

INSTRUCTIONS

For Assembly of the SIS Hub Printed Circuit Board (PCB)

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Date: 9/17/2015

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<https://github.com/SISProject/SISDocs/TOU.pdf>

1) INTRODUCTION.

The SIS hub contains a printed circuit board (PCB) that must be assembled before the Hub can be powered and used. The parts list for the printed circuit board can be found in Appendix A of this document and at:

<https://github.com/SISProject/SISDocs/HubPartsList.xlsx>

The SIS Hub is based on the Particle “Photon” module (see: <https://www.particle.io/>). The SIS Hub printed circuit board has been designed to accept the Particle “Electron” as well¹. The parts in the section of the Parts List labeled “Required Parts for PCB Assembly” must be purchased and available before the board can be assembled per these instructions. The parts in the section of the Parts List labeled “Optional Parts for Box Mounting and Powering” are not covered in these instructions. A separate instruction is provided for the recommended (but not mandatory) assembly of the completed PCB into a rugged plastic enclosure. See:

<https://github.com/SISProject/SISDocs/SISHubAssembly.pdf>

2) TOOLS AND SUPPLIES.

Before beginning assembly of the shield board, the following tools and supplies should be at hand:

- a) Tools:
 - i) Soldering Iron

¹ The Electron is not available at the time of this publication. The PCB design is based on preliminary specifications from Particle and has not been tested with an Electron. The PCB will also accept a Particle “Core” module; however, the SIS firmware no longer supports the Core.

- ii) Needle Nose Pliers
 - iii) Diagonal Cutter
 - iv) Wire stripper
 - v) Philips head screwdriver
- b) Supplies:
- i) Electrical solder
 - ii) Electrical tape
 - iii) Solder wick or solder remover
 - iv) SIS hub parts kit (see parts list)
- c) Optional (see photo 1, below):
- i) Soldering iron stand
 - ii) PC board adjustable soldering stand
 - iii) Magnifier
 - iv) Multi-meter



Photo 1. PC Board Adjustable Soldering Stand and Multimeter.

3) ASSEMBLY INSTRUCTIONS.

- a) **Soldering.** Assembly of the SIS Hub PCB requires that you have knowledge of skill of electronic soldering. A good tutorial on this subject can be found at:

<https://learn.sparkfun.com/tutorials/how-to-solder---through-hole-soldering>

- b) **General instructions:** Before beginning assembly, please read through and understand these general instructions:

- i) All parts are mounted on the top side of the board. The top side of the board is the side with the silk screen printing on it – see photos 2 and 3, below.

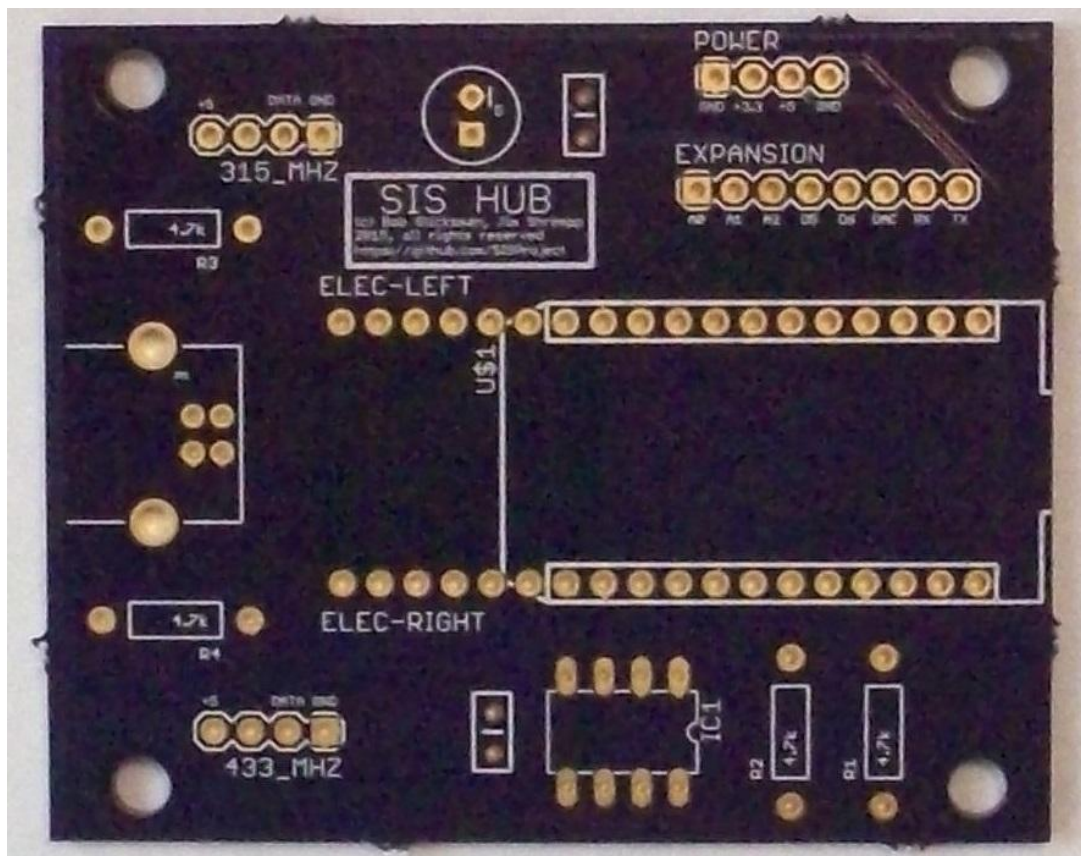


Photo 2. Top Side of Blank SIS Hub PCB.

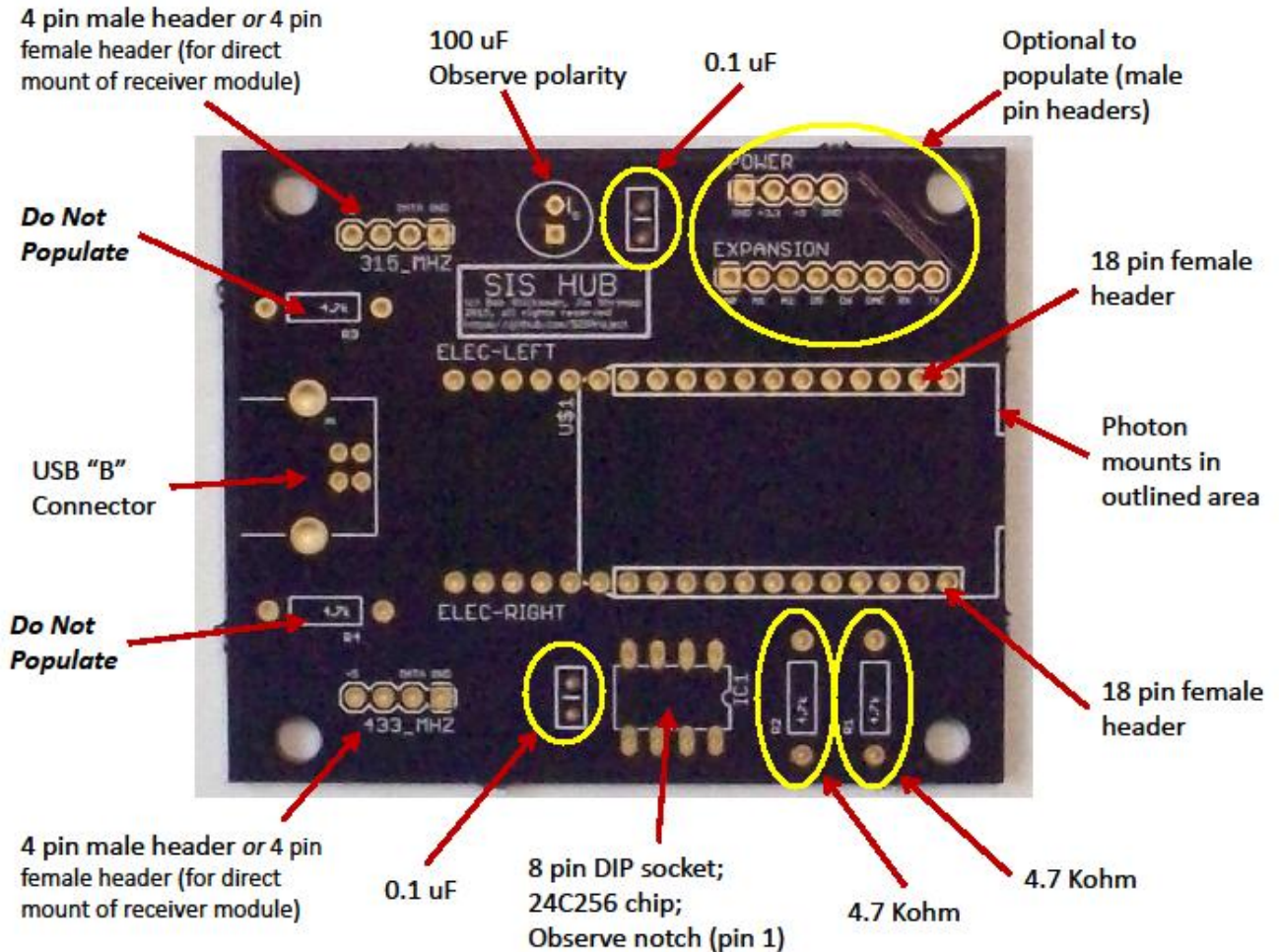


Photo 3. SIS Hub PCB with major parts identified.

- ii) All parts are soldered on the bottom side of the board only.
 - iii) The following parts have rigid pins and do not grip the board to hold the part in place when the board is inverted to solder the pins on the bottom. It is recommended to place the part on the top of the board, align the part as necessary, and apply electrical tape to hold the part in place for soldering. As soon as the board is inverted for soldering on the bottom side, solder the two pins at opposite ends (diagonally, in the case of the DIP socket) first to hold the part rigidly. Then solder the remaining pins to the board.
- (1) 0.1" male pin headers. Care must be taken to keep these parts in vertical alignment as they tend to tilt sideways because they are loose in the holes in the board. Place these parts into the holes so that the short pin ends protrude through to the bottom of the PC board. Align each connector vertically and use electrical

tape to hold it firmly into the holes, with the plastic center pieces firmly seated into the top side of the PC board and the connector straight up and down and not slanted sideways.

(2) Female headers for Photon/Electron Module. The headers require extreme care to ensure that the Photon/Electron module fits properly in the headers after they are soldered to the board. See instructions below for the recommended procedure.

(3) DIP socket. The DIP socket is easier to solder since it has two rows of pins that will prevent it from tilting. However, it should be taped or otherwise affixed to the top side of the PC board so that it stays in place when the board is inverted for soldering.

iv) The USB “B” connector has mounting tabs that are bowed outward to snap into a PC board. Once inserted into the PC board properly, the tabs will hold the connector in place when the board is inverted for soldering. See the assembly instruction details for this step in the SIS Hub PCB assembly for further details.

c) Inspect the blank PC board for damage and deburr edges.

i) File down any burs on the board edges to avoid cuts and scrapes

ii) Visually inspect the board for any damage or defects, such as:

(1) Breaks in conformal coating, except for solder pads and vias.

(2) Ensure that holes are drilled in the center of each component solder pad.

iii) Place a multimeter in resistance measurement mode and check that there is an open circuit between the “+5”, “+3.3” and the two “GND” pads on the “POWER” pads at the top of the board. Refer to photos 2 and 3, above, for details. If there is not an open circuit between any of these contacts on a bare PC board, then the board has a power short and should not be used.

d) Align and solder two 18 pin female headers for the Photon or Electron.

i) **NOTE:** The PCB has been designed to accept two 18 pin female headers for mounting an Electron. These headers can also be used with the smaller (24 pin) Photon or Core modules. If support for the Electron is not required, smaller 12 pin female headers *may* be used (but the 18 pin headers will support both the Photon and the Electron modules). If 12 pin headers are used, they must be mounted in the 12 pins closest to the front of the PCB, i.e. within the silkscreen outline shown in photo 3. Follow the same instructions as for 18 pin headers, below.

- ii) Place a Photon or Electron (or Core) into the 18 pin female headers, as shown in photo 4, below. If using a Photon or Core (24 pin devices), align the device in the middle of the header, as shown in the photo.

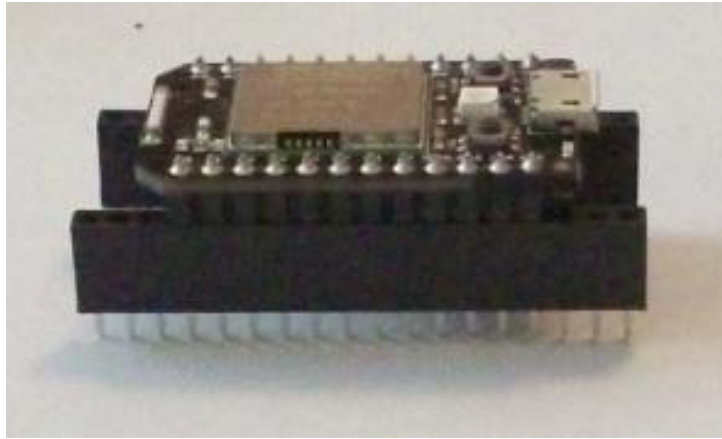


Photo 4. Female header alignment using a Photon, Electron or Core.

- iii) Place the female headers into the PCB and secure the assembly firmly using electrical tape. See photo 5.



Photo 5. Securing the female headers into the PCB.

- iv) Solder the end two pins at each end of each of the female headers, and shown in photo 6, below. Then, remove the electrical tape and unplug the Photon, Electron or Core device from the headers and solder the rest of the female header pins to the

PCB. Carefully inspect the solder joints to make sure that there are no cold joints and no bridging of solder between the pins.

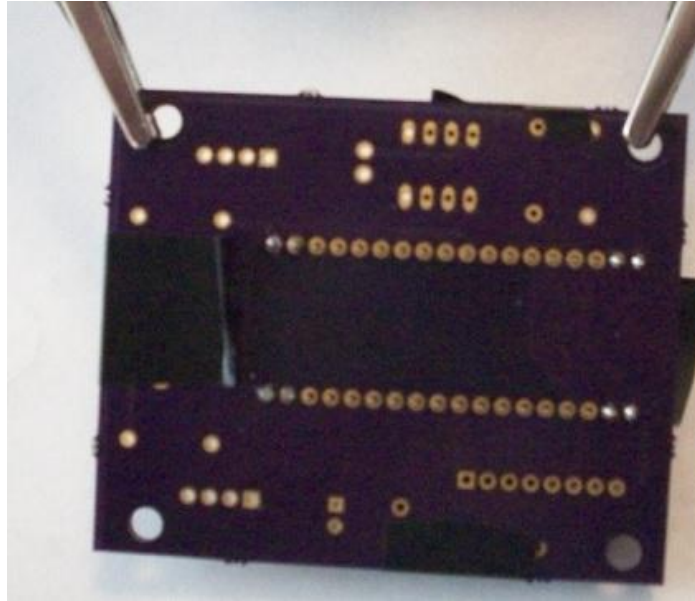


Photo 6. Soldering corner pins to the PCB.

e) Solder 0.1" male pin headers to the PCB.

- i) **NOTE:** *the SIS hub PCB accepts two, 4 pin male headers for cabling the RF receiver modules to the PCB. Alternatively, 4 pin female headers may be soldered to the PCB and the receiver modules may be plugged directly into the board via these female headers. This eliminates the need to mount the RF receiver modules externally from the PCB, however testing has shown that receiver range may be degraded if the RF receiver modules are mounted closer than 4" from each other and from the chip antenna on the Photon module.*
- ii) Break off two, 4 pin segments from a long, 0.1" spaced male pin header.
- iii) Place one 4 pin male header into the holes on the PCB marked "433 MHz". The long pins and plastic body go on the top of the PCB.
- iv) Use electrical tape to secure the 4 pin header to the PCB. Make sure that the header pins are vertical.
- v) Invert the board and solder the two end pins to the PCB, taking care not to move the header connector out of the position that it was taped into. Then, solder the two

middle pins. Carefully inspect that there are no cold solder joints nor bridged solder joints. Remove the electrical tape.

vi) Repeat this procedure for the “315 MHz” header.

vii) **NOTE:** There is a set of 4 holes marked “POWER” and 8 holes marked “EXPANSION” at the top of the PCB (photo 3). These are used only for expansion of the I/O capabilities of the PCB. They are normally left unoccupied; however, you may optionally break off male pin headers and solder them to the PCB using the same procedure as above.

f) Solder the USB “B” connector to the PCB.

- i) Insert the USB “B” connector into the PCB, with the connector end facing the rear of the board. There are two large holes that mate with tabs on the connector. The connector will snap into the board and the tabs will hold it in place while soldering.
- ii) Invert the PCB and solder the tabs and the 4 connector pins to the board. As always, inspect that there are no cold solder joints nor bridged pins.

g) Solder the 8 pin DIP socket to the PCB.

- i) Insert the DIP socket into the top side of the PCB. Make sure that the notched end of the socket faces the front of the board (side opposite to the USB connector).
- ii) Use electrical tape to hold the socket firmly onto the PCB.
- iii) Invert the board and solder two opposing corner pins to the PCB, taking care not to move the DIP connector out of the position that it was taped into. Then, solder the remaining pins. Remove the electrical tape and carefully inspect that there are no cold solder joints nor bridged solder joints.

h) Solder the remaining components to the PCB.

- i) **NOTE:** all remaining components have two long leads that can be bent over to hold the component into position when soldering. Bend the leads to insert the component into the top side of the PCB, as needed. Then, bend over the leads on the bottom side of the PCB so that the component stays in place and solder the two ends to the board. Inspect the solder joints. Then, using diagonal cutters, clip off the excess leads from the bottom side of the PCB.
- ii) **NOTE on the 100 uF electrolytic capacitor:** This device is polarized. The positive (+) side has the longer lead. The negative (-) side has a silver stripe near it on the capacitor body. The positive (+) side goes into the square hole in the PCB and the

- negative (-) side goes into the round hole in the PCB (also marked with a “-“ symbol). *Make sure to observe correct polarity when soldering the capacitor to the PCB.*
- iii) The two 0.1 uF capacitors are non-polarized. It does not matter which lead goes into which hole on the board.
 - iv) Two 4.7Kohm resistors are soldered into the positions labeled “R1” and “R2” on the PCB. These can be found near the front of the board, near the 8 pin DIP.
 - v) **NOTE:** there are two more positions marked “R3” and “R4”. These are located near the rear of the PCB, near the 315 MHz and 433 MHz connectors. **DO NOT SOLDER ANYTHING INTO THESE POSITIONS** if you plan to use both 433 and 315 MHz receivers. If you plan to use only one receiver, you may solder a 4.7Kohm resistor into the board position adjacent to the receiver module connector that you DON’T plan to use. This pullup resistor will prevent noise on the open connection from triggering the RF receiver decoding software. If you later decide to use the second receiver, you must disconnect the pullup resistor from the board (e.g. clip it off using diagonal cutters). *THE RECEIVERS WILL NOT WORK PROPERLY WITH A PULLUP RESISTOR INSERTED.*
- i) **Completed PC Board.**
- i) See photo 7 for the completely assembled PCB. Plug the Photon or Core into the very front of the female headers on the PCB, as shown in the photo. Plug the 8 pin 24C256 IC into the 8 pin DIP socket with the notch facing the front of the board, as shown in the photo. Inspect the board to make sure that all components have been properly inserted and soldered onto the board.



Photo 7. Assembled PCB.

3) ASSEMBLY AND TESTING.

The RF Receivers are connected to the PCB using the two 4 pin male headers. Strip a 4 wire section off of a female-female jumper cable (item 11 on the Parts List) and plug one end into a 4 pin header on the board and the corresponding wires to the pins of the 315 MHz and 433 MHz RF receiver modules. *TAKE CAREFUL NOTE* to connect the +5, GND and Data pins on the receiver module to the corresponding pins on the PCB, as labeled.

The board is powered using a standard A/B USB cable² and USB power supply³ (or USB port on a computer). After connecting the receiver modules and carefully checking the correct wiring, use the USB A/B cable to power the board. The LED on the Photon should light up, as shown in photos 8 and 9, below. The color that the LED lights up, as well as whether it lights solid, flashing or “breathing” will depend upon that status of the WiFi connection and of the firmware loaded to the Photon or Electron module. See the “SIS Installation Instructions” document for information about loading software to the SIS Hub and testing it out:

<https://github.com/SISProject/SISDocs/SISInstallationInstructions.pdf>

² Optional item 9 on the Parts List.

³ Optional item 10 on the Parts List.

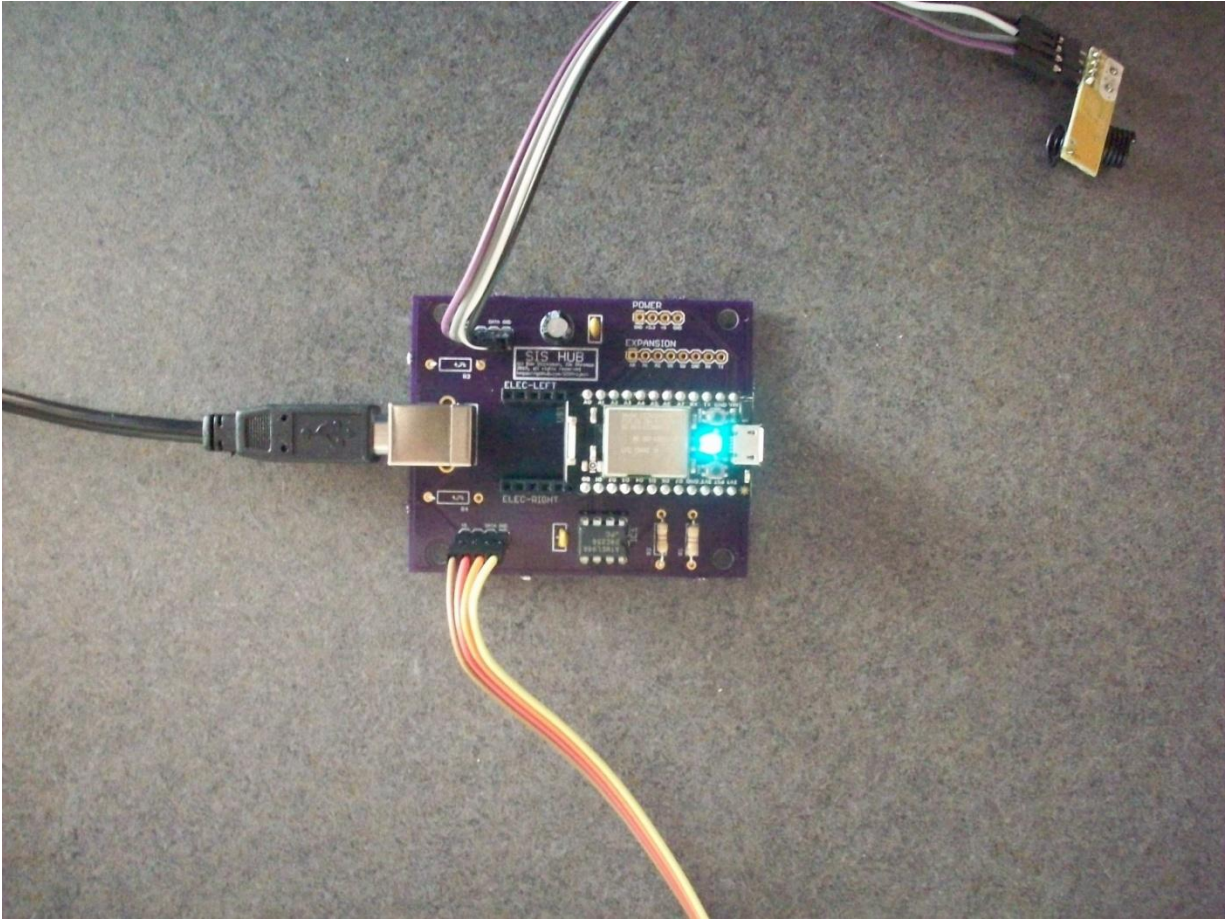


Photo 8. Completed PCB, powered and wired to receivers modules.

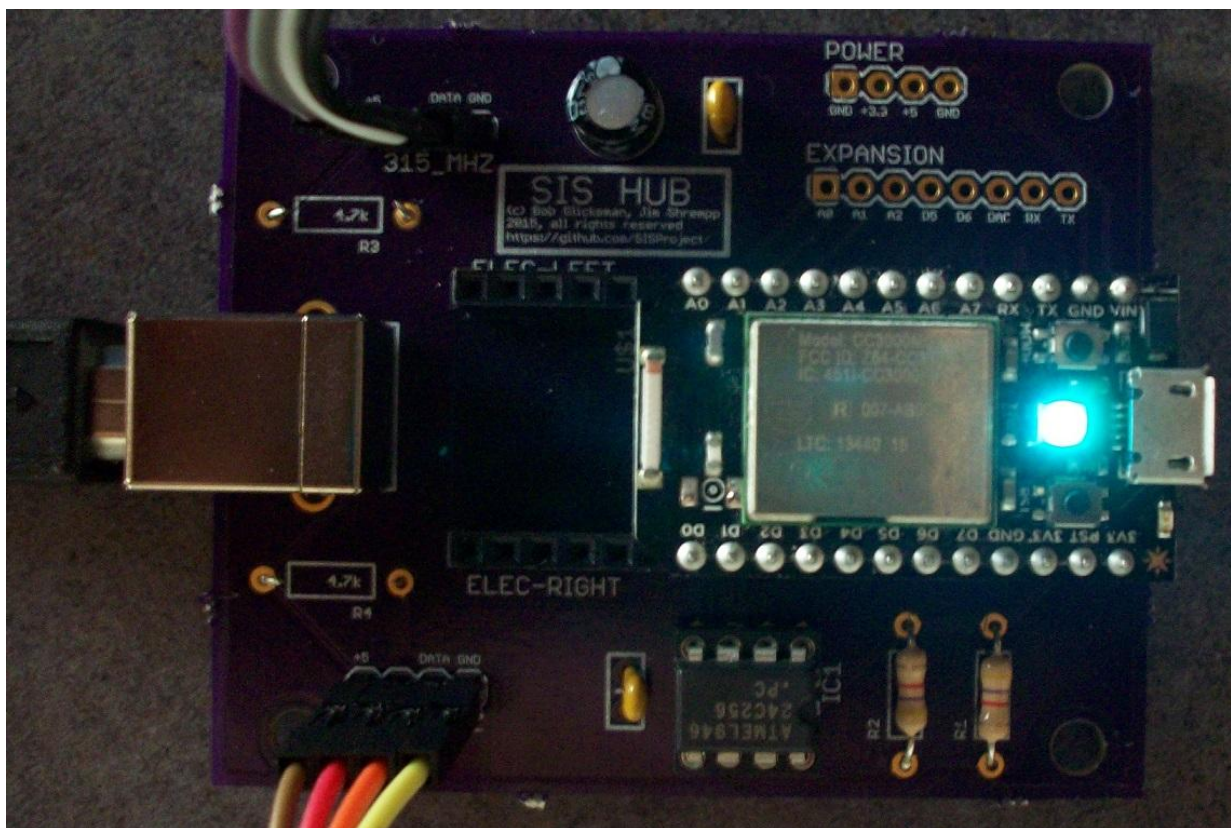


Photo 9. Closeup of completed and powered PCB.

The completed USB hub assembly and RF receiver modules may be mounted in a suitable drilled plastic enclosure. A separate instruction is provided in this package covering the preparation and mounting of the SIS Hub PCB, receiver modules, and power cable in such an enclosure:

<https://github.com/SISProject/SISDocs/SISHubAssembly.pdf>

APPENDIX A: SIS HUB PARTS LIST

Item #	Qty	Vendor	Vendor Part #	Description	REQUIRED PARTS FOR PCB ASSEMBLY	Notes
					Link	
1	1	OSHPark	SIS Hub PCB	SIS Hub Printed Circuit Board	https://oshpark.com/shared_projects/ptHf88wY	Custom PCB - order from OSHPark or use the Eagle files to order from another vendor.
2	1	Particle	Photon	Particle Photon WiFi Microcontroller with breadboard headers	https://store.particle.io/?product=particle-photon	The Particle Electron may be supported in the future. The PC board has extension mounting holes to accommodate the larger Electron.
3	1	Jameco	AT24C256PC	24C256; 32 KB I2C EEPROM	http://www.jameco.com/webapp/wcs/store/servlet/Product_10001_10001_200580_-1	
4	1	E-Bay	NA	315 MHz OOK Receiver	http://www.ebay.com/itm/315MHz-433MHz-Wireless-Super-Heterodyne-Remote-RX-Receiver-Module-107dBm-/181711941472?var=&hash=item2a4ee02f60	Select 315 Mhz from dropdown list. The same part is available from many Asian vendors on E-Bay and Amazon.
5	1	E-Bay	NA	433 MHz OOK Receiver	http://www.ebay.com/itm/315MHz-433MHz-Wireless-Super-Heterodyne-Remote-RX-Receiver-Module-107dBm-/181711941472?var=&hash=item2a4ee02f60	Select 433 MHz from dropdown list. The same part is available from many Asian vendors on E-Bay and Amazon.
6	10	Jameco	CF1/4W472JRC	resistor - 4.7Kohm, 1/4 watt axial lead (minimum qty = 10)	http://www.jameco.com/webapp/wcs/store/servlet/Product_10001_10001_691024_-1	Need 2 resistors
7	10	Jameco	SR205E104MAA-VP	0.1 uF Capacitor, 50 volt (minimum qty = 10)	http://www.jameco.com/webapp/wcs/store/servlet/Product_10001_10001_544868_-1	need 2 capacitors
8	10	Jameco	100UF/16V 6X5	100 uF Capacitor, electrolytic	http://www.jameco.com/webapp/wcs/store/servlet/Product_10001_10001_94289_-1	need 1 capacitor
9	1	Jameco	USB-B-S-RA-WT	USB connector, B female	http://www.jameco.com/webapp/wcs/store/servlet/Product_10001_10001_230958_-1	
10	1	Adafruit	907	Panel Mount USB cable, B male to B female	http://www.adafruit.com/products/907	
11	1	Adafruit	266	40 conductor female-female jumper wires, separable.	http://www.adafruit.com/products/266	Required only if the receivers are not mounted to the PC board. These jumpers are used to connect pin headers soldered to the board in the receiver positions to the pins on the remotely mounted receivers.
12	1	Jameco	7000-1X40SG-R	Breakaway headers, straight, male	http://www.jameco.com/webapp/wcs/store/servlet/Product_10001_10001_160882_-1	Required only if the receivers are mounted remotely from the PC board. May also be used for POWER and EXPANSION connections to the PC board.
13	2	Digi-Key	S7016-ND	18 Pin female header	http://www.digikey.com/product-search/en?keywords=S7016-ND	18 Pin headers will accommodate both Photon and Electron. 12 pin female headers may be used if only Photon support is needed.
14	1	Jameco	6100-8-R	8 pin DIP socket	http://www.jameco.com/webapp/wcs/store/servlet/Product_10001_10001_51626_-1	Alternative is to solder the Photon directly to the PC board, or to use 0.1" spaced female pin headers.
					OPTIONAL PARTS FOR BOX MOUNTING AND POWERING	
1	1	Office Max	25038085	enclosure; 1.75 liter (3"H x 7"W x 9-1/2"D)	http://www.officedepot.com/a/products/452333/Really-Useful-Boxes-Plastic-Storage-Box/	A smaller enclosure may be used if receivers are mounted to PC Board directly vs taped to the sides of the enclosure. However, range of reception may suffer if the receivers are not at least 4" apart (and apart from the Photon WiFi chip). Boxes are available in various colors.
2	4	jameco	2104-632-AL-7	standoff, female-female, 1/2", 6-32 threaded	https://www.jameco.com/webapp/wcs/store/servlet/ProductDisplay?storeId=10001&langId=-1&catalogId=10001&pa=77543&productId=77543	Use as required to mount PC board into the enclosure. Board will accommodate 4 standoffs. See below for Nylon standoffs if desired.
3	10	jameco	H554-ND	Screw, 6-32x1/4", pan head, phillips	https://www.jameco.com/webapp/wcs/store/servlet/ProductDisplay?storeId=10001&langId=-1&catalogId=10001&pa=2094418&productId=2094418	Use as required to mount PC board into the enclosure. Board will accommodate 4 screws (board to standoff) + 4 screws (standoff to enclosure). See below for Nylon screws, if desired.
4	4	Digi-Key	36-1903C-ND	standoff, female-female, 1/2", 6-32 threaded	http://www.digikey.com/product-search/en?KeyWords=36-1903C-ND&WT.z_header=search_go	Nylon alternative to metals standoffs, if desired.
5	100	Digi-Key	H554-ND	Screw, 6-32x1/4", pan head, phillips	http://www.digikey.com/product-search/en/hardware-fasteners-accessories/screws-bolts/2097339?k=H554-ND	Nylon alternative to metal screws, if desired. Minimum order is 100 screws (need 8).
6	10	Jameco	0505HC-101S-R	Cable tie mount, nylon, 3/4" (minimum qty = 10)	http://www.jameco.com/webapp/wcs/store/servlet/Product_10001_10001_182942_-1	Use as required for neatness. Should only require 4 or so tie mounts
7	100	Jameco	CV-07S-R	Cable tie, nylon, 3" (minimum qty = 100)	http://www.jameco.com/webapp/wcs/store/servlet/Product_10001_10001_70561_-1	Use as required for neatness. Should only require 4 or so ties
8	1	Office max	912408	Scotch Outdoor Mounting Tape - Double Sided (one roll)	http://www.officedepot.com/a/products/745021/Scotch-Permanent-Heavy-Duty-Outdoor-Mounting/	Use as required to affix receiver modules to the enclosure. Not required if receivers are mounted on the PC Board.
9	1	Jameco	10U2-02206-BK	USB Cable; A male to B male.	http://www.jameco.com/webapp/wcs/store/servlet/Product_10001_10001_222010_-1	Optional - needed to bring power to the SIS Hub
10	1	Jameco	GS05U-USB	USB Power supply; 1Amp	http://www.jameco.com/webapp/wcs/store/servlet/Product_10001_10001_2155823_-1	Optional - needed to bring power to the SIS Hub. Any USB power supply, 5 volts at 500 ma or more will work, as will USB