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

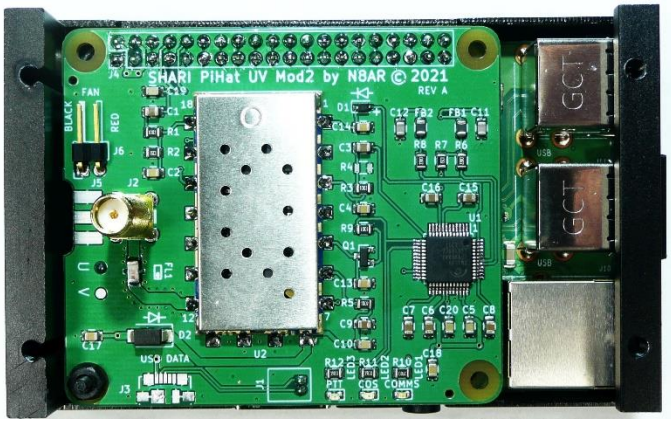
SHARI (**S**A818 **H**am **A**llstar **R**adio **I**nterface) PiHat Allstar Node (Unistorm Case) is a kit construction project that implements a Raspberry Pi3 or Pi4 hosted Allstar node using a NiceRF SA818 embedded UHF (420 – 450 MHz) or a VHF (144-148 MHz) radio module. The radio module and interface 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 millmeter 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	2021-12-66	Initial release
1.01	2021-12-29	Modified JST cable installation
1.02		Deprecated
1.03	2022-11-28	Corrected errors in version 1.02

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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
- 300 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

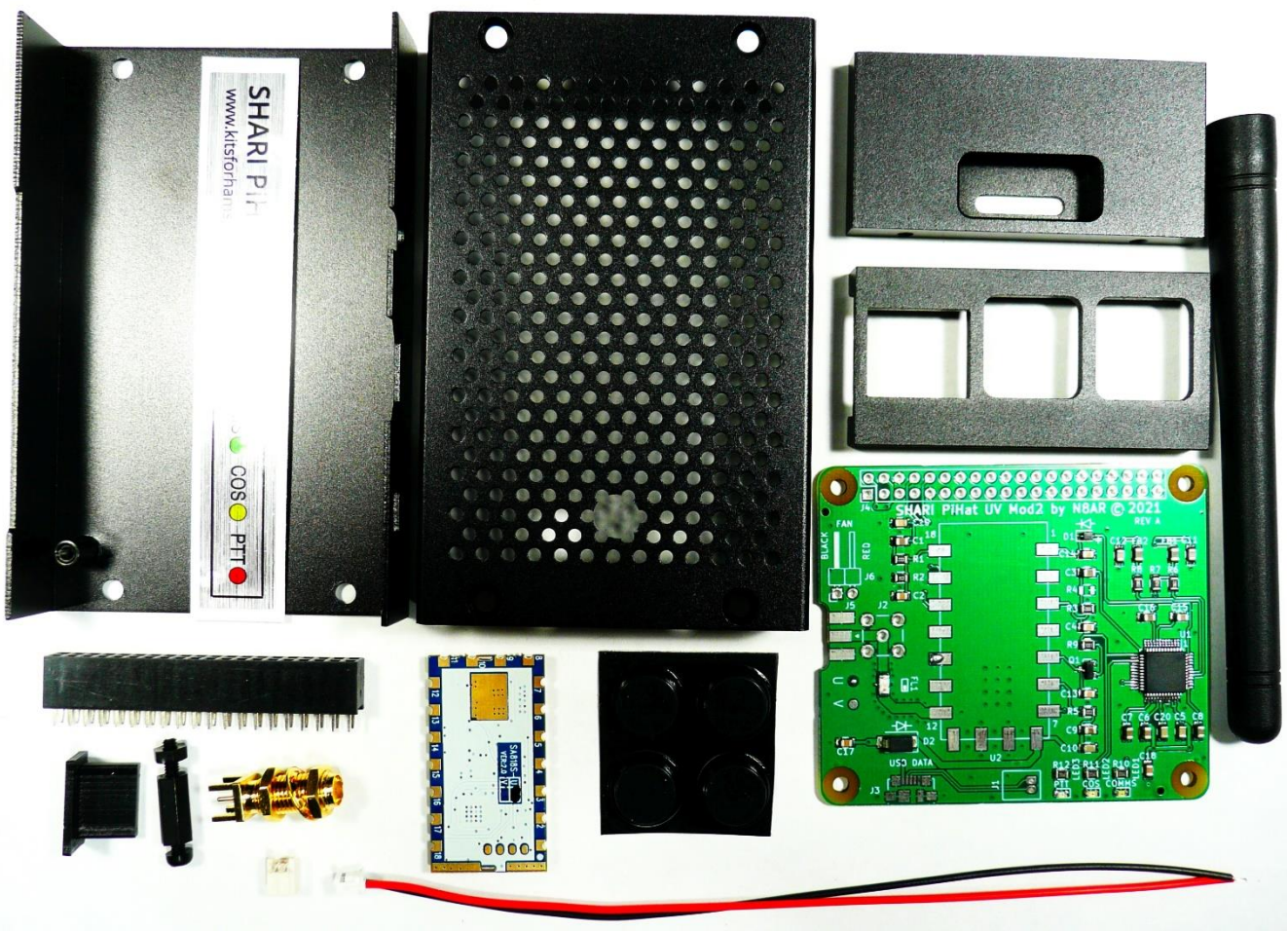
- **Operational Issues?**
    - If you use WiFi instead of wired ethernet for your Allstar node, the all aluminum case design may significantly reduce the WiFi range of your node versus a plastic case.

- **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 – Easy**
    - There are no holes to drill in the case. The 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/Straight Antenna) Kit



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

- Unistorm Pi3 or Pi4 case
- 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) straight rod antenna
- Vertical mount SMA connector, washer and two nuts
- 1 mm plastic 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
- 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 a straight rod antenna. A different but similar construction procedure is used for the elbow 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 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 locating the SHARI PiHat Mod2 PC board in the kit.

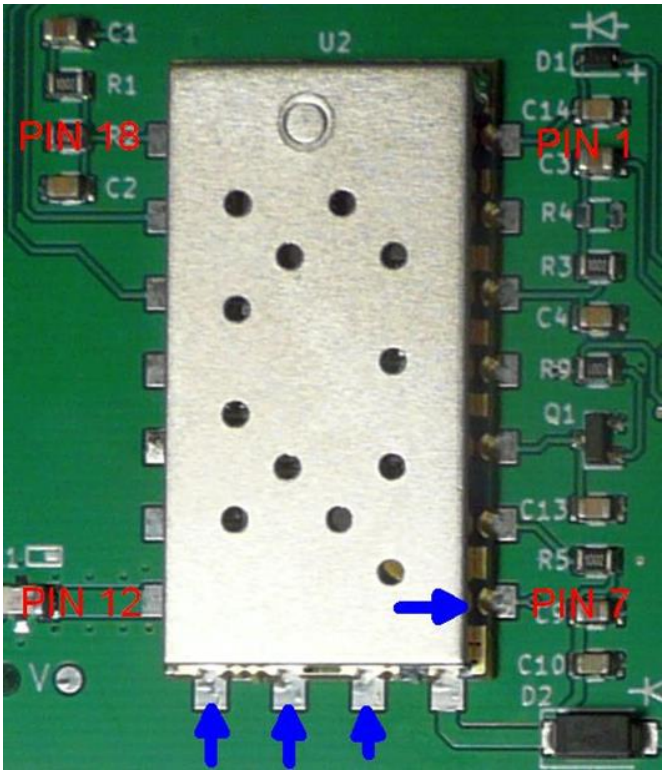
In this task, you will solder the SA818 radio module to the PC board in the U2 position. You will solder 18 castellated holes on the module edges to the pads on the PCB. If you have never soldered castellated holes before, please go to https://learn.sparkfun.com/tutorials/how-to-solder-castellated-mounting-holes/all for an excellent tutorial on how to solder castellated mounting holes as used on the RF module you are about to install.

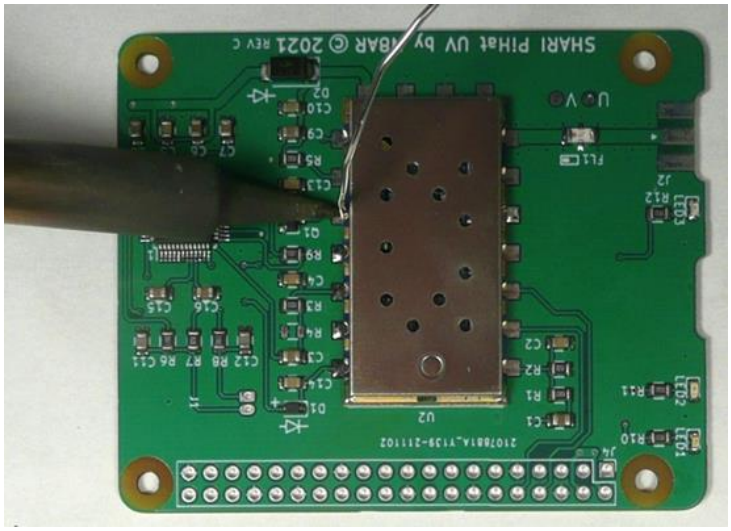
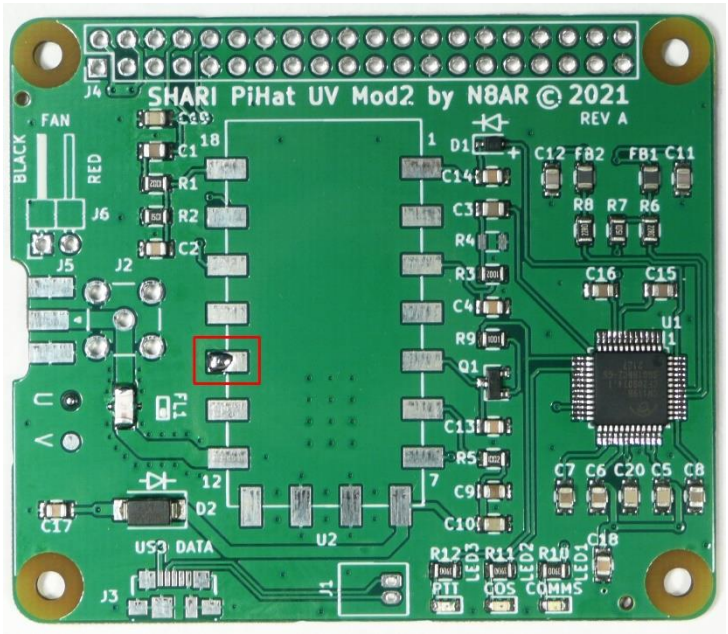
Here are some things to be aware of before you begin soldering.

- 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.



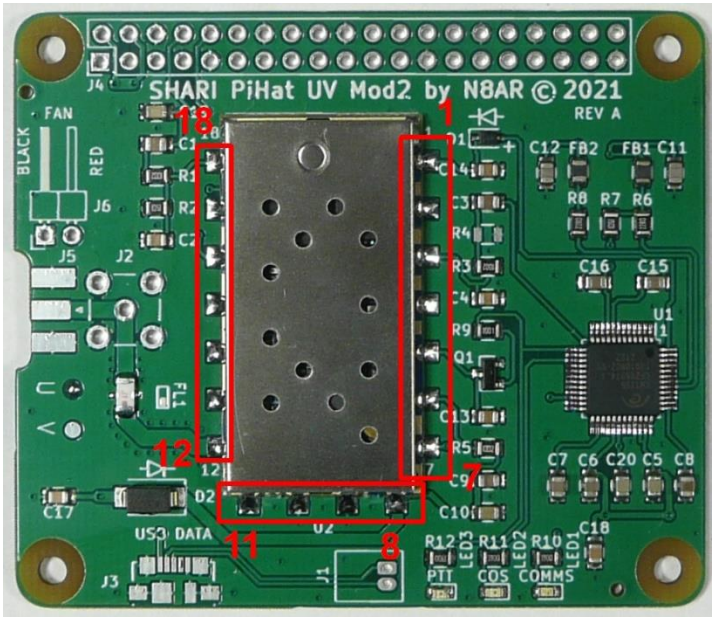
Soldering Hint for castellated holes Clean your soldering iron tip. Hold the solder vertically with the end against the pad on the PC board and the solder touching the wall of the castellated hole. Then, with the soldering iron tip touching the pad and at about a 30 degree angle to the PC board, push 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.**

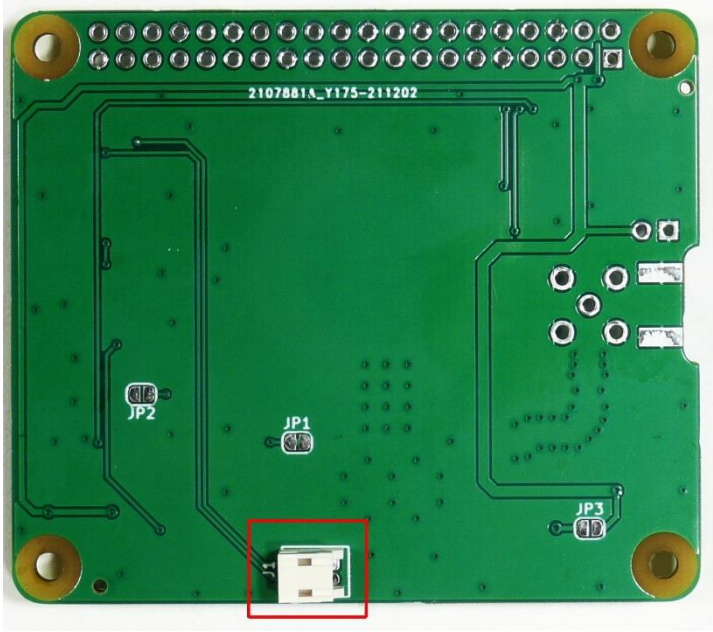
Place the U2 radio module in the correct position on the board. Reheat the solder on pad 14 from the previous step. Reposition the module as necessary and let the solder cool to hold the module in the correct position.

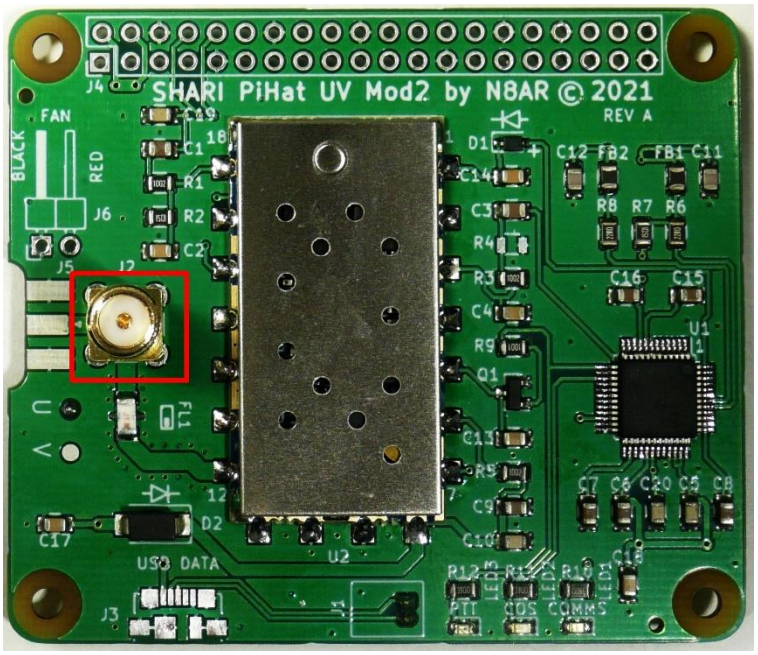
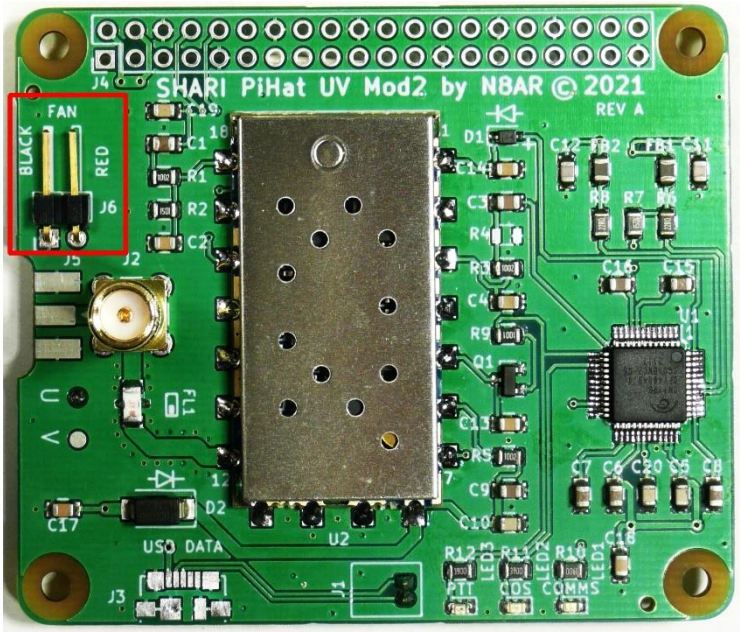
IMPORTANT - Make sure the module is oriented properly on the PCB and flush (**very important**) with the surface of the PC board.

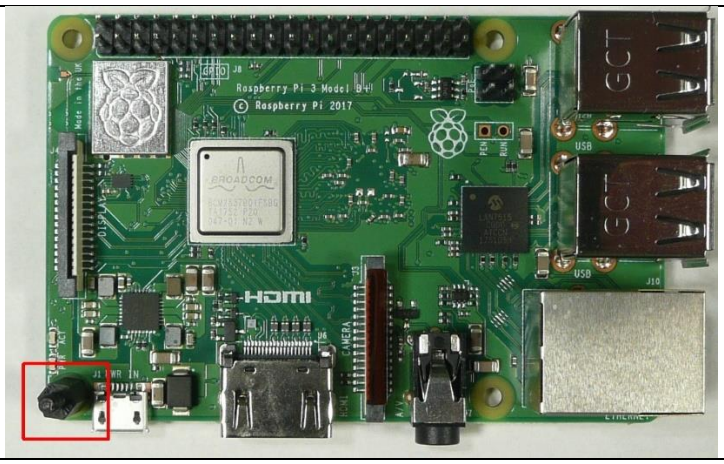
1) Solder pin 1 through pin 7
2) Solder pin 18 through pin 12
3) Solder pin 8 through pin 11

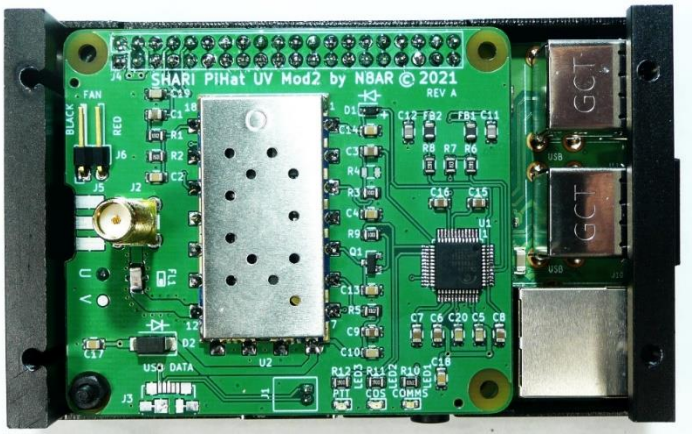


Insert the right angle JST connector into the J1 position on the bottom of the board in the orientation shown in the picture and solder its 2 leads.



Insert the straight mount SMA connector in the J2 position on the PC board. Solder the center conductor and four grounds on the bottom of the board.	
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.	

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.	
Solder the 40 pins of the GPIO connector. Your assembly should now look like the photo to the right.	

Step 2. SHARI PiHat Unistorm USB Cable Installation

In this step, you 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.

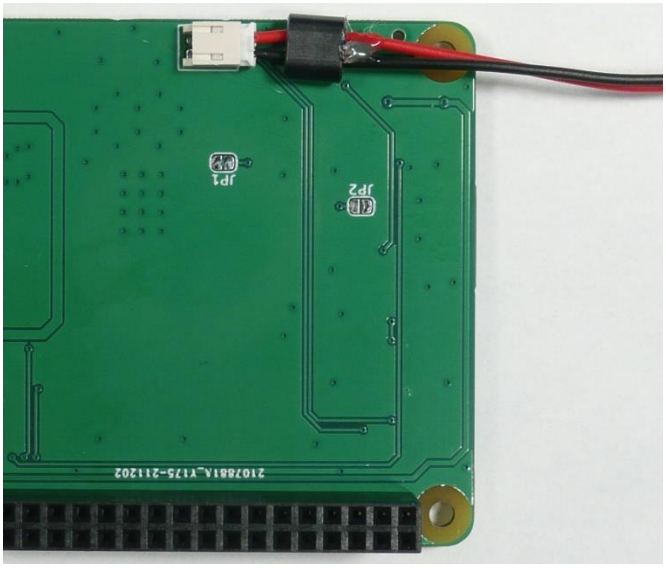
This procedure shows what we consider to be the optimum routing for this cable for the Pi3 and the Pi4. Try to keep the red and black wires in the cable parallel and touching each other. This will help to minimize impedance variations along the cable and to minimize coupling of the transmitted RF to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

To begin, disassemble the Pi and the SHARI PiHat board from the case.

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.



Reassemble the SHARI PiHat board onto the Pi as follows:

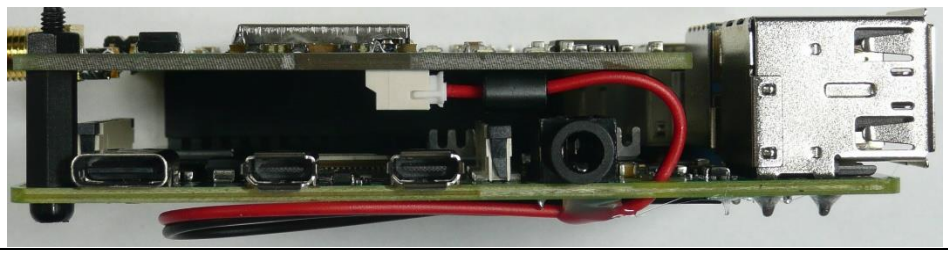
Route the cable through the unused mounting hole on the Pi and install the Pihat board on the Pi by plugging it into the 40 pin connector and over the 11 mm spacer. Install the nut on the spacer.

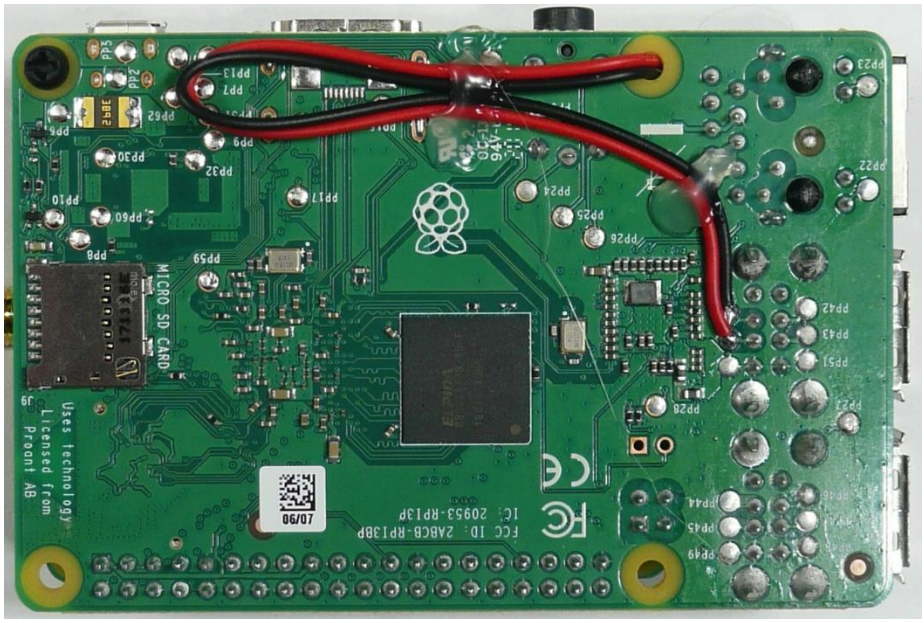
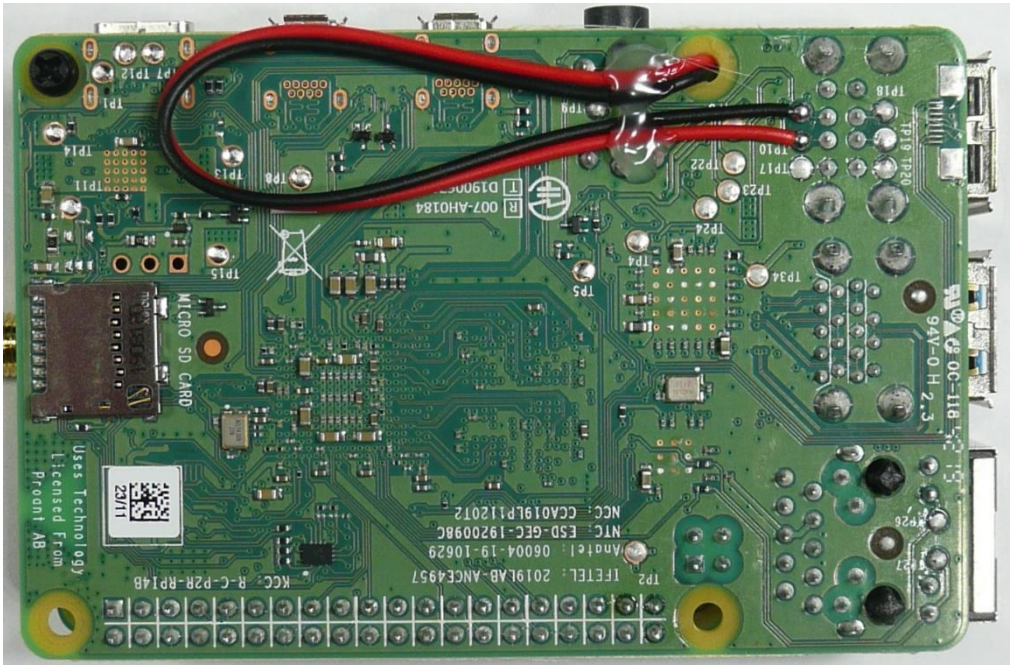
Observe the connection points (test pads) in the following photos.

- 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 3. SHARI PiHat Unistorm Final Assembly (Part One)

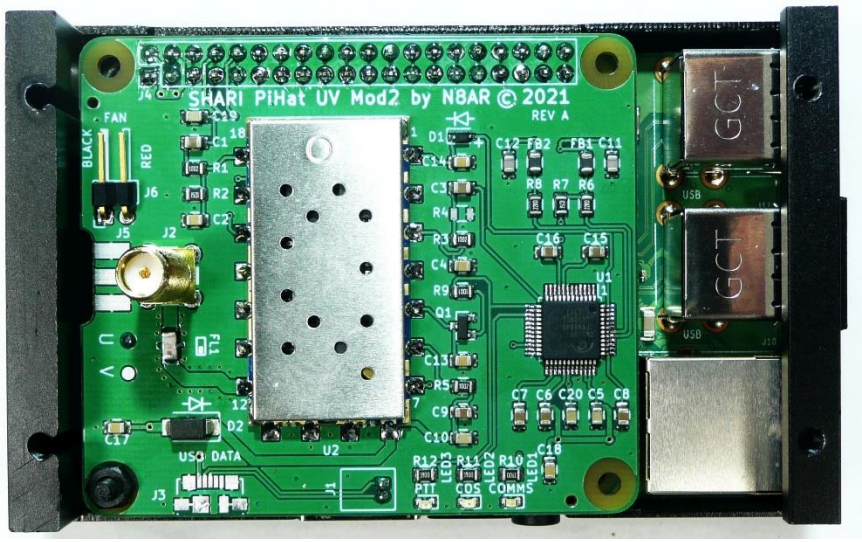
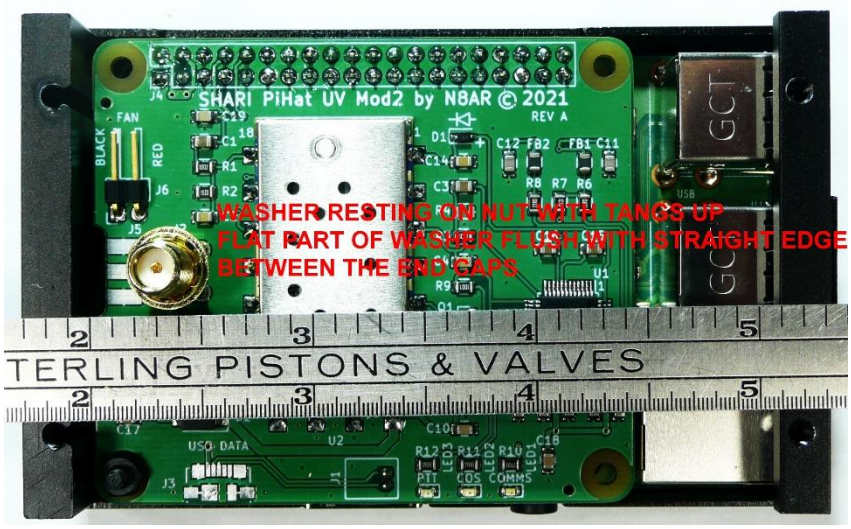
In this step, you will complete the assembly of your SHARI PiHat Unistorm node.

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 use the Phillips screwdriver that came with the case screws, you do not have to separate the boards 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.

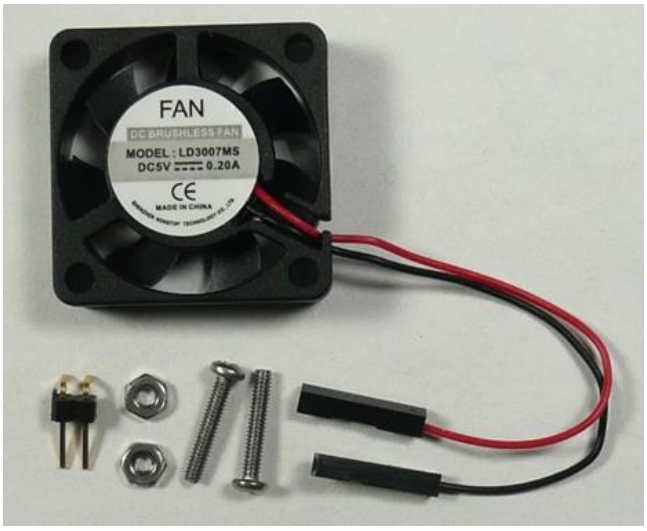
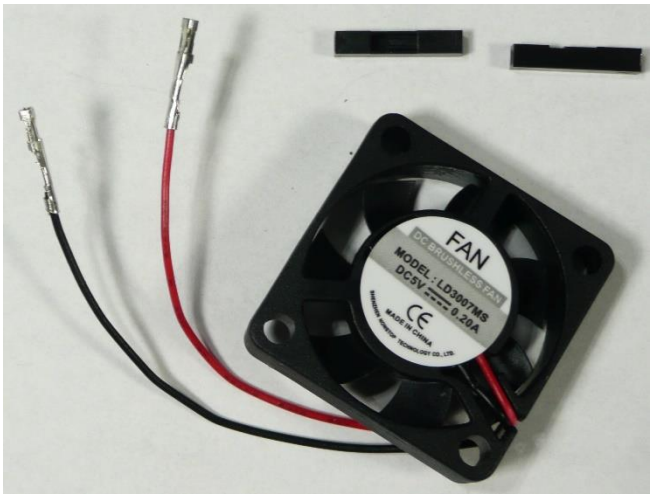
Place the Pi in the bottom half of the Unistorm case and secure with one silver colored Phillips mounting screw.

- 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.
- 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 other endcap in position and secure with two screws through holes in the bottom of the case.

Your assembly should now look like the photo to the right.	
Thread a nut onto the SMA connector. Position it so that its top surface is just below the top surfaces of the end caps. Place the star washer onto the SMA connector with its tangs pointing up. Readjust the nut so the flat part of the top of the washer is flush with the tops of the end caps. You want the tangs to be above the tops of the end caps so the washer will be compressed by the top cover when it is installed. HINT: A straight edge is ideal for setting this height. Continue with step 4 if you purchased the fan option, otherwise proceed to step 5	

Step 4. 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)

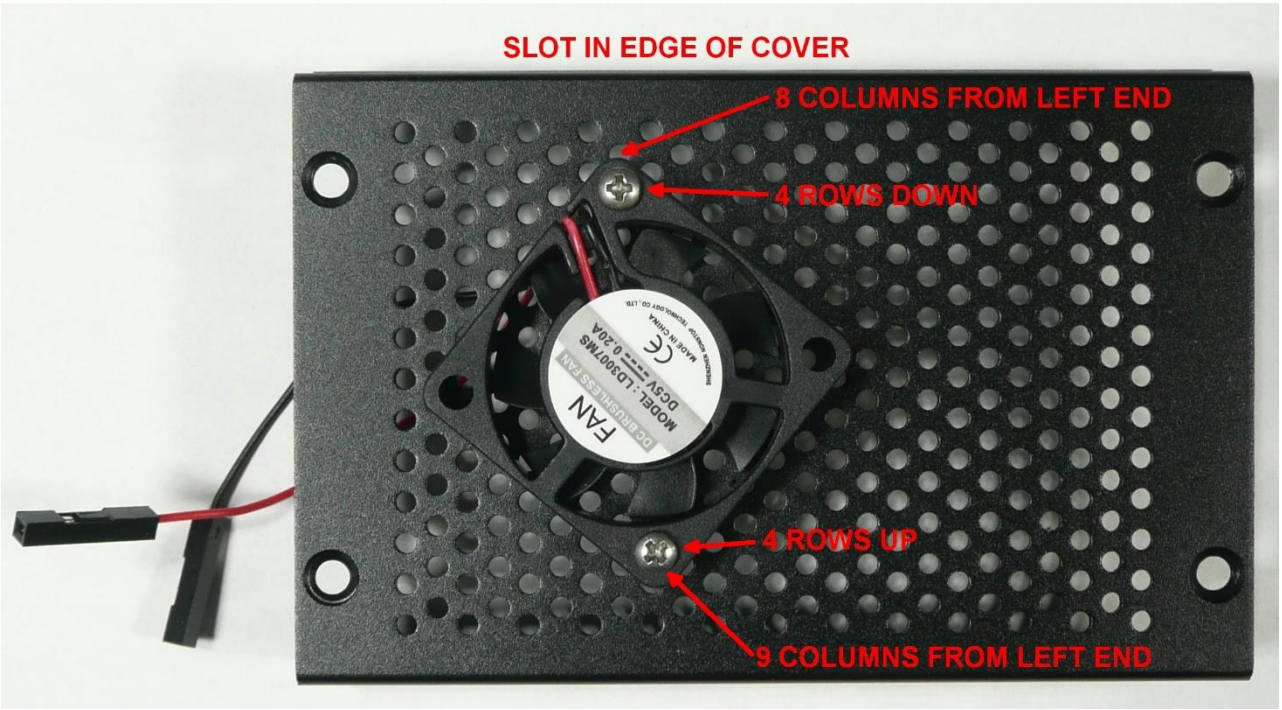
The parts included with the fan option are: • 30x30x7 mm fan, 5 VDC • 2 2-56 x ½" screws with nuts • 2 position right angle male pin header The wires on the fan are terminated with Dupont female connectors.	
Remove the 2 plastic crimp housings from the female pins on the red and black wires by gently 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 for the elbow rod antenna. For this straight rod antenna version, move the fan to the right of the antenna. Note: The Unistorm case manufacturer apparently has at least two different vent hole patterns for the top cover which have slightly different hole spacing. The fan may does not have to be rotated 45 degrees as shown in the picture for the fan holes to align with the cover vent holes in the other pattern.

- 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 ½" 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 5. 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.

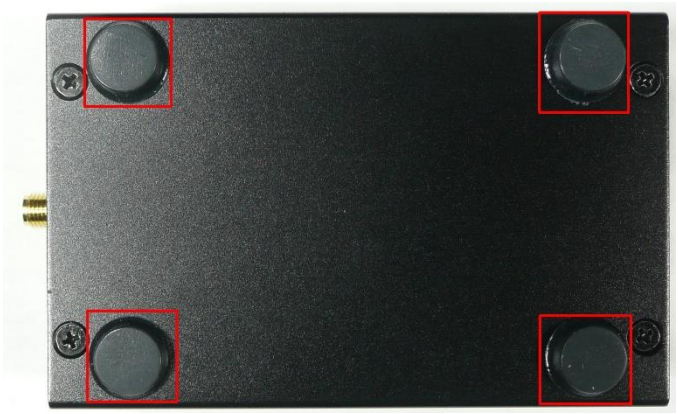
- Verify that the top cover is contacting the star washer on the SMA connector. To do this look for a gap of approximately 0.010 to 0.020 inches between the top of the end cap and the cover. Readjust the nut on the SMA connector if necessary.

- Install four cover screws.

- Tighten all eight cover screws.

- Thread the second nut onto the SMA connector and tighten it down on the top cover to compress the star washer.

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. It will fit on either side but if you put it on the side with the access slot, the order of the LEDs on the label will be the same as the board.	
The USB port that you connected the JST cable to internally can no longer be used by a USB device. Plug the USB hole plug into the USB jack of the Pi3 or Pi4 used for the internal connection of the JST cable. On the Pi3, this will be the top jack of the left column as shown in the photo. For the Pi4, this is the also the top jack of the left column (the black colored jacks, not the blue ones). Make sure you orient the plug correctly. The part of the plug that engages the jack is offset so that the cover portion of the jack does not interfere with a USB device plugged into the jack below it.