Mini Horn-Can Radio Telescope

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Materials

Horn-Can Components/Parts			
Component	**Price**	**URL**	**Notes**
RTL SDR Blog V3	$33.95	Amazon	
Nooelec SAWbird+ H1	$44.95	Amazon	Low noise amplifier (LNA) designed for 21 cm hydrogren line
Superbat RF coaxial SMA Male to SMA Female	$9.49	Amazon	I used a 2 meter long cable, you can choose shorter/longer if needed
RF DC Block 2W SMA Connector	$11.99	Amazon	
2 pcs brass SMA male plug panel mount 4 hole	$15.29	Amazon	
1 Gallon F-Style Reusable Metal Can	$22.99	Amazon	
Southwire 4-Gauge Solid SD Bare Copper Ground Wire	$17.07	Amazon	This is a 15 ft spool of copper wire, only need 4 inches for the can. Recommend you find spare copper to save on costs.
3M Aluminum Foil Tape 2.5 in wide	$23.98	Amazon	
Pro Select R-Matte Plus-3, 0.5 in x 48 in x 8 ft R-3.2 ISO Rigid Foam Board Insulation	$19.92	Home Depot	This amount can make 2 horn antennas if needed
Cost	$199.63		

*Prices may vary

Frame			
Hardware	**Price**	**URL**	**Notes**
2 in x 2 in x 8 ft Furring Strip Board Lumber	$3.35 per x 3 $10.05	Home Depot	Need 3 minimum
5/16 in Wing Nut (50 pack)	$13.93	Home Depot	Need 10
5/16 in x 3.5 in Hex Bolt	$0.51 per x 10 $5.10	Amazon	Need 10
2 in Phillips Flat Head Wood Screw (50 pack)	$10.32	Home Depot	Need 6
Cost	$39.40		

*Prices may vary

Tools			
Tool	**Price**	**URL**	**Notes**
OXO Good Grips Smooth Edge Can Opener	$25.49	Amazon	Used to cut bottom out of 1 Gallon F-Style Can safely
Soldering Iron Kit, 60W, 10-in-1 Adjustable Temp	$11.99	Amazon	Comes with holder and solder wire
10 Amp Variable Speed Reciprocating Saw	$54.99	Harbor Freight	Used to cut the wood
Helping Hands	$5.99	Harbor Freight	Required to safely solder copper wire + SMA male plug panel to 1 Gallon F-Syle Can
DEWALT 20V Max 2 Tool Combo Kit	$219 On sale sometimes	Acme Tools	Recommend impact driver and hammer drill
DEWALT Screwdriver Bit Set, 40 Piece	$39.99	Amazon	Need a Phillips bit
DEWALT Drill Bit Set, 21 Piece	$24.99	Amazon	Need a 1/8 in, 1/4 in, and 3/8 in bit
Wire cutter			Used to cut the 4 gauge copper wire
Markers/Sharpie			Mark measurements
Tape measure			
Long straight edge			
Box cutter			Used to cut the insulation board
Soldering hot air gun			Not necessary, but makes attaching the SMA male plug panel easier
Cost	$382.44		

*Prices may vary

If you have no tools, this project will cost at least $600. I recommend the power tools because it is difficult to cut the wood with a manual saw as well as making holes in the wood and 1 Gallon can.

I also recommend purchasing an external battery pack with a micro USB connector to supply power to the LNA. It's light weight and can sit on the frame while conducting scans.

Construction

There are three parts to build; the horn antenna, paint can receiver, and the stand to hold the telescope. Each part will be built separately before putting it all together.

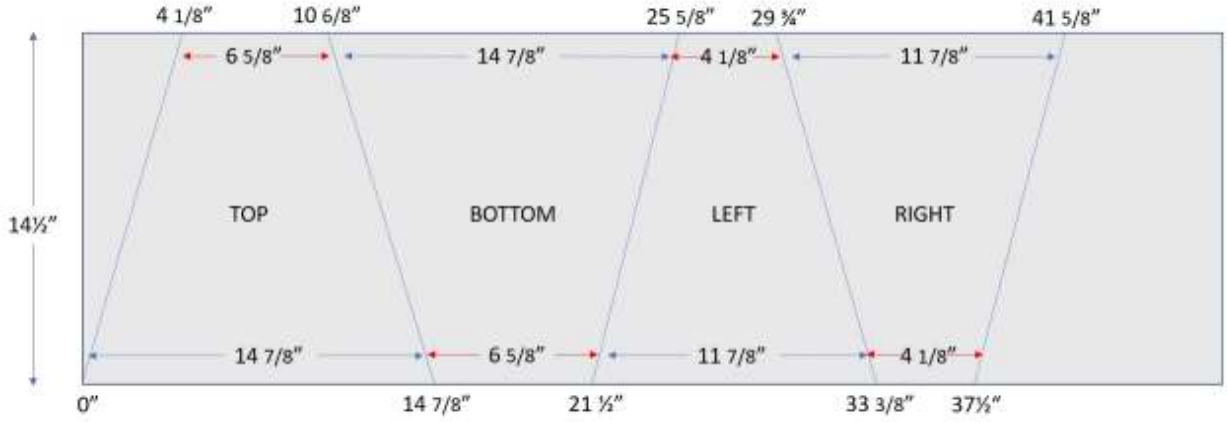
Horn Antenna Construction

Materials:

- Pro Select R-Matte Plus-3, 0.5 in x 48 in x 8 ft R-3.2 ISO Rigid Foam Board Insulation
- 3M Aluminum Foil Tape 2.5 in wide
- Box cutter
- Markers/Sharpie
- Tape measure
- Long straight edge

Steps:

1. Measure and mark the foam board as such



2. Cut along the lines to create 4 panels

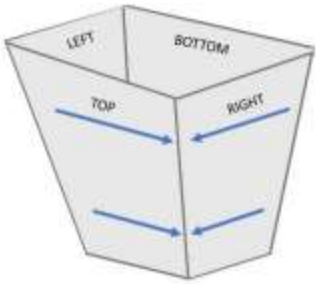
3. Lay the panels out

4. Use the aluminum tape to connect the panels where the edges meet. This should be done three times.

Top -> Left

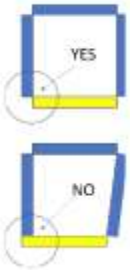
Left -> Bottom

Bottom -> Right



5. Fold the panels together and aluminum tape the untaped edges together, Right -> Top

6. Aluminum tape the inside edges. Don't let two pieces overlap.



to hold

7. Once the inside edges are taped, begin taping all edges both inside and out. There should be no exposed insulation.

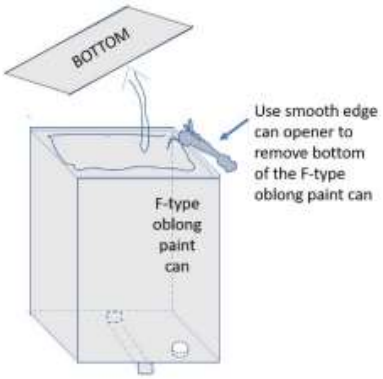
The aluminum tape acts as a reflector to redirect the signal toward the copper wire.

Paint Can Receiver Construction

The paint can is the back end of the horn antenna. It is the link between the hardware and electronics. The signal travels throught the panels of the horn where it is collected by the feedthrough antenna, the 4 in copper wire. The copper wire is connected to the SMA male plug panel mount which connects to the electronics.

Materials:

- 1 Gallon F-Style Reusable Metal Can
- Brass SMA male plug panel mount 4 hole
- 4 in copper wire
- Hammder drill
- 1/4 in and 1/8 drill bit
- OXO Good Grips Smooth Edge Can Opener
- Soldering iron capable of 350°C
- Solder wire
- Soldering hot air gun *optional, but makes life easier
- Helping Hands – to hold the copper and SMA male plug panel mount
- Wire cutter
- Markers/Sharpie
- Tape measure
- Long straight edge

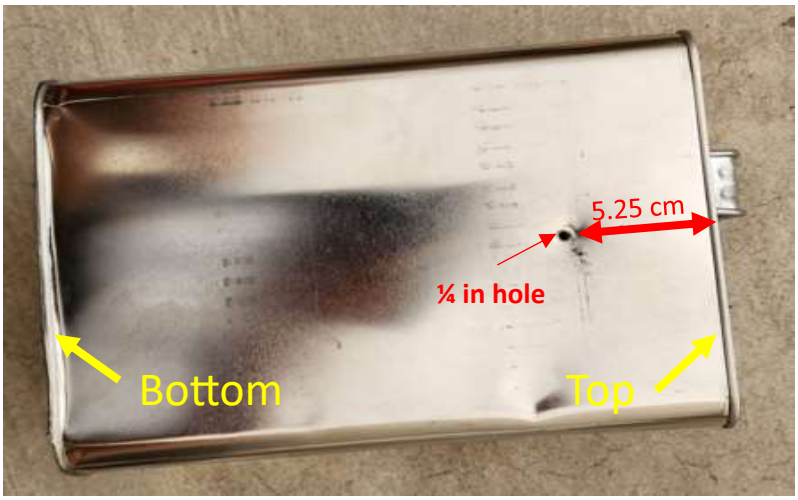


Steps:

1. Remove the bottom of the paint can (portion without the handle) using the can opener or another tool. Be careful of the sharp edges.

2. Drill a 1/4 in hole on the wide side of the can, 5.25 cm from the top of the can. Remember you just removed the bottom of the can. Place a small block of wood or object that fits snugly inside the can to prevent bending during drilling. Remove the block for later use.

This hole will be used for the feedthrough antenna.



3. Use the aluminum tape to cover the inside and outside of the spout on the paint can.

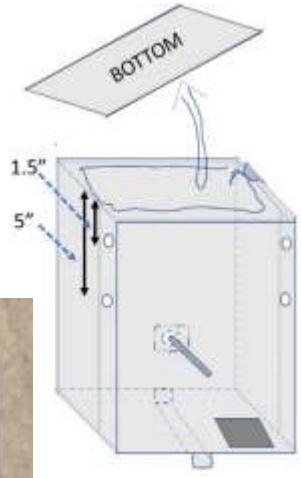
4. Cut the 4 gauge copper wire to 4 in. Wire needs to be short enough so that it doesn't touch any edges of the paint can

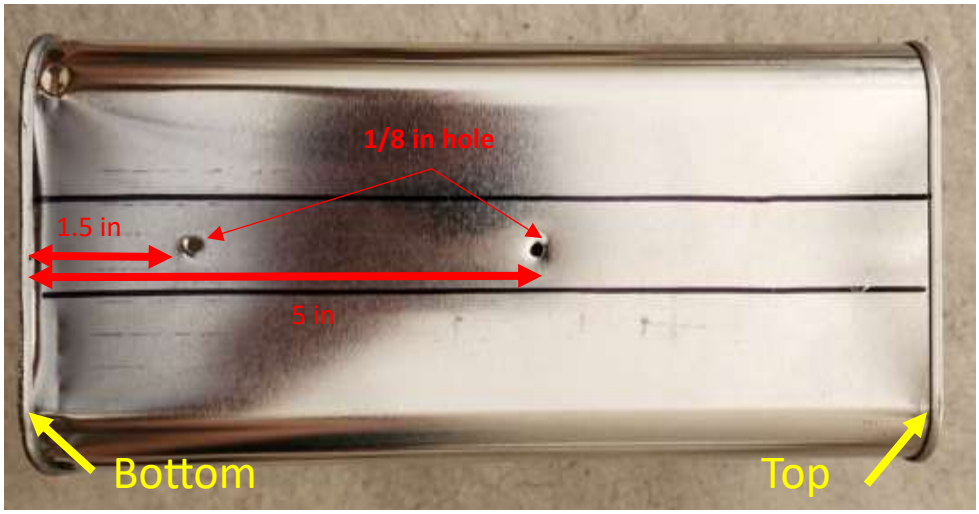
5. Heat soldering iron to 350°C and use helping hands to solder copper wire to the SMA male plug panel mount. This is your feedthrough antenna. USE CAUTION TO NOT BURN YOURSELF Let it cool before next step.

6. This step will connect the feedthrough antenna to the paint can. This can be done in two ways. First way is to heat the surrounding area of the 1/4 in hole with the soldering iron at 350°C. Once it's hot enough, solder around the hole and carefully slide the copper wire into the hole, with the copper inside the paint can and the SMA male plug panel on the outside of the paint can. Make sure the copper wire doesn't touch the sides of the paint can. Center the antenna and heat the solder between the can and the antenna to make a solid connection.

Second way is to do the same thing, but with the soldering hot air gun. This method is much easer compared to using the soldering iron.

7. Last step is to drill holes in the side of the paint can to attach to the frame. Use your wood as a guide to find the center of the paint can. Trace the outline. From the bottom of the can, measure and mark 1.5 in and 5 in from the open edge of the can. Do this on both sides. Place your wood block to prevent bending of the paint can. Using the 1/8 in drill bit, make 4 holes at your previous marks on the paint can.





Support Stand Construction

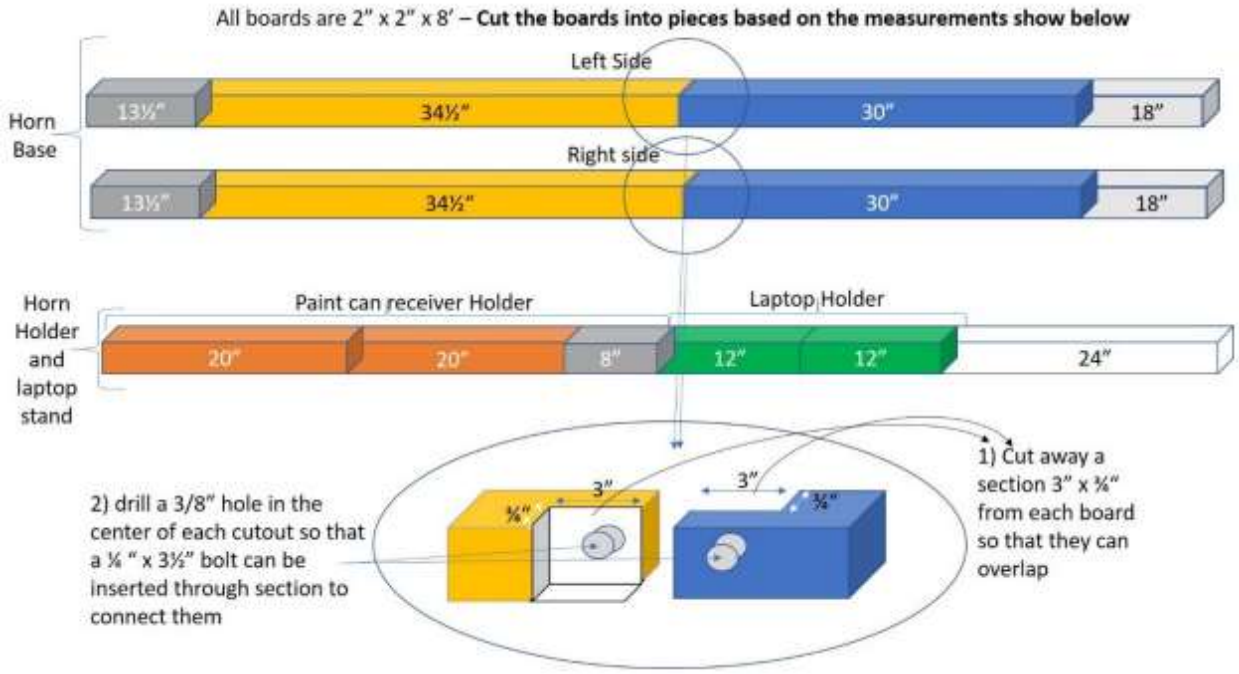
The support stand is the frame to hold the horn antenna.

Materials:

- 3x 2 in x 2 in x 8 ft Furring Strip Board Lumber
- 10x 5/16 in Wing Nut
- 10x 5/16 in x 3.5 in Hex Bolt
- 6x 2 in Phillips Flat Head Wood Screw
- Reciprocating Saw
- Impact driver
- Hammer drill
- Phillips bit
- 1/8 in, 1/4 in, and 3/8 in bit
- Markers/Sharpie
- Tape Measure
- Long Straight Edge
- Safety Glasses

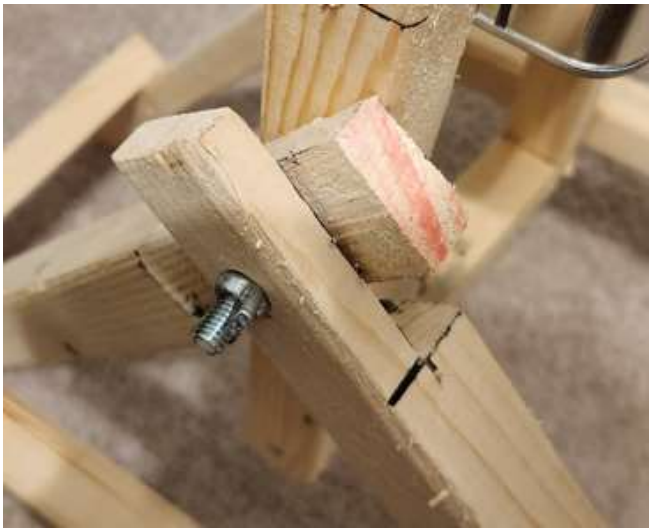
Steps:

1. Cut the wood using the measurements below. Don't forget to wear eye protection!

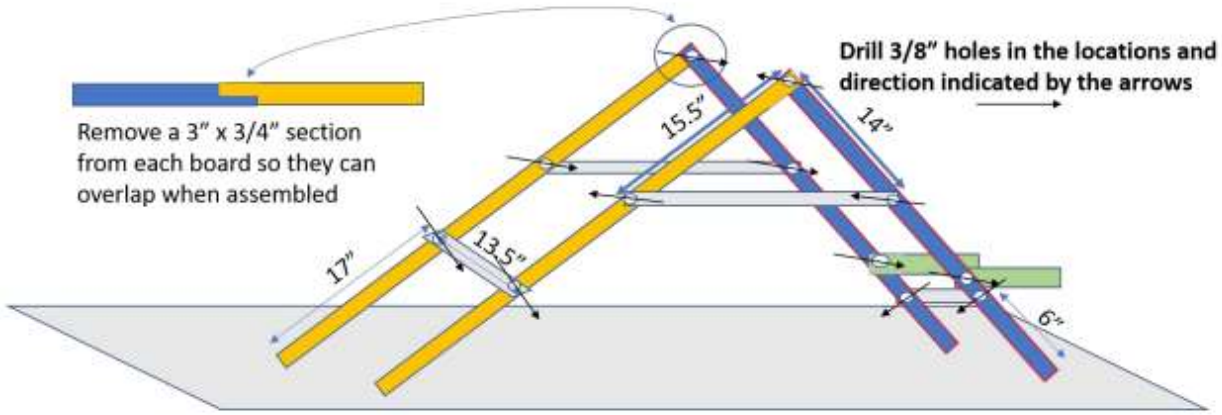


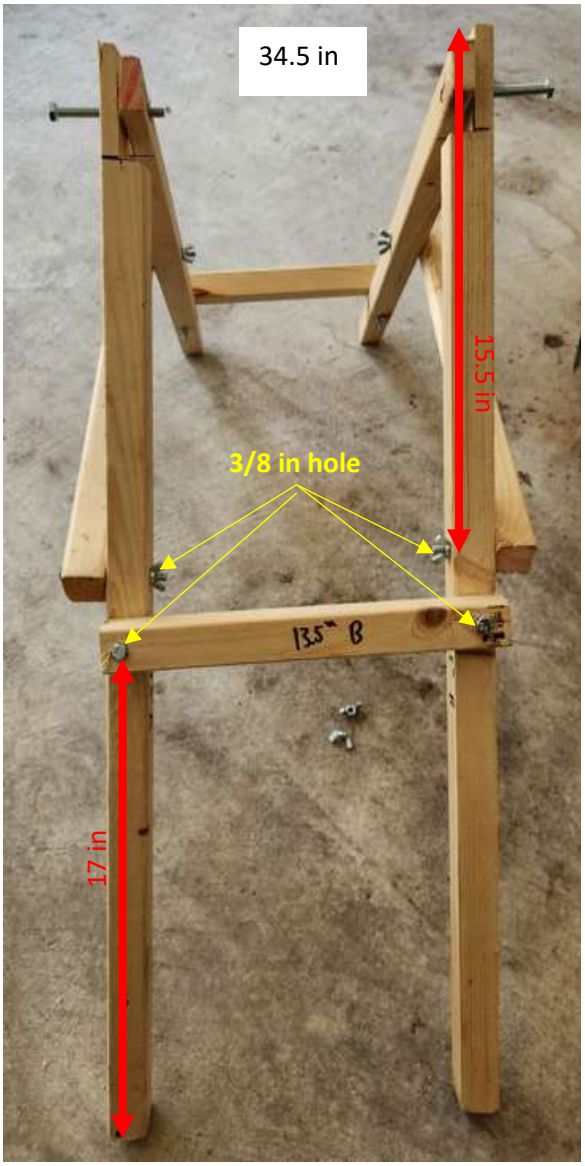
All three pieces of wood will be used. Disregard the laptop holder portion, unless you want to use it.

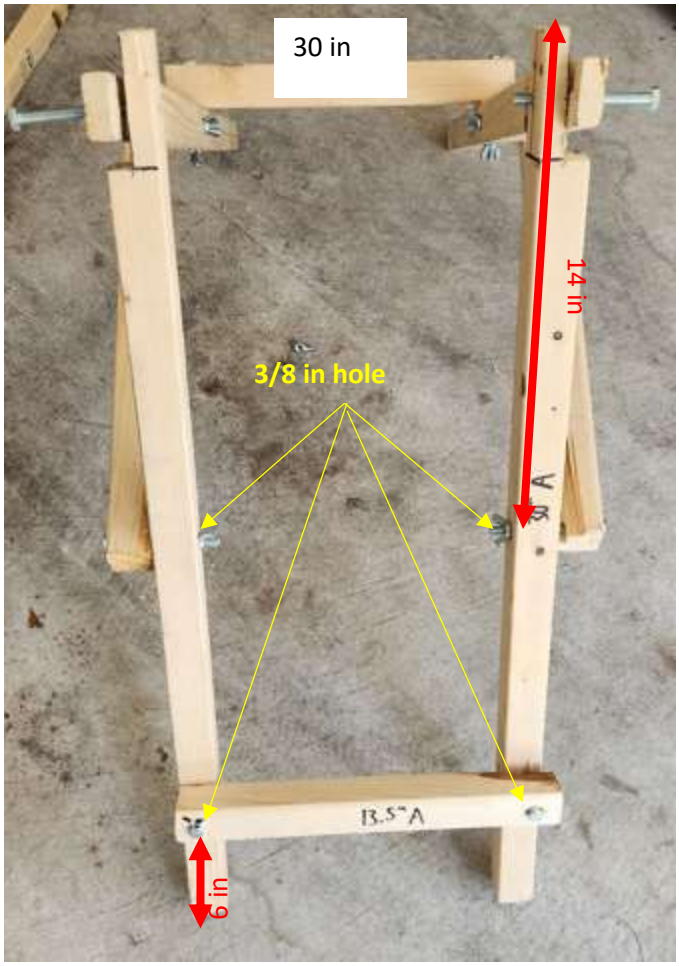
The 34.5 in pieces and the 30 in pieces need to have a portion cut out on the ends to attach. Recommend lining the two pieces up together and drilling the 3/8 in hole through. You can also measure out where the middle of the cut out portion is and drill your 3/8 in hole individually through the cut out.



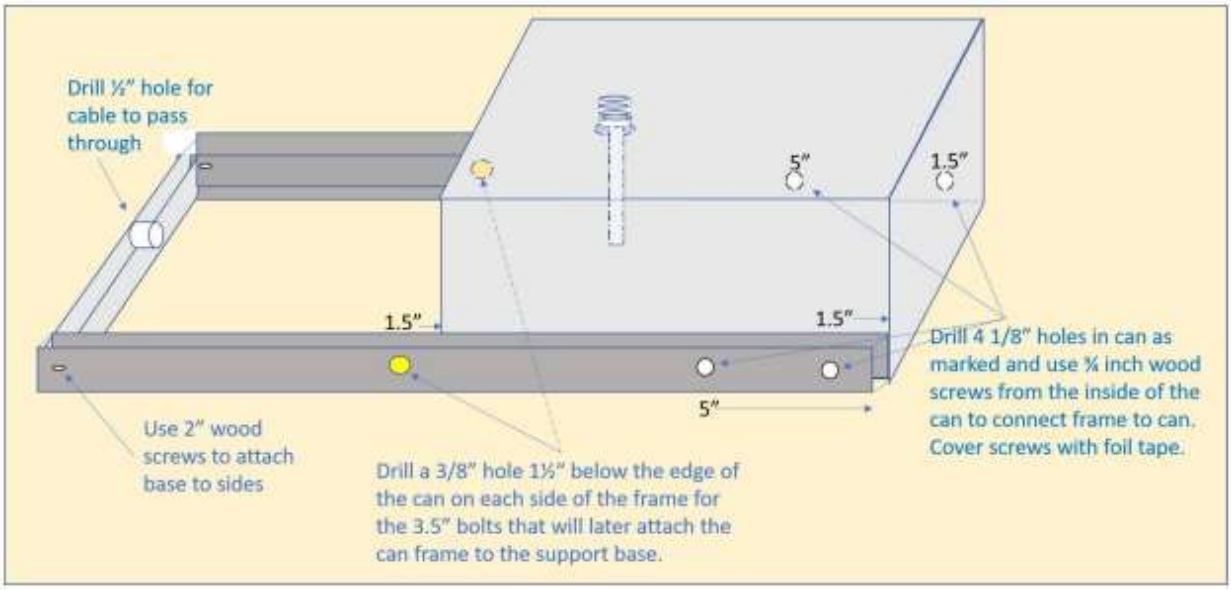
2. 3/8 in holes will need to be drilled in the spots shown below





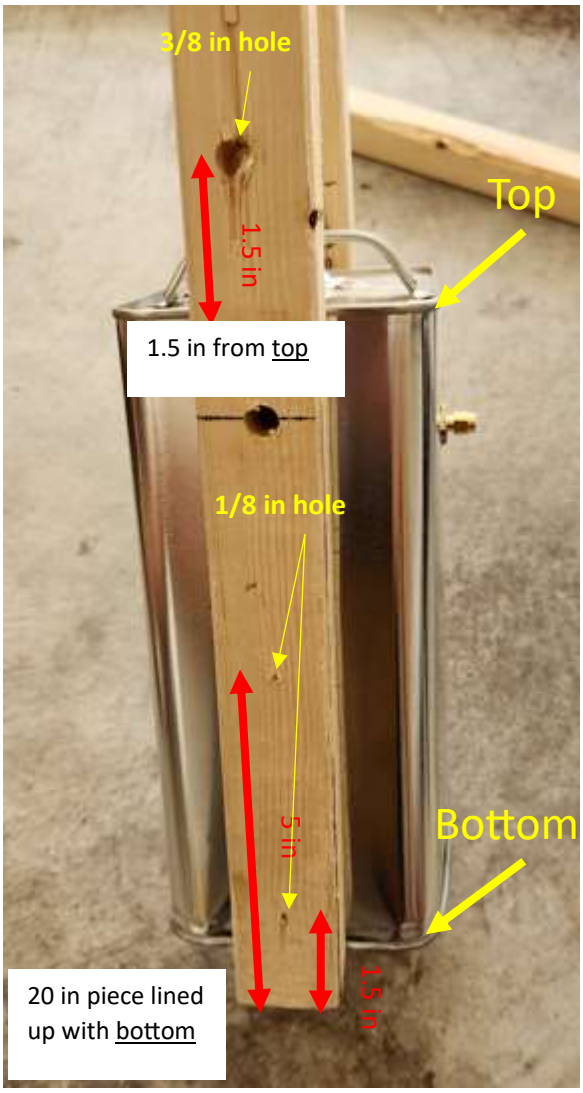


These pictures show where to put all 10 3/8 in holes as well as the 3.5 in hex bolts and wing nuts. These pictures do not have the laptop holder.



3. Make the paint can wood and "U" attachment to attach the horn antenna to the support stand. Use the two 20 in pieces of wood. Mark and measure 1.5 in and 5 in from the edge of the 20 in wood. Drill two 3/8 in holes at the positions on each of the 20 in wood pieces.

4. Line up the 20 in wood pieces with the bottom (open edge) of the paint can. Make a mark 1.5 in below the top (part with the handle and spout) of the paint can on both 20 in pieces of wood. This will be a 3/8 in hole to connect the "U" to the support stand. Drill 3/8 in holes at the markings.



5. The 8 in piece of wood will need to be cut down to about 6 5/8 in (width of the paint can) to fit in between the two 20 in pieces. Make sure it fits snug between the two 20 in pieces. Drill a ½ in hole in the middle of the this ~6 5/8 in piece to allow cables to pass through.

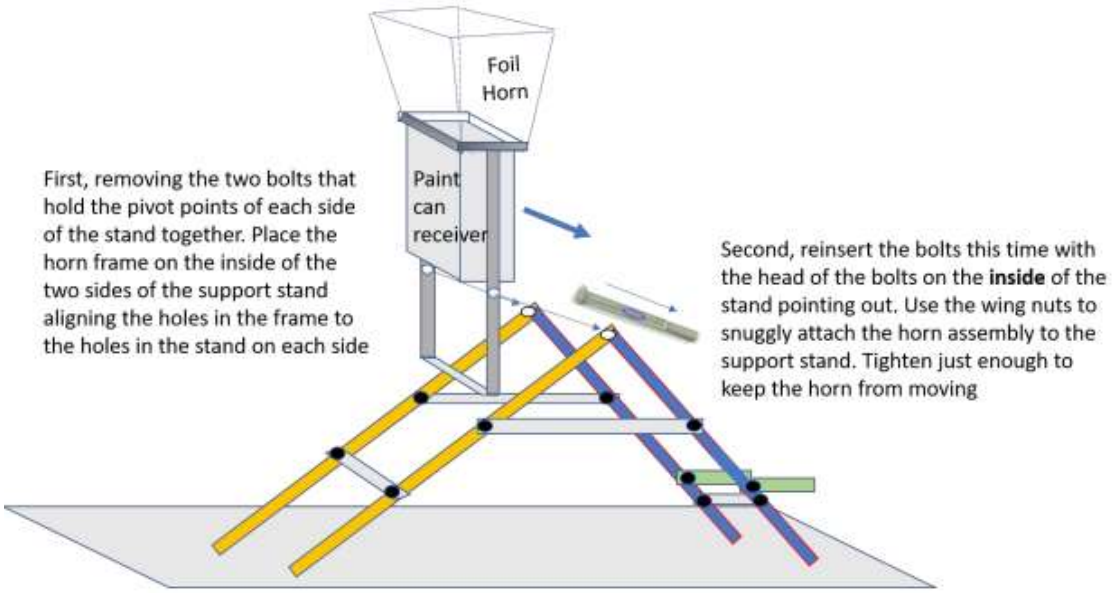
6. Attach the "U" attachment and the paint can as shown in the diagram above. Use four 2 in wood screws to attach the paint can to the "U" frame. Drill the 2 in wood screws from the inside of the paint can to create a flat surface on the inside. Then use aluminum tape to cover the head of the wood screw on the inside of the paint can.

7. Attach the 20 in wood pieces to the 6 5/8 in wood piece using 2 in wood screws.

Assembly

1. Attach the horn to the paint can. Slide the paint can to the edge of the horn. Apply a lot of aluminum tape to attach the two together. Tape both inside and outside to ensure there are no gaps. The tape on the outside needs to be strong enough to prevent the can from moving.

2. Attach the horn antenna to support stand. Follow the diagram below. Running the 3.5 in hex bolts through the cut out portion on the support stand and the 3/8 in hole located 1.5 in below the paint can on the “U” frame.




NCE FOAM INSULA
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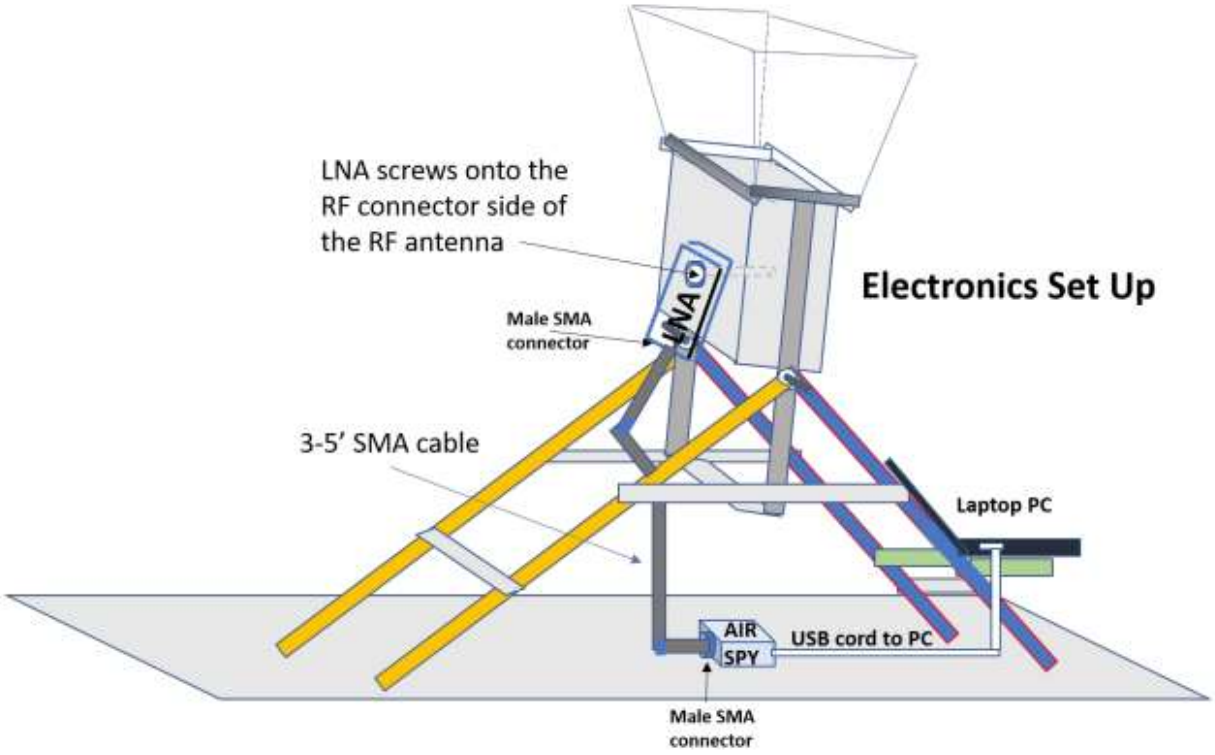
Electronics Set Up

Materials:

- RTL SDR Blog V3
- Nooelec SAWbird+ H1
- Superbat RF coaxial SMA Male to SMA Female
- RF DC Block 2W SMA Connector
- External battery with micro USB connector to power LNA
- Laptop



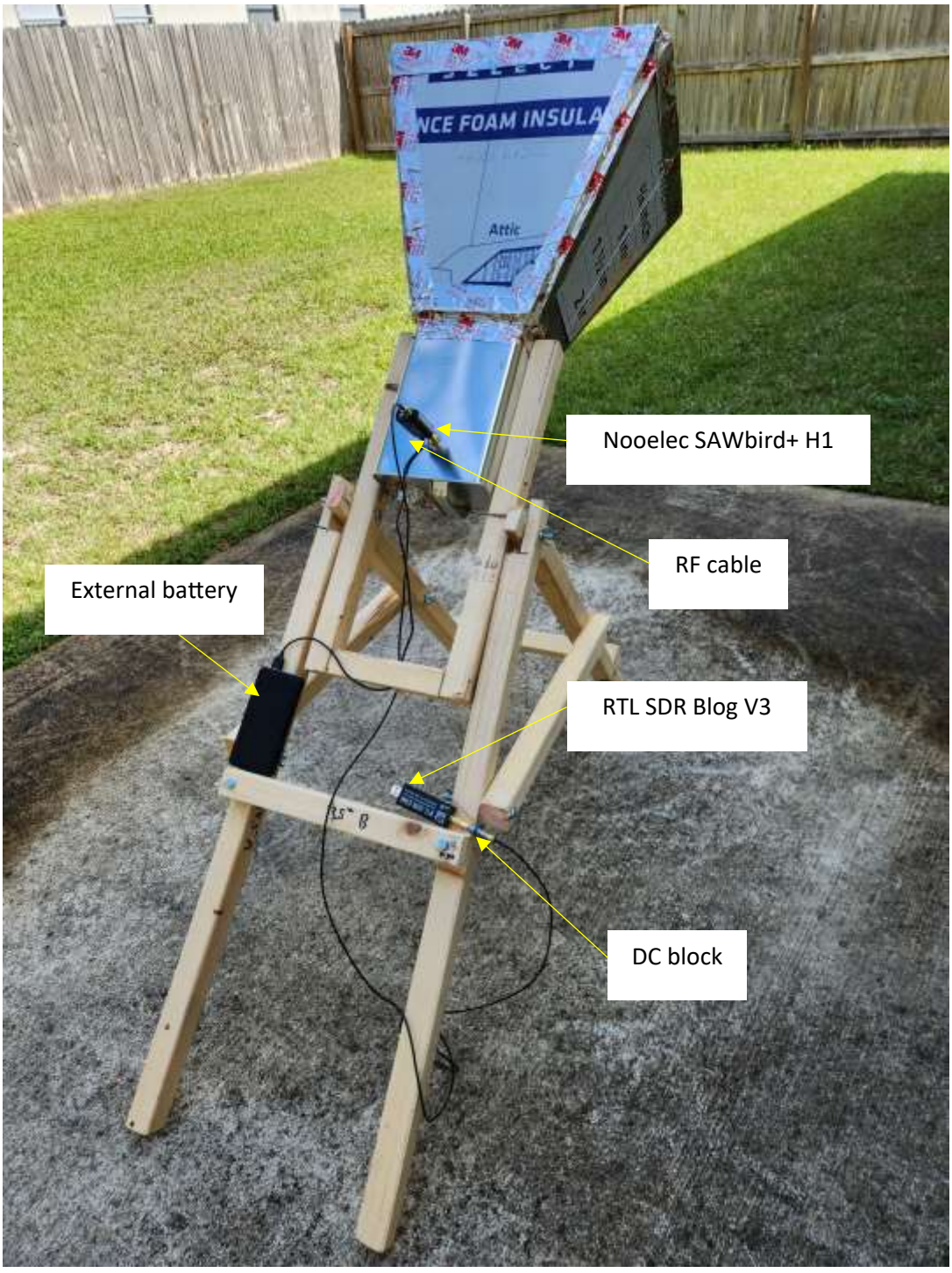
1. Attach Nooelec SAWbird+ H1 low noise amplifier (LNA) to the RF plug on paint can. I attached an extra female to male attachment to give some extra space to plug in the micro usb cord to power the LNA.

2. Attach the Superbat cable male connector to the LNA female

3. Attach the RF DC Block male connector to Superbat cable female

4. Attach RTL SDR male connector to RF DC Block female

5. Plug USB side of RTL SDR into USB port on laptop


Nooelec SAWbird+ H1
RF cable
External battery
RTL SDR Blog V3
DC block

Thank you

The diagrams/schematics were taken from the MiniHorn construction pdf at West Virginia University's DSPIRA board.

Here is the link https://wvurail.org/dspira-lessons/FilesUploaded/MiniHorn_construction.pdf