

SHARI PiHat Allstar Node Construction Manual (Unistorm Case with Elbow Antenna)

SHARI (SA818 Ham Allstar Radio Interface) PiHat Allstar Node (Unistorm Case) is a kit construction project that implements a Raspberry Pi3 or 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 created with a SHARI PiHat Unistorm Case kit, a Raspberry Pi3 or Pi4 (with power supply and microSD card) and an Allstar image.



The SHARI PiHat PCB is implemented with surface mount parts, a NiceRF radio module with castellated holes for mounting to the PC board 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.

The kit also contains a Unistorm Raspberry Pi case.

There are two antenna options available as well as an optional cooling fan option.

The kit builder must decide between a case for the Raspberry Pi3 or the Raspberry Pi4, the type of antenna and the fan option when ordering the kit.



Antenna options:

1. Elbow 2" Rod Antenna - An edge mounted SMA connector exits the case through a hole in the endcap drilled by the kit builder. A 3D printed hole location template is supplied with the kit to aid in proper hole location for drilling. A cooling fan option (shown in photo) is also available.



2. Straight 4" Rod Antenna - A vertical mounted SMA antenna jack exits through a hole in the top cover. The kit is supplied with the hole punched in the case top cover. The cooling fan option can still be used with the vertical antenna option.



Cooling Fan Option:

1. A 30 millimeter fan is installed on the top cover using two screws into existing holes. The fan wires are routed through existing holes in the top cover and plugged into a 2 position right angle pin header on the PCB which is soldered to the PC board by the kit builder.

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	2021-12-16	Initial release
1.01	2021-12-29	Modified JST cable installation
1.02	2022-04-28	Plastic or brass spacer
1.03	2023-05-26	Added note about fan installation and alignment tool
1.04	2024-07-14	Changed fan orientation

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SHARI PiHat (Unistorm Case) Allstar Node Overview

Key Features

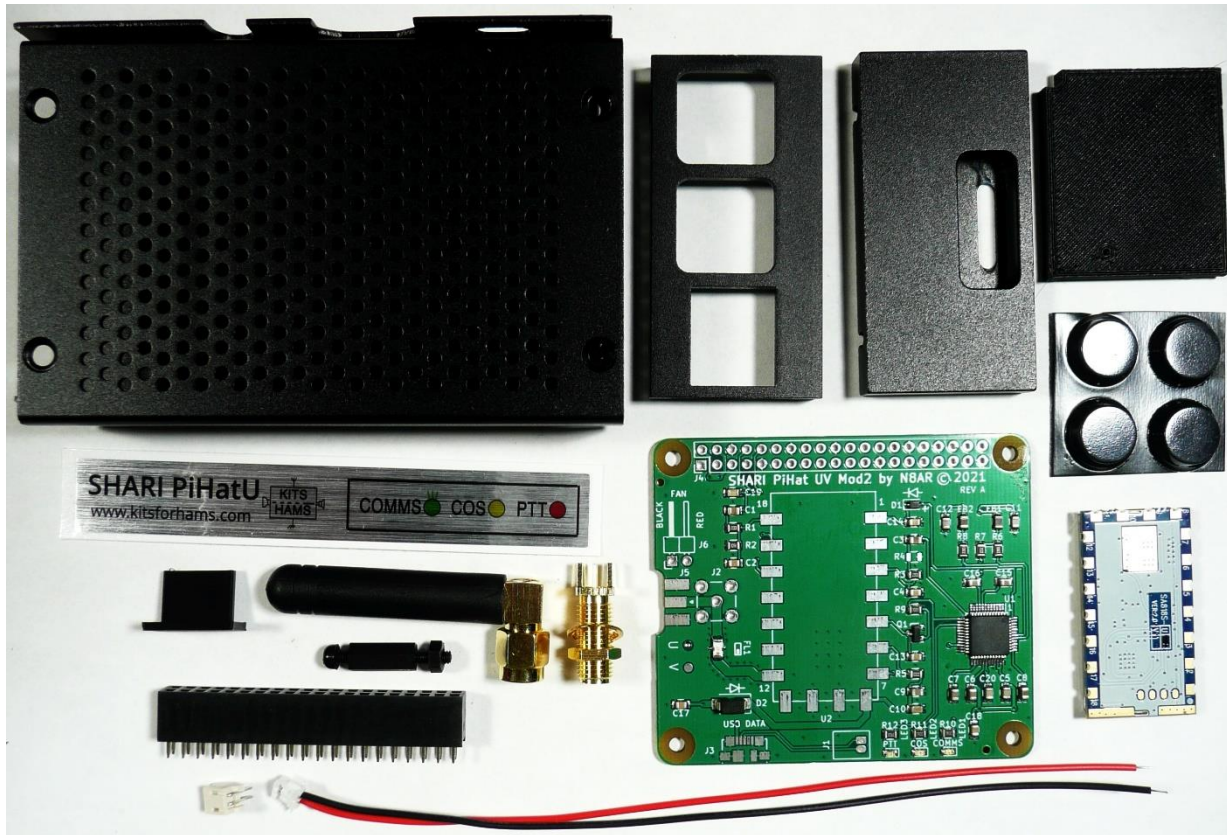
- Uses CMedia CM108B or CM119B USB Audio IC.
- Uses a NiceRF SA818 UHF (420-450 MHz) or VHF (144-148MHz) embedded radio module (www.nicerf.com) with an LTCC lowpass output filter
- 350 to 600 milliwatts RF output power
- Raspberry Pi, power supply and microSD card provided by kit builder.
- Unistorm Pi3 or Pi4 rugged, RFI resistant metal enclosure.
- 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.
- Clamp-on ferrite provided to mitigate buzz interference from high RF fields near the Pi power supply.
- Two antenna options (Elbow and Straight Rod).
- Cooling fan option (requires no additional holes to be drilled in the case)

Setting Expectations

- **Operational Issues?**
 - If you use WiFi instead of wired ethernet for your Allstar node, the all aluminum case design may significantly reduce the WiFi range of your node versus a plastic case.
- **Degree of soldering difficulty –Medium**
 - Assembly of the SHARI PiHat kit requires standard through-hole soldering of two leaded connectors. The SA818 embedded radio module is surface mounted using castellated holes soldered to very large solder pads on the PCB. (we will install the SA818 module for you for a small increase in price). 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 one 9/32" hole in an aluminum end plate for the elbow antenna option. A 3d printed hole location tool is provided to help in determining the hole location. (A required hole through the top cover is provided for the straight antenna option)
 - The case screws together using a small Phillips screwdriver.

Required Materials

SHARI PiHat (Unistorm Case/Elbow Antenna) Kit



The above photo shows the parts (except ferrite cores) in the kit for the elbow antenna kit option.

- Unistorm Pi3 or Pi4 case
- 3d printed hole location tool
- Four polyurethane adhesive coated feet
- SHARI PiHat (U or V) label
- SHARI PiHat UV Mod 2 PCB with installed SMD components
- SA818 (U or V) radio module
- USB jack plug (prevents plugging a connector into the USB port used by SHARI)
- UHF (or VHF) elbow antenna
- Edge mount SMA connector
- 11 mm plastic or brass spacer, screw and nut
- 2 row, 40 pin female GPIO connector
- 2 position JST right angle connector and cable

Kit Builder Supplied Parts

- Raspberry Pi3, Pi3B+ or Pi4B (1,2 or 4 GB ram)
- Appropriate 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)
- Center punch and drill set
- Drill driver
- Small side cutters
- Small hot glue gun (recommended)

SHARI PiHat (Unistorm Case/Elbow Antenna) Kit Construction Overview

This procedure uses pictures and written instructions to guide you through the process of construction a SHARI PiHat node in a Unistorm case with an elbow rod antenna. A different but similar construction procedure is used for the straight rod antenna.

Any Raspberry Pi3 or Pi4 (furnished by the builder) can be used. There are two different Unistorm cases to accommodate the difference in location of the USB and Ethernet connectors between the Pi2/Pi3 and the Pi4.

The pictures in this procedure show a Pi3. The construction process for a Pi4 is essentially the same with the exception of the connection of the wires to the USB connection points on the Pi. Photos and text are used to describe the difference.

Step 1. SHARI PiHat PCB Assembly

In this step, because you have selected the elbow antenna option, you will drill a 9/32" diameter hole in an aluminum end cap.

Locate the Unistorm case end cap with the slot which provides access for the microSD card to be inserted in the Pi. Also locate the 3D printed hole location tool.

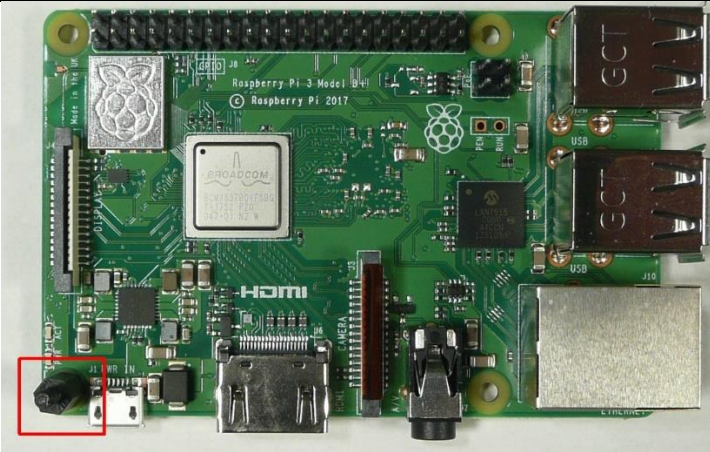


Place the hole location tool on the end cap. Ensure that the tool is tight against the top and right edges of the end cap. Keep it tight and mark the location of the hole by inserting a center punch (or similar device) in the hole in the tool. **(NOTE: The vertical channels have been eliminated on the newest end caps. Thus the alignment ridge in the tool has been removed. Take care to ensure you are aligning the tool correctly as shown in the picture)**



Next, you will assemble the Pi and SHARI board into the case to verify the location of the hole.

Locate the 11 mm plastic or brass spacer and mount it to your Pi using the included screw.



Place the Pi in the bottom half of the Unistorm case and secure with one silver colored Phillips mounting screw.



Place the end caps in position and secure them to the lower cover using 4 screws.



Install the 2 row, 40 position female pin header GPIO connector onto the matching connector on the Pi. Press firmly in place so there is no gap between the connector plastic bodies.

Place the SHARI PiHat Mod2 PC board in place on the GPIO connector and the 11 mm spacer. Fasten in place using the 2.5 mm nut onto the 11 mm spacer.

Observe the location of the mark for the hole in the end cap. It should be centered horizontally on the middle PCB trace for the SMA edge connector and about 0.020 inches above the top surface of the board. Adjust the mark for the hole location if required.

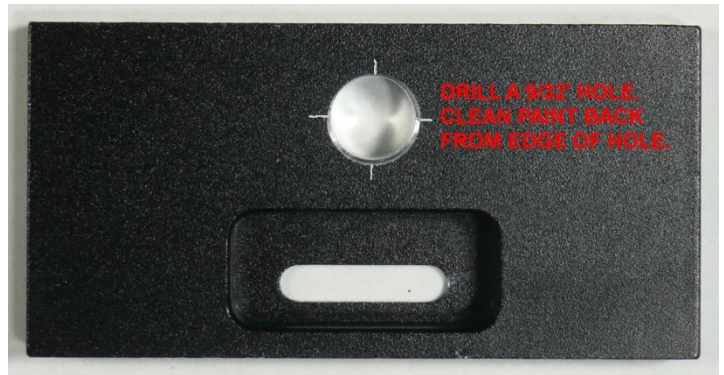


Remove the end cap.

We suggest you lightly scribe horizontal and vertical lines on the inside of the end cap centered on the marked hole. You will use these scribed crosshairs to ensure the hole remains centered as you drill it.

Drill a small pilot hole through the end cap. Use increasing larger drills to increase the hole diameter to $9/32''$ (or use a good step drill). Be very careful the center of the hole does not wander.

Clean the paint to expose bare aluminum about $1/32''$ around the edge of the hole so that the star lock washer used with the SMA connector will contact the electrically conducting aluminum instead of the black powder paint which is an insulator.



Step 2. SHARI PiHat Mod2 PCB Assembly

In this step you will fabricate the SHARI PiHat Mod2 PCB. You will install the SA818 radio module, the 2 position JST connector, the 40 pin GPIO connector, the 2 position RA male pin header for the fan option (if applicable) and the SMA RF connector. Begin this task by removing the SHARI PiHat Mod2 PC board from the case.

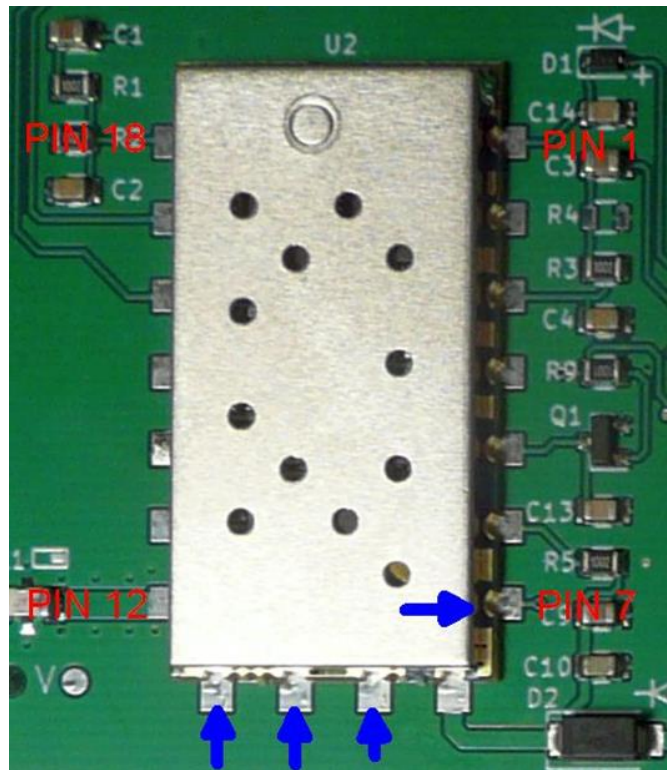
In this task, you will solder the SA818 radio module to the PC board in the U2 position. You will solder 18 castellated holes on the module edges to the pads on the PCB. If you have never soldered castellated holes before, please go to <https://learn.sparkfun.com/tutorials/how-to-solder-castellated-mounting-holes/all> 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 attaches to and flows up the wall of the castellated hole on the two outside solder joints but fails to attach to the wall in the two middle solder joints.

- 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.

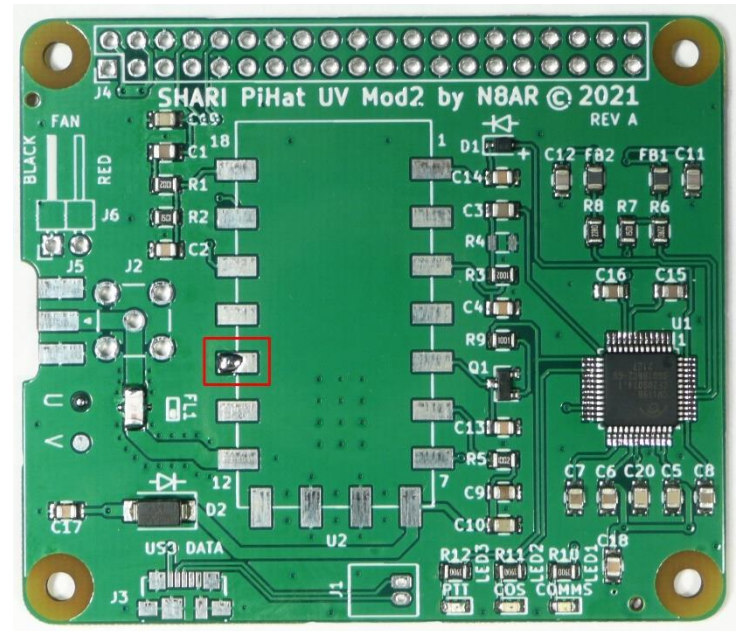


Soldering Hint for castellated holes

Clean your soldering iron tip. Hold the solder vertically with the end against the pad on the PC board and the solder touching the wall of the castellated hole. Then, with the soldering iron tip touching the pad and at about a 30 degree angle to the PC board, push the tip into the solder. As soon as the solder melts pull it away and continue to push the molten solder towards the wall of the castellated hole. As soon as the solder flows up the side of the castellated hole, remove the soldering iron tip.



Flow a small amount of solder onto pad 14 outlined in red on the SHARI PiHat PCB.

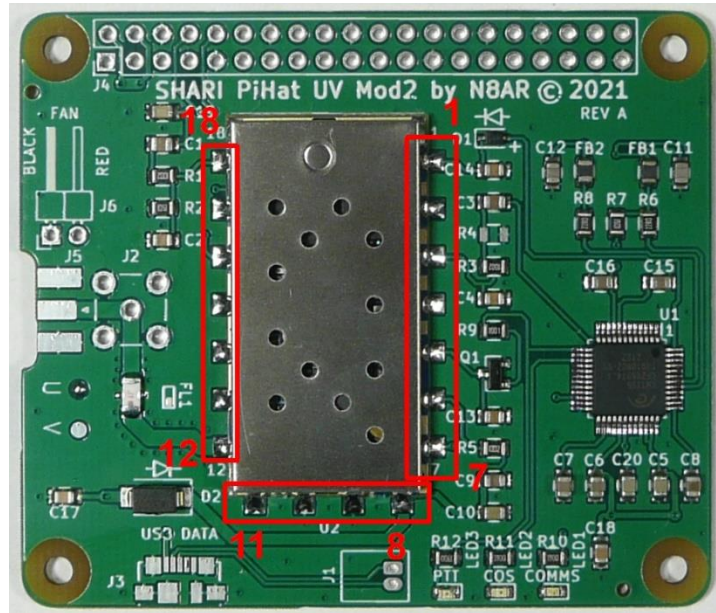


Use the following procedure to solder the module. **Observe that there are castellated holes on only one end of the SA818 module. Be sure to orient the module so the castellated holes on the module align with all the PC pads on the board.**

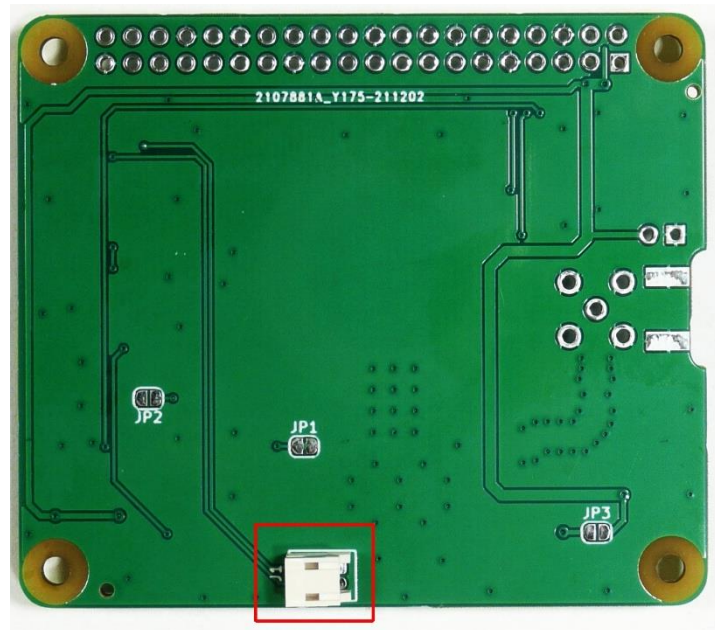
Place the U2 radio module in the correct position on the board. Reheat the solder on pad 14 from the previous step. Reposition the module as necessary and let the solder cool to hold the module in the correct position.

IMPORTANT - Make sure the module is oriented properly on the PCB and flush (**very important**) 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

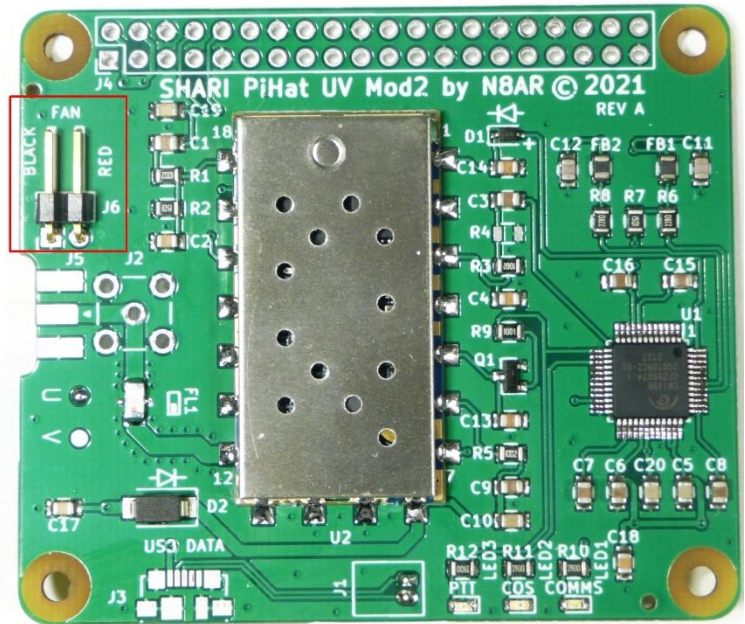


Insert the right angle JST connector into the J1 position on the **bottom of the board** in the orientation shown in the picture and solder its 2 leads.



If you have purchased the cooling fan option, insert the 2 position RA male header into the J6 location on the PC board and solder 2 pins.

This completes the assembly of the PC board.



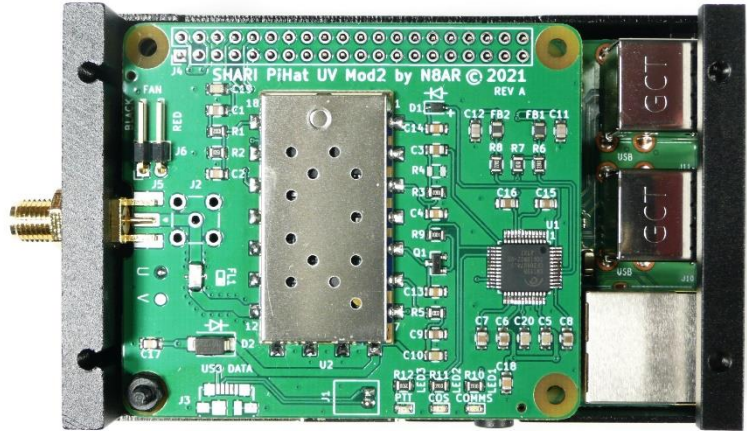
Step 3. SHARI PiHat Mod 2 PC Board Final Assembly

In this step you will complete final assembly of the PiHat Mod2 PC board installing the SMA edge mount connector. You will then complete the disassembly of the node in preparation for the next step.

Install the PC board back onto the 40 pin GPIO connector and 11 mm plastic standoff in the case. Install the plastic nut on the 11mm standoff and tighten.

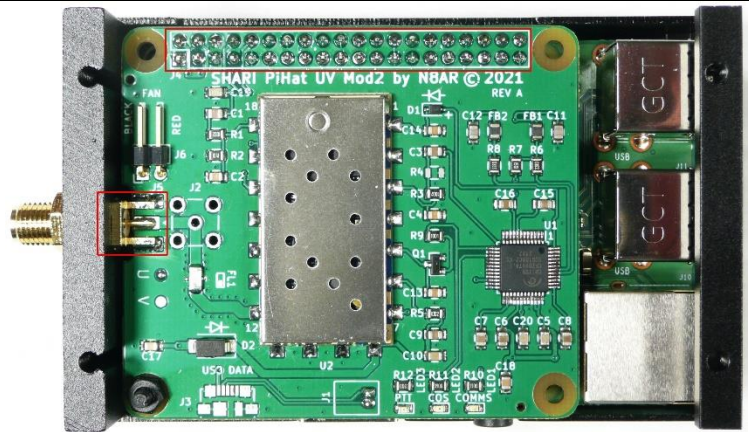
Remove the nut and star lock washer from the edge mount SMA connector. Install the SMA connector in the 9/32" hole you drilled. Install the lock washer with the tangs towards the endplate followed by the nut. Snug the nut but do not tighten.

Engage the edge mount SMA connector with its center conductor on top of the board onto the edge of the PC board in the J5 position while installing the end plate with SMA connector into the case. Install two screws at the bottom of the case to hold the end plate. Tighten these screws. Verify the end plate is tight and perpendicular to the bottom.



Center the SMA connector center conductor on the PC board trace for J5 and then tighten the nut on the SMA connector. It is normal that there is a gap between the edge of the PC board and the connector.

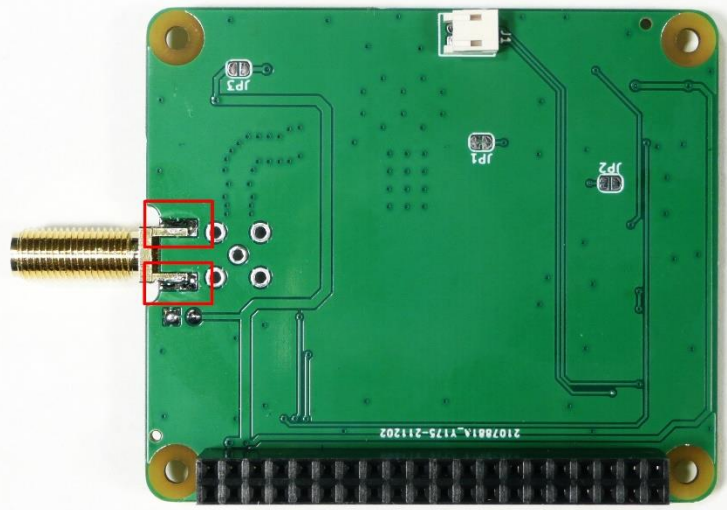
Verify alignment and then solder the center conductor and 2 ground pins of the SMA connector to the pads on the PC board. Verify that the PC board is flush with the GPIO connector and solder 40 pins.



You will now disassemble your node in order to solder the other 2 pins of the edge mount SMA connector to the bottom of the PC board and prepare for final assembly.

- Remove the nut and washer from the SMA connector.
- Remove the two screws securing the SMA connector end plate and slide it out of the case.
- Remove the plastic nut from the 11 mm spacer.
- Disconnect the SHARI PiHat Mod2 PC board 40 pin female GPIO connector from the Pi male connector. Set the SHARI PiHat Mod 2 board aside
- Remove the two screws holding the other end cap to the bottom cover and remove the end cap.
- Remove the screw attaching the Pi to the case bottom cover and remove the Pi. Set it aside.

Solder the two SMA ground pins on the bottom of the SHARI PiHat Mod2 PC board.



Step 4. SHARI PiHat Unistorm USB Cable Installation

In this step, you then will install the cable providing the internal USB connection between the Pi's USB port and the JST connector on the bottom of the SHARI PiHat Mod2 PCB.

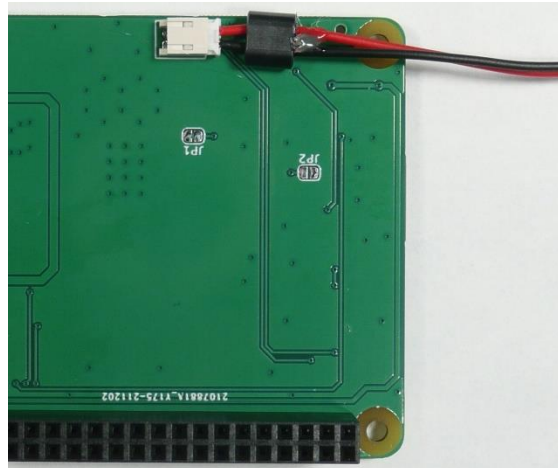
In the following tasks, the JST cable providing the USB connection to the PiHat Mod2 board is routed through the Pi unused mounting hole (opposite the one with the 11 mm spacer) to USB port test pads on the Pi. The location of the pads is different between the Pi3 and the Pi4.

This procedure shows what we consider to be the optimum routing for this cable for the Pi3 and the Pi4. Try to keep the red and black wires in the cable parallel and touching each other. This will help to minimize impedance variations along the cable and to minimize coupling of the transmitted RF to the cable where it can be modulated by the 1 millisecond packet bursts resulting in a 1 Khz whine in TX audio.

Locate the JST cable. Slide the ferrite core with the two holes onto the red and black wires. Use a dab of hot glue to keep it in place.

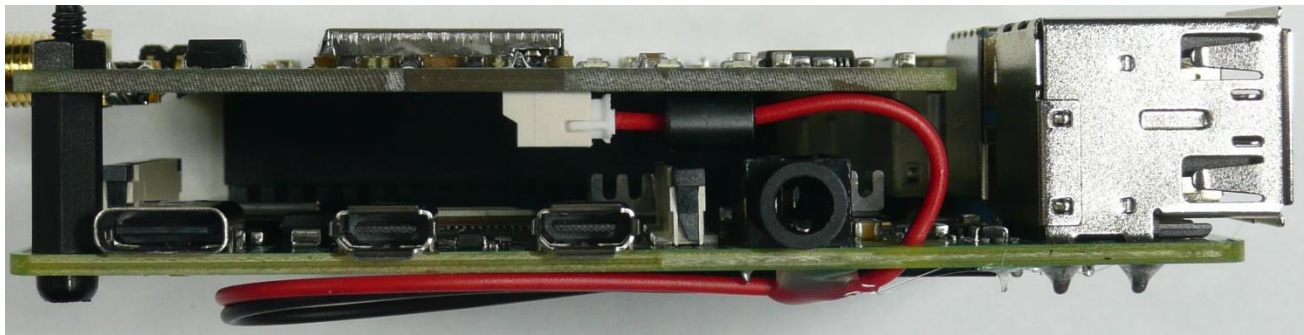
CAUTION: The tip of some hot glue guns may be hot enough to melt the insulation on the wire.

Plug the cable into the JST jack on the bottom of the PiHat Mod2 PC board.



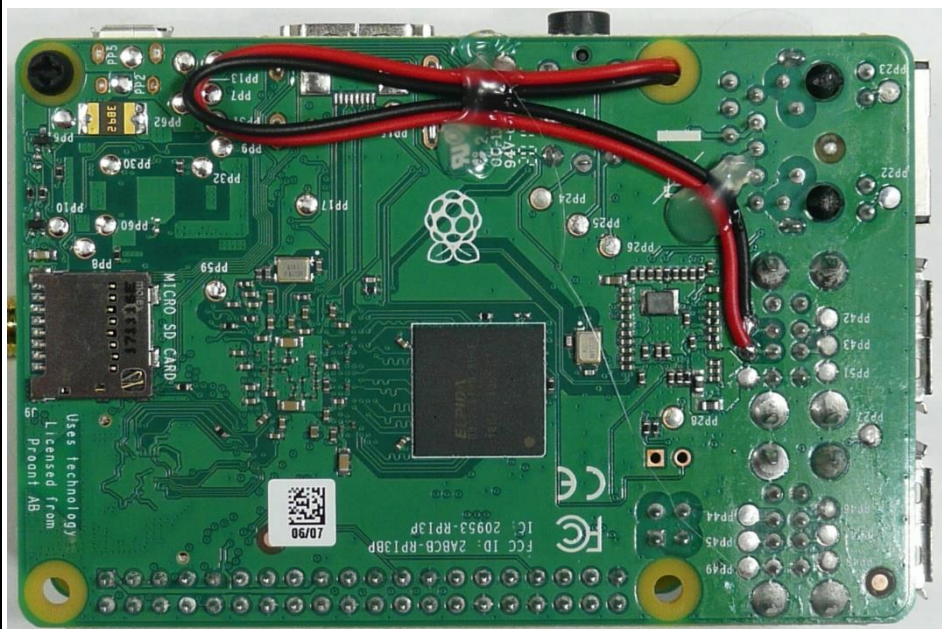
Route the cable through the unused mounting hole on the Pi and install the PiHat board on the Pi by plugging it into the 40 pin connector and over the 11 mm spacer. Observe the connection points (test pads) in the following photos.

- Do not route the wire so that is taut between the JST jack and the hole in the Pi. Rather leave some excess slack so that when removing the PiHat board from the Pi, you can unplug it from the GPIO connector, flop it over and unplug the JST connector.
- Solder the wires to the pads in the positions shown. We have found the best way to do this is to first apply solder to the test pads to form a circular mound of solder on the pad. Then reheat the solder and push the wire into the solder ball.
- Use hot glue to secure the wires in place and to ensure the solder joints will not be compromised when connecting/disconnecting the JST connector. Try to use the cable routing shown. Attempt to keep the wires parallel to each other as much as possible. Do not apply hot glue to SMD components on the Pi board. Note the two hot glue locations used in the photo.



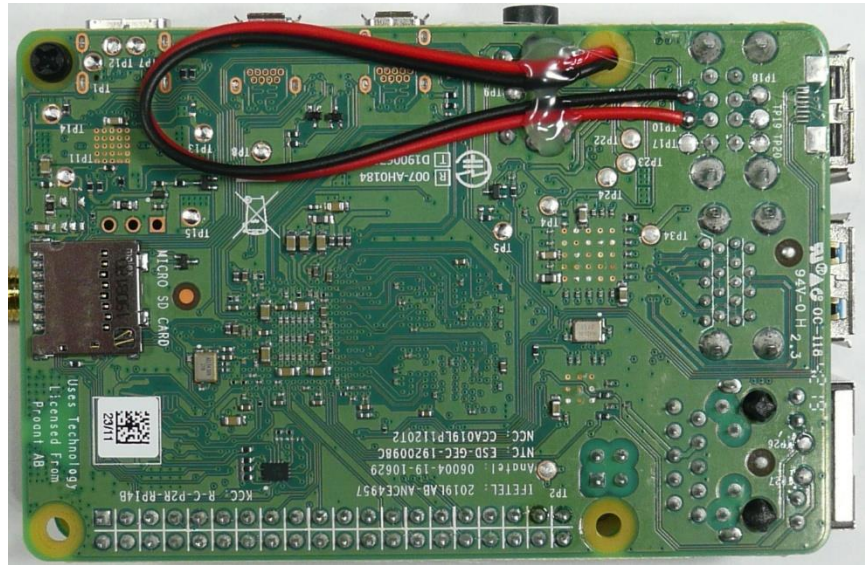
This is the suggested wire routing on a Pi3B+.

Note that the pads are not labeled on this board. In the group of 3 pads, you connect to the two pads that are farthest from the GPIO connector edge of the board. Do not connect to the pad connected to the ground plane.



This is the suggested wire routing on a Pi4B

Solder the red wire of the USB cable to TP10 of the Pi4.
Solder the black wire to TP6.



Step 5. SHARI PiHat Unistorm Final Assembly (Part One)

In this step, you will complete the assembly of your SHARI PiHat Unistorm node.

Remove the PiHat board from the Pi by unplugging it from the GPIO connector, turning it over and unplugging the JST connector.

HINT: If you have a small enough Phillips screwdriver you do not have to do this as you can install the Phillips screw that holds the Pi board to the case standoff by working through the mounting hole in the PiHat above the screw.

Place the Pi in the bottom half of the Unistorm case and secure with one silver colored Phillips mounting screw.

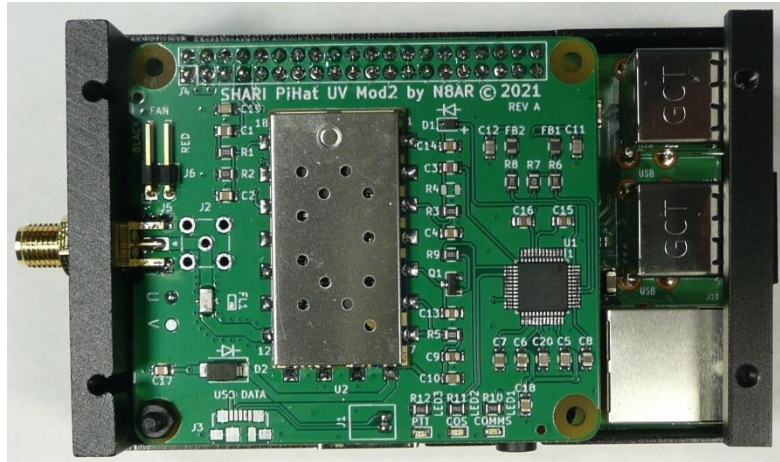


- Place the endcap in position over the USB and ethernet connectors and secure with two screws through the holes in the bottom of the case. DO NOT tighten these screws yet as you will need to manipulate this end cap to get the screws into the top holes later in this assembly.
- Install the PiHat board by plugging it into the GPIO connector and over the 1 mm standoff. Install and tighten the plastic nut on the standoff
- Place the endcap in position over the SMA connector and secure with two screws through holes in the bottom of the case.
- Place the star lockwasher on the SMA connector with the teeth towards the endcap. Thread on the nut and tighten snugly.

Your assembly should now look like the photo to the right.

If you have not purchased the fan option skip to Step 7, Final Assembly (Part Two).

Otherwise continue with Step 6, Fan Option Installation



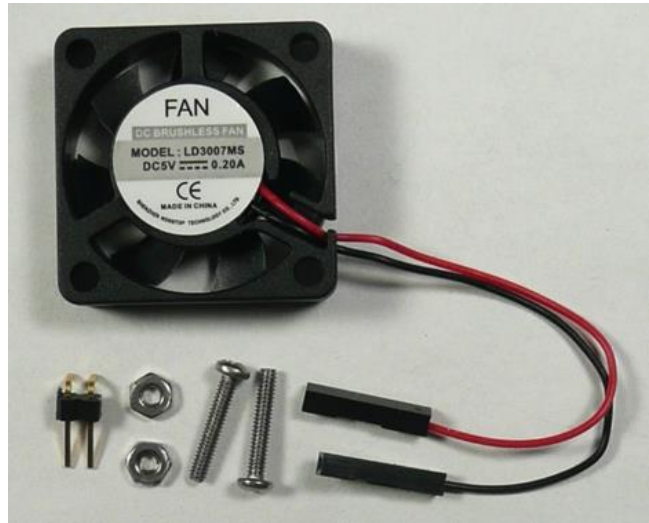
Step 6. Fan Option Installation

In this step, you will install the fan on the top cover of the Unistorm case using provided screws and nuts. The 2 position right angle male pin header should have been installed in the PiHat PC board during the performance of the last operation in Step 2 (PCB Assembly)

The parts included with the fan option are:

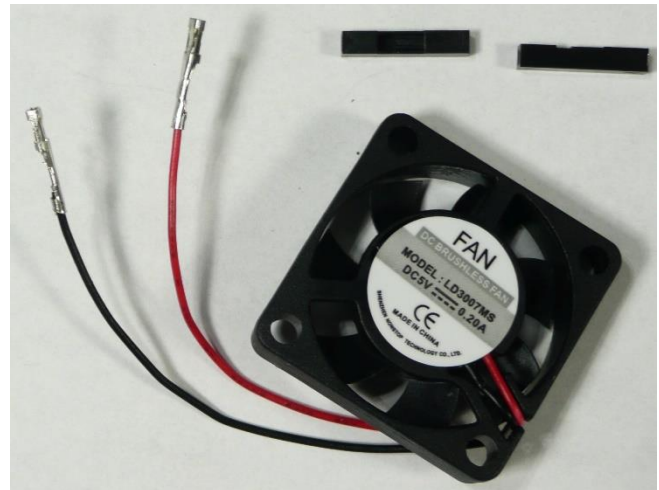
- 30x30x7 mm fan, 5 VDC
- 2 2-56 x 1/2" screws with nuts
- 2 position right angle male pin header

The wires on the fan are terminated with Dupont female connectors.



Remove the 2 plastic crimp housings from the female pins on the red and black wires by gently lifting the tab retaining the pin and pulling on the wire. Here is a link to a Youtube video on pin removal.

[DuPont pin removal](#)



The next picture shows a suggestion for the location of the fan on the top cover of the Unistorm case..

(Note: The fan mounting holes now align with the holes in the top cover with the fan edges parallel to the cover edges instead of rotated to 45 degrees as shown in other pictures in this document)

- Feed the red and black wires through 2 holes in the cover located below where they exit the fan. Fasten the fan in place using the 2-56 x 1/2" screws. The holes in the cover are slightly smaller in diameter than the 2-56 screws but it is easy to create threads in the cover holes as you drive the screws.
- Install the 2-56 nuts onto the screws and tighten
- Install the DuPont plastic housings on the fan terminals





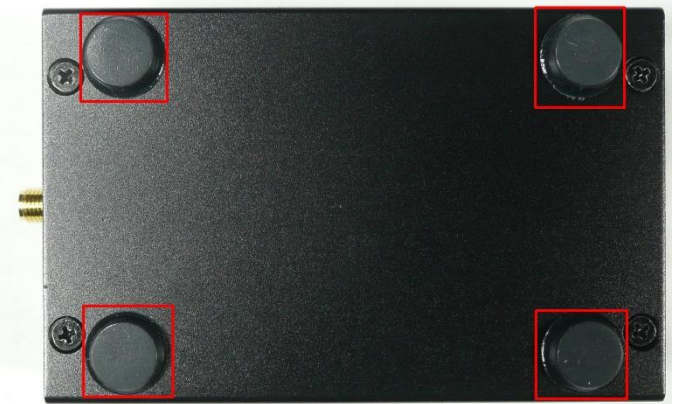
Step 7. SHARI PiHat Unistorm Final Assembly (Part Two)

- If you are installing a cover with the fan option, while holding the top cover, slide the DuPont connectors on the ends of the red and black wires onto the male fan connector pins (J6). The connection locations (RED and BLACK) are silk screened onto the PC board.
- Making sure to orient the top cover correctly so that the slots in the top and bottom cover matchup, place the top cover on the case and install four cover screws.
- Tighten all eight cover screws.

HINT: If you can not align the screw holes in the cover with the holes in the endcaps, loosen the 2 screws in the bottom cover for the USB/ethernet connector end cap



Install four polyurethane feet onto the four corners of the bottom cover.



Install the SHARI PiHatU label on the case.

