Short-wave converter for the 27MHz band

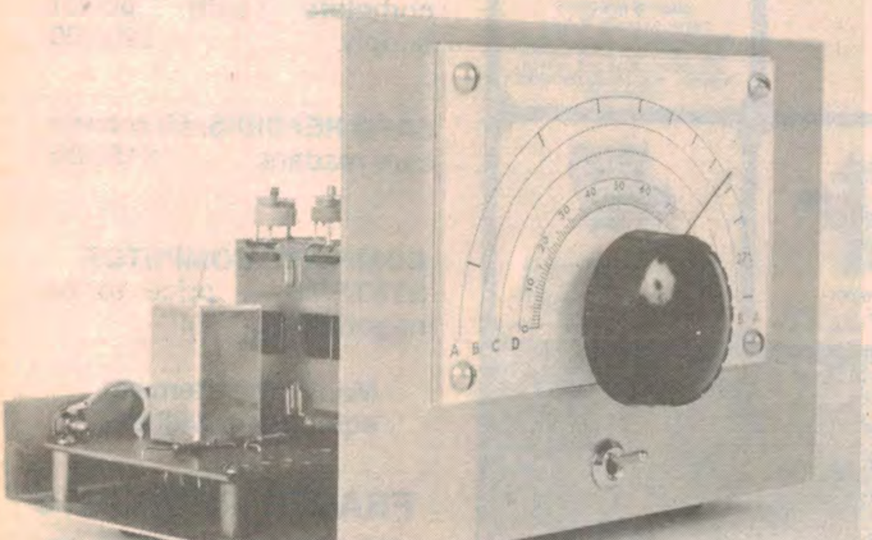
. . . simple project for listening to amateurs and "CBers"

Here is a timely addition to our line of converters, designed to let you listen in to the increasing activity on the 27MHz band. It should be particularly handy if "CB" operation becomes legal, as now seems likely. The converter is simple, effective and suitable for use even with personal portable receivers.

by IAN POGSON

Beginning in April, 1973, the author described a series of simple converters covering various tuning ranges. Since then, interest has grown considerably in the 27MHz band. With more Novices being added to the ranks in the near future and the possibility of legislation being enacted to permit greater use of the 27MHz band, one can only guess at the amount of activity that these factors will generate. Even now, listening around on the band any night or at week-ends, there is quite a lot to be heard. With all this in mind, I was prompted to add a converter to the series to specifically tune the 27MHz band.

After some thought, it was decided that the original concept should be followed, using the original "universal" PC board. Also, many beginners (and others) would wish to feed such a converter into a personal portable or perhaps a larger transistor domestic type radio, as well as those readers who might want to feed the converter into a short wave receiver which did not tune up to 27MHz. Each of these requirements has been considered and although the circuit as shown is designed to feed into a receiver tuning the broadcast band, details will be given later on showing how it can be fed into a short wave receiver at about 3.5MHz.



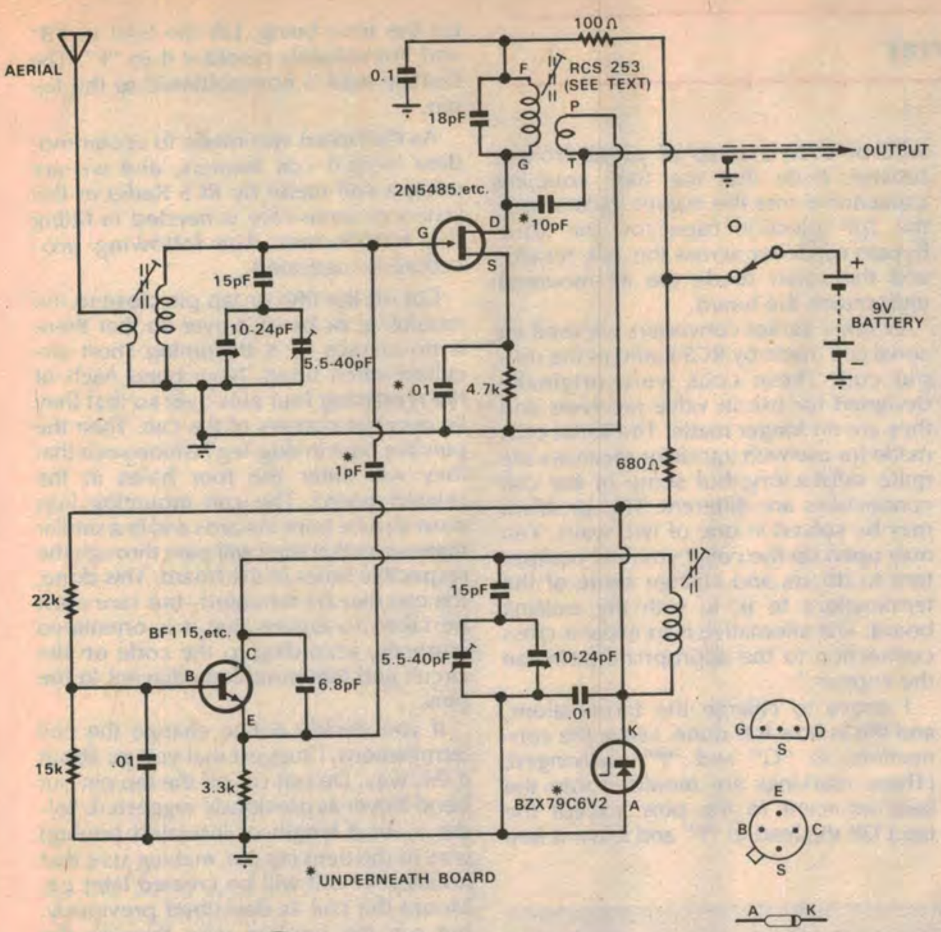
Frontal view of the completed converter, with the aerial coil and tuning gang both visible behind the front panel. A simple, folded aluminium chassis is used.

Perhaps at this early stage it should be pointed out that there are some limitations to feeding the converter into an ordinary broadcast receiver. It means, of course, that you are limited to the amount of selectivity available in the receiver, although generally this should be sufficient. Also, the normal receiver is designed to resolve AM transmissions and will not respond satisfactorily to other modes such as FM and SSB. Fortunately, most of the transmissions at present on the 27MHz band are on AM and so any restrictions here will be minimal.

The circuit is an adaptation of those which have been presented before. It may be seen that it is about as simple as it could be. The mixer is a junction FET, with a tuned circuit at signal frequency in the gate or input circuit. The drain or output of the FET includes another tuned circuit, this time at the first intermediate frequency, to feed into the broadcast receiver. There is a 4.7k resistor in the source of the FET, which may appear to be a rather high value, one which would bias the FET well back into the "knee' or non-linear part of the characteristic curve. This is so, in fact, and is a requirement for efficient mixing of the incoming signal with that from the local oscillator.

The local oscillator itself uses a bipolar transistor, and the circuit is an adaptation of that used for our Solid State Dip Oscillator and many other more recent projects. This oscillator can be made to operate satisfactorily over a very wide frequency range. The tuned circuit consists of a coil winding similar to that used for the signal frequencies, together with the other section of a 2-gang variable capacitor.

It may be seen that there is a 15pF capacitor connected in series with each section of the gang. These are added to restrict the tuning range provided by the



27MHz CONVERTER

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available size of gang. There is also a variable trimmer across each section of the gang. These, together with the slugs in each of the coils, provide for correct alignment and band coverage. Output from the oscillator is taken from the emitter via a 1pF capacitor to provide injection into the gate of the FET mixer.

The components used in the converter are normally stocked items and no trouble should be experienced in obtaining a complete kit. The types of capacitors required are shown in the parts list.

For the mixer transistor, there are at least four different type numbers which we know to be suitable. These are 2N5485, FE5485, MPF106 and BFW11, all having substantially the same characteristics. The oscillator transistor is a bipolar and such types as BF115, TT1002, SE1002, or similar should be satisfactory in this position.

The prototype printed circuit board was made by RCS Radio Pty Ltd, but there are quite a few manufacturers of printed circuit boards and suitable boards may be also available from other makers. As mentioned in previous articles on converters, we have attempted to make this a multi-purpose board and during assembly, you will notice that there are many unused holes. To avoid any possible errors due to the extra holes, I suggest that extra care be taken during assembly.

The output transformer is an RCS type 253 broadcast aerial coil connected in reverse. Possibly other brands could be used, provided they can be made to fit the space on the printed board.

The dial assembly calls for special comment, particularly as the "Jabel" dial used on the prototype is no longer available in this form, having since been modified. The actual mounting centres have been retained but the height has been increased by about 12mm. This means that the front panel has to be increased in height. This has been taken care of in the dimensions given in the parts list, and the metalwork drawing has also been altered to suit.

A good place to start construction is to wind the aerial and oscillator coils. The aerial coil consists of a primary and a secondary, with the secondary wound first. The start of the winding is anchored by soldering it to the lug of the former, according to the drawing. The finish of the winding may be temporarily held in place with a small piece of adhesive tape. Leave this end free while the primary of two turns is wound over the bottom end of the secondary. The start is anchored by soldering it to the appropriate former lug and the finish may also be held in place by drawing it tightly and soldering it to its lug. The finish of the secondary is now soldered to its lug.

The oscillator coil is treated in much the same way, except that it only has one winding. Keep it in mind that the frequency stability of the oscillator largely depends on this coil. It should therefore be wound firmly and finished in a workmanlike manner. The start and finish must be soldered to the lugs as shown in the drawing, so that the connections suit the pattern on the printed circuit board. To ensure that the windings of both coils stay firmly intact, they should now be given a coat of cellulose lacquer or other suitable material.

Before the 2-gang variable capacitor

PARTS LIST

- *1 Chassis-panel, 165mm long x 127mm high x 127mm deep*
- *1 Cabinet to suit*
- *1 Dial assembly, Jabel 6/36N*
- *1 Flexible coupling, ¼in x ¼in, Jabel*
- *1 Miniature toggle switch, SPDT*
- *2 Terminals, 1 red, 1 black*
- *2 Large 3-tag strips (battery supports)*
- *4 Rubber feet*
- *1 Grommet for coax cable*
- *6 Spacers, 12½mm long, tapped ⅛in Whitworth*
- *1 Printed board, 152mm x 76mm, 73/3C*
- *1 Aerial Coil, RCS type 253*
- *2 Neosid coil formers, 7.6mm x 35mm, with grade 900 slug and can*
- *1 Zener diode, BZX79C6V2*
- *1 Transistor, 2N5485 or similar*
- *1 Transistor, BF115 or similar*
- *1 9V battery, No. 2362*

RESISTORS (½W)

- *1 100 ohms*
- *1 680 ohms*
- *1 3.3k*
- *1 4.7k*
- *1 15k*
- *1 22k*

CAPACITORS

- *1 1pF NPO ceramic*
- *1 6.8pF NPO ceramic*
- *1 10pF NPO ceramic*
- *2 15pF NPO ceramic*
- *1 18pF NPO ceramic*
- *1 10-24pF Roblan 2-gang variable*
- *2 5.5-40pF Philips trimmers*
- *3 .01uF 200V greencaps*
- *1 0.1uF 100V greencap*

MISCELLANEOUS

Hookup wire, coax cable, solder, scresw, nuts

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, providing the ratings are not exceeded.

27MHz short-wave converter

can be fitted to the board, leads must be soldered to the two bottom lugs of the fixed plates. About 50 mm of 20 gauge tinned copper wire should be used, with a loop wound firmly around each lug before soldering. This will prevent the soldered joint from coming adrift when the other end of the lead is soldered to the board. A trimmer must also be soldered to each section of the gang and as may be seen from the picture, we used the newer solid dielectric type. If you have the old "beehive" trimmers, then use them by all means.

Care should be taken when soldering the gang trimmers in place. Make sure that good soldered joints are made, without damaging the trimmers by burning or overheating.

Possibly the most interesting part of the construction is assembly of the printed board. Although this is a straightforward job, it is advisable to approach it in a systematic manner. A good place to start is with the resistors, followed by capacitors and other small items, including the transistors. Do not forget the link, which may be a piece of tinned copper wire or even a scrap of pigtail from a resistor. Note that the 10pF coupling capacitor across the output transformer, the 1pF injection capacitor, the .01uF bypass capacitor across the 4.7k resistor and the zener diode are all mounted underneath the board.

In some earlier converters we used an aerial coil made by RCS Radio as the output coil. These coils were originally designed for use in valve receivers and they are no longer made. The aerial coils made for use with transistor receivers are quite satisfactory, but some of the coil connections are different. This problem may be solved in one of two ways. You may open up the coil if you feel competent to do so, and change some of the terminations to fit in with the existing board. The alternative is to make a cross connection to the appropriate point on the copper.

I chose to change the terminations, and this is how it is done. Leave the connections to "G" and "P" unchanged. (These markings are moulded into the base adjacent to the pins, except the tap.) Lift the lead to "F" and leave it free for the time being. Lift the lead to "B" and immediately resolder it to "F". The floating lead is now soldered to the tap pin.

As the board was made to accommodate Neosid coil formers, and we are using a coil made by RCS Radio in this instance, some care is needed in fitting this transformer. The following procedure is suggested.

Cut off the fifth or tap pin close to the moulding, or bend it over so that there is no chance of it becoming short circuited when fitted. Now bend each of the remaining four pins over so that they lie over the corners of the can. Then the pins are bent in dog-leg fashion such that they will enter the four holes in the printed board. The can mounting lugs must also be bent inwards and in a similar manner so that they will pass through the respective holes in the board. This done, the can may be mounted—but care must be taken to ensure that it is orientated correctly, according to the code on the circuit and that moulded adjacent to the pins.

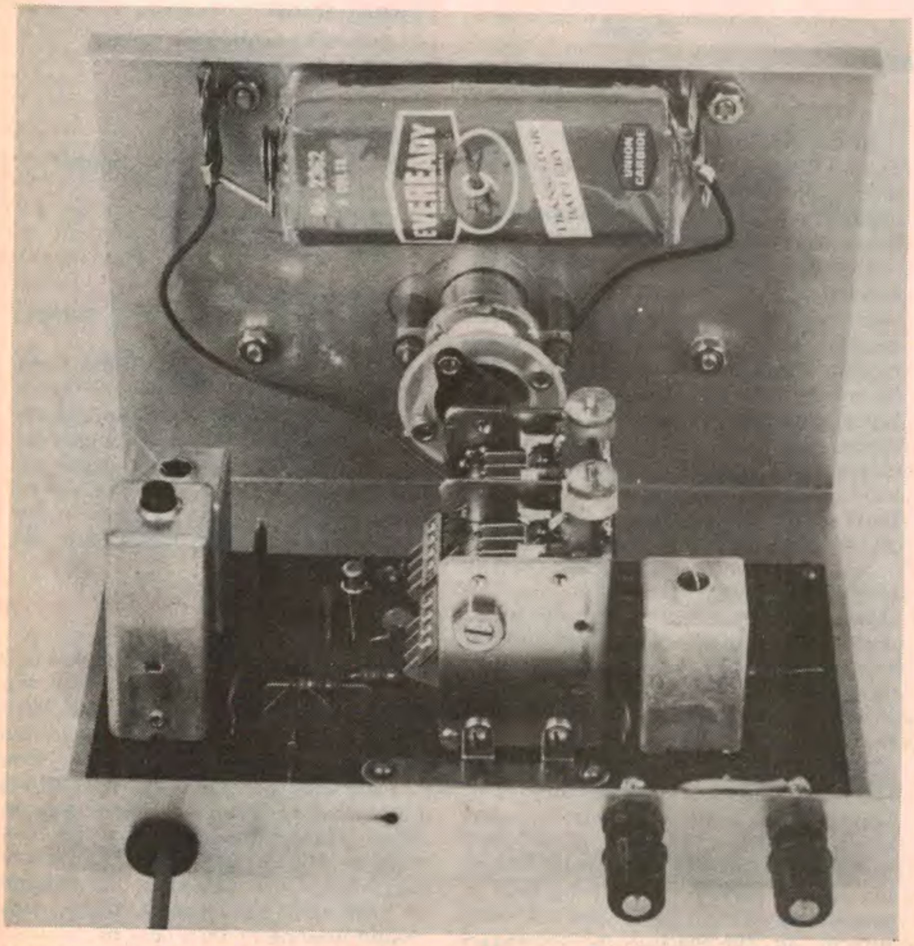
If you decide not to change the coil terminations, I suggest that you go about it this way. Do not cut off the tap pin but bend it over as previously suggested. Solder a short length of insulated hookup wire to the bent tap pin, making sure that no short circuit will be created later on. Mount the coil as described previously, but run the hookup wire through the centre slug adjusting hole in the board. Solder pins "G", "F" and "P" but do not solder "B" to the copper pads. Instead, run the lead of hookup wire to the pad adjacent to "B".

Fit the aerial and oscillator coils into their cans and bend the lugs over so that when the screws are used for mounting, they will contact the side of each hole. This is to ensure that the can is connected to the earthed copper. Each coil is fixed to the board with two 6BA screws. If 6BA screws are not readily available, the alternative is to re-tap the holes to ⅛in Whitworth.

The 2-gang capacitor is fixed to the board with four screws. An option is to add two extra PCB mounting spacers under the board, to two of the screws, one nearest the front panel and adjacent to the oscillator circuitry, with the other diagonally opposite. The other four spacers are fitted at each corner of the board.

This completes the assembly of the board, except for some leads which must be provided to go to external points. Leads of sufficient length are soldered to the earth point near the earth terminal on the back skirt of the chassis, the aerial point of the coil to the aerial terminal, the +9V point to the switch and a lead from the copper earth for the negative terminal of the battery. The coax cable is connected with the inner conductor to the output point and the braid is soldered to the earth copper nearby.

The two terminals, rubber grommet,



This rear view shows the main disposition of components, including the flexible dial drive coupling. The oscillator coil is at left, nearest the front panel.

27MHz converter

switch, dial assembly and battery may now be fixed to the chassis-panel. As we mentioned earlier, the dial we used is no longer made but if you have one, then it may be used, as the mounting holes remain the same. Alternatively, the new dial may be used as suggested, or you may make your own arrangements as you see fit, possibly by still making use of the dual ratio dial drive by Jackson Bros. This drive is available as a separate item from Messrs Watkin Wynne, 32 Falcon Street, Crows Nest, NSW 2065.

The complete dial assembly is supplied with a scale, having in addition to a 0-100 logging scale, four blank ranges, which may be calibrated according to actual needs. However, calibration of this may present problems to those readers who do not have any instruments for calibrating. To help with this problem, we are printing a full size scale so that you may cut it out and use it directly, or you may take the information and mark it on the scale provided on the dial assembly.

When mounting the dial assembly, we suggest that you make provision for the battery by adding a large 3-tag strip under each of the two top screws. The battery may then be strung across these strips as may be seen in the picture.

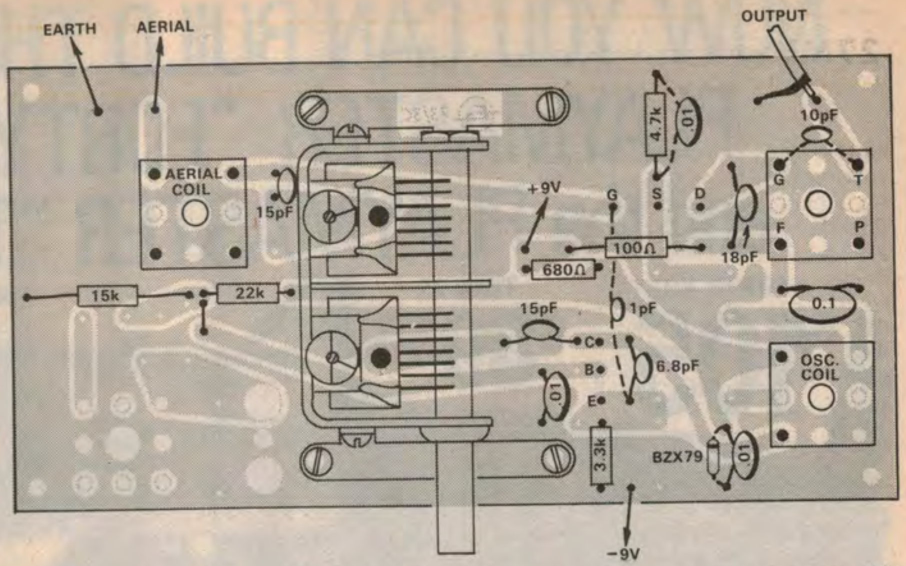
At this stage, a careful check should be made to ensure that no errors have been made on the board assembly and elsewhere. Satisfied that all is well, the board may now be screwed to the chassis, not forgetting the flexible coupling between the gang and the dial drive. A short spindle is required between the drive and the coupling and this may be obtained from an offcut of a potentiometer spindle.

All interconnecting leads are now terminated to the respective points. The negative battery connection may be tied to the earthed lug on the appropriate tag strip, whereas an insulated lug will be used for the positive connection at the other end. If you use heavy gauge tinned copper wire for these connections, it should be sufficient to hold the battery in place. However, if you wish, an extra bracket may be fitted according to your own ideas.

Having completed the mechanical work, the converter is ready to be put into operation. Quite a number of items must be considered here. We will assume that you have a suitable broadcast receiver into which to feed the converter. We will also assume that you have an aerial which is efficient at 27MHz. Hopefully, you will also have access to a signal generator or modulated oscillator which you may use to align and adjust the calibrations against the dial scale. If not, then you will have to use whatever information you can relating to the frequency of received signals and try to adjust the dial calibrations accordingly.

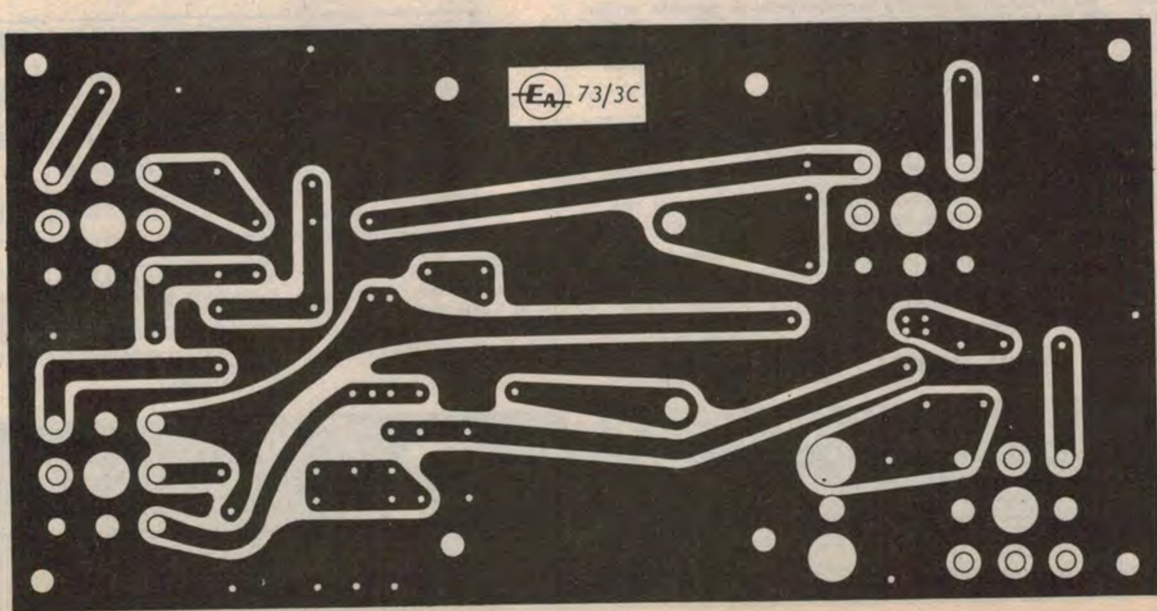
If you have an ordinary broadcast receiver with aerial and earth terminals and without a ferrite rod aerial, then you may feed the output coax cable directly into the aerial and earth terminals. On the other hand, if you have a small transistor personal portable receiver, or a larger receiver with a ferrite rod aerial fitted, then you may use this instead. However, some preparation is necessary before you can use this type of receiver.

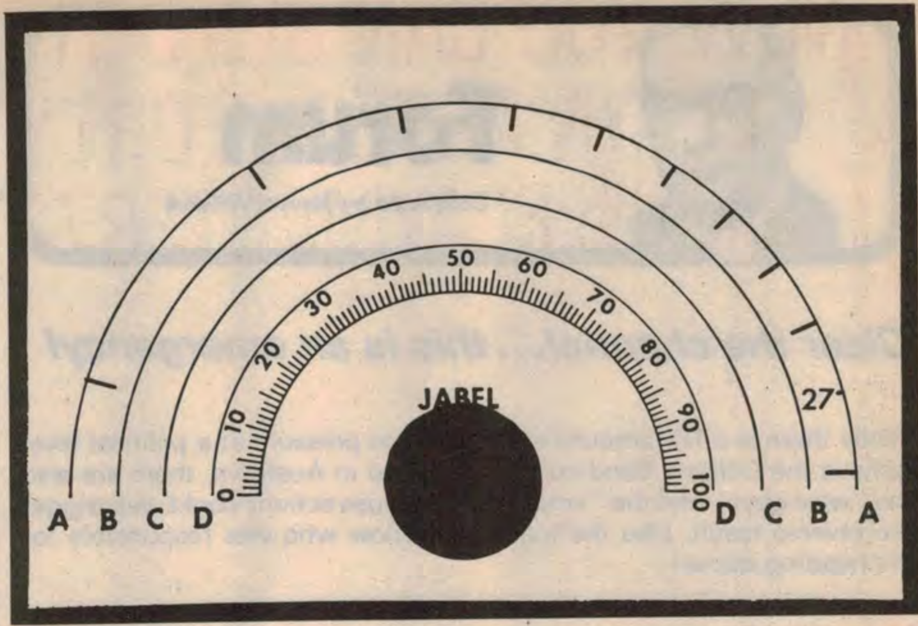
The simplest way is to get a few yards of insulated hookup wire. After determining which way the ferrite rod aerial runs inside the receiver, wind from six to ten turns of hookup wire around the receiver so that the ferrite rod is parallel with the axis of your winding. The winding may just be bunch wound and the



The component layout shows the PC board as viewed from the component side. Pay particular attention when inserting polarity conscious components.

Below is an actual size reproduction of the PCB pattern.





This full size reproduction of the dial scale may be either copied or used direct. The blank ranges may be calibrated according to requirements.

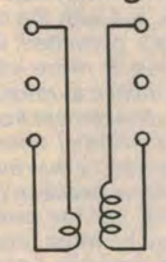
two insulated ends twisted together to hold the winding in place. Now bare the two ends and solder them to the two connections of the coax cable from the converter.

The above method is quite a rough looking job but works very well. However, if you wish, then it is up to you to devise a more neat way of winding and arranging the turns around the receiver. On the other hand, if you wish you may be able to open up the set and if space permits, wind six turns or so directly around the ferrite rod, again using insulated hookup wire and terminating it to the cable from the converter.

Switch on the receiver and tune right down to the high frequency end of the dial, so that you have just tuned past station 3NE, or 1600kHz. This will ensure a clear spot as your first intermediate frequency. The receiver should be left tuned to this position. Switch on the converter and with the volume control on the receiver set to a suitable level, adjust the slug in the converter output coil for maximum noise or hiss. You may find that the slug will protrude somewhat above the top of the can. If this is excessive, then the 18pF capacitor should be reduced to 15pF.

As an alternative to setting the receiver tuning just outside the broadcast band, you may wish to choose a lower frequency. However, this has problems of broadcast stations breaking through, particularly at night. To reduce this possibility, you may be able to rotate the receiver to null out the interfering station, or perhaps even stand the receiver on end to reduce pickup of the ferrite rod.

Coil Winding Details



COIL CONNECTIONS VIEWED FROM ABOVE

COIL DETAILS
Aerial coil: Tuned winding, 15 turns 30B&S enamel wire on Neosid 7.6mm former. Coupling winding, 2 turns 30B&S enamel wire wound over earthy end of tuned winding. Use grade 900 slug and mount in can.
Oscillator coil: One winding, 15 turns 30B&S enamel wire. Other details as above.

Assuming that you have a calibrated signal generator available, set it to 27MHz and feed it into the aerial of the converter. Set the converter dial pointer to 27MHz. Adjust the slug in the oscillator coil until the generator signal is heard. Also adjust the slug in the aerial coil for maximum response. Keep the signal generator level such that only sufficient signal is fed in to make effective adjustments to the slugs and trimmers.

Now set the signal generator to 27.9MHz and set the converter dial pointer to 27.9MHz, which is the last point towards the other end of the dial. Adjust the oscillator trimmer until the signal is heard and then adjust the aerial coil trimmer for maximum response. As always, when aligning a superhet receiving system, this process must be repeated several times until the calibrations are set at the correct points near each end of the dial respectively.

Each time the oscillator coil slug or trimmer is adjusted, the slug or trimmer on the aerial coil should also be adjusted.

If you are unable to obtain the use of a signal generator for calibration and alignment, then it will be a matter of making use of whatever facilities may be available. If you do not have any means of generating a signal yourself, then a friend may be able to help. It should not be very difficult to identify a signal of known frequency around 27MHz and so calibrate that end, but it may be more difficult to get a calibration for the other end.

Although about as simple as it could be, this little converter can give a very good account of itself given a broadcast receiver of reasonable sensitivity and a good aerial system. I have tried the prototype, using an aerial for amateur bands from 3.5MHz to 28MHz and feeding it into a portable transistor receiver with a ferrite rod and I was more than surprised at the performance. At nights and at weekends, many signals may be tuned in with good reception.

If you would rather feed the converter into a short wave receiver which will tune around 3.5MHz but does not tune right up to 27MHz, then this may be done by substituting for the RCS aerial coil with one of your own winding. Use a Neosid former 7.6mm diameter and 60mm long, with two grade 900 slugs and a can. Wind a primary with 120 turns of 28B&S enamel wire and terminate to suit the tuned winding on the board. The output or secondary winding consists of 12 turns of the same wire wound over the earthy end of the primary. It is terminated to suit the output on the board. The tuned winding is shunted with an 82pF NPO ceramic or a polystyrene type.

Having done this, it will be necessary to set it to frequency by whatever means you have available and align and calibrate the rest of the unit. There is one point however. It is not likely that the calibrated dial scale which we used on the prototype will be accurate for this application. No doubt readers wishing to do this will have facilities to do their own calibrating.