A 2m filtered preamp for wideband receivers. – Construction notes.

The kit from AMSAT-UK contains all the parts and hardware necessary to build the 2m filtered preamplifier. With all the nuts and washers and mounting hardware, there are over 60 individual parts to this project. The connectors supplied are a high quality PTFE insulated reduced flange N-type for the connection to the antenna and a chassis mounted female BNC for the RF output to the receiver, this also carries the 5 V DC input from a FUNcube dongle or the DC supply from an external bias tee or radio.

I would like to say thanks to Rob M0TXO and the members of the FUNcube dongle user group who conducted a poll to decide on the most popular connectors and their configuration for this project.

The recommended order of construction is

1) Place the bare PCB into the lid of the diecast box and mark the 10 holes ready for drilling.
2) Assemble the electronic components onto the PCB.
3) Test the PCB for correct current consumption.
4) Mount the connectors into the lid of the box.
5) Place the completed PCB onto the M3 bolts. Tighten without flexing the board, then connect the final capacitor C1 to the N-type and a wire connection on the BNC.

**Marking and drilling the enclosure.**

The enclosure used is a Hammond diecast box. The PCB is mounted into the lid. No holes are required in the body of the box. Place the PCB into the lid of the box and making sure the component side is facing up towards you. Place in a position that gives equal space all around and then, holding tightly, use a pencil or permanent marker to draw circles for the two connectors and the 8 mounting holes. Take care to hold the pencil upright, holding it at an angle will put the holes in the wrong place. With the position of the holes marked, centre punch each one ready for drilling. For those who prefer to work with dimensions, the BNC connector outline is shown on the left below. The mounting for M3 screws on the N-type is the same, but the centre hole is smaller than the BNC. Personally, I drilled my boxes with 3.2mm for the mountings, 9mm for the centre of the BNC and 5mm for the centre conductor of the N-type.

![BNC mounting](image1)

![Reduced flange N-type with 4mm diam PTFE dielectric.](image2)
Component list. All components 0805 unless specified

Capacitors.

C1  8p2 ceramic leaded  
C2  8p2 ceramic 0603  
C3 C5 C15 C16  27pF ceramic 0603  
C4  56pF ceramic  
C6 C7  470pF ceramic  
C8  220nF ceramic  
C9  C11  1nF ceramic  
C12 C14  12pF ceramic  
C10  4.7uF 16V tant ‘B’  
C13  3.3pF leaded (fitted across L6)  
C14  12pF ceramic  
C17  220pF ceramic

Inductors

L1  82nH  1008  
L2 L3 L8  47nH  0805  
L4 L9  220nH  0805  
L5 L7  56nH  0805  
L6  47nH  1008

Semiconductors

IC1  SPF5043 -RFMD  
IC2  78L series 3v3 regulator

Filters

F1 F2  TA147 surface acoustic wave filter

Hardware

Enclosure  Eddystone / Hammond diecast box  92 x 30 x 38mm  
1 x  double sided FR4 printed circuit board  
J1  Reduced flange N type connector  
J2  BNC chassis socket  
8 x  12mm long M3 pan head bolts  
8 x  Nickel plated brass M3 half nuts and spring washers  
8 x  M3 full nuts  
1 x  Short length of  22SWG tinned copper wire.

Component overlay
Assembling the PCB.
The PCB is double sided FR4 material measuring 24.2 x 67mm. It uses plated through holes for earthing and signal routing. The components are on the top side only, but because the SAW filters are leaded components, the underside of the board must not be bolted down to the surface of the enclosure lid. Signal tracks and a green solder resist layer are present on both sides of the board. Only a few component designations are printed on the top side silk screen. However, the outline for each component is shown. The pictures of a completed board and the component overlay will help with board assembly. Note C13 is not shown but it is mounted in parallel with L6. Most of the components are supplied taped to a sheet which identifies the value. Remove components from their packaging and fit them one value at a time. Fault finding is always more difficult when the components are in the wrong places!

Completed board

If you are new to surface mount construction then try to find a small soldering iron bit and solder with a flux core that has an overall max diameter of 0.8mm. It is possible to assemble this board with just your eyes alone, but a magnifier of some kind is a definite advantage. The headband magnifiers are excellent. Or, a hands free illuminated magnifier will do a good job. The other vital piece of ‘kit’ is a good pair of tweezers. Which reminds me, don’t squeeze too hard on the tweezers. If a component ‘pings out’ of a tightly held pair of tweezers it will travel several metres never to be seen again. If held with a more gentle grip, the component may fall, but it will land on the workbench or PCB and will be recovered.

Where to start? A good question. Start with the SMD components. I began assembly with the two input LC filters. In particular, C3 C4 and S must be mounted before installing the SAW filters. A helpful rule is that if you leave the larger components until last, they will not get in the way of your soldering iron. After the input filter, the inductors and capacitors can be mounted in any convenient order. The capacitor C10 is a SMD tantalum part. These are polarised and must be connected the correct way round. They have caused some problems in the past as they have an unusual convention of marking the terminals. The positive end has a bar printed near it. – I know, who thought of that? Anyway, just remember the bar is at the positive end, not a minus sign and all will be fine.

The last parts fitted should be the voltage regulator, the SAW filters and then using static sensitive
precautions, the SPF5043. The capacitor C13 does not have pads on the PCB, but instead is mounted over L6. See picture. The last component fitted, after testing, will be the leaded capacitor C1. This is added after the board is mounted to the connectors. The leaded components must not short to the lid of the enclosure, trim the excess leads so they protrude no more than 1mm from the underside of the board. This applies to the SAW filters and the voltage regulator.

**SPF5043 PINOUT**

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<tr>
<td>1</td>
<td>Output</td>
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<tr>
<td>2</td>
<td>Ground</td>
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<tr>
<td>3</td>
<td>Input</td>
</tr>
<tr>
<td>4</td>
<td>Ground</td>
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**Testing the board.**

With all the components except C1 on the board, it’s possible to test the preamp to see that you have IC1 in the correct way round and that the bias circuit is OK. Using a 5 to 12 volt supply, connect the negative line to ground on the board. Any of the mounting holes will do. Then, using a multimeter set to current in series with the positive supply, touch the wire onto either the positive end of C10 or the junction of L9 and C11. If all is well you will see 22 to 26mA of current.
Fitting the connectors and PCB to the enclosure. The PC board is drilled so it can be mounted onto the M3 screws used for the connectors. The photo below shows the 4 stages of building the 2m filtered preamp. Note that in these versions the inductors used are different from the ones supplied in the kit.
1) A drilled lid that has been checked to ensure the connectors and holes will line up.
2) The 2 connectors are fitted to the lid with M3 screws. Each of the 8 screws used has a spring washer and a half nut. These are finger tightened only.
3) The completed PCB is lowered onto the 8 screws. It should slide down the M3 bolt and seat evenly onto the half nuts. The M3 screws are then tightened in turn, the nuts should not spin due to the spring washers and they should tighten fully to the lid. When tight, add a M3 full nut and tighten all 8 nuts a little at a time until they are tight. As you do this look at the board and ensure it is seated properly. It should be straight and should not show any sign of flexing / bending. Take care, this is the stage where components can be cracked.
4) With the board securely in position add C1, keeping the lead length short, to connect the inner of the N connector to the PCB. Finally add a short length of wire to connect the inner of the BNC to the board as shown.

Applying power and testing the preamp.

The preamp is now ready for final testing. DC voltage can be fed to the preamplifier in a number of ways. FUNcube dongles from serial numbers above 800 can feed +5V from the USB port via the coax. You can also feed DC via the coax from radios like the IC910 or the FT847. The limiting factor here is that the regulator used has a dissipation limit of 300 – 400mW. This is normally adequate, but under elevated temperatures e.g. top of the mast on a very hot day may cause the regulator to activate the internal power limiting. Another alternative, if you do not wish to use the internal bias tee, is to leave L9 off the board and to attach a DC supply to the junction of L9 and C10 / C11.

Having powered the device successfully, the level of background noise audible in an SSB receiver will increase. If used with a software defined radio you should see the background noise increase by 10 - 12dB. To check the filtering, tune the radio to a signal outside the 2m band, e.g. a 70cm beacon or repeater or perhaps a UHF TV sound channel. Adding the filter should reduce the level by 60dB which in most cases puts the unwanted signal down into the noise.

Typical performance.

The following results were obtained from a typical preamplifier.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Response</th>
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<tbody>
<tr>
<td>70MHz</td>
<td>-70dB</td>
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<tr>
<td>108MHz</td>
<td>-63dB</td>
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<tr>
<td>119MHz</td>
<td>-60dB</td>
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<td>134MHz</td>
<td>-38dB</td>
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<tr>
<td>159MHz</td>
<td>-46dB</td>
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<tr>
<td>214 – 455 MHz</td>
<td>Better than -70dB</td>
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