SwitchDoc Labs

WeatherSense
Solar Powered Air Quality Sensor
WeatherProofing Manual

February 2021
Version 1.1

Table of Contents

Cautions when building and using WeatherSense Sensors

1) Keep all water away from the electronics and power supply at all times!
2) This is not a toy! Keep it out of reach of young children and pets.
3) SwitchDoc Labs assumes no liabilities in the use of this kit, beyond the refund of the purchase price.

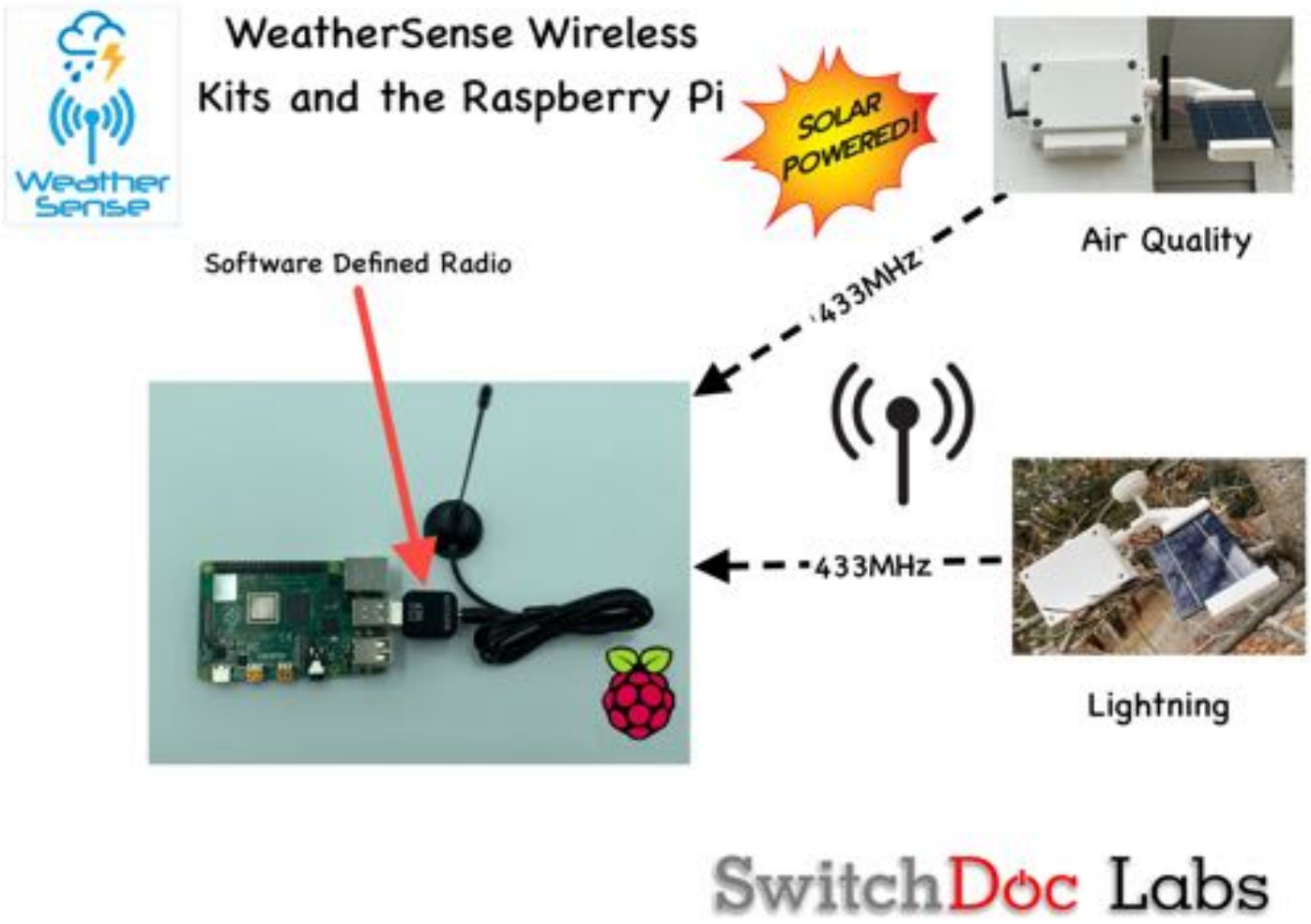
Errata

What is The WeatherSense Solar Powered Air Quality Sensor?

Easy to build. Easy to learn about the IOT (Internet Of Things) and the Raspberry Pi.

The **heart** of the new WeatherSense Sensors is the our new 433MHz MiniProPlus CPU board in working in conjunction with the HM3301 Laser Air Quality Sensor.

The **WeatherSense Air Quality** kit is so simple that even middle school children can build it with just a little adult help for configuration and installation.



Full Open Source Arduino IDE compatible C Software that you can Modify and the open source Python3 software for the Raspberry Pi.

We provide the Python3 software (for the Raspberry Pi) and C for the WeatherSense AQ. All open source with the kit. The Pure Python software can be modified to add new sensors, support new cloud software and connect up to your own projects and software.

Before You Build Your WeatherSense AQ

You should build and test your WeatherSense AQ system as BEFORE you put it in the optional 3D Printed case. The WeatherSense Air Quality Assembly and Test manual will tell you how to do that. Get it working first, then put it in the case. Believe us, it is always easier to debug the system before you close it up in the case! All manuals are available on the WeatherSense AQ Product page on shop.switchdoc.com.

Step by Step Assembly and Parts List

Cautions: Keep your static charge to a minimum during your assembly and operation. Touch metal before handling parts. Avoid shuffling your feet. Before starting assembly, layout all the parts above and familiarize yourself with the various parts.

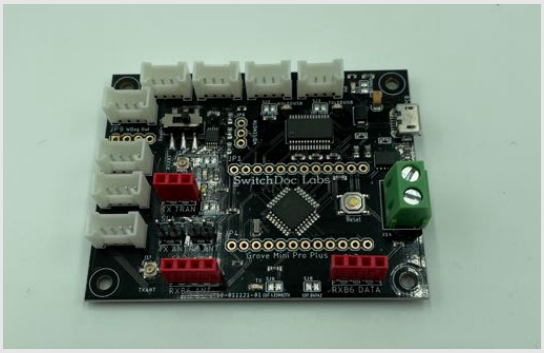
What are we doing here?

We are assembling and weatherproof the WeatherSense AQ System.

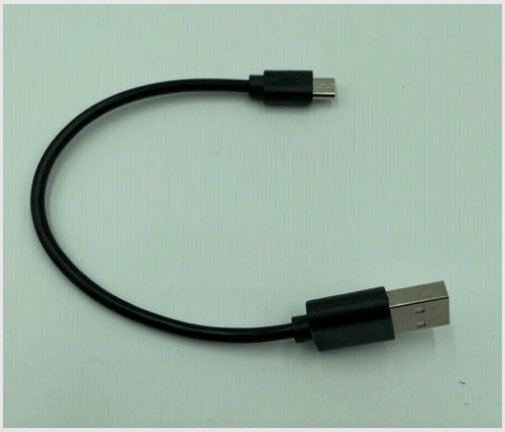
In this manual, we are going to assemble the WeatherSense AQ system and test all the functions.

Parts List

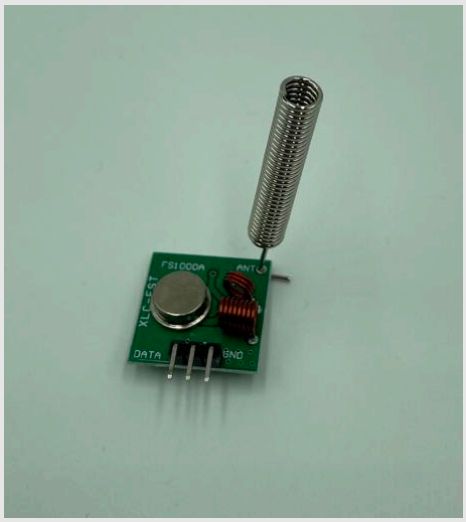
Part A
SwitchDoc Labs Grove Mini Pro Plus



Part B
Short USB A to Micro USB

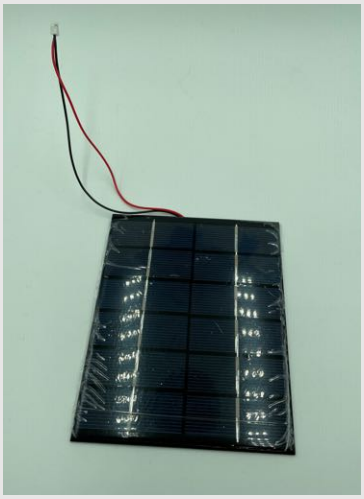


Part C
433MHz Transmitter with Antenna



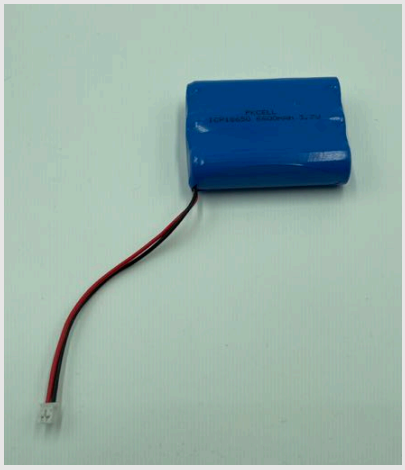
Part D
HM3301 Laser Quality Sensor

Part E
330mA 6V Solar Panel



Part F
SunAirPlus2 Solar Power Data Collector and Controller

Part G
3.7V LiPo Battery (Not included)



Part H
Two (2) 20cm Grove Cables

Part I
Box Bottom

Part J
Box Top

Part K
Air Quality Housing

Part L
Optional Power Box Plug

]]]]

Part M
Box Plug

Part N
Joiner

Part O
Bent Joiner

Part P
Saucer Lightning Housing Top

Part Q
Saucer Lightning Housing Bottom

Part R
Solar Bracket

Parts you need to buy separately from the kit

- 3.7V LiPo Battery
- Raspberry Pi
- Compatible SDR Software Defined Radio (For example: https://hpjhlytllzrwf4qn-24552113.shopifypreview.com/products/software-defined-radio-sdr-and-antenna)
- 16GB SD Card (unless you bought the SD Card from SwitchDoc Labs)
- Power Supply for the Raspberry Pi

What else do you need for Assembly and Weatherproofing?

- 1 – 510mm x 3.6mm screen spline (any hardware store)
- 6 – 6mm M3 screws (Amazon - https://amzn.to/2K200QC)
- 8 – 5mm M3 screws
- 4 – 8mm M3 screws
- 2 – 16mm M3 screws
- 2 – 12mm M3 Screws
- 8 – 5mm M3 Brass Threaded Inserts (Amazon - https://amzn.to/39Rf9iL)

(All this hardware is available as a small hardware package here: https://shop.switchdoc.com/products/weathersense-aq-lightning-hardware-parts-kit)

1 Package of Duct Seal (for covering holes and screws)
(Amazon - https://amzn.to/33SMkyE
Any Hardware Store)

How to select a LiPo Battery

The WeatherSense AQ requires 3.7V LiPo battery.

How large of a LiPo battery you need depends on how much sun you get and how often you have cloudy weather. Generally, we would recommend a 6600mAh battery such as https://www.adafruit.com/product/353. Adafruit has a great selection and you can find good ones on SparkFun.com too.

WARNING: if you get them off of Amazon, check the wiring. Most of them are wired backwards.
Here's a great website showing the problem and how to rewire the batteries if you wish:

https://docs.particle.io/tutorials/learn-more/batteries/

Step by Step Assembly

You will need to disassemble the unit that you assembled in the WeatherSense AQ Assembly and Test and follow the assembly instructions below.

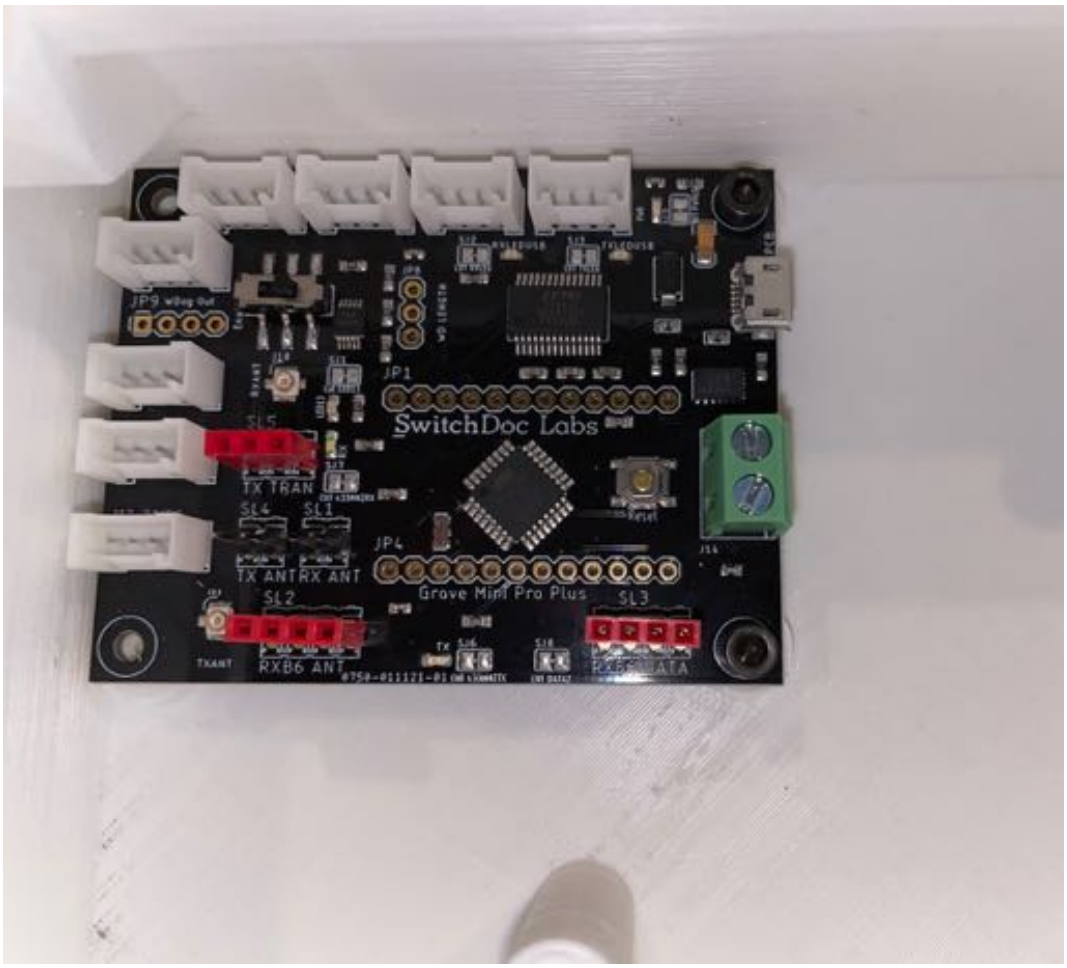
Step 1: Superglue 6 5mm brass inserts into the bottom box (Part I) as in the picture below. Use a screw to help you position and glue the inserts into the box. Apply glue to the outside of the inserts then push them into the hole and gently unscrew the screw. If they are too tight to push in, gently pound the screw (with the insert attached as below) into the bottom box. Super glue an additional 2 5mm brass inserts into the AQ Housing (Part K) Let dry at least 30 minutes.

Step 2: Using two 5mm screws, attach the Laser AQ sensor (Part D) to the bottom box (Part I) on the side. As with all screws in this project, tighten snugly but don't over tighten. You will pop the brass inserts out of the box and have to re-glue them!

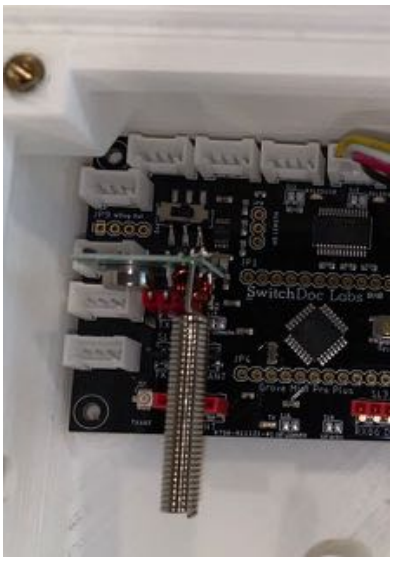
Step 3: Plug in the Grove 20cm cable (Part H) into the Laser AQ Sensor (Part D) routing it through the hole in the bottom box (Part I) and then plug in the optional power reduction jumper (see the AQ assembly manual) into the SET pin on the Laser AQ Sensor (Part D) and route the cable through the hole in the bottom box (Part I) as shown above.

Step 4: Take 2 12 mm screws and screw them in the holes shown from the inside of the bottom box (Part I) so they just extend through the box as to mount the AQ cover (Part K) onto the bottom box (Part I). Now attach the AQ Housing to the bottom box by holding the housing and screwing in the screws into the brass inserts. You don't have to screw them all the way in, just enough to hold the box.

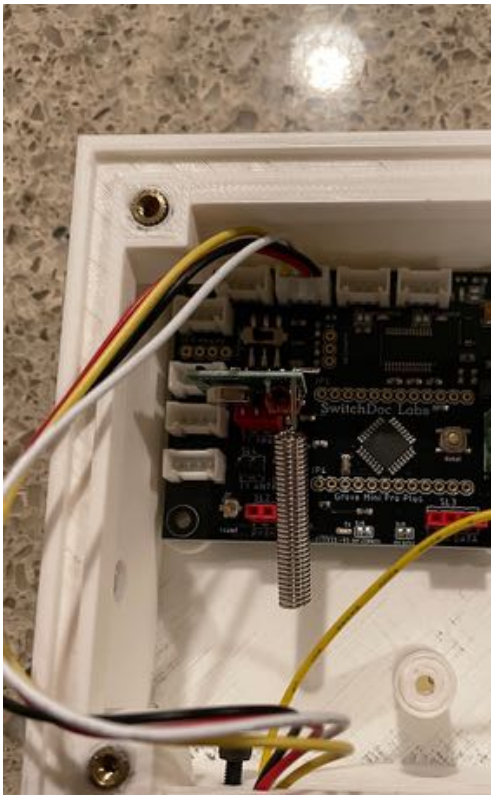
Step 6: Attach the MiniProPlus (Part A) to the bottom box (Part I) using two 5mm screws as shown below. As always, tighten, but don't over tighten the screws as you will strip the plastic threads.



Step 7) Take the 433MHz transmitter (Part C) and plug it into the TX header on the MiniProPlus board (Part A). Make sure you have bent the pins slightly (down-up-down) to ensure that you get a good connection.

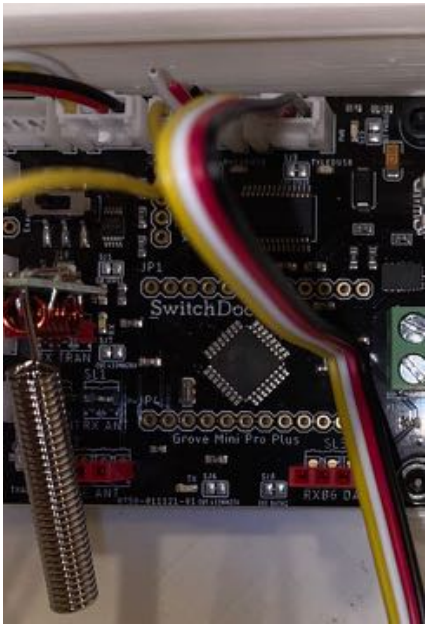


Step 8: Take the 20cm Grove Cable (Part H) that is connected to the Laser AQ Sensor (Part D) and plug it into the Grove connector marked J5-I2C on the MiniProPlus board (Part A).

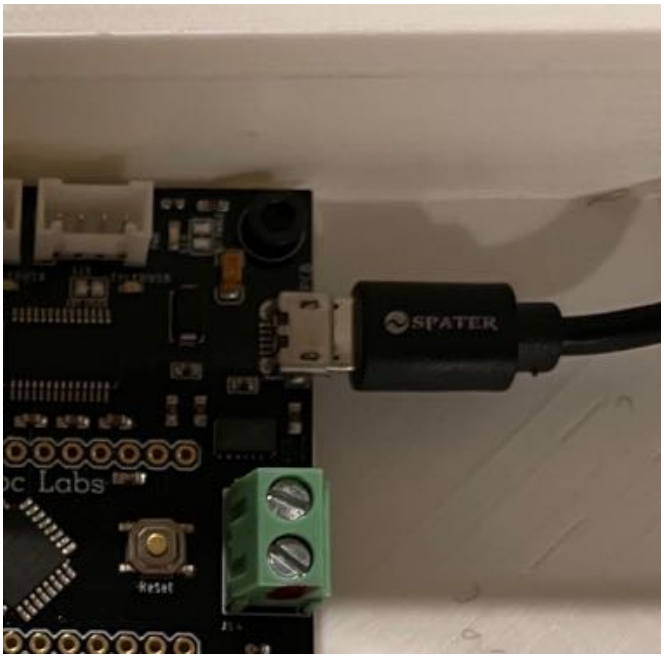


Step 9: Optional – If you did the optional AQ power reduction, plug the single wire Grove cable into the plug marked D2/D3 on the MiniProPlus board (Part A)

Step 10: Plug the remaining 20cm Grove cable (Part H) into the J7-I2C Grove connector on the MiniProPlus (Part A).

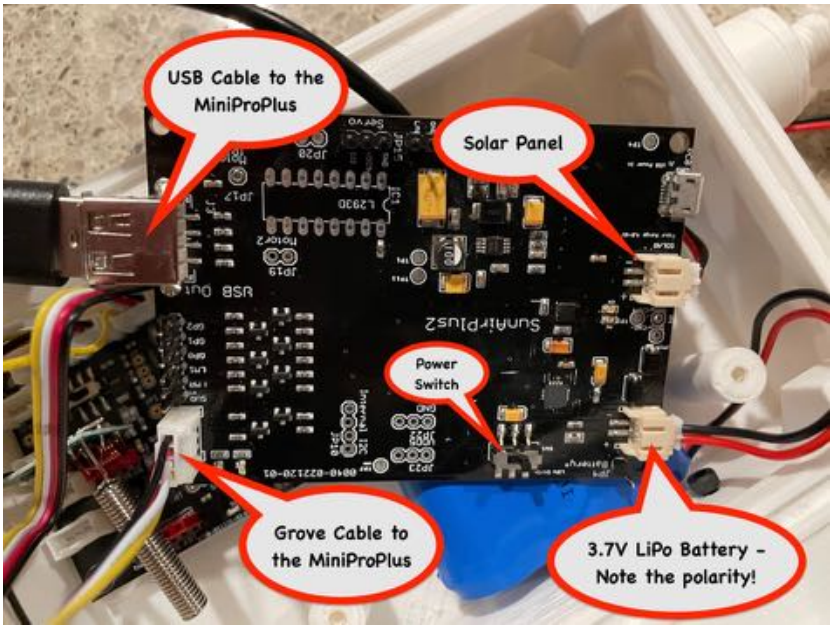


Step 11) Plug the USB micro to USB Type A cable (Part B) into the MiniProPlus (Part A).



Step 12: Insert your LiPo Battery (not included – example shown as Part G) into the space provided. You can use Velcro or double sided tape to secure the battery to the bottom box (Part I).

Step 13: Making sure the SunAirPlus2 switch is in the off position (slide towards the battery connector), plug in the battery (Part G) to the JST-2 connector marked Battery on the SunAirPlus2 Board (Part F) as shown below.

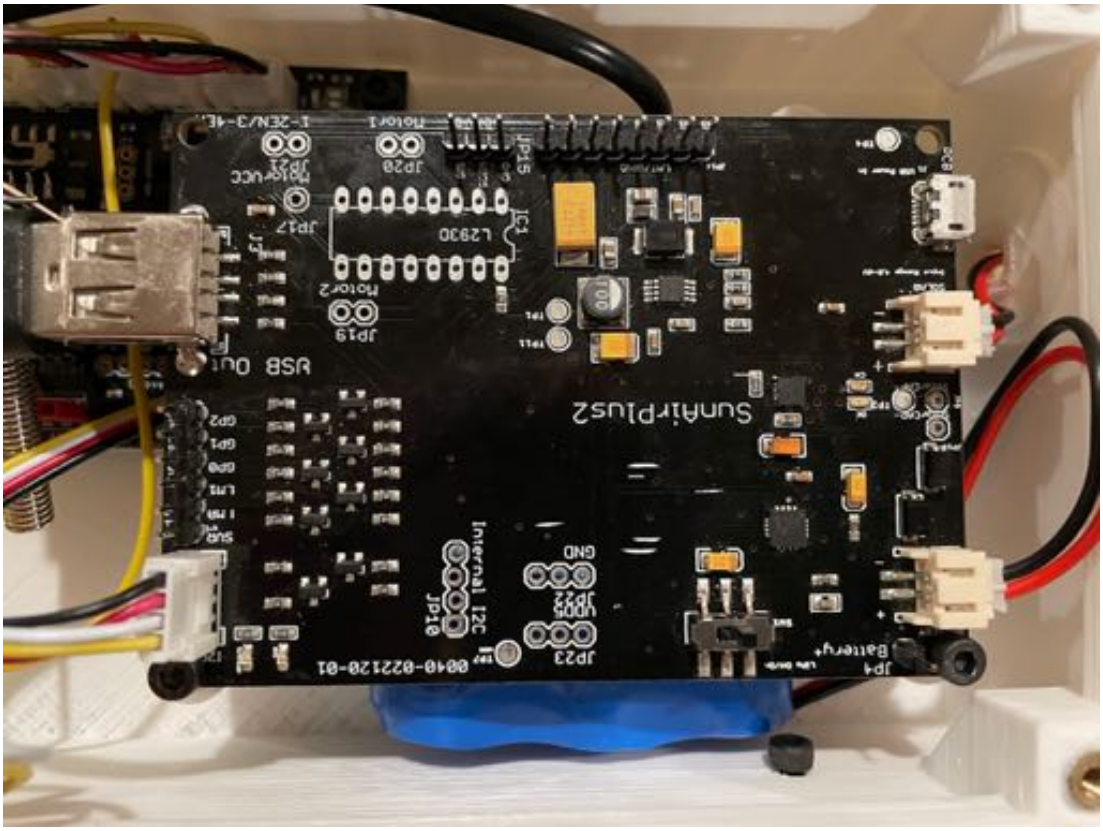


Step 14: Attach the Solar Panel (Part E) JST-2 plug to the JST-2 connector on the SunAirPlus2 (F) board as shown above.

Step 15: Attach the USB Cable (Part B) to SunAirPlus2 (Part F) as shown above.

Step 16: Plug in the 20cm Grove Cable connected to the MiniProPlus (Part A) (plugged into J7-I2C) into the SunAirPlus2 board Grove connector as shown above.

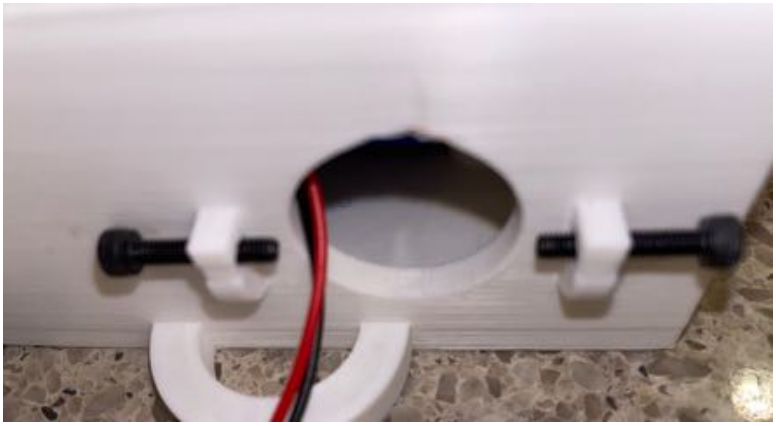
Step 17: Attach the SunAirPlus2 board (Part F) to the bottom box (Part I) using two 5mm screws as shown.



Step 18: Check to see that the Box Plug (Part M) fits in the right side hole of the bottom box (Part I). If it doesn't, file the Box Plug (Part M) down until it does fit. And it should fit pretty snugly.

Step 19: Screw the Joiner (Part N) into the Box Plug (Part M). Don't screw it all the way in. Just until it is snug.

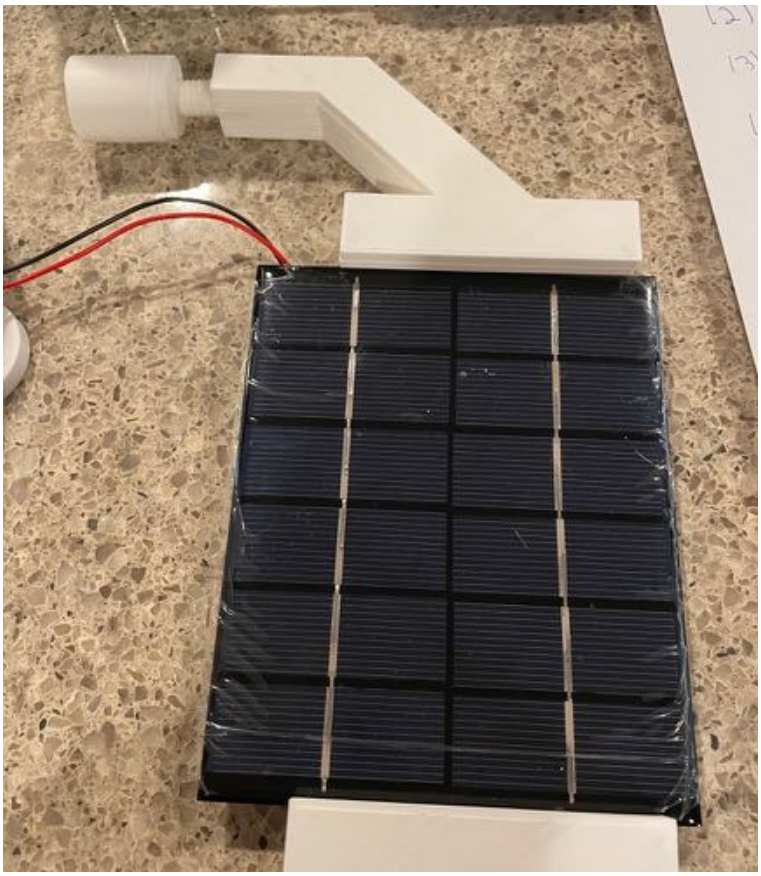
Step 20: Take the two 16mm screws and thread them through the lock blocks on the right side of the bottom box (Part I) as shown.



Step 21: Take the Solar Bracket (Part R) and screw in the Joiner (Part N) and Box Plug (Part M) assembly. Again, don't screw it all in, just until it's snug and oriented correctly as shown below. The wire channel on the Box Plug (Part M) should be pointed down while the panel should up be at 45 degrees. You can use a drop of glue if the threads don't hold.

Step 22: Remove the plastic from the front of the Solar Panel (Part E)

Step 23: Slide the Solar Panel (Part E) into the slots on the Solar Bracket (Part R) with the wires facing down. If it is too loose, secure with tape or glue. Your Solar Bracket Assembly is complete.



Step 24: Slide the complete Solar Bracket Assembly into the bottom box (Part I) hole on the left side, making sure all wires are in the slot and not being pinched by the assembly. Align the holes on both sides of the Box Plug (Part M) with the lock screws. Tighten the lock screws.

Initial Testing

This is a good time to do some testing before we do the final assembly.

If you have the SwitchDoc Labs SD Card, you can proceed to Step 4.

Step 1: Install the SDL modified version of rtl_433.

In a terminal window on your Pi at /home/pi type:

```
git clone https://github.com/switchdoclabs/rtl_433.git
```

Then compile it on the Raspberry Pi:

```
cd rtl_433/
mkdir build
cd build
cmake ..
make
make install
```

Step 2: Install the WeatherSense AQ Software using these commands:

```
cd
git clone https://github.com/switchdoclabs/SDL_Pi_WeatherSense.git
```

Step 3: Add needed python modules to your system (a list will be provided on forum.switchdoc.com in the near future). If you want to jump into it, run

```
sudo python3 WeatherSenseMonitor.py
```

And start adding in the missing libraries as they come up as missing imports, otherwise do at least the following:

Installing mariadb:
https://pimylifeup.com/raspberry-pi-mysql/

```
sudo apt-get install python3-dev libmysqlclient-dev
sudo pip3 install mysqlclient
```

Next:

```
sudo -u root -p < WeatherSenseWireless.sql
```

Step 4: Note the IP Address of your Raspberry Pi. Type in the following commands to get your IP address:

```
hostname -I
```

You will get something like this:

```
pi@SwitchDocLabs:~/SDL_Pi_WeatherSense AQ $ hostname -I
192.168.1.44
```

Step 5: Update WeatherSense to the latest version. Type the following commands into a terminal window.

```
cd
cd SDL_Pi_WeatherSense
git pull
```

You will see something like this:

```
pi@SwitchDocLabs:~/SDL_Pi_WeatherSense$ git pull
remote: Enumerating objects: 19, done.
remote: Counting objects: 100% (19/19), done.
remote: Compressing objects: 100% (2/2), done.
remote: Total 12 (delta 10), reused 12 (delta 10), pack-reused 0
Unpacking objects: 100% (12/12), done.
```

```
From https://github.com/switchdoclabs/SDL_Pi_WeatherSense AQ
   f2193a0..c98a45c  master     -> origin/master
Updating f2193a0..c98a45c
Fast-forward
 README.md               |  2 ++
 SkyCamera.py            |  2 +-
 WeatherSense AQ.py      |  2 +-
 pclogging.py            | 12 +++++++-----
 state.py                |  3 +++
 testWirelessSensors.py  | 18 ++++++++++----------
 6 files changed, 22 insertions(+), 17 deletions(-)
```

Or, if your software is up to date:

```
pi@SwitchDocLabs:~/SDL_Pi_WeatherSense$ git pull
Already up to date.
```

Step 6: First we will test the reception of the wireless weather sensors. Test your SDR and WeatherSense installation as follows. Note you must have completed the WeatherSenseAQ assembly.

```
cd /home/pi/SDL_Pi_WeatherSense

sudo python3 WeatherSenseMonitor.py
```

Turn on your WeatherSense AQ sensor by using the switch on the SunAirPlus2 board. You will then see something similar to this on your terminal window:

```
pi@SwitchDocLabs:~/SDL_Pi_WeatherSense $ sudo python3 WeatherSenseMonitor.py
Pending jobs:
    readSensors (trigger: date[2021-02-27 12:13:55 PST], pending)
-----------------

Scheduled Jobs
######
-----------------
Read Wireless Sensors
######
Jobstore default:
    No scheduled jobs
-----------------
starting 433MHz scanning
######
processing AQI Data
This is the raw data: {"time" : "2021-02-27 12:49:58", "model" : "SwitchDoc Labs AQI", "len" : 46,
"messageid" : 0, "deviceid" : 1, "protocolversion" : 1, "softwareversion" : 1,
"weathersenseprotocol" : 15, "PM1.0S" : 3, "PM2.5S" : 4, "PM10S" : 4, "PM1.0A" : 3, "PM2.5A" : 4,
"PM10A" : 4, "AQI" : 16, "loadvoltage" : 4.960, "batteryvoltage" : 4.160, "batterycurrent" :
154.000, "loadcurrent" : 77.100, "solarpanelvoltage" : 3.032, "solarpanelcurrent" : -0.000, "auxa"
: 3, "mic" : "CRC"}
```

What does the JSON from the WeatherSenseAQ Sensor mean?

The WeatherSenseMonitor.py python3 program reads in the 433MHz signals into the Raspberry Pi, decodes them and formats the results as a JSON packet that will be provided to the WeatherSenseMonitoring software for processing and storage in the database. More about the SDL_Pi_WeatherSense software in the WeatherSense Software Manual.

If you have other WeatherSense Sensors (such as SkyWeather2, WeatherRack2, F016TH Indoor sensors, etc), you will see them show up in the list too.

```
processing AQI Data
This is the raw data: {"time" : "2021-02-27 12:49:58", "model" : "SwitchDoc Labs AQI", "len" : 46,
"messageid" : 0, "deviceid" : 1, "protocolversion" : 1, "softwareversion" : 1,
"weathersenseprotocol" : 15, "PM1.0S" : 3, "PM2.5S" : 4, "PM10S" : 4, "PM1.0A" : 3, "PM2.5A" : 4,
"PM10A" : 4, "AQI" : 16, "loadvoltage" : 4.960, "batteryvoltage" : 4.160, "batterycurrent" :
154.000, "loadcurrent" : 77.100, "solarpanelvoltage" : 3.032, "solarpanelcurrent" : -0.000, "auxa"
: 3, "mic" : "CRC"}
```

The values and units of the are:

- timestamp: When the packet has been received
- model: SwitchDoc Labs AQI
- len: Number of bytes in the packet
- messageid: Reset to 0 on bootup
- deviceid: 1 – If you have more than one AQ sensor, you can change this ID by recompiling the software
- protocolversion: Current protocol of the AQ sensor
- softwareversion: This shows the current version of the software on the Mini Pro Plus
- weathersenseprotocol: 15 for WeatherSenseAQ
- PM1.0S – concentration of 1.0 micron particles ug/m***3 (Standard)
- PM2.5S– concentration of 2.5 micron particles ug/m***3 (Standard)
- PM1.0S – concentration of 10 micron particles ug/m***3 (Standard)
- PM1.0A – concentration of 1.0 micron particles ug/m***3 (Atmospheric)
- PM2.5A– concentration of 2.5 micron particles ug/m***3 (Atmospheric)
- PM1.0S – concentration of 10 micron particles ug/m***3 (Atmospheric)
- AQI – The Air Quality Index of the above data – EPA calculation

The solar data collected by the device is:

- loadvoltage: Voltage supplied to the computer (V)
- batteryvoltage: Voltage of the LiPo Battery (V)
- batterycurrent: Current being supplied by the battery (mA)
- loadcurrent: Current being supplied to the computer (mA)
- solarpanelvoltage: Voltage of the Solar Panel (V)
- solarpanelcurrent: Current being supplied by the Solar Pane (mA)

The AuxA variable contains state information about what sensors the WeatherSenseAQ has connected to and if the sensor is in low voltage mode.

Each bit of the lower four bits of the AuxA variable (0CAB) are coded as:

C = 1, Voltage below 2.9, HM3301 not turned on, 0 means normal operation
A = 1, SunAirPlus2 (Solar) Present, 0 not present
B = 1, HM3301 Present, 0 not present

You now have completed testing of your WeatherSenseAQ sensor. ‘

Final Assembly

Step 1: Before you do anything else, make sure you move the power switch on SunAirPlus2 to on (the LEDs should light up).

Step 2: Push a small screw driver through all four holes on the Box Top (Part J) to prime the screw holes.

Step 3: Take the 510mm Screen Spline and push it into the Box Top (Part J) channel. Start in the middle of a long side. This becomes the bottom of the Box Top (Part J).

Step 4: Screw down the Box Top (Part J) with the spline gap at the bottom. Start all four 8mm screws until they just start into the brass inserts on the bottom box (Part I) and then go around and tighten all the screws down (but not too tightly!). This process adjusts for any minor alignment issues with your 3D Printer.

Final WeatherProofing

We suggest you use Duct Seal to seal the box. It can easily be removed for access or changes and will stay pliable for a long time.

Step 1: Using the Duct Seal, make small blobs and cover all the screw holes on the top of the assembled.

Step 2: Using the Duct Seal, make a small blob and cover the unused antenna hole on the right side of the box bottom (Part I).

Step 3: Using the Duct Seal, seal the wire channel under the Box Plug on the Solar Bracket Assembly. You can also seal around the Box Plug as it goes into the Box.

Congratulations! Now go and enjoy all that data coming into your system. And check out the Advanced Programming manual.

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.