RF preselector for the broadcast band

Here's a little RF preselector that can really improve reception of signals on the AM broadcast band. It can boost the level of weak signals and at the same time attenuate adjacent interference and noise. Just the shot for broadcast-band DX enthusiasts!

by IAN POGSON

Let's say you're a broadcast-band DX enthusiast, who likes to log as many distant stations as you can. Or someone living quite a way from the nearest AM radio stations, who still likes to listen to them for the latest regional news, etc. Either way, you're likely to experience problems — weak signals, interference from strong adjacent signals or severe noise.

Luckily these problems can often be helped considerably by using an RF preselector unit like that described here, ahead of your existing receiver. The preselector provides additional gain, to boost weak signals, together with additional selectivity to help reduce the interference from adjacent signals and noise. It also has a ferrite rod aerial, whose directivity can be an advantage if your existing receiver doesn't have one.

Just how much improvement you're likely to get by using the preselector depends mainly on your existing receiver. If it already has a good ferrite rod aerial, plenty of gain and good selectivity (perhaps by virtue of an RF stage and multiple IF stages), the preselector may not be of much use — you're probably getting the best possible reception already. But this sort of ideal situation probably isn't too common; most modern receivers don't have an excess of either gain or selectivity.

In general, the best way to find out if the preselector will improve your reception is to try it. But where weak signals and interference are a problem, there probably aren't too many receiving setups which won't be improved by adding the preselector.

The prototype was tried out initially in our laboratory in the inner area of Sydney, where electrical noise is particularly bad. Using a communications type receiver with a random wire antenna, all of the local stations were received quite satisfactorily, although some were a little noisy. By adding the preselector instead of the random wire, those stations which were noisy were received with a noticeable reduction in noise.

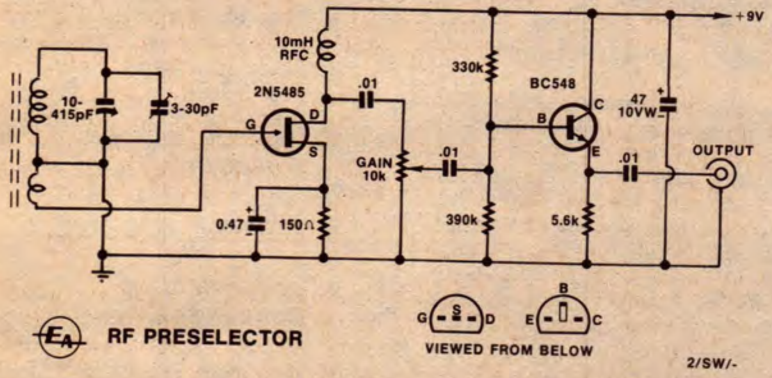
On the more ambitious side, we attemped to reach out beyond the immediate metropolitan area, for "DX" signals. A number of stations were received without the preselector, but were so noisy that they were of no entertainment value. One of these stations was 2CT, located south-west of Sydney in Campbelltown and only running a power of 100 watts. By adding the preselector the signal was brought up by a worthwhile amount but it was initially still noisy. This was improved by rotating the device, including the ferrite antenna, so that minimum noise was received. In spite of the severe noise problem, the station was then brought in quite well.

Another difficult one was station 2GO in Gosford, about 70km or so north of Sydney. To make the situation more difficult, station 2WL south of Sydney in Wollongong is much stronger and only separated from 2GO by 9kHz. This introduces a severe selectivity problem and the preselector can do only a little to alleviate this. However, by adding the preselector and tuning carefully, we were able to receive 2GO quite well.

As another example we checked the ABC Regional station 2CR in Orange, about 300km west of Sydney. It runs a power of 50kW and can be received in the Sydney area, but where noise is a problem reception is often not worthwhile. By adding the preselector again, we were able to bring 2CR up out of the noise and reception became quite good.

So that we could give some more examples of the use of the preselector under conditions which are less severe and more likely to approximate those for the average reader, I took the preselector home to a northern suburb of Sydney and connected it to a similar type of receiver. Under these conditions, the preselector was able to justify itself equally as well as under the noisy city conditions. Naturally, with noise much less of a problem, all of the stations referred to earlier were received loud and clear.

Needless to say, the preselector won't perform miracles. If a signal can be made useful by virtue of extra gain, a little extra selectivity and the ability of a ferrite rod antenna to discriminate against noise from a particular direction, then the preselector will be worthwhile. But naturally enough there is a limit: when signals are very weak, then very little can be done to make them usable.



A FET input stage is used to minimise cross modulation.

An aluminium case was used to house the prototype.

PARTS LIST

1 Box 130mm wide x 104mm high x 75mm deep (Australian Transistor Co.)
1 Front panel overlay
1 Jabel dial type HSO
1 Small knob
1 SPDT miniature toggle switch
1 10k linear potentiometer
1 Neosid ferrite rod 203 x 13mm, F14
1 Small rubber grommet
2 Rubber grommets for ferrite rod
2 Brackets for ferrite rod (see text)
1 Philips 3-30pF solid dielectric trimmer
1 RCA socket (single hole mounting)
1 RCA plug
1 2-pin miniature speaker socket
1 2-pin miniature speaker plug
4 Rubber feet
1 Roblan 10-415pF single gang variable capacitor
1 ¼in extension spindle
1 Miniature tagstrip with 7 prs tags
1 10mH RF choke
1 2N5485 transistor
1 BC548 transistor

RESISTORS, ½W: 1x150 ohms, 1x5.6k, 1x330k, 1x390k.

CAPACITORS
3 .01uF LV plastic
1 0.47uF 35VW tantalum
1 47uF 10VW electro

MISCELLANEOUS:
Hookup wires, solder, solder lug, screws, nuts, 22B&S enamel copper wire, audio type coaxial cable.

NOTE: Resistor wattage ratings and capacitor voltage ratings are those used on the prototype. Components with higher ratings may generally be used providing they are physically compatible. Components with lower ratings may also be used in some cases, provided the ratings are not exceeded.

The foregoing comments generally apply to daylight reception conditions. Quite a different set of conditions normally apply for night time reception. In general, literally dozens of stations may be tuned in at night, coming from country towns and other states. Even under these conditions, the preselector can be very useful in improving reception of many of these signals.

There is one important point to note concerning night time reception. Stations from about 75 to 150km distant come into the category where both ground wave and sky wave signals may be present at the same time. This can lead to severe distortion of the audio component. This may occur only sporadically, or it may be such that the signal is rendered useless. There is little which can be done in this type of situation.

The circuit of the preselector is just about as simple as it could be. There is a ferrite rod with two coil windings, the larger one being tuned to the wanted signal by a 10-415pF variable capacitor and a 3-30pF trimmer in parallel. The small winding conveys the signal to the gate of a junction FET, which is self-biased with a 150 ohm resistor in its source. The resistor is bypassed to RF with the 0.47uF shunt capacitor, to prevent degeneration. The drain load is a 10mH RF choke.

The amplified signal is taken from the FET drain via a .01uF DC blocking capacitor to a 10k gain control. From the gain control rotor, the signal is fed via another .01uF blocking capacitor to the base of a bipolar transistor wired as an emitter follower. The emitter follower is biased with the 330k and 390k resistors and has a 5.6k emitter load resistor. The signal emerges from the emitter follower via another .01uF capacitor to the output socket. The purpose of the emitter follower is to transform from a high to a low impedance, so that the high output impedance of the FET may be matched into the low impedance aerial input of a following receiver.

It may be seen from the circuit that a power supply of 9 volts is required. The current is just a few milliamps and this may be supplied by a dry battery or any other suitable DC source. Although 9V is specified, anything between about 7 and 12V will suffice. The use of a plugpack mains adapter can be recommended. The Ferguson type PPA6 or equivalent will give about 9V DC with the small load current involved.

Construction may be best approached by making up the subassemblies first. The ferrite rod aerial involves a winding operation and making up a pair of brackets. Before winding can be done, a cardboard former is needed. Take a piece of flat cardboard and cut a piece about 60mm long and wide enough to that it will just bend around the ferrite rod, with the edges butted together. This operation calls for some patience as it is a little tricky to get it just right. Complete the tube by wrapping it with some good quality insulation tape.

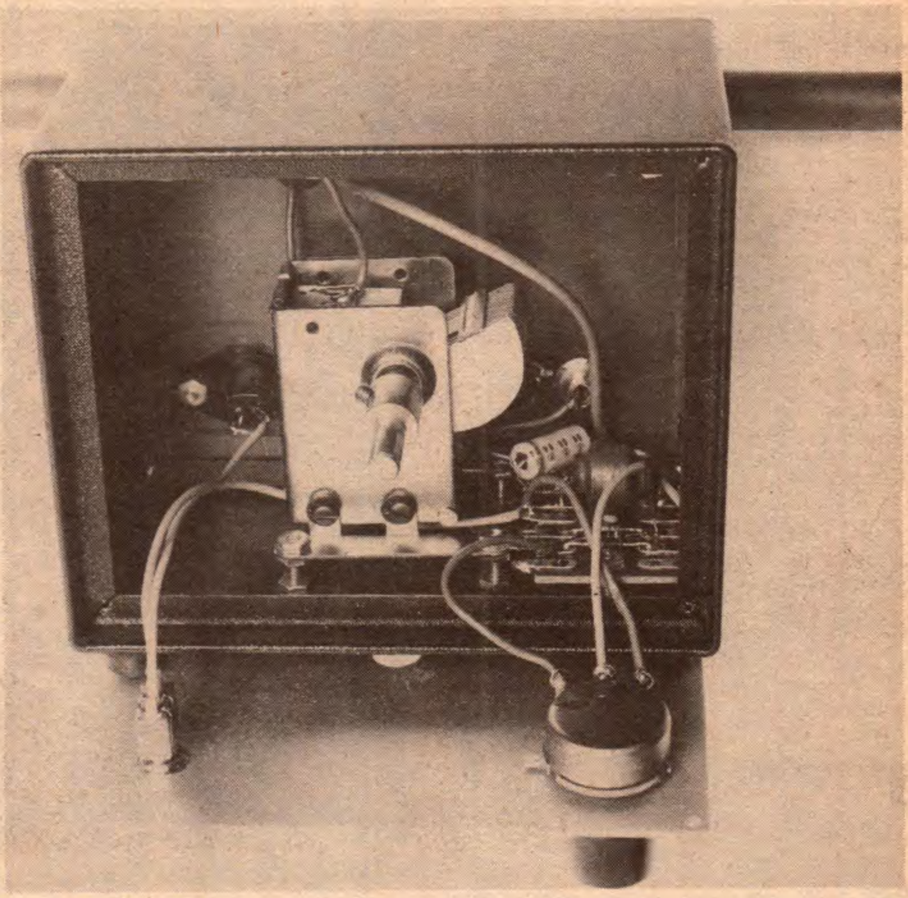
Start the main winding about 10mm from one end of the former and anchor the start of the winding with some insulation tape. Use 22B&S enamel wire and wind on 42 turns, terminating with another piece of tape. Leads of 20 to 30mm should be left at each end until they are cut later on. Leave a gap of 4mm after the finish of the first winding and wind on another 6 turns, leaving leads as before.

Cut the four leads to about 10mm long and clean the enamel from each, right back to the windings. Tin the leads and twist the two adjacent ones together and solder them. Now bend the resultant three terminations into a small loop. Slide the coil along the rod so that the end of the 6 turn winding is about 50mm from the end of the rod. Now solder the lug of the fixed plates of the Philips trimmer to the extreme end of the 42 turn winding and join the other lug to the twisted termination of the coils with a piece of tinned copper wire. The two rubber grommets may be slipped on to the rod and the assembly put aside for the time being.

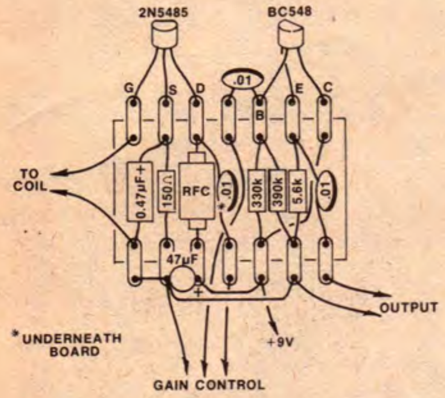
Make up a pair of brackets, one each right and left hand. Scraps of 16 gauge aluminium are ideal but brass, copper, or mild steel may be used. The drawing shows how this is done.

Now assemble and wire the small tagboard. This task is an easy one and it is made clear by the diagram. Make sure that all leads are kept short and neat and that all soldered joints are done properly. Care should also be taken to make sure that component polarity is observed where required, and overheating should be avoided when soldering. When complete, a careful check should be made to ensure that there are no errors or omissions.

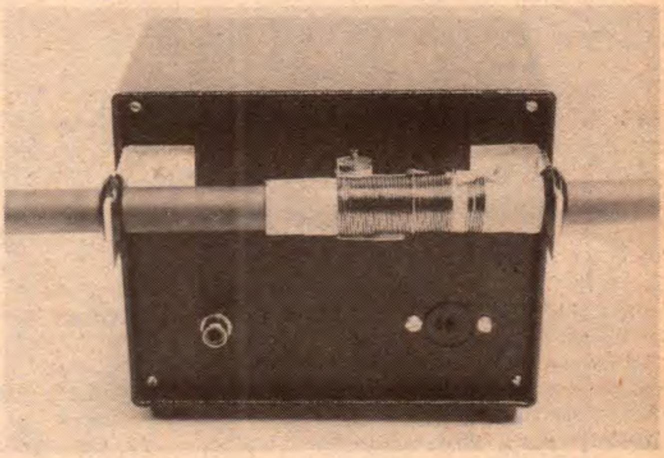
The necessary holes should now be drilled in the box, including the front and back panels. The position of each item may be obtained from the pictures. Care should be taken to make sure that the mounting holes for the variable capacitor are such that the spindle is on the centre line of the front panel. Also, the spindle clearance hole in the front panel should be at the correct height; the feet of the capacitor will need to be about 8mm above the bottom of the box. Holes for mounting the tagboard assembly should coincide



ABOVE: *this internal view shows how the assembled tagstrip and the tuning capacitor are arranged inside the case. Note how the tuning capacitor is stood off the bottom of the case.*



Follow this simple wiring diagram.



RIGHT: *rear view showing how the ferrite rod aerial is mounted. The output socket is at bottom left, while at bottom right is the power supply input socket.*

with the two end centre holes of the board, and the board when mounted should clear the wall of the box and the feet of the capacitor.

When assembling the variable capacitor and the board assembly into the box, they are stood off the bottom of the box by means of screws, with three nuts on each screw. A solder lug is fixed under the top nut of the capacitor mounting screw at the front and nearest the board assembly. The lug is directed to the adjacent earth lug and then soldered. The extension spindle on the variable capacitor is fixed after it has been cut to the right length.

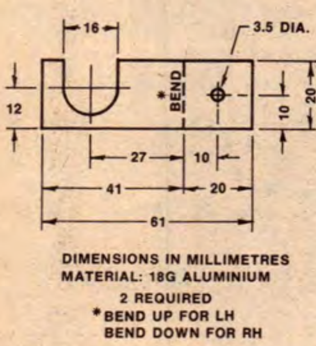
During the process of fixing the components to the box, interwiring should be done at the same time. Leads to and from the panels should be left slack enough to allow access to the inside with the panels suitably hinged out of the way. While we did not use a shielded or coaxial lead from the output point on the board to the output socket on the back panel, it would be a good idea to do this to ensure that there will be no trouble with instability.

The leads to the ferrite rod aerial windings are run through a rubber grommet in the back panel. The earth lead is run to the earth lug on the output socket and this is also run to the negative supply line at the supply socket, as well as running to the nearest earth point on the board. The lead from the 6 turn winding on the coil is run in audio type coaxial lead to the gate of the FET.

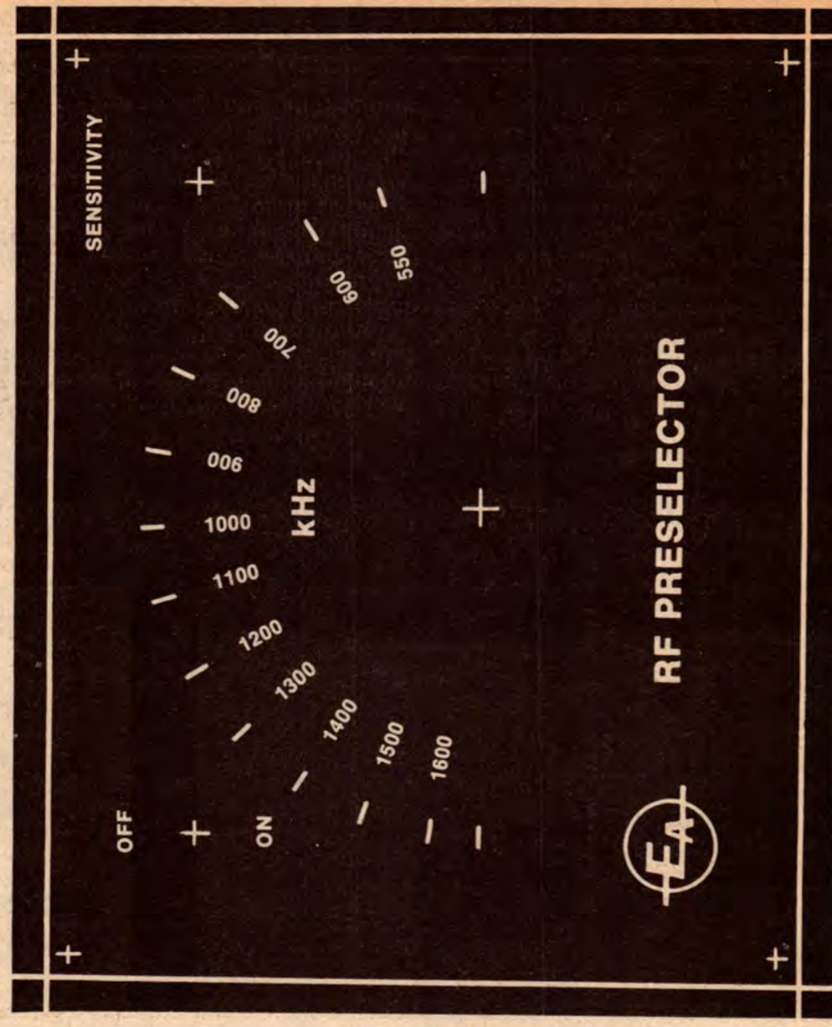
RF Preselector

With assembly and wiring complete, it is a good idea to go over the preselector and make sure that all is well before applying power. Having done all this, a source of 9V DC is required, as mentioned earlier. The next consideration is just how to feed the output of the preselector into the receiver. There are two general possible situations — where the receiver is provided with aerial and earth terminals and the case where there are no terminals and the receiver already uses a ferrite rod aerial.

Where aerial and earth terminals are provided, it is quite easy to run a short length of coaxial lead from the output socket of the preselector to the appropriate terminals on the receiver.



Here is the metalwork diagram for the two aerial rod support brackets.



Actual size reproduction of the front panel artwork.

In the case where a receiver has a built in ferrite rod aerial, the easiest way to couple in is to take a length of insulated hookup wire and wind it around the receiver case, at right angles to and incorporating the ferrite rod. Three turns should be sufficient; then twist the leads together, making a twisted pair about 600mm long. Run these back to the output socket of the preselector.

Note that when using the preselector with a receiver of this type having its own ferrite rod aerial, there is a risk of instability if the two are brought too close together. If you suspect that this is happening, the cure is to move the receiver away from the preselector and also try rotating the receiver so that its aerial rod is at right angles to the preselector rod.

With the preselector coupled to the receiver, we are now ready to make initial checks. Tune the receiver to a weak station and with the gain control on the preselector well advanced, peak up the received signal with the tuning knob on the preselector. Rotate the preselector for a drop in signal strength. This should be fairly sharp and the rod will be pointing in the direction of the transmitter. The preselector should then be turned at right angles to this position. The gain control is adjusted for the best results.

If, having adjusted the preselector thus far, there is still a problem with noise or interference from a nearby transmission, the preselector should be carefully rotated to find a possible alternative position which reduces the problem. The best teacher is experience: after a short while it will become clear as how to get the best out of the preselector.

After the preliminary tests the preselector will need to be calibrated so that the pointer on the dial scale has real meaning. We have reproduced the front panel details so that manufacturers who see fit may provide ready made panels complete with calibrations, etc. On the other hand, readers may see fit to make use of the reproduction in the magazine to make up a panel.

Before attempting calibration, the dial should be rotated so that the variable capacitor is fully closed. The two lines, one at each extreme end of the scale, should be used to position the dial correctly on the spindle.

Tune in to a station of known frequency at the low frequency end of the band and adjust the preselector tuning for maximum. Any error in reading may be corrected by sliding the coil on the rod. Now tune in a station of known frequency at the high frequency end of the band and make the necessary corrections with the trimmer on the coil. Repeat the process a number of times until the calibrations are correct at both ends of the band.

If you are able to use a signal generator and elect to do so, then all you have to do is to set the generator to the wanted frequency, bring the generator's output lead close to the coil on the ferrite rod, adjust the output level of the generator and proceed as above.

After the preselector has been accurately calibrated, it is wise to make use of the calibrations when attempting to tune in a difficult signal. Unless the preselector is set fairly close to the wanted frequency, there is the possibility that it will respond to a stronger signal near to where it is set, causing some confusion due to spurious responses.