min to 50 min and maximum to 550 due to base on testing the servo motor only react between 50 and 550 (will further investigate on this issue suspect is due to servo motor but yet to confirm with scope).
- For the servo postion array such as Servo_Prg_X, the position is store as position therefore a positoin convert to duty cycle is needed.
- Function Set_PWM_to_Servo is to convert the position to duty cycle and update to the pwm channel
  - void Set_PWM_to_Servo(int iServo, int iValue)
    - iServo select the LEDC channel for writing duty.
    - Ivalue select the position to convert to duty tobe set for selected channel.

3.4.1.4 Set_PWM_to_Servo

```
/* MOTOR CODE START */
void Set_PWM_to_Servo(int iServo, int iValue)
{
 Serial.print(F("iServo: "));
 Serial.print(iServo);
 Serial.print(F(" iValue: "));
 Serial.println(iValue);
 // 讀取 EEPROM 修正誤差
 iValue = (iValue*MAX/180.0)+MIN; /* convertion to pwm value */
 double NewPWM = iValue + preferences.getDouble((String(iServo)).c_str(),0); /* zero error
calibration */
 /* 0 = zero degree 550 = 180 degree*/
 ledcWrite(iServo,NewPWM);
}
```

- We have printed the input parameter iServo and iValue for debug purpose.
- We have do conversion for iValue from position to duty cycle
- We have done the zero error calibration but currently not in use the value will always be zero.
- We will udpate the pwm channel value with ledcWrite.