RFID Station Build and Installation Instructions

By: Jim Schrempp, Bob Glicksman and Mike Calyer; v1, 2/06/2020

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https://github.com/TeamPracticalProjects/MN_ACL/blob/master/Terms_of_Use_License_and_Disclaimer.pdf

TABLE OF CONTENTS.

OVERVIEW.

This document provides step-by-step instructions for assembling an RFID Station. Before proceeding with this project, you must read and accept the "*Terms_of_Use_License_and_Disclaimer*" document which is located in the root level of this repository. It is strongly suggested that you read and understand the document "*RFID_ACS_Overview_Document*" which is located in the *Documents* folder of this repository before deciding whether or not to proceed with this project!

In order to build an RFID Station, you must procure the parts listed in the "*RFID_Station_Parts_List*" that is located in the *Hardware* folder of this repository. In addition, you must have the necessary skills and tools, as follows:

- PCB assembly: This project requires that you assemble a custom designed printed circuit board (PCB). Board assembly requires through-hole electronic soldering tools and skills. PCB assembly does not require surface mounting of parts. Eagle CAD files are provided so that you can order blank PCBs from a manufacturer of your choice. Links to two manufacturers that we have tested are included in the parts list.

- Enclosure manufacture: The enclosure is made from laser cut ¼" thick birch. Vector CAD (.svg) files are included in the *Hardware* folder of this repository. We at Maker Nexus have access to in-house laser cutters, but you should be able to order laser cut parts from a reputable on-line vendor. The enclosure itself is glued together. All electronic parts are assembled on the underside of the enclosure front cover and either screwed or hot glued in place.

- Firmware installation: The Station is not complete until the Particle Argon microcontroller is captured into your Particle cloud account and the firmware is flashed onto it. You will be required to understand how to use the Particle Workbench Visual Studio IDE in order to edit files containing your secret encryption keys, build, compile and flash firmware code to your Argon device, create webhooks in your Particle cloud account using the Particle Console. Our documentation will guide you through this process, but you need to know how to use Particle's tools before you can follow these instructions. Refer to: www.particle.io for further details.

NOTE: *Do not proceed to order parts and to attempt this project until you are confident that you have the necessary skills, tools and knowledge to do so. We are not responsible for the outcomes of your attempts to build and install this project. You may contact us if you get stuck or have a problem, but we make no guarantees that we can help you or even that we can respond to your inquiries.*

This document is divided into major sections:

- PCB Assembly Instructions: this section provides you with detailed instructions for assembling the custom PCB needed for this project. This is normally the first step that you will take, as the assembled PCB is a major component of the overall Station assembly.

- Enclosure Fabrication Instructions: this section describes how to assemble the enclosure from the laser cut parts. The back, sides, top and bottom are fit and glued together to form the enclosure. The front panel must first have the electronics installed on it and is then fit to the enclosure and fastened down with screws and nuts.

- Station Assembly Instructions: this section includes instructions for assembling and wiring the electronics onto the Station front panel. When this is complete, the front panel is attached to the rest of the enclosure and fastened down with screws.

- Firmware Installation and Testing Instructions: summary instructions for capturing the Argon into your Particle account and for compiling and flashing the firmware onto the Argon are contained in this section. Reference is made to detailed system and software installation instructions that are contained in a separate document.

- Troubleshooting: instructions about how and what to check in the event that the RFID Station that you built does not come up fully operational. This is not a step-by-step debugging set of instructions, but it may help you if the Station exhibits some common problems. You will need a multi-meter and possibly a magnifying glass, as well as familiarity with the Particle web environment in order to troubleshoot your RFID Station.

We suggest that you follow these instructions in this order. However, you may wish to assemble the PCB and then assemble and wire up the remaining electronics on the bench in order to flash the firmware and test out the electronics before manufacturing the enclosure and mounting the electronics therein.

PCB ASSEMBLY INSTRUCTIONS.

The completed printed circuit board (PCB) is shown in figure 1-1, below. The major parts are called out in this figure.

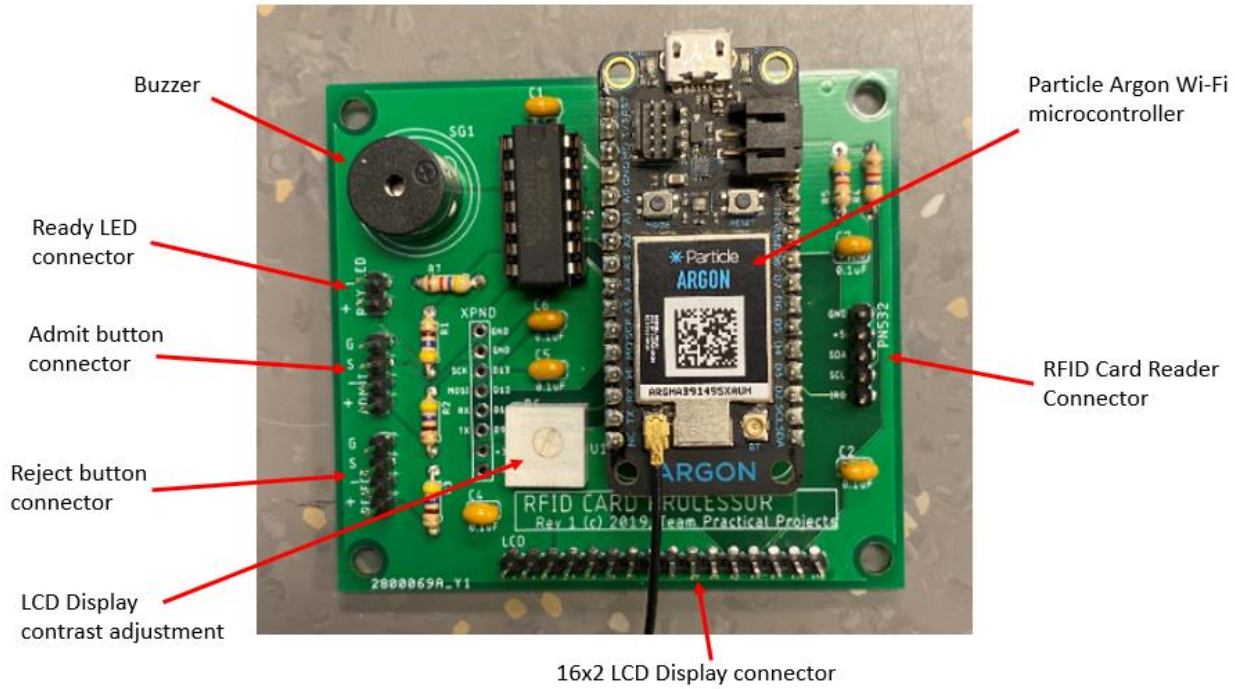

Figure 1-1. Completely Assembled PCB.

Assembly of the PCB begins with the blank PCB and the parts to be used in board assembly. In order to assemble the PCB, you will need the following tools and materials:

- Fine tipped electronics soldering iron
- Electrical solder
- Needle nose pliers
- Diagonal wire cutters
- Electrical tape

You should also have a multi-meter available and know how to use it.

You can solder the parts onto the PCB in any order that you wish. However, we recommend that you follow the order in our instructions.

Begin with the bare PCB, shown in figure 1-2.

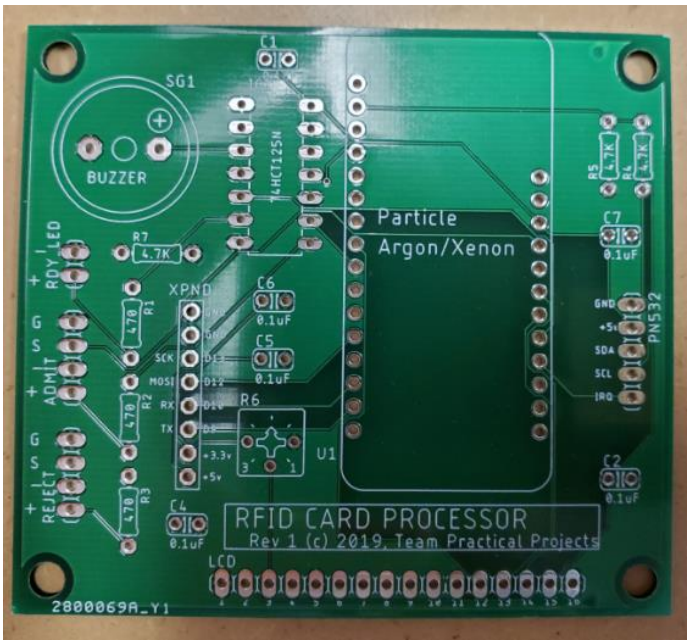

Figure 1-2. Bare PCB.

Figure 1-2 shows the top side of the PCB. This is where you will insert the parts. After inserting parts, flip the board over and solder the leads to the bottom of the PCB, being careful to keep the parts firmly seated onto the board.

Before proceeding further, we recommend that you make sure that there are no shorts on the bare PCB – particularly that neither the 3.3 volt nor the 5 volt power rails are shorted to ground. The connector field labeled XPND has to pins marked GND and pins marked +3.3v and +5v. Use your multi-meter to check that neither the +3.3v nor the +5v pins are shorted to GND and that +3.3v and +5v are not shorted to each other. If there is a short, you have a bad PCB; you could try to discover what is wrong, but most likely you have a bad manufacturing situation and the board should be thrown away.

Mount and solder six 0.1uF capacitors (C1, C2, C4, C5, C6, C7), as shown in figure 1-3.

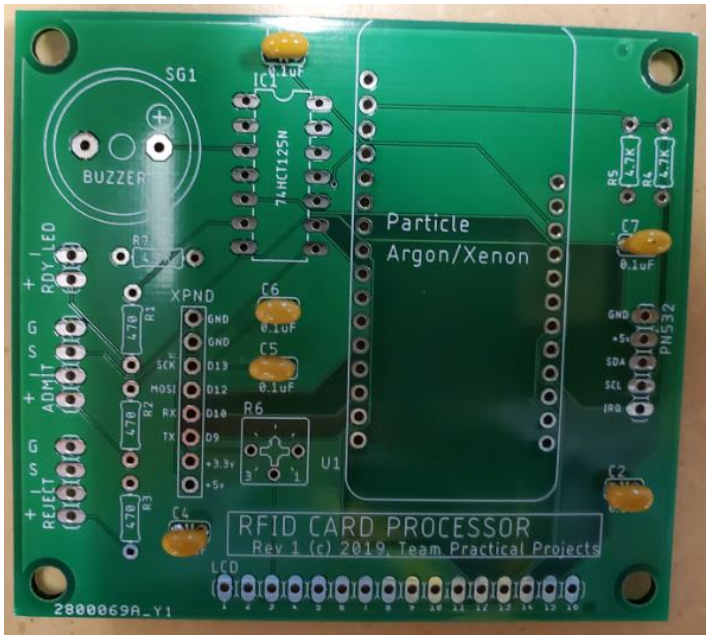

Figure 1-3. Mount decoupling capacitors.

Next, mount and solder three 4.7K resistors, as shown in figure 1-4 (R4, R5, and R7). *Be careful to check the color code on the resistors and/or to check the resistance with a multi-meter prior to soldering in the resistors.* Do not confuse these with the three 470 ohm resistors that are assembled onto the PCB in the next step.

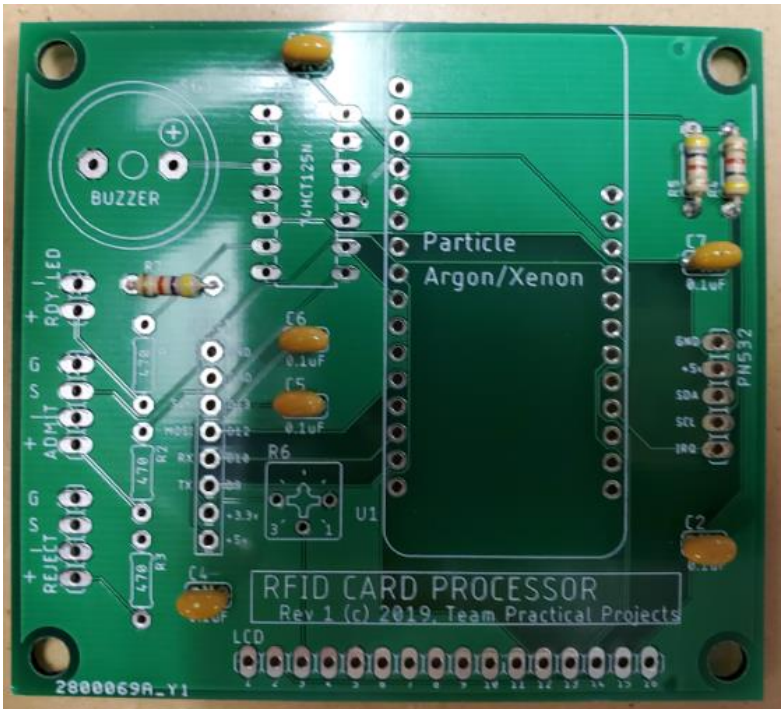

Figure 1-4. Mount 4.7K resistors.

Next, mount and solder three 470 ohm resistors, as shown in figure 1-5 (R1, R2, and R3). *Be careful to check the color code on the resistors and/or to check the resistance with a multi-meter prior to soldering in the resistors.* Do not confuse these with the three 4.7 K ohm resistors that were assembled to the PCB in the prior step.

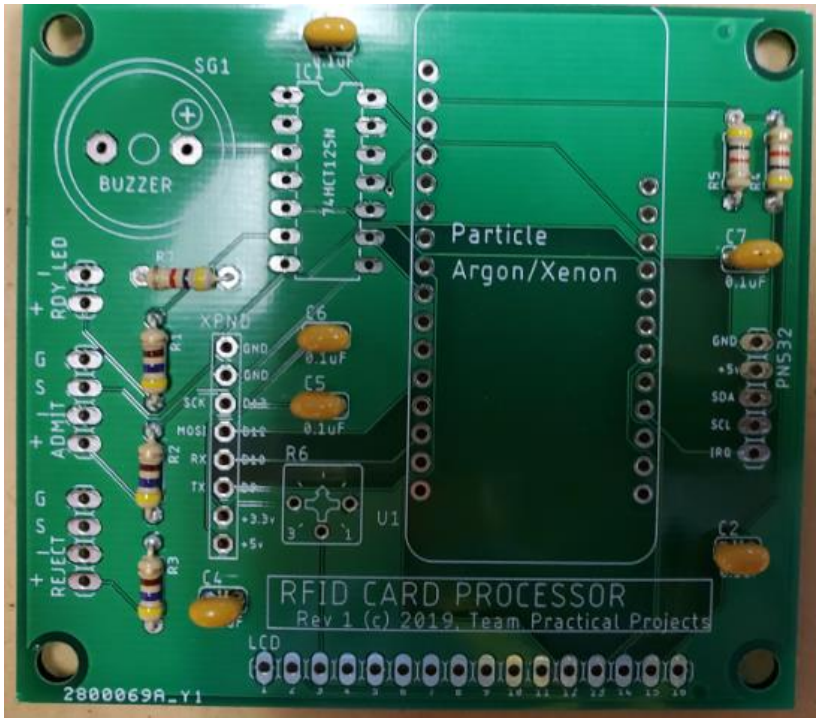

Figure 1-5. Mount 470 ohm current limiting resistors.

The next step is to mount the 14 pin DIP socket in the IC1 position, as shown in figure 1-6. Position the socket so that the notch in the plastic body is facing up, i.e. as shown in the silkscreen on the PCB.

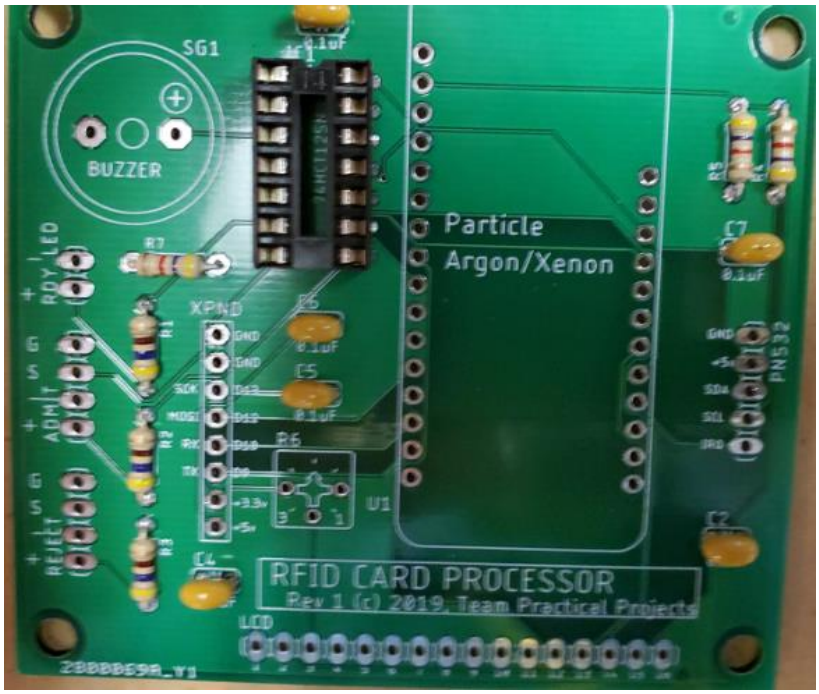

Figure 1-6. 14 pin DIP socket for IC1.

Unlike the components that were previously soldered to the PCB, the leads on the DIP socket are small and cannot be bent over on the underside of the board to hold the socket in place while soldering. We suggest that you affix the socket to the PCB using electrical tape to hold it in place while soldering, as shown in figure 1-7.

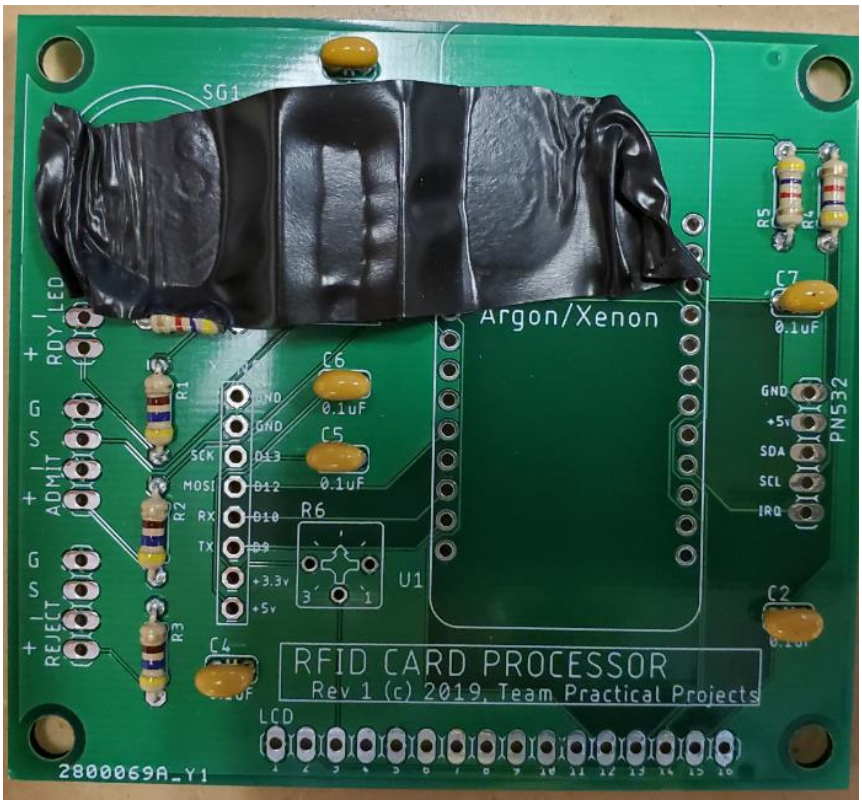

Figure 1-7. Holding the DIP socket in place for soldering.

Carefully examine the soldering on the bottom of the board to make sure that there are no solder bridges, either between pins or between a pin and vias on the board. See figure 1-8 for a closeup. Note the small through board via near pin 4 that must not be soldered.

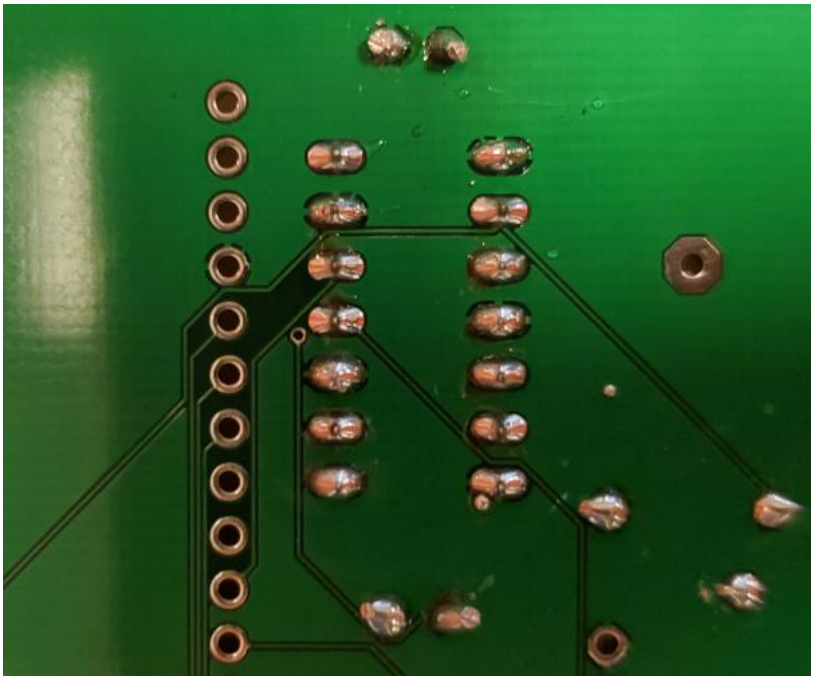

Figure 1-8. View of IC1 solder side.

Next, place the 10K potentiometer (R6) into the holes on the PCB, as shown in figure 1-9.

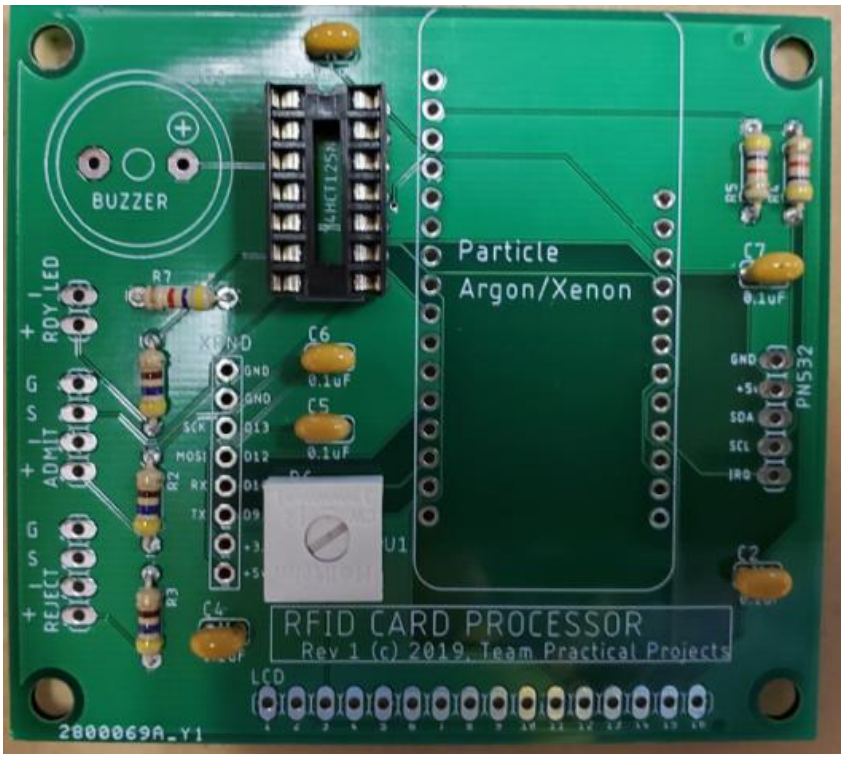

Figure 1-9. Mounting 10K potentiometer

The potentiometer can only mount on the PCB in one way. As with the IC socket, it is suggested that you use some electrical tape to hold the potentiometer fast to the front of the PCB while soldering the leads on the back of the PCB – see figure 1-10.

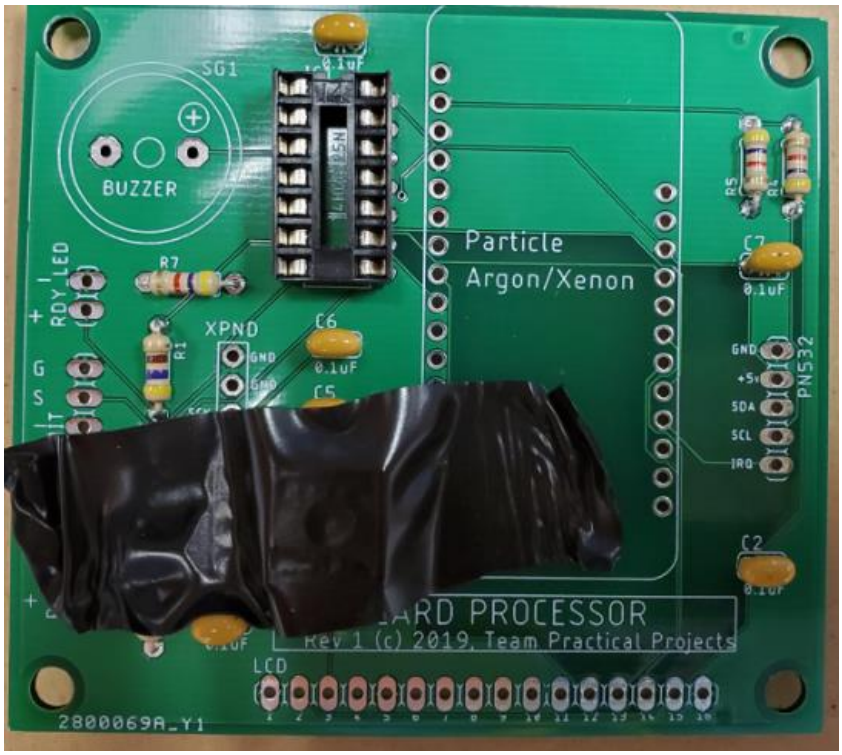

Figure 1-10. Holding the potentiometer in place for soldering.

The next item to solder to the PCB is the piezo buzzer. Note in figure 1-10 that there is a plus (+) sign by one of the buzzer terminals on the PCB. The buzzer must be placed so that the plus (+) lead of the buzzer is aligned with the plus (+) sign on the PCB.

Figure 1-11 shows the buzzer inserted into the PCB with the plus (+) label indicating where the plus (+) lead of the buzzer is. However, the label can move in shipping and is not always reliable. Remove the label and observe the plus (+) mark on the buzzer itself to be sure that you have placed the buzzer on the PCB properly.

Figure 1-11. Placement of Buzzer

After removing the label and double checking the buzzer placement on the PCB, use some electrical tape to hold the buzzer fast to the PCB, as shown in figure 1-12.

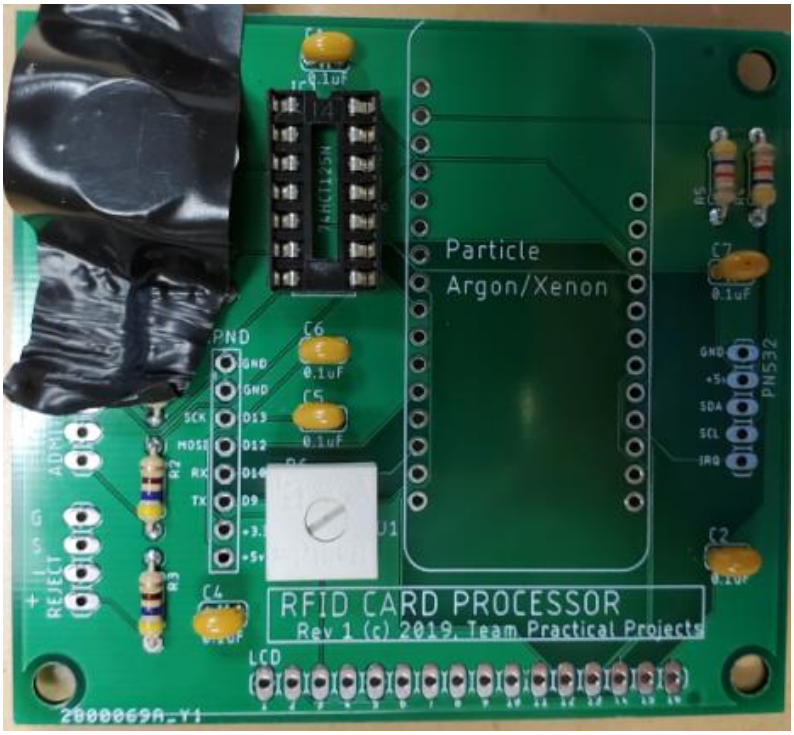

Figure 1-12. Holding the Buzzer in Place.

How, flip the board over and solder the buzzer leads to the PCB.

Now that you have soldered the electronic components onto the PCB, it is time to mount the connectors. Take one of the male pin header strips and break off a 5 pin section. We suggest that you use the smaller of the Argon female header connectors to help mount the 5 pin male header as shown in figure 1-13.

Figure 1-13. Using the Argon Female Connector to Help Mount the 5 pin Male Header.

Now, insert the solder pins of the 5 pin male header into the PCB in the area marked “PN532”. Use electrical tape to hold this assembly in place for soldering, as shown in figure 1-14. Take

care to make sure that the tape holds the connector completely upright and not tilted to the PCB (i.e. at right angles to the PCB). See figure 1-14 for details.

Figure 1-14. Mounting the 5 Pin Header.

Solder the header to the PCB and remove the electrical tape. Unplug the Argon female connector from the pin header and check your work. See figure 1-15 for what the result should look like.

Figure 1-15. 5 Pin Header Assembled onto the PCB.

Next, mount the button/LED pin header connectors on the opposite end of the PCB. The procedure is similar to the 5 pin header, above. Break off two 4 pin header sections and one 2 pin header section from a male pin header strip. Insert these into the smaller Argon female connector so that the male pin headers align with the holes on the PCB, as shown in figure 1-16.

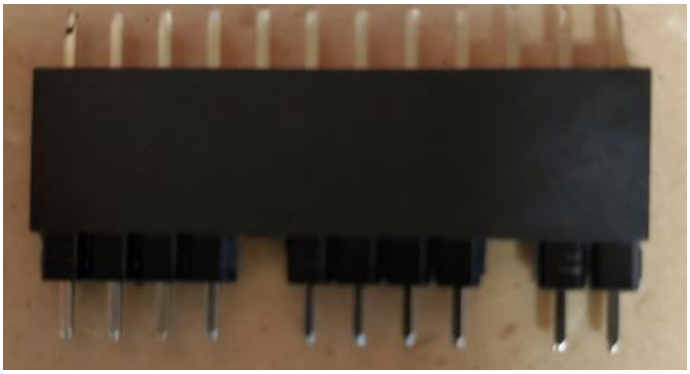

Figure 1-16. LED Connectors Ready for Assembly.

Insert the male pin header solder pins into the PCB and hold the assembly in place and upright (perpendicular to the PCB) using electrical tape, as you did for the 5 pin header. Take care that

the assembly is firmly inserted into the PCB and upright. Then solder the pin headers to the PCB. The PCB should look similar to figure 1-17.

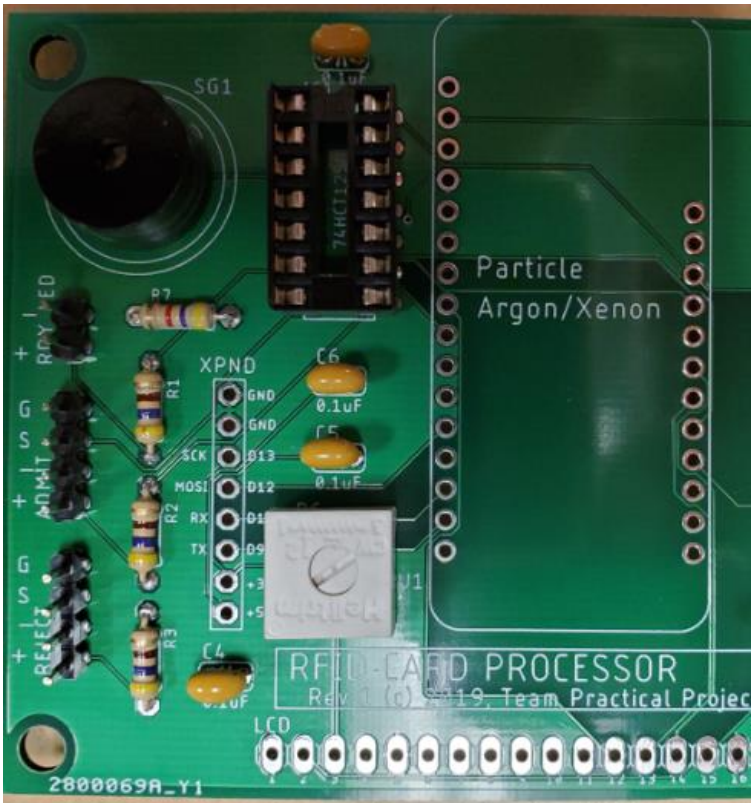

Figure 1-17. Button/LED Header Assembled to PCB.

Break off a 16 pin male pin header strip and insert it into the LCD connector on the PCB. Use electrical tape to hold the strip in place and vertical, as in the previous steps. Solder the 16 pin header strip to the PCB. We suggest that you solder the two ends and the pin in the middle first, to hold the whole connector body in place. Then solder the remaining pins to the PCB. Figure 1-18 shows the PCB as it should look after this step.

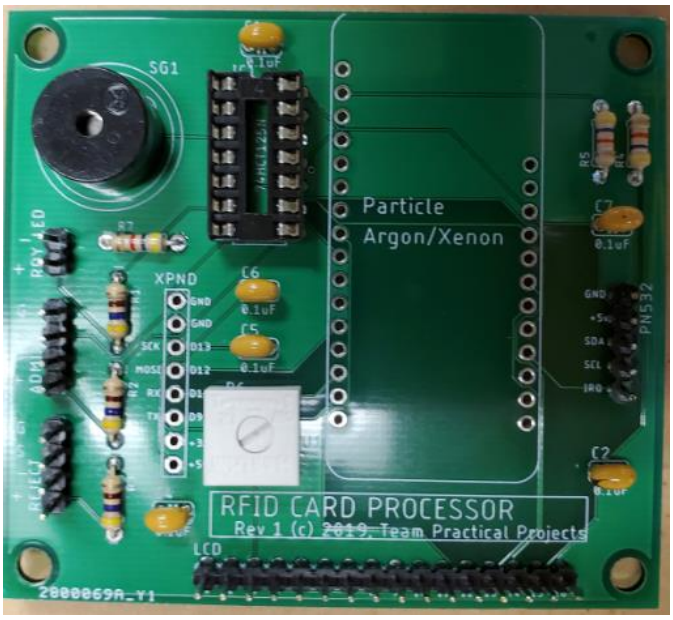

Figure 1-18. LCD Connector added to the PCB.

The next step is to mount the two female connector strips for the Argon to the PCB. The best way to assure that the connectors are soldered to the PCB in alignment (so that the Argon male pins will fit correctly into the two female connectors after soldering to the PCB) is to insert the connectors onto the Argon first, as shown in figure 1-19.

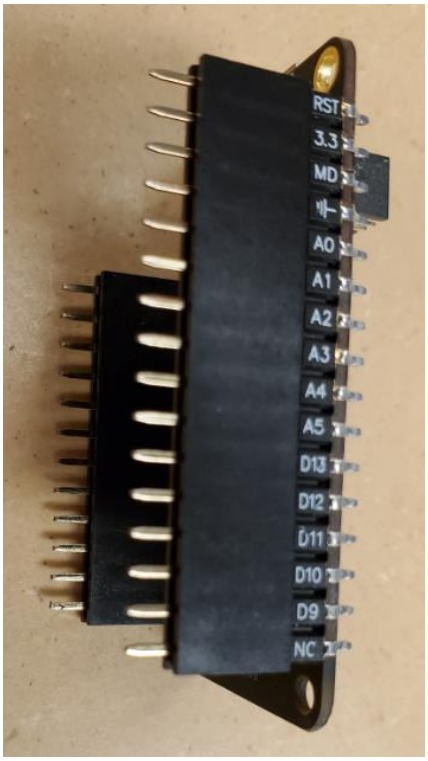

Figure 1-19. Mounting the Argon female headers to the Argon for soldering.

Next, the entire assembly is inserted onto the PCB and held on place with electrical tape. **BEWARE**: *cover the 2D barcode on the Argon with something non-sticky before placing sticky electrical tape over it*! You do NOT want the barcode label to peel off of the Argon when you later remove the electrical tape! See figure 1-20 for this step.

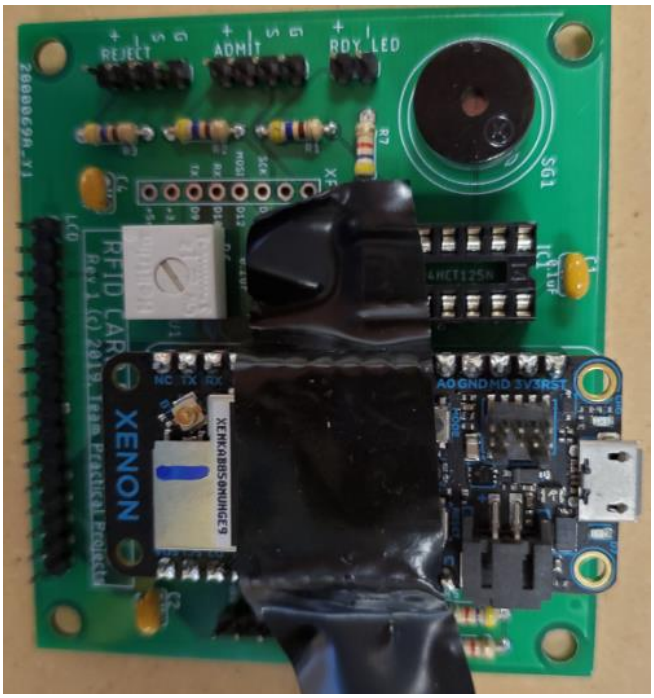

Figure 1-20. Holding the Argon/header connectors to the PCB for soldering.

Make sure that the Argon/connectors are flush to the PCB and fully inserted. Now, carefully flip the PCB over and solder the two end pins and one center pin on each of the two header connectors to the PCB, as shown in figure 1-21. Do not solder more pins than this in order to avoid heat damage to the Argon. Three pins are enough to hold the connectors firmly in place for subsequent soldering with the Argon removed.

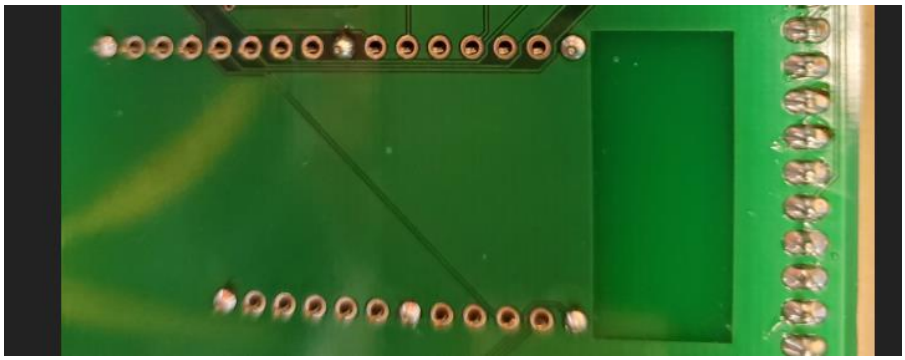

Figure 1-21. Soldering 3 pins of each connector to the PCB with the Argon still inserted.

Now, remove the Argon so that it will not be subjected to further heat stress and then solder the remaining Argon header pins to the PCB.

Carefully inspect all solder joints on the PCB to be sure that all connections have been made and that no cold solder joints remain. Clean excess solder and flux off of the underside to the PCB and inspect the top (component) side of the PCB to ensure that everything is properly mounted. The completed PCB should look like the photo in figure 1-22, below.

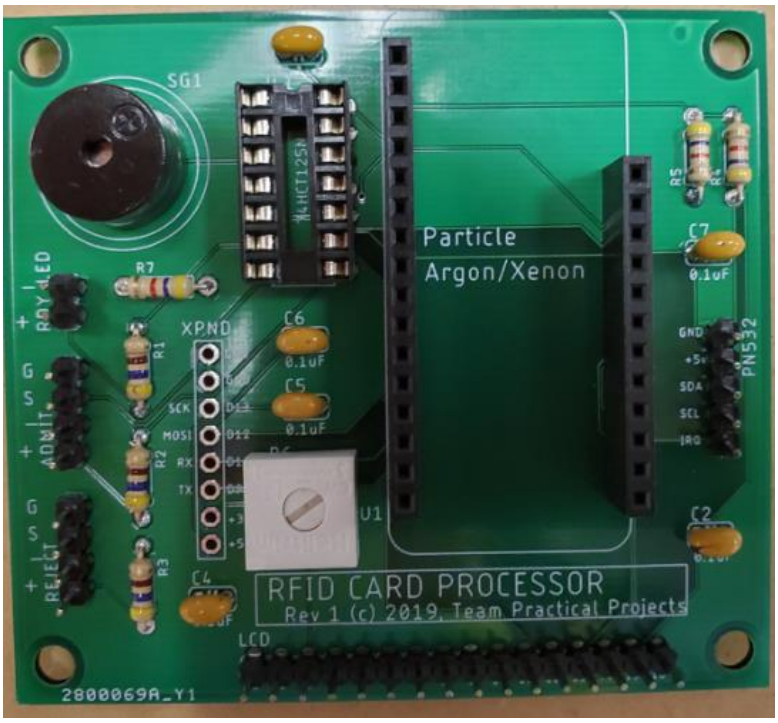

Figure 1-22. Completely soldered PCB – top view.

To finish the PCB assembly, Insert the Argon into the connectors provided on the PCB. The micro USB on the Argon should be at the top of the board as oriented in figure 1-22. Insert the 74AHCT125 level shifter IC into the 14 pin socket (IC1). The chip has a notch and/or a white dot at the top of the chip. The chip must be oriented with this notch/dot toward the top of the PCB and aligned with the notch on the IC connector.

At this point, you can power up the PCB using the micro USB connector on the Argon module. The board should power up and 5 volts and 3.3 volts should be available in the XPND connector that is just to the left of the 10 K ohm trim pot. If you want to claim the Argon to your Particle account at this time, you will first need to plug the WiFi antenna into the u.FL connector on the Argon. Skip ahead to figures 3-8 and 3-9 in the section “STATION ASSEMBLY INSTRUCTIONS”, below.

ENCLOSURE FABRICATION INSTRUCTIONS.

This section describes building the enclosure. The enclosure is laser cut from ¼" birch stock, or similar material. The laser cut parts of the enclosure are called out in figure 2-1, below.

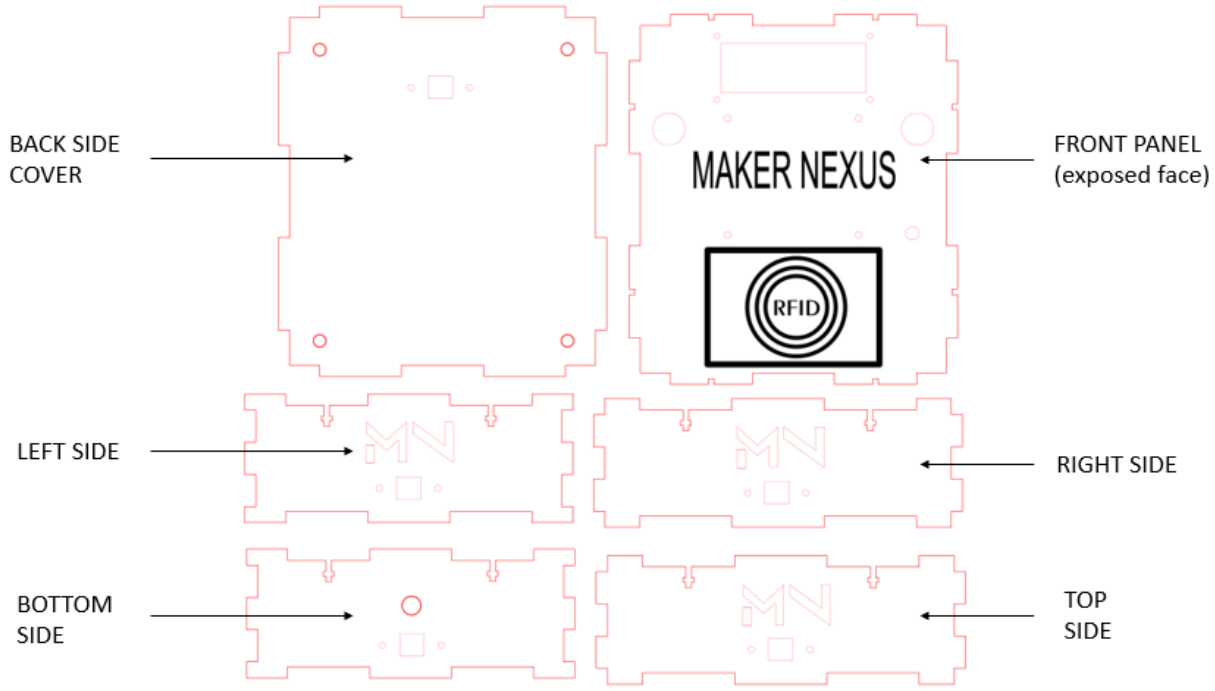

Figure 2-1. Laser cut parts of the enclosure.

Place the back side bottom cover on a flat surface with the outside face facing down. Next, fit the left side panel to the left side of the box bottom and the bottom side panel to the bottom side of the box bottom. The sides should fit snugly to the bottom panel and should stay in place temporarily without gluing. Fit the right side and top side to the box bottom in the same way. The enclosure parts should all fit snugly. Check that the outside surfaces are positioned on the outside of the enclosure. Check that the front panel fits correctly onto the assembled box with the engraving facing up. Now remove the front panel. Glue the box pieces together with wood glue or other fastener that is compatible with the enclosure material. Wait for the glue to dry. Double check that the enclosure front panel fits correctly onto the assembled enclosure and that the front cover mounting screws fit in the indentations on the front panel and the enclosure side.

The front panel is NOT glued onto the enclosure – it is held to the enclosure by machine screws and nuts. The assembled enclosure should look like the figures below.

Figure 2-2. Assembled enclosure – top view.

Figure 2-3. Assembled enclosure – top side view.

Figure 2-4. Assembled enclosure – bottom side view.

STATION ASSEMBLY INSTRUCTIONS.

This section contains instructions for mounting the RFID Station electronic components onto the enclosure. Prior to this step, you should have completed assembly of the *RFID Card Processor* printed circuit board (PCB) and have the laser cut enclosure top (front) panel available. All of the electronics (except for the box power cable) mount on the underside of the enclosure top panel.

The tools that you will need for the steps described in this section are:

- Fine tipped electronics soldering iron
- Electrical solder
- Needle nose pliers
- Diagonal wire cutters
- Calibrated wire stripper
- Phillips head screwdriver
- (optional) swage connector crimping tool
- Electrical tape
- Hot glue gun
- Multi-meter

The LCD display module and the custom PCB mount onto the underside of the top (front) panel using M3-05 x 16 mm machine screws. The panel is laser cut to accommodate tapered phillips head screws that fit flush into the top (outside face) of the panel. If necessary, use a 7/32” drill bit to manually ream out the mounting holes on the top side of this panel until the phillips head screws fit flush to the panel face. The screws are held in place by M3 nylon washers which also serve as standoffs. See figure 3-1, below.

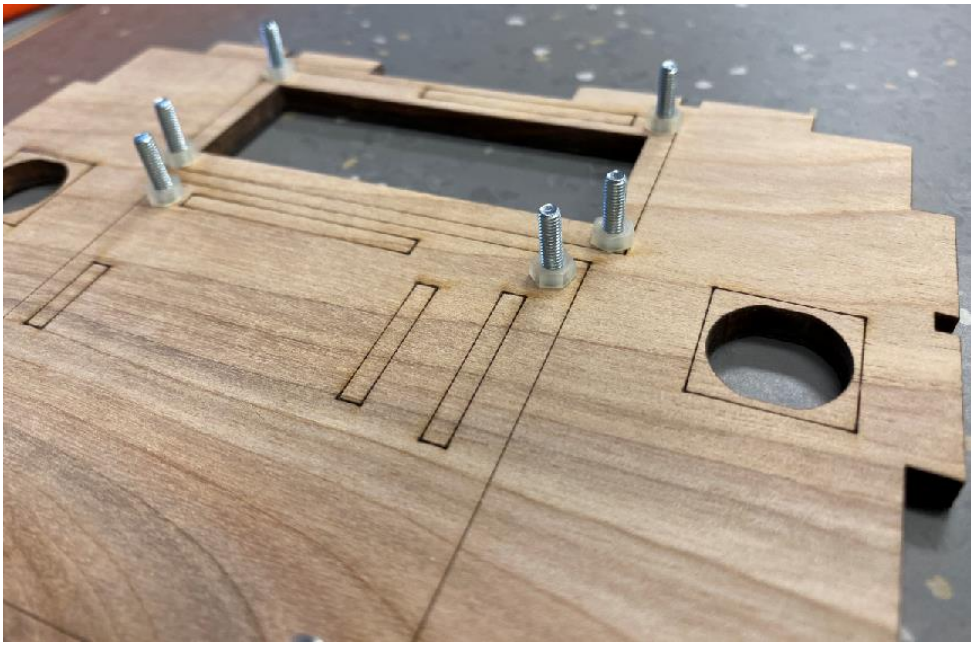

Figure 3-1. Mounting for the LCD display and PCB using machine screws.

Eight screws are used to mount these components – 4 for the LCD display module and 4 for the PCB. A second set of nylon washers is used to hold these modules in place after they are inserted onto the enclosure panel. The finished assembly picture in figure 3-10 illustrates this. At this point, however, you should simply prepare the panel as in figure 3-1.

The next step is to solder pigtail connector wires onto the red and the green backlit pushbutton switches. The connections to these switches are shown in figure 3-2.

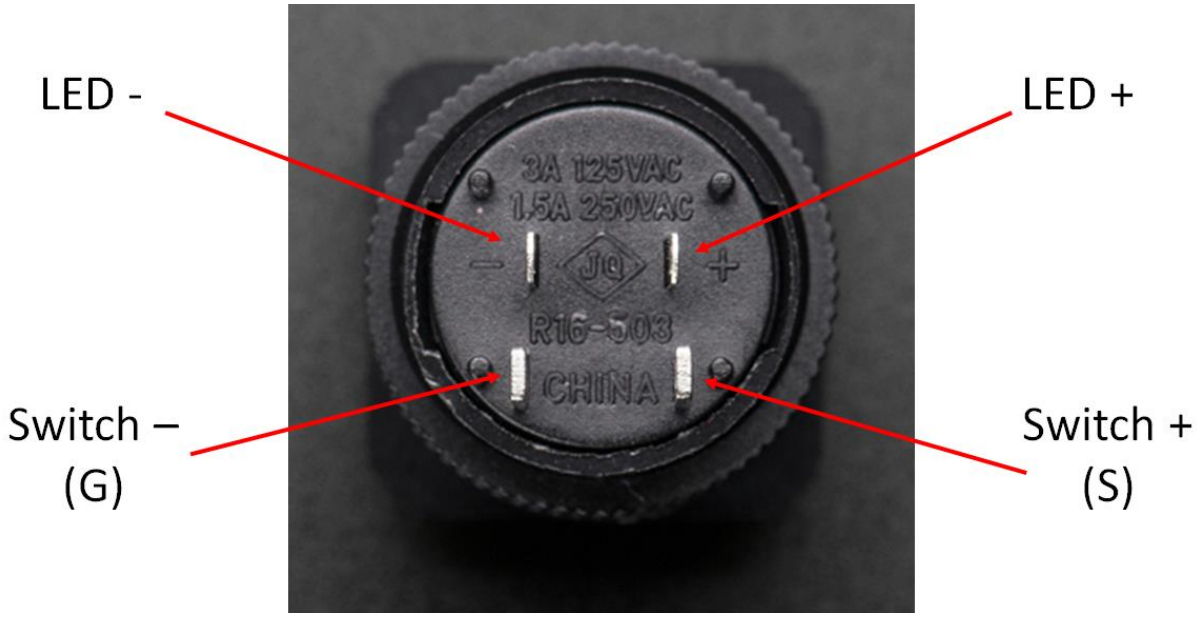

Figure 3-2. Pushbutton switch terminals.

Four 9-inch long female-female wires are used to connect these terminals to the corresponding male connectors on the PCB. There are several ways to prepare these wires for soldering to the pushbutton switch swage terminals:

- Cut off the female pin header connector at one end of each wire; carefully strip back ¼" of insulation from the cutoff end of the cable; tin the bare wire and solder to one of the swage lugs on the pushbutton switch. This method is illustrated in figure 3-3, below.
- Cut off the female pin header connector at one end of each wire; carefully strip back ¼" of insulation from the cutoff end of the cable; crimp a matching swage connector onto the bare wire. The swage connector must fit snugly onto the pushbutton switch terminal.
- Bend and solder a stiff, male header pin to each pushbutton switch terminal, making sure that the mechanical connection is solid. Female-female jumper wires can then be connected to the male terminals at both the pushbutton switch and the PCB ends.

Regardless of the method that you use, you should use a different color wire for each terminal on the pushbutton switch and you should CAREFULLY note which color goes with which terminal, as annotated in figure 3-2.

After affixing 4 connector wires to each of the red and green pushbutton switches, take two more female-female connector wires and solder them to the 5 mm green LED, using any method that suits you. Once more, make CAREFUL note of the color of the wires – the longer lead on the LED is the "+" wire and the shorter lead on the LED is the "-" wire. The finished product should look like figure 3-3, below.

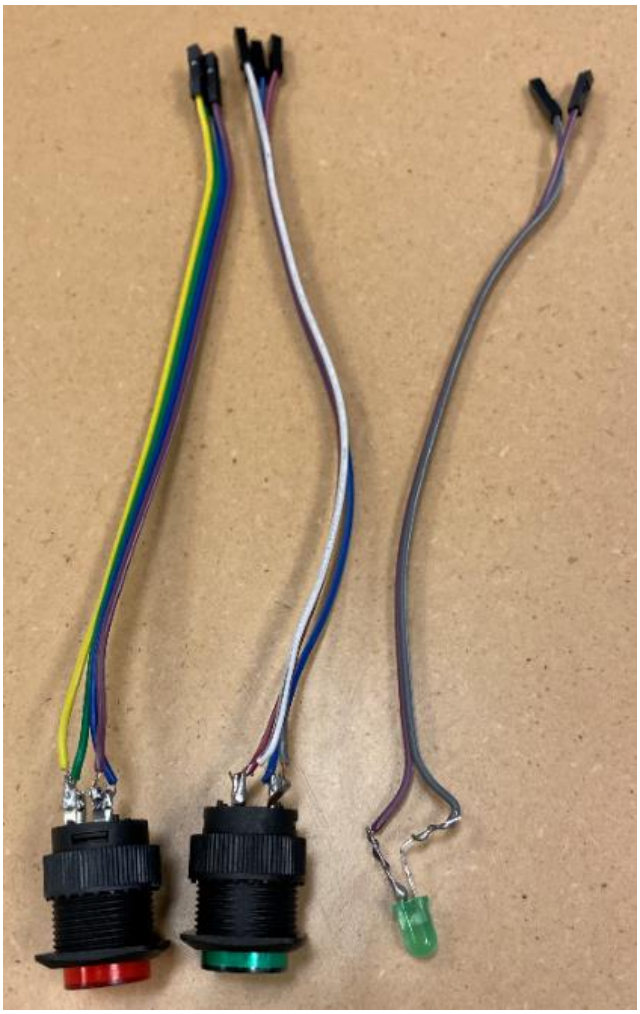

Figure 3-3. Cable assemblies for the buttons and ready LED.

Break off a 16 pin male header and solder it to the LCD module with the male connector pins on the bottom (non-display) side of the LCD module; see figure 3-4. Now mount the LCD panel on the mounting screws and fasten tight using 4 nylon nuts; see figure 3-4.

Mount the red and green pushbutton switches onto the enclosure front panel as shown on figure 3-4. The pushbutton switches come with their own threaded hold-down fasteners. The red pushbutton is on the left side as viewed in figure 3-4; the green pushbutton is on the right side.

The 5 mm green LED can be panel mounted using the parts in the parts list. However, the enclosure panel is too thick for these panel mounts to fit well. Take a 7/16” drill bit and use it to manually ream out some of the panel thickness until the LED panel mounting clips snap the LED firmly into place. See figure 3-4 for what the results of this step should look like.

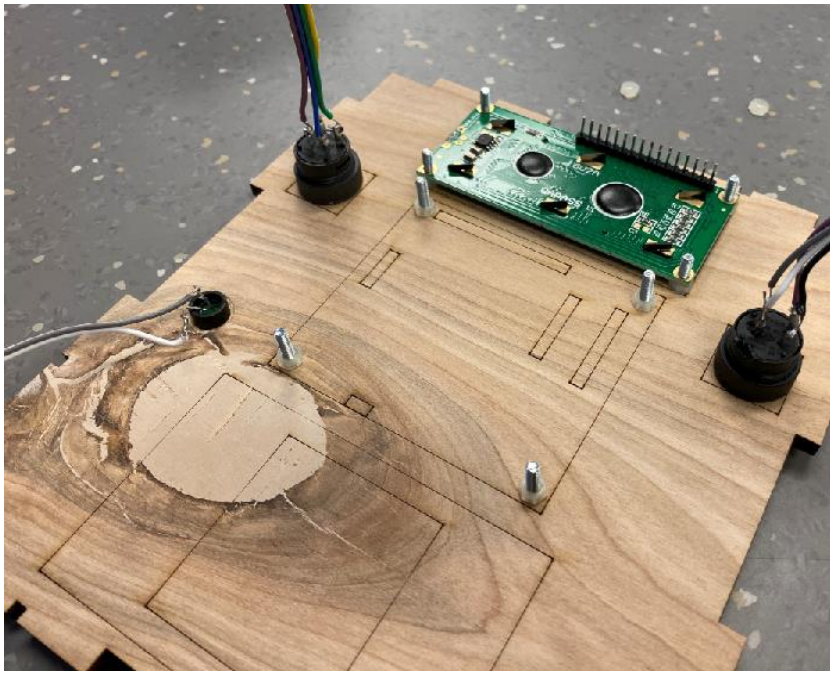

Figure 3-4. Mounting the LCD, buttons and admit LED.

Strip off a 16-wire strip from the female-female ribbon cable assembly from the parts list. Connect one end of this cable to the LCD male header pins, as shown in figure 3-5, below. Be careful to place the connections in the order of the wires in the ribbon cable; the wires are one-to-one in order between the LCD module and the corresponding 16-pin male header on the PCB. The cable listed in the parts list is about 8” long; however, shorter wires (4” or longer) may be more convenient, if you have them.

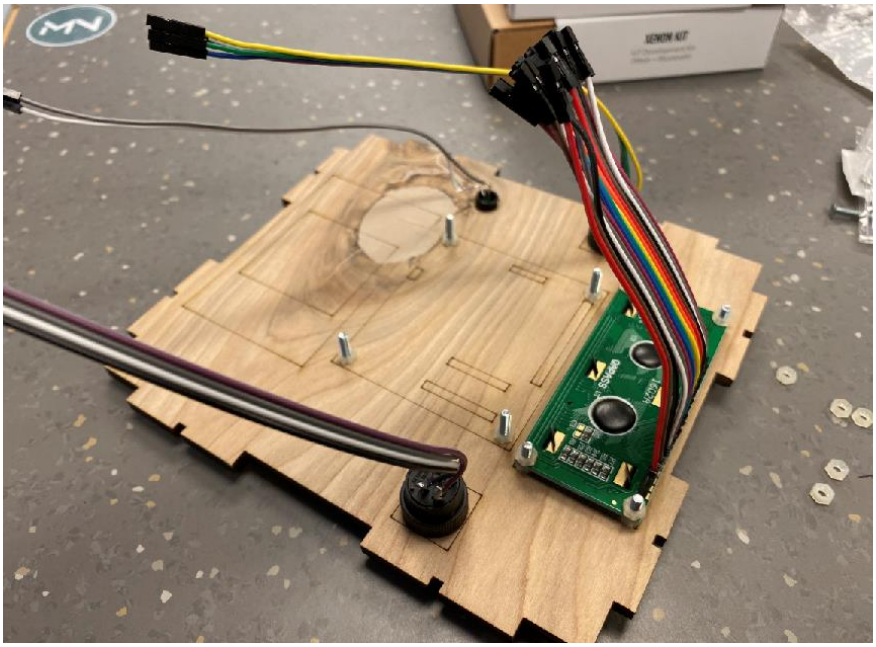

Figure 3-5. LCD cable.

The next step is to prepare the PN-532 RFID module for mounting and cabling. If the module does not have male pin headers soldered onto it, break off a 4 pin section of Male PCB headers and an 8 pin section of male PCB headers and carefully solder them onto the component side of the PN-532 RFID reader module, as shown in figure 3-6. Use electrical tape to hold the headers in place on the top of the board while soldering to the bottom side of the module. Take care to ensure that the pin headers remain vertical while soldering them into place.

A 5-wire strip of female-female ribbon cable is used to connect this module to the RFID male header connector on the PCB. Four of the wires attach to the 4 pin header marked: GND, VCC, SDA, SCL, in order. The fifth wire attaches to the IRQ pin on the 8-pin male header. The other 7 pins on this header are not connected. Make a careful note of which color wire is attached to which pin for later connection of this 5-wire cable to the electronics PCB.

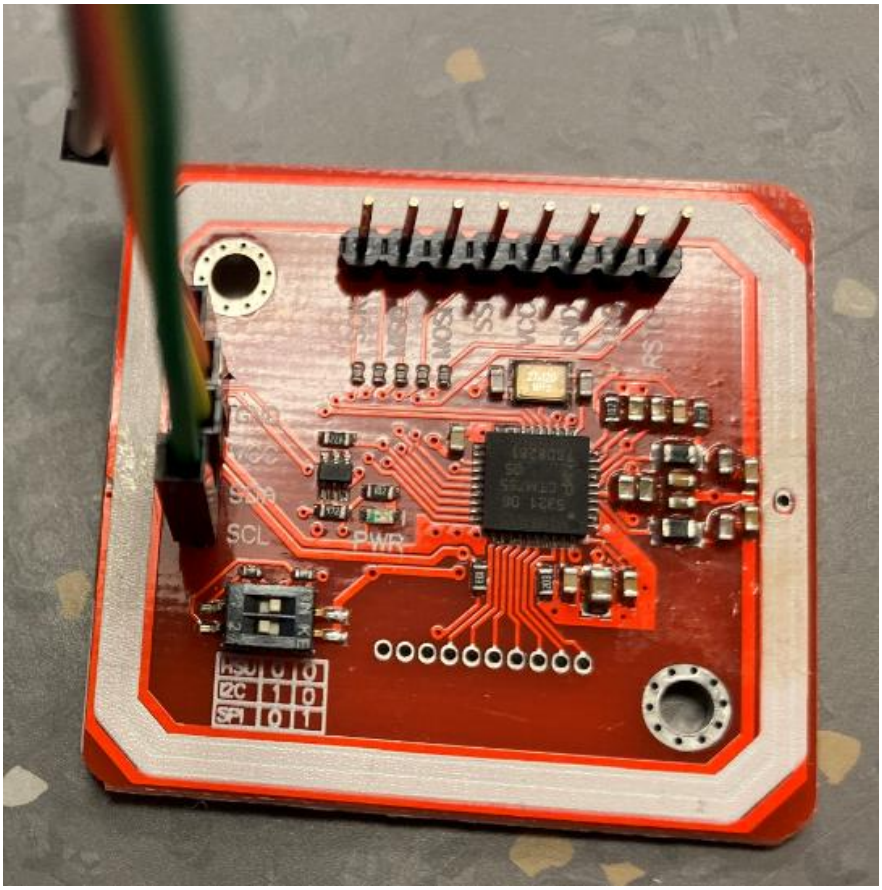

Figure 3-6. Cabling the RFID board.

There are a set of 2 micro-miniature DIP switches just below the 4 pin header on the RFID module. Carefully remove the plastic covering these switches and use a tiny screwdriver to set them as shown in figure 3-7. Double check that these switches are set as in the figure and 3-7 and fully seated into these positions. *Otherwise, the RFID module will not work!*

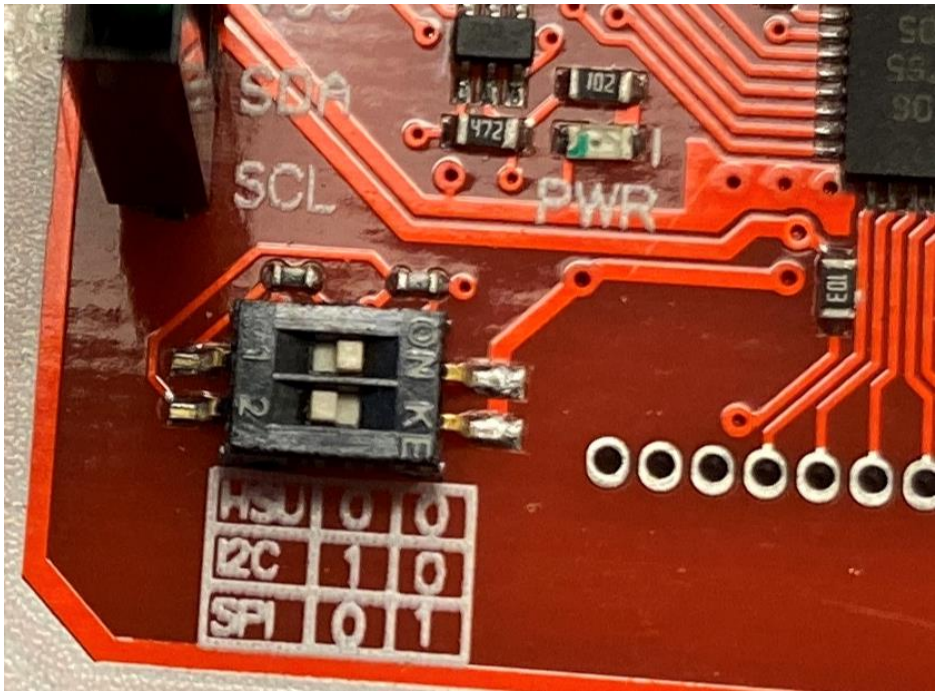

Figure 3-7. Setting RFID DIP switches.

The custom electronics PCB was assembled in an earlier step. It is now time to connect the patch antenna to the WiFi u.FL connector in the Argon module that is in the PCB, See figure 3-8 for details.

The u.FL connector is very small and quite hard to position so that it snaps into place securely. A closeup of this connection is shown in figure 3-9, illustrating correct insertion of the antenna connector onto the Argon module.

Next, use a hot glue gun to glue the PN532 RFID module to the underside of the front panel. Position the RFID module so that the male pin headers are away from the micro USB connector on the electronics PCB when the PCB is mounted as shown in figure 3-10 below. Glue down just the corners of the module and let the glue cool before proceeding.

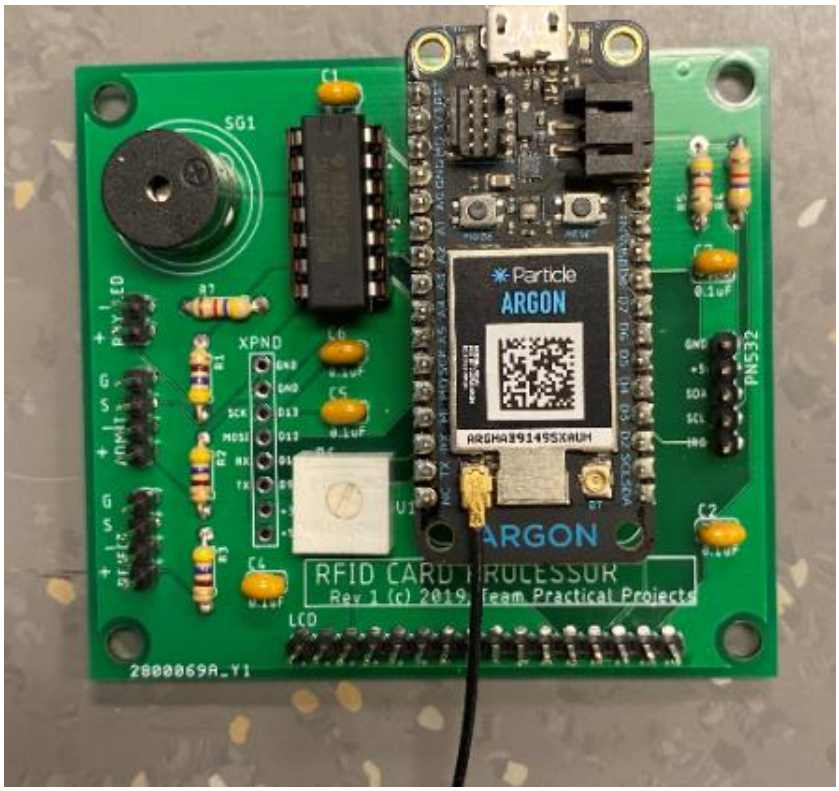

Figure 3-8. Connect WiFi antenna to Argon.

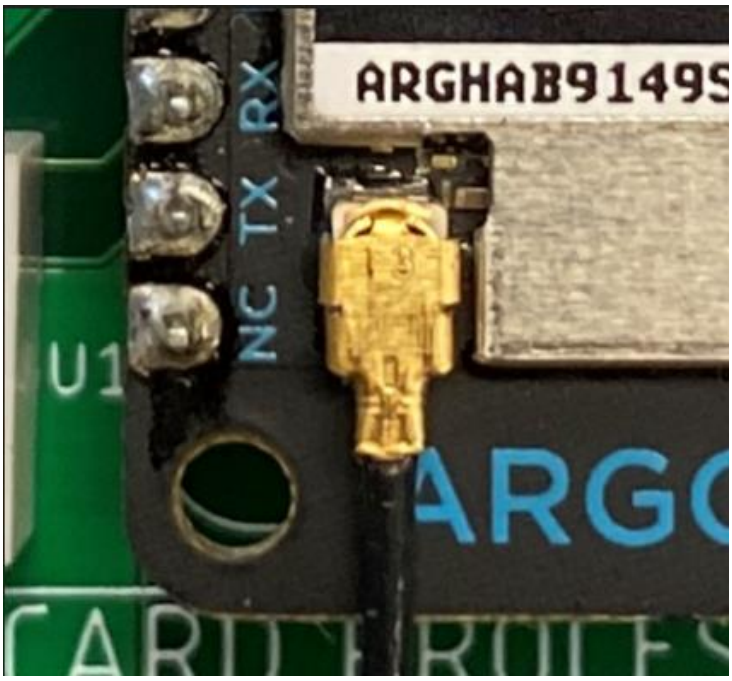

Figure 3-9. WiFi antenna detail view.

Now, we are ready to mount the custom electronics PCB onto the screws in the enclosure panel, as shown in figure 3-10, below. Mount the PCB so that the 16 pin LCD header connector is adjacent to the LCD module and connect the LCD ribbon cable female pins to the male pins on the PCB, as shown in the figure. *Make absolutely sure that that cable connections are one-to-one between the LCD module and the PCB; no wires should be crossed*. Use the wire colors to double check your work!

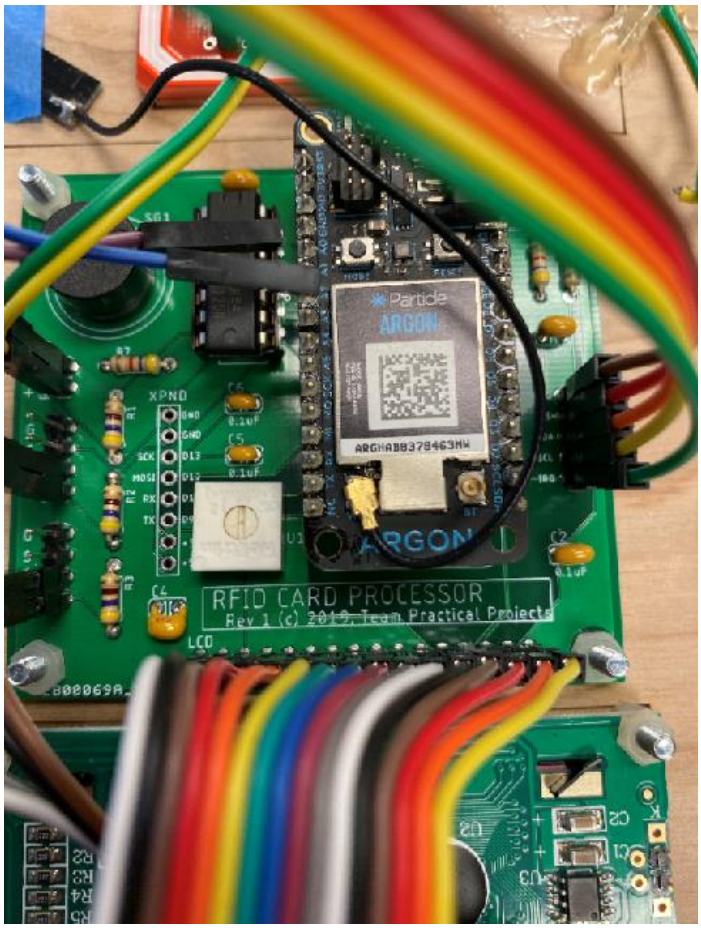

Figure 3-10. Mounting and cabling the PCB.

Next connect the 5-wire ribbon cable from the PN532 RFID module to the PN532 male header connector on the PCB. Make sure that the corresponding signals are connected to the correct pins, as indicated by the labeling on the PCB.

Finally, connect the cables from the pushbutton switches and the green LED to the corresponding male header pins on the PCB, following the labeling on the PCB. Go back to your notes about which color wire is connected to which contact on the pushbutton and the LED

to ensure that you connect the correct wires to the correct pins. *The LED connections are polarized and the LEDs will not light of the connections are reversed*.

The final step in the enclosure assembly is to mount the pigtail power cable on the enclosure and connect it to the micro USB on the Argon module. See figure 3-11 for details.

Figure 3-11. Mounting the power cable between the PCB and the enclosure.

The power cable comes with its own box mounting screws. The enclosure is laser cut with power cable mounts on each side and on the back of the enclosure. Mount the power pigtail cable to the enclosure wherever it makes most sense to bring power to the RFID Station when it is mounted in your facility. Take care to route the power cable so that it does not interfere with

the ribbon cables connecting the RFID module to the PCB. If necessary, re-route the RFID module ribbon cables to not interfere with the power cable route.

The enclosure is now complete. The top panel can be flipped over so that the electronics mounts inside of the enclosure and the top panel is seated correctly into the box.
Eight black M3 machine screws and nuts are used to fasten the top panel firmly onto the rest of the enclosure. There are cutouts in the side of the enclosure to fit in the screw body with a nut attached to it. The knurled screwheads can then be manually tightened to hold the cover firmly to the rest of the enclosure. However, we recommend that you power the electronics and test it out before you close up and fasten the enclosure.

You can now connect the power to the power pigtail cable on the enclosure, using the USB 5 volt power supply and a USB A/B male cable. The Argon should go through its bootup procedure and you should follow Particle's directions to claim your Argon to your Particle account, if you haven't already done so. (https://docs.particle.io/quickstart/argon/) (https://docs.particle.io/tutorials/device-os/led/argon/).

After the RFID Station powers up, you should look at the LCD module. The LCD should be lit up. Take a small screwdriver and adjust the 10 k ohm trim pot (R6) on the electronics PCB until each of the 2 rows of 16 characters is illuminated but the background of the LCD is dark. There won't be any useful information on the LCD at this point in time, but the LCD contrast will be optimized using this procedure.

FIRMWARE INSTALLATION AND TESTING INSTRUCTIONS.

After capturing the Argon to your Particle account, you need to flash the firmware to it. Comprehensive testing of the RFID Station requires a complete system installation. This includes setting up secret encryption keys, configuring EZ Facility for API access, setting up and configuring the Facility Database, setting up Particle webhooks that interact with the Facility Database and EZ Facility, and flashing the station firmware to the Argon. See the document "*RFID_System_Build_and_Install_Manual*" in the *Documents* folder in this repository for details.

Once the system is set up and firmware flashed to the RFID Station, the Station will boot up into the DEFAULT station type. When this happens, the following should be observed:

- The red REJECT pushbutton LED lights continuously.
- The green ADMIT pushbutton LED lights continuously.
- The green READY LED lights continuously.
- The buzzer sounds briefly.
- A message is displayed on the LCD panel.

If these tests all pass, the RFID Station can be set to be another station type using the *MN_Station_Configurator* app or the Particle Console. See the "*RFID_System_Build_and_Install_Manual*" for details.

If these tests do not pass, or if the RFID Station does not respond to an RFID card being presented to it, see the *Troubleshooting* section, below.

TROUBLESHOOTING.

This section is intended to help you troubleshoot your RFID Station in the event that there is a hardware problem with your Station. This is not intended to be a comprehensive troubleshooting guide, but the information may be helpful for common problems.

The Station Appears Dead.

If there are no lights, sounds or any signs of life, the first thing to check is the power. The PCB has an expansion connector field (XPND) with +5 volts, +3.3 volts, and two GND pins on it. Take a multi-meter and check for the presence of 5 volt and 3.3 volt power to the PCB. The +5 volt power should be between 4.5 and 5.5 volts. The +3.3 volt power should be between 3.0 and 3.6 volts. If any of these tests fail, check the following:

- Make sure that you have USB power to the micro USB connector on the Argon. Check all power supplies and cables.
- Make sure that the Argon is inserted correctly into the header socket pins.
- Make sure that the 74AHCT125 IC is inserted correctly into its socket. Unpower the PCB remove this chip from its socket and then repower the PCB and check the voltages again. If the power is now correct, then something is wrong with this IC or its insertion into the board.
- Remove power and remove the Argon from its socket. Place the Argon on a flat, non-conducting surface and plug USB power back into its micro USB socket. If the Argon comes up powered properly, then there is something wrong with the PCB. If the Argon does not come up properly, then the Argon module is bad.
- If the PCB has a problem, carefully check and then double check all solder connections. Make absolutely sure that there are no solder bridges, either between solder connections and/or between a soldered pin and a via on the PCB. Also, make sure that there are no cold solder joints anywhere on the PCB.
- Remove the Argon and the 74AHCT125 IC from their sockets. Remove all cables from the PCB. Use a multimeter to check the resistance between +5 volts and GND and between +3.3 volts and GND. The +5 Volt – GND should read as an open circuit. The +3.3 volt – GND should read about 10 K ohms (owing to the LCD trim pot R6). If this is not the case, then there is something wrong with the PCB assembly.
- If the PCB checks out OK, then put the 74AHCT125 chip and the Argon back into their sockets but do not reconnect any of the external connections to the PCB. Power up the Argon and check the +3.3 volt and +5 volt supplies. If these are OK, then the cabling to the PCB is the problem. If not, then the board is the problem.
- Unpower the PCB. Re-cable each component to the PCB, one component at a time, and then re-power the PCB: READY LED, ADMIT pushbutton, REJECT pushbutton, LCD, and RFID module. If there was a cabling problem, it should be apparent in this process. If not, then the bad external component should be apparent in this process. Check the polarity on the LEDs and the cable and solder connections to each of these external components until the problem is isolated and corrected.

Checking out the Buzzer, Pushbutton LEDs and READY LED.

If the PCB seems to come up OK but any of these components does not seem to be operating, then carefully check the connections between the affected component and the PCB. Make sure to double check the polarity of LEDs. *If an LED is wired backwards, it will not light up*. Likewise, if the buzzer was inserted backwards, it will not sound.

The Particle *Tinker* app can be used to test out these components by setting the relevant Argon pin to HIGH (to activate the component) and LOW to deactivate it. The Argon pins to activate are as follows:

- Buzzer – pin D2
- Ready LED – pin D4
- Admit (green) pushbutton – A4
- Reject (red) pushbutton – A5

NOTE: These devices are level-shifted from 3.3 volts to 5 volts using the 74AHCT125 IC. If the component is correctly wired to the PCB, use a multimeter to check the voltage out of the relevant pin on the Argon and the voltage out of the relevant pin on the level shifter IC. The IC may be bad or a pin may not be correctly inserted in the IC socket, or the socket might not be soldered correctly to the PCB.

Checking out the LCD Display.

If the PCB seems to come up OK but the LCD is completely dark, then the LCD has been cabled incorrectly to the PCB, or else the header pins are not correctly soldered to the LCD or else the PCB or the cable itself has a defect. Carefully check all connections. Note: it is very easy to get wires crossed in the interconnecting ribbon cable, so *triple check* your connections!

LCD pin 15 should have 3.3 volts to it – this is the backlight power pin. The corresponding backlight ground pin is pin 16. Check that backlight power is on the LCD. You might want to remove all of the other cable connections to the LCD module except for these two pins and make sure that the backlight is wired correctly. If there is power across pins 15 and 16 and the backlight doesn't come on, then the LCD module is bad.

If the LCD backlight is on but there is no display on the LCD, and if the cabling between the PCB and the LCD is correct, then the first thing to do is to adjust the trim pot (R6) on the PCB. Turn the pot control until the maximum contrast between the characters and the background is obtained.
If the LCD is backlit and the contrast is correctly adjusted but there are no characters on the display, then either the cabling is bad, the connector pins on the LCD or the PCB are not soldered in well, or there is a solder short in the connector or the cabling is incorrect or the cable wires are bad. Triple check all of these things. *It is very easy to have a female cable connector not be plugged into the male board connector pin but look like it is connected properly*, owing to

the density of this connector. If everything else looks good and the LCD seems to be working but the information displayed is not correct, then reset the Station and try again. If this does not work, re-flash the firmware to the Station and try again. If all else fails, go to the Particle web IDE and look for the “LiquidCrystal” library. Load the test code “Spark-HelloSparkey.cpp” into the web IDE. Change the pin definitions as follows:

- LCD RS – Argon A0
- LCD EN – Argon A1
- LCD D4 – Argon A2
- LCD D5 – Argon A3
- LCD D6 – Argon D5
- LCD D7 – Argon D6

So, the declaration in the test code should be:

LiquidCrystal lcd(A0, A1, A2, A3, D5, D6);

After making this change to *Spark-HelloSparkey.cpp*, compile this code in the Web IDE and flash it to the Argon to test out the connections to the LCD.

Checking out the PN532 RFID Module.

If the PCB seems to come up OK but if the Station doesn’t respond to the presence of RFID cards, then there may be a problem with the PN532 RFID module. The first thing to note is that the little yellow LED on this module is lit. If it is not lit, then the module does not have power from the PCB. Check the cabling between the PN532 pin header on the PCB and the RFID module. Make sure that +5 volts and GND are correctly cabled. The LED on the RFID module must be lit to indicate that the module is powered.

Next, check the micro DIP switch settings. The PN532 RFID module will not work if these DIP switches are not set properly. See figure 3-7 in this document for the correct settings of the DIP switches. *NOTE: the DIP switches are very small and hard to see*. Flip each switch back and forth to make sure that the final setting of each DIP switch is positively in place.

If the DIP switches are properly set, double check the cabling between the module and the PCB. Make sure that the INT pin, which is on a different connector on the module from the other connections, is connected to the INT pin on the PN532 header connector on the PCB.

Make sure that you are using Mifare Classic 1K cards! An incorrect card type may not give any response when presented to the RFID module in the Station.