SHARI Construction Manual

SHARI (**S**A818 **H**am **A**llstar **R**adio **I**nterface) is a kit construction project that implements a Raspberry Pi hosted Allstar node using a NiceRF SA818 embedded UHF (420 – 450 MHz) radio module. An Allstar node can be implemented with SHARI and a Raspberry Pi (2, 3 or 4) running the Allstar program.

SHARI plugs into two USB jacks on the Raspberry Pi for 5 VDC power, the Allstar interface and radio programming. Front panel LEDs on the SHARI module indicate the status of SHARI – POWER (green), CONNECTION STATUS (blinking green), COS (yellow) and PTT (red). SHARI RF output power is 100 to 400 milliwatts.

Figure 1 - SHARI Plugged Into a Raspberry Pi

Figure 2 – SHARI has Two Type A Male USB Connectors for the Allstar Interface and Radio Programming

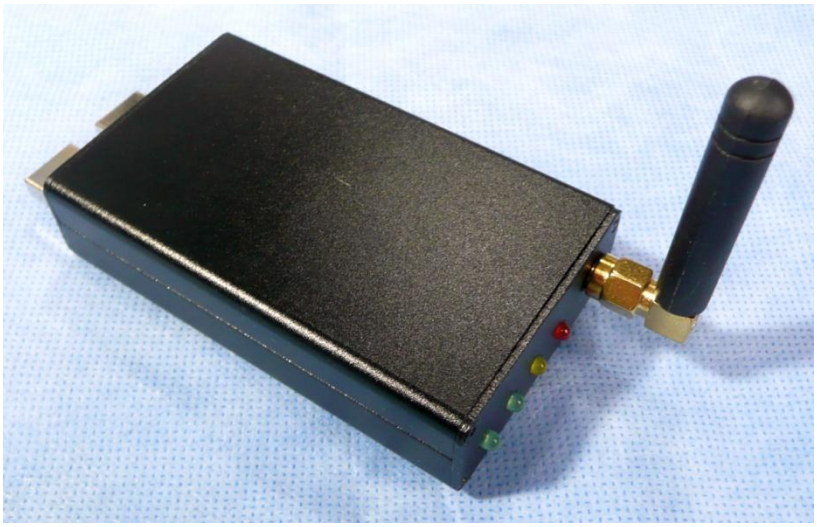

Figure3 – Four LEDs indicate the Status of Power, Allstar USB Interface, Radio COS and Radio PTT

SHARI is implemented using a single PCB containing surface mount and through hole parts. The board is supplied with all the small surface mount parts installed. The kit builder installs eight through-hole parts and the SA818 radio module.

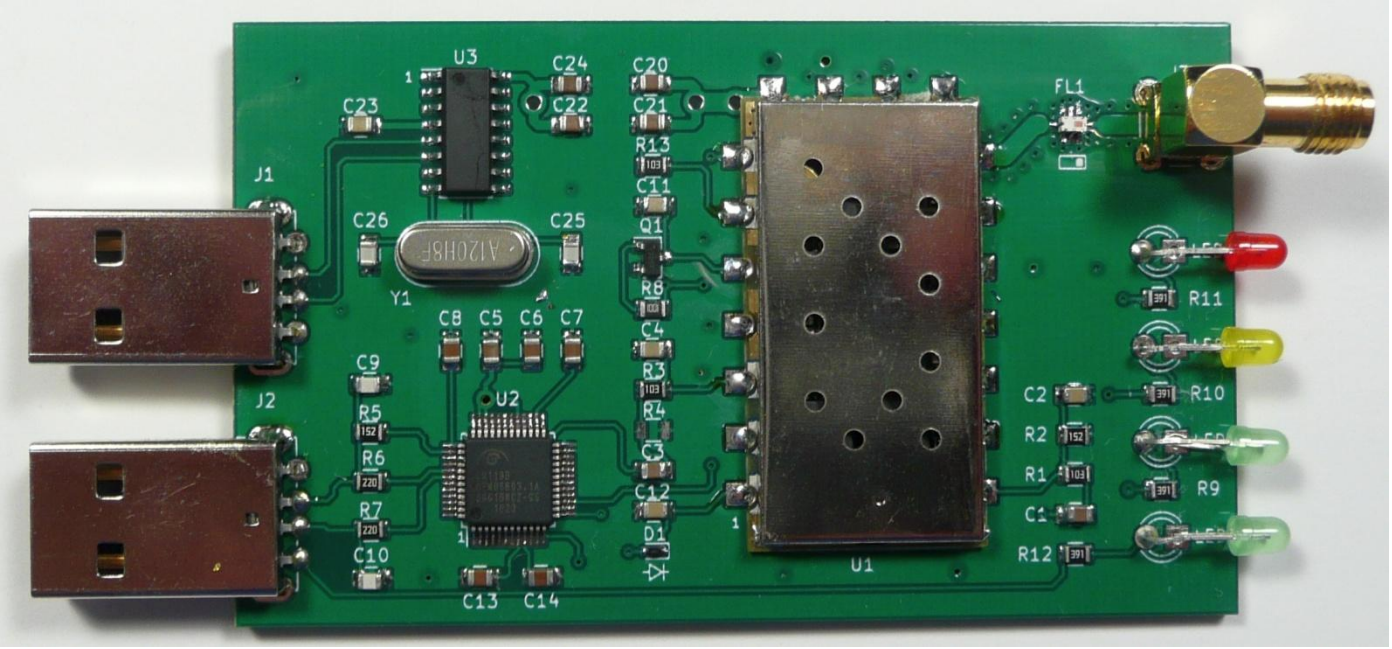

Figure 4 – SHARI PCB with all Components Installed

SHARI's enclosure is constructed of two pieces of extruded aluminum. It measures 3.2 inches long by 1.4 inches by 0.8 inches tall. Two 3D printed end caps containing all required holes and cutouts are attached to the ends of the extrusions using flat head screws. Blank painted aluminum end caps which can be cut/drilled by the kit builder are also provided with the kit in the event the builder needs additional shielding for use in a high RF environment.

SHARI was designed by N8AR and 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 with ham radio equipment, 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	2019-09-11	Initial release
1.01	2019-09-28	Updated schematic. Modified procedure to install USB connectors
1.02	2019-10-25	Modified LED lead bending instructions, Added instruction to install antenna
1.03	2019-11-22	Added caution about installing the SA-818. Minor grammar/punctuation fixes
1.04	2020-01-18	Based on feedback from users,revised the order of installation of parts on the PC board.
1.05	2020-08-15	Clarified shorts to shield on SA-818 module
1.06	2020-09-23	Clarified explanation of shield ground
1.07	2020-12-23	Added information to install ferrite on Pi Power supply cable

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SHARI Overview

Key Features

- Uses CMedia CM108 or CM119B USB Audio IC.
- Uses a NiceRF SA818 embedded UHF (420 to 450 MHz) or VHF (144 to 146 MHz) radio module.
- 4.8 kHz max deviation at 1 kHz.
- CTCSS encode/decode (about 600 Hz deviation).
- 100 to 400 milliwatts RF output power.
- Small, portable, USB-powered.
- Rugged RFI-resistant metal enclosure.
- USB serial connection to the Raspberry Pi to change RF and CTCSS frequencies.
- 3D printed plastic enclosure ends provided to minimize mechanical assembly effort.
- Blank metal end caps included for modification and use in the event of RFI issues.

Setting Expectations

- **What's missing from this miniature design?**
    - External frequency selection - RF frequency, CTCSS frequency and squelch level is set by running the *SA818-prog* program on the Raspberry Pi.

- **Degree of soldering difficulty –Medium**
    - **Medium**– Assembly of the SHARI kit requires standard through-hole soldering of 8 leaded components. The embedded radio module is surface mounted by soldering castellated holes to very large solder pads.

- **Degree of mechanical difficulty - easy (if you use the 3D printed plastic end caps)**
    - The SHARI boards fit snuggly in the metal enclosure. Due to manufacturing tolerances on the extrusion used for the enclosure, you may need to use sandpaper to adjust the board for a snug fit in the case.
    - If you decide to use the metal end caps, you will need to refer to the end cap drawings in the appendix to mark, drill and cut the required holes and slot.

Required Materials

- SHARI Kit (see Appendix 1 for parts list, schematics and pcb layouts)

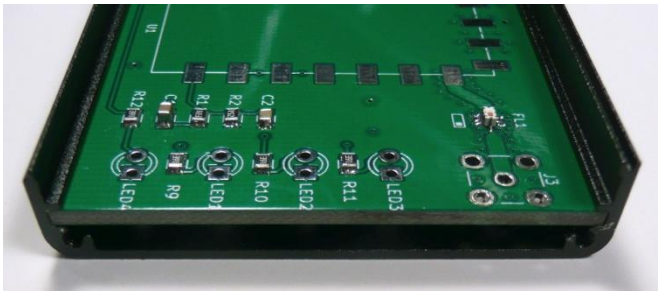
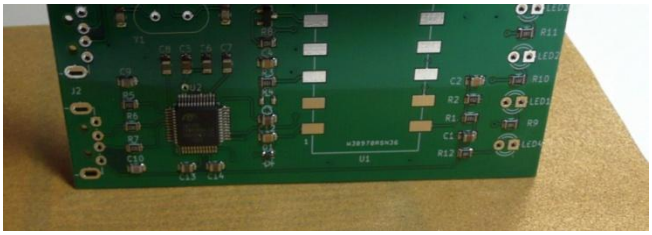
Figure 5 – SHARI Kit Components (included ferrite filter not shown)

- Tools
  - Low wattage (50 watt) solder pencil with small tip and solder.
  - Higher wattage solder iron to solder SMA RF connector and USB connector ground tabs.
  - Phillips screwdrivers (#1), small side cutters, small needle nosed pliers.
  - *If using metal end caps* - a drill with 1/8 inch and 1/4 inch bits and a set of small files.

Step 1. Fitting the PCBs to the case

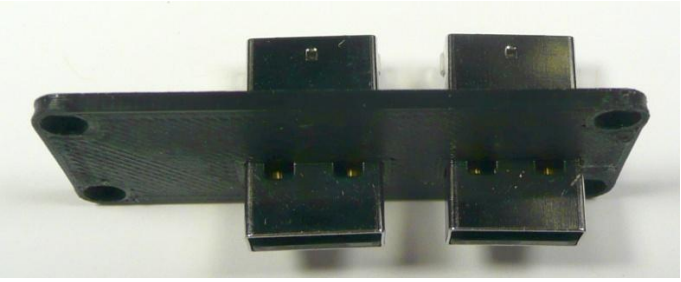
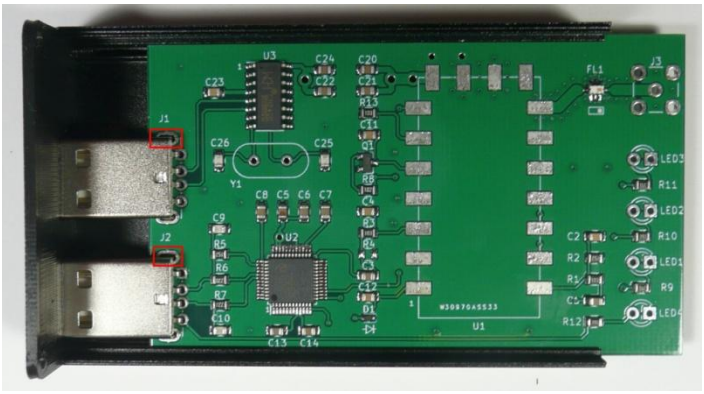
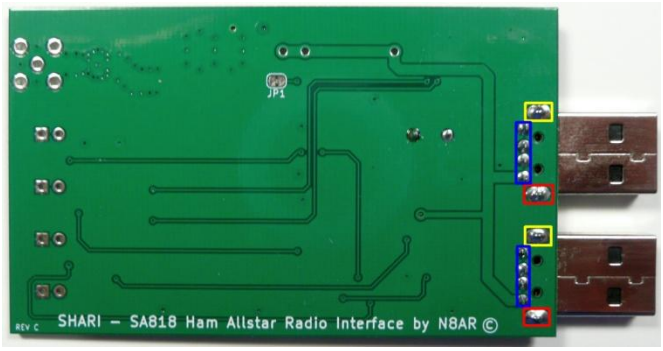
In this step you will verify that the PC board fits into the case mounting slots. If it is too wide, you will modify the board as required by sanding the edges. (Note: We are currently supplying the kit with the PCB pre-fitted and shipped in the case)

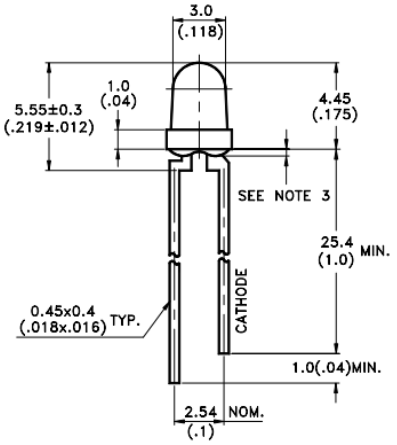
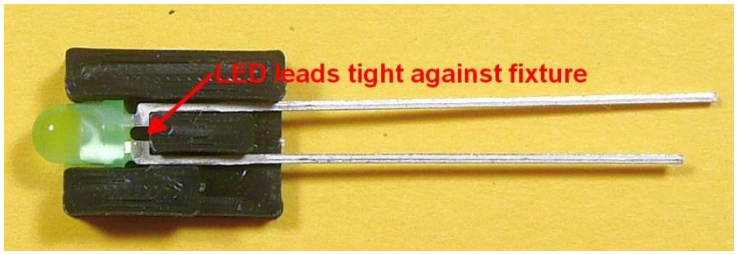
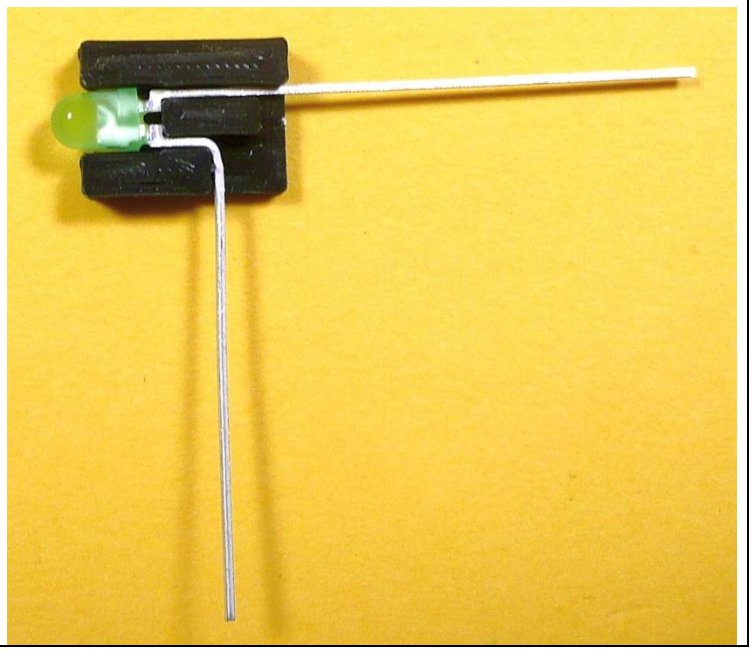
CAUTION: The SHARI PC board contains static sensitive parts. Use static prevention procedures when working with the PC board.

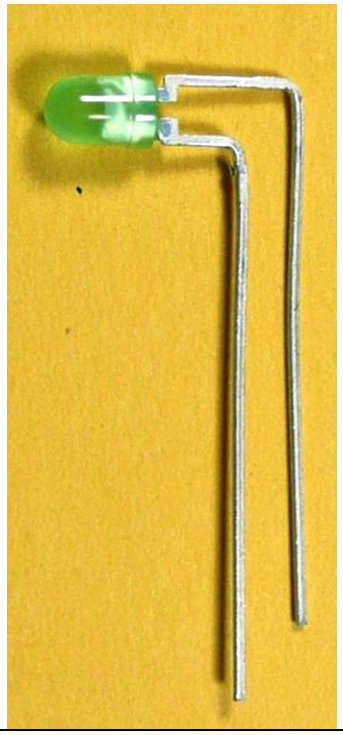
Attempt to insert the PC board into the provided slots in one of the case half extrusions. Due to manufacturing tolerances, we have found that there is some variation in the width of the case. Sometimes the boards fit nicely and sometimes they are too wide. If the board does not fit, first try the other case half extrusion. If necessary, use fine sandpaper (220) included with the kit to remove material equally from both long edges of the PCB until you achieve a slightly snug fit. We suggest you place the sandpaper on a flat surface and move the long edges of the board over the sandpaper .	 
Remove the board from the extrusion. Clean the PC board of any dust you created in the sanding process using 91% Isopropyl alcohol (available at your local drug store). Keep track of which extrusion you have selected for mounting the board.	

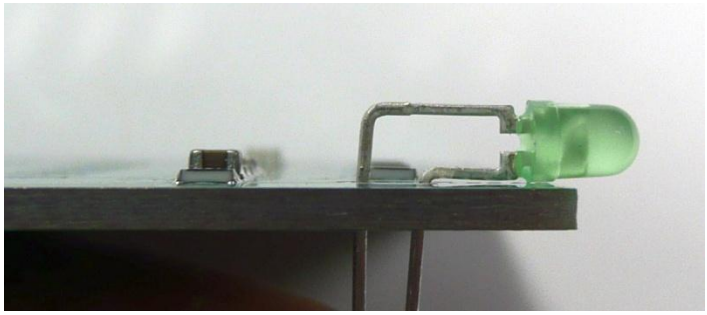
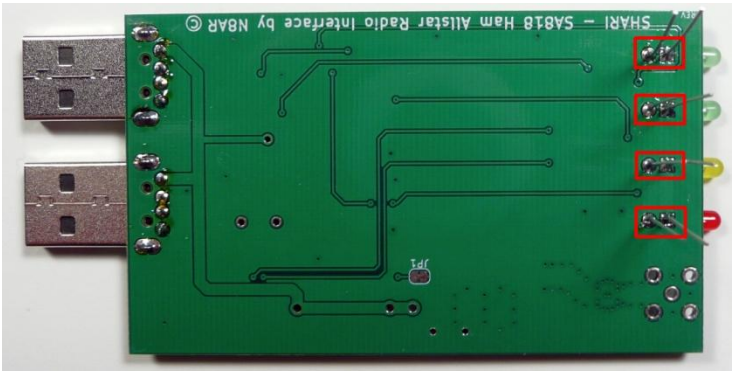
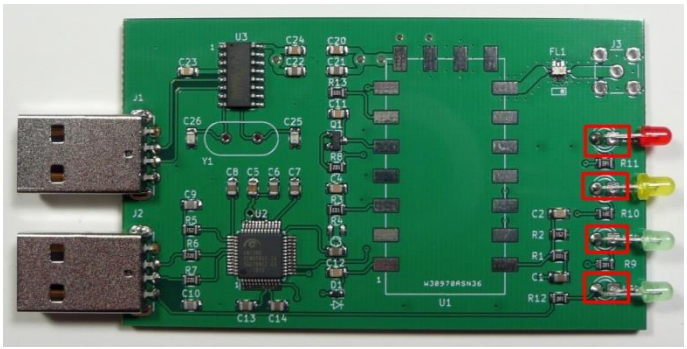
Step 2. Installing the Eight Through-Hole Parts and Radio Module

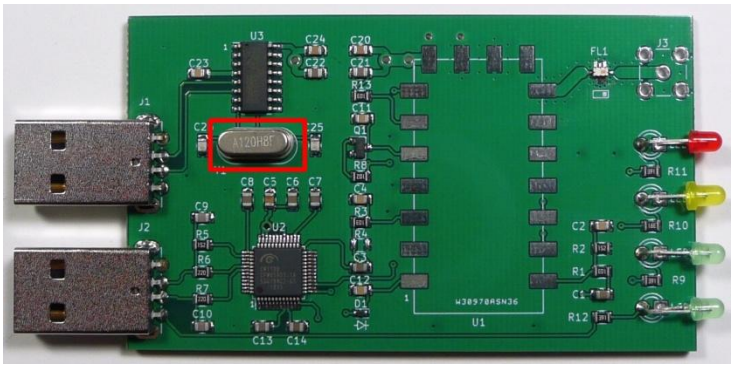
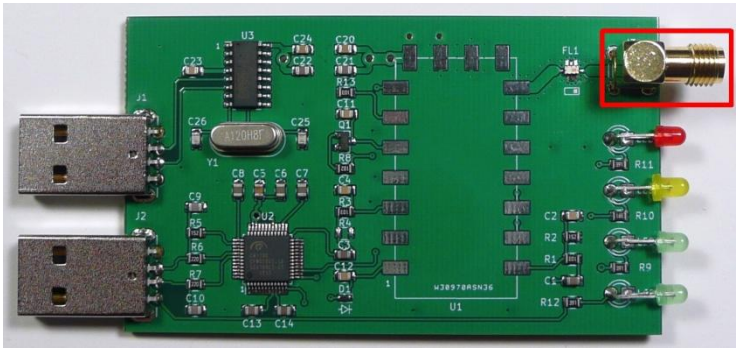
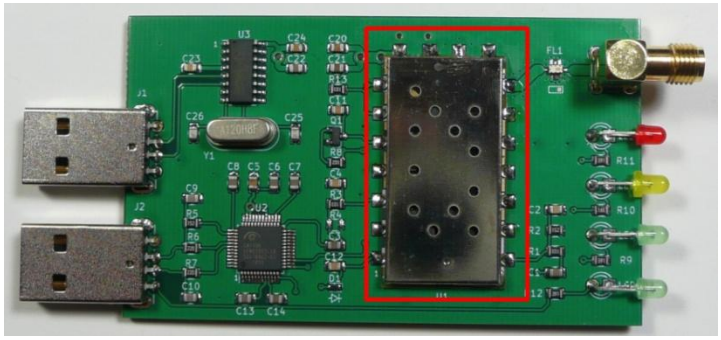
In this step, you will complete the PC board assembly by soldering the 2 USB connectors, 4 LEDs, 12 MHz crystal, SMA RF Connector and the SA818 Radio Module to the PC board.

Fit check the two type A USB connectors in the USB end cap. They should slide in snugly. If they do not fit, enlarge the openings using a small fine file as required to remove material equally from all four sides of the opening. Remove the USB connectors from the end cap.	
Insert the 2 USB connectors into the J1 and J2 positions in the PC board from the top as shown in the photo. Press firmly to ensure they contact the PC board. Slide the board and connectors into the extrusion half you selected in Step 1. Slide the end cap over the USB connectors and use 2 case screws to fasten the end cap to the extrusion. **CAUTION: Use care to ensure you do not cross-thread the screws.** Position the board so that the connectors barely protrude through the end cap. Ensure the connectors are parallel to the board and fully seated to the board. Then solder the two mounting/shield pins from the top as indicated by the red rectangles in the photo to the right. This will hold the connectors in the proper position for soldering on the back side of the board.	
Remove the board with USB connectors from the case. Be careful not to disturb the positioning of the USB connectors in the board. Solder the two mounting/shield pins from the bottom as indicated by the red rectangles in the photo to the right. Fit check the board with connectors by installing the board in the case/end cap. Reheat solder joints and adjust the USB connector if required. Remove the board with USB connectors from the case and solder the two mounting/shield pins outlined in yellow and then the eight remaining pins outlined in blue. Remove the board with installed USB connectors from the case.	

In the next step you will prepare four LEDs for installation in the PC board by forming their leads. The two objectives are: 1) for the slightly larger diameter annular ring at the base of the LED body to be located behind the edge of the PC board when the LED is installed on the PC board so the end cap does not push on the LED annular ring when it is installed over the LED. 2) for the LEDs to protrude through the front panel an equal distance .	
Your SHARI kit contains a 3D printed LED leading forming tool to use in forming the leads. Insert the LED in the tool. Note the position of the shorter LED lead. Ensured that the LED leads are tight against the fixture as shown in the photo.	
Grasp the short lead and bend it 90 degrees as shown in the photo. Be sure it bends tight against the fixture	

Bend the second lead 90 degrees	
Both leads bent and ready for installation	

Insert the first green LED with the newly formed leads into the LED4 position on the board and position it as shown in the photo to the right. Note that the largest diameter part of the LED body is touching the PC board. Repeat for LED1 (green), LED2 (yellow) and LED3 (red)	
While holding the LEDs so they do not fall out, turn the board over on a flat surface. Align the LEDs so they are perpendicular to the end of the board. Ensure that they protrude an equal length from the board and that the annular rings at the base of the LEDs do not protrude beyond the edge of the board. Lightly solder the ground lead (square pad) of each LED. Lift up the board and examine the positioning and alignment of the LEDs. Adjust as necessary by reflowing the solder joint(s) and moving the LED. When they are all in proper alignment solder the LEDs starting with the positive lead (round pad) and then touching up the negative ground lead (square pad)	
Trim the excess lead length of all 4 LEDs	

Insert the crystal, Y1, into the PC board from the top as shown in the photo. Solder the two pins on the bottom side of the board. Trim excess lead length.	
Insert the SMA RF connector in the J3 position on the PCB. Position it so the connector output is perpendicular to the edge of the PCB and solder it in place.	
Next, you will solder the SA818 radio module to the PC board in the U1 position. You will solder 18 castellated hole 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.	

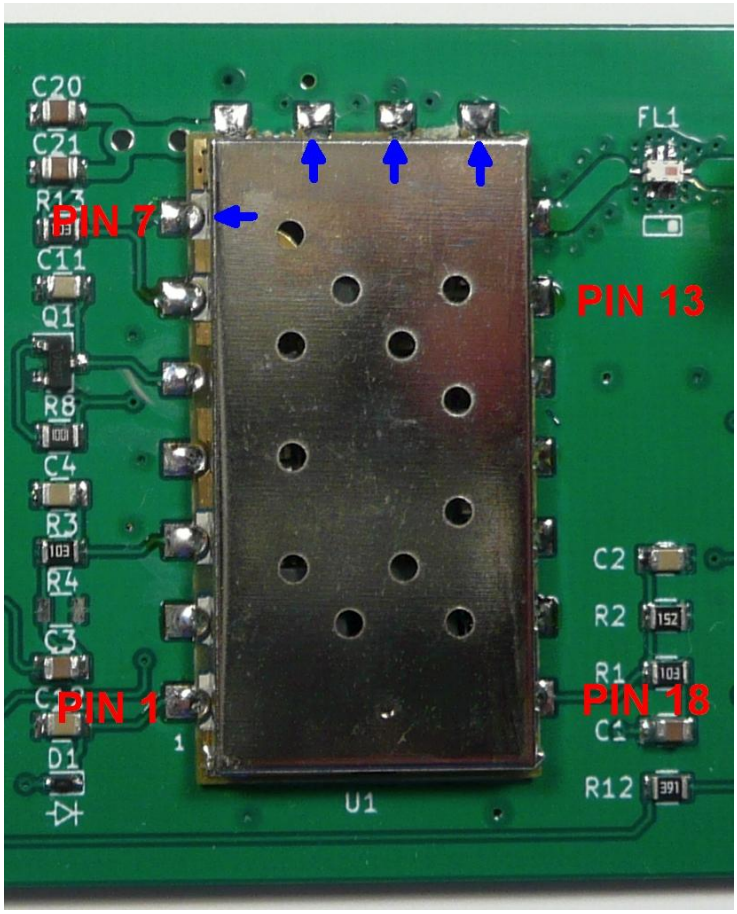
The SA818 radio module pin numbering is shown in the photo. The pin numbers increase clockwise from Pin 1. The SA818 radio module pin numbering is shown in the photo. The pin numbers increase clockwise from Pin 1. Pins 7, 9, 10 and 11 (blue arrows) are connected to ground on the PC board when you solder the module to the PC board. The shield of the module is also connected to ground of the PC board because it is soldered by the manufacturer to ground on the SA818 module PC board so an ohmmeter check between the shield and pins 7, 9, 10 or 11 will also read zero ohms.

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.

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.**

1) Apply a small amount of solder to the pad for pin 13.
2) Place the module in position and reheat the solder on pad 13 so the module contacts the board in the proper position. Reheat pad 13 and reposition the module as necessary.
3) Solder pin1 through pin7
4) Solder pin 18 through 12
5) Solder pin 8 through 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.



Jumper JP1 programs SHARI for low power. Do not cut this jumper as SHARI has not been tested for high power.

Jumper JP2 is used to modify an input depending on whether a CM108B (shorted) or CM119B (open) is installed on your board. This connection is made by us before shipping the board.	

Step 3. OPTIONAL - Cutting Holes in the Aluminum Enclosure End Caps

The SHARI kit ships with 3D printed plastic end caps that align with the connectors and LEDs on the printed circuit board. The enclosure's original metal end caps are also included. Drilling and cutting the aluminum end caps is required only if you decide not to use the plastic end caps because they are not as pretty, you need additional EMI shielding or you just like the challenge.

The SHARI enclosure requires an end cap with two slots for the USB connectors. A second end cap is required with one hole for the RF connector and four for the LEDs.

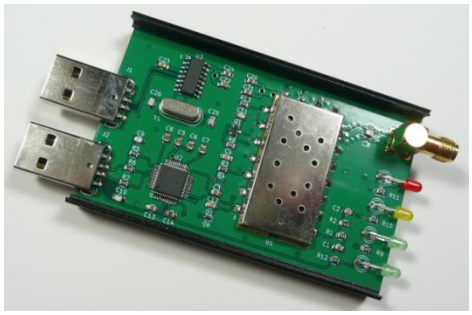
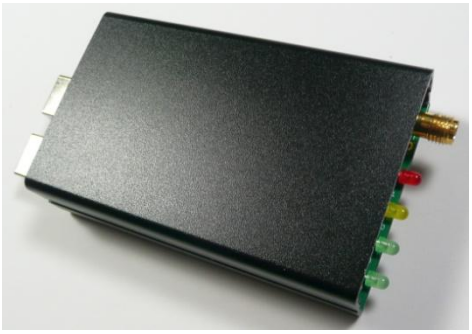
Dimensioned drawings for the end caps are shown in Appendix 3.

After cutting the required holes, we have found that a black permanent marker works nicely to "touch-up" the exposed aluminum.

Step 4. Final Mechanical Assembly

In this section, you will perform final assembly of SHARI. If you are using the 3D printed plastic end caps supplied with the SHARI kit, some final cleanup may be required. If you are using aluminum end caps, skip the first two paragraphs below.

Dimensioned drawings of these end caps are supplied in Appendix 3 of this document. There are two end caps that we will call LED and USB. LED has four 1/8" diameter holes for the LEDs and one 1/4" hole for the RF connector. USB has two slots for the male USB connectors.

Small holes tend to print undersize in the 3D printing process. Therefore it may be necessary to "clean out" the holes in the LED end cap to enlarge the hole. Use a 1/8" drill bit for the four LED holes and a ¼" drill bit for the SMA RF connector. Fit check the LED end cap over the LEDs and RF connector on the PC board	
You should have cleaned out the rectangular holes in the USB end cap when you installed the USB connectors onto the PC board. If not, shame on you for not following directions! Do it now.	
Slide the PC board into the slots in the extrusion case half you selected in Step 1 with the component side of the PC board facing away from the extrusion.	
Press the two case half extrusions together.	

Attach the USB end cap using four black flathead screws. Use care when installing the screws to avoid cross-threading them. The holes are tapped so the screws should turn easily.	
Attach the LED end cap to the other end of the case using four black flathead screws.	
Two silicone feet have been provided with the kit to provide support to the LED end of SHARI when she is plugged into the USB ports on your Pi. Its thickness is appropriate for various Pi cases that I use. Use them at your discretion.	
Apply the “SHARI” label and attach the antenna to the SMA connector.	

Step 5. Installing the Ferrite Filter

A split core ferrite filter is now included with both the SHARI kit and the SHARI assembled unit. We started including the ferrite after we received a number of reports from SHARI users of hearing a “buzz” or “hum” when using SHARI.

We conducted an investigation into the cause of this buzz and found that the buzz is caused by your Pi power supply or other similar wall warts in the immediate area of the SHARI antenna. What is happening is your when she is transmitting, SHARI is also coupling RF energy into the power lead between the Pi and Pi power supply. The resulting current on the shield of your power cable, at your chosen transmit frequency, is being pulse amplitude modulated at a 60 Hz rate by your Pi power supply rectifier diodes which only conduct over part of the 60 Hz cycle resulting in sidebands every 60 Hz (i.e. 60,120,190 ....Hz) about your transmit frequency. So your power cable is re-radiating a pulse amplitude modulated signal.

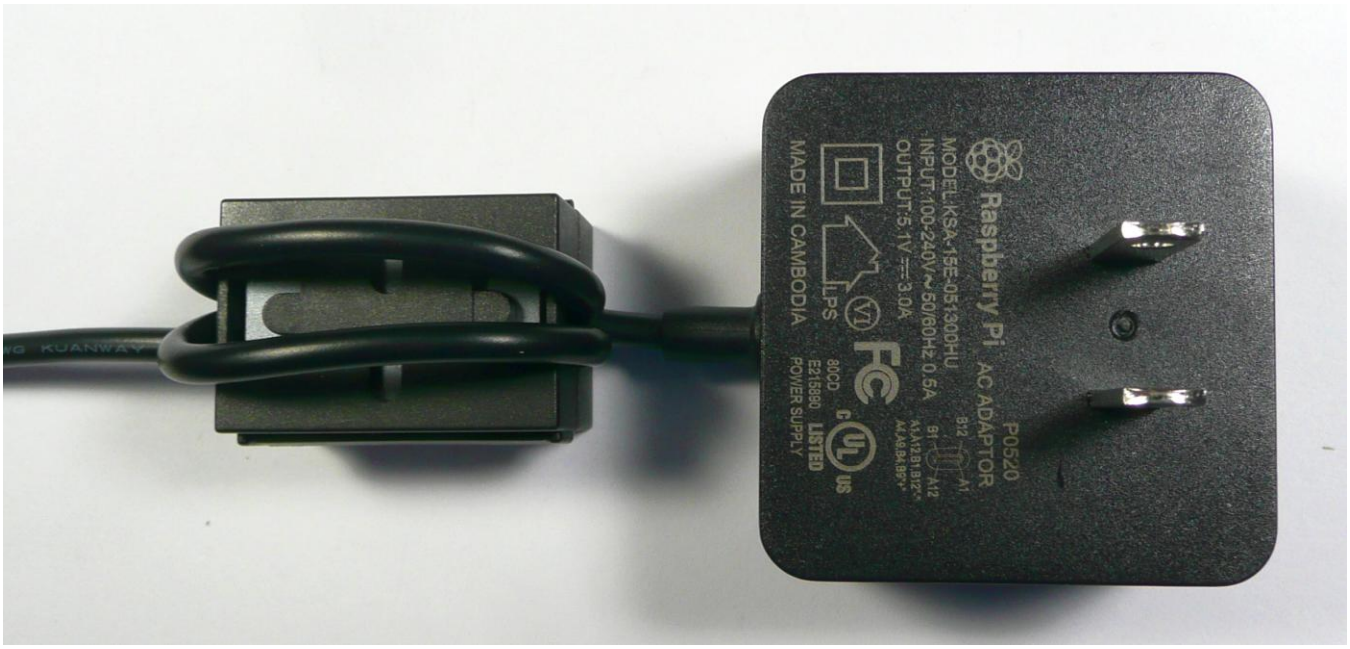
The radio (usually an HT) you are using to listen to your node receives the RF signal from your node plus this pulse amplitude modulated signal. These signals are combined in your radio receiver. The combined signal depends on the signal strength and phase difference between the two signals. At certain physical positions of your HT antenna relative to SHARI’s antenna and your Pi power cord, the signals can combine to result in a weak, AM modulated FM signal being detected by your HT. The buzz is a result of the detection of this weak signal. If you move your HT a few inches there is no buzz because the signal from SHARI is stronger, move it a few more inches and you hear a buzz as the two signals tend to cancel each other due to destructive interference.

Moreover, this same phenomena can occur when you transmit to SHARI from your HT. In this case, the ham(s) you are talking to may hear a buzz on your signal.

So the buzz is a result of poor RF decoupling in your Pi power supply. We tested several Pi power supply brands and they all produced the re-radiated AM modulated signal to various degrees.

We found that a properly selected ferrite filter installed on the power cord to the Pi right at the Pi power supply prevented most of the induced RF current from entering the Pi power supply. Thus the level of AM modulation was reduced sufficiently to eliminate the buzz. We also found that the small ferrites installed by some vendors of Pi power supplies were ineffectual in reducing the AM modulation.

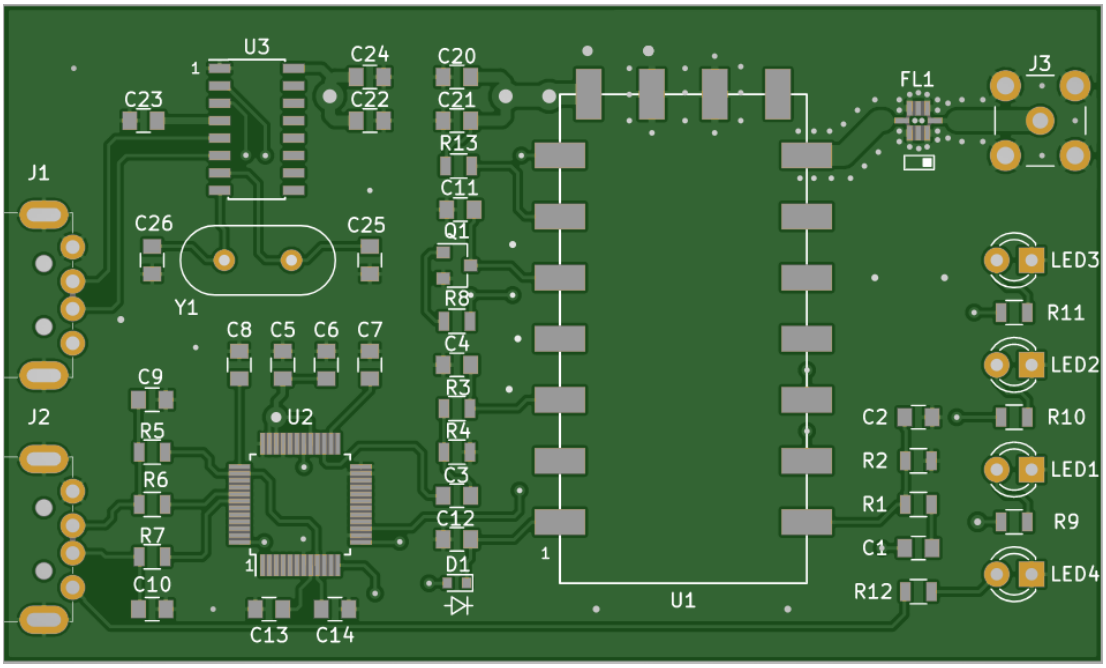
We recommend that you install the supplied split core, clamp-on ferrite on the cord right at the Pi supply. We recommend that you wind three turns through the core. In other words, the wire passes through the core three times. The following picture shows our ferrite core installed on a genuine Raspberry Pi4 power supply.



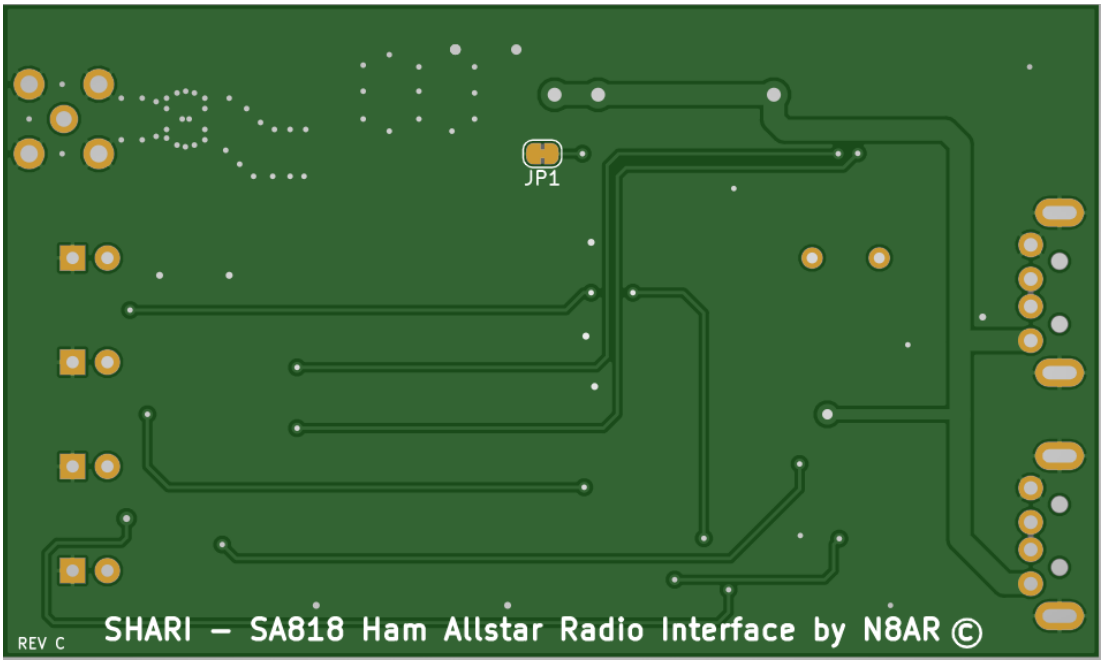
Split Core Ferrite Installed on Raspberry Pi Power Supply Cable (three turns)

Appendix 1. SHARI Parts List and Board Layouts

REF	NAME	PART NO	DESCRIPTION	MFG	QTY
	PC Board		SHARI Rev C PCB	PCBway	1
R1,R3,R13	Resistor	RC0805JR-0710KL	Resistor, 10K ohm, SMD, 0805,	Yaego	3
R2,R5	Resistor	RC0805JR-071K5L	Resistor, 1.5K ohm, SMD, 0805,	Yaego	2
R4	Resistor	NA	Do Not Install		0
R8	Resistor	RC0805JR-071KL	Resistor, 1K ohm, SMD, 0805,	Yaego	1
R9,R10,R11,R12	Resistor	RC0805JR-07390RL	Resistor, 390 ohm, SMD, 0805,	Yaego	4
R6,R7	Resistor	RC0805JR-0722RL	Resistor, 22 ohm, SMD, 0805,	Yaego	2
C1,C3	Capacitor	CC0805KY5V6BB106	Capacitor, 10uF, 10V, SMD, 0805, Y5V	Yaego	2
C2,C4,C11,C12,C23	Capacitor	CC0805KRX7R8BB102	Capacitor, 1000pF, 10V, SMD, 0805, Y5V	Yaego	5
C6,C7,C8,C13,C14,C21,C22	Capacitor	CC0805ZRY5V6BB475	Capacitor, 4.7uF, 10V, SMD, 0805, Y5V	Yaego	7
C5,C20,C24	Capacitor	CC0805ZRY5V9BB104	Capacitor, 0.1uF, 50V, SMD, 0805, Y5V	Yaego	3
C9,C10	Capacitor	CC0805JRNPO9BN101	Capacitor,100pF, 50V, SMD, 0805, COG	Yaego	2
C25,C26	Capacitor	CC0805JRNPO9BN180	Capacitor,18pF, 50V, SMD, 0805, COG	Yaego	2
FL1	Filter	0400LP15A0122E	Low Pass Filter, 400 MHz	Johanson	1
Q1	Transistor	2N7002	Transistor, Mosfet, N-Channel, 60 V, 200 mA	ONSemi	1
U1	Radio Module	SA818-U	UHF Module, 1 Watt	NiceRF	1
U2	USB Audio IC	CM119B	USB Audio Codec	Cmedia	1
U3	USB/Serial IC	CH340G	USB/Serial Converter, SOP-16	Jiangsu Qin Heng	1
D1	Diode	BAT43XV2	Shottky Diode, 200 mA, 30 Volt	ONSemi	1
LED1,LED4	Green LED	LTL-4231N	3mm, Through Hole, Green, Diffused	Lite-On	2
LED2	Yellow LED	LTL-4251N	3mm, Through Hole, Yellow, Diffused	Lite-On	1
LED3	Red LED	LTL-4221N	3mm, Through Hole, Red, Diffused	Lite-On	1
Y1	Crystal	ABL-12.000MHZ-B2	HC/49US, 12 MHz	Abracon	1
J1,J2	Connector	UP2-AH-1-TH	Connector, USB, Male, Type A	CUI	2
J3	RF Connector		RF Connector, RA, PCB mount	Unknown	1
	Enclosure	N/A	Extruded aluminum enclosure, 80x50x20mm		1
	Antenna	SW433-WT36	Antenna, UHF, RA	Unknown	1
	Label	N/A	SHARI I/O Aluminized Label	Stickers Int'l	1
	End Plates	N/A	3-D Printed End Plates (set of 2)		1

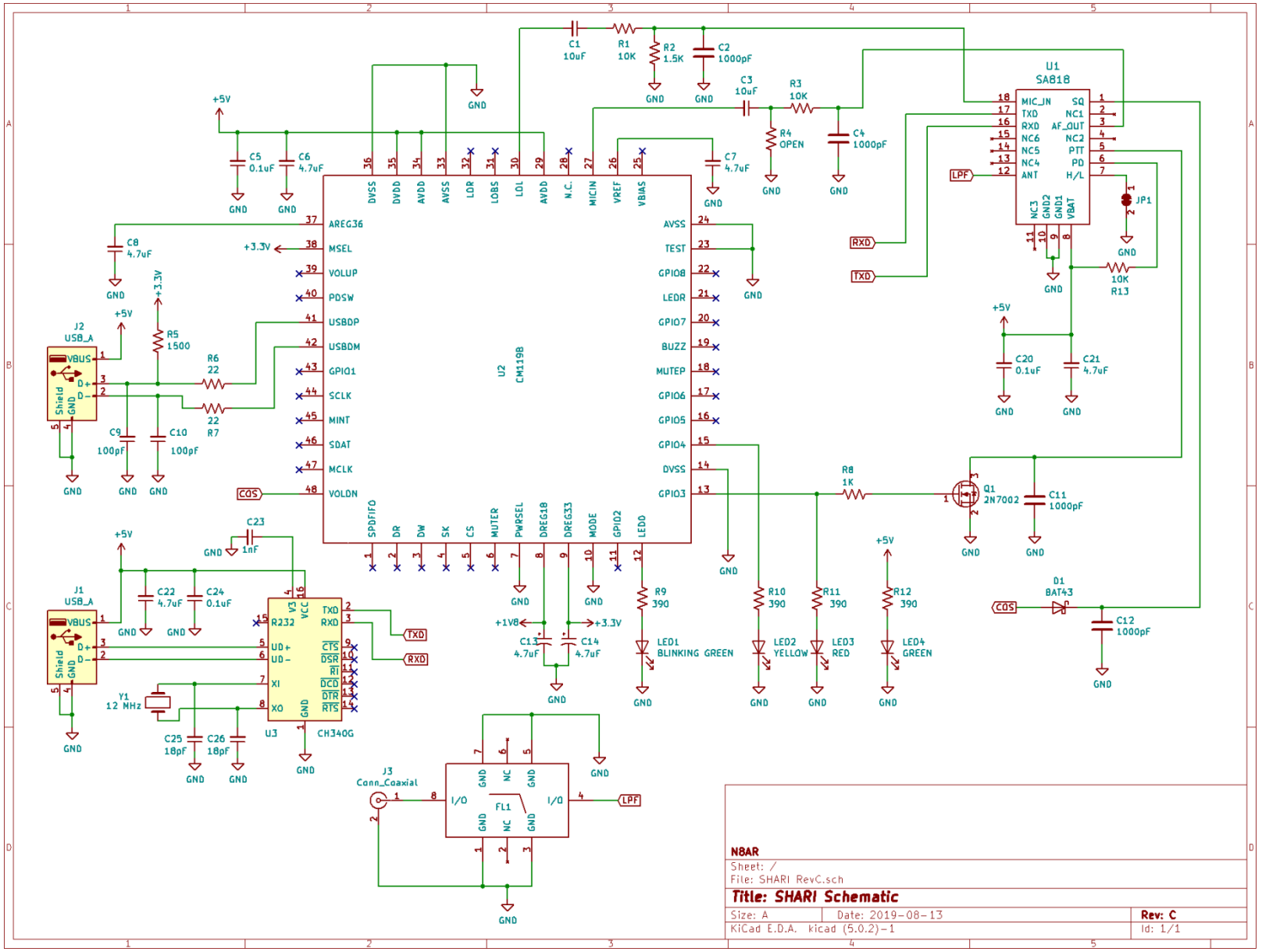


SHARI Surface Mount PCB Top



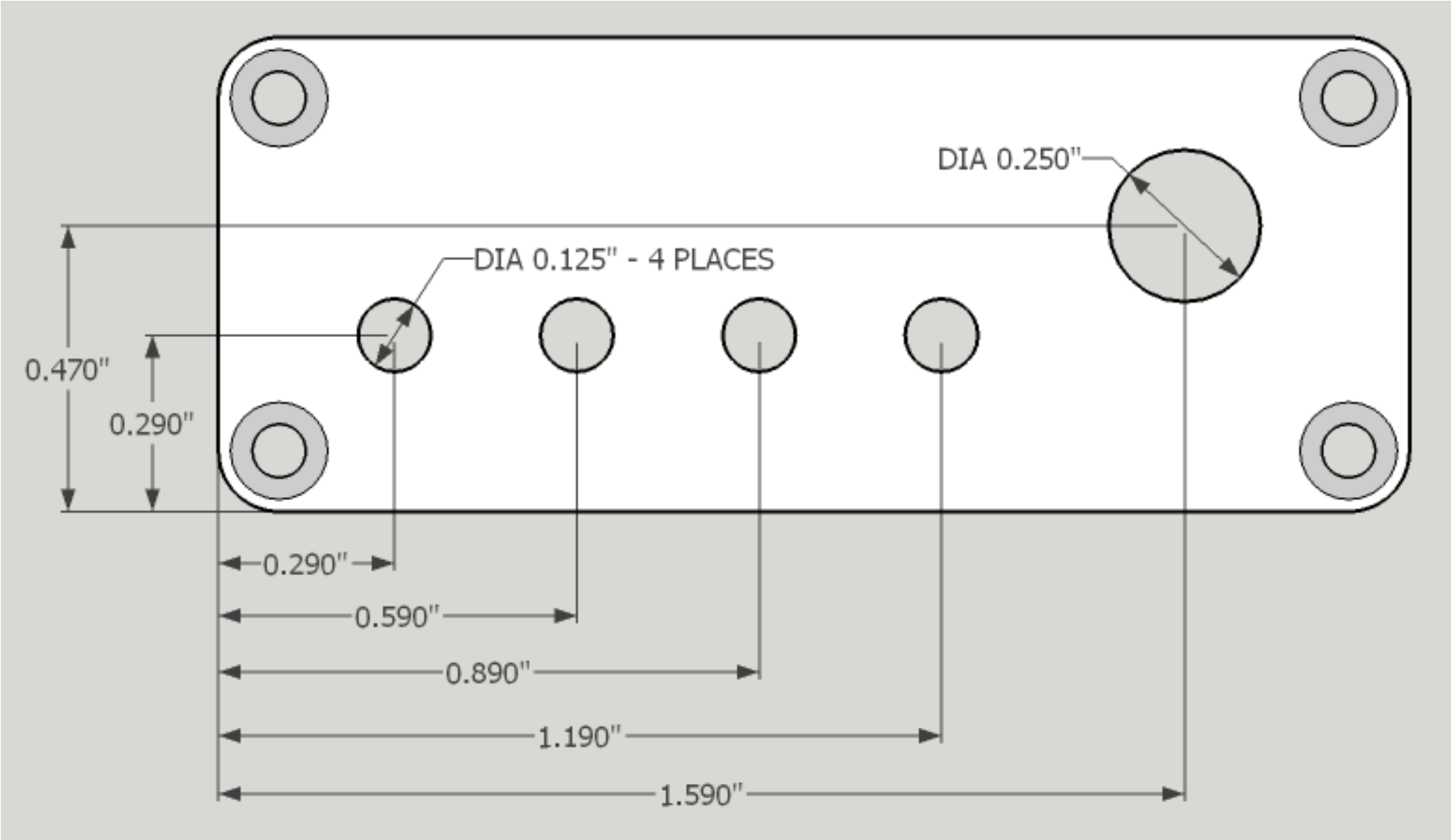
SHARI Surface Mount PCB Bottom

Appendix 2. SHARI Schematic Diagram



Appendix 3. End Cap Drilling Templates

LEDs and RF Connector End Cap



USB Connector End Cap