ThunderBoard Lightning Detector Extender Kit

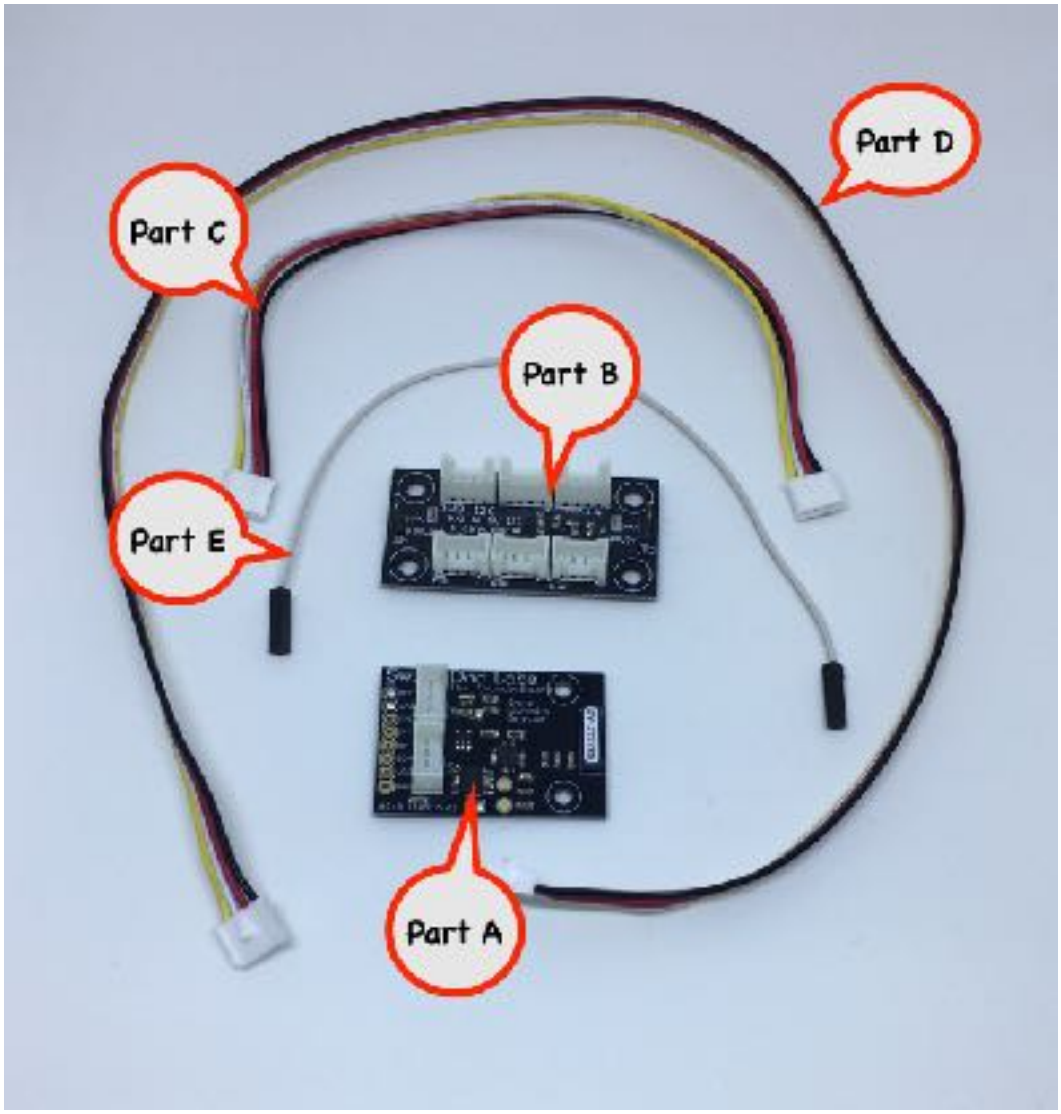
March 2018

SwitchDoc Labs

What is in the ThunderBoard Lightning Detector Extender Kit?

The ThunderBoard Lightning Detector Extender for the OurWeather Weather Kit has a total of five parts.

- Part A - ThunderBoard I2C Lightning Detector
- Part B - 3.3V to 5.0V I2C Hub and Voltage Translator
- Part C - 1 20cm Grove Cable
- Part D - 1 50cm Grove Cable
- Part E - 1 female to female jumper wire



Required Software

Your OurWeather should be running Version 031 or higher to work with this Extension kit. See OurWeather manual to update your software.

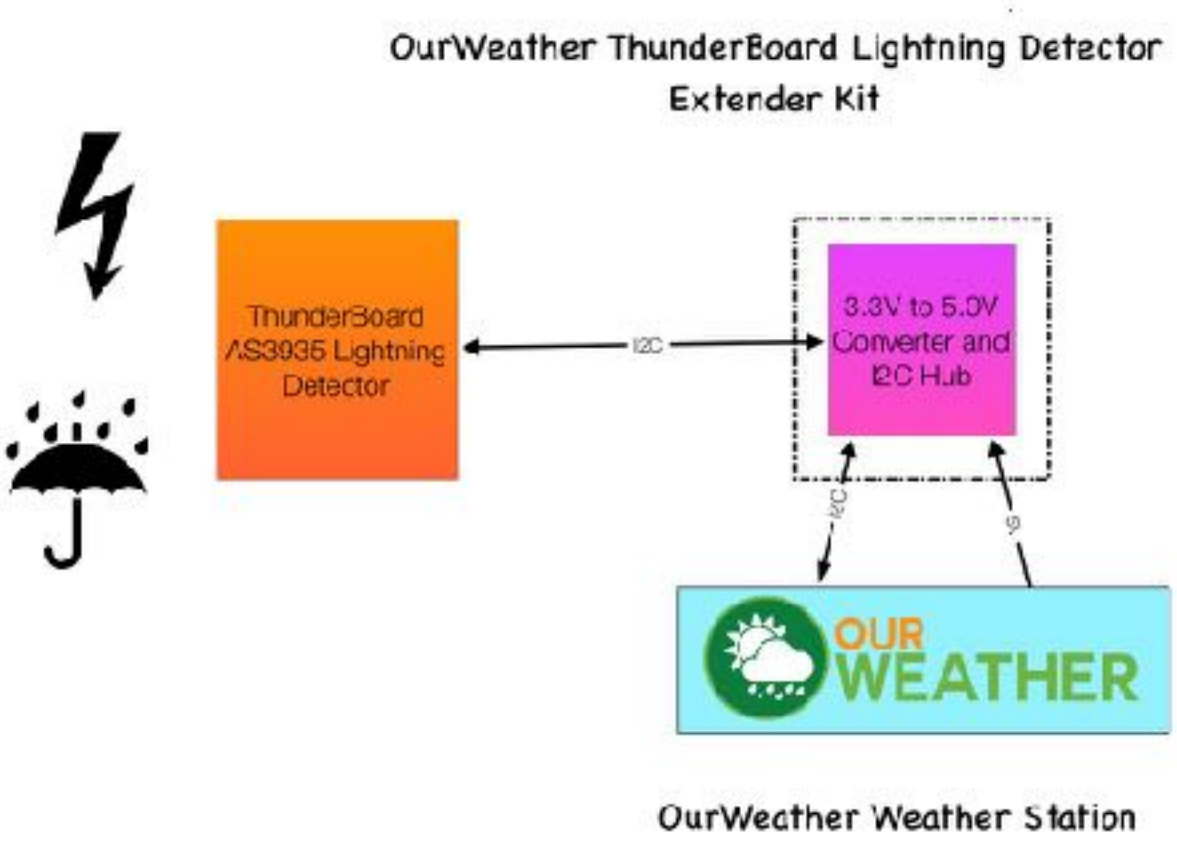
How does this Kit work?

The ThunderBoard Lightning detector is based on an AS3935. The ThunderBoard picks up lightning, puts it through a complex evaluation algorithm and then reports the results to the OurWeather Weather Station.

The Austrian Microsystems AS3935 is a programmable Lightning Sensor IC that detects the presence and approach of potentially hazardous lightning activity in the vicinity and provides an estimation on the distance to the head of the storm. The embedded lightning algorithm checks the incoming signal pattern to reject the potential man-made disturbers and various noise sources.

The AS3935 can also provide information on the noise level and inform OurWeather of the noise. It comes pre-calibrated, meaning that you don't have to write complex frequency calculation code, you can simply program the correct calibration details and get cracking finding storms.

Every 5 seconds, OurWeather polls the ThunderBoard and picks up the latest information.



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Warning

The Thunder Board contains world-class, award winning, super advanced technology from AMS. However, this device should NOT be used as the basis for evacuation or safety decisions in the case of storms, hurricanes, cyclones or other weather events.

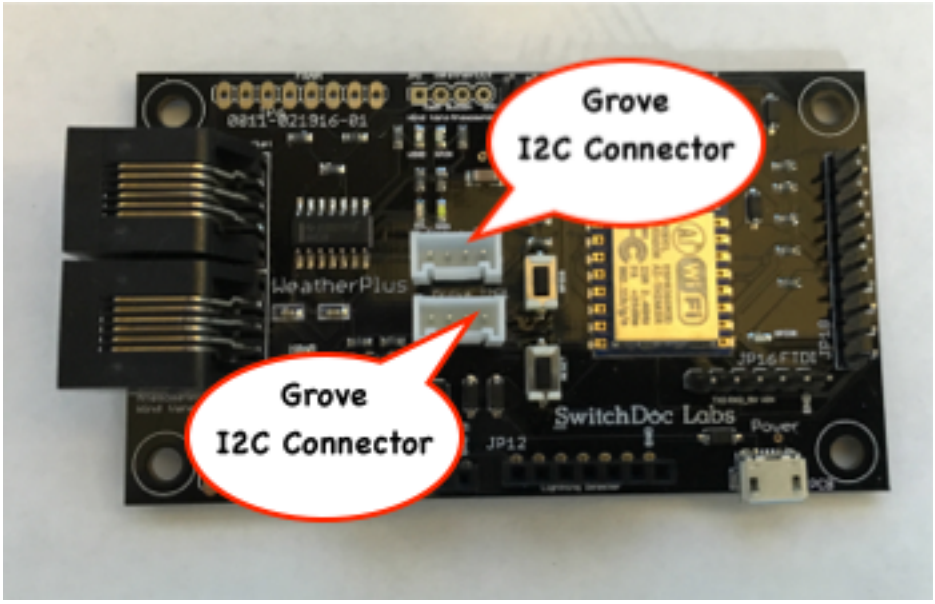
Please rely on local authorities to tell you what to do.

However, if your Thunder Board gave you prior warning of a storm before local authorities did, and subsequently enabled you to save your cat from being swept away or your washing from getting wet, we'd like to hear about it!

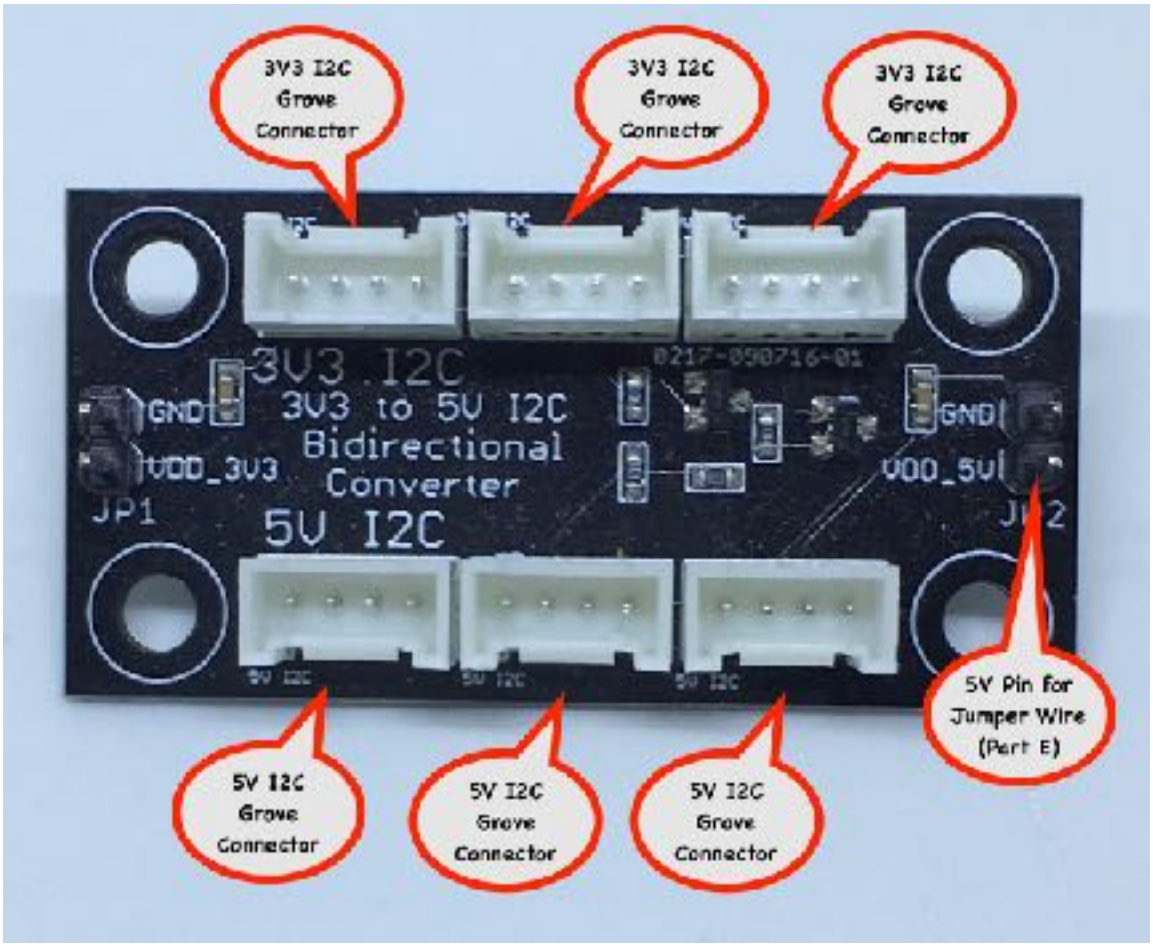
Step by Step Assembly

Step 1 - Unplug all power to your OurWeather Weather Kit

Step 2 - Connect a 20cm Grove Cable (Part C) to one of the Grove I2C Ports on the WeatherPlus board in your OurWeather Kit. Note: If both of your I2C Ports on your WeatherPlus board are filled, then unplug one of them and connect that cable to one of the 3V3 I2C Grove Connectors on Part B. I2C is a bus and you can plug them into any of the 3V3 I2C plugs.



Step 2 - Plug the other end of the 20cm Grove Cable (Part C) into a 3.3V I2C Port (I2C is a bus so any of the top 3 will work) on Part B, the 3.3V to 5V I2C Converter and Hub. NOTE: We are using this board as an I2C Hub and using it to add additional pull-ups on the SDA and SCL lines on the I2C bus. Both sides of the board are actually wired to 3.3V on the WeatherPlus board.

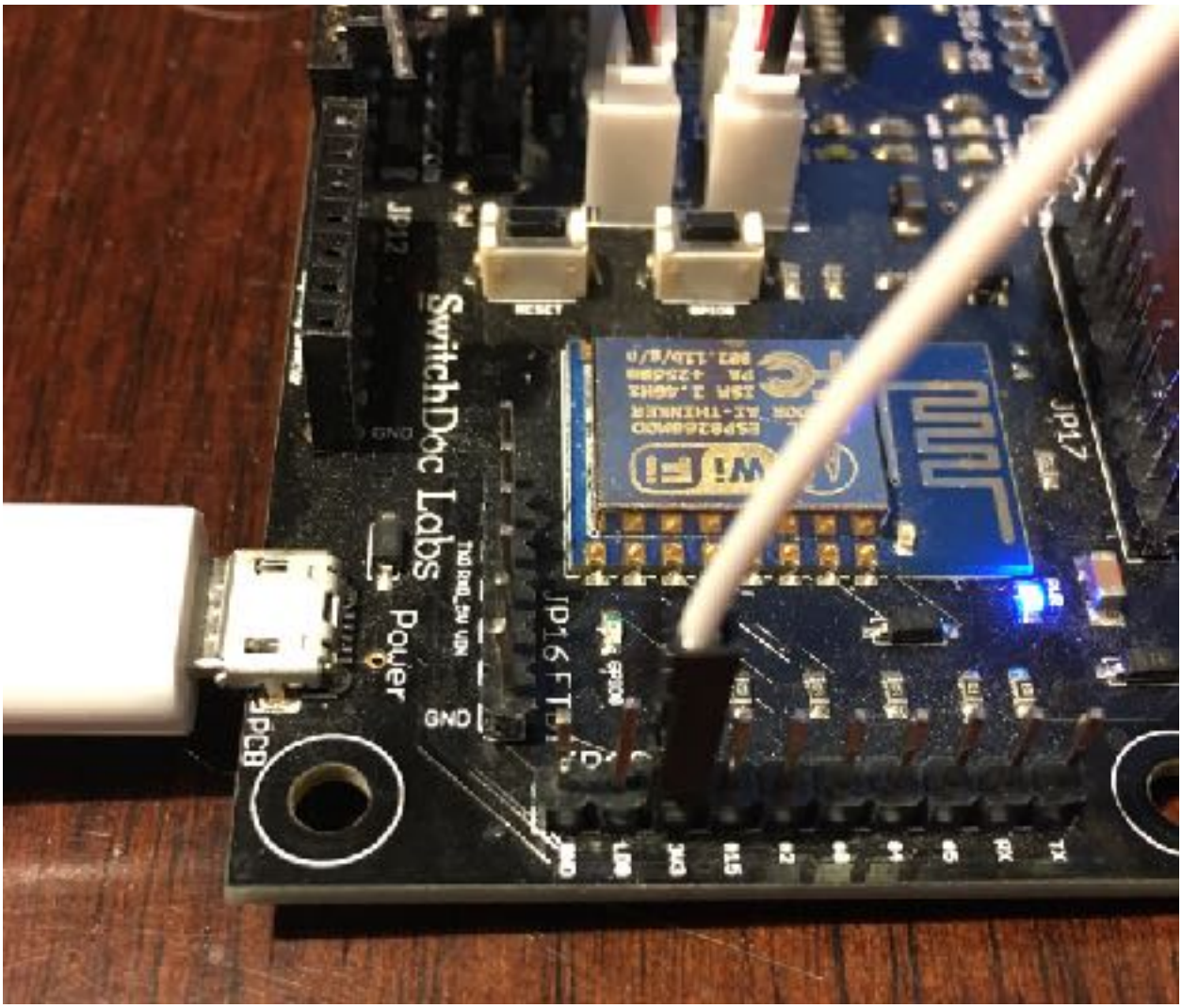


Step 3 - Plug the end of the 50cm Grove Cable (Part D) into one of the 5V I2C Grove Connectors on the 3.3V to 5V Converter Hub (Part B).

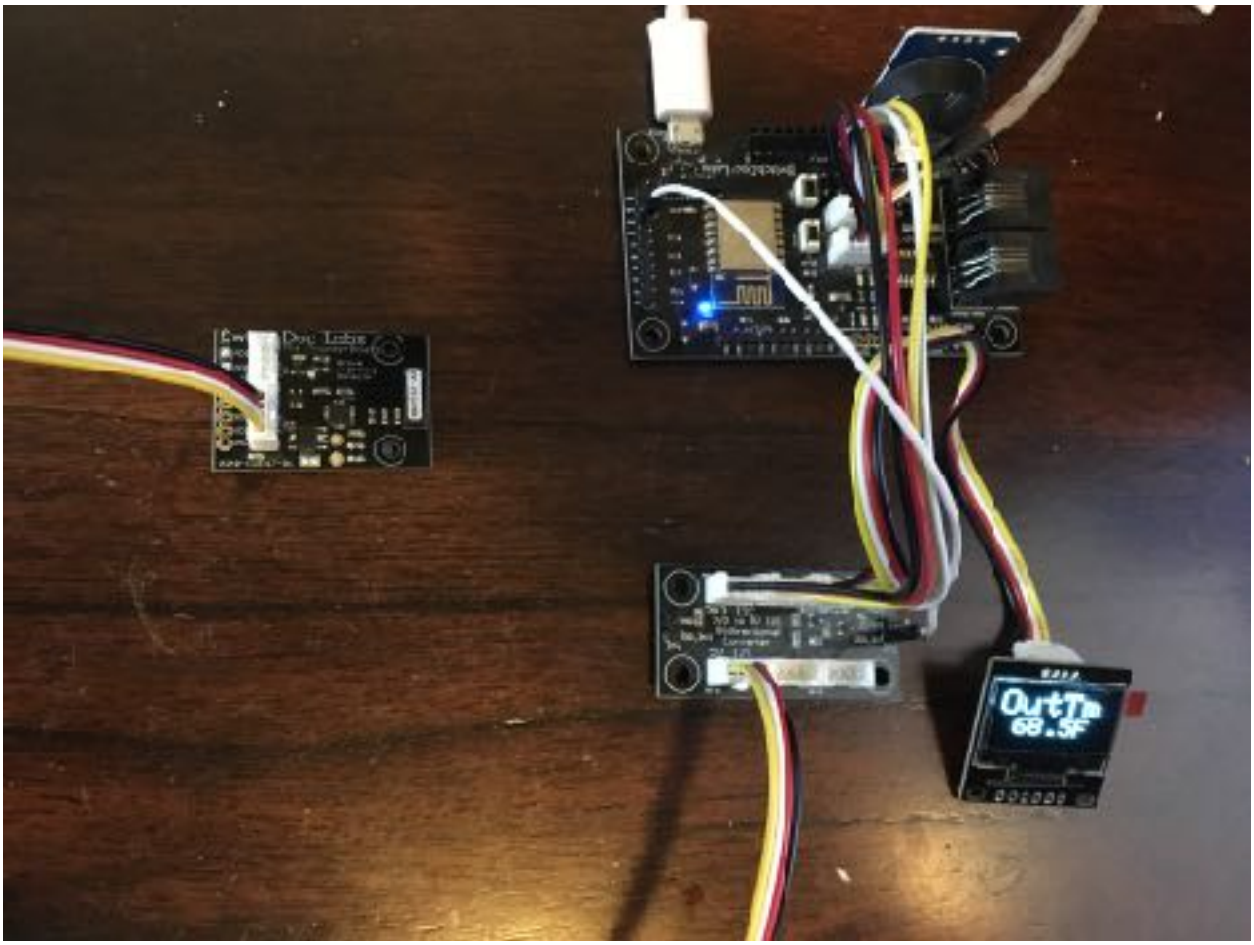
Step 4 - Plug the other end of the 50cm Grove Cable (Part D) into the I2C Grove Connector on the ThunderBoard (Part A). **NOTE: Why do we have a 50cm cable on the ThunderBoard? So you can move it away from RFI (Radio Frequency Interference) sources like the WeatherPlus board and other OurWeather parts.**

Step 5 - Plug one end of the female to female jumper wire (Part E) into the 5V Pin for Jumper Wire shown on the Part B picture above. MAKE SURE YOU DO THIS CORRECTLY.

Step 6 - Plug the other end of the female to female jumper wire (Part E) into the third from the bottom pin (marked 3V3) on the right row of pins on the WeatherPlus board as below (connector JP18). MAKE SURE YOU DO THIS CORRECTLY.



You are now done. Check all your connections and make sure they are correct. Your wiring should look like the picture below.



Testing - What is on the OurWeather Display?

Step 1 - Plug the Power back into the OurWeather Weather Kit

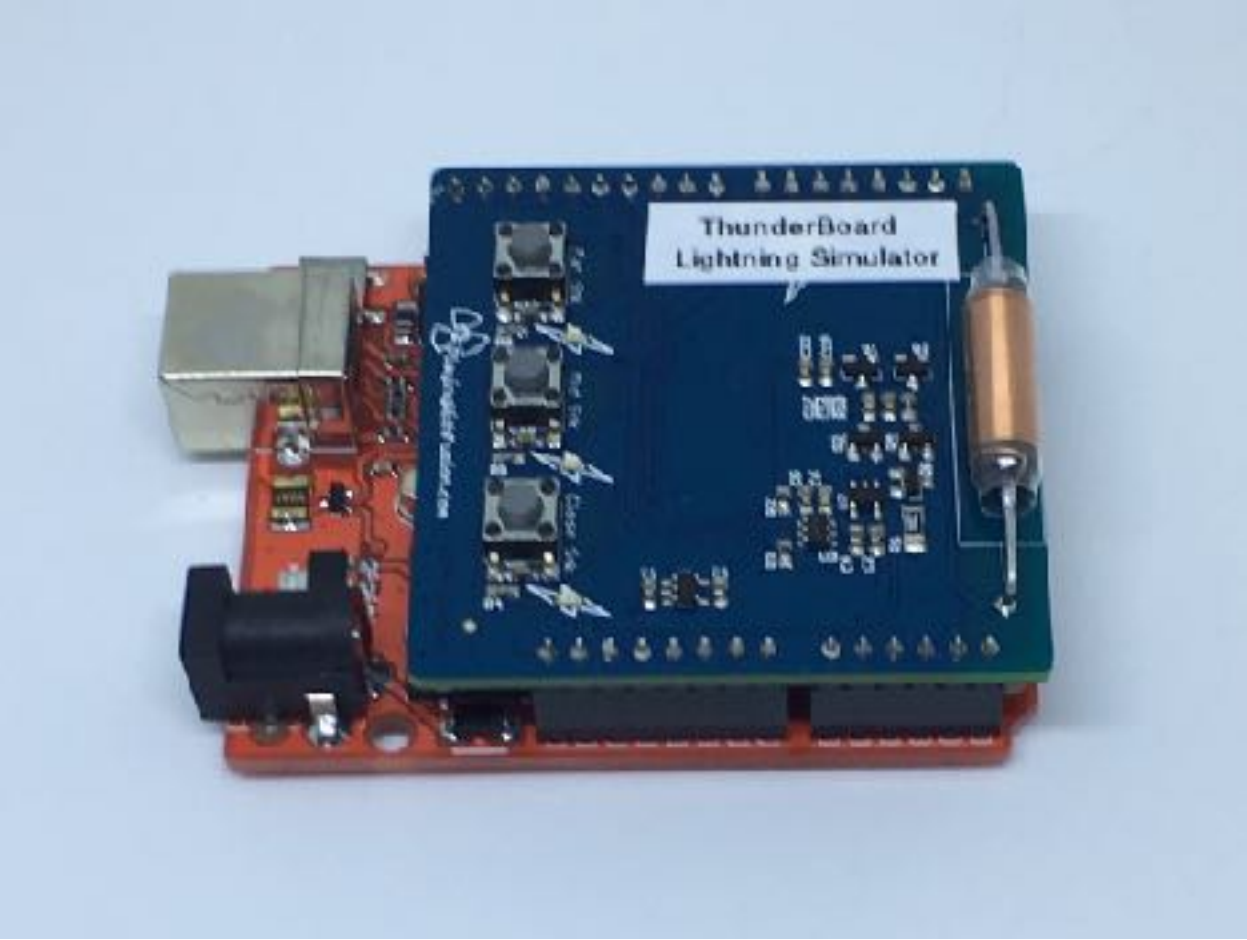
Step 2 - When the OLED display cycles around to show the weather information, you will see a lightning status screen go by that will be blank, since there is no lightning reporting yet. You should see the light on the ThunderBoard turn on when you power the system and will turn off when OurWeather is running and checking the ThunderBoard for lightning.

Step 3) Seeing your board work. You can move the ThunderBoard close to monitors and cell phones and you should pick up noise or distributors. When the ThunderBoard has seen something, the white LED on the ThunderBoard will turn on. It will turn off when OurWeather has read the board.

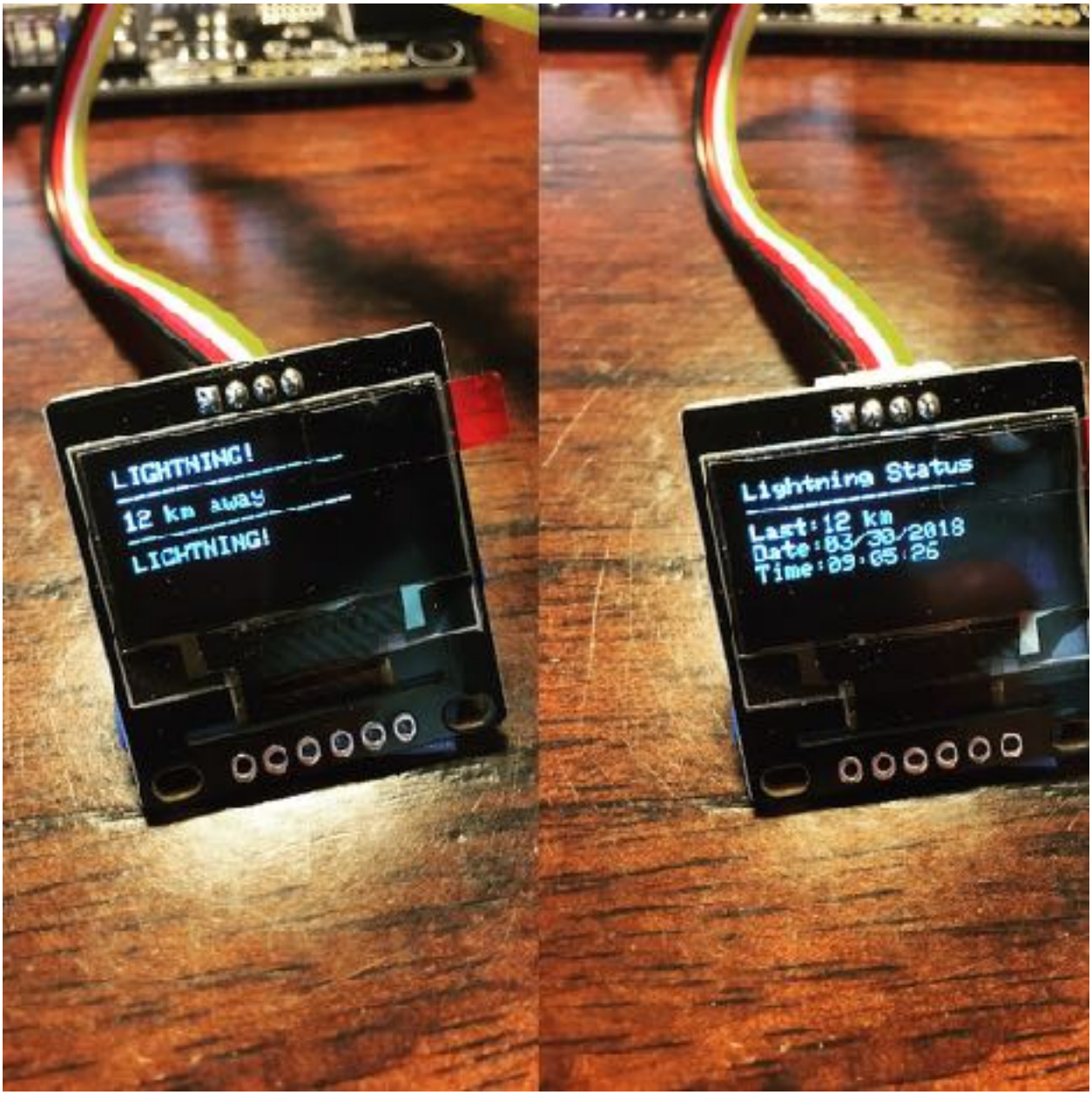
To thoroughly test your system (aside from waiting for a lightning storm) simulating lightning takes some additional hardware. SwitchDoc Labs sells a Arduino based lightning simulator called the ThunderBoard Lightning Simulator.

You can find it here:

https://shop.switchdoc.com/products/the-thunder-board-i2c-lightning-simulator



When OurWeather picks up some lightning, you will see the below cycle through on your OurWeather OLED display.



What Does the ThunderBoard Report?

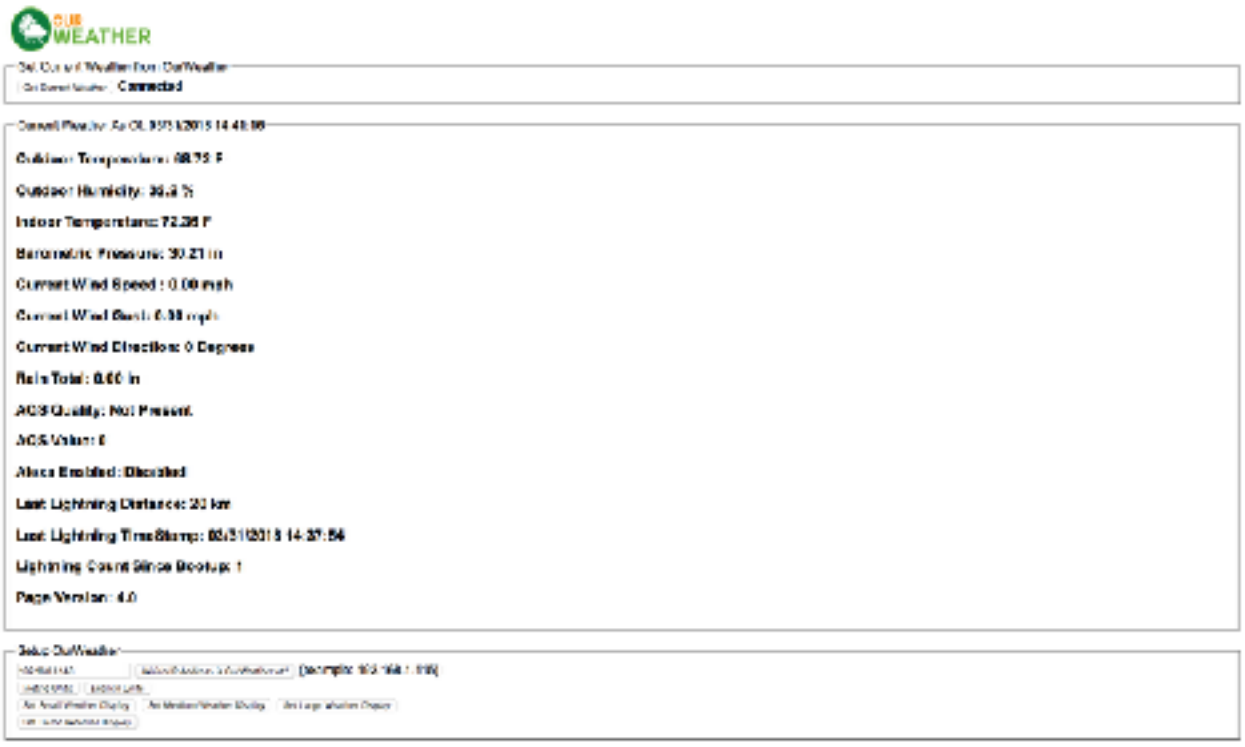
The ThunderBoard Lightning Detector reports the following information to OurWeather, which uses the information in the display and also reports it to Alexa.

ThunderBoardLast	Returns all the current lightning information from OurWeather	{"ThunderBoardLast": "20 km, 03/31/2018 14:37:54,20,Lightning detected, 03/31/2018 14:37:54,1", "id": "1", "name": "OurWeather", "connected": true}
ThunderBoardParams	Returns the current ThunderBoard Parameters	{"ThunderBoardParams": "2,1,7,0,2,2", "id": "1", "name": "OurWeather", "connected": true}

It records the following information:

as3935_LastLightning - Distance of the last lightning strike (e.g. 7km)
as3935_LastLightningTimeStamp - Time of the last lightning strike
as3935_LastLightningDistance - integer distance (e.g. 7)
as3935_LastEvent - The last event recorded by the ThunderBoard (see below)
as3935_LastEventTimeStamp - Time Stamp of last event
as3835_LightningCountSinceBootup - Number of lightning strikes since bootup

If you have a ThunderBoard connected to OurWeather it will also show up on www.switchdoc.com/OurWeatherPage.html when connected to your OurWeather station (see the OurWeather manual).



The three events that the ThunderBoard will report are:

INT_NH Interrupt: Noise level too high, try adjusting noise floor
INT_D Interrupt: Disturber detected
INT_L Interrupt: Lightning Detected.

Advanced Usage

OurWeather Software Version 031 or higher contains the following REST variables:

Format of the specialized JSON for the ThunderBoardLast response:

as3935_LastLightning - Distance of the last lightning strike (e.g. 7km)
as3935_LastLightningTimeStamp - Time of the last lightning strike
as3935_LastLightningDistance - integer distance (e.g. 7)
as3935_LastEvent - The last event recorded by the ThunderBoard (see below)
as3935_LastEventTimeStamp - Time Stamp of last event
as3835_LightningCountSinceBootup - Number of lightning strikes since bootup

Format of the specialized JSON for the ThunderBoardParms response:

as3935_NoiseFloor - Current Noise Floor (0-7)
as3935_Indoor - Indoor (0) Outdoor (1)
as3935_TuneCap - Current Tune Cap value for the AS3935 (0-15)
as3935_DisturberDetection - 0 - detect and report disturbers 1 - do not report
as3935_WatchdogThreshold - WatchDog Threshold (0-15)
as3935_SpikeDetection - Spike Rejection Value (0-15)

For other OurWeather REST commands, see the OurWeather Advanced Programming manual on www.switchdoc.com/OurWeather.

Optional - Tuning the ThunderBoard AS3935

While the ThunderBoard should work right out of the box, some users may want to adjust the various parameters to improve performance or gather disturber information.

There are six different parameters you can modify from the www.switchdoc.com/OurWeatherAdmin.html as can be seen below:

Noise Floor

The output signal of the AFE is also used to generate the noise floor level. The noise floor is continuously compared to a reference voltage (noise threshold). Whenever the noise floor level crosses the noise threshold, the AS3935 issues an interrupt (INT_NH) to inform the external unit (e.g. MCU) that the AS3935 cannot operate properly due to the high input noise received by the antenna (e.g. blocker). Low values of the Noise Floor makes the ThunderBoard more sensitive, but may pick up more noise. Default of 2. Range 0-7.

Tuning Capacitor

Internal Tuning Capacitors (from 0 to 120pF in steps of 8pf). This adjusts the receiving antenna to maximize lightning detection. A value of 7 is default. Range of 0-15.

If you want to exactly tune your ThunderBoards, you can hook it up to an Arduino and then run the software provided in:

https://github.com/switchdoclabs/SDL_Arduino_ThunderBoard_AS3935

Watchdog Threshold

The external antenna is directly connected to the Analog Front-end (AFE), which amplifies and demodulates the received signal. The watchdog continuously monitors the output of the AFE and alerts the integrated lightning algorithm block in the event of an incoming signal.

The output signal of the AFE is monitored by the watchdog, which enables the signal validation (in case the input signal crosses a certain threshold. The AS3935 is automatically set back to Listening Mode once the Signal Validation block has made an assessment on the nature of the received signal (lighting or disturber). it is possible to change the level of this watchdog (increase number) threshold to increase the robustness to disturbers.

If higher thresholds are used, the AS3935 would loose sensitivity for very far lightning events, with an improvement of the man-made disturber rejection as benefit. Default of 3, range of 0-15.

Spike Rejection

The signal validation in the ThunderBoard AS3935 checks the shape of the received signal. In particular, the AS3935 can reject the impulse signals, like spikes, picked up by the antenna. The AS3935 has the ability to improve the spike rejection by increasing the number of the Spike Rejection register. Larger valuescorrespond to more robust disturber rejection, with a decrease of the detection efficiency. Default of 3, range 0-15/

Indoor / Outdoor Selection

The AFE (Analog Front End) amplifies and demodulates the AC-signal picked up by the antenna. Since the AS3935 is a lightning sensor based on narrowband receiving technique (center frequency of 500kHz and a bandwidth of about 33kHz), the AFE bandwidth is meant to be greater than the antenna bandwidth. In this way, it is possible to consider that the gain within the antenna bandwidth as constant.

The gain of the AFE by default is optimized to operate indoor (e.g. inside a building). If the AS3935 operates outdoor, then the AFE gain setting has to be set to a lower value, as shown in the Table 15. Indoor and Outdoor setting must be selected according to according to the application.

Report Disturbers / Do not Report Disturbers Selection

The lightning algorithm block, processing the demodulated signal, can distinguish between lightning signal and man-made disturbers. If the received signal is classified as a man-made disturber, then the event is rejected and the system automatically goes back into listening mode to minimize current consumption. If the incoming signal identifies a lightning event, then the statistical distance estimation block performs an estimation of the head of the storm.

Selection to Report Disturbers will enable reporting on disturber events. This will show up in the LastEvent data fields.

Conclusion

In general, it cannot be stressed enough that while the Thunder Board will certainly let you know about electromagnetic pulses and its best guess about lightning distance, in real life storms do not generally hang around all the time ready for testing this module. Also, rain clouds don't necessarily mean lightning! Be patient, use your OurWeather to record what happens over time and enjoy learning more about storm patterns in your geographical location.

The easiest way to test your Thunder Board and project is to purchase the Thunder Board Lightning Simulator from SwitchDoc Labs. You can simulate far, mid and close lightning strikes.

NOTE: KEEPING YOUR THUNDER BOARD NEAR MONITORS, MOBILE PHONES OR OTHER EMF SOURCES WILL GENERATE NOISE AND DISTURBER INTERRUPTS AND CAN MASK ACTUAL LIGHTNING AND PULSES FROM THE THUNDER BOARD LIGHTNING SIMULATOR!