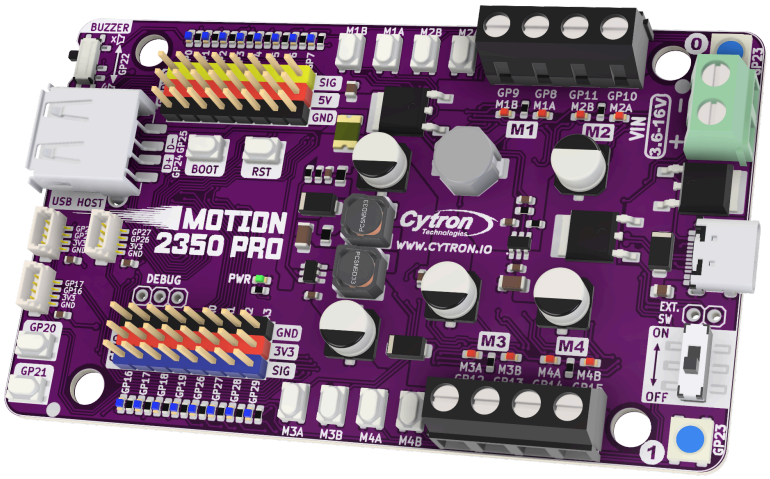
MOTION 2350 Pro

An Advanced Robotics Controller for Beginners



Datasheet

Rev 1.0
July 2024

1. BOARD LAYOUT & FUNCTION

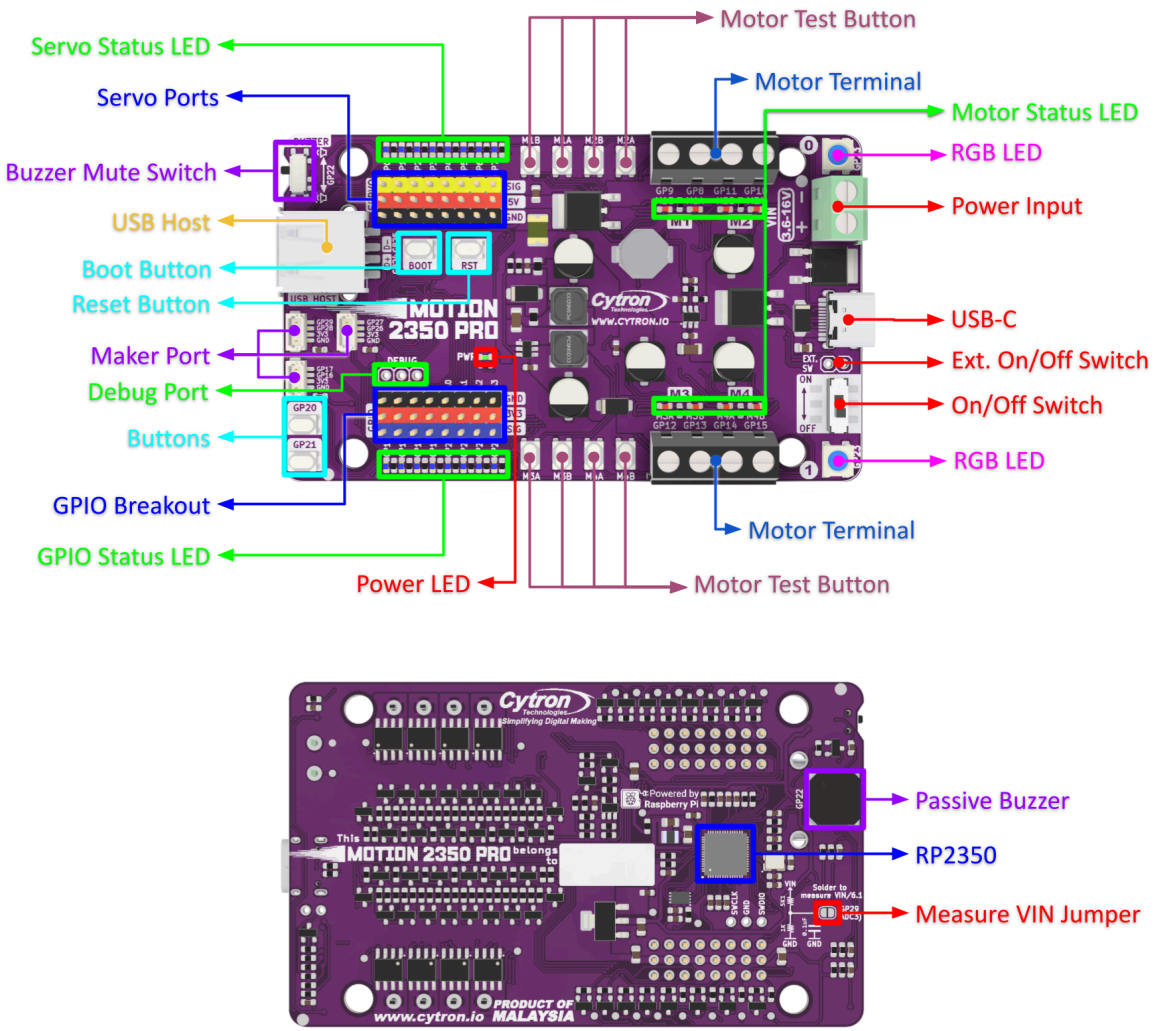


Figure 1: MOTION 2350 Pro Board Functions

Function	Description
Power Input	Terminal for external 3.6V - 16V DC power input. Can be powered up with external LiPo or 4x AA batteries.
On/Off Switch	Turn On/Off the power.
Ext. On/Off Switch	Header for external On/Off switch. The onboard switch must be in Off position to use the external switch.
5V Supply	Power output for external servos. Controlled by an automatic voltage selector, the output of 5V supply depends on the input from the VIN.

VIN	5V Supply output
VIN > 5.8V	It will step down the VIN voltage to 5V.
VIN < 5.5V	It will follow the VIN voltage.

<table>
<tr><td>USB-C</td><td>Used for upload programs from PC.
Used to power up the board.</td></tr>
<tr><td>GPIO/Servo Status LEDs</td><td>LED indicator for digital IO.
Turn on when the IO state is high.</td></tr>
<tr><td>GPIOs Breakout</td><td>Arranged in color-coded GVS format.
With 3.3V power output for each GPIO.

<table>
<tr><th>GPIO</th><th>PWM</th><th>SPI</th><th>I2C</th><th>UART</th><th>Analog</th></tr>
<tr><td>16</td><td>PWM0-A</td><td>SPI0 SDI</td><td>I2C0 SDA</td><td>UART0 TX</td><td>-</td></tr>
<tr><td>17</td><td>PWM0-B</td><td>SPI0 CSn</td><td>I2C0 SCL</td><td>UART0 RX</td><td>-</td></tr>
<tr><td>18</td><td>PWM1-A</td><td>SPI0 SCK</td><td>I2C1 SDA</td><td>UART0 CTS</td><td>-</td></tr>
<tr><td>19</td><td>PWM1-B</td><td>SPI0 SDO</td><td>I2C1 SCL</td><td>UART0 RTS</td><td>-</td></tr>
<tr><td>26</td><td>PWM5-A</td><td>SPI1 SCK</td><td>I2C1 SDA</td><td>UART1 CTS</td><td>ADC0</td></tr>
<tr><td>27</td><td>PWM5-B</td><td>SPI1 SDO</td><td>I2C1 SCL</td><td>UART1 RTS</td><td>ADC1</td></tr>
<tr><td>28</td><td>PWM6-A</td><td>SPI1 SDI</td><td>I2C0 SDA</td><td>UART0 TX</td><td>ADC2</td></tr>
<tr><td>29</td><td>PWM6-B</td><td>SPI1 CSn</td><td>I2C0 SCL</td><td>UART0 RX</td><td>ADC3</td></tr>
</table></td></tr>
<tr><td>Servo Ports</td><td>Connectors for 8 x RC servo motors.
Signal is connected to GP0, GP1, GP2, GP3, GP4, GP5, GP6, and GP7.
For 5V, please refer to the 5V Supply section.</td></tr>
<tr><td>Maker Ports</td><td>JST-SH 4-Ways Connector for external modules.
Compatible with Qwiic, STEMMA QT and Grove (Via Conversion Cable).

These pins are available on Maker Ports:
GP16, GP17, GP26, GP27, GP28 and GP29.</td></tr>
<tr><td>Motor Test Buttons</td><td>Press to test the functionality of the motor driver.
Motor will run at full speed.</td></tr>
<tr><td>Motor Terminals</td><td>Connect to the motor terminal.
Motor voltage at full speed is equal to power source voltage.
Motor direction is dependent on the polarity.</td></tr>
<tr><td>Motor Status LEDs</td><td>Turn on when the motor is running.</td></tr>
<tr><td>USB Host</td><td>USB type A port for USB Host.
The connected pins to USB data transmission on this port are:

<table>
<tr><th>USB Pins</th><th>GPIO</th></tr>
<tr><td>D+</td><td>GP24</td></tr>
<tr><td>D-</td><td>GP25</td></tr>
</table></td></tr>
</table>

RGB LEDs	User programmable WS2812B RGB LEDs, NeoPixel compatible. Connected to GP23.
Piezo Buzzer	Can be used to play tone or melody. Connected to GP22.
Buzzer Mute Switch	Used to mute the piezo buzzer.
Measure VIN Jumper	Solder this jumper to measure VIN on the GP29(ADC3). ** Please be aware that the GPIO LED on GP29 will always turn on due to the high input from the VIN measurement.*

Table 1: MOTION 2350 Pro Board Functions

2. PINOUT DIAGRAM

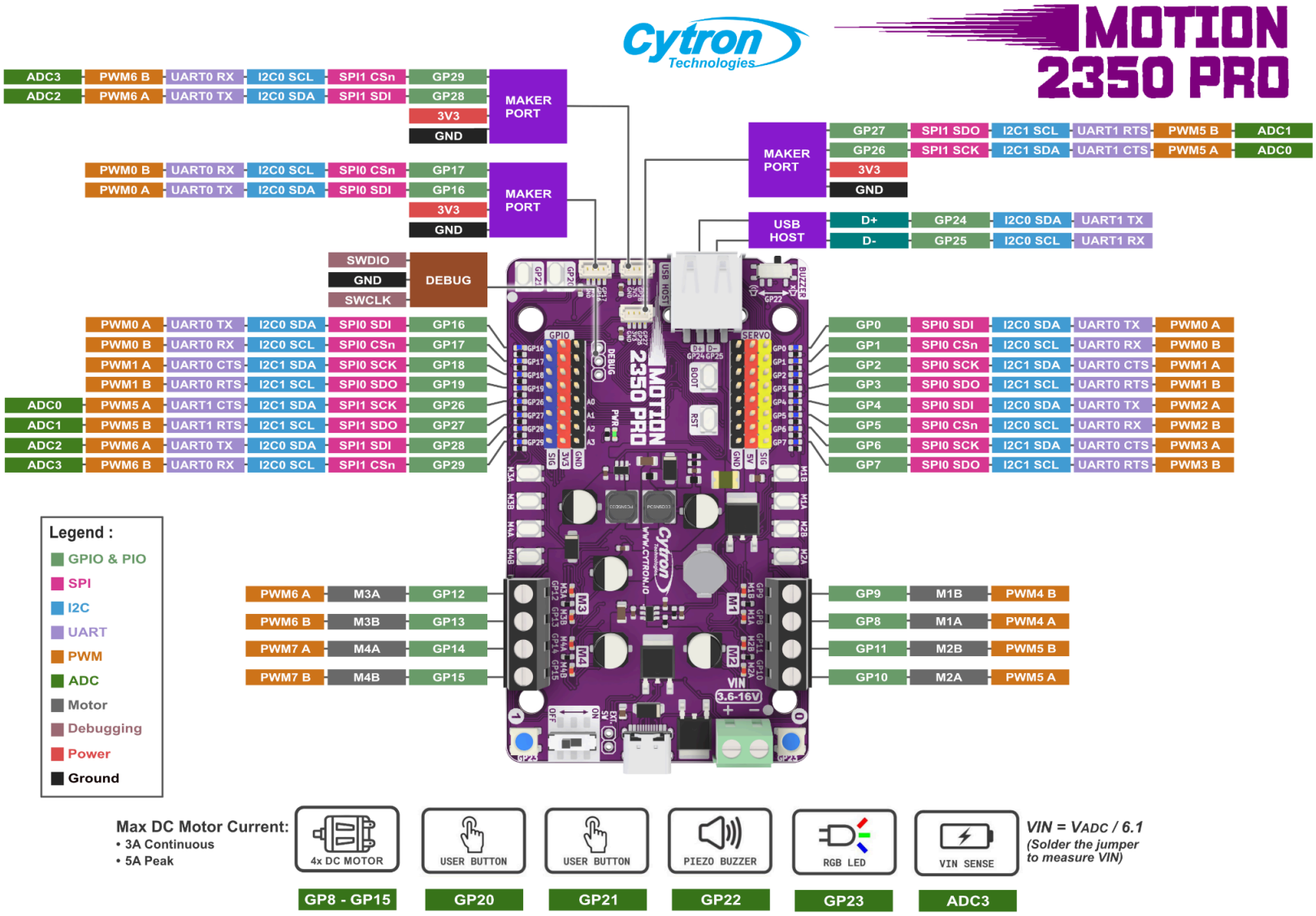


Figure 2: MOTION 2350 Pro Pinout Diagram

3. SPECIFICATIONS

No	Parameters		Min	Max	Unit
1	Power Input Voltage (USB or VIN) *		3.6	16	V
2	Digital Input Voltage	Low Level	-0.3	0.8	V
		High Level	2.0	3.6	V
3	Digital Output Voltage	Low Level	0	0.5	V
		High Level	2.6	3.3	V
4	Analog Input Voltage		0	3.3	V
5	Vmotor (Only USB is connected)		VUSB - 0.4		V
6	Vmotor (Only VIN is connected)		VIN		V
7	Vmotor (USB and VIN are connected)	VIN < VUSB	VUSB - 0.4		V
		VIN > VUSB and VIN - VUSB < 0.6	VIN - 0.4		V
		VIN - VUSB > 0.6	VIN		V
8	5V Output Voltage (Servo Ports)	VIN > 5.8V	5		V
		VIN < 5.5V	VIN		V
9	USB Host Output Voltage		-	5	V
10	USB Host Output Current		-	100	mA
11	Maximum DC Motor Current each Channel	Continuous	-	3	A
		Peak (< 5 seconds)	-	5	A
12	DC Motor Driver PWM Frequency		-	20	kHz
13	Total +3V3 Output Current (GPIO Breakout & Grove Ports)		-	200	mA
14	Total +5V Output Current (Servo Ports)	VIN < 5.8V	-	3	A
		VIN > 5.8V	-	2	A
15	Operating Temperature		-20	85	℃

Table 2: MOTION 2350 Pro Absolute Maximum Ratings

* *It's not recommended to connect both USB and VIN at the same time. Although it's perfectly safe to do so.*

5V Port Automatic Voltage Selector

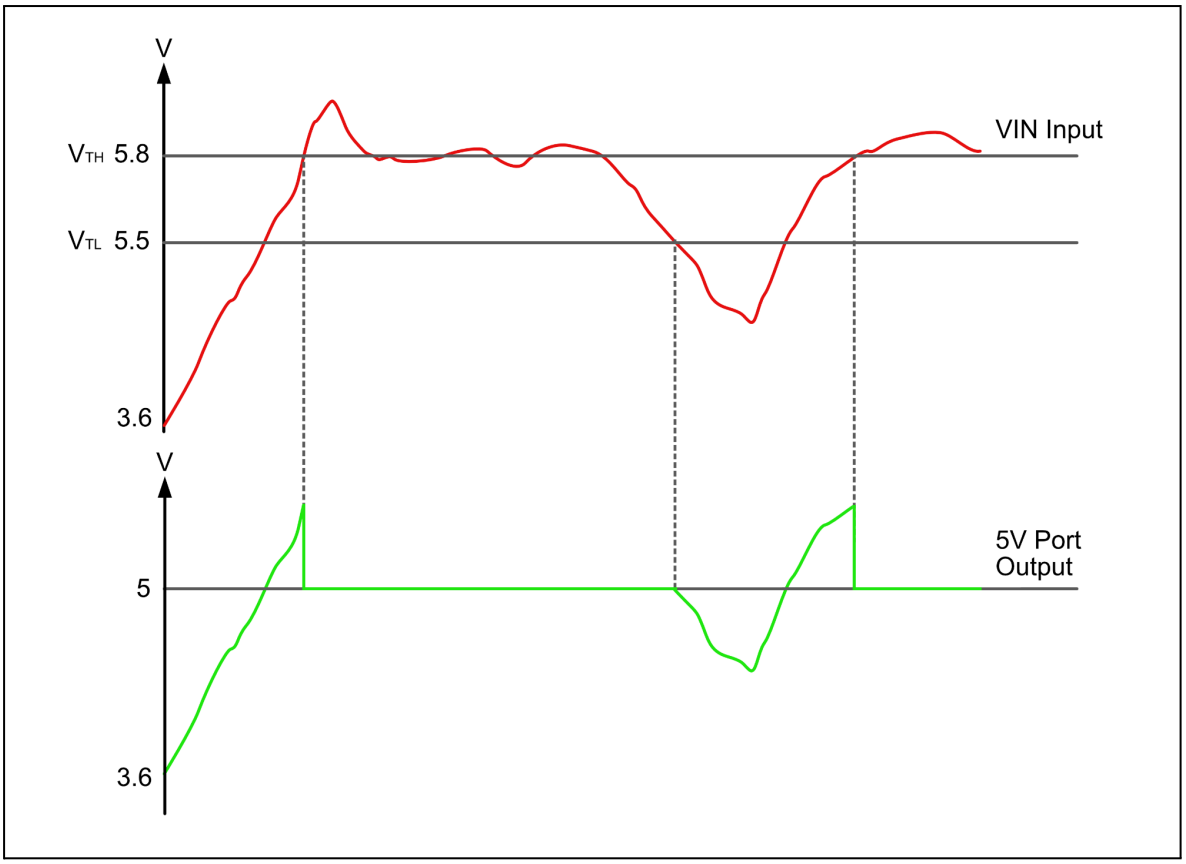


Figure 3: 5V Port Automatic Voltage Selector

The 5V port output is controlled by Schmitt Trigger to automatically control the output voltage on the 5V port output. It is to protect the servo and provide stable output voltage. When the VIN input voltage more than the high threshold voltage V_{TH} 5.8V, it will switch the output to an internal buck converter 5V. Will retain the 5V output until it reaches the low threshold voltage V_{TL} 5.5V.

4. DIMENSION

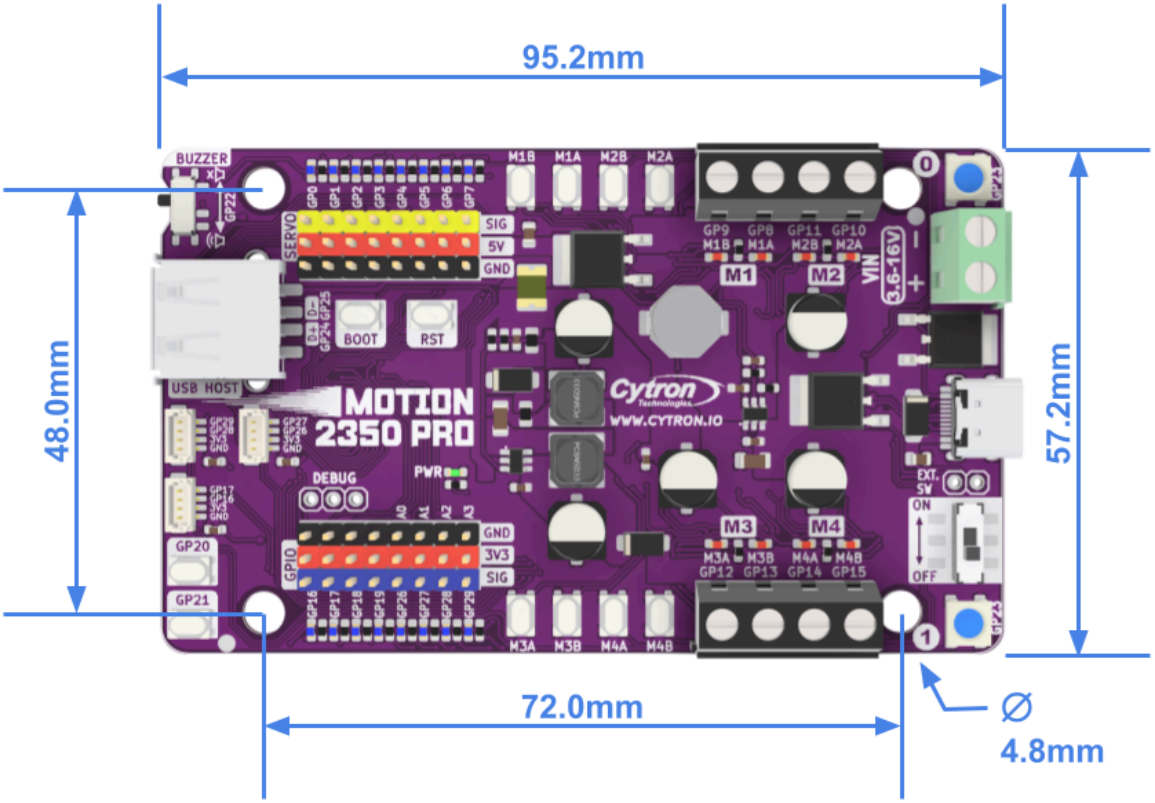


Figure 4: MOTION 2350 Pro Dimension

5. INTERFACE

Motor Driver

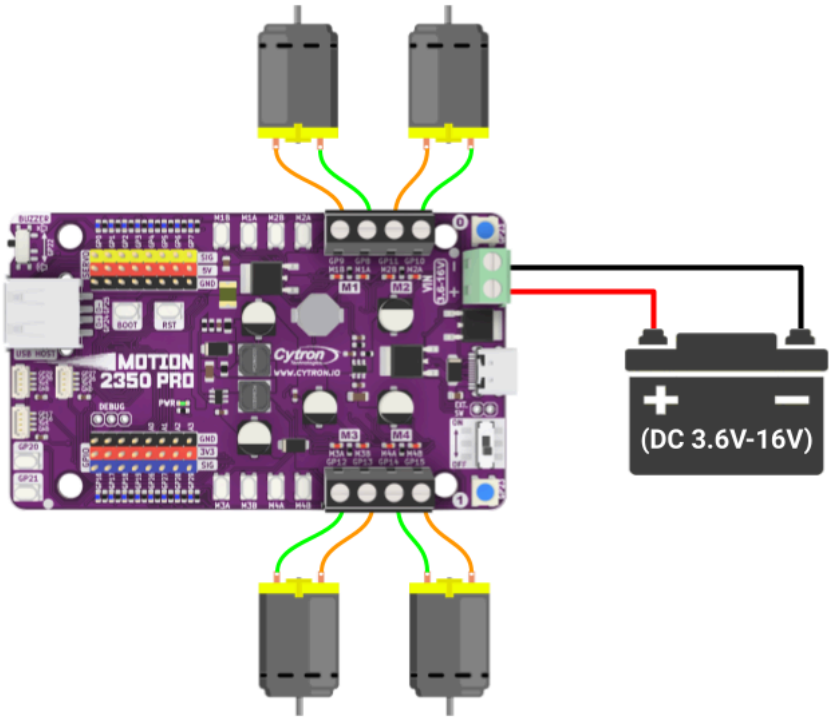


Figure 5: Connection Diagram for Brushed DC Motor

* *Actual motor direction is depending on the motor connection.*
  Swapping the connection (MA & MB) will reverse the direction.
* *The motor driver do not have overcurrent protection, please be aware with the max current rating on the motor. Overdraw the current can damage the motor driver.*

Input Voltage Measurement

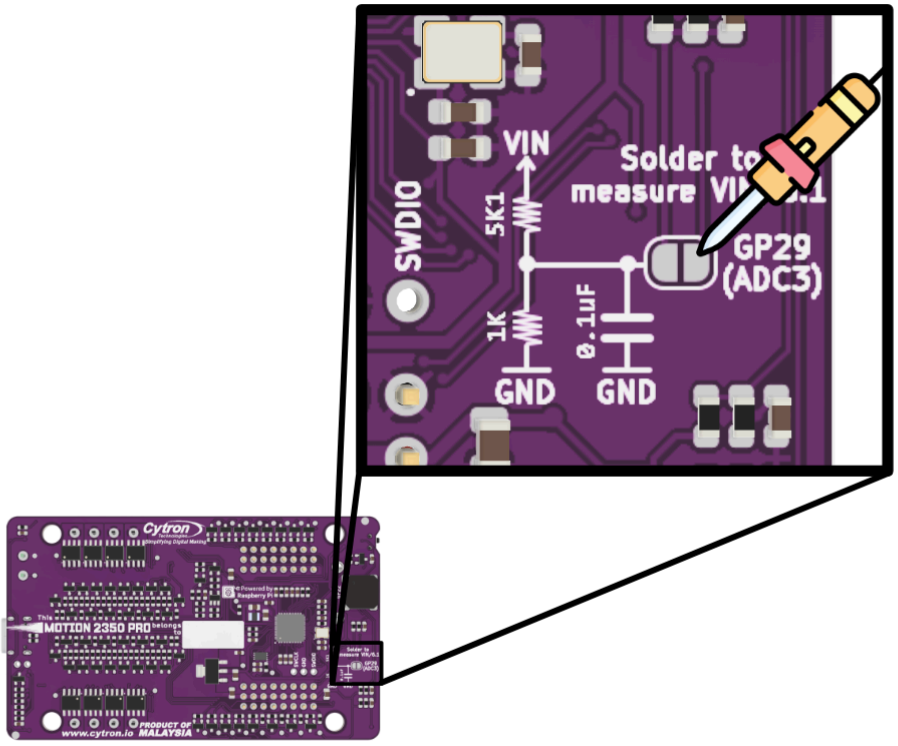


Figure 6: Solder to measure the VIN

Calculate the VIN on the GP29(ADC3) using this formula:

$$V_{IN} = V_{ADC} / 6.1$$

Where:

V_{IN} = VIN input terminal or VUSB input voltage (whichever is higher).

V_{ADC} = The ADC input voltage after converted from raw input data.

6. IMPORTANT NOTES

RP2350 GPIO Pull-Down Issue (Errata E9)

The RP2350 IC has a known hardware issue (Errata E9) affecting its General-Purpose Input/Output (GPIO) pins. When a GPIO pin is configured as an input with the internal pull-down resistor enabled, it exhibits a bus-hold-like behavior. After receiving a high input, the pin fails to properly pull down to 0V and instead retains a voltage of approximately 2.15V. It also happens even if the internal pull-down is disabled and an external pull-down is used (if the resistor value is too high).

To mitigate this issue, implement external pull-down resistors with a value less than 8k Ohms for each used pin.

Caution: This equipment is not intended for use in residential environments and might not provide adequate protection to radio reception in such environments.

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