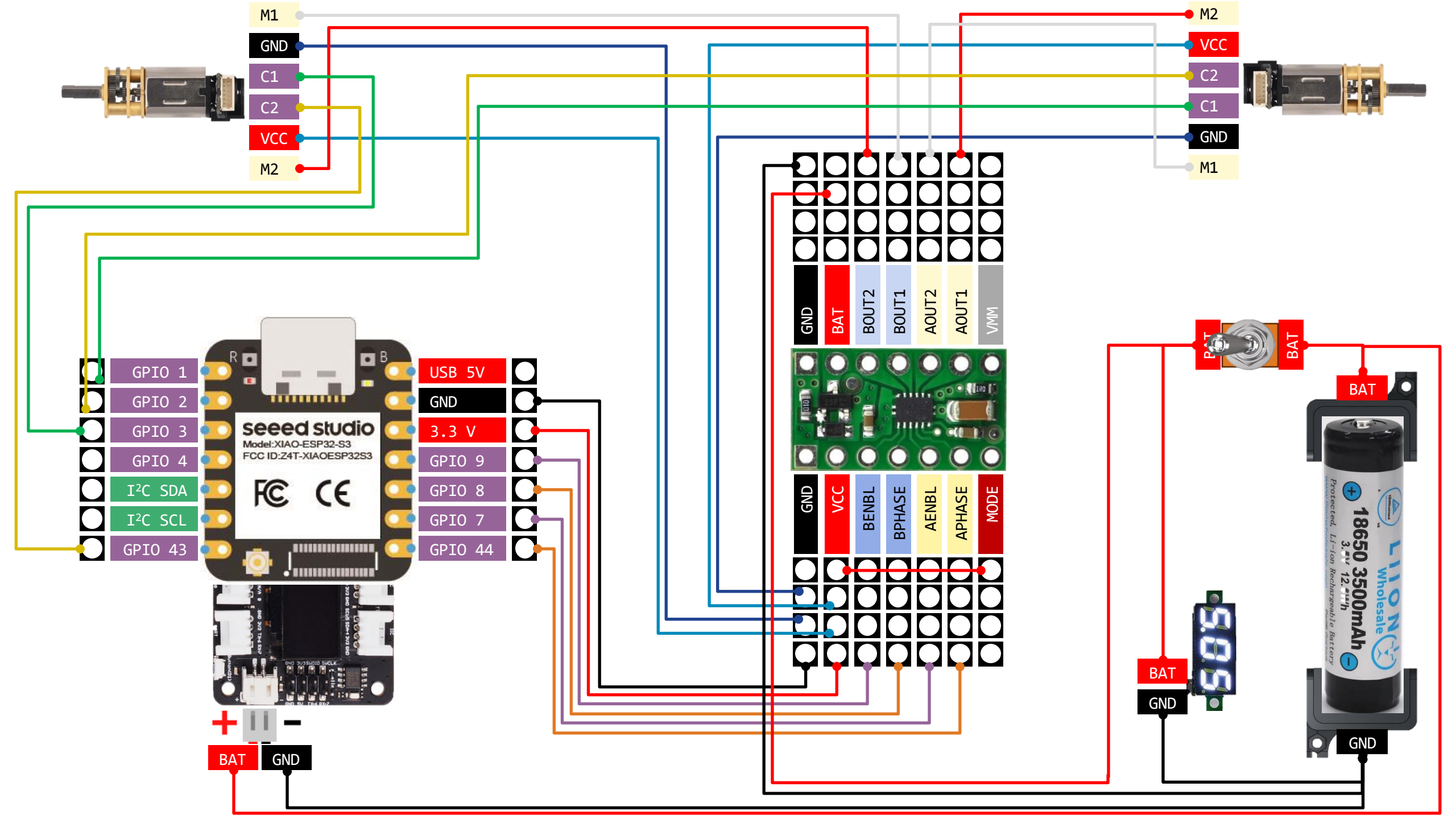
Safety And Electronics

Mobile Robotics

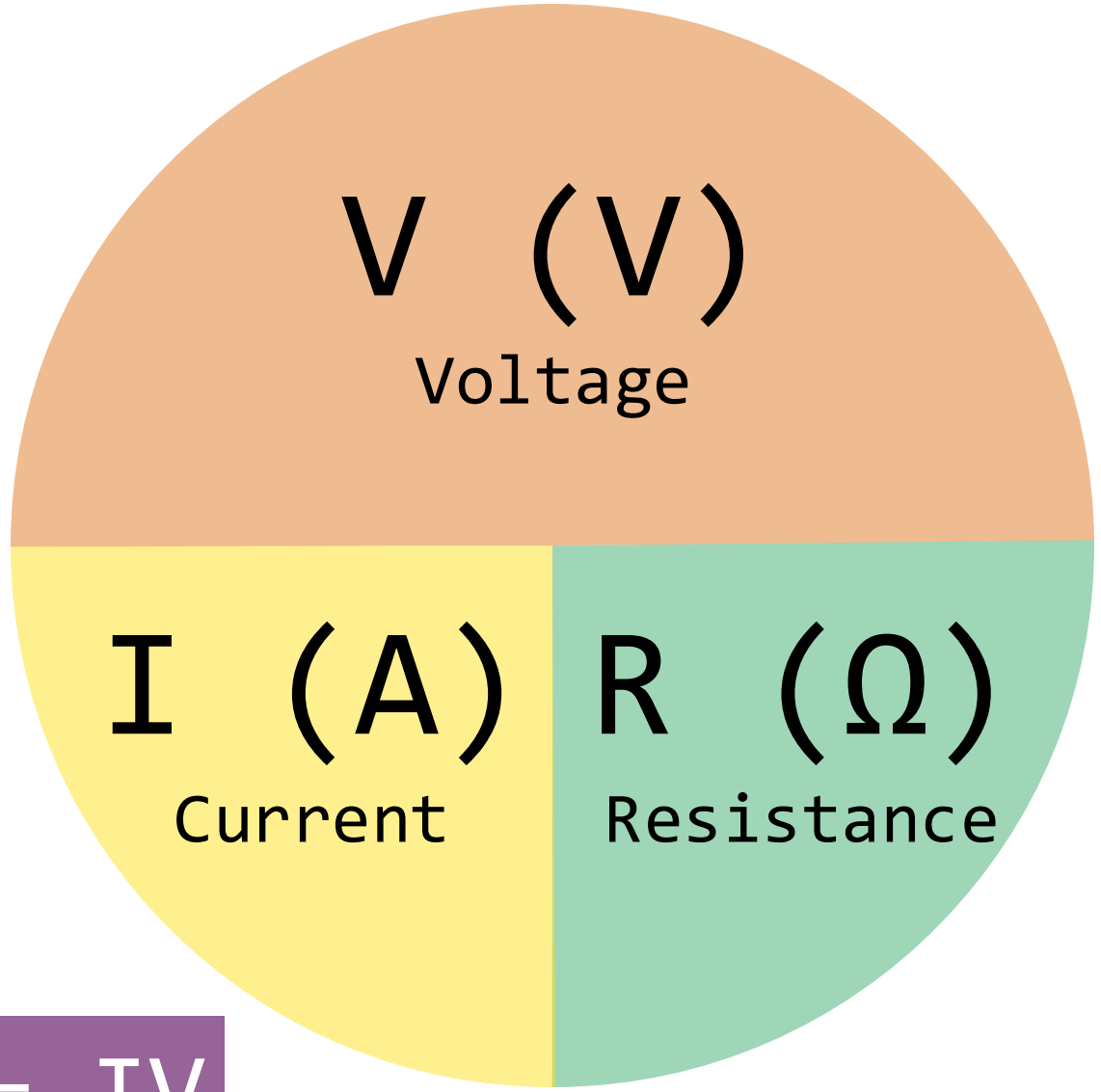
Anthony J. Clark

Today

- Safety
- Component specifications
- Review requirements
- Wiring diagrams
- Coding with Toit


M1
GND
C1
C2
VCC
M2
M2
VCC
C2
C1
GND
M1
GND
BAT
BOUT2
BOUT1
AOUT2
AOUT1
VMM
GND
VCC
BENBL
BPHASE
AENBL
APHASE
MODE
GPIO 1
GPIO 2
GPIO 3
GPIO 4
I²C SDA
I²C SCL
GPIO 43
USB 5V
GND
3.3 V
GPIO 9
GPIO 8
GPIO 7
GPIO 44
seeed studio
Model:XIAO-ESP32-S3
FCC ID:Z4T-XIAOESP32S3
BAT
GND
BAT
BAT
18650 3500mAh
GND
BAT
GND

Basic Circuit Theory: Ohm's Law



$P = IV$

Battery Safety

Warning: Lithium-ion batteries may explode or burn due to improper use. Using these batteries for purposes not intended by the manufacturer, including outside a battery pack and/or without a BMS, may cause severe injury and damage. We are not responsible for any injuries caused by lithium-ion batteries - use at your own risk.

- Li-Ion Wholesale

Selected Battery Safety Tips

Charging and discharging

- Never completely discharge batteries (**3.2V** for this class)
- Never charge batteries to more than their full charge voltage (**4.2V**)
- Do not charge unattended or leave in the charger unattended

Storing and transporting

- Do not store li-ion batteries fully charged for an extended period (i.e., weeks)
- Store batteries at **3.5 to 3.7V**
- Store and transport batteries in a packed, non-conductive, and safe container

Fire safety

- If a rechargeable battery catches fire, the FAA recommends pouring water or soda on the battery and surrounding areas - ideally, use a foam extinguisher to quell the fire

Selected Electronics Safety Practices

- Always check for loose wires and debris before powering your circuit
- Always disconnect power before adding connections
- Keep an eye on your battery's voltage level
- Keep an eye on the heat being generated by your components
- Be careful with static electricity (you can accidentally fry a component)

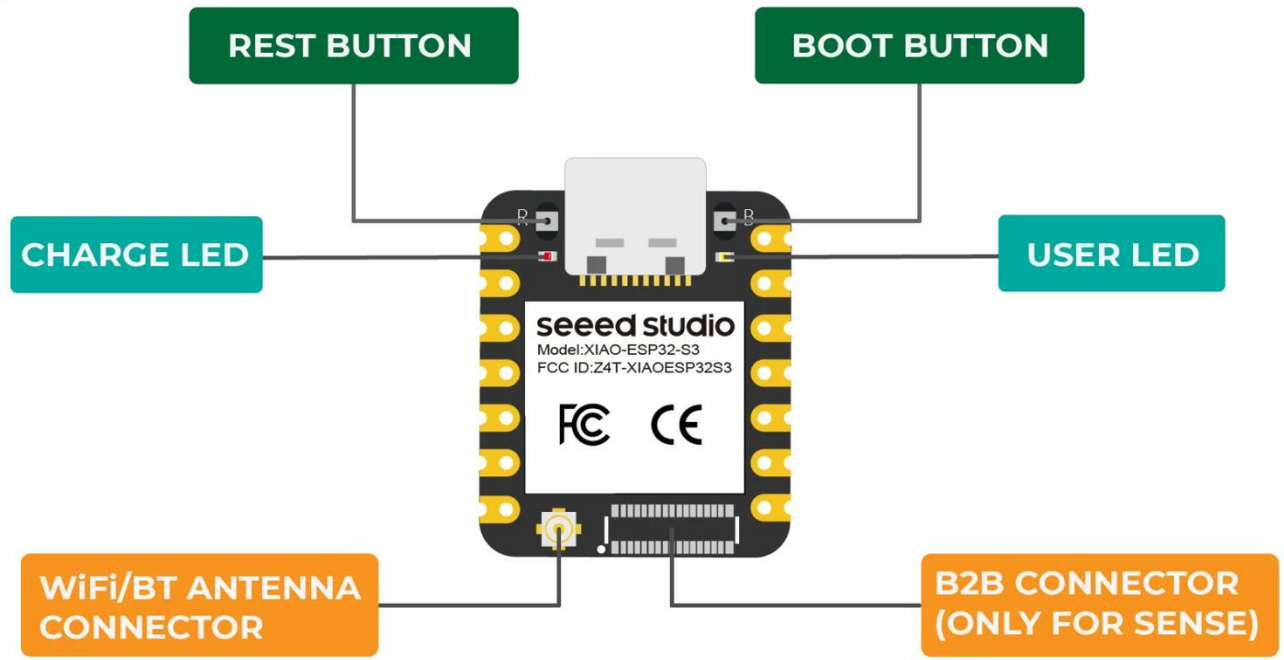
Read the entire list of safety tips on the course website

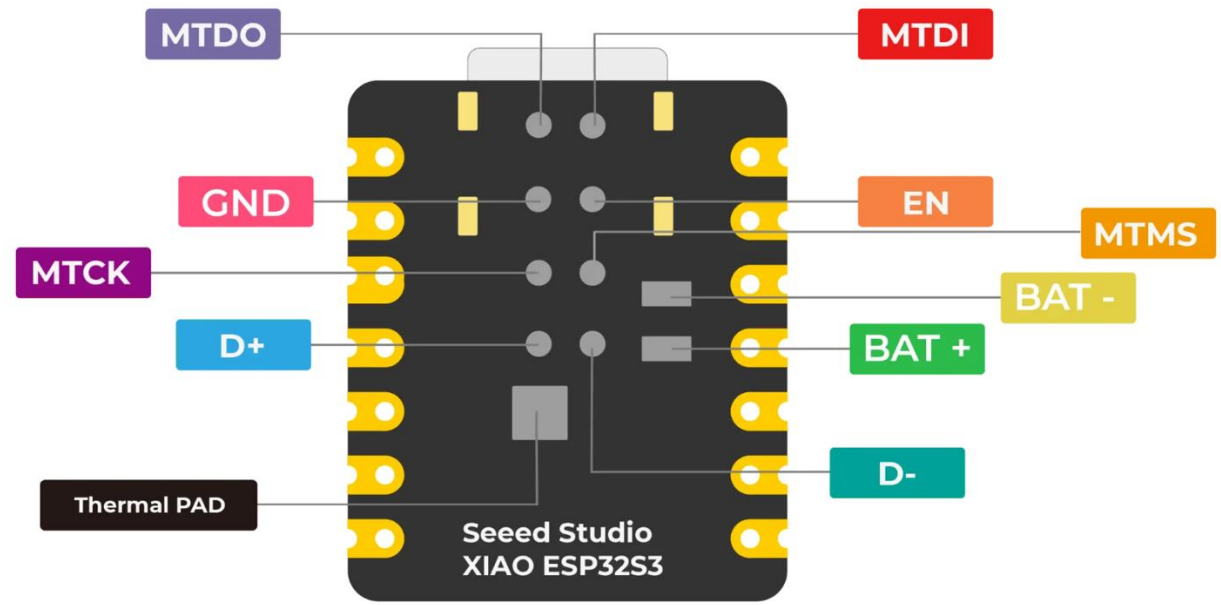
Today

- Safety

- Component specifications
  - Microcontroller: ESP32-S3
  - Peripheral: Expansion Board
  - Motors: Micro Metal Gearmotors
  - Motor Driver: DRV8835
  - Breadboard
  - Power System: Battery, Switch, Voltage Tester

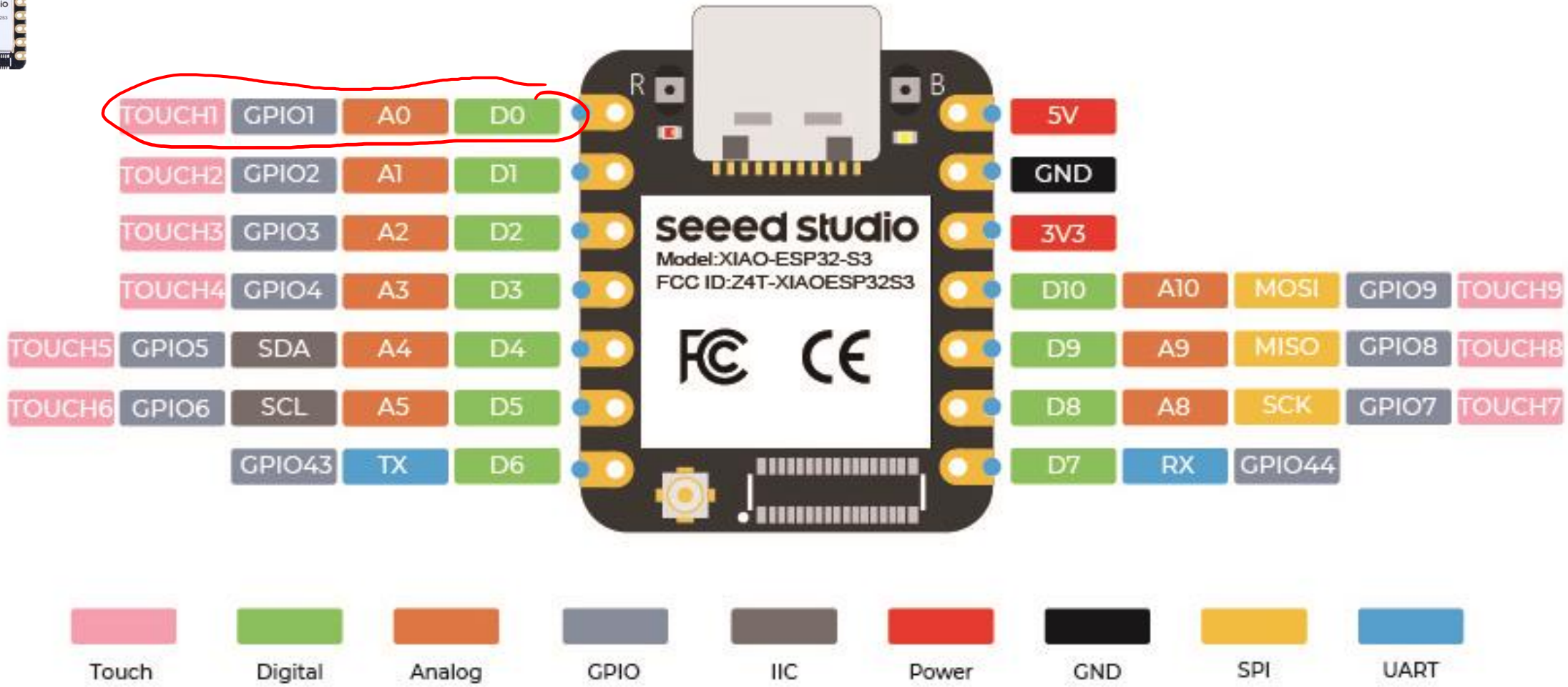
Specifications	
Processor	ESP32-S3R8 Xtensa LX7 dual-core, 32-bit processor that operates at up to **240 MHz**
Wireless	Complete 2.4GHz Wi-Fi subsystem BLE: Bluetooth 5.0, Bluetooth mesh
Memory	On-chip **8M** PSRAM & **8MB** Flash
Interface	1x UART, 1x IIC, 1x IIS, 1x SPI, 11x GPIOs (PWM), 9x ADC, 1x User LED, 1x Charge LED 1x Reset button, 1x Boot button
Dimensions	21 x 17.8mm
Power	Input voltage (Type-C): **5V** Input voltage (BAT): **4.2V**
	Circuit operating Voltage (ready to operate): - Type-C: 5V@**19mA** - BAT: 3.8V@**22mA**
	Charging battery current: **100mA**
Low Power Consumption Model	Modem-sleep Model: **3.8V/25 mA** Light-sleep Model: **3.8V/2 mA** Deep Sleep Model: **3.8V/14 µA**
Wi-Fi Enabled Power Consumption	Active Model: **~ 100 mA**
BLE Enabled Power Consumption	Active Model: **~ 85 mA**
Working Temperature	-40°C ~ 65°C
GPIO Pin Limits	About **20 mA**





[Getting Started with Seeed Studio XIAO ESP32S3 (Sense) | Seeed Studio Wiki]

[High-Performance Dev Board with Wi-Fi and BLE - XIAO ESP32S3]

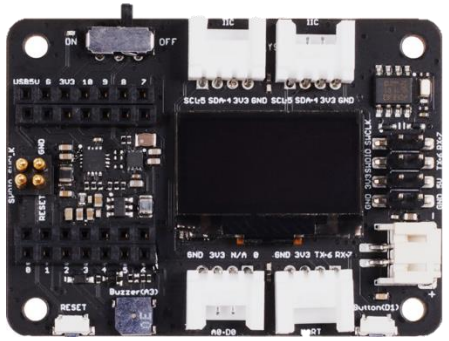


[Getting Started with Seeed Studio XIAO ESP32S3 (Sense) | Seeed Studio Wiki]

[High-Performance Dev Board with Wi-Fi and BLE - XIAO ESP32S3]

```
#define USB_VID 0x2886
#define USB_PID 0x0056

static const uint8_t LED_BUILTIN = 21;
#define BUILTIN_LED LED_BUILTIN  // backward compatibility
#define LED_BUILTIN LED_BUILTIN  // allow testing #ifdef LED_BUILTIN

static const uint8_t TX = 43;
static const uint8_t RX = 44;

static const uint8_t SDA = 5;
static const uint8_t SCL = 6;

static const uint8_t SS = 44;
static const uint8_t MOSI = 9;
static const uint8_t MISO = 8;
static const uint8_t SCK = 7;

static const uint8_t A0 = 1;
static const uint8_t A1 = 2;
static const uint8_t A2 = 3;
static const uint8_t A3 = 4;
static const uint8_t A4 = 5;
static const uint8_t A5 = 6;
static const uint8_t A8 = 7;
static const uint8_t A9 = 8;
static const uint8_t A10 = 9;

static const uint8_t D0 = 1;
static const uint8_t D1 = 2;
static const uint8_t D2 = 3;
static const uint8_t D3 = 4;
static const uint8_t D4 = 5;
static const uint8_t D5 = 6;
static const uint8_t D6 = 43;
static const uint8_t D7 = 44;
static const uint8_t D8 = 7;
static const uint8_t D9 = 8;
static const uint8_t D10 = 9;

static const uint8_t T1 = 1;
static const uint8_t T2 = 2;
static const uint8_t T3 = 3;
static const uint8_t T4 = 4;
static const uint8_t T5 = 5;
static const uint8_t T6 = 6;
static const uint8_t T7 = 7;
static const uint8_t T8 = 8;
static const uint8_t T9 = 9;
```

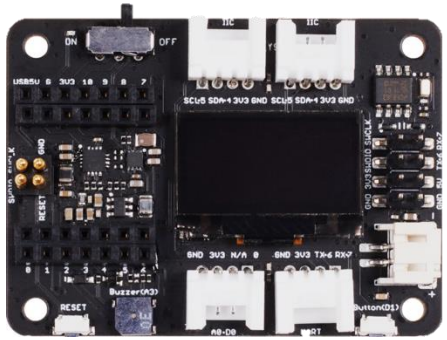
Arduino Pin Configuration (useful when Seeed Studio documentation is lacking)

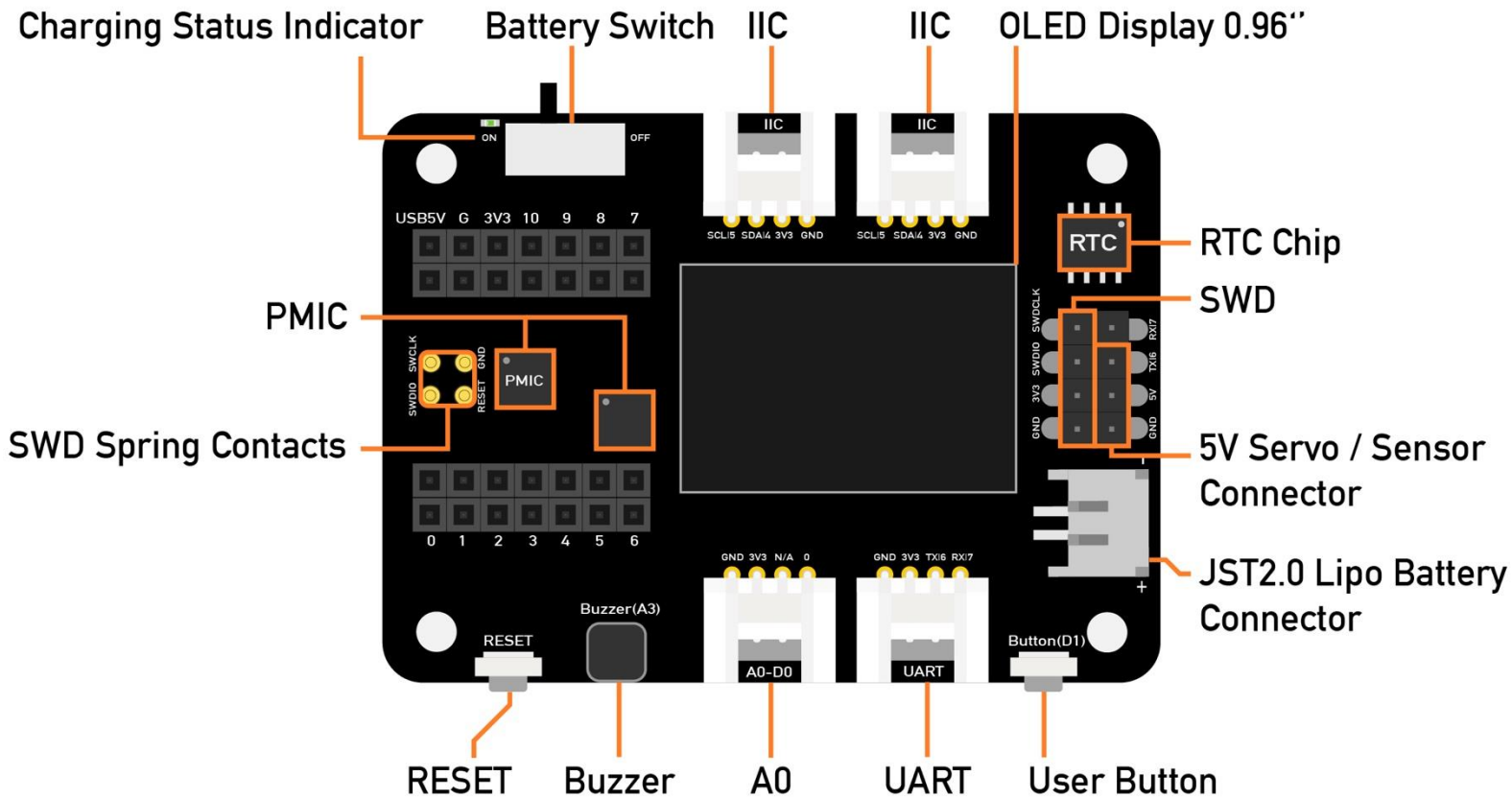


Specifications	
Operating voltage	5V / **3.7V** Lithium Battery
Charging current	460mA (Max)
RTC timer precision	± 1.5S/DAY(25°C)
RTC battery	CR1220
Display	0.96" OLED display
Display Current	15 mA
Expandable memory	MicroSD card
Grove Interface	Grove IIC*2, Grove UART*1, A0/D0 Grove*1
Other External Equipment	Passive buzzer, user button, 5V servo connector

Expansion Board Base for XIAO | Seeed Studio Wiki

Seeed Studio XIAO Expansion board for XIAO Series with Grove OLED - IIC, Uart, Analog/Digital - Seeed Studio





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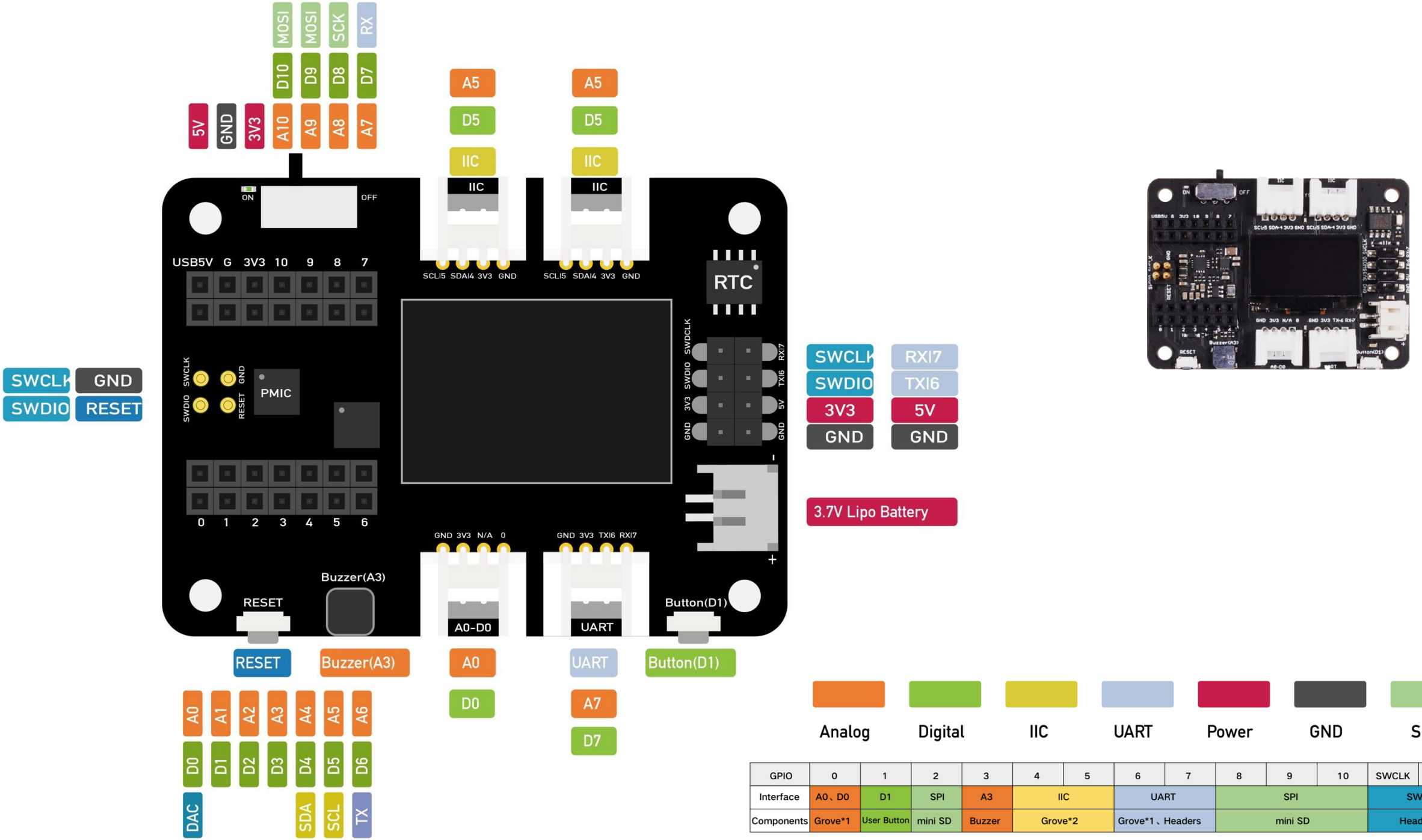
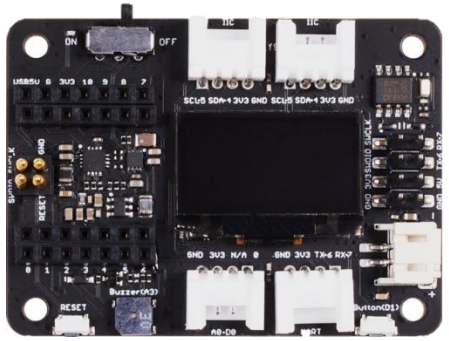
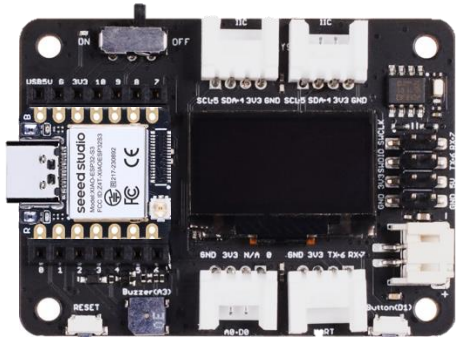
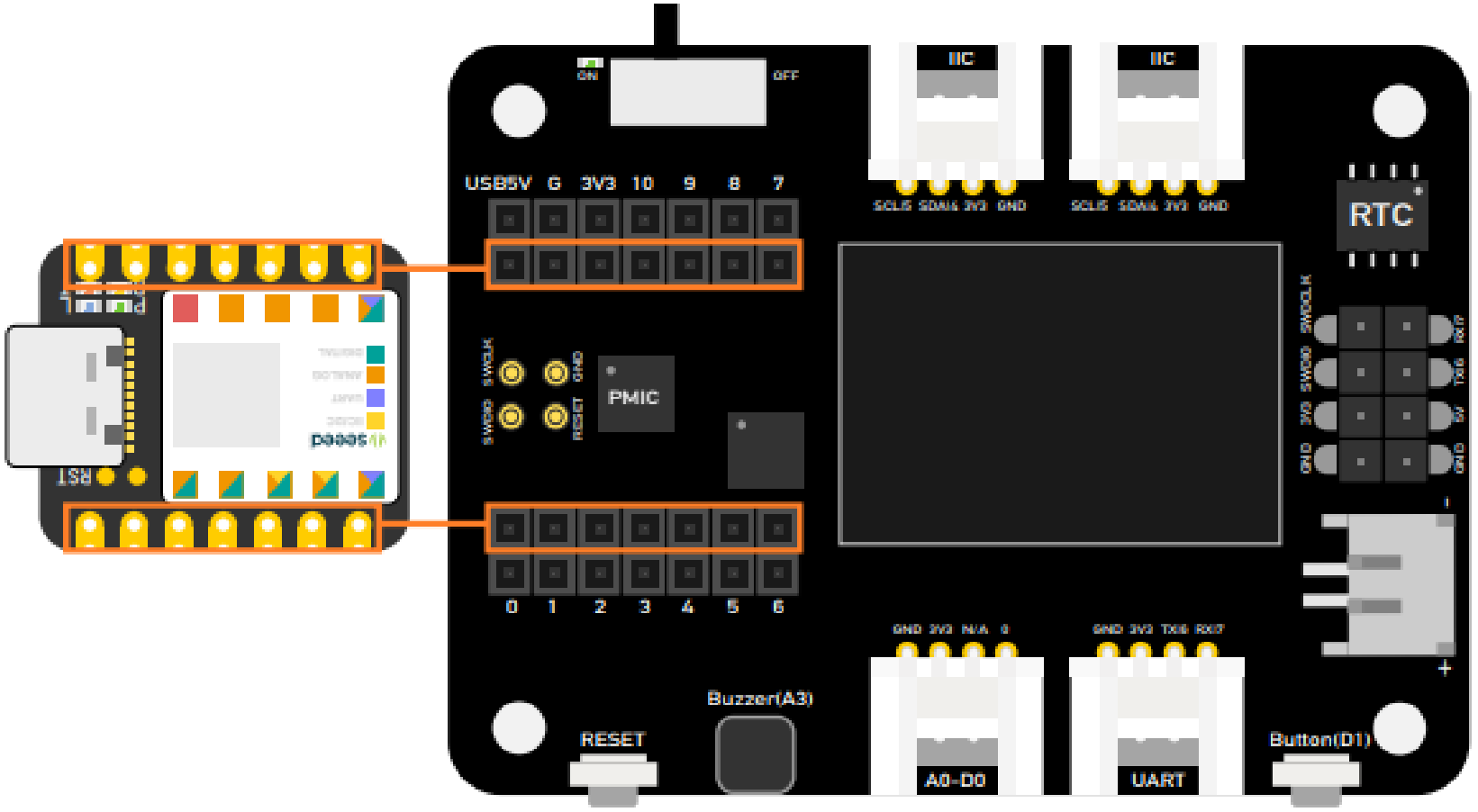


GPIO	0	1	2	3	4	5	6	7	8	9	10	SWCLK	SWDIO	RESET
Interface	A0、D0	D1	SPI	A3	IIC		UART		SPI			SWD		RESET
Components	Grove*1	User Button	mini SD	Buzzer	Grove*2		Grove*1、Headers		mini SD			Headers		Button







[Expansion Board Base for XIAO | Seeed Studio Wiki]

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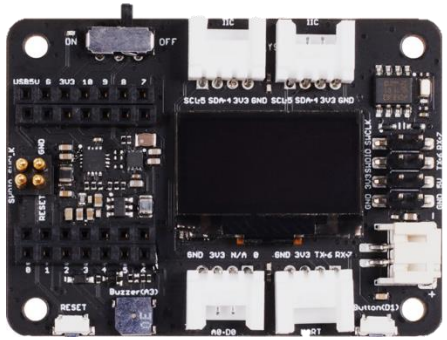

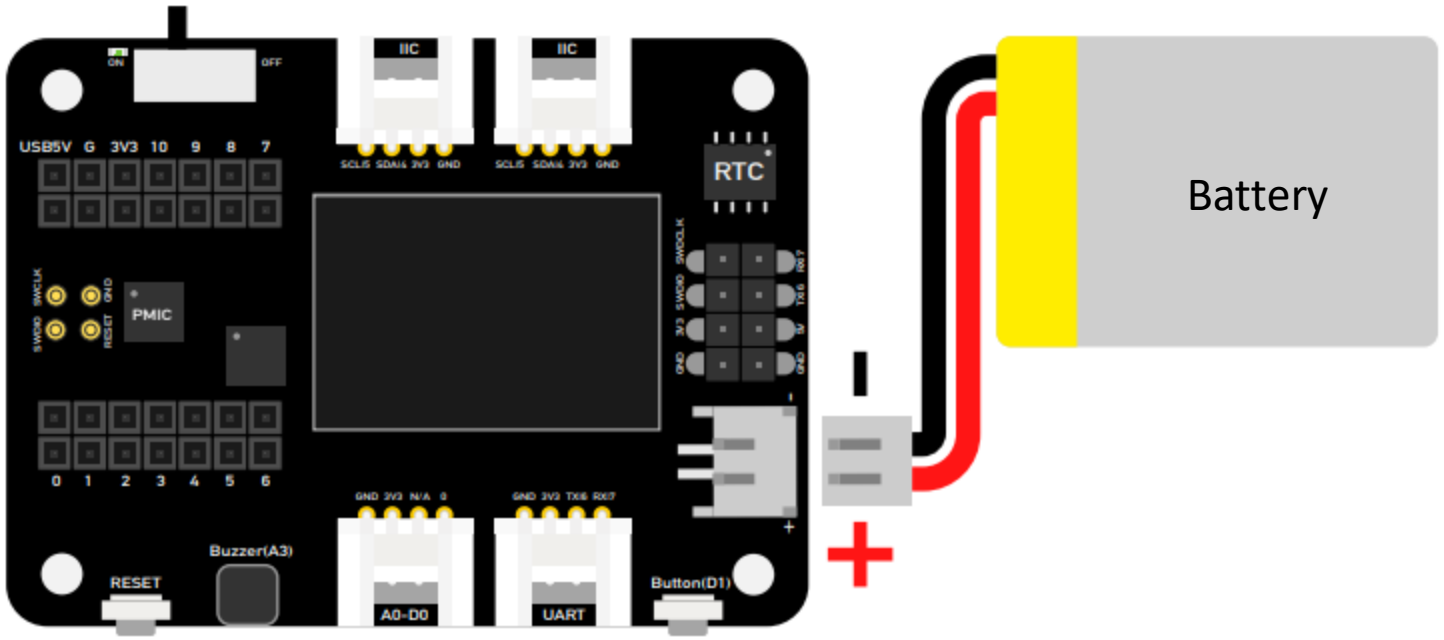

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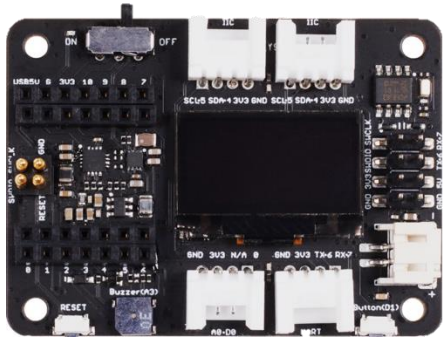

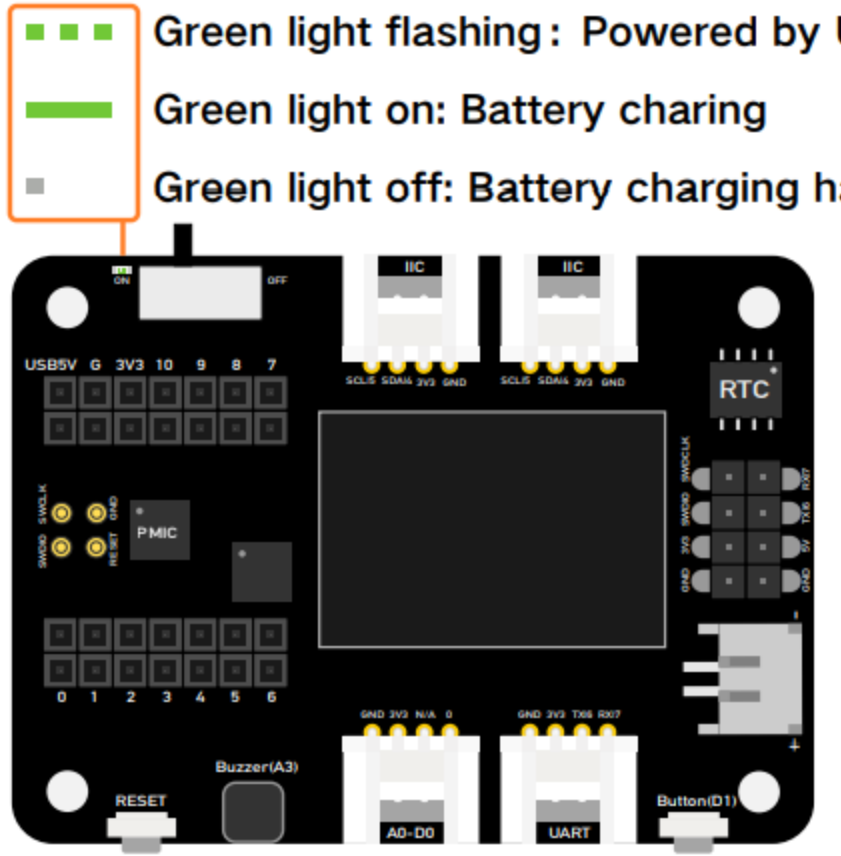

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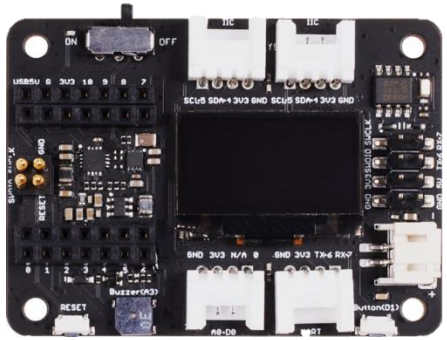
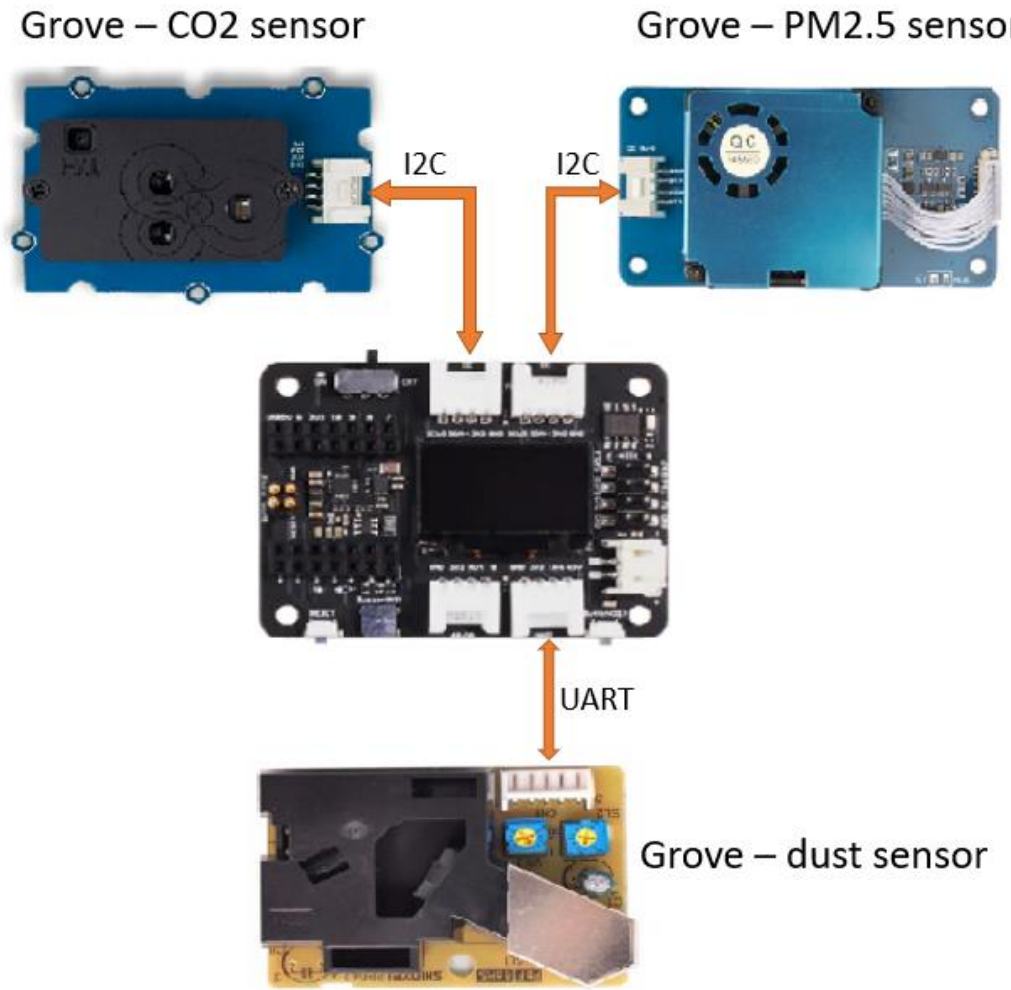


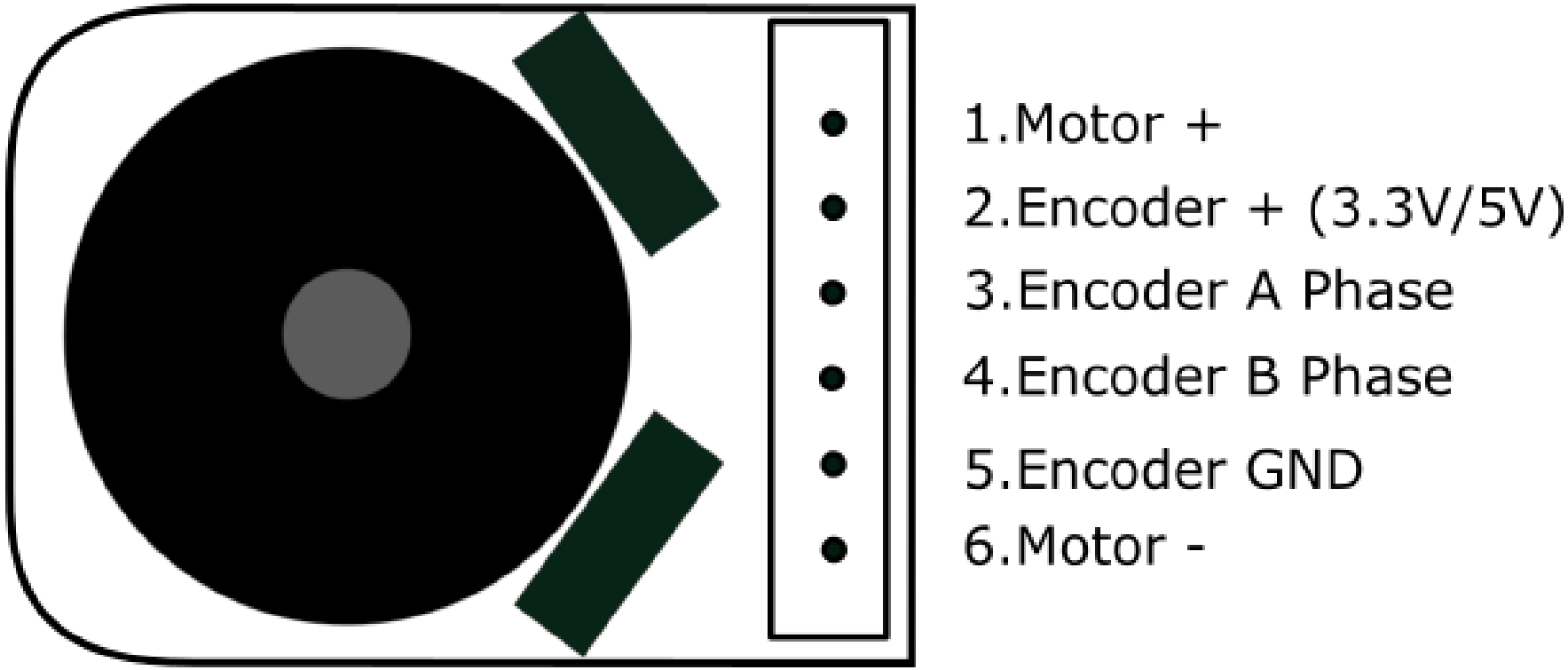


[Expansion Board Base for XIAO | Seeed Studio Wiki]

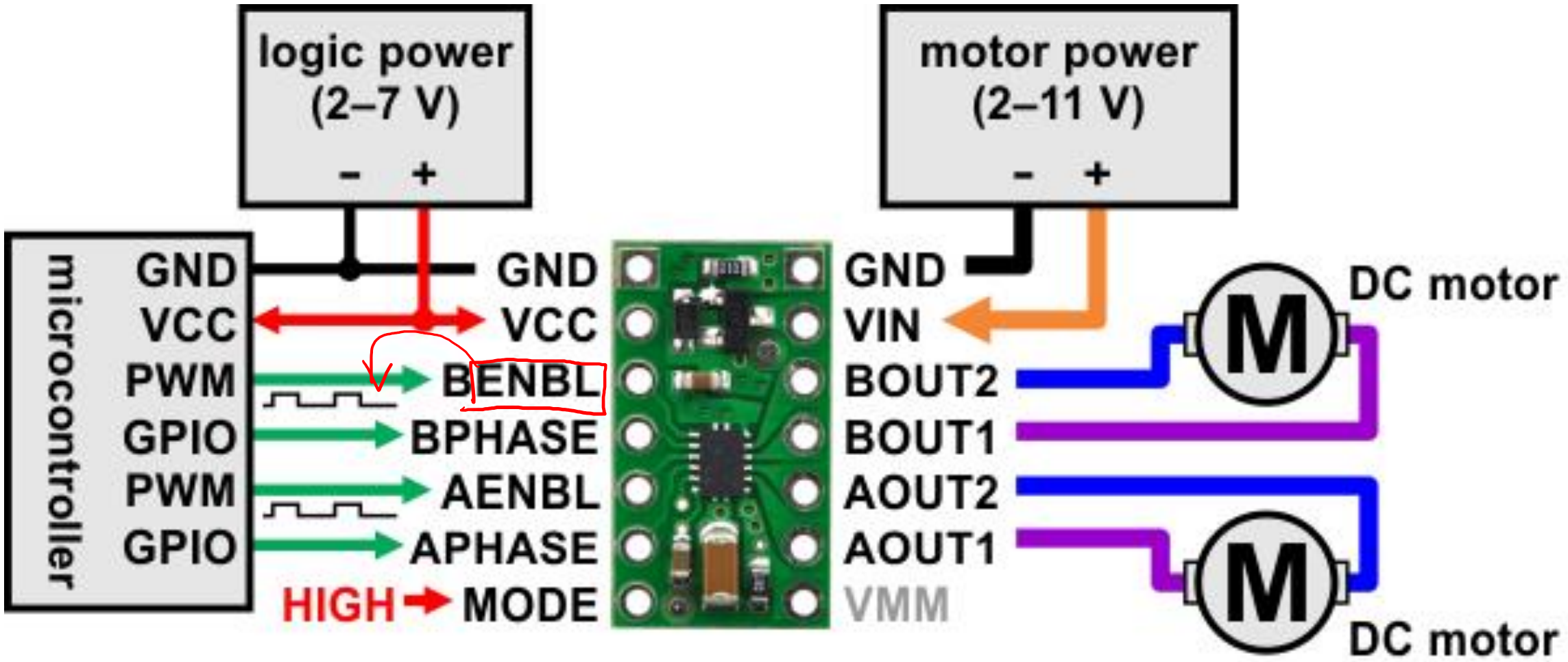
[Seeed Studio XIAO Expansion board for XIAO Series with Grove OLED - IIC, Uart, Analog/Digital - Seeed Studio]

Specifications	
Rated Voltage	**6.0V**
Motor Speed	15000 RPM
Gear Reduction Ratio	50:1
Reducer Length	9.0 mm
No-Load Speed	**310 rpm@6V**
No-Load Current	60 mA
Rated Torque	0.35 kg.cm
Rated Speed	180 rpm@6V
Current Rating	**170 mA**
Instant Torque	0.8 kg.cm
Hall Feedback Resolution	700
Weight	18 g

Micro DC Geared motor w/Encoder - 6V 310RPM 50:1 - DFRobot



[Micro DC Geared motor w/Encoder - 6V 310RPM 50:1 - DFRobot]



Datasheet from TI (PDF)

Pololu - DRV8835 Dual Motor Driver Carrier

Specifications	
Motor driver:	DRV8835
Motor channels:	**2**
Minimum operating voltage:	**0 V**
Maximum operating voltage:	**11 V**
Continuous output current per channel:	**1.2 A**[2]
Peak output current per channel:	1.5 A
Continuous paralleled output current:	2.4 A[2]
Maximum PWM frequency:	250 kHz
Minimum logic voltage:	**2 V**
Maximum logic voltage:	**7 V**
Reverse voltage protection?:	Y

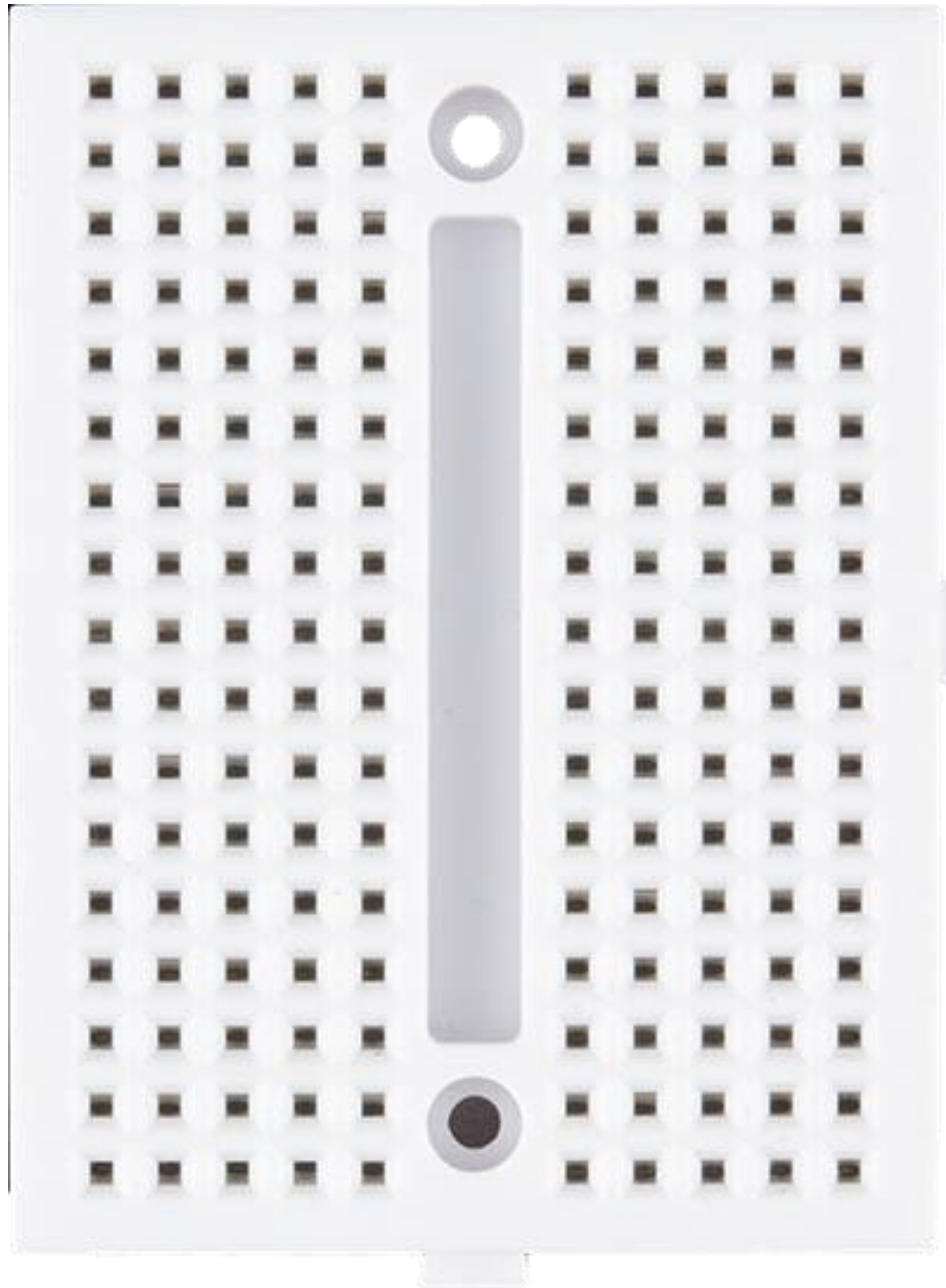
2. Typical results with VIN=5 V, VCC=5 V, and 100% duty cycle at room temperature.

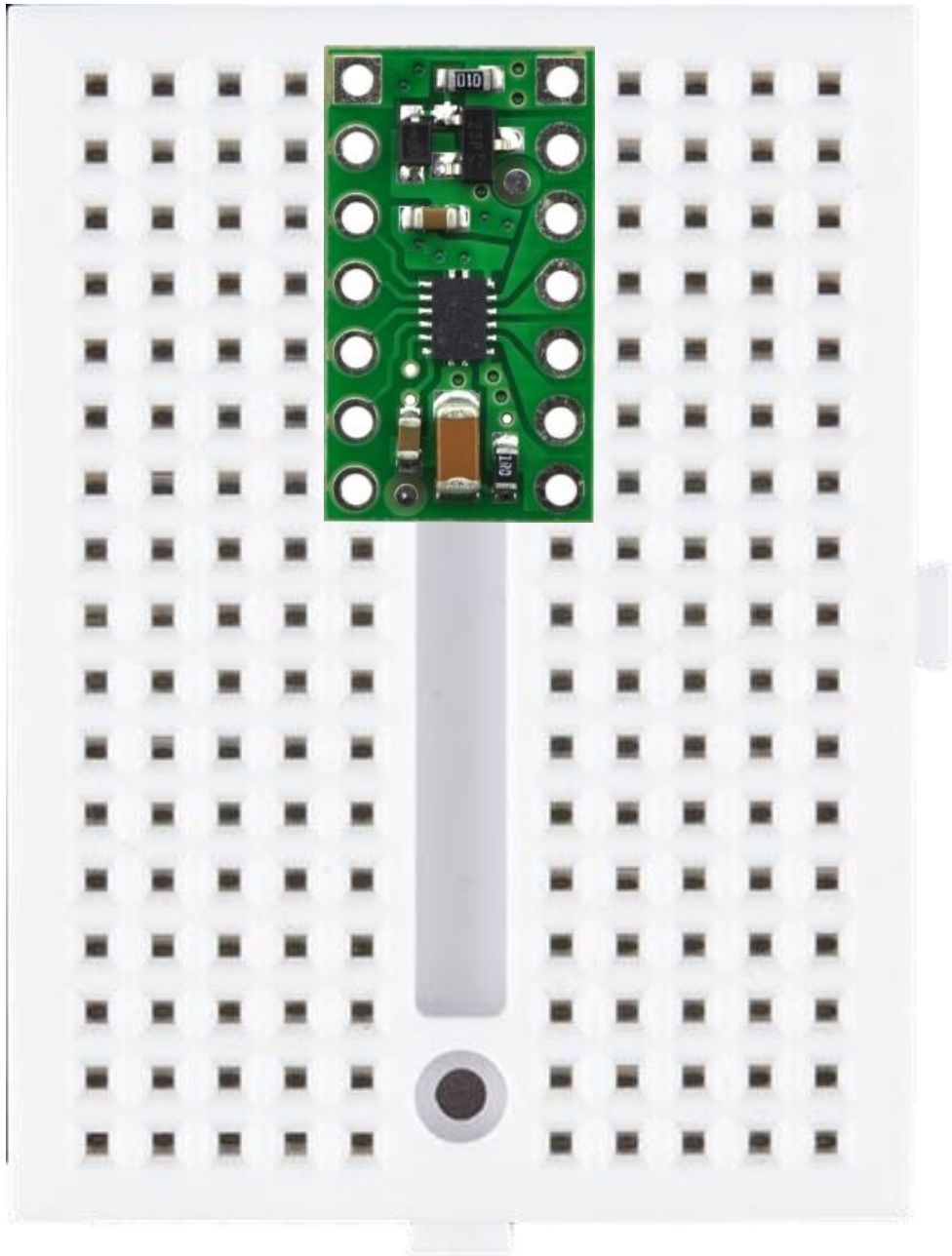
Pololu - DRV8835 Dual Motor Driver Carrier

PIN	Default State	Description
VIN		Reverse-protected motor power supply input. While the driver can operate from a motor supply of 0 V to 11 V, the reverse-protection circuit will start negatively affecting performance below a few volts, and 1.5 V is the lower limit of where it can be used. Power can be supplied directly to VMM to bypass the reverse-protection circuit.
VCC		1.8 V to 7 V logic power supply connection. Logic supply current draw is typically only a few milliamps at most, so in many applications this pin can optionally be dynamically powered by a microcontroller digital output.
VMM		This pin gives access to the motor power supply after the reverse-voltage protection MOSFET (see the board schematic below). It can be used to supply reverse-protected power to other components in the system. It is generally intended as an output, but it can also be used to supply board power (such as in cases where the motor supply voltage is too low for the reverse-protection circuit).
GND		Ground connection points for the motor and logic power supplies. The control source and the motor driver must share a common ground.
AOUT1		The motor A half-bridge 1 output.
AOUT2		The motor A half-bridge 2 output.
BOUT1		The motor B half-bridge 1 output.
BOUT2		The motor B half-bridge 2 output.
AIN1/APHASE	LOW	A logic input control for motor channel A.
AIN2/AENABLE	LOW	A logic input control for motor channel A.
BIN1/BPHASE	LOW	A logic input control for motor channel B.
BIN2/BENABLE	LOW	A logic input control for motor channel B.
MODE	LOW	Logic input that determines the control interface. Logic low on this pin results in IN/IN mode while logic high results in PHASE/ENABLE mode.

Simplified drive/brake operation with MODE=1 (PHASE/ENABLE)				
xPHASE	**xENABLE**	**xOUT1**	**xOUT2**	**operating mode**
0	PWM	PWM	L	forward/brake at speed PWM %
1	PWM	L	PWM	reverse/brake at speed PWM %
X	0	L	L	brake low (outputs shorted to ground)

Pololu - DRV8835 Dual Motor Driver Carrier





Specifications	
Max Continuous Discharging Current:	**10A**
Typical Capacity	**3500 mAh** (3350mAh minimum)
Style	BUTTON top
Approximate Nominal Dimensions (including button)	69.1mm length x 18.6 mm diameter
Maximum Dimensions (including button)	69.6mm length x 19.0mm diameter
Discharge cut-off voltage	2.5V (approximate)
Voltage	**3.6V**
Full Charge Voltage	4.2V
Charge Current	1.675A standard
Protection Cutoff Current	15-20A
Protection IC	Ricoh
MOSFETS Quantity	3
Origin	Cell made in Korea or China, button top manufactured in China, Protection IC made in Japan. Assembled in China.
Cell Certifications	UN38.3 test report, IEC62133, CB Scheme, UL1642
Battery Assembly Certifications	UL2054, CE, UN38.3 test report, IEC 62133-2: 2017, RoHS, REACH, CB Scheme. cTÜVus mark, UL 62368-1:2019 R10.21 CSA C22.2 NO. 62368-1:19

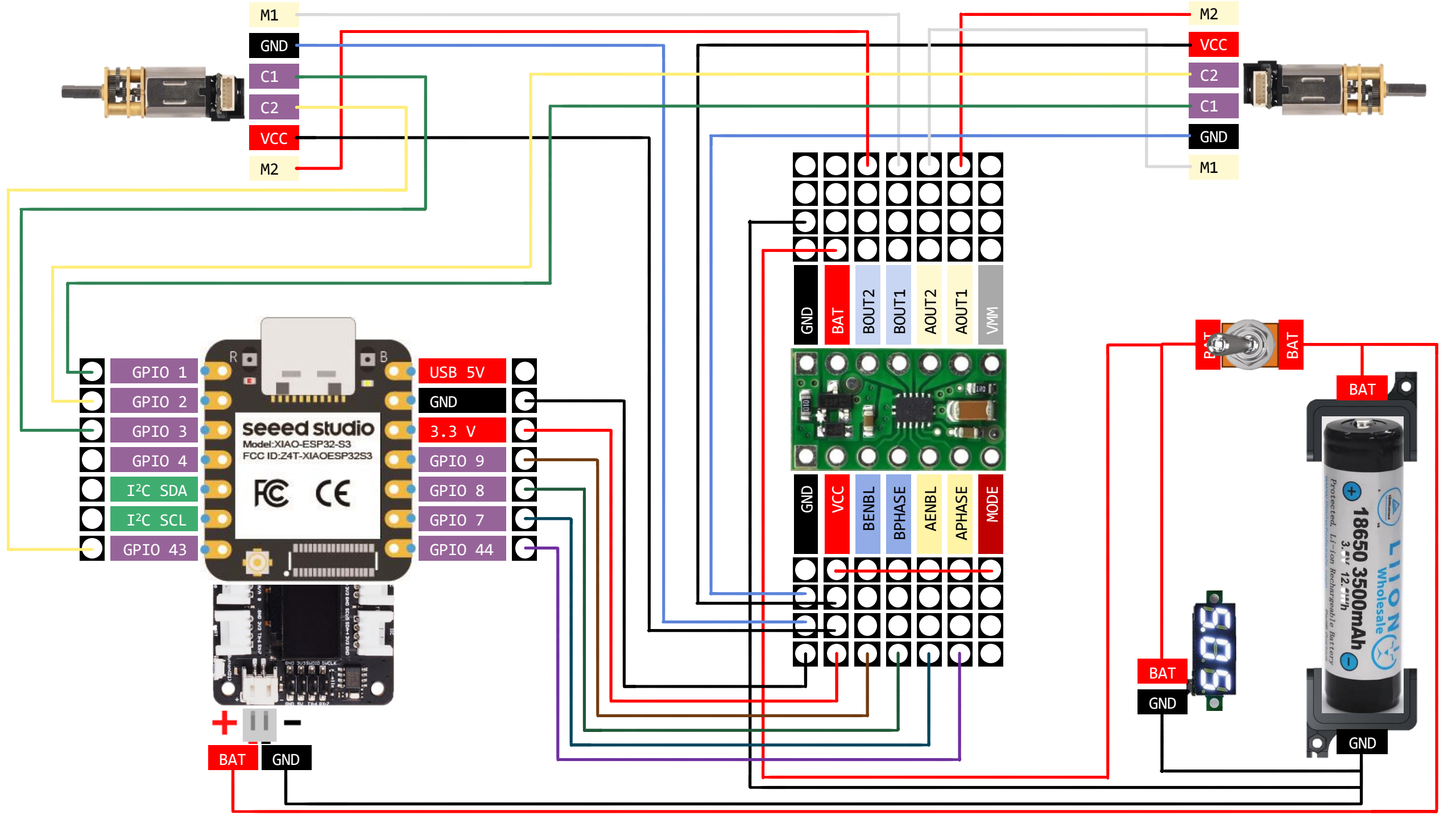
Protected 3500mAh 10A 18650 Button Top Battery

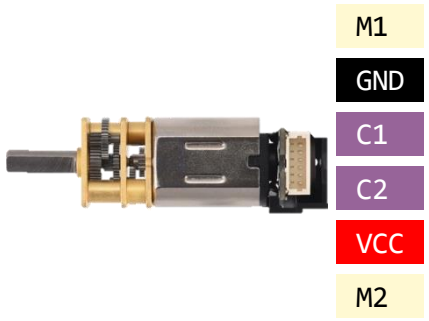
Electrical Requirements

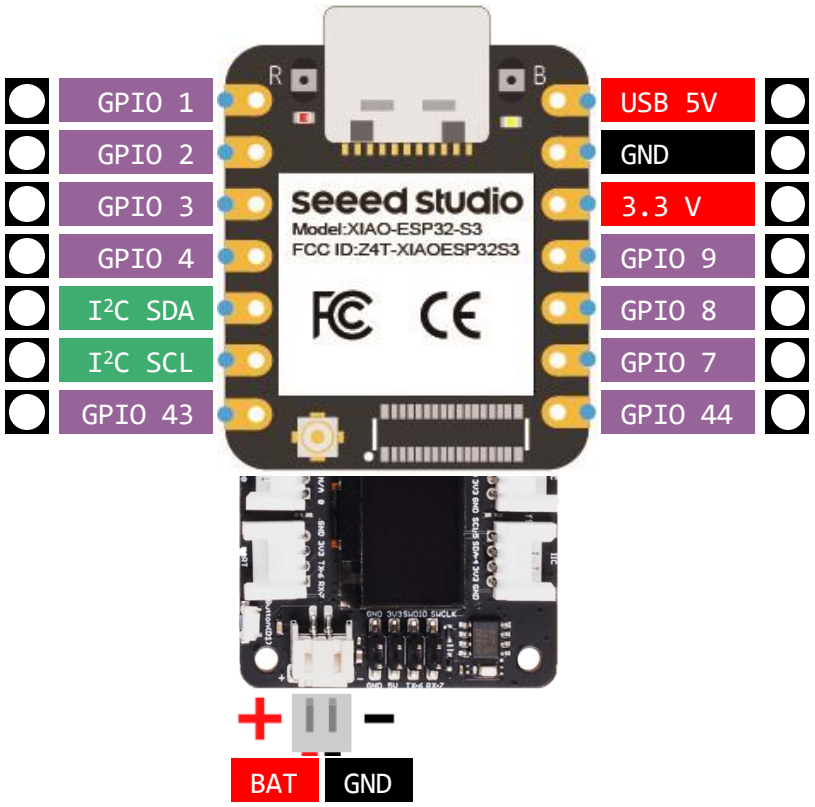
	Voltage	Current	Power
Battery	3.6 V	10 A (max)	36 W
USB	5 V	500 mA (USB 2.0)	2.5 W

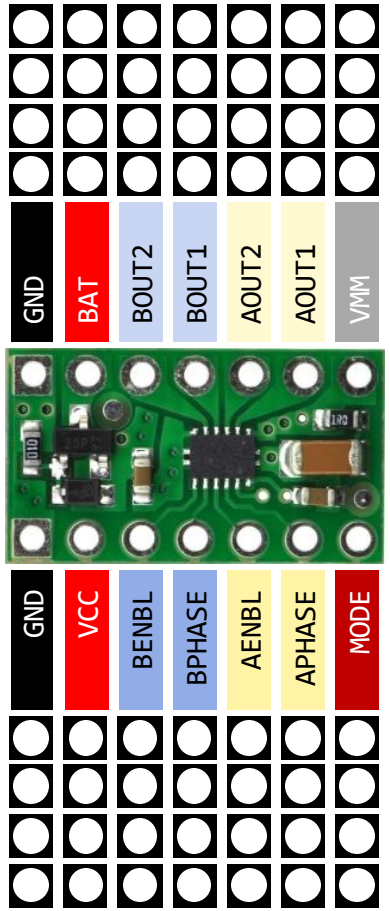
	Voltage	Current	Power
Microcontroller	3.3 V (or 5 V USB)	150 mA (with WiFi)	495 mW
Expansion Board	3.7 V (battery)	15 mA (with display)	56 mW
Motor Driver Control	3.7 V (battery) (up to 11 V)	<1.2 A> (per channel max)	<8.88 mW> (max)
Motor Driver Logic	3.3 V (2 to 7 V)	negligible	0
Left Motor	3.7 V (battery) (up to 6 V)	150 mA (full speed estimate)	560 mW
Right Motor	3.7 V (battery) (up to 6 V)	150 mA (full speed estimate)	560 mW
Left Encoder	3.3 V (2.7 V to 18 V)	negligible	0
Right Encoder	3.3 V (2.7 V to 18 V)	negligible	0
Total		**~500 mA**	**~1.8 W**

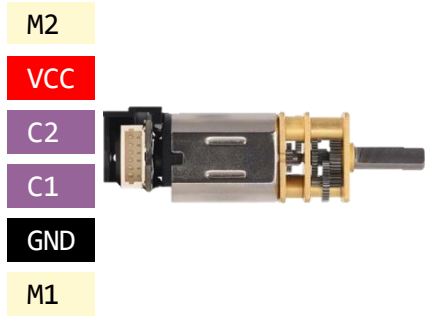
You always want to give yourself a safety margin for “spikes”


M1
GND
C1
C2
VCC
M2
M2
VCC
C2
C1
GND
M1
GND
BAT
BOUT2
BOUT1
AOUT2
AOUT1
VMM
GND
VCC
BENBL
BPHASE
AENBL
APHASE
MODE
GPIO 1
GPIO 2
GPIO 3
GPIO 4
I²C SDA
I²C SCL
GPIO 43
USB 5V
GND
3.3 V
GPIO 9
GPIO 8
GPIO 7
GPIO 44
seeed studio
Model:XIAO-ESP32-S3
FCC ID:Z4T-XIAOESP32S3
BAT
GND
BAT
BAT
GND
BAT
18650 3500mAh
GND


M1
GND
C1
C2
VCC
M2


GPIO 1
GPIO 2
GPIO 3
GPIO 4
I²C SDA
I²C SCL
GPIO 43
USB 5V
GND
3.3 V
GPIO 9
GPIO 8
GPIO 7
GPIO 44
seeed studio
Model:XIAO-ESP32-S3
FCC ID:Z4T-XIAOESP32S3
BAT
GND

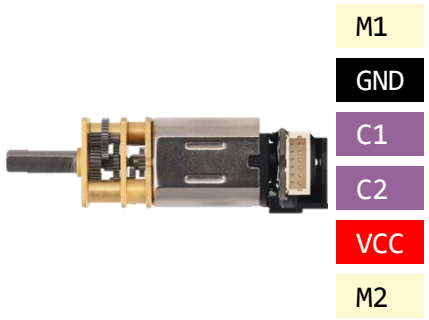

GND
BAT
BOUT2
BOUT1
AOUT2
AOUT1
VMM
GND
VCC
BENBL
BPHASE
AENBL
APHASE
MODE


M2
VCC
C2
C1
GND
M1

BAT
BAT

BAT
GND

BAT
18650 3500mAh
LiION
Wholesale
GND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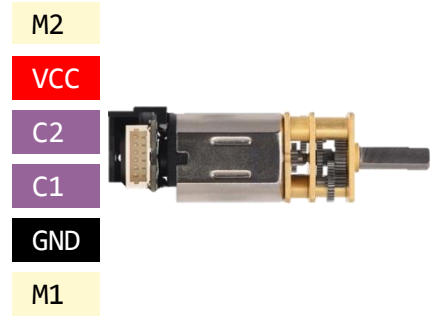
C1
C2
VCC
M2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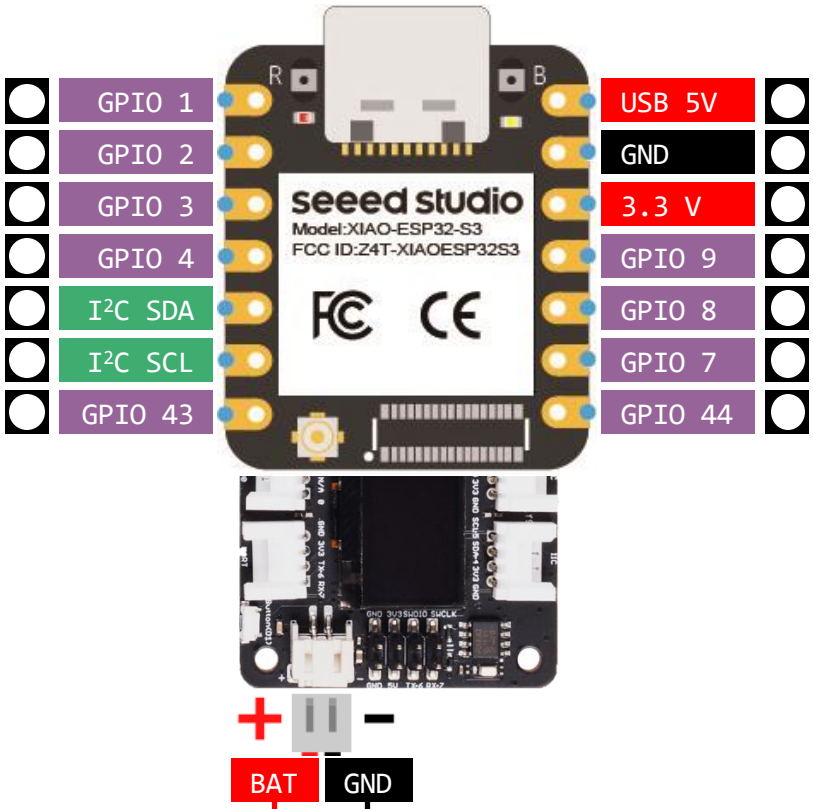
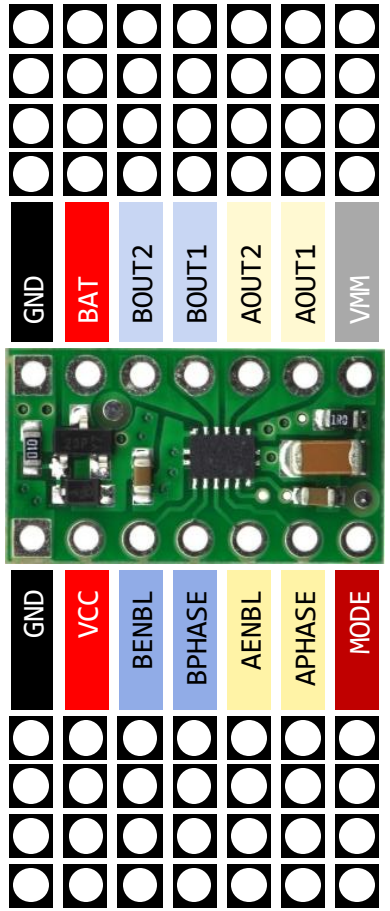
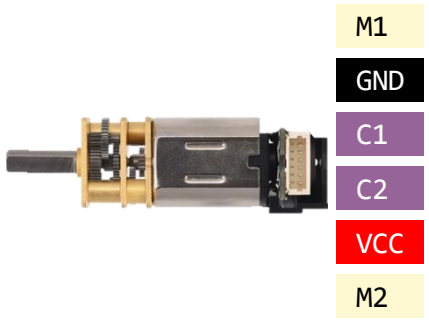
VCC
C2
C1
GND
M1


GPIO 1
GPIO 2
GPIO 3
GPIO 4
I²C SDA
I²C SCL
GPIO 43
USB 5V
GND
3.3 V
GPIO 9
GPIO 8
GPIO 7
GPIO 44
seeed studio
Model:XIAO-ESP32-S3
FCC ID:Z4T-XIAOESP32S3
BAT
GND


GND
BAT
BOUT2
BOUT1
AOUT2
AOUT1
VMM
GND
VCC
BENBL
BPHASE
AENBL
APHASE
MODE

BAT
BAT
BAT
18650 3500mAh
LION
Wholesale
BAT
GND
GND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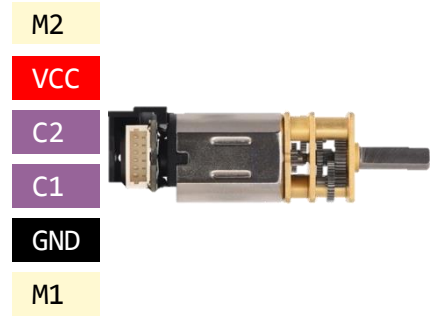
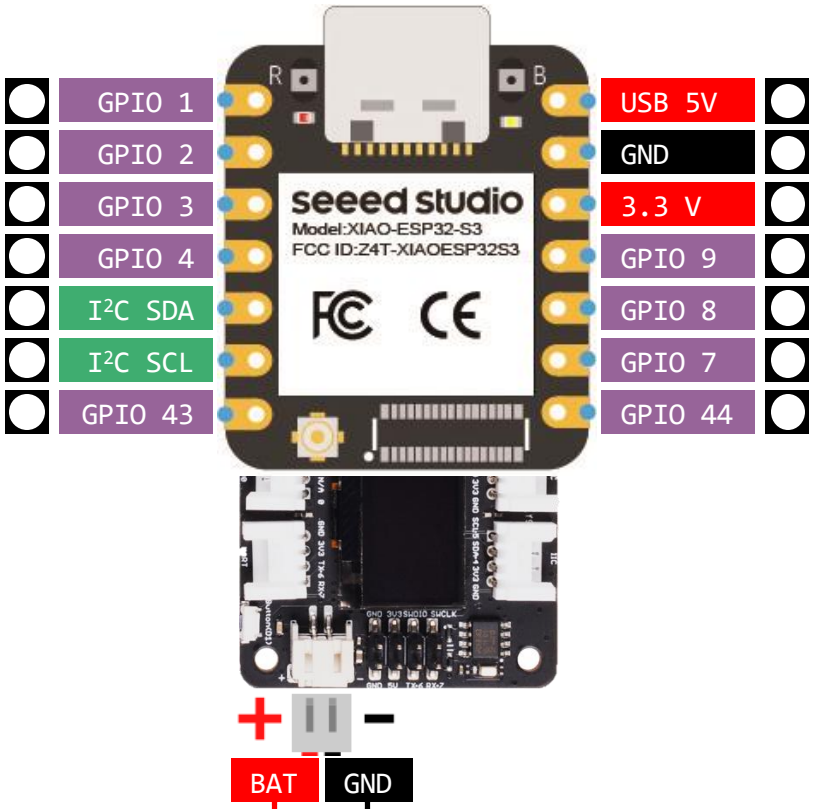
C1
C2
VCC
M2


M2
VCC
C2
C1
GND
M1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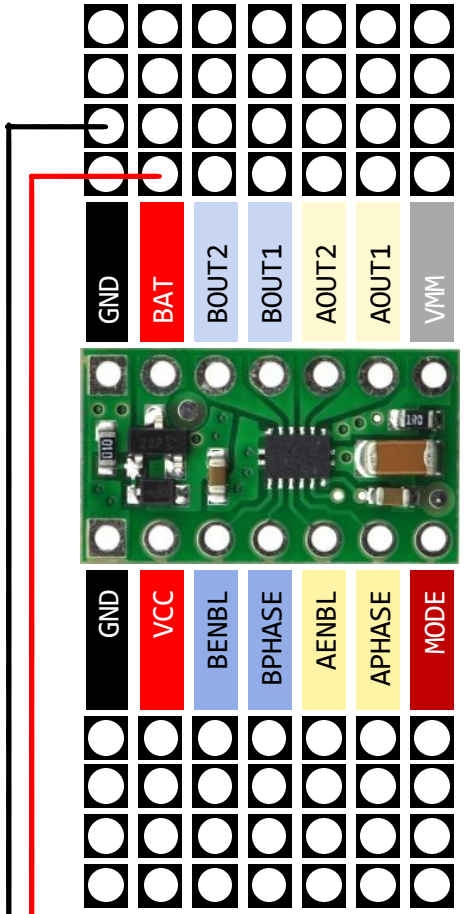
BAT
GND


GND
BAT
BOUT2
BOUT1
AOUT2
AOUT1
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GND
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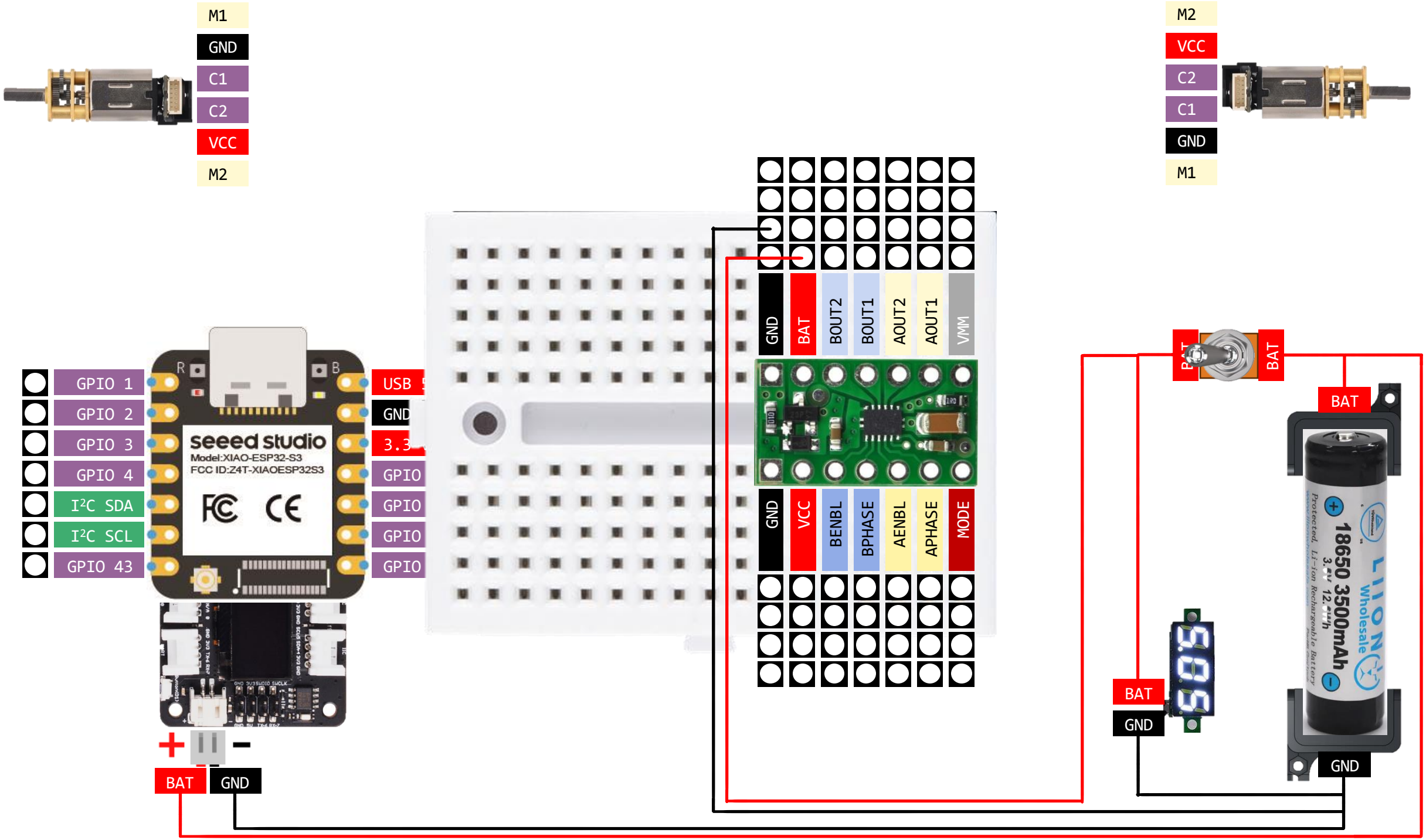
M1
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C1
C2
VCC
M2
M2
VCC
C2
C1
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M1
GND
BAT
BOUT2
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BAT
GND
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18650 3500mAh
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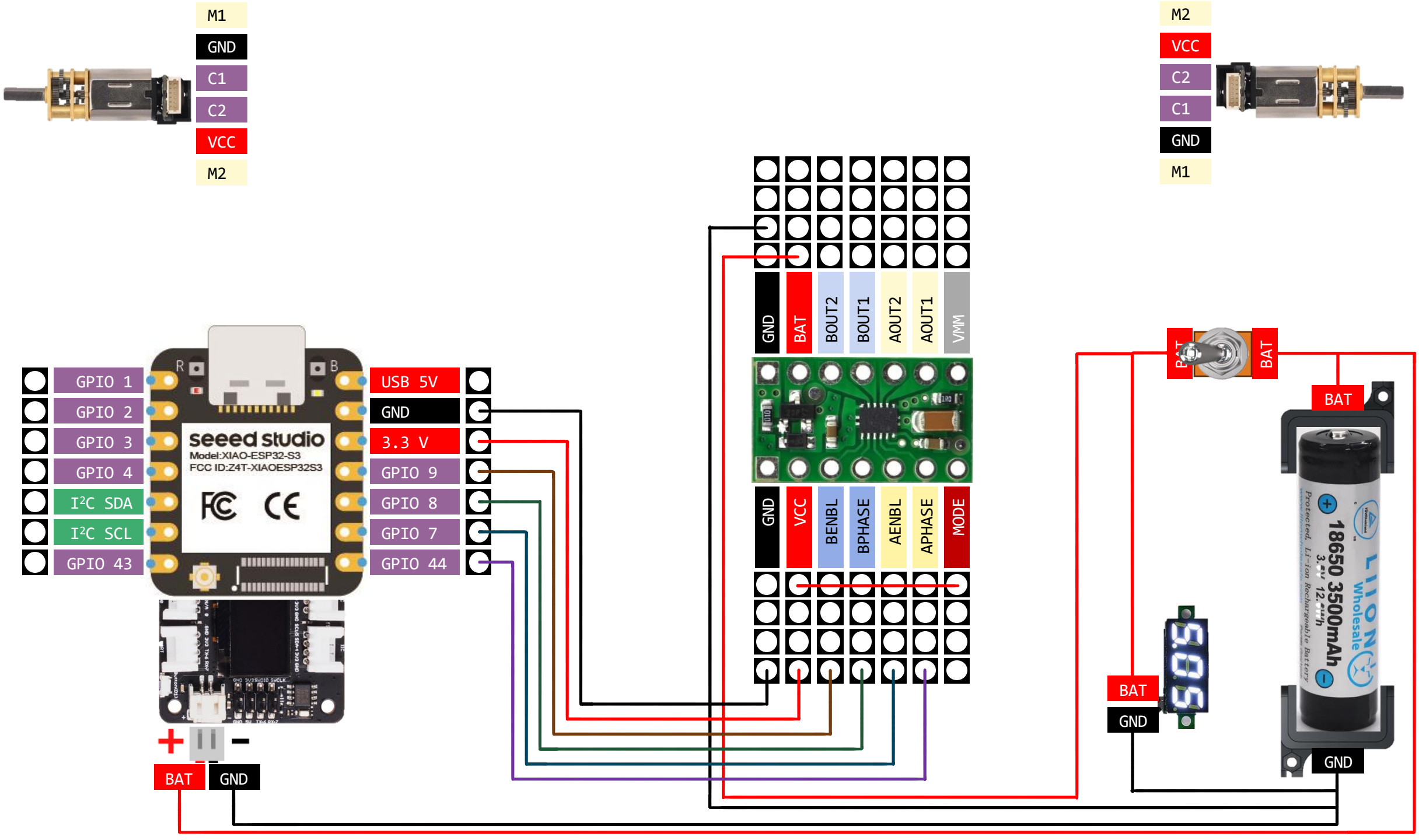
GND
GND

Time to Wire

Hello Toit


M1
GND
C1
C2
VCC
M2
M2
VCC
C2
C1
GND
M1
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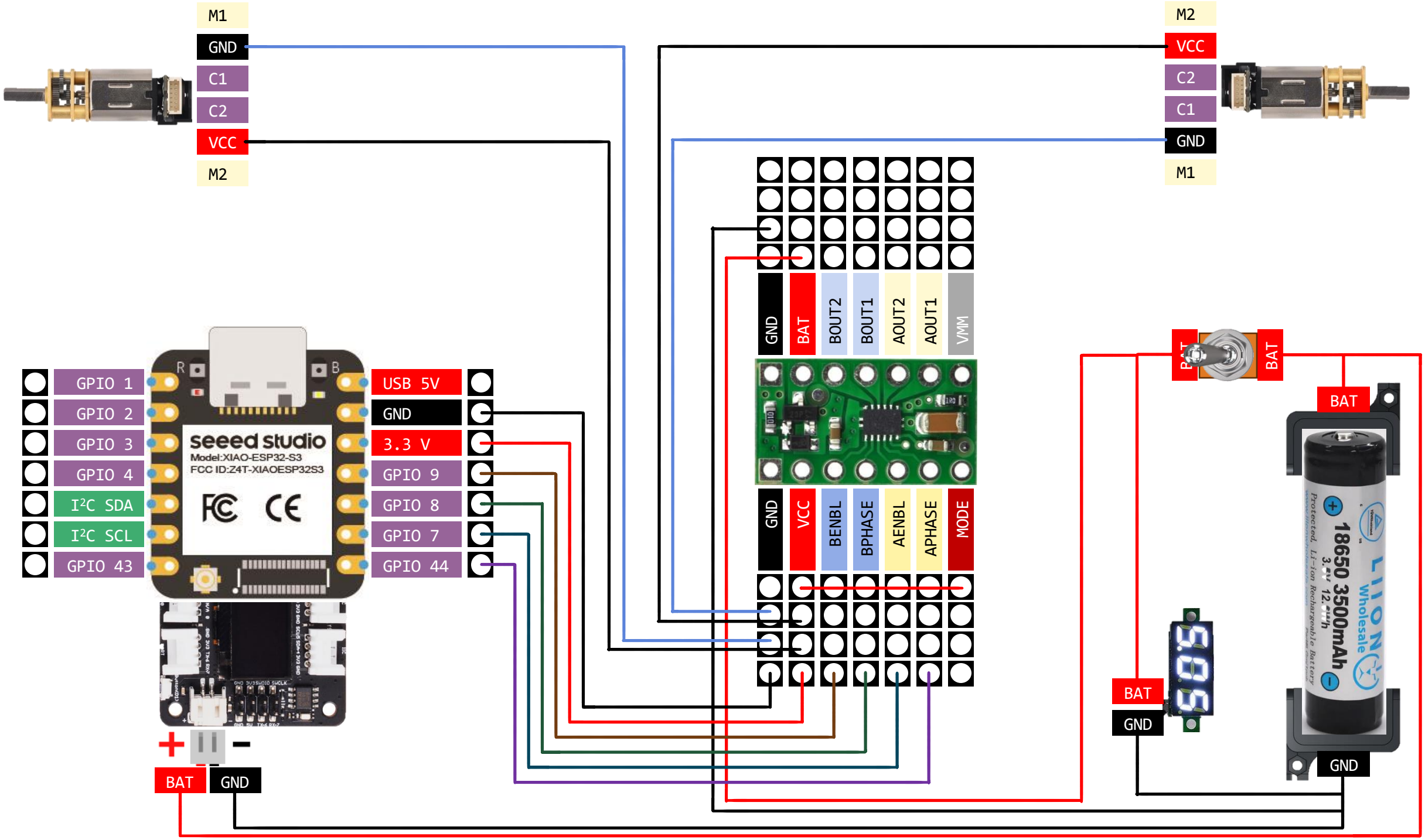
M1
GND
C1
C2
VCC
M2
M2
VCC
C2
C1
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M1
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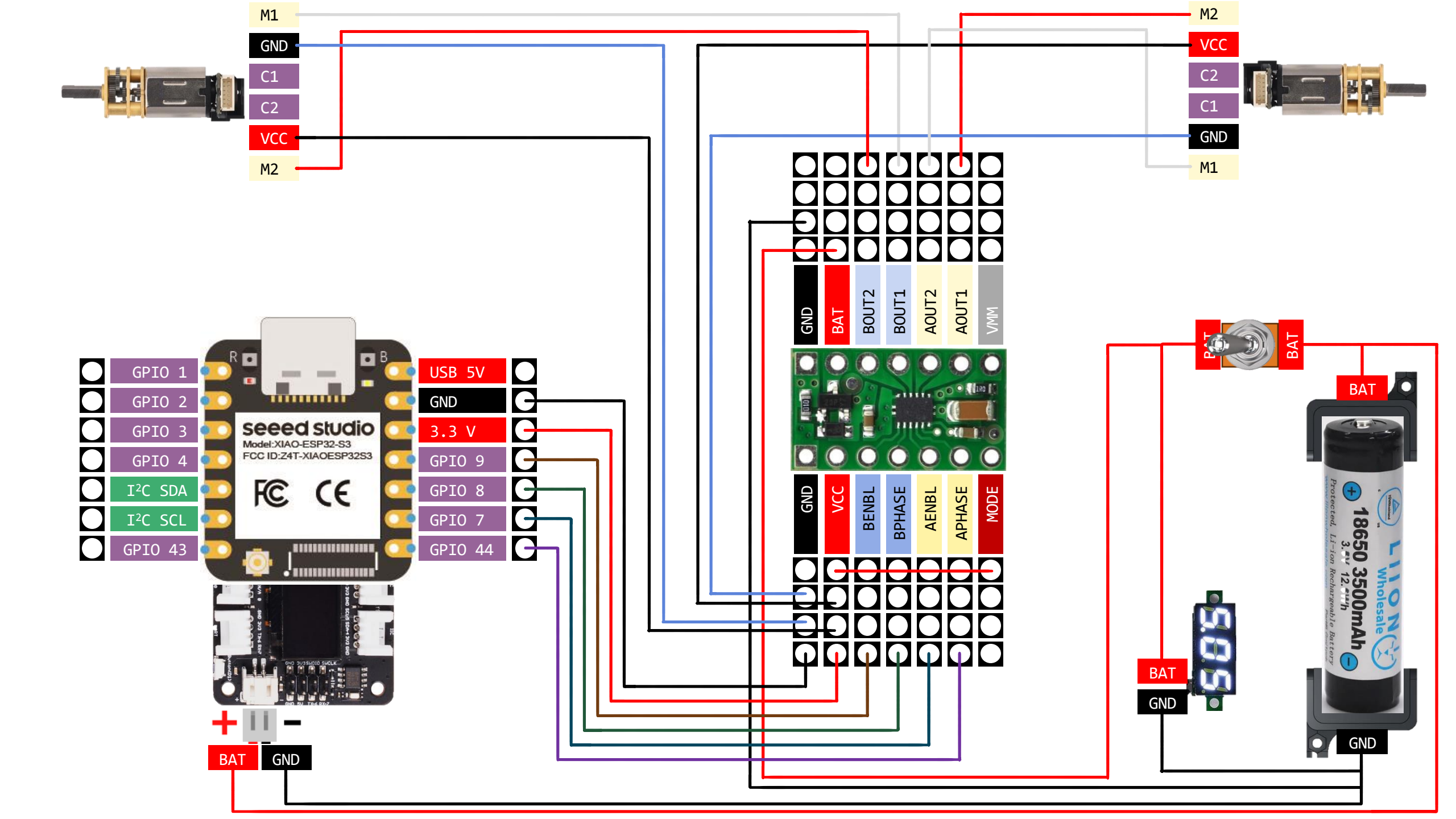
M1
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C2
VCC
M2
M2
VCC
C2
C1
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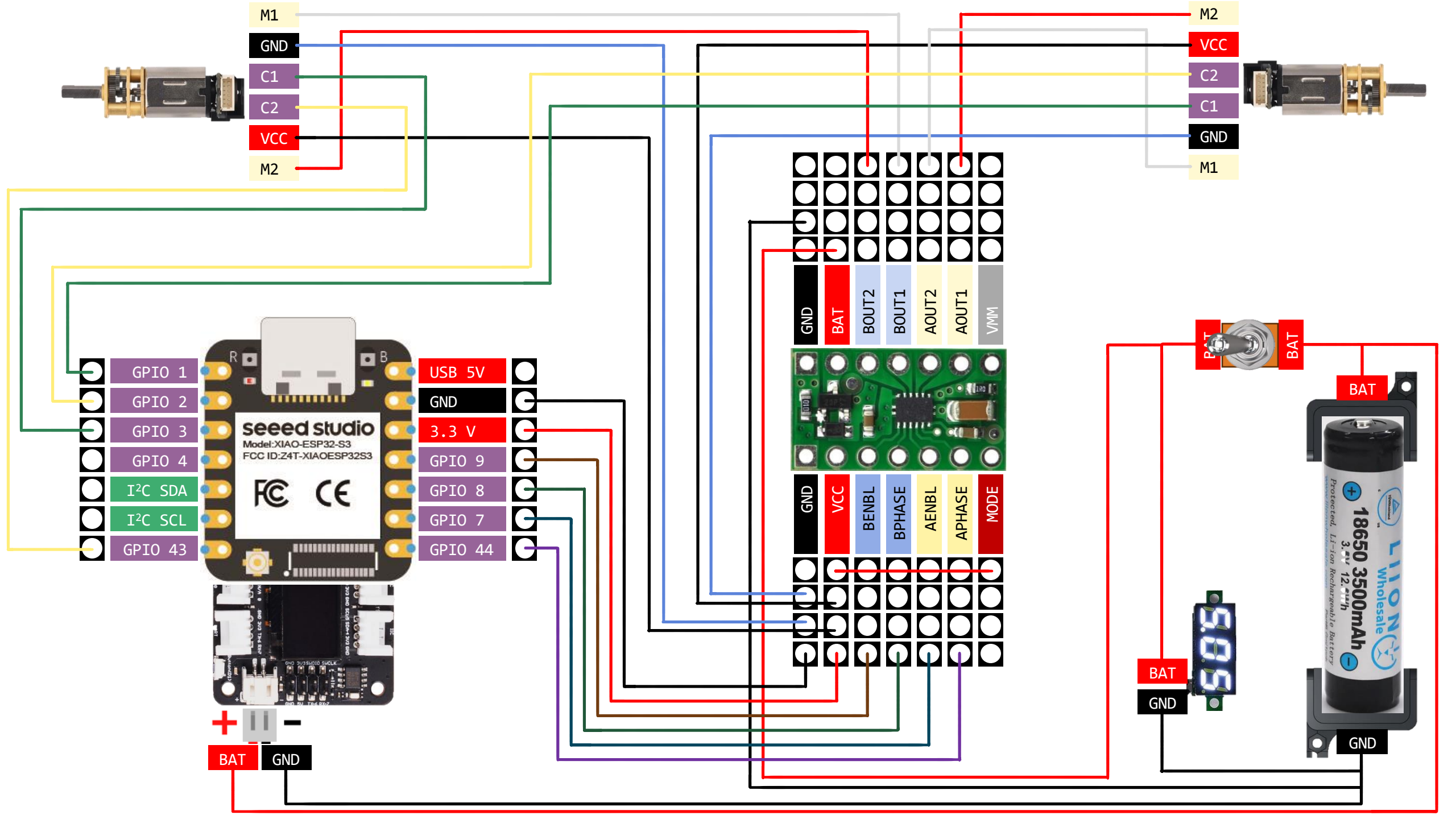
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Toit Motor Control