A 70cm Pre-amplifier for mode U/V satellite reception. **Assembly Instructions**

This kit contains all the components, connectors, mounting hardware and the enclosure for a 70cm band preamplifier. For best results the completed pre-amp should be mounted close to the antenna.
The kit uses surface mount components to ensure the performance will be consistent with each unit constructed. The input circuit has 3 capacitors which are 0603 size. As these are quite small, they have already been soldered to the PCB. The remaining devices are all 0805 size or larger. You will need a soldering iron with a bit small enough for the 0805 components, but with enough 'power' to solder the earth connections of the PGA-103 and the 78M05 voltage regulator to the PCB ground plane. A pair of SMD tweezers and a magnifier of some sort will be an advantage. You will also need a 3.5mm and 4.5mm drill bit. A centre punch will make precise drilling easier

The recommended order of construction is to start by drilling the lid for the N-type connectors, then mount the connectors and the PCB into the lid and tighten down securely. The final step is to populate the PCB with the electronic components. I would suggest that you only remove the components one at a time from their packaging when you are ready to solder them to the PCB.

So, let's start building your 70cm pre-amplifier.

1) Remove the 4 screws from the diecast box. Remove the lid, components and PCB.
   Take the PCB, component side up and position centrally into the lid. Ensure that there are even spaces between the PCB and the sides and the ends of the lid. This is important as you do not want the coils L1 and L2 to be too close to the aluminium box. When you are satisfied with the position of the PCB, hold it very firmly in place and using a fine tipped marker or a sharp pencil, mark the position of the 10 holes. Remember for best results, hold the marker vertically and not at an angle. I always try and draw a circle rather than trying to mark with a single 'spot'.

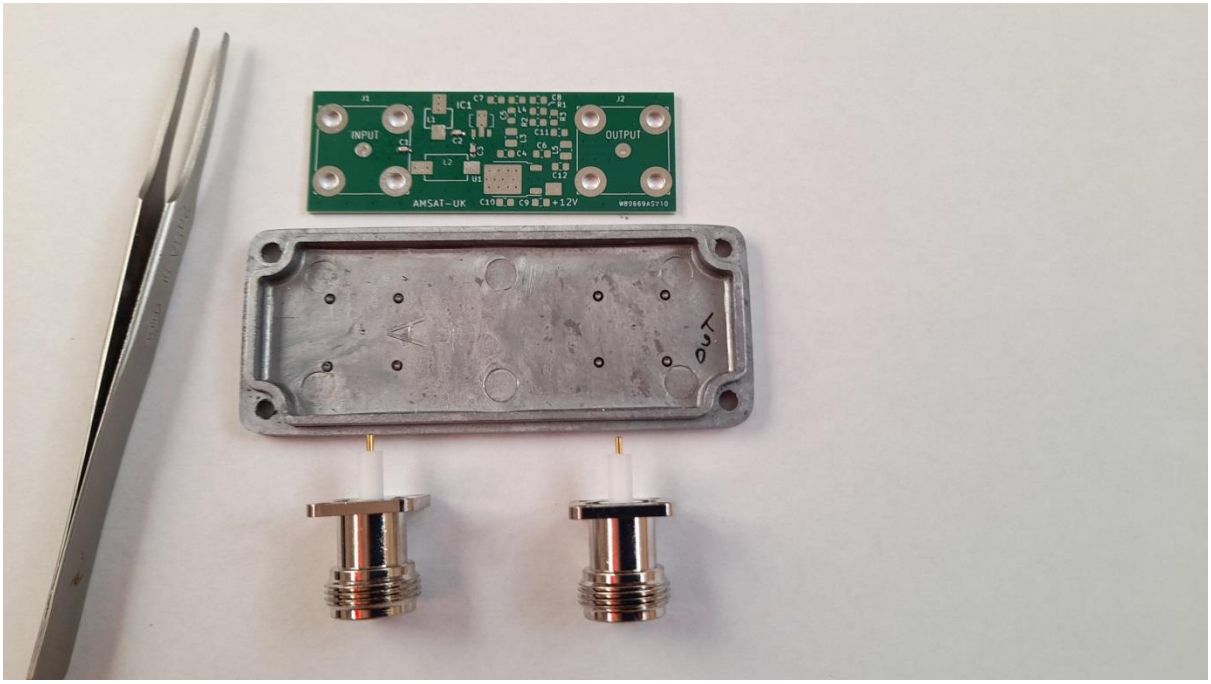


Figure 1 Marking the lid for drilling

2) Next, remove the PCB and if you have one, very carefully centre punch the middle of each of the circles you have made with the marker. Drilling precisely is important, but there is a very small margin for error. The brass bolts used are 3mm diameter while the clearance holes in the connectors are 3.2mm dia. By using a 3.5mm drill we have a small tolerance…but not much.
If you are happy with the marking out, drill the 4 outer holes 3.5mm and the central hole 4.5mm.
De-burr the holes on the inside of the lid to remove any excess Aluminium.

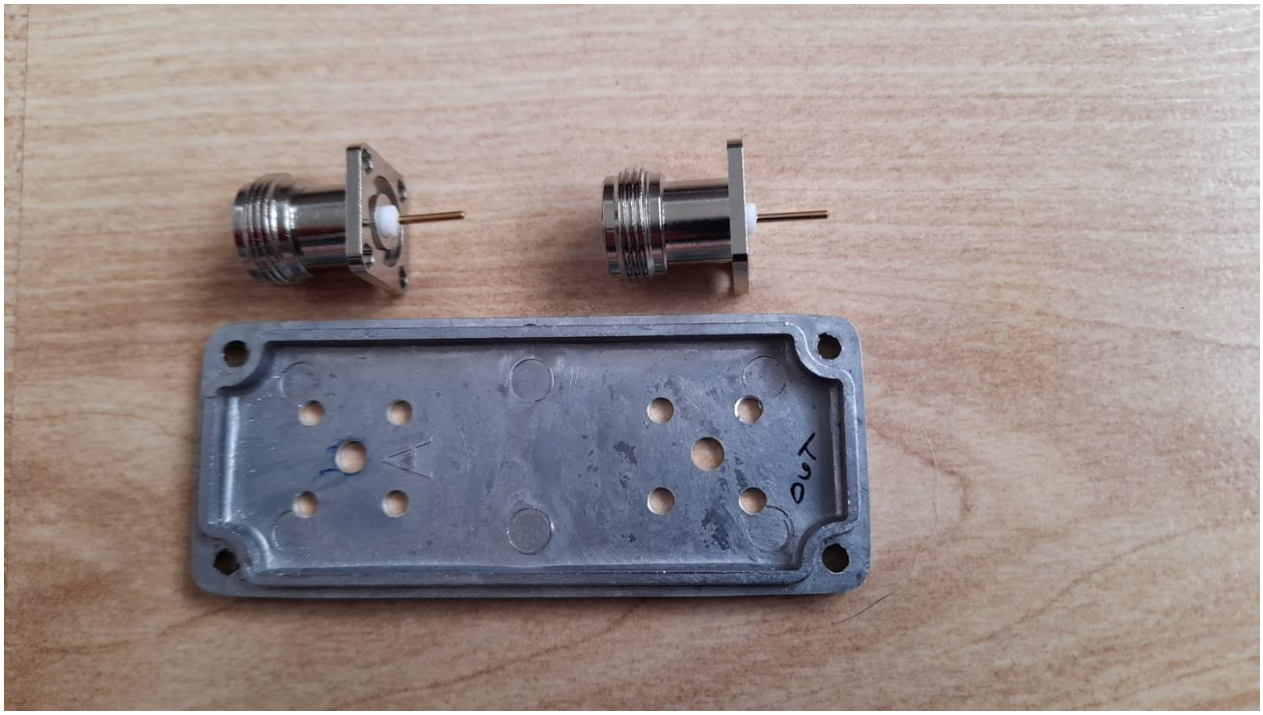


Figure 2 Lid drilled correctly for N-Type connectors

3) Take each N-type and check the PTFE insulation passes through the central hole in the lid. Holding the connector in place, mark the PTFE so it can be cut back with a sharp knife so it is flush with the inside of the lid. This is shown in the image above. No PTFE should protrude into the box as the PCB needs to be bolted down to the lid.

4) The moment of truth…….
Place the N-type connectors into the top of the lid and fit the 8 x M3 screws.
Then slide the PCB over the 8 screws. Fit the nuts and tighten down finger tight.
Now you need to look carefully to see if it all fits.
Is the PCB flush with the lid of the box on all 4 sides?
Is the PCB being held above the surface because the PTFE has not been sufficiently trimmed?
Looking at the M3 screws are they all at 90 degrees to the lid? If not, they are probably pushed out of line by an incorrectly drilled hole in the lid.

If all is correct, you can move onto the next step. If not, you need to identify which hole or holes in the lid are in the wrong place. You can make small adjustments with a round needle file.
Whatever you do - **DO NOT OPEN UP THE HOLES IN THE PCB** as the PCB has plated through

holes and drilling or filing will remove the ground connection between the top and bottom side of the board.

5) With all the 'mechanics' correct, remove the nuts, fit the spring washers against the PCB and refit the nuts. You are nearly ready to start soldering the board and the first step is to solder the input and output connections of the pre-amp to the N-types. Before you solder, you need to cut down the inner connections with a pair of cutters. I found that the nuts prevented access, so I had to remove one of the bolts to make enough room. Leave about 2.5 to 3mm above the PCB and then securely tighten all the nuts. Finally, solder the input and output connections.

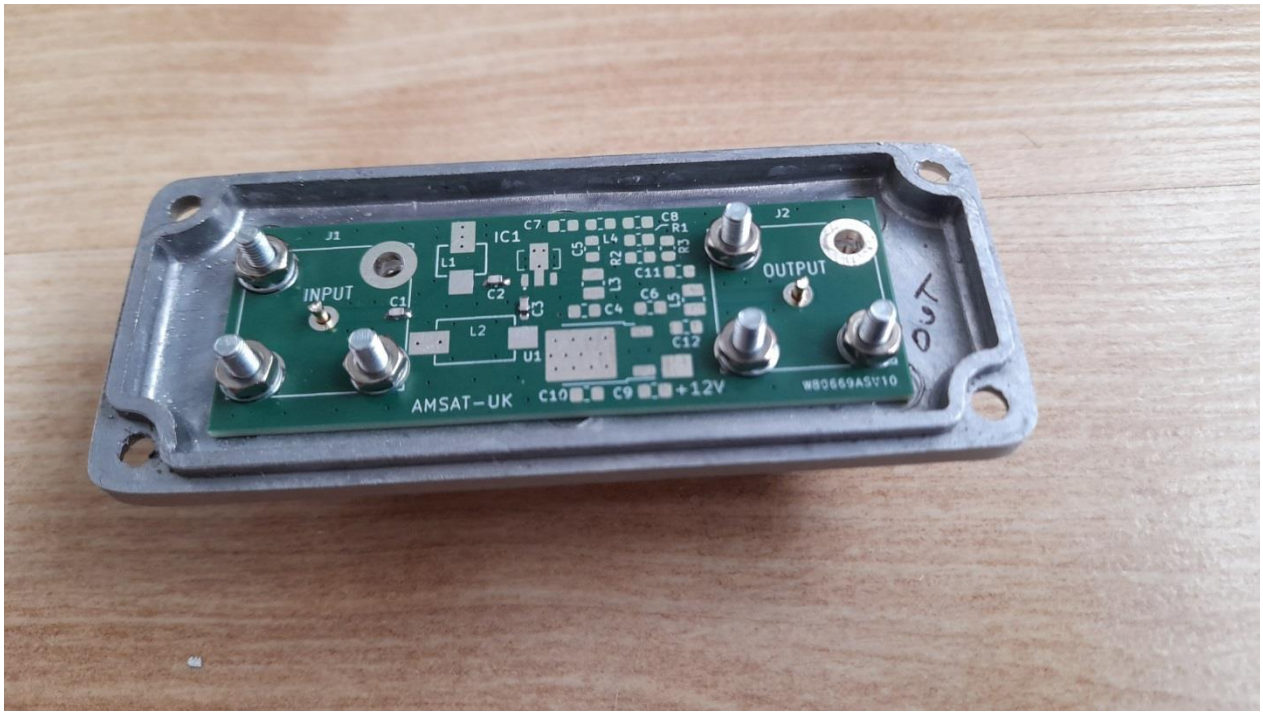


Figure 3 PCB mounted. Bolts removed to allow cutting of the inner conductor

6) Now it's time to solder the components to the PCB.
You need to decide how you are going to power the pre-amplifier. There are 2 options:
a) By sending a voltage down the coax cable from a bias tee in the shack, or from a radio like the IC9700 which can do this automatically. This is the suggested default method.
b) By using a separate 9V – 13.8V supply line. If this is your choice you will need to fit a feedthrough capacitor to the diecast box and connect it directly to the square pad marked +12V near the input pin of the 78M05 voltage regulator U1. You may also wish to leave out L5. – See the circuit diagram.

Assuming you are going to provide power down the coax, then my suggested approach is to proceed as follows.

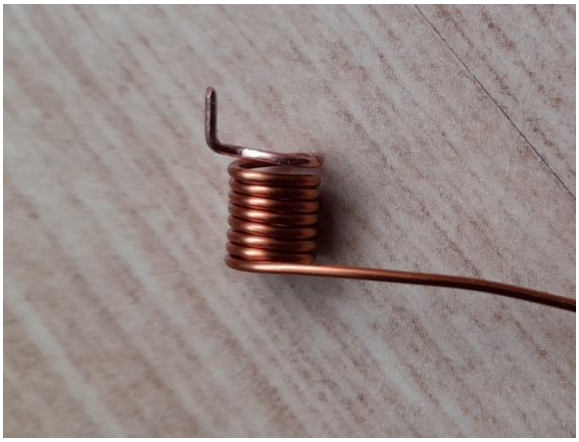
7) a) Firstly, solder all the resistors and capacitors in place
b) Solder the inductors L3 L4 and L5

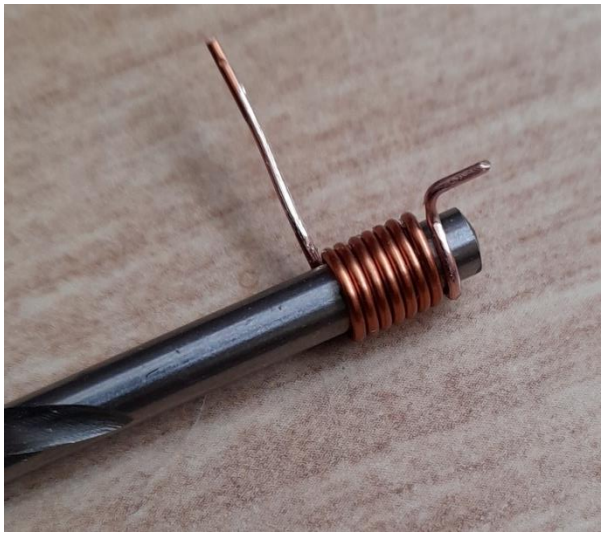
c) Solder the Voltage regulator U1 and the PGA-103. – Note; it's important to get a good ground connection under the tabs of these devices. You will need a decent sized soldering iron for this. I usually place a little solder on the PCB ground connection where the tab will go and then put a little flux on that. Then I hold the device in place. It will be slightly raised above the surface due to the solder on the board. Heat the tab of the device until the solder melts and the device moves down onto the PCB. Check before lifting the iron off, that the device is located correctly. i.e. that the input and output pins are in the right place. Then lift the iron off. Let the device cool down and finally, solder the remaining pins and a little more to the tabs if needed

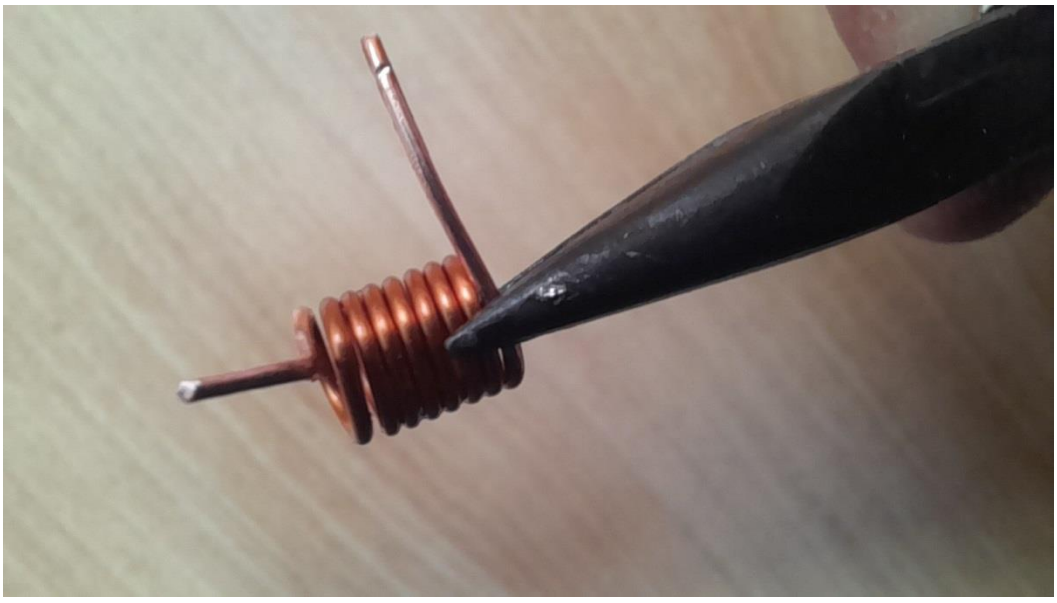
8) The last two components are L1 and L2. These inductors are hand wound using the 0.8mm diameter enamelled Copper wire provided in the kit.

Let's start with L2. This is the most critical, as it is part of notch filter for the 2m band.
a) Unwind the copper wire and pull straight. Look at the wire and select the straightest end. We will use that for L2. I normally always strip the enamel from the wire before forming the legs that will be soldered to the PCB, this avoids the problem of trying to remove enamel from the inside of tight bends, which is never successful.
b) Using a sharp knife carefully strip away the insulation for about 20mm or so from the end of the wire. Take care not to cut into the copper- This will be one of the connections to the PCB.
c) Take a 4.5mm drill bit. Position the start of the 20mm section on the drill bit and hold in place. Carefully wind 8 full turns closely wound with no gap between turns. Cut the wire about 20mm from the bit then remove the coil.
d) Taking the end that has been stripped of enamel, hold the end of the coil with a small pair of pliers and bend the wire end 90 degrees away from the coil. Reposition the pliers and place another 90 degree bend so that when the coil is mounted onto the PCB, the body of the coil will be between 2.5 and 3mm above the board.
d) Moving to the other end of the coil, re-insert the drill bit and look carefully for where the wire will needs to be bent away from the coil. This will be at the point exactly 8 full turns from the start. Next you may need to unwind about ¼ of a turn so you can strip the enamel from the end of the wire. It's a bit fiddly, but keeping the coil on the drill bit prevents it being deformed.
e) When the wire end is stripped of enamel, rewind the last ¼ turn back onto the drill bit and carefully locate the point at which you need to bend the wire by 90 degrees. Remove the drill bit and bend the wire by 90 degrees in two places to match the other end. Hopefully you now have a symmetrical coil. Trim the ends to about 2-3mm where they will be soldered to the board and fit to the PCB without introducing any gaps between turns.

The photos below are not the best example but do show the process.







9) Make L1 in a similar way with the remaining 0.8mm dia wire. It is 2 turns with a 4.5mm internal diameter, but it does have a significant gap between turns. Use the picture below as a guide. It should also stand about 2.5 to 3mm above the board.

With both coils fitted, construction is complete. Check all the soldering visually, ensuring there are no dry joints or shorts from solder splashes between components.
Time for testing!

10) The first test is simply to measure the supply current. If you have a current limited supply you should set the limit to 250mA. Be careful as there was no room on the PCB for a polarity protection diode. The current should typically be 84mA from any DC supply from 9V to 13.8V.

11) Notch Filter alignment.
The notch filter is a series tuned circuit with an 8.2pF capacitor in series with L2. As constructed, I found an 8 turn close wound coil with no gap between turns will resonate with 8.2pF around 139MHz. We need to reduce the inductance of the coil by opening up the 2 turns at the earthed end just enough to increase the resonant frequency and place the notch into the 2m band. If you have a spectrum analyser this is easy. However, it's nearly as easy if you don't.
Attach the preamp input to a 2m antenna and its output to a 2m radio. Tune the radio to a beacon or repeater. Looking at the radio's S meter, or these days an SDR waterfall, note the signal level. Using your fingers or something that will not damage the coil, gradually open a small gap, about one wire diameter, between the second and third turn from the earthed end. Hopefully you will see the signal level reduce. Move down to the next turn, that's between the first and second turn and then open that gap slightly. Repeat the process until the signal reaches a null. It should be fairly easy to get a null that exceeds 30dB. If you see the signal beginning to increase again, you've gone too far and you'll need to compress the coil a little.

12) That's it… You're ready to go.
The coil L1, part of the input high pass filter, can be optimised for best noise figure or input return loss. But without the correct test equipment, this isn't an easy task. In practice any increase in performance by adjusting L1 will be marginal and setting it up visually should be perfectly fine for most applications.

If you have any questions about construction or testing, you are welcome to e-mail.

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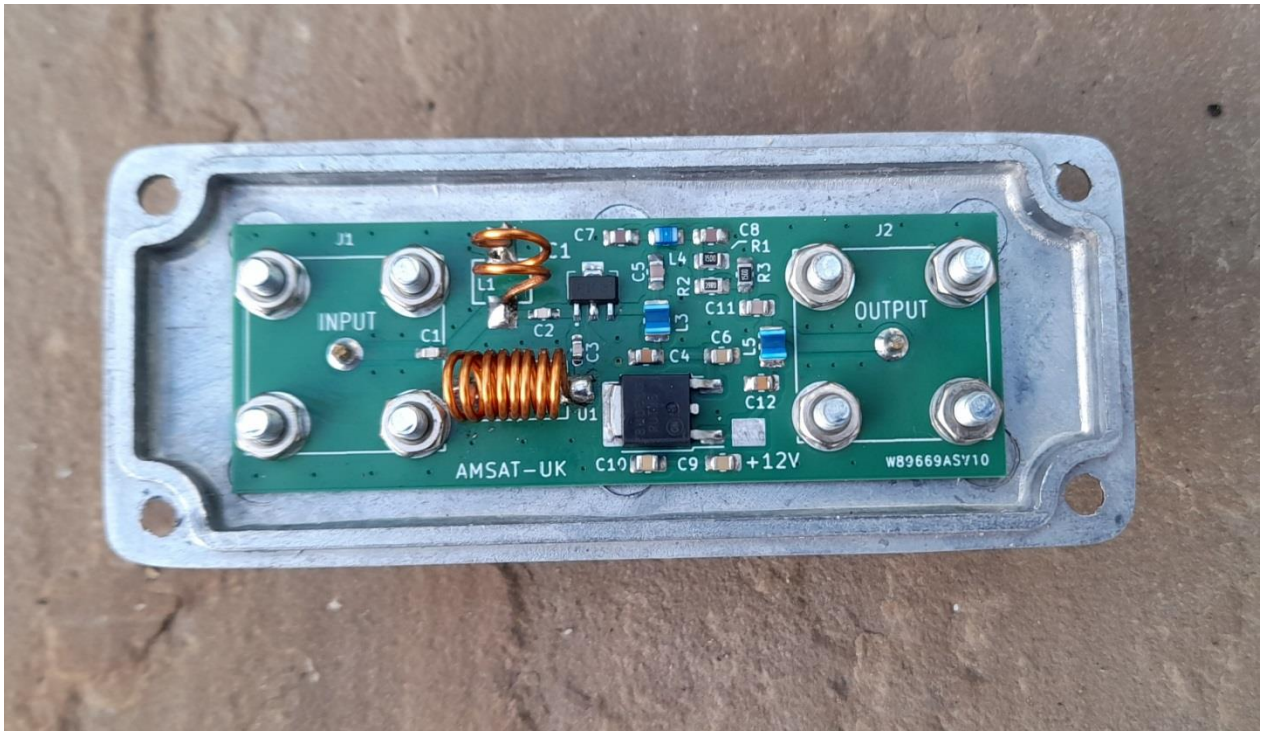

Figure 4 Completed Pre-amp. Top view with L2 tuned

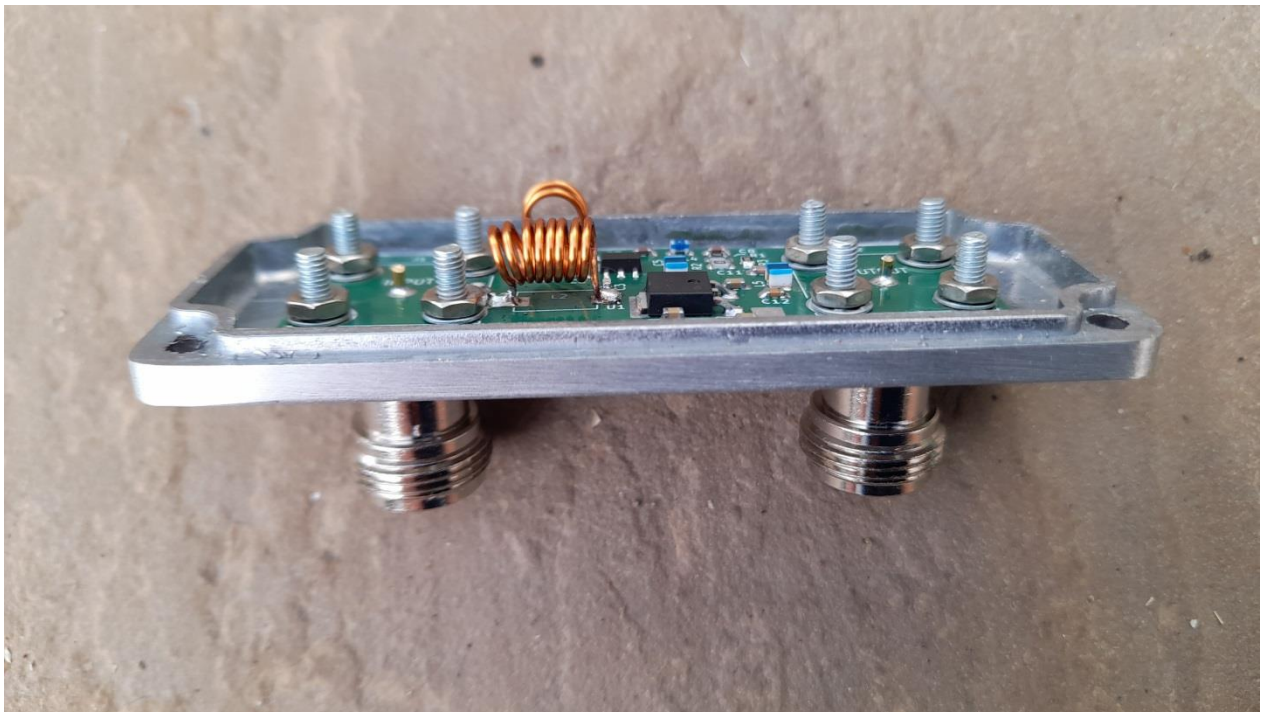

Figure 5 Completed Pre-amp. Side view

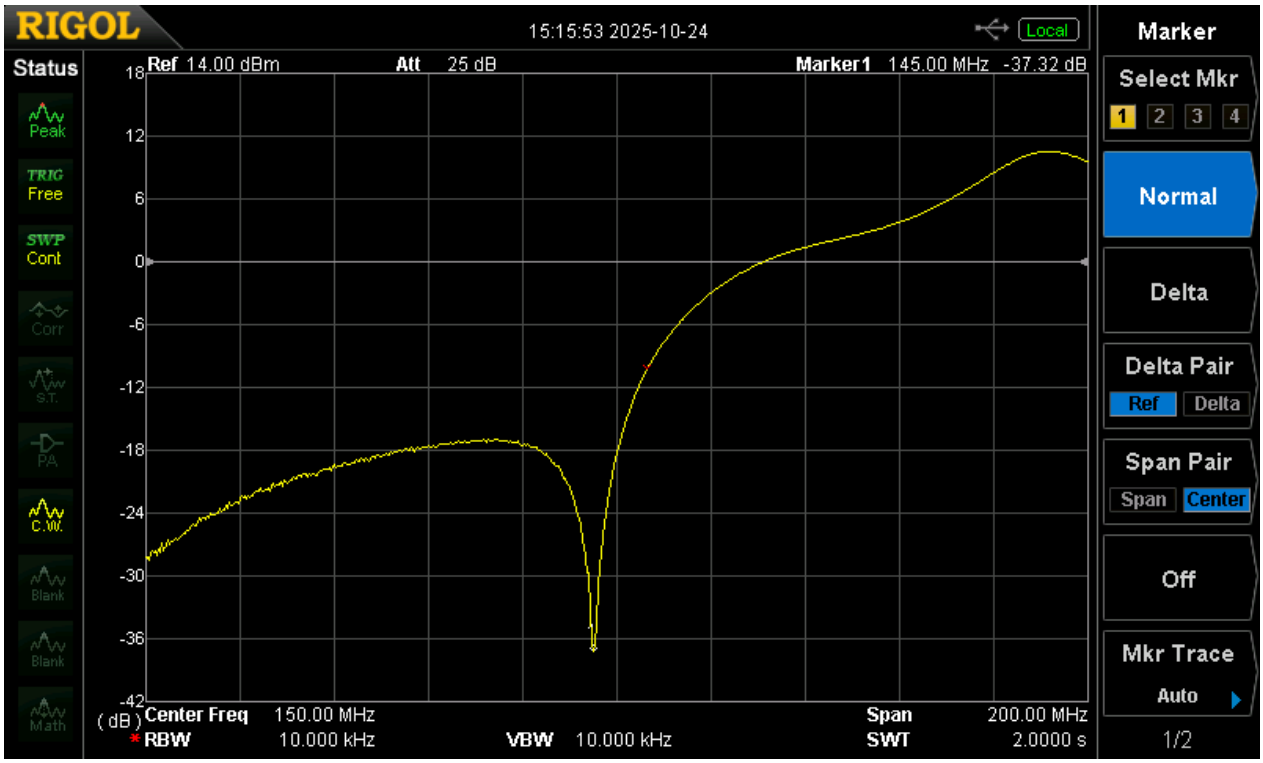

Figure 6 Spectrum analyser plot of the 2m notch filter performance.

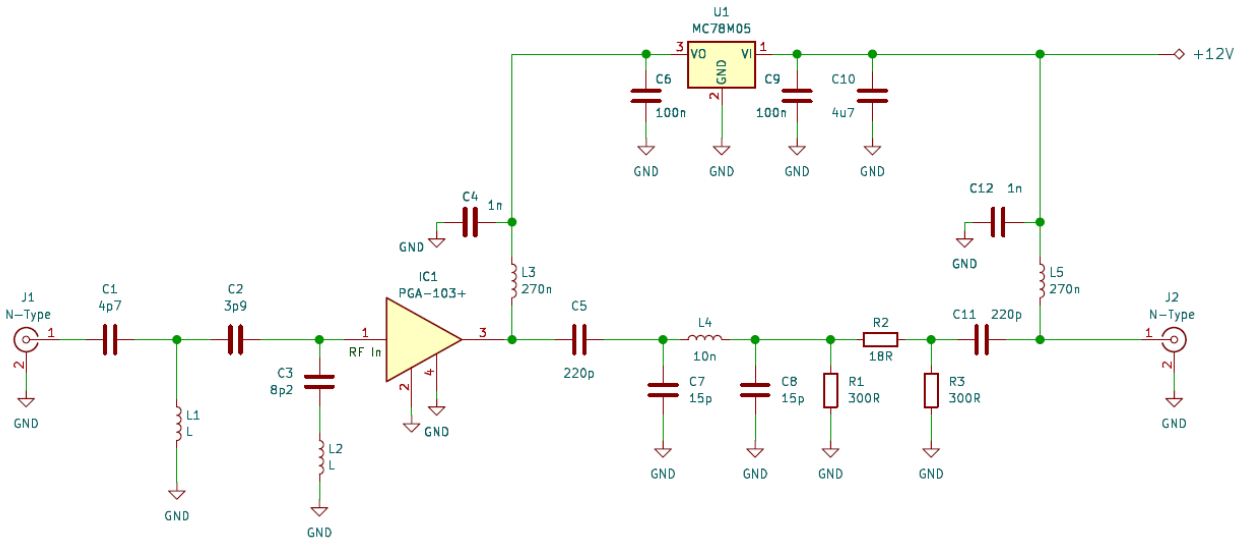

Figure 7 Circuit diagram

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