SHARI PiHat Allstar Node Construction Manual

SHARI (**S**A818 **H**am **A**llstar **R**adio **I**nterface) PiHat Allstar Node is a kit construction project that implements a Raspberry Pi4 hosted Allstar node using a NiceRF SA818 embedded UHF (420 – 450 MHz) or a VHF (144-148 MHz) radio module. The radio module and interface circuits are located on a custom Raspberry Pi Hat board. A complete Allstar node can be implemented with a SHARI PiHat kit, a Raspberry Pi 4 (with power supply and microSD card) and an Allstar image.

Figure 1 - SHARI PiHat complete node

Figure 2 – SHARI PiHatU board installed in case with Raspberry Pi 4

A SHARI PiHat Allstar Node kit consists of the SHARI PiHat PCB with antenna and a case.

The SHARI PiHat PCB is implemented with surface mount parts and through-hole connectors. The board is supplied with all the small surface mount parts installed. The kit builder installs two through-hole connectors, an SMA RF connector and the SA818 radio module.

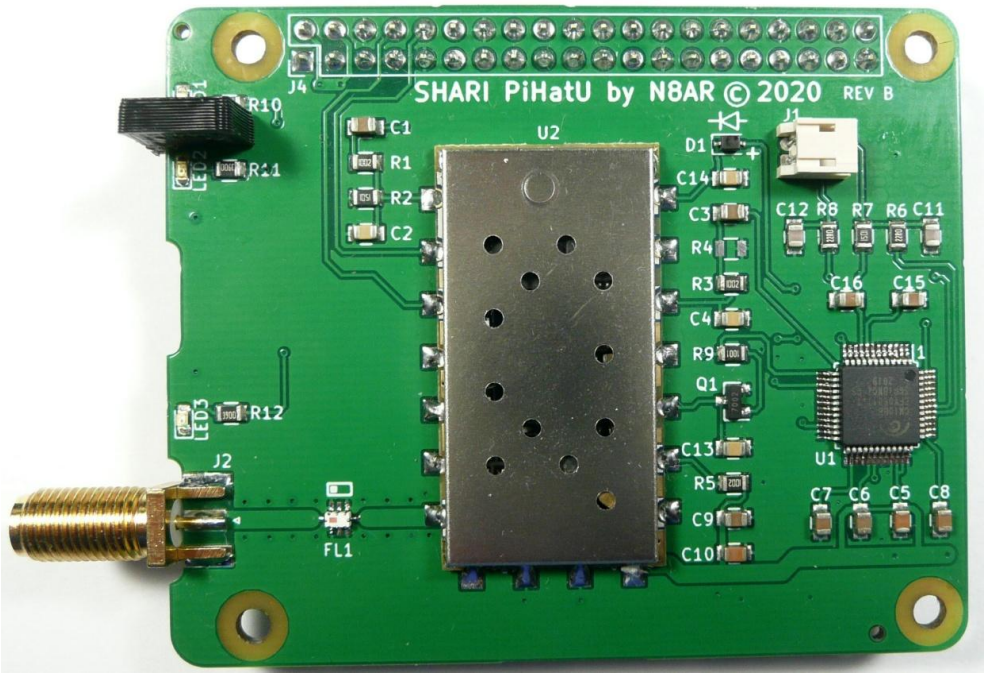


Figure 3 – Completed SHARI PiHatU (UHF) PC board assembly

The kit also contains an Argon Neo case. The kit builder drills 5 holes in the case. A 3D printed hole location template is supplied with the kit to aid in proper hole location.

Figure 4 – Argon Neo Package

SHARI is supported via the SHARI group at www.groups.io/g/shari

Disclaimer:

This device interfaces with equipment that could be damaged by said device. You are responsible for installing, configuring, testing and verifying that the device performs properly in your environment. The developers cannot be held liable for any direct, indirect, consequential or incidental damages to other pieces of software, equipment, goods or persons arising from the use of this device.

Since you are assembling a kit for use in the amateur radio service, you are responsible for proper operation of the assembled unit including RF power output, proper modulation, output frequency and harmonic/spurious output levels.

By constructing this device you accept the above terms.

Release Notes:

RELEASE	DATE	CHANGES
1.00	2020-07-26	Initial release
1.01	2020-08-26	Added more detail the SA818 installation procedure. Other minor changes
1.02	2020-10-03	Added USB filler plug and more SA818 module soldering instruction details

Table of Contents

SHARI PiHat Allstar Node Overview

Key Features

- Uses CMedia CM108B or CM119B USB Audio IC.
- Uses a NiceRF SA818 UHF (420-450 MHZ) or VHF (144-148MHz) embedded radio module (www.nicerf.com) with an LTCC lowpass output filter
- 150 to 400 milliwatts RF output power
- Raspberry Pi4, power supply and microSD card provided by kit builder.
- Argon Neo rugged RFI-resistant metal enclosure also acts as heat sink for the Pi4.
- RX/TX serial connection from the Pi4 GPIO to the SA-818 radio module to change RF module parameters including RF and CTCSS/CDCSS frequencies.
- 3D printed plastic hole location tool to aid in modifying the case

Setting Expectations

- **What's missing from this miniature design?**
    - External frequency selection - RF frequency, CTCSS frequency and squelch level is set by running a program on the Raspberry Pi.

- **Degree of soldering difficulty –Medium**
    - Assembly of the SHARI PiHat kit requires standard through-hole soldering of two through hole leaded connectors. The embedded radio module is surface mounted using castellated holes soldered to very large solder pads on the PCB. The SMA RF connector is also soldered to large pads on the PCB. **The builder also has to solder two small wires to test point pads on the Raspberry Pi4.**

- **Degree of mechanical difficulty - Medium**
    - The kit builder has to drill 5 holes in the Argon Neo case. A 3D printed hole location tool is included with the kit to aid in this process.

Required Materials

- SHARI PiHat Kit

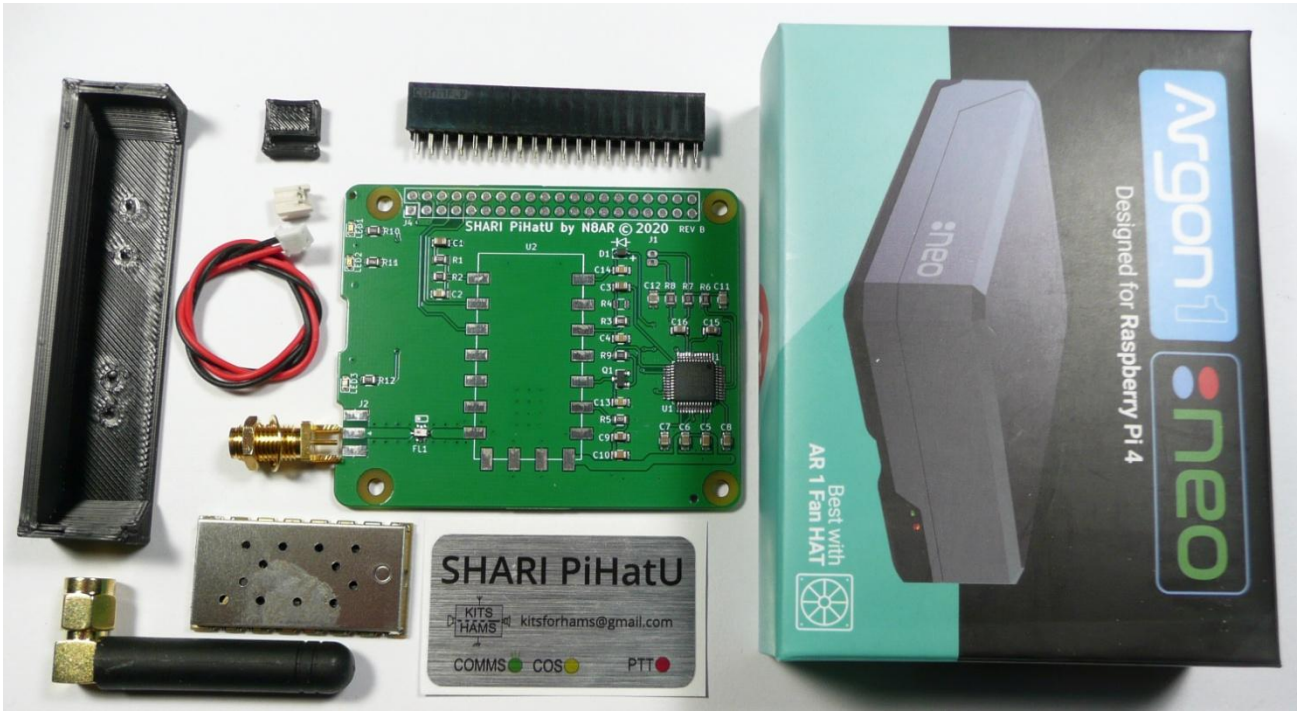


Figure 5 – SHARI PiHatU Kit Parts (Ferrite Core and USB Filler Plug not shown)

- Kit Builder Supplied Parts
  - Raspberry Pi4 (1,2 or 4 GB ram)
  - Raspberry Pi4 Power Supply
  - MicroSD card (16 GB recommended)

- Tools
  - Low wattage (50 watt) temperature controlled soldering station with small tip and solder.
  - Phillips screwdriver (#1)
  - Small side cutters
  - Automatic center punch
  - Drill set with 1/16”, 1/8” and 9/32” drills
  - Drill motor or drill press
  - Small hot glue gun

Step 1. Drilling the Required Holes in the Argon Neo Case

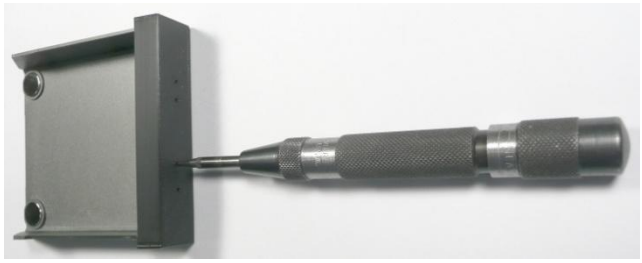
Perform this step if the required holes are not already drilled in the Neo case.

In this step you will drill the required holes in the Argon Neo case. The holes are:

- Three 1/16” LED viewing holes
- One 9/32” SMA connector clearance hole
- One 1/8” USB cable pass-thru hole.

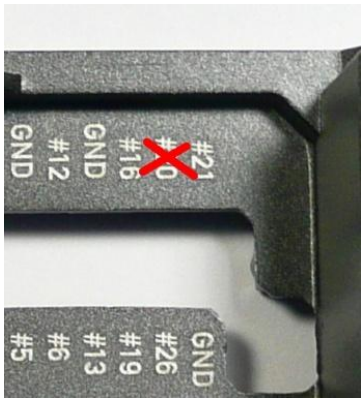
The location of all the holes should be carefully marked. An automatic spring-loaded center punch is ideal for this task. Marking with a scribe and center-punching the marks also works.

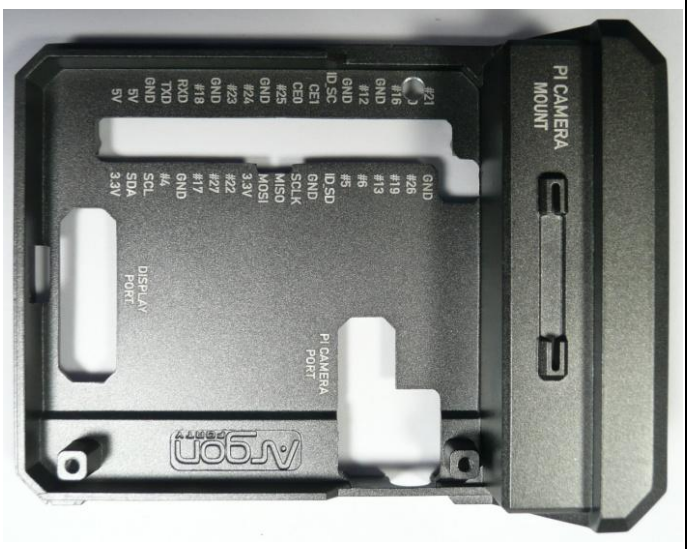
Locate the 3D printed hole location tool provided with the kit	
Install the hole location tool onto the end of the Argon Neo case top cover.	

Ensure that the hole location tool contacts all surfaces of the cover. Check that the cover is fully seated and verify that it contacts the tool in the area shown as red dashes in the picture.	
Use a center punch to mark the location of the four holes in the top cover. An automatic center punch with a small tip is ideal. If your center punch has a larger tip, consider drilling out the holes in the hole location tool to the diameter of the tip of your center punch. You could also use a small sharp scribe to mark the hole locations and then use your center punch.	
Drill three 1/16” holes to the left and one 9/32” hole to the right as shown in the picture. The three holes to the left are LED viewing holes. The hole to the right is a clearance hole for the SMA antenna connector. Use care to ensure that the holes are centered on the original marked locations. A step drill with two flutes works great to drill the 9/32” hole. It is recommended that a small drill be used to start each hole and then the hole be expanded to the required size using drills of increasing diameter to ensure that the finished holes remain centered on the marked location.	

Now use a larger drill, twisting it by hand, an exacto knife or a small file to remove the paint around the 9/32” hole for about 1/32” so that the serrated washer used under the nut of the SMA connector which protrudes thru the hole will contact bare metal and not just paint. This is critical. If the connector is not electrically connected to the case at this point you may hear a “whine” at about 1 kHz in the SHARI PiHat audio.

Locate the center piece of the Argon Neo case. You will be drilling a 1/8” USB cable clearance hole located on the “2” of “#20” as shown by the red “X” in the picture.



Mark the hole location with a center punch and drill a 1/8” hole.	

Step 2. SARI PiHat PCB Assembly

In this step, you will complete the PC board assembly by soldering the SA818 Radio Module; the 40 pin GPIO connector; the 2 pin JST connector J1 for the USB signal; and the SMA antenna connector to the PCB.

First, you will solder the SA818 radio module to the PC board in the U2 position. You will solder 18 castellated holes on the module edges to the pads on the PCB. If you have never soldered castellated holes before, please go to

https://learn.sparkfun.com/tutorials/how-to-solder-castellated-mounting-holes/all

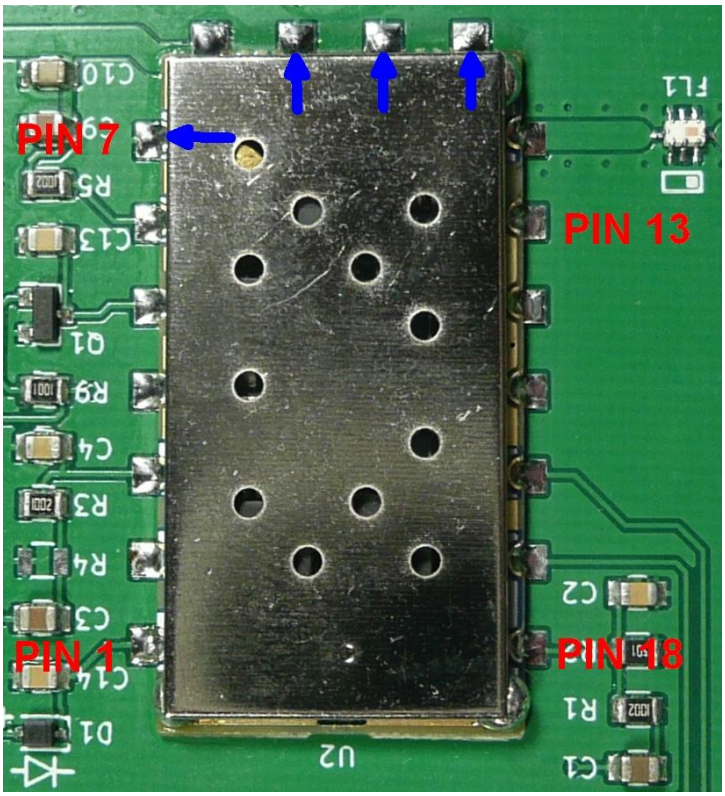
for an excellent tutorial on how to solder castellated mounting holes as used on the RF module you are about to install.

Here are some things to be aware of before you begin soldering.

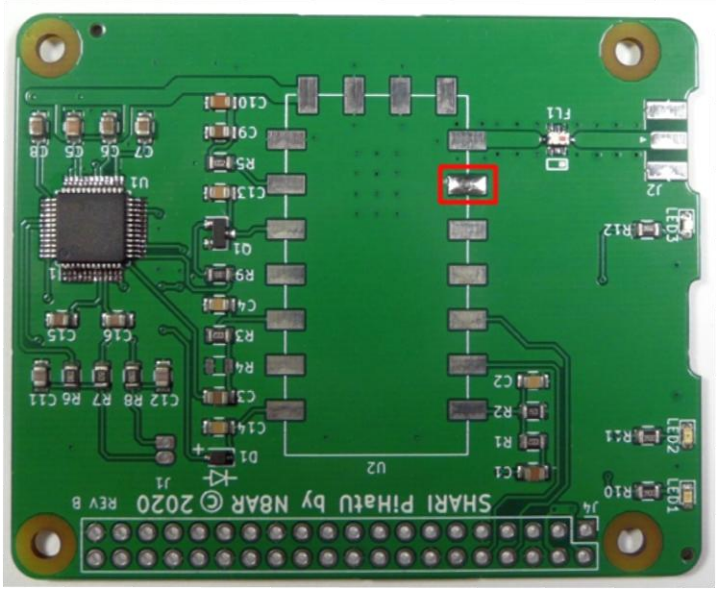
- The SA818 radio module pin numbering is shown in the photo. The pin numbers increase clockwise from Pin 1. Note that Pins 7, 9, 10 and 11 (blue arrows) are connected to ground of the PC board and to the shield of the module.

- Pins 8, 9, and 10 require more time to heat as you are soldering to pads connected to a large trace (pin 8) or the board ground plane (pins 9 and 10). Make sure that the solder contacts the wall of the castellated hole on all your solder joints. In the picture to the right, note how the solder flows up the wall of the castellated hole on the two outside solder joints but fails to attach to the wall in the two in the middle.

- The module shield is notched above each castellated hole except pins 9, 10 and 11 to minimize the possibility of a solder short to the shield from the castellated hole. Ensure that your soldering does not create a short of any castellated hole to the shield with the exception of pins 7, 9 10 and 11. Check with an ohmmeter if in doubt.



Flow a small amount of solder onto pad 13 outlined in red on the SHARI PiHat PCB.



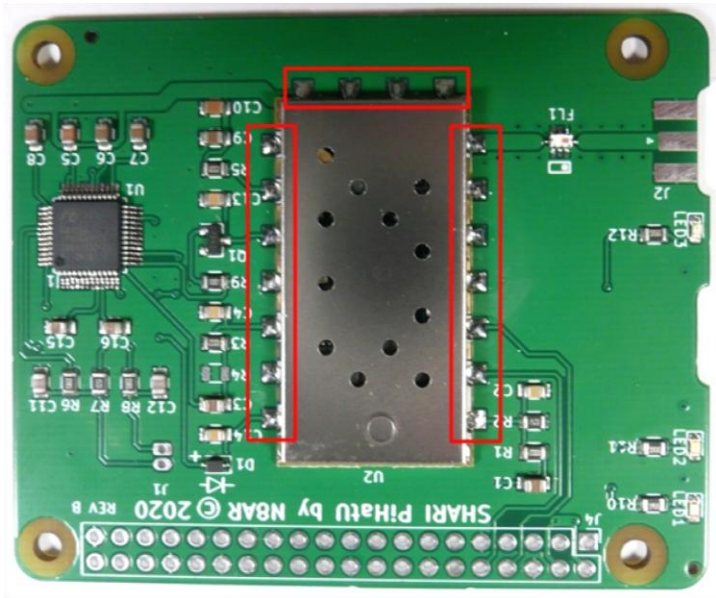
Use the following procedure to solder the module. **Be sure to orient the module so the castellated holes on the module align with all the PC pads on the board.**

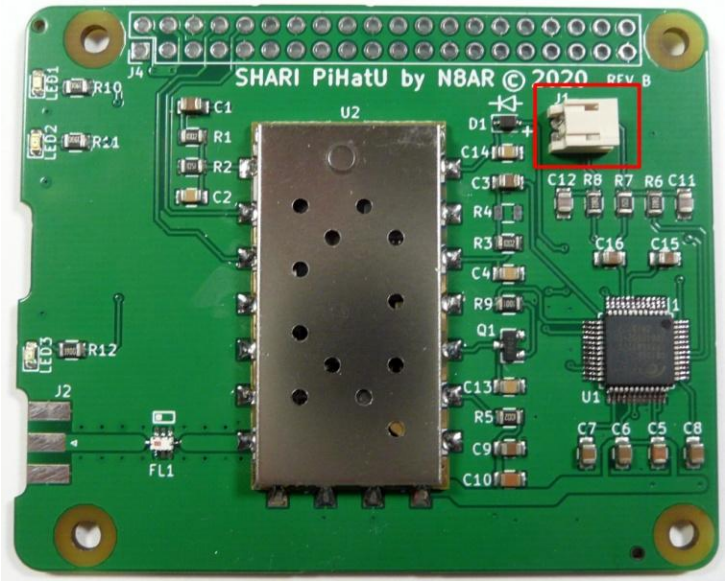
Place the U2 radio module in the correct position on the board. Reheat the solder on pad 13 from the previous step. Reposition the module as necessary and let the solder cool to hold the module in the correct position.

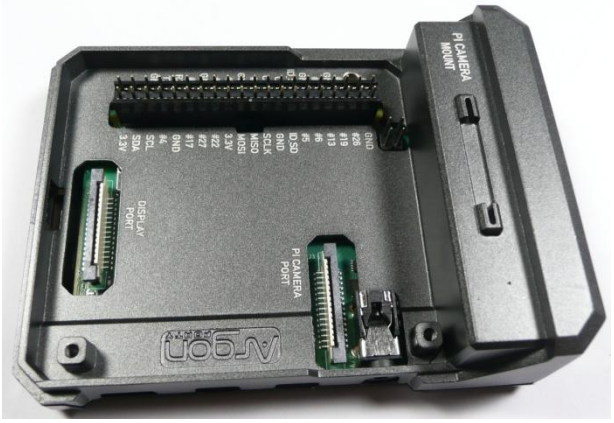
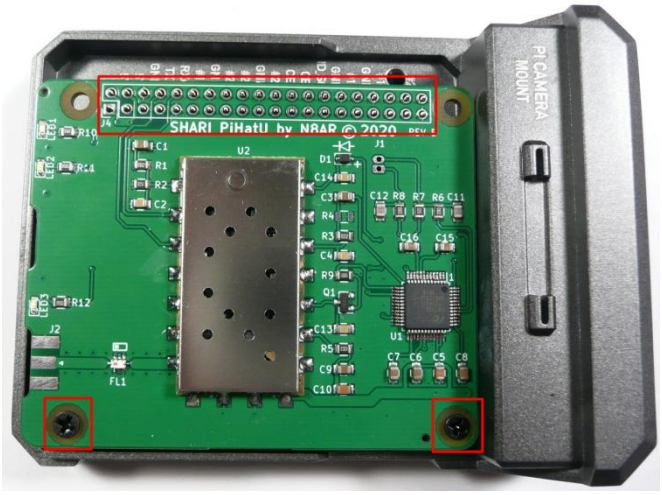
IMPORTANT - Make sure the module is oriented properly on the PCB and flush with the surface of the PC board.

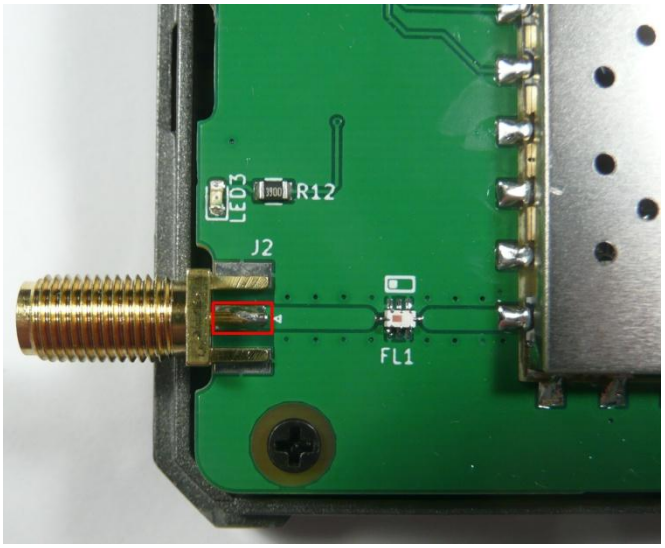
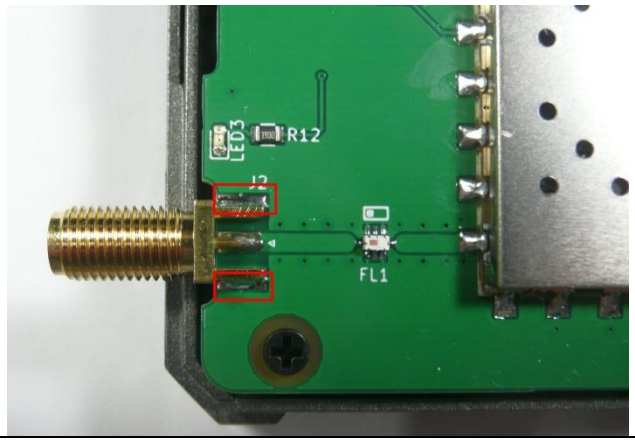
1) Solder pin 1 through pin 7
2) Solder pin 18 through pin 12
3) Solder pin 8 through pin 11

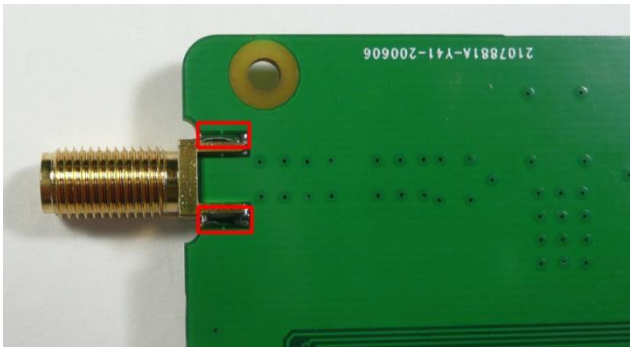
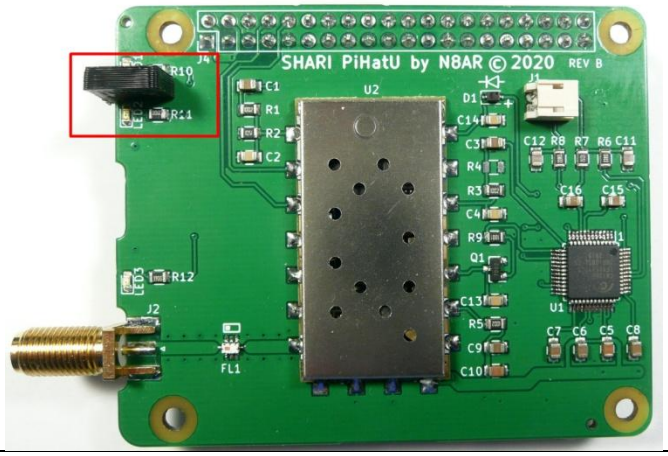
Final note – Pin 13 is a no connect. If you should end up with it shorted to ground or the shield that is OK.



Insert the right angle JST connector into the J1 position on the board in the orientation shown in the picture and solder its 2 leads.	
Temporarily install your Raspberry Pi4 into the Neo case. **Do not use the thermal transfer pad at this time**. Insert the Pi4, place the bottom cover over it and use four screws to secure the cover.	

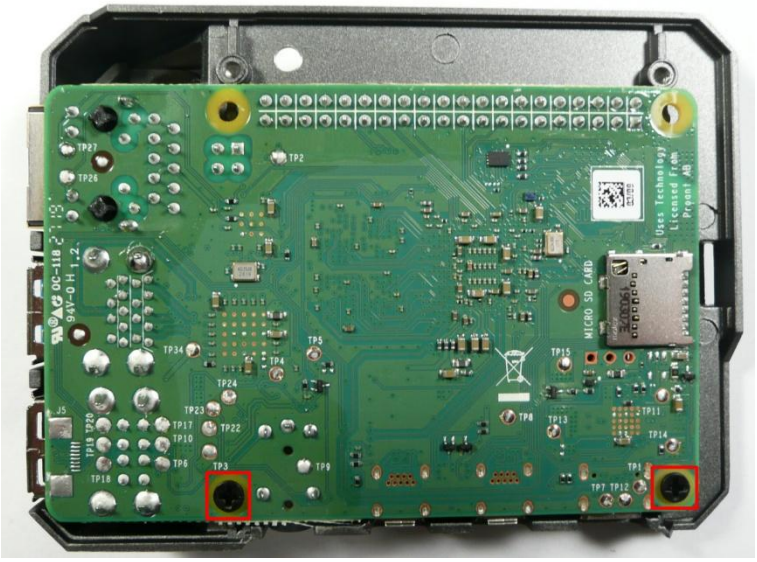
Press the 40 pin female GPIO connector onto the male header pins of the Pi4.	
Place the PiHat PCB over the female GPIO pins. Fasten the board in place using two mounting screws. Solder the 40 pins of the GPIO connector.	

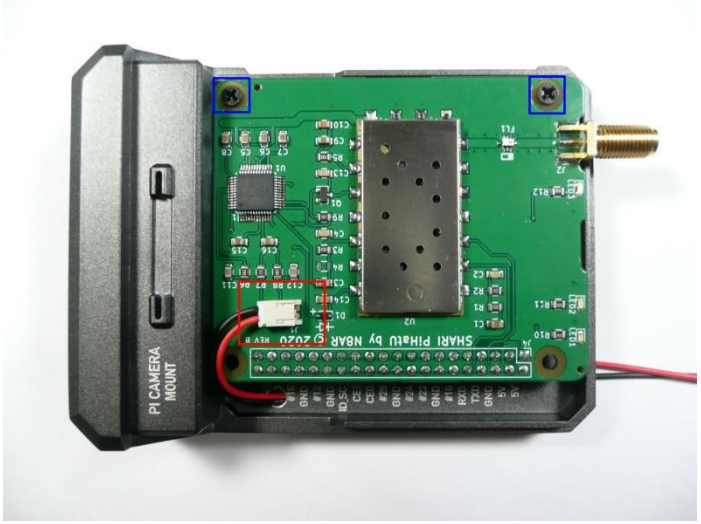
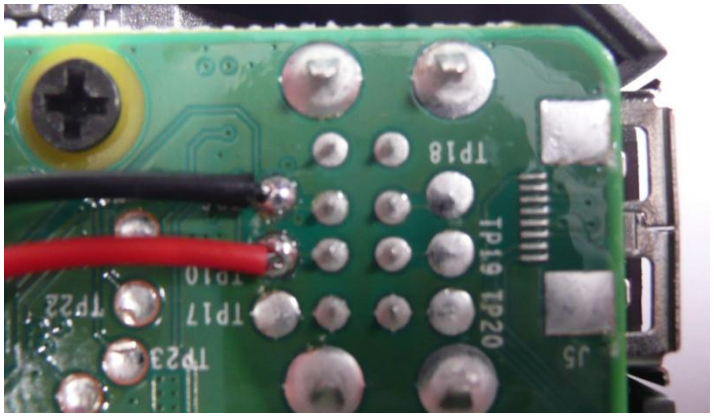
Place the SMA antenna J2 in position on the pads on the PiHat PCB. Align it so that it is perpendicular to the edge of the PCB and the axis of the center conductor is parallel to the plane of the PCB. **Lightly** solder the center pin of the connector to the pad on the PCB to hold it in place so you can check its alignment.	
Attempt to slide the Argon Neo case top cover into place and verify that the SMA connector fits through the hole in the cover. Re-melt the solder connection of the SMA center pin and reposition the SMA connector to center it in the hole if required. Use caution to avoid damaging the pad on the PCB.	
When you are satisfied with the SMA connector alignment, solder the two ground pins to the PCB pads. Check and rework the center pin solder joint as required.	

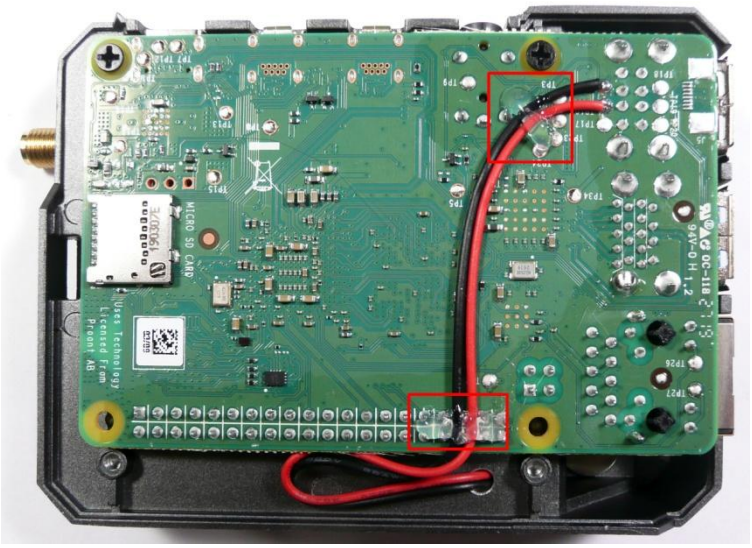
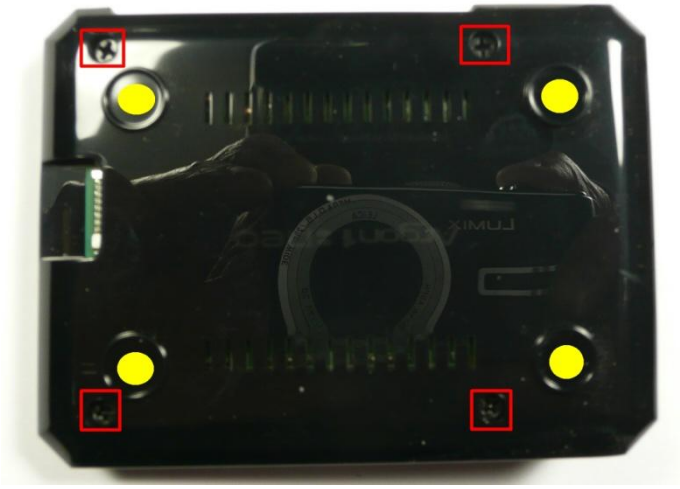
Remove the 2 screws holding the PiHat PCB in place and remove the PCB. Solder the 2 SMA connector ground pins on the bottom side of the PCB.	
Slide the 3D printed LED light shield in place between LED 1 and LED 2 on the PCB This completes the construction of the PiHat PCB. Set it aside for final assembly.	

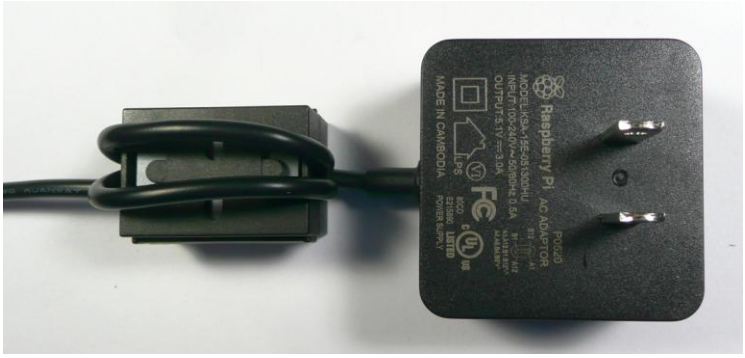
Step 3. SHARI PiHat Allstar Node Final Assembly

In this section, you will perform final assembly of your SHARI PiHat Allstar node. Begin by removing the case bottom cover by removing four screws. Remove the Pi4 board.

Locate the grey heat conducting pad packaged with your Neo case. **Remove the protective plastic film** from one side of the pad exposing a sticky surface. Place this pad with the sticky side over the CPU and adjacent IC and gently press it in place as shown in the photo. It will stick to them. IMPORTANT – Do **not** use the black pad.	
Remove the protective plastic film from the other exposed surface of the heat transfer pad. Insert the Pi4 board into the Neo case and temporarily hold it in place using two screws.	

Plug the USB cable into J1 (red rectangle) on the SHARI PiHat board. Thread the cable through the clearance hole in the case and plug the PiHat board onto the PI4 board GPIO connector. **Support the Pi4 from the bottom as you plug in the PiHat board as it has no support from the bottom cover at this time**. Secure the PiHat board in place using two screws (blue rectangles) and tighten them.	
Solder the red wire of the USB cable to TP10 of the Pi4. Solder the black wire to TP6. We have found the best way to do this is to first apply solder to the TP10 and TP6 pads to form a semicircle ball of solder on the pad. Then reheat the solder and push the wire into the solder ball.	 

Route the USB cable wires as shown. Route the wires between the GPIO connector pins. Do not route them over the top of the pins as they may be pushed into the pins by the bottom cover risking the possibility of piercing the wire insulation. Fasten the cable in place using hot glue in the areas shown. Do not apply the hot glue in a thick layer as it may prevent the bottom cover from installing correctly.	
Remove the two screws used to temporarily hold the Pi4 board. Place the bottom cover in position over the Pi4 and use four screws (red) to secure it. Apply the four black foam feet that came with the Argon Neo case to the four recesses (yellow) for them in the Argon Neo bottom cover	

Install the top cover. Place the serrated SMA washer with the teeth towards the case cover on the SMA connector. Install the SMA nut and tighten slightly.	
Apply the SHARI PiHat label to the top cover of the case. Attach the antenna to the SMA connector.	
Install the ferrite core supplied with the kit at the power supply end of the cable. Pass the wire through the center of the core 3 times This ferrite will ensure that you have no “hum” or “buzz” interference while using the node. Here is a link to a discussion on this topic. https://groups.io/g/SHARI/topic/hum_buzz_on_signal/73406860?	

Insert the 3D printed USB filler plug supplied with the kit into the top left USB jack. This is the USB port that is used internally by the SHARI PiHat (the wires you soldered to the Pi4 board).