

# SwitchDoc Labs

SolarMax LiPo Assembly and Testing Guide

November 2019

Version 1.3

For powering solar systems such as systems based on the  
Raspberry Pi, Arduino and ESP32/ESP8266  
and the SwitchDoc Labs System



## Table of Contents

<b>Errata</b> .....	<b>1</b>
<b>What is SolarMAX LiPo?</b> .....	<b>2</b>
<b>SolarMAX Specifications</b> .....	<b>2</b>
<b>What is in the SolarMax LiPo Kit?</b> .....	<b>4</b>
<b>What Else is Required for the SolarMax LiPo Kit?</b> .....	<b>4</b>
<b>SolarMax LiPo Part Identification</b> .....	<b>6</b>
<b>Step by Step Assembly</b> .....	<b>9</b>
<b>Wiring the SolarMax LiPo</b> .....	<b>12</b>
<b>Solar Panel Wiring</b> .....	<b>12</b>
<b>Grove Wiring Table</b> .....	<b>14</b>
<b>Jumper Wiring</b> .....	<b>18</b>
<b>USB Cable Wiring</b> .....	<b>20</b>
<b>LiPo Battery Wiring</b> .....	<b>20</b>
<b>Finally</b> .....	<b>24</b>
<b>Testing Your SolarMAX LiPo System</b> .....	<b>24</b>
<b>Testing With SkyWeather</b> .....	<b>24</b>
<b>Testing with a Raspberry Pi (without SkyWeather)</b> .....	<b>26</b>
<b>Installing Your SolarMAX LiPo System</b> .....	<b>27</b>
<b>The Science and Education Goals Behind SolarMax</b> .....	<b>29</b>
<b>Support</b> .....	<b>29</b>
<b>Disclaimer</b> .....	<b>30</b>

# Errata

Version 1.3 - Removed single jumper pin from LIPOBATIN to 5V. Added Grove cable from Arduino Mini Pro LP to USB PowerCentral Enable/Control port to implement hysteresis during low power conditions. See article on [www.switchdoc.com](http://www.switchdoc.com)

# What is SolarMAX LiPo?

SolarMAX LiPo is a SwitchDoc Labs designed system to charge LiPo batteries from 12V Solar panels in order to provide more power to small computer systems. SolarMAX is designed to collect and return data about the solar panel system to the powered (or other) computer via a LoRa link. SolarMAX collects and transmits the following data every 30 seconds:

- LiPo Battery Voltage
- LiPo Battery Current
- Solar Panel Voltage
- Solar Panel Current
- Load Voltage
- Load Current

It also supplies the following about inside the SolarMAX box:

- Inbox Temperature
- Inbox Humidity

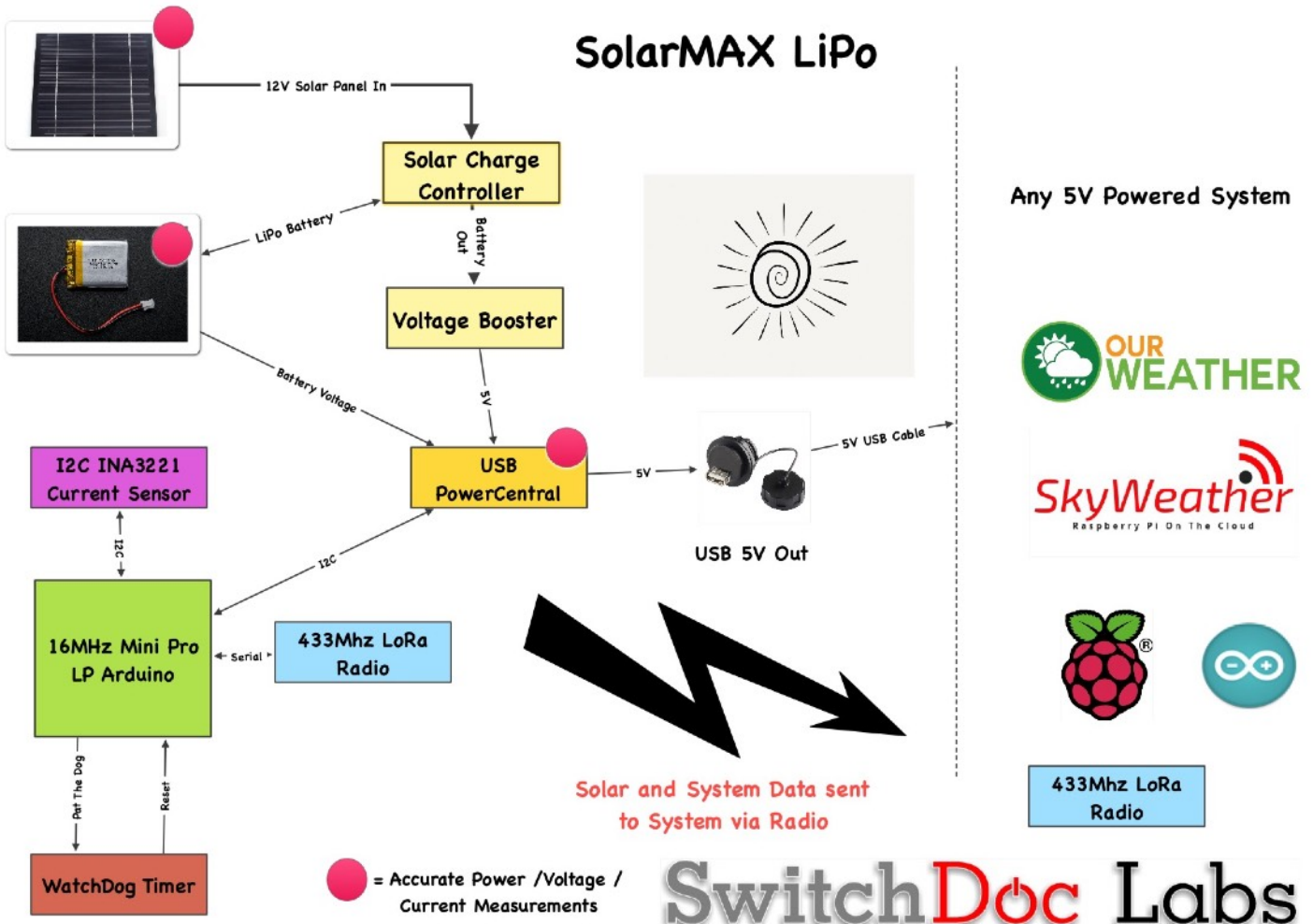
SolarMAX uses a 433MHz LoRa module which can transmit up to 2 kilometers or further with larger antennas and uses very little power.

This is a perfect system for powering SkyWeather and other small computer systems.

## SolarMAX Specifications

Solar MAX LiPo			
	Min	Nominal	Max
Solar Panel Voltage	9V	12V	18V
VOC			24V
5V Load Current			1.5A
Solar Charging Current			2A

# SolarMAX LiPo



## What is in the SolarMax LiPo Kit?

- High Current INA3221 with Terminals
- 12V Solar Charger for LiPo
- USB PowerCentral
- Dual WatchDog Timer
- 16MHz Mini Pro LP
- 6 Port I2C Hub
- HDC1080 Temp Hum
- LoRa 433MHz Radio
- LoRa 433MHz Radio
- MC4 Plus Female (and Pin)
- MC4 Minus Male (and Pin)
- USB Weatherproof Plug
- Short USB Cable Type A - Type A
- 20cm Grove Cables - 6 Cables
- Grove Connector to Female Pin Headers - 1 Cable
- Single Wire Female to Female Jumper - 2 Wires

## What Else is Required for the SolarMax LiPo Kit?

**3.7V LiPo battery** - We recommend > 6600mAh [adafruit.com](https://www.adafruit.com) - we often use the <https://www.adafruit.com/product/353>

**M2 Nylon Hex Thread Assortment** - <https://shop.switchdoc.com/products/14opcs-box-m2-nylon-hex-thread-assortment-kit>

**Solid Core Hookup Wire 22 Gauge** - <https://amzn.to/3202Ppa>

**Bud Enclosure NBB-22241 Style B - 6-25/32" x 10-23/32" x 6-25/32"** - <https://amzn.to/2zk8B8R>

**100W 12V Solar Panel with MC4 Connectors** - <https://amzn.to/2Z1Bv32>

-Or-

**50W 12V Solar Panel with MC4 Connectors** - <https://amzn.to/2ZrFT0e>

## Optional

**Solar Panel Crimping tools for MC4 (optional)** - <https://amzn.to/2U6IN9J>

## Tools

Page 4

Version 1.3 November 2019

Soldering Iron  
Straight blade Small Screwdriver  
Crosspoint Small Screwdriver  
Super Glue  
Silicon Caulking  
Wire cutter  
Wire stripper

Drill  
Drill Bits for:  
1" holes  
2/3" holes

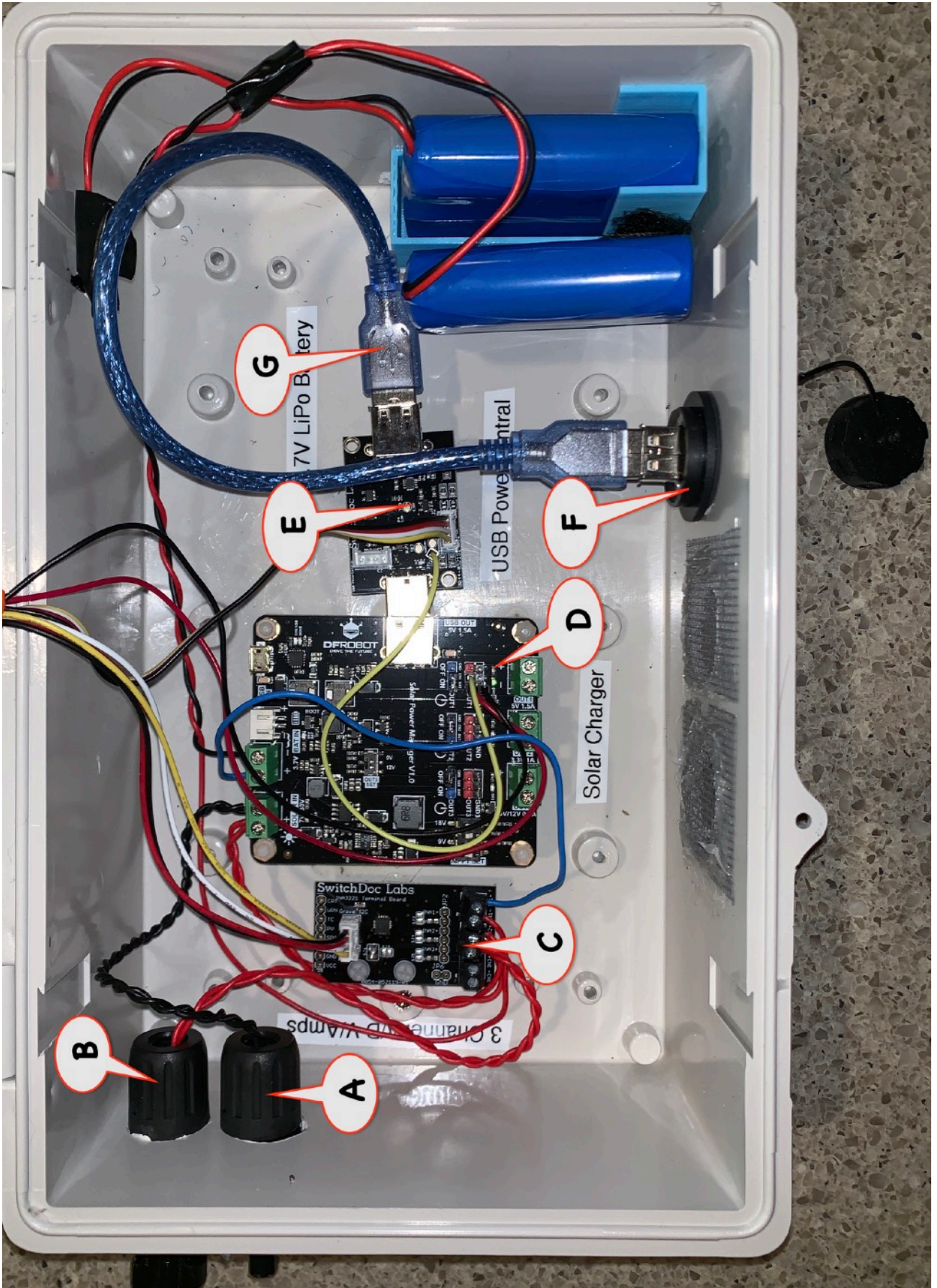
# SolarMax LiPo Part Identification

- **Part A - MC4 Minus Male (and Pin)**
- **Part B -MC4 Plus Female (and Pin)**
- **Part C -High Current INA3221 with Terminals**
- **Part D -12V Solar Charger for LiPo**
- **Part E - USB PowerCentral**
- **Part F - USB Weatherproof Plug**
- **Part G - Short USB Cable Type A - Type A**
- **Part H - Identical LoRa 433MHz Radio (one for SolarMax)**
- **Part H - Identical LoRa 433MHz Radio (one for receiving Computer)**
- **Part I - 16MHz Mini Pro LP**
- **Part J - HDC1080 Temp Hum**
- **Part K - 6 Port I2C Hub**
- **Part L - Dual WatchDog Timer**

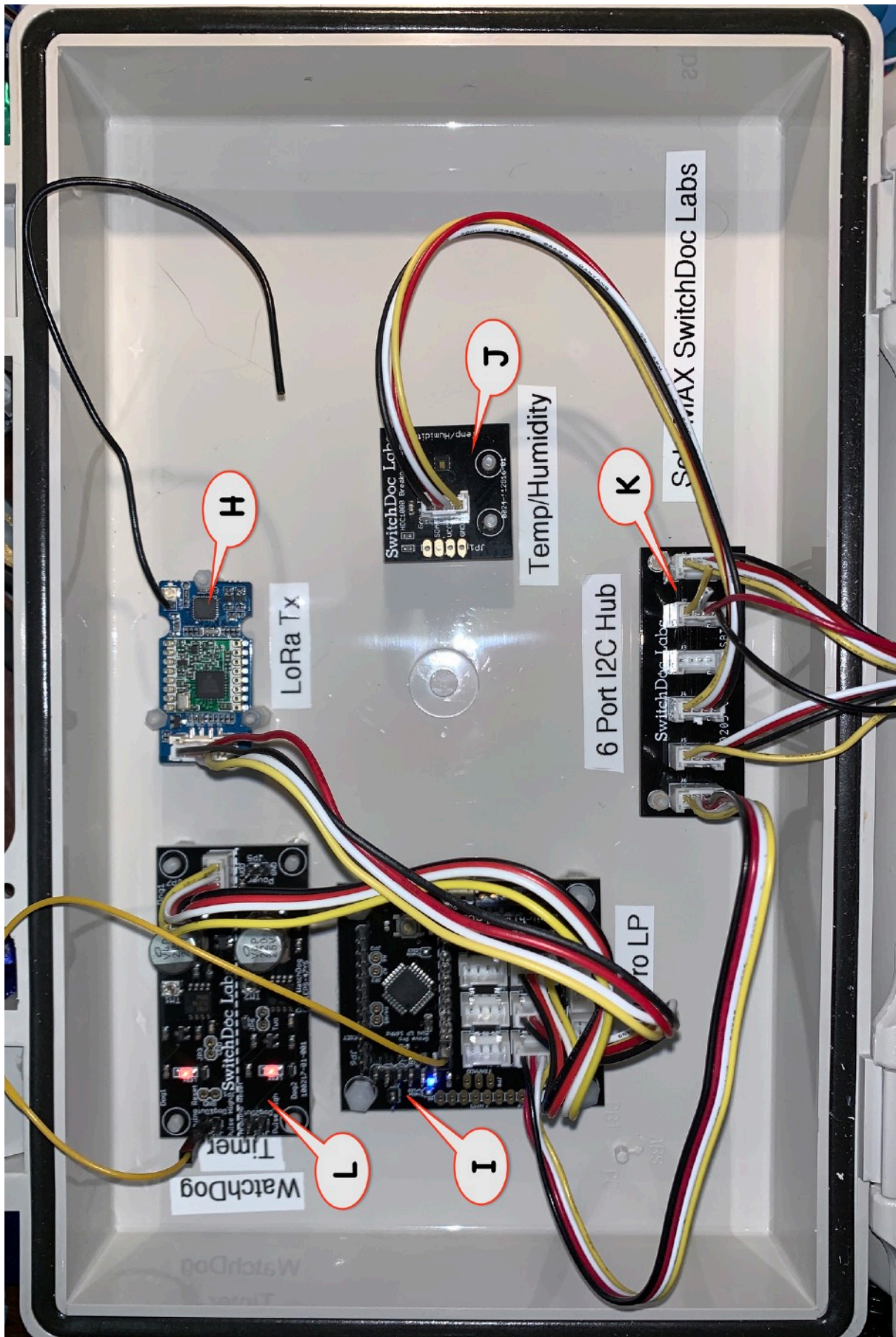
## Cables

- **20cm Grove Cables - 7 Cables**
- **Grove Connector to Female Pin Headers - 1 Cable**
- **Single Wire Female to Female Jumper - 2 Wires (one not used)**









## Step by Step Assembly

**Step 1)** Drill two 2/3" holes in the upper left side of the lower part of the Bud Box. (See Part A and Part B location on pictures above)

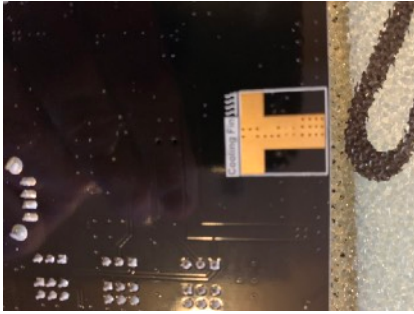


**Step 2)** Drill 3 1" holes in the front of the lower part of the box. Separate the holes by at least 2 inches, center to center. (Two vent holes and one hole for the Part F- USB Weatherproof Plug.

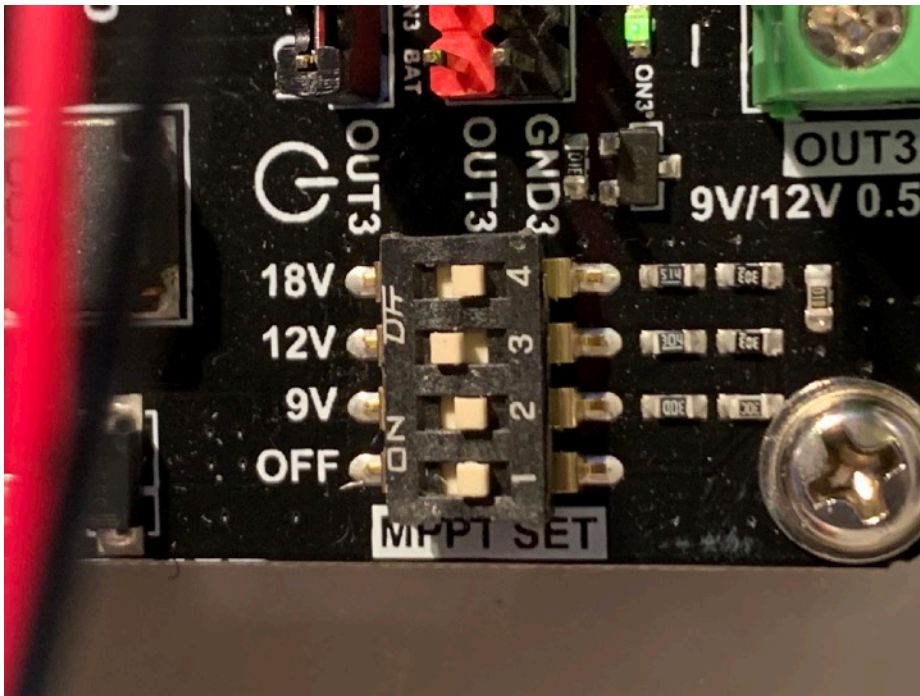


**Step 3)** Insert Part F - USB Weatherproof Plug into the BUD Box, with the cap on the outside in the rightmost 1" hole. Screw down.

**Step 4)** Place the heat sink on the back of Part D, the Solar Controller.



**Step 5)** Set the DIP Switch on the Solar Charger(Part D) to 12V MPPT for the most efficient charging.



**Step 6)** Attach Nylon Headers (with screws or bolts) to all the boards (Parts C, D, H, I, J, K and L). Note: Part E (USB PowerCentral) will hang off the Solar Control by itself without supports. Feel free to add them if you wish! Note that the Solar Charger has screws and headers included in the package with the heatsink.

**Step 7)** Glue an additional nylon spacer on Part J (HDC1080 Temp/Humidity Sensor) and two on Part C (INA3221) the same height of the spacers from Step 5) to provide a stable base.

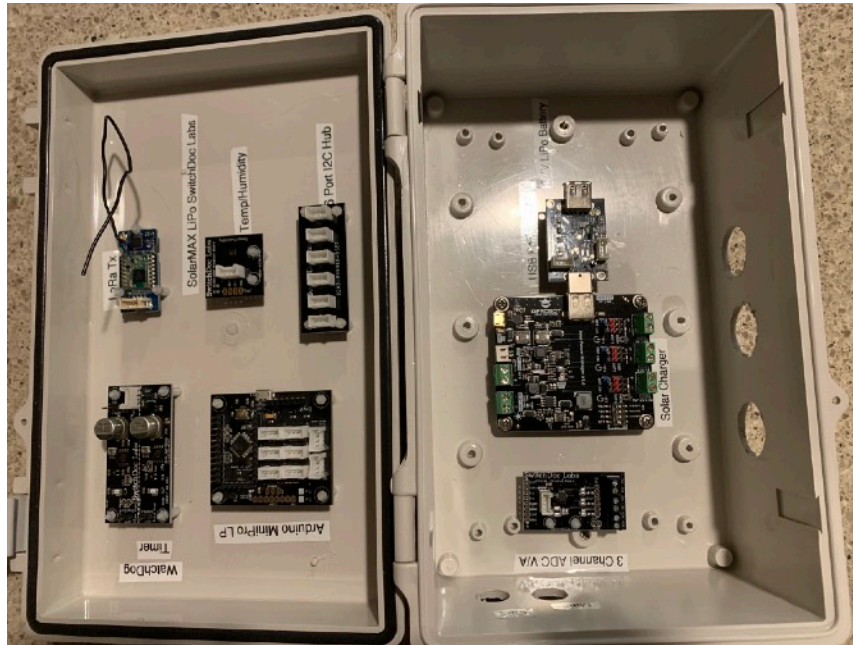
**Step 8)** Removed

**Step 9)** Removed  
Page 10



**Step 10)** Using the super glue, attach all the boards to the locations shown in the two two part identification pictures above. Let dry. The plug in the USB PowerCentral board (Part E) into the Solar Charger Board (Part D).

**Step 11)** Label all parts - optional - but you will be happy you did.



**Step 12)** Using some Silicon Caulking, attach some screen over the center and left 1” hole to keep the bugs out of the box.

Now we move on to the wiring of the SolarMAX LiPo.

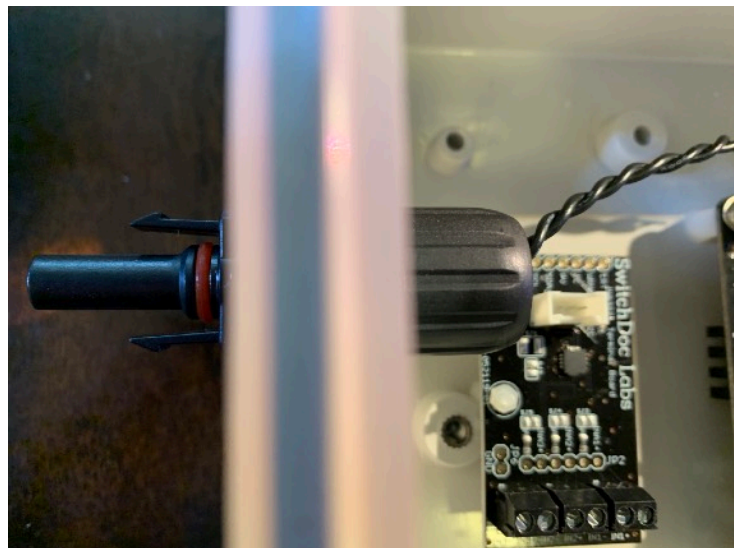
# Wiring the SolarMax LiPo

As you wire this unit, remember you are dealing with lots of current and voltages. Triple check your wiring! Wiring things backwards or incorrectly can result in destruction of the electronics and possible over heating. BE CAREFUL!

## Solar Panel Wiring

**Step 1)** Take the male Part A - MC4 Minus Male (and Pin) and two 12cm lengths of black wire. Strip the ends, twist them together (here's a fast way of doing that - <https://www.switchdoc.com/2015/07/handy-tip-building-braided-cables-for-projects/> ).

Now insert one end of the braided wire (with then ends stripped of the insulation) into the pin (the male pin has the larger hole in the end) and crimp it down. We recommend you buy the crimper tool for MC4 plugs as mentioned above. Slide the Male MC5 Plug into the Minus Hole in the box and put on the other parts and screw it down.





**Step 2)** Place the other end of the black wire into the “-“ terminal of the Solar Charger SOLAR IN terminal.



**Step 3)** Using red 14cm long wires, braid them together, strip, crimp then and assemble the female MC4 and install it in the Plus Hole in the box. Run the end of this wire to the 3 Channel ADC (Part C) and secure them in the IN2+ screw terminal.

**Step 4)** Using Red 14cm long wires, braid them together and strip the ends. Run this wire from the 3 Channel ADC (Part C) IN2- screw terminal to the “+” terminal on the Solar Charger (Part D) in the SOLAR IN back.

This completes the Solar Panel Wiring. CHECK YOUR WORK! You will destroy the electronics if you mess up with this wiring.

Now we move on the Grove Wiring table.

## Grove Wiring Table



Note - again, make sure you are connecting things to the right places. It all matters. Optional: We find the plastic clips on the Grove cable plugs annoying and often cut them off with wire clippers.

Select the proper grove cables and connect them as shown in the table.

SolarMAX LiPo Grove Wiring Table				
Step #	Cable Type	From	To	Notes
Step W1	20cm Grove	Grove Connector on INA3221 Part C	Any Port on the 6 Port I2C Hub (Part K)	
Step W2	20cm Grove	Grove Connector Marked I2C on USB PowerCentral (Part E)	Any Port on the 6 Port I2C Hub (Part K)	
Step W3	20cm Grove	Grove Connector on HDC1080 Temp/ Humidity (Part J)	Any Port on the 6 Port I2C Hub (Part K)	
Step W4	20cm Grove	Grove Connector Marked Grove I2C on Mini Pro LP (Part I)	Any Port on the 6 Port I2C Hub (Part K)	

## SolarMAX LiPo Grove Wiring Table

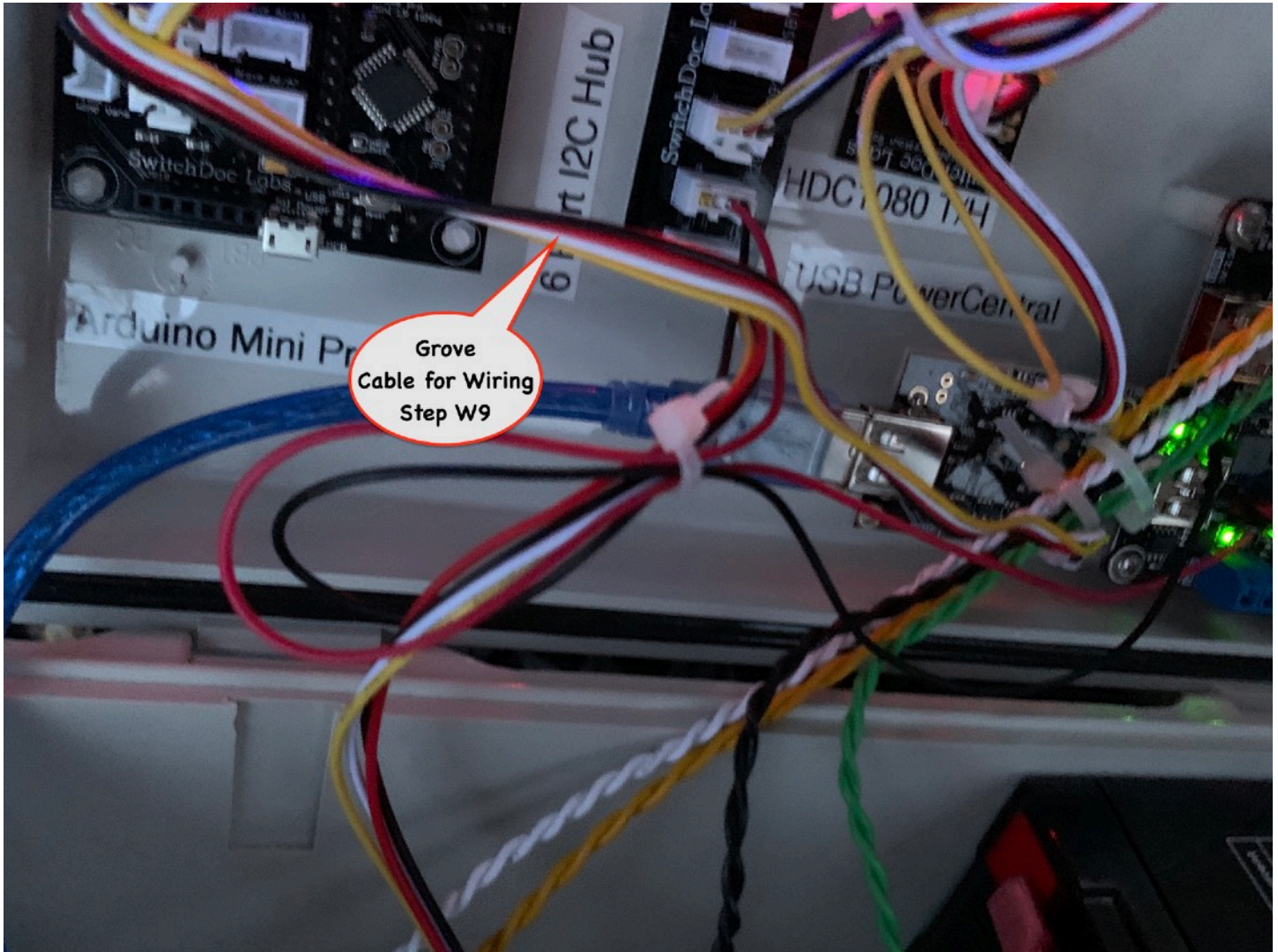
Step #	Cable Type	From	To	Notes
Step W5	20cm Grove	Grove Connector Marked D6/D7 on Mini Pro LP (Part I)	Grove Connector on LoRa TX (Part H)	
Step W6	20cm Grove	Grove Connector Marked D8/D9 on Mini Pro LP (Part I)	Grove Connector on WatchDog Timer (Part L)	
Step W7	20cm Grove With Female Headers	Any Port on the 6 Port I2C Hub (Part K)	Red Wire to OUT1 Pin (red header) - Black Wire to GND1 (black header - See picture below) on Solar Charger (Part D)	Clip the Yellow and White wires near the Grove Plug
Step W8	20cm Grove With Female Headers			Clip the Yellow and White wires near the Grove Plug

## SolarMAX LiPo Grove Wiring Table

Step #	Cable Type	From	To	Notes
Step W9	20cm Grove	Grove Connector Marked D8/D9 on Mini Pro LP (Part I)	USB PowerCentral Control/ Enable Grove Connector	



The above picture shows the results of Step W7 from above. **Don't get this wrong! Check it again!**



This completes the Grove Wiring for SolarMAX LiPo. Next is the jumper wiring.

### Jumper Wiring

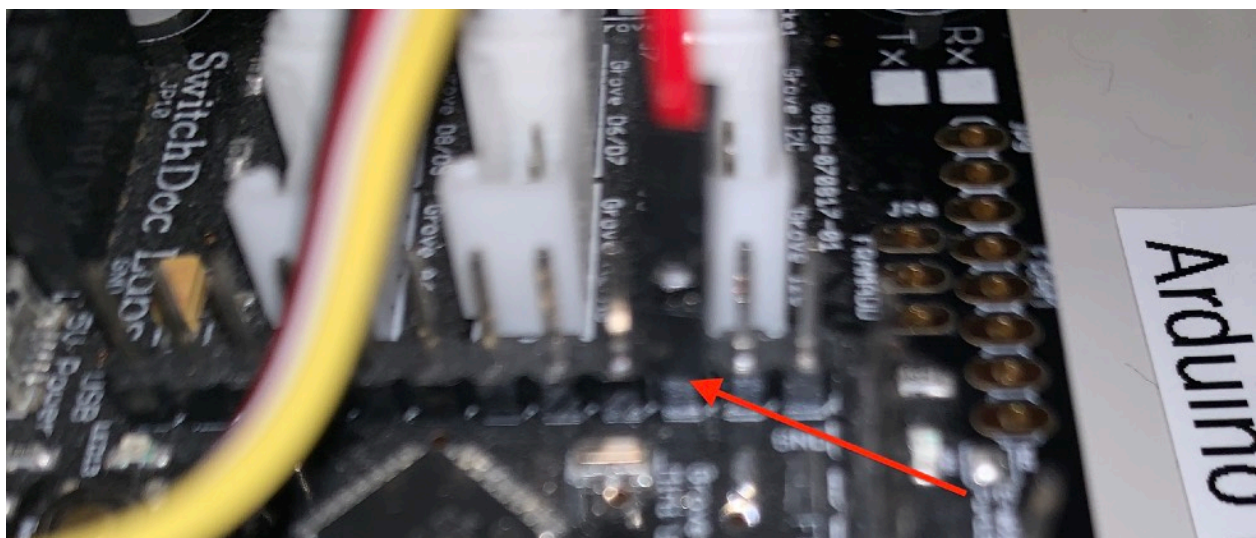
**Step 1) REMOVED**



**Step 2)** Take a Female to Female single wire jumper and connect it to the Arduino Reset on plug JP4 on the WatchDog Timer board (see picture).



**Step 3)** Then connect the other end of the wire in Step 2) it to the 3rd to the left most pin on the second row of the male pins on the Mini Pro LP Arduino board (Part I). See the picture below to get it right! This is the wire that is connected to the WatchDog timer board. If the WatchDog timer is not patted by the Arduino periodically, then the WatchDog reboots the Arduino Mini Pro LP. This makes sure the computer doesn't get lost and powers up correctly regardless of the funky way the power comes on from the solar panels. :)



If your jumper wires are loose, then put a drop of super glue at the place where the jumper meets the header. This will secure them.

This finishes the Jumper Wiring. Now on to the USB wiring.

## USB Cable Wiring

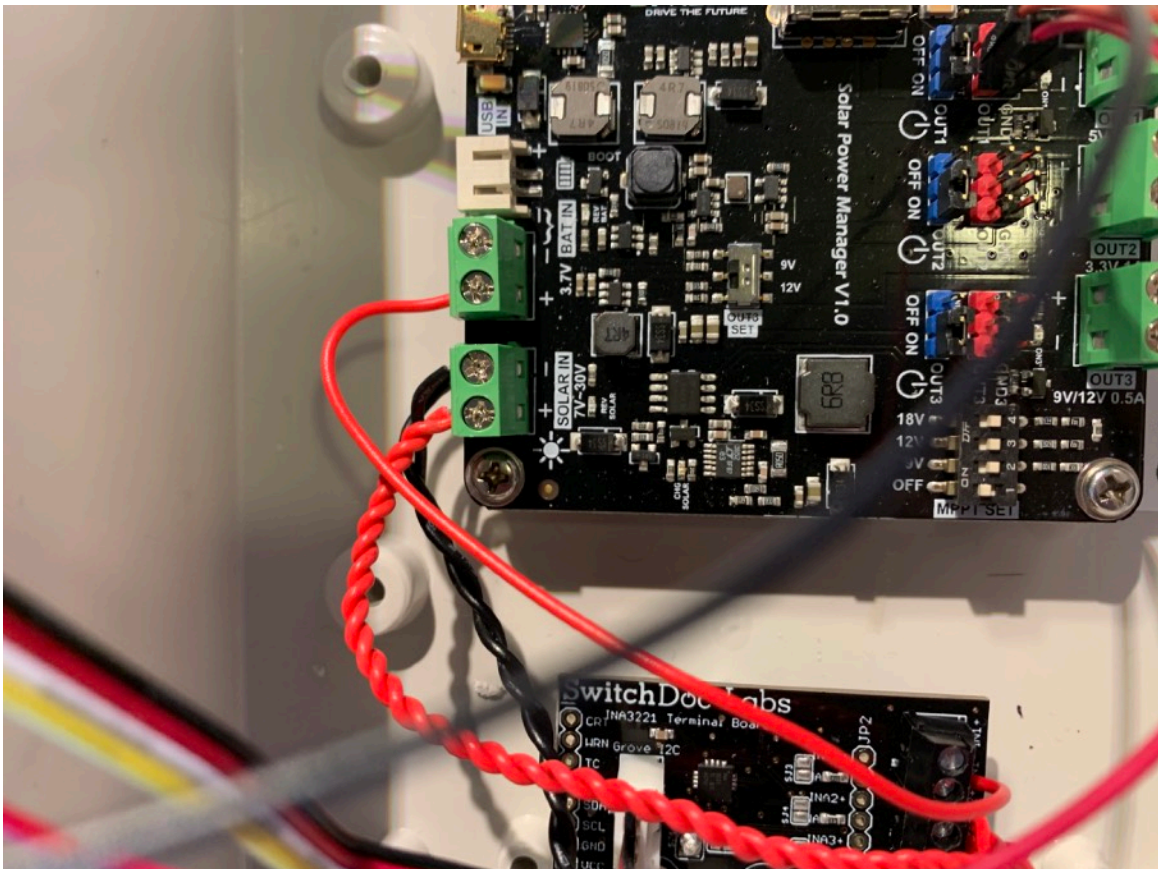
**Step 1)** Take your short Type A to Type A USB Cable (Part G) and plug one end into the USB connector on USB PowerCentral (Part E) to the USB Connection on the USB Weatherproof Plug (Part F).

This finishes the USB Wiring. Now on to the Battery wiring.

## LiPo Battery Wiring

This is the last of our wiring for SolarMax. Be careful as you are using a live, probably charged LiPo battery. Pay close attention. Especially when soldering. **Don't short the wires!**

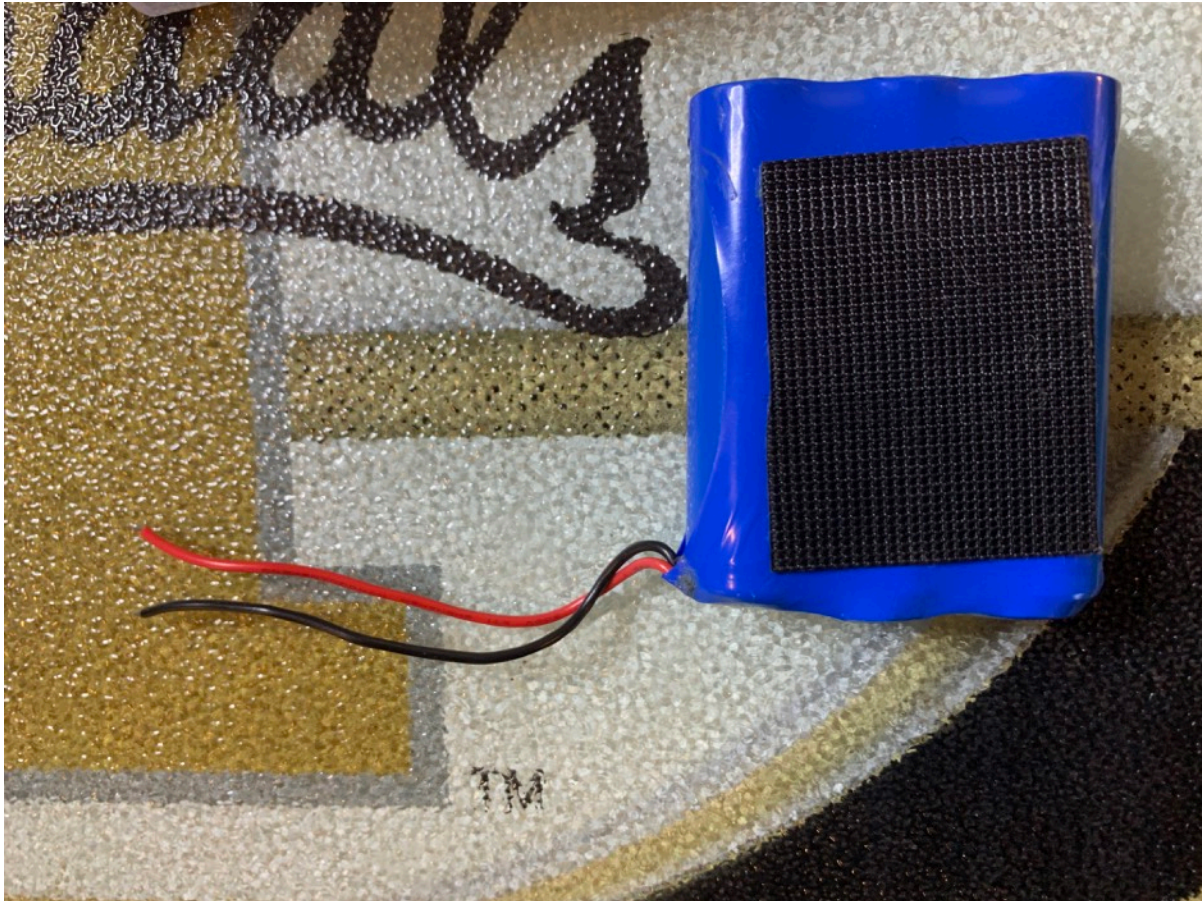
**Step 1)** Cut a 13cm Red wire and strip both ends. Connect one end to IN1- screw terminal and the other end to the "+ Plus terminal on the 3.7V BAT IN plug on the Solar Charger (Part D). **BE CAREFUL TO DO THIS CORRECTLY. CHECK IT AGAIN.**





**Step 2)** Cut a 26cm Red wire and a 16cm Black wire and braid them together. Yes, red one is longer than the black wire. Strip the ends.

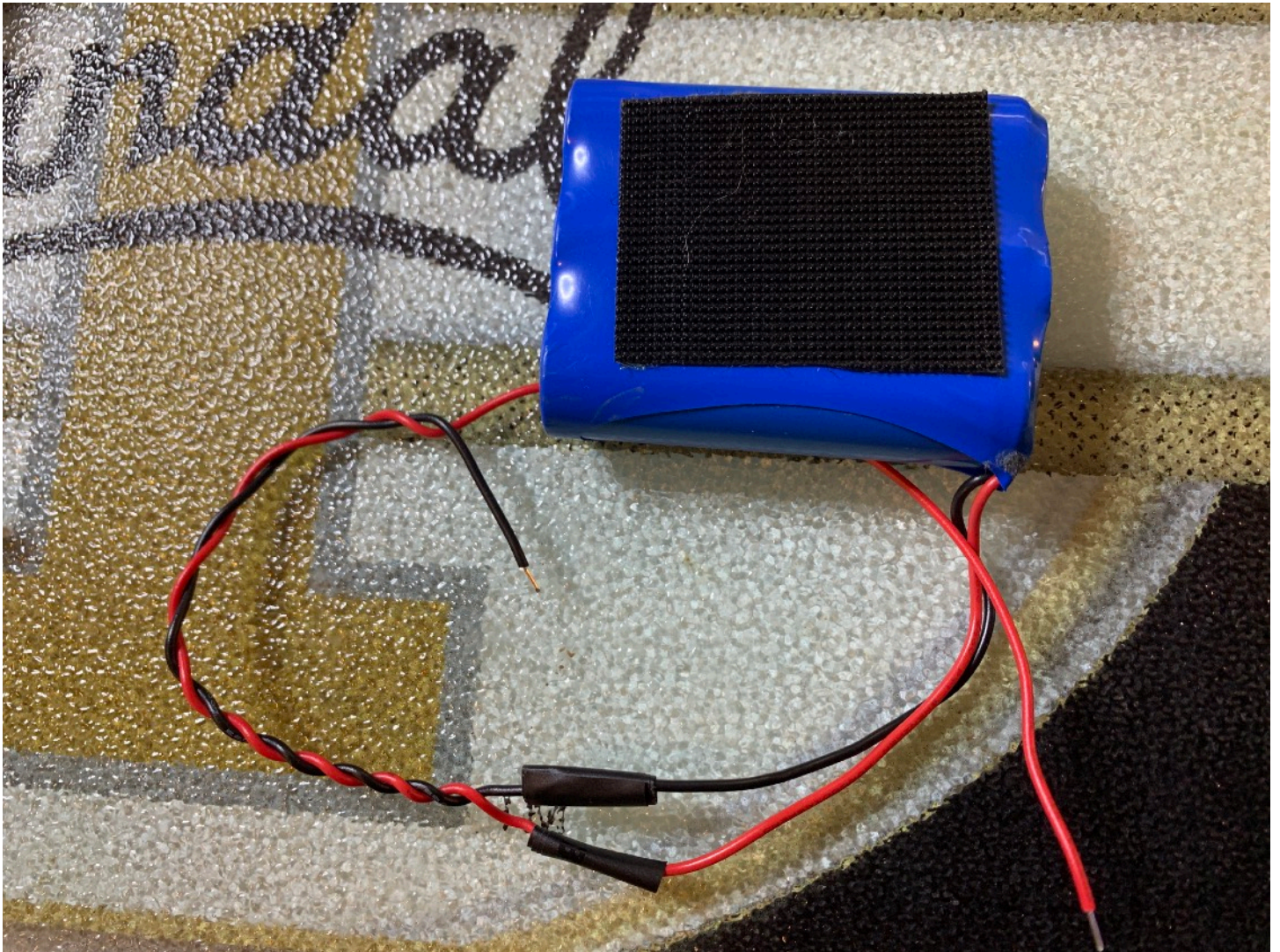
**Step 3)** Take your LiPo battery and cut the plug off of the cable. **CUT EACH LINE SEPARATELY! Do not short them together. This is a live battery and is most likely charged!** The battery we are using is the Adafruit 6600mAh 3.7V LiPo battery (<https://www.adafruit.com/product/353> ). Note we have put velcro on the back to mount the battery to the side of the box.



**Step 4) WARNING SOLDERING STEP** - Solder the plus (likely red) wire on the battery to the 26cm Red wire on the cable you built in Step 2). Insulate this connection with electrical tape.

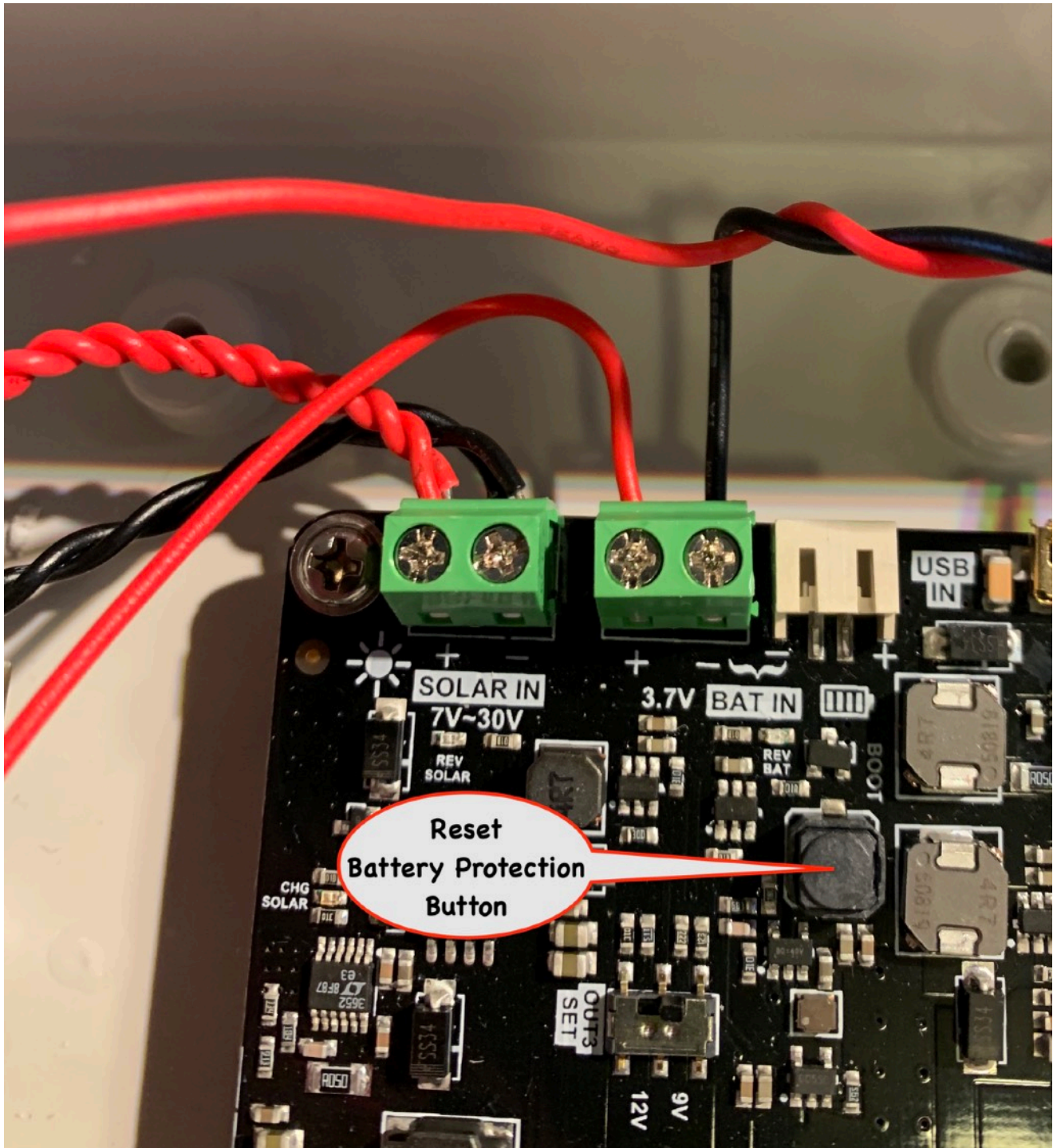


**Step 5) WARNING SOLDERING STEP** - Solder the ground (likely black) wire on the battery to the 16cm Black wire on the cable you built in Step 2). Insulate this connection with electrical tape.





**Step 6) FINAL BATTERY INSTALLATION! BE CAREFUL.** Don't short the wires or touch them to other hardware in the box. Take your battery assembly and velcro or otherwise secure it to the box. Take the black wire (Ground) and connect it to the "-" screw terminal on 3.7V BAT IN on the Solar Charger board (Part D)



**Step 7) THIS IS THE FINAL WIRING STEP - THIS WILL TURN YOUR SYSTEM ON!** Before doing this step, go back and check all of your wiring to this point. Take the 26cm red wire (from the wiring assembly connected to the battery that you built in Step 2) and connect it to the IN1+ screw terminal on the INA3221 3 Channel ADC (Part C). If your battery is charged, then you should see lights on many of the boards. If your battery is not charged, then you can plug in your solar panel and charge the battery that way, or connected a micro USB 5V Power supply to the USB IN plug on the Solar Charger board (Part D).

**If you see no lights, then you need to reset the battery protection circuitry (you may have to do this every time you disconnect or reconnect the battery). Push the button as shown in the diagram above to turn on your system. This should only happen if you remove or replace the battery.**

Finally

Clean up your wiring by using some wire ties to make it neat!

## Testing Your SolarMAX LiPo System

If you are using a SkyWeather system, SkyWeather comes with support for SolarMAX. If you don't have a SkyWeather system, jump down to "Testing your SolarMAX with a Raspberry Pi". If you see the yellow light on the Mini Pro LP board (Part D) flicker about every 30 seconds then you are transmitting data. If you want to see what you are transmitting, hook up an FTDI cable (<https://shop.switchdoc.com/products/ftdi-cable-5v-3-3v-with-usb-cable> or <https://www.adafruit.com/product/70>) and look at the serial panel (baud = 115200) in the Arduino IDE and you will see lots of data about what the SolarMAX system is doing and reporting.

In either of these two testing methods, the first thing to do is to power down your Raspberry Pi and plug the second LoRa Radio (Part H) into the Serial port on your Pi2Grover board (<https://shop.switchdoc.com/products/pi2grover-raspberry-pi-to-grove-connector-interface-board>).

### Testing With SkyWeather

Power down your system. Then plug in the LoRa Radio (Part H) into the Serial Grove connector on the Raspberry Pi Pi2Grover board.

Next, login into your Raspberry Pi in the SkyWeather kit and "cd SDL\_Pi\_SkyWeather"

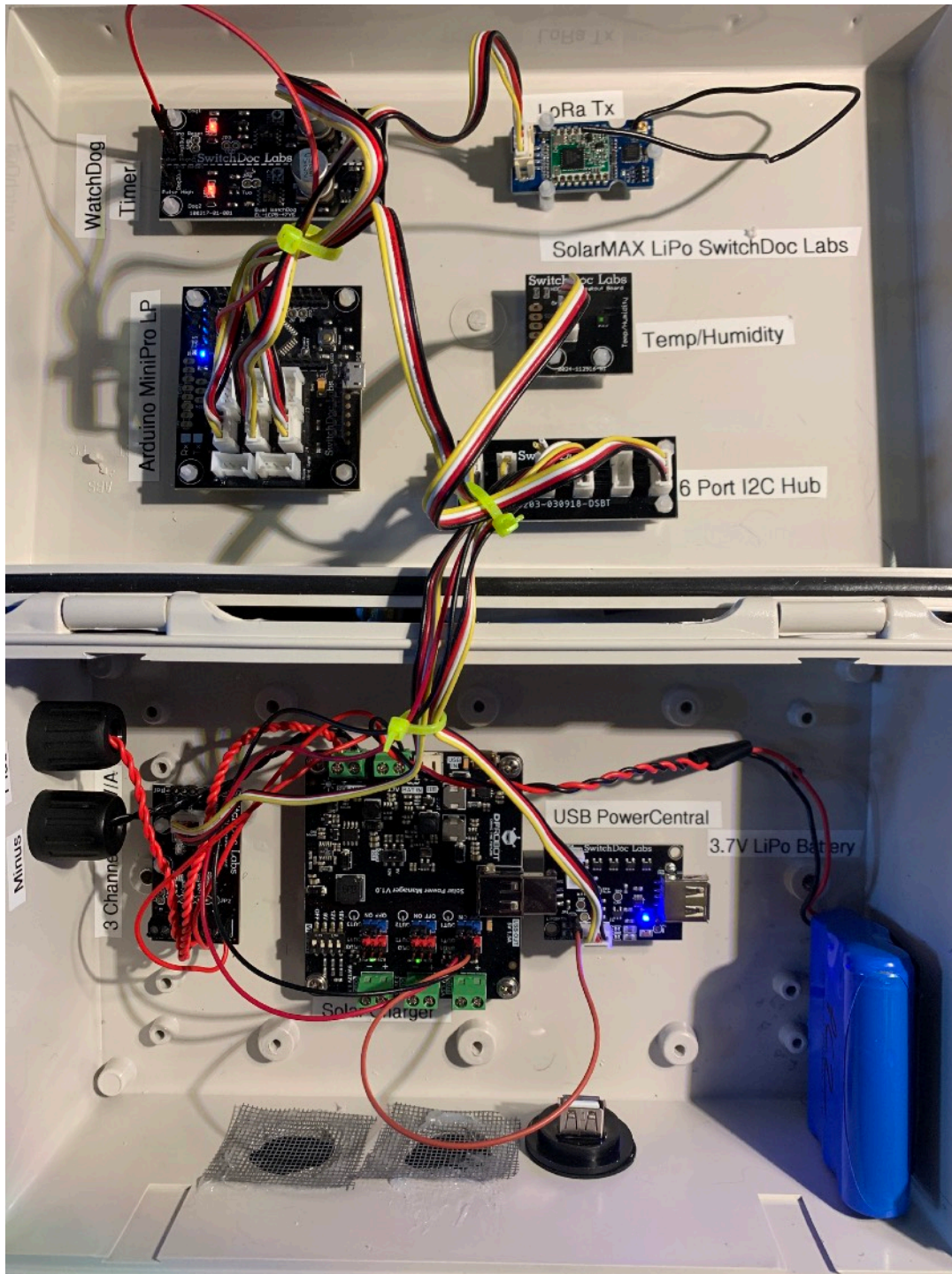
Note: You can't be running SkyWeather in the background when you are running this test. You must kill the process by doing something similar to this (your process number will be different):

```
pi@switchdoclabs:~/SDL_Pi_SkyWeather $ ps xaf | grep python
 236 ?        Ss      24:52 /usr/bin/python -O /usr/share/wicd/daemon/wicd-daemon.py --no-daemon --
keep-connection
 502 ?        S       13:29  \_ /usr/bin/python -O /usr/share/wicd/daemon/monitor.py
```

Page 24

Version 1.3 November 2019





```

22940 pts/0    S+      0:00  |          \_ grep --color=auto python
22889 pts/1    S+      0:00  |          \_ sudo python SkyWeather.py
22894 pts/1    Sl+     0:18  |          \_ python SkyWeather.py
pi@switchdoclabs:~/SDL_Pi_SkyWeather $

```

Then you have to kill the process:

```
sudo kill -9 22894
```

Then you can check to see the process has been killed.

```
pi@switchdoclabs:~/SDL_Pi_SkyWeather $ ps xaf | grep python
236 ?      Ss      24:53  /usr/bin/python -O /usr/share/wicd/daemon/wicd-daemon.py --no-daemon --
keep-connection
502 ?      S       13:30  \_ /usr/bin/python -O /usr/share/wicd/daemon/monitor.py
23014 pts/0   S+      0:00   |          \_ grep --color=auto python
pi@switchdoclabs:~/SDL_Pi_SkyWeather $
```

Now type the following command on your command line:

```
sudo python testWXLink.py
```

After a while you will see something like this and then your SolarMax is working!

```
Good CRC Recived
(protocol_ID = ', 8)
(protocol_software_version = ', 2)
protocol 8 - SolarMAX received
SMOTFloat=40cae041
ITemperature from SolarMAX temperature: 28.1C
IHumidity from SolarMAX humidity: 40.3%
SolarMax batteryVoltage = 4.10
SolarMax batteryCurrent = 17.20
SolarMax loadVoltage = 5.00
SolarMax loadCurrent = 150.10
SolarMax solarPanelVoltage = 11.90
SolarMax solarPanelCurrent = 108.80
SolarMax auxA = 0.00
SolarMax Message ID 5845
Tick! The time is: 2019-08-28 17:26:30.070106
Starting readWXLink
Tick! The time is: 2019-08-28 17:26:35.084211
after WXLink waitRX
```

## Testing with a Raspberry Pi (without SkyWeather)

To test on a Raspberry Pi (without SkyWeather) you need to hook up the LoRa Radio to the serial port on the Raspberry Pi. This can be done most easily by using a Pi2Grover and plugging the Grove cable into the Grove Serial connector on the device. Otherwise, you will need to wire up the device to 3V, Ground and then connect Rx (GPIO 14) and Tx (GPIO 15). Easier to use use a Pi2Grover (<https://shop.switchdoc.com/products/pi2grover-raspberry-pi-to-grove-connector-interface-board>) IMHO.

Step 1) Download the SolarMAX python library:

```
git clone https://github.com/switchdoclabs/SDL\_Pi\_SolarMAX
```

Step 2) run the program testWXLink.py

After a bit (30 seconds or so) you will see something like the following:

```
pi@switchdoclabs:~/SDL_Pi_SolarMAX $ sudo python testWXLink.py
```

Page 26

Version 1.3 November 2019

```

('HW-Version: ', 18)
Starting readWXLink
-----
block1= [171, 102, 82, 159, 21, 16, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 191, 159, 159, 64,
64, 253, 218, 65, 192, 251, 29]
block2= [66, 211, 77, 130, 64, 204, 204, 40, 67, 205, 204, 77, 67, 201, 118, 62, 65, 204, 204, 156,
66, 0, 0, 0, 0, 114, 23, 0, 0, 238, 26]
-----
block 1
ab66529f151000000000000000000000000000000000000000000000000000bf9f9f4040fdda41c0fb1d
block 2
42d34d8240cccc2843cdcc4d43c9763e41cccc9c420000000072170000eela
-----
Starting readWXLink
('block1 length=', 32)
('block2 length=', 31)
ReversedreceivedCRC= eela
length of stb1+sb2= 59
ab66529f151000000000000000000000000000000000000000000000000000bf9f9f4040fdda41c0fb1d
42d34d8240cccc2843cdcc4d43c9763e41cccc9c42000000007217
calculatedCRC = eela
Good CRC Received
('protocol_ID = ', 8)
('protocol_software_version = ', 2)
protocol 8 - SolarMAX received
SMOTFloat=40fdda41
ITemperature from SolarMAX temperature: 27.4C
IHumidity from SolarMAX humidity: 39.5%
SolarMax batteryVoltage = 4.07
SolarMax batteryCurrent = 168.80
SolarMax loadVoltage = 4.99
SolarMax loadCurrent = 205.80
SolarMax solarPanelVoltage = 11.90
SolarMax solarPanelCurrent = 78.40
SolarMax auxA = 0.00
SolarMax Message ID 6002
Tick! The time is: 2019-08-28 18:20:44.194668
Starting readWXLink
Tick! The time is: 2019-08-28 18:20:49.207370
Starting readWXLink
Tick! The time is: 2019-08-28 18:20:54.215075
Starting readWXLink
Tick! The time is: 2019-08-28 18:20:59.220710

```

It's working!

## Installing Your SolarMAX LiPo System

Plug your solar panel into the appropriate MC4 plugs on the outside of your box and your SolarMAX system is complete.

Take a TypeA USB to TypeA USB Cable and plug in your computer system. SolarMAX provides 5V through the USB cable. If you need a USB Micro, or USB C cable you will need to get the appropriate converters to go from USB Type A to your device.

SkyWeather comes with a Type A USB input so you just need a Male to Male Type A USB extender cord.

Enjoy getting all this data about your solar system!

# The Science and Education Goals Behind SolarMax

Everything we build for the Maker market is designed for education and learning. Making is education. Making is learning. Building your own projects allows you to innovate around a framework and do wonderful things that of which we have never thought.

The educational goals for SOLarMAX are:

- Building a solar panel controller and charger system
- Using an Arduino and LoRa radio to gather and transmit data to a Raspberry Pi or Arduino
- Connecting up a radio to the Raspberry Pi
- Understand how your Solar Panel system is behaving by looking at the4 data.
- Understand your solar environment and what affects it
- Learn about the new technology called the Internet of Things

## Support

As with all SwitchDoc Labs products, technical support is given through the forums on [Forum.switchdoc.com](http://Forum.switchdoc.com). If you have issues that can be solved by our fabulous customer service department, please go to [www.switchdoc.com](http://www.switchdoc.com) and send your issues through our Contact page on the top menu.

## **Disclaimer**

SwitchDoc Labs, LLC takes no responsibility for any physical injuries and possession loss caused by those reasons which are not related to product quality, such as operating without following the operating manual and cautions, natural disasters or force majeure.

SwitchDoc Labs, LLC has compiled and published this manual which covers the latest product description and specification. The contents of this manual are subject to change without notice.