

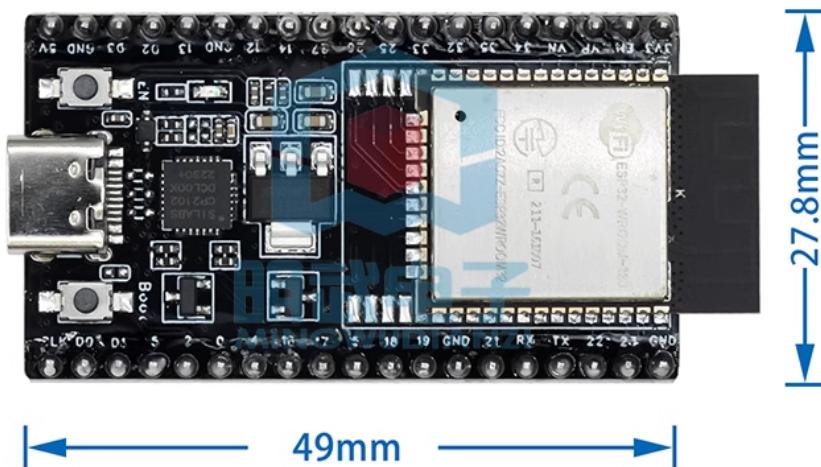
RT 2025

Microcontroller - ESP32

ESP32 - WROOM-32D

重量：约9.6克

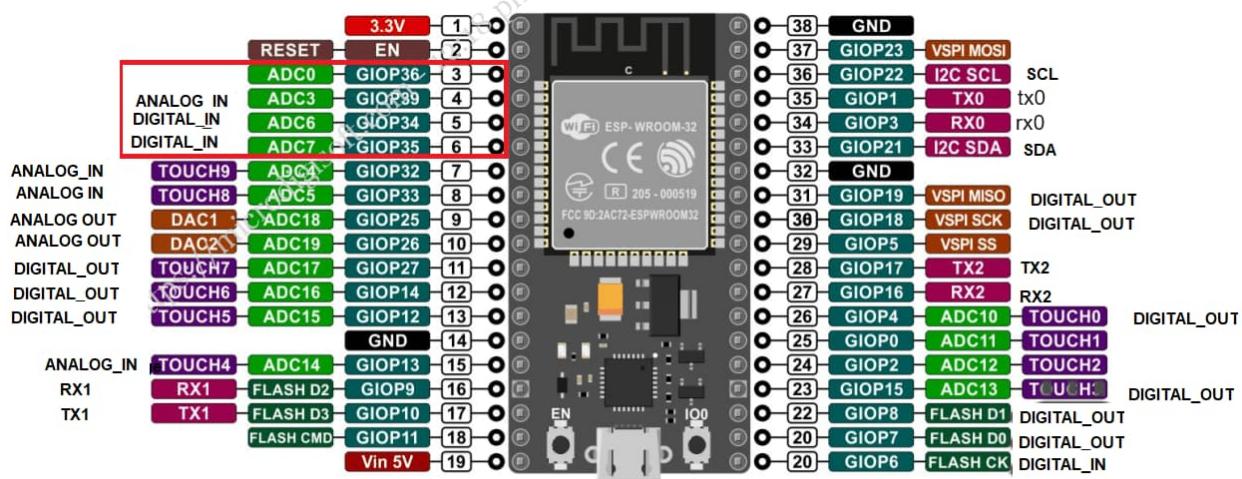
尺寸：49mm*27.8mm



黑色搭载WROOM-32D (C□)

PINOUT

<https://lastminuteengineers.com/esp32-wroom-32-pinout-reference/>



VS Arduino UNO

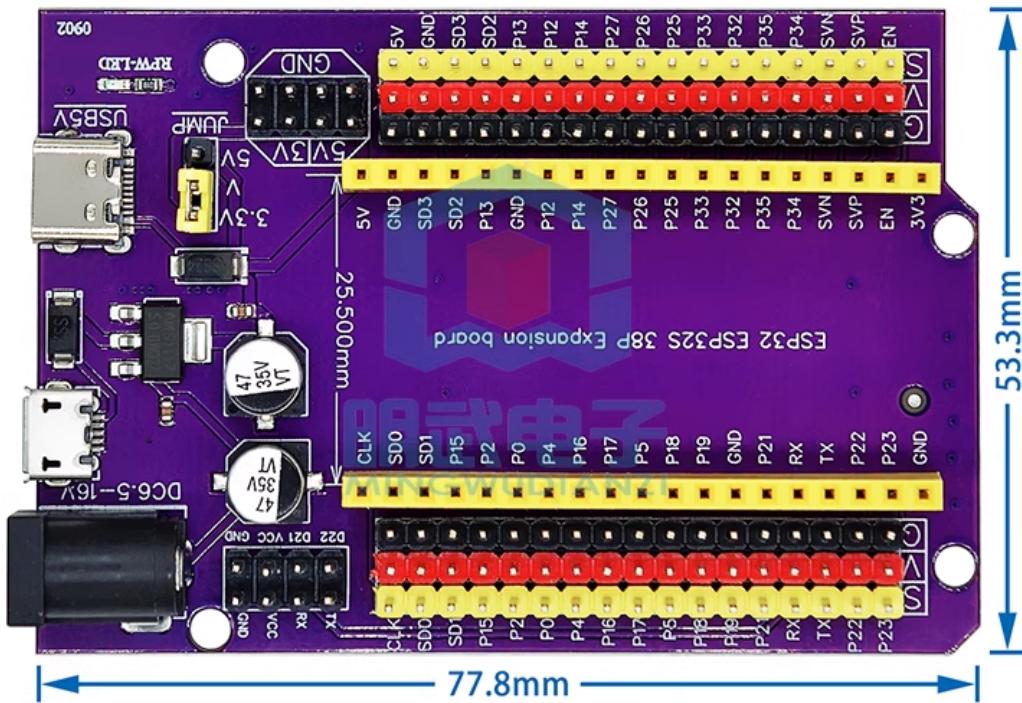
<https://www.elprocus.com/difference-between-esp32-vs-arduino/>

Arduino UNO vs ESP32 https://youtu.be/RiYnucfy_rs?si=UYDTnVhNb-jQcZx4

Expansion board

重量：29克

尺寸：77. 8mm*53. 3mm



ESP32S紫色扩展板 38Pin

Nema 17 stepper motors

产品实拍

The product will



Model: 17HS3430S

Rated current: 0.4A

step angle: 1.8"

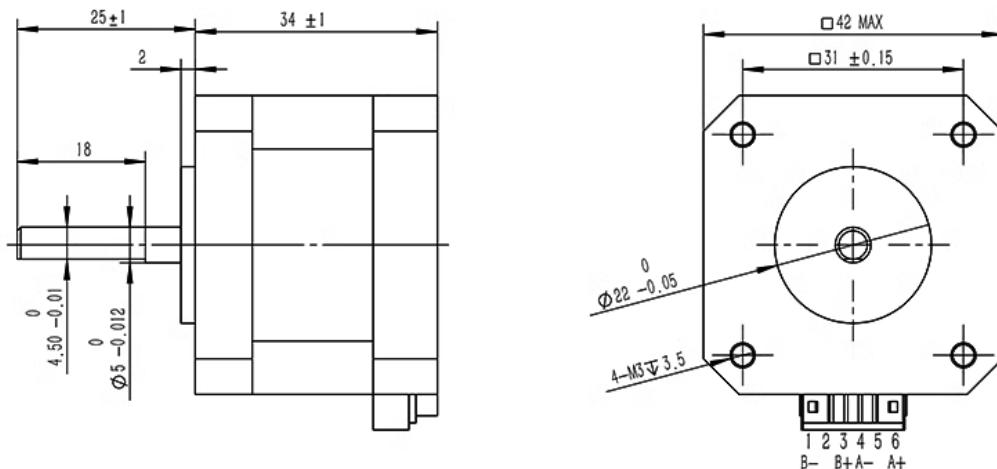
Torque: 0.28N.m

Weight: 220g

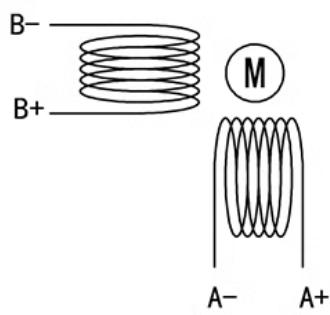
Size

42步进电机尺寸

单位: mm



电气原理图



Exciting Sequence
励磁顺序

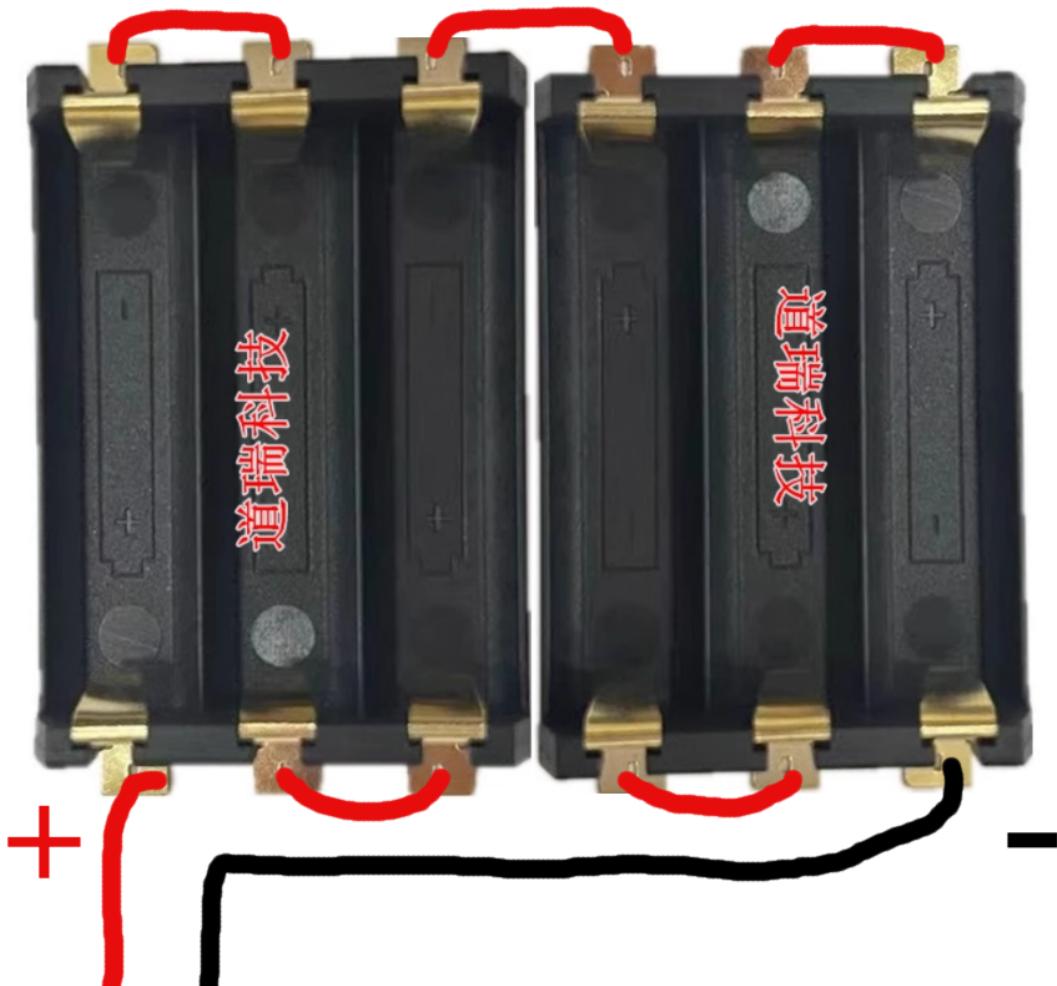
STEP	A+	B+	A-	B-
1	+	+	-	-
2	-	+	+	-
3	-	-	+	+
4	+	-	-	+
5	+	+	-	-

↓ CW ↑ CCW

42电机型号	步距角 (°)	机身长 (mm)	电流 (A)	电阻 (Ohm)	电感 (mH)	保持转矩 (N.cm)	转子惯量 (g.cm²)	引线数 (NO.)	重量 (g)
17HS3430	1.8°	34	0.4	30	35	28	34	4	220

Power

Battery box



Voltage boost converter

Model: XL6019

data sheet:

https://drive.google.com/file/d/1aRfQj2Vfkf8p_HJzwZNX2GNEz_uSwfp8/view

<https://youtu.be/cRpwCPshTN0?si=SU0Xg6shHttVJ7ht>

- input range - 3V - 35V
- output range: 3.5 - 35V
- maximum output current: 5A
- high efficiency up to ~94%

Input	Output	Output current	Power	Efficiency
7.4V	12V	1A	12W	95.4%
7.4V	12V	2A	24W	94.8%



Motor driver

Intro

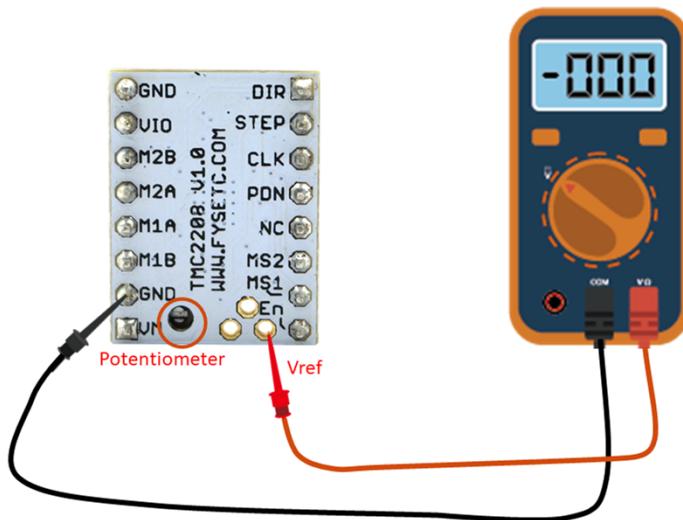
<https://wiki.fysetc.com/TMC2208/>

Stepper motor ultimate guide

<https://howtomechatronics.com/tutorials/arduino/stepper-motors-and-arduino-the-ultimate-guide/>

Adjust vref

<https://www.circuitist.com/how-to-set-driver-current-a4988-drv8825-tmc2208-tmc2209/>



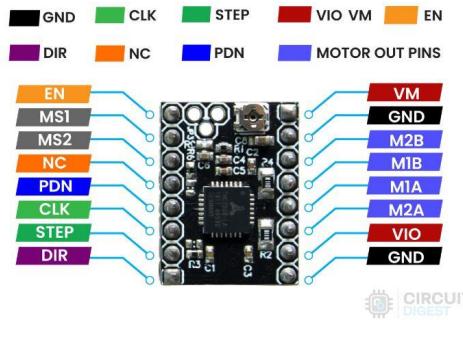
TMC2208

$$VREF = \text{current} * 2.5V / 1.77A$$

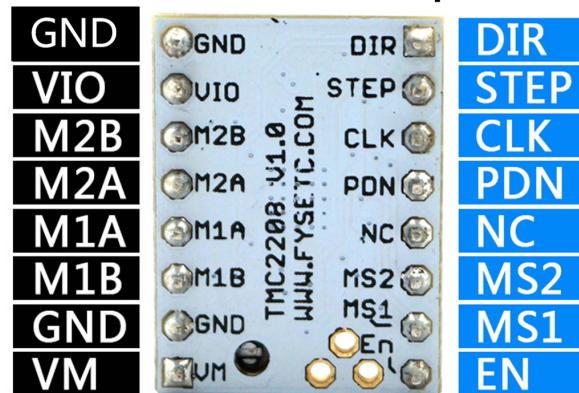
or simplified:

$$VREF = \text{current} * 1.41 = 0.4A * 1.41 = 0.56$$

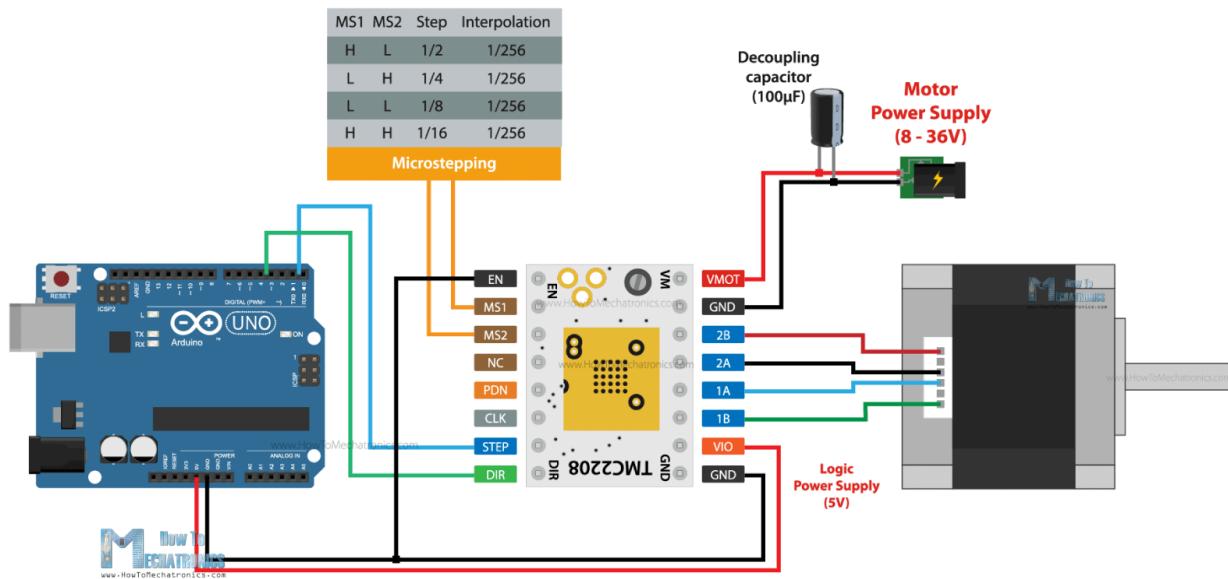
Front



TMC2208 Motor Drive Pin Descriptions



Wiring without motor driver expansion board



Micro-stepping

Why

- high step resolution

- rotate smoothly

How

https://youtu.be/X4qkWxRBTEg?si=ITPLcBUN7Yy0_xfU

- 200 full steps per revolution, 1.8" per step.
- 1/4 micro-stepping - $200 * 4 = 800$ pulses per rev

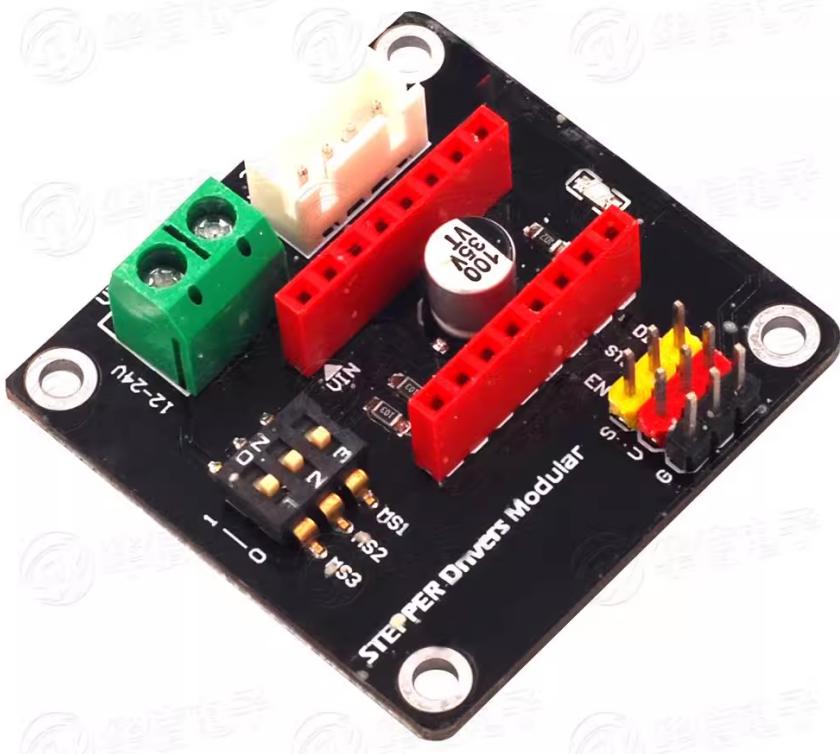
Error with 1 missing step? with 1/4 micro-stepping:

wheel C = 200mm, $200\text{mm} * 1/200 * 1/4 = 0.24\text{mm}$

TMC2208 micro- stepping setting

MS1	MS2	Micro step Resolution
LOW	LOW	1/8
LOW	HIGH	1/4
HIGH	LOW	1/2
HIGH	HIGH	1/16

Motor driver controller expansion board



- Compatible driver: A4988, DRV8825, TMC2208
- built-in required capacitor
- switches for micro-stepping control
- pins for motors and micro controller connections.

Base board

Lower: metal 200 × 118mm R5, 125g, metal aluminum alloy



R5系列

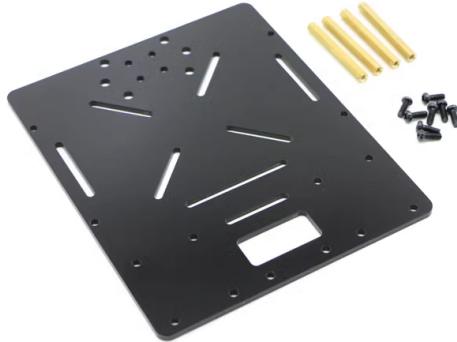
四轮小车铝合金板

铝合金材质 表面氧化喷砂 | 赠送加高铜柱螺丝



Upper: acrylic 144×118mm

R3系列两轮/三轮 多用智能小车底盘加高板



了解参数 放心使用

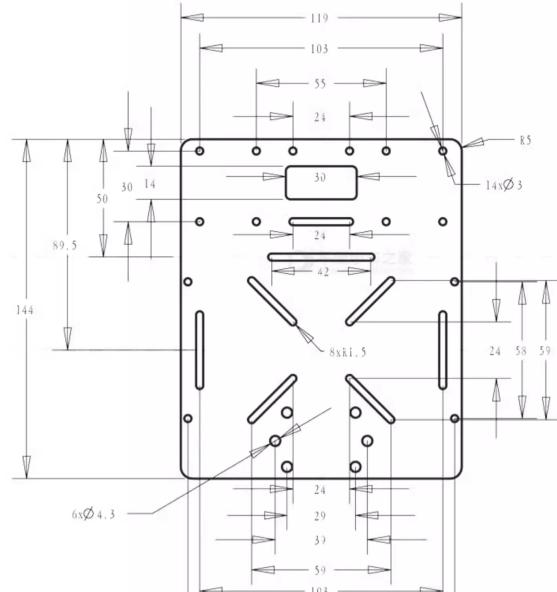
PRODUCT INFORMATION

机械图纸 单位: mm

如果购买1层，铜柱会配M3*40双通铜柱4个+配套的螺丝

如果购买多层，第一层发M3*40双通铜柱4个+配套的螺丝

第二层及其以上发M3*40单通铜柱4个+配套的螺丝螺母



Parts

- Lower level base board
- Upper level base board
- black standoff - x4
- wheel - x2
- ball caster - x1
- brass standoff - x2
- Stepper motor - x2
- Stepper motor mounting bracket - x2
- Stepper motor cable(6pin to 4pin) - x2

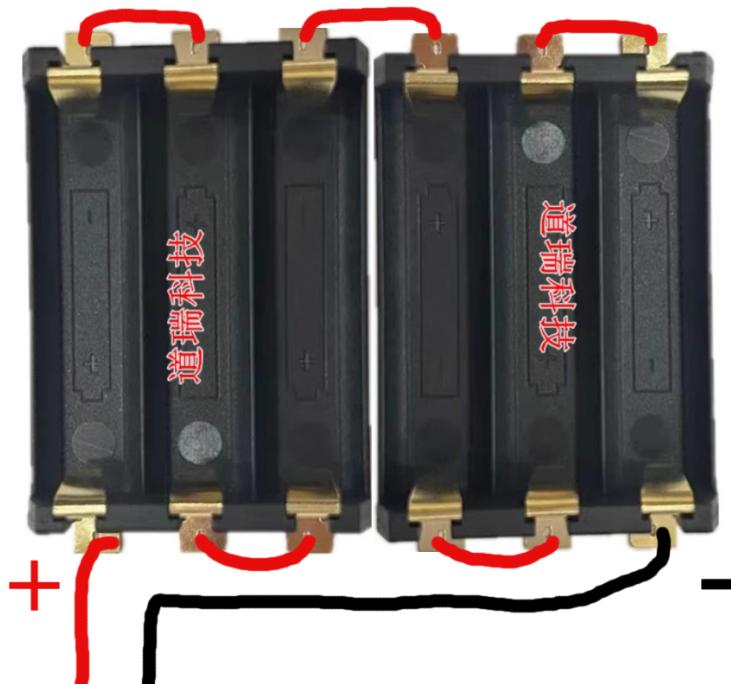
- motor driver TMC2208 - x2
- motor driver expansion board - x2
- battery holder(3 slots) - x2
- voltage booster module
- power cable with DC power jack
- esp32
- esp32 expansion board
- cross screwdriver
- M3 screws and nuts

Building Notes

- Soldering - safety first
 - Use tweezers
 - put the soldering iron on the holder, stay away from anything, especially the cable.
 - Use steel ball to clean the solder head
 - Use soldering flux(paste) to get the solder to stick on the surface
 - After use, unplug the power and wait until it completely cools down.
- Stepper motor driver - heat sink is not required as our current is low
- Correct placement - stepper motor driver and ESP32 module on the expansion board, see wiring diagram.
- Use the right screwdriver, wrong one could damage the screws, especially the built-in ones on the boards.
- Prevent electrical shorts which cause damage to components
 - Use spacers/standoffs for mounting the modules
- Remove battery immediately if you see or smell smoke

Build steps

- Build battery holder - soldering



- Wire the battery holder, voltage booster, set output voltage to **12V**, verify it with multimeter, learn how to change the display.
- Motor driver - Set VREF to **0.52 - 0.55V**
 - connect power(battery box and voltage booster), **DO NOT connect motors when setting VREF**
 - Detail instruction, see above Motor driver section.
- Test motors - see wiring diagram diagramm <https://github.com/frdeng/RT-2025/blob/main/docs/S2-wiring.png>
 - test with example sketch <https://github.com/frdeng/RT-2025/tree/main/example-code/stepper-without-lib>
 - test with different micro-stepping

- Mount and install
 - ESP32
 - motors
 - wheels
 - Battery holder
 - Voltage booster
 - Buttons
- Wiring <https://github.com/frdeng/RT-2025/blob/main/docs/S2-wiring.png>
- Optional
 - gyro
 - solder pins
 - Calibrate the gyro
 - Install gyro
 - Display
 - Laser - for alignment

Pin map

	GPIO
Left motor DIR	32
left motor STEP	33
left motor EN	25
right motor DIR	26
right motor STEP	27
right motor EN	14
Button - enabling motors	
Button - start a run	
Button - reset ESP32	

TODOs

- ESP32 Over the air OTA programming
 - <https://randomnerdtutorials.com/esp32-over-the-air-ota-programming/>
- Design and build alignment device
- Design and build dowel holder
- All team - write your own program.