

PhysWatt Calibration Manual

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1. Flash Firmware

When flashing firmware on a PhysWatt, both channels A and B, need to be updated one by one, using the following steps:

1. When flashing Firmware, unplug PhysWatt from the power supply. Carefully disconnect and remove the top PCB.
2. On FTDI, place the jumper pad at pins, G and 3.3V, as shown in [Figure 1](#).
3. Connect FTDI to a PC using a data cable. The FTDI and its pinouts are shown in [Figure 1](#) below.

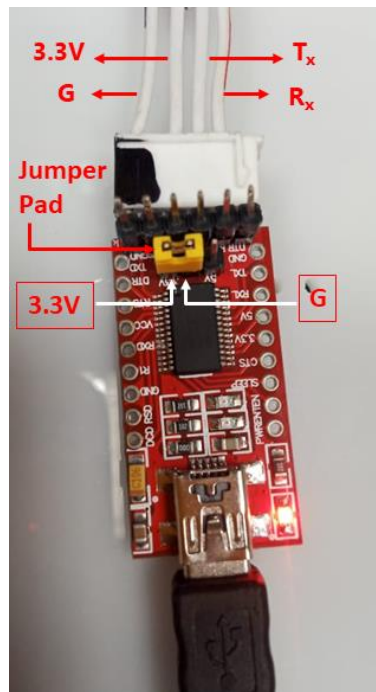


Figure 1: The front side of the used FTDI and its pinouts. An adapter (with four wires and female headers on either side) is attached to the FTDI. In this adapter, wires connected to Rx and Tx are connected to one header and wires connected to G and 3.3 V are connected to the other header.

4. Plug in the four FTDI pins: G, 3.3V, Rx, Tx, to the respective four points/connectors: G, 3.3V, A9, A10, on the STM32 of one of PhysWatt channels, as indicated in [Figure 2](#). ([Figure 5](#) shows the position of the STM32 modules for each respective channel.)

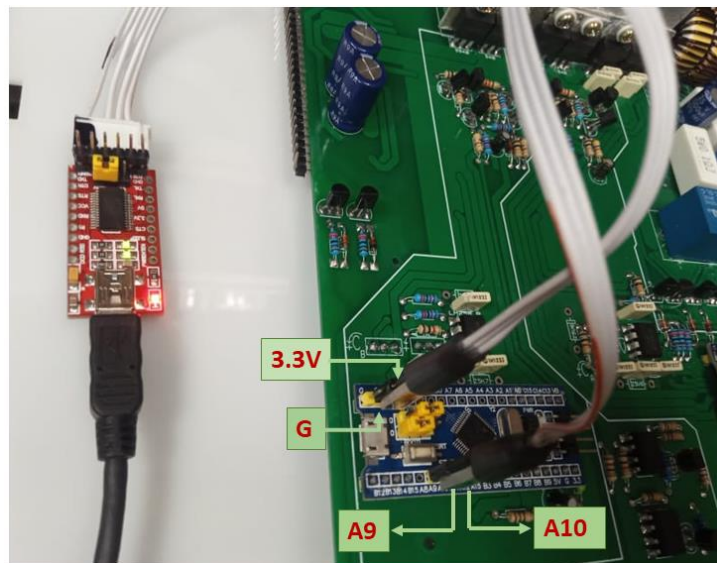


Figure 2: Connections of FTDI pins on STM32 (located on PCB of PhysWatt).

5. Place the jumper pad on the jumper pins close to point 1 on STM32, as shown in **Figure 3 (a)**.

Note: After performing Flash firmware, make sure to place the jumper pad back at its previous position (close to point 0), as demonstrated in **Figure 3 (b)**. Otherwise, PhysWatt will be inoperative for further processes and PhysLogger Desktop App will not respond.

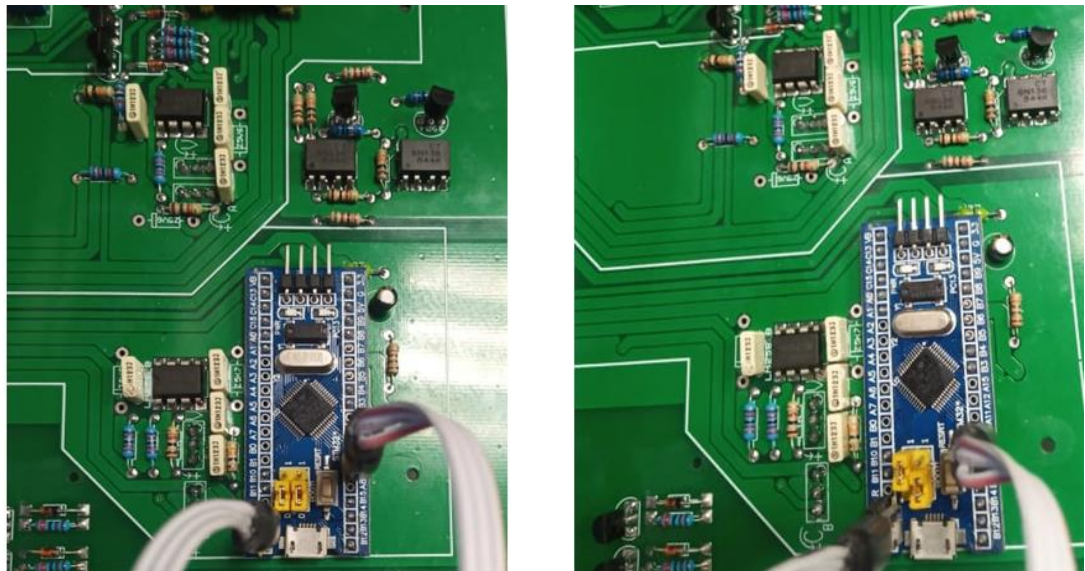


Figure 3: Position of the upper jumper pad on STM32 (a) after flash firmware (b) during flash firmware of PhysWatt channel

6. After connecting everything, launch PhysLogger Desktop App on your PC and open Console by pressing F8 (you may need to wait a few seconds before any connected devices appear on the screen).
 - I. In Console, type and enter `flash`.
 - II. Select (6) PhysWatt as the device that needs to be flashed.
 - III. Select (1), the serial port where the FTDI cable is connected. **Figure 4** shows a typical sequence of instructions and messages in the console.

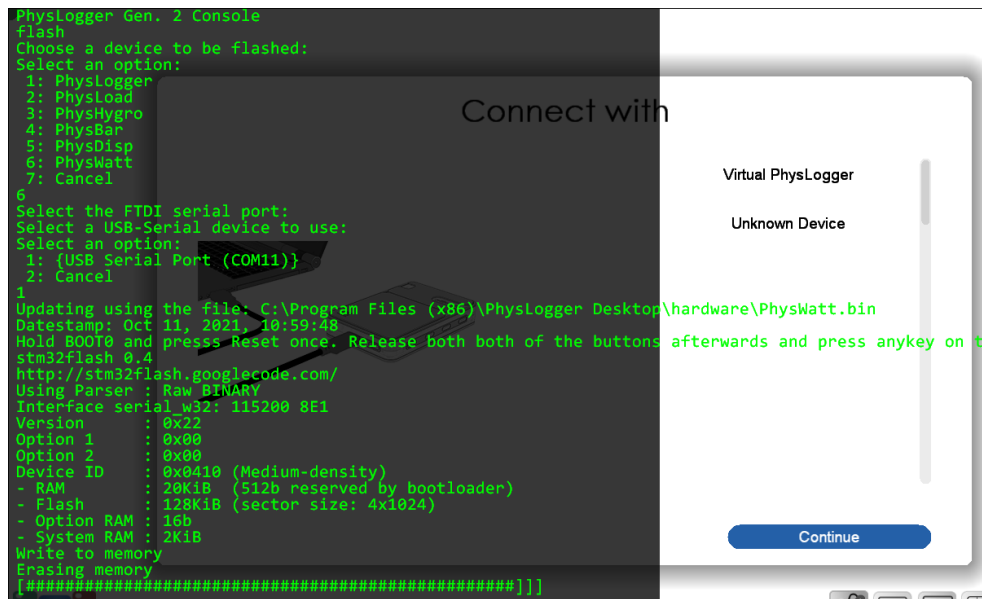


Figure 4: Typical messages that are displayed when flashing has been successfully completed.

- IV. When prompted, “Hold BOOT0 and press Reset once,” press the Reset Flash button on STM 32, as shown in Figure 5. Wait for a moment and then press any key on the keyboard to continue.

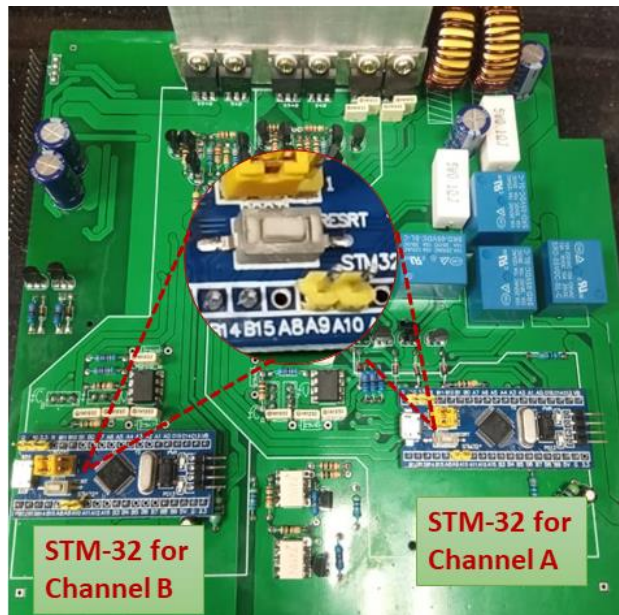


Figure 5: RESET FLASH button, located on STM32 of PhysWatt PCB needs to be pressed and released, when prompted in the Console.

- V. A message “#####]]]” as shown in Figure 4 will appear on the Console screen when flash firmware is complete. The display of three-box brackets “]]]” at the end of the message indicates a successful firmware process in that channel.
7. Repeat steps 4 to 6 to flash the second channel of PhysWatt.

2. Checking and verifying voltages before calibration

Note: Before checking voltages, please make sure that the PhysWatt is flashed with the latest firmware.

2.1 Checking voltage of channels

1. Power up PhysWatt by connecting it to a 220 V main AC supply. A programmed message “Qosain Scientific 2.0” should appear on the display. If this message does not appear, refer to the troubleshooting section of this manual.
2. Using a voltmeter, check and measure voltages of channel A and B. To do this, touch the red lead of Multimeter with the positive terminal of channel A, and the black lead of multimeter (connected to COM port) with the negative terminal (which is grounded by default) of channel A. The terminals for channel A and B are demonstrated in **Figure 6 (a)**.
3. **Figure 6 (b)** exemplifies the measurement procedure. Voltage measured for both channels should be in the range of 12 ± 0.2 V.
4. Repeat Step 2-3 to check voltage of channel B.

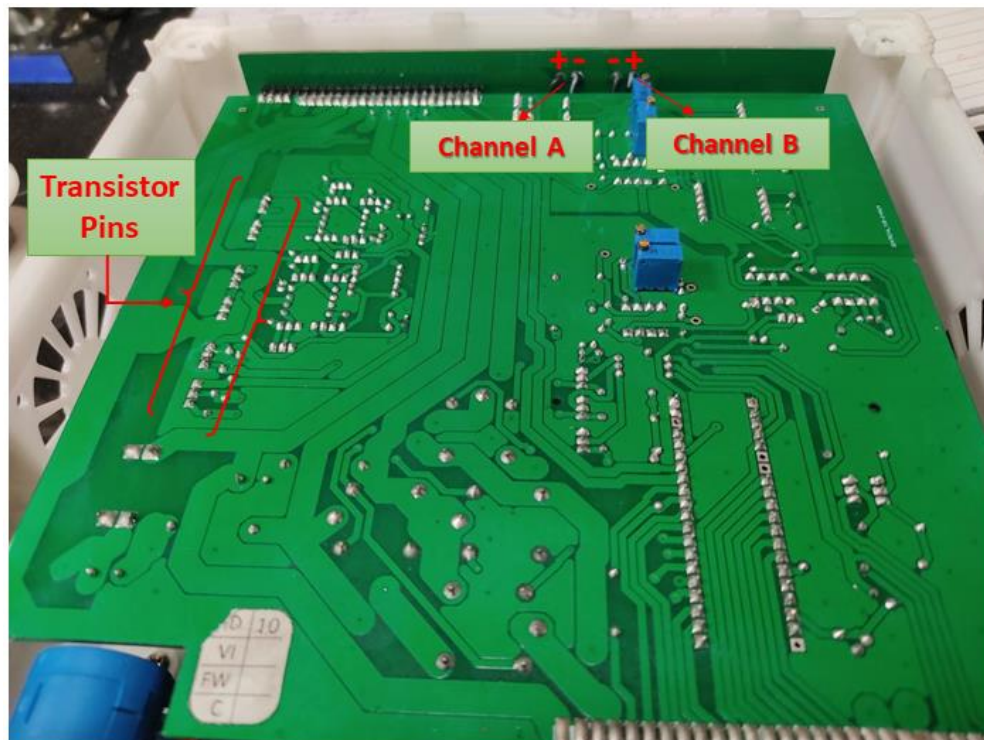


Figure 6: The positive and negative terminals of Channel A and B. Before calibration, the voltage of both channels and the voltage supplied at the transistor pins, needs to be checked and verified. See **Figure 7** to see the expanded view of the transistor pins.

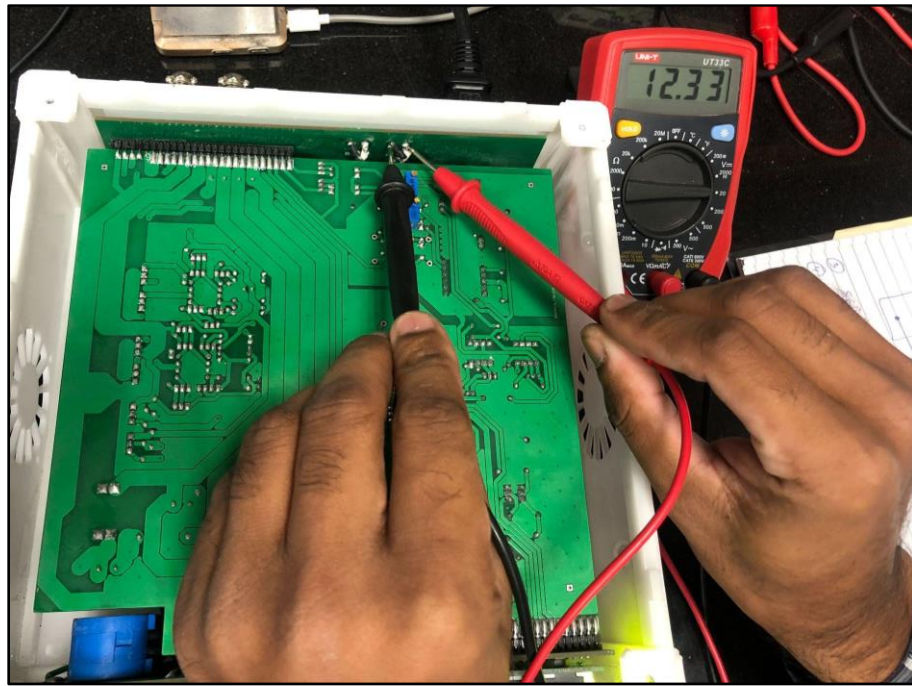


Figure 6 (b): Measurement of voltage of Channel A. The red and black lead of voltmeter is touched to the positive and negative terminal of channel A (referred in Figure 6-a) respectively.

2.2 Checking voltages on transistor pins

1. Using a voltmeter, check the voltages at all the transistor pins. A total of six transistors are used, i.e., two 9540, two 540 and two 7805 transistors.
2. Keep in mind that the center pin of all transistors are connected to ground, hence, while checking voltages the black lead of the Multimeter (connected to COM part) should be touched to the ground pin of the respective transistor. For example, to measure voltage of transistor 9540, put the red lead of the multimeter at the first pin of the transistor and black lead at the ground pin of that transistor.

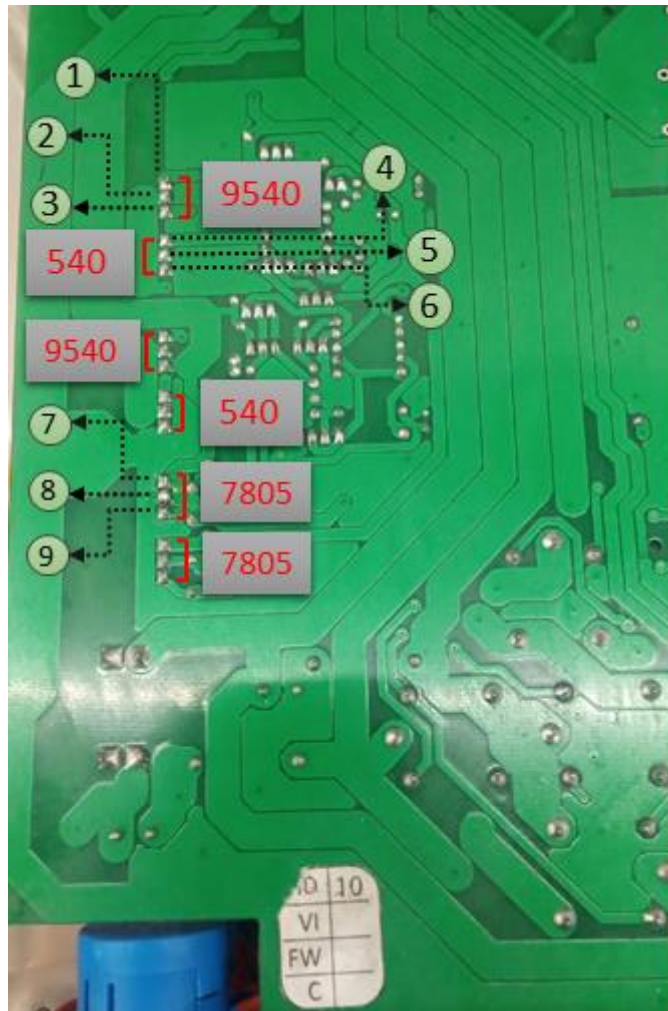


Figure 7: Expanded view of the transistors (referred in Figure 6). Voltage needs to be checked at all these transistors and then compared with voltage values in **Table 2**.

3. Record and verify that the measured voltage at each pin corresponds to the respective value in **Table 2**. Measured values that are in good agreement with the mentioned ranges in **Table 2** are an initial test of whether calibration will be successfully completed. If a measured voltage deviates from the expected range, the user is advised to check and re-solder any inadequately soldered component.
4. For the same transistor, the standard values of voltages are also the same. To put it simply, the first pin of every 540 transistor should have 10.8 V, the third pin 0.0 V while the center pin is the ground.

Note: Be very precise when checking voltages: if the voltage probe touches a ground and live pin simultaneously, connections can be short-circuited.

Note: For utmost accuracy, ensure that the voltmeter being used is not showing a low battery symbol.

Transistor	Pin No.	Voltages
9540	1	12.3 V
	2	Ground
	3	12.3 V
540	4	10.8 V \pm 0.2 V
	5	Ground
	6	0.0 V
7805	7	12 V
	8	Ground
	9	5 V

Table 2: Standard values of voltages for the transistor pins.

3. Calibration of PhysWatt

Both channels A and B of PhysWatt are required to be calibrated once. The voltages and currents of each channel are calibrated in the constant voltage and constant current mode, respectively of PhysWatt.

Note: If the top PCB of PhysWatt had been removed during the flashing process, carefully replace it before initiating the calibration procedure. If the PCB is not adequately fitted, the LCD of PhysWatt may display gibberish or not turn on at all (refer to the Troubleshooting Section).

2.1 Calibrating voltages of PhysWatt channels

For the voltage calibration of PhysWatt, you are required to perform the following steps:

1. Power up PhysWatt by connecting it to a 220 V main AC supply. A programmed message “Qosain Scientific 2.0” should appear on the display. If this message does not appear, refer to the troubleshooting section of this manual.
2. Set the voltage of Channel A to 2 V by rotating the knob in a clockwise direction, while keeping the current limit at 0.2 A.
3. Use Rigol DM3068 Digital Multimeter to measure the voltage across Channel A of PhysWatt, as demonstrated in **Figure 8**.

Note: Ensure that the Rigol multimeter is set at the DC voltage mode.

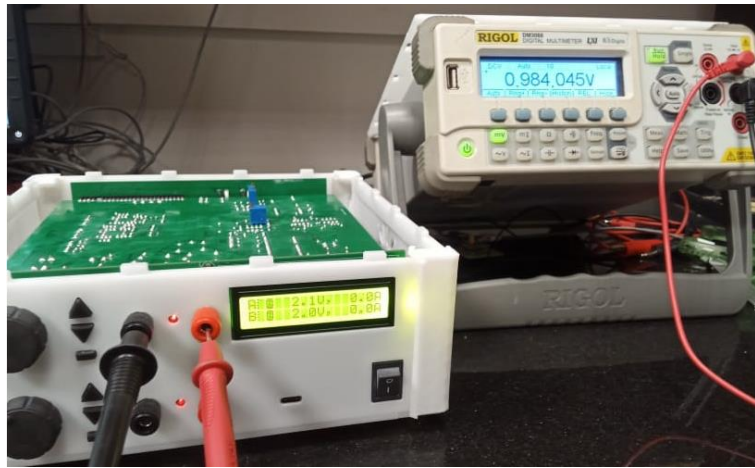


Figure 8: Connection of Rigol Digital Multimeter 3068 (set at DC voltage mode) to Channel A of PhysWatt.

4. The voltage value that appears on the Rigol Multimeter display should have the exact value as we set manually on PhysWatt. If the voltage values differ, refer to the next step for adjustment of the voltage.
5. For tuning the voltage value, use a screwdriver to adjust the resistance of the variable resistor located on PCB of PhysWatt for Channel A, as shown in [Figure 9](#).

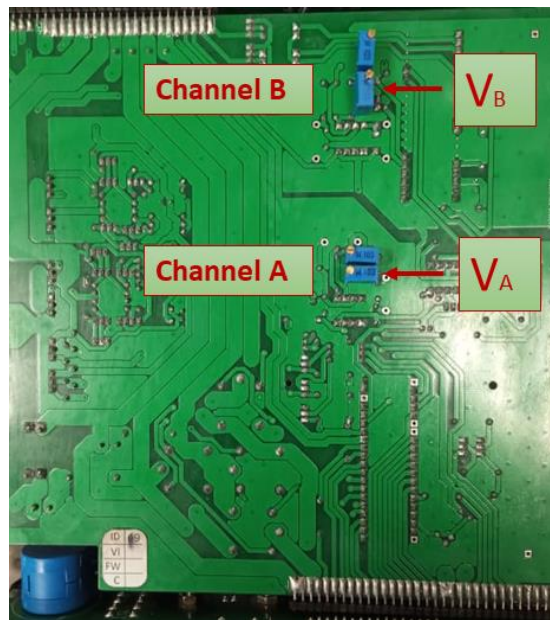


Figure 9: The positions of variable resistors of both channels for voltage calibration.

6. To increase the voltage value, rotate the screwdriver in the clockwise direction and vice versa. However, for Channel B, rotate in the directions opposite to that of Channel A. Refer to [Table 2](#).

The direction of rotation of the screwdriver		Channels of PhysWatt	
		A	B
Voltage	To increase	Anti-clockwise	Clockwise
	To decrease	Clockwise	Anti-clockwise
Current	To increase	Anti-clockwise	Clockwise
	To decrease	Clockwise	Anti-clockwise

Table 2: The rotational directions of the variable resistors that increase and decrease the voltages and currents of PhysWatt.

7. Adjust the variable resistance until the voltage value on the multimeter and PhysWatt display are in an agreement of at least ± 30 mV.
8. Repeat voltage calibration at a higher voltage value, for example a voltage in the range of 9 V to 10 V.
9. Repeat this procedure to calibrate the voltage of Channel B.

2.2 Calibrating current of PhysWatt channels

To ensure maximum accuracy of the current calibration of two channels, we perform two types of calibration:

- i. Coarse Calibration
- ii. Fine Calibration

The difference between these calibrations is the usage of differently rated resistors and thus, different current limits. During coarse calibration, a resistor of high-value resistance, 18Ω 5 W, is utilized that causes minimal heating and fewer chances of damage. During fine calibration, we use a resistor with low resistance, 2.2Ω , that heats up rapidly.

i. Coarse Calibration

1. Set the voltage of Channel A at 10 V by rotating the knob to its maximum position.
2. For coarse calibration, use a resistor of 18Ω and set the current limit of Channel A to 0.2 A.
3. Connect one end of the resistor to the red terminal of Channel A and the other end to the red lead of Rigol DM3068 Multimeter, as demonstrated in [Figure 10](#).

Note: Ensure that Rigol DM3068 Multimeter is set to the DC current mode.

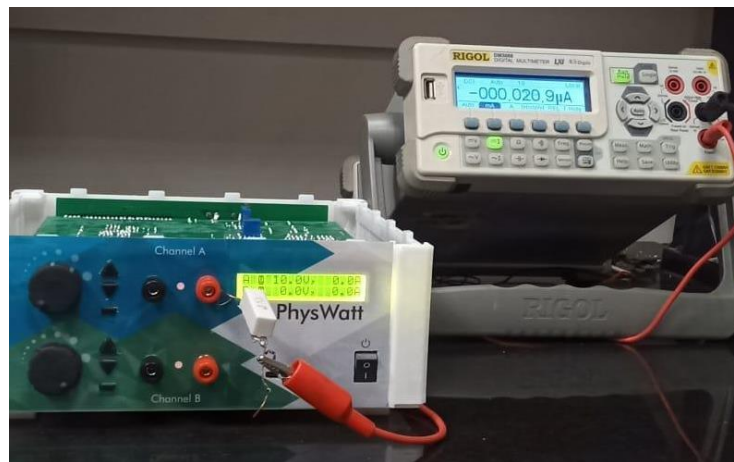


Figure 10: Connecting one end of the resistor to Channel A and the other end to the digital multimeter 3068 set at DC Current mode.

4. Complete the circuit by connecting the black test lead (connected to the COM port) of Rigol Multimeter) to the black terminal (which is grounded by default) of Channel A as demonstrated in [Figure 11](#).

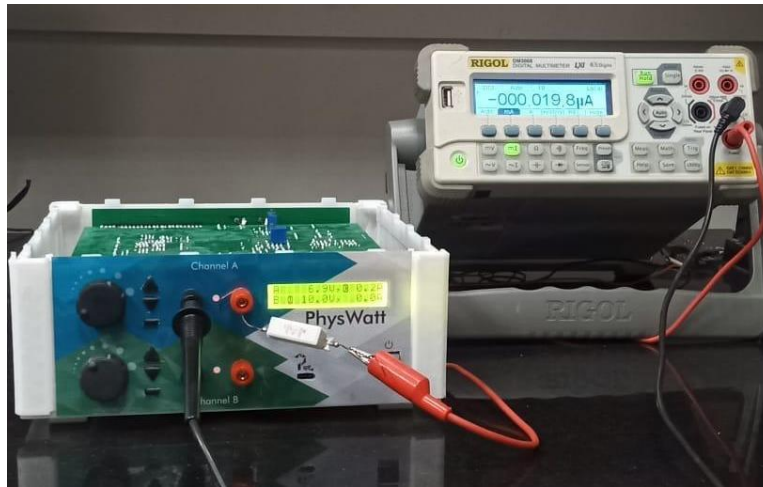


Figure 11: Complete the circuit by connecting black lead of Rigol Digital Multimeter 3068 to the black terminal of Channel A.

5. Compare the values of both currents, the current set manually on PhysWatt (in this case 0.2 A), and the one displayed on the Rigol Multimeter. If there is any difference, it needs to be adjusted, as described below.
6. To adjust the current value, rotate the variable resistor of channel A, located at PCB, using a screwdriver, as shown in [Figure 12](#).

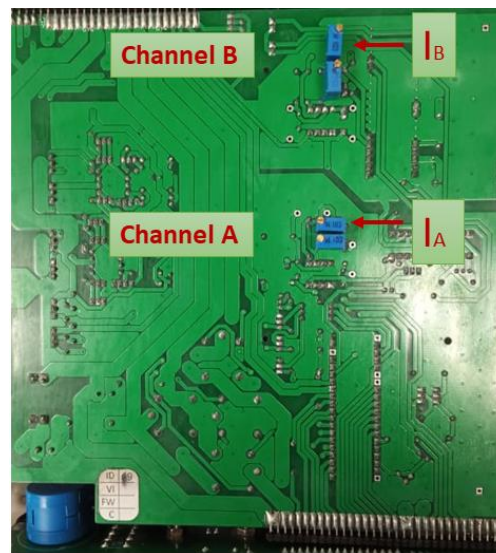


Figure 12: The positions of variable resistors for current calibration of both channels

7. If the current value on the Rigol multimeter is less than the value being shown on PhysWatt display, rotate the screwdriver in anti-clockwise direction and vice versa (refer to [Table 2](#)).
8. Coarse current calibration of a channel will be completed once the current value on the Rigol multimeter is adjusted to be $\leq \pm 40$ mA of the value displayed by PhysWatt.

ii. Fine Calibration

Note: You need to be very vigilant of time while performing fine calibration to prevent heating up of the resistor as it may damage the parts and internal circuitry of PhysWatt.

1. For fine calibration, use a resistor of 2.2 Ω .
2. Set the current limit of channel A to 3.5 A while keeping all other settings similar to coarse calibration.
3. Repeat Steps 3 to 8 of the above procedure (of coarse calibration).

The calibration process is repeated for the other channel of PhysWatt. After completing both coarse and fine calibration and before plugging out the main switch, remember to perform these two steps:

- Keep the voltage of both channels to 10 V.
- Turn off PhysWatt using its power button.

3. Troubleshooting

Table 3 describes the troubleshooting procedures for common possible errors during flashing or calibrating a PhysWatt.

No	Error/Symptom	Solution
1	Flashing of Channel A fails.	Check if the pins of FTDI are connected properly.
		Check position of the jumper pads on STM32 of Channel A.
		Check and resolder (if needed) the following pins of STM32 of channel A on PhysWatt: G, 3.3V, A9, A10.
2	Flashing of B channel fails.	Check if the pins of FTDI are connected properly.
		Check position of the jumper pads on STM32 of channel B.
		Check and resolder (if needed) the following pins of STM32 of channel B on PhysWatt: G, 3.3V, A9, A10.
3	No programmed message of “Qosain Scientific” is displayed on PhysWatt when turning it on.	Ensure that the top PCB of PhysWatt is properly placed and connected with the rest of the assembly.
		Check the position of the jumper pads on STM32 of both channels as shown in Figure 3 (b).

		<p>Check and replace the inductors of both Channels A and B.</p>
		<p>Check if both of the channels have been flashed properly.</p>
<p>4</p>	<p>During current calibration, no current is shown on the Rigol Multimeter while the PhysWatt display shows the current value set manually.</p>	<p>Check if the Multimeter is in the constant current mode.</p>
		<p>Check if the current range of the Rigol Multimeter is set at Amperes in the constant current mode.</p>