G4DHF Transverter on 160, 80 and 40m.

In the August issue, David Johnson described a unique Transverter — one which enabled you to turn your 2 metre multimode into an HF Transceiver running on 20, 15 and 10 metres. This of course is the opposite way round to most Transverter designs — you normally find them taking 10 metres up to 2 metres.

In the August issue, we described a natty little transverter to effectively turn your 2 metre multimode into an HF transceiver. Due to many requests, here is a modified version which will get you an 160, 80, and 40 metres at considerably lower cost than buying an HF rig! It is useable on SSB, CW and even FM is you want. Modification by Tony Bailey, G3WPO.

This article has raised a lot of interest, together with many requests for a version which covers the lower frequency bands.

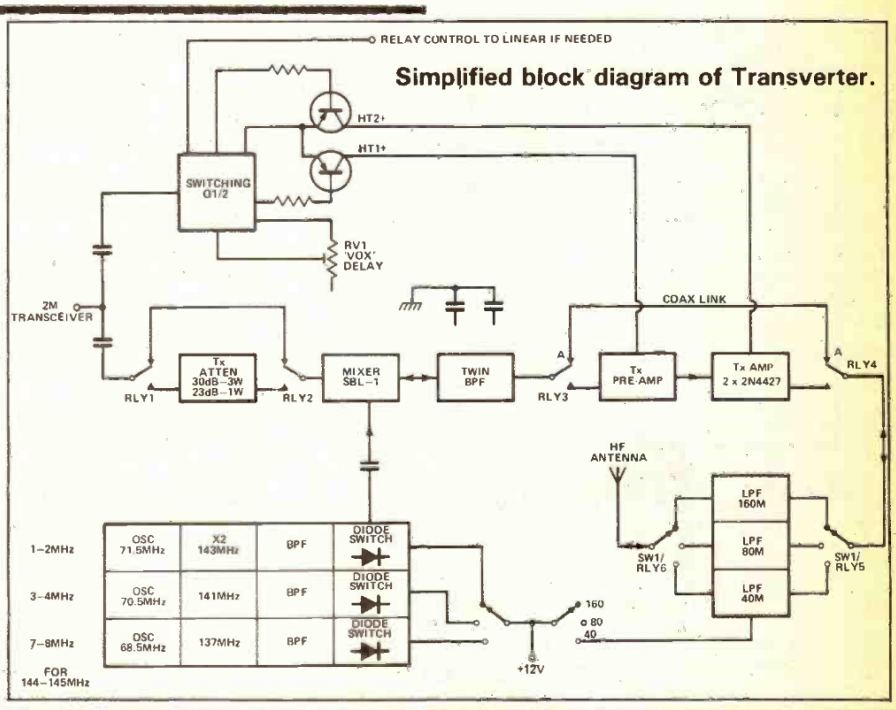
With David's permission, a modified version is to be described which enables coverage of these three lower bands. Reference should be made to the original article in the August issue for the main circuit details although a precis is given here for those without the original. The modified circuit diagram and pcb layouts are reproduced here together with full constructional details for constructors convience.

Circuit

The transverter is designed around an SBL-1 bi-directional mixer, with the VHF signal on 2 metres mixing both transmit and receive with a diode switched local oscillator which produces the required output frequency. It is important that the mixer is driven with the correct power level of around 5mW, and is terminated in a 50 ohm load. Higher powers will cause saturation of the diodes and lots of spurious products.

A pair of relays switch in an attenuator pad, which is selected to reduce the output power of the 2 metre rig down to the MW level on transmit only. In the original a 30dB pad was used for a 3 watt input — it is possible to use almost any input power down to the actual 5mW by selection of the appropriate resistor values in the pad.

The three diode switched oscillators are identical in design, except for some inductor values, and produce stable, low-noise, low harmonic outputs of approx 0.7V RMS correctly terminated at the mixer. For the lower frequency bands in question (taking 80 metres as an example), an input of 144.000MHz requires an injection frequency of 141.000MHz to produce a 3.0MHz output. The 2 metre rig then tunes 144.5 —



Simplified block diagram of Transverter.

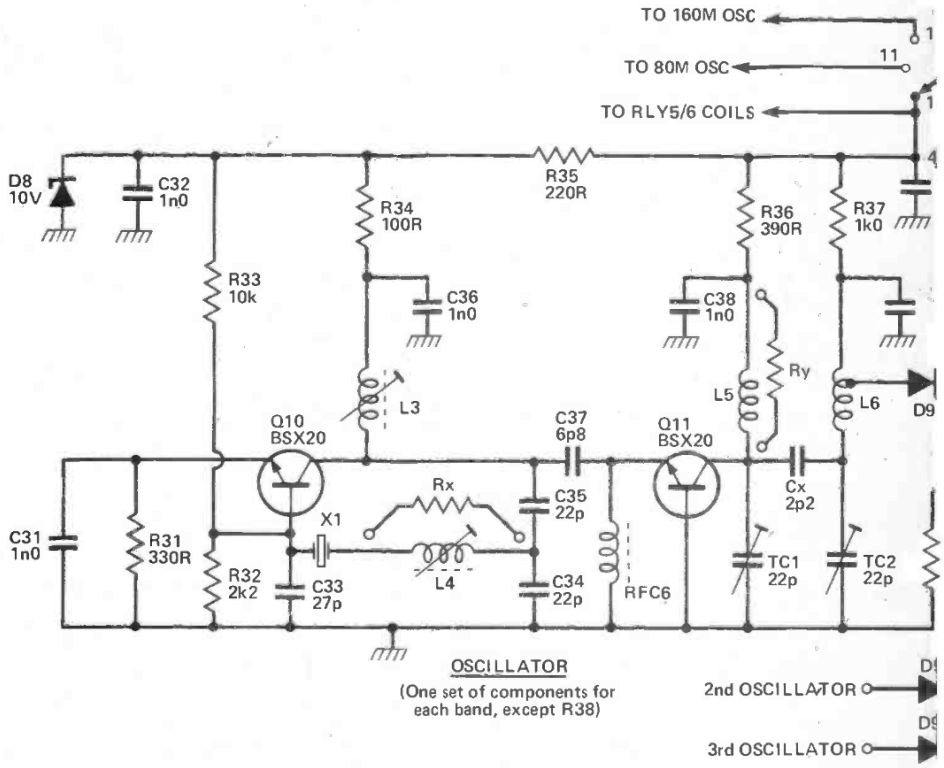
145.800 to cover the amateur 80 metre band of 3.500 – 3.800MHz. Similarly, 160m tunes 144.800 – 145.000MHz, and 40 metres 144.000MHz – 144.100MHz.

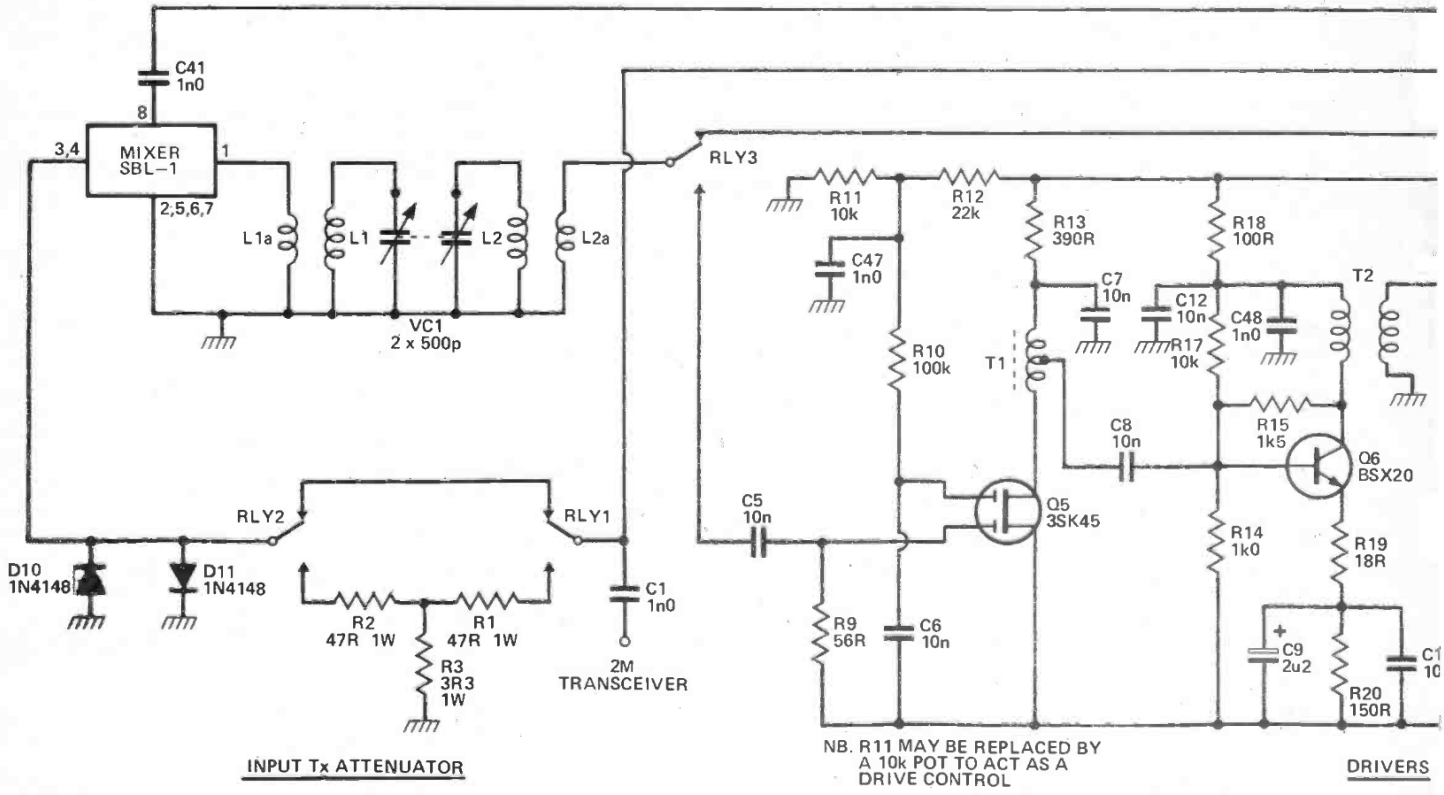
The oscillators use an overtone circuit (Q10) running at half the output frequency (70.5MHz for 80 metres) which is then doubled by Q11 and filtered through L5 and L6. The outputs are diode switched via D9, to give a low imepedance output to the mixer.

The mixer output will contain sum and difference frequencies, and the correct one is selected by the preselector L1/2 and VC1. In the original, a dual gang 250pF capacitor was used, but a 450/500pF max version is required here to achieve the frequency coverage, together with a higher value for the torodial inductors. The preselector is active in both transmit and receive modes.

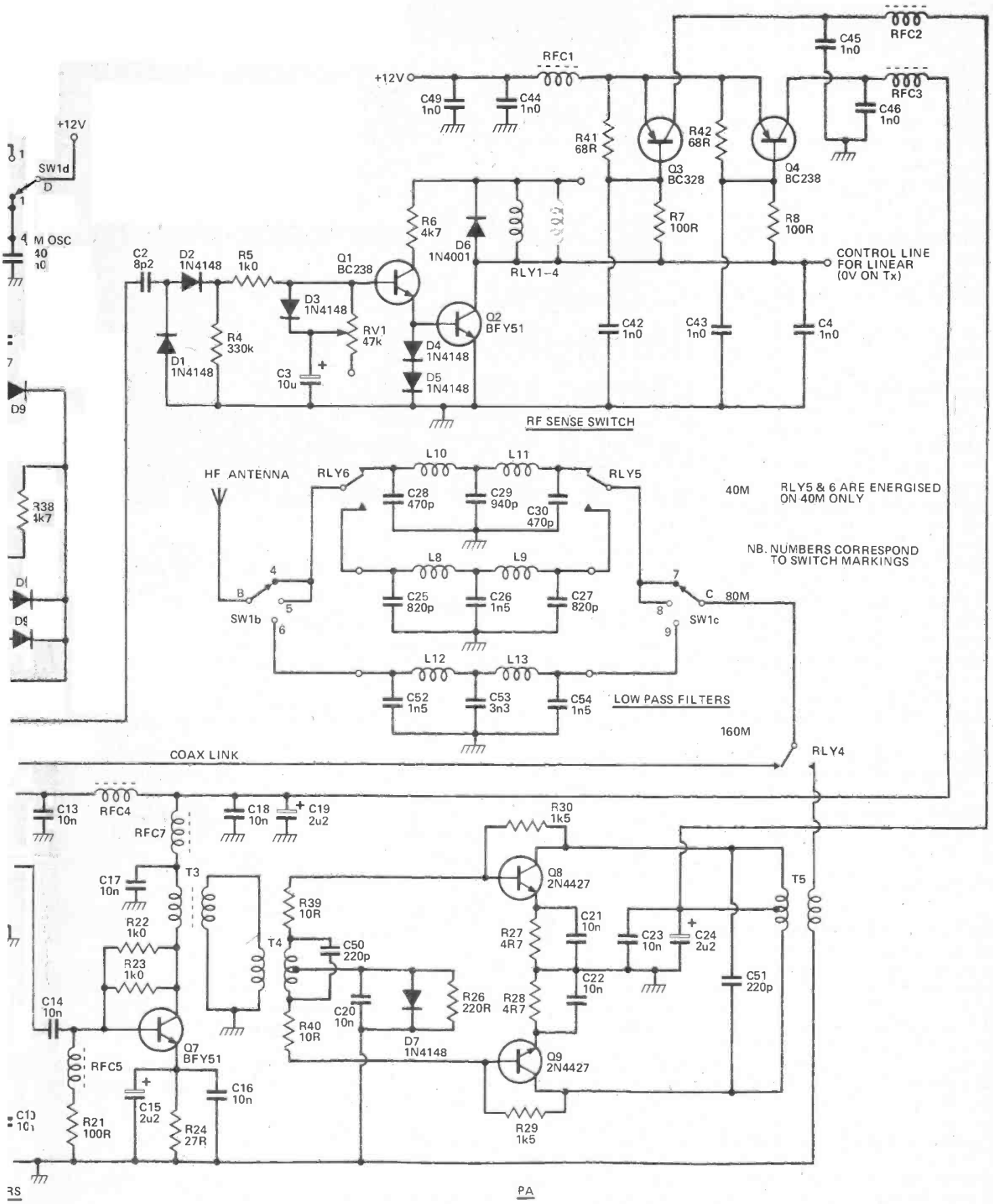
On receive, signals are routed through RLY3, and low pass filters, to the mixer, then up-converted to appear at 2 metres. No preamplification is required – the basic sensitivity of this transverter is that of your 2 metre rig less the conversion loss of the mixer (7dB). Thus sensitivities of around 0.3 – 0.4 uV can be expected which are entirely adequate for the LF bands.

On transmit, signals are amplified up to a level of around 2-3 watts by the broadband amplifier chain Q5,6,7 and Q8/9. This section of the circuit is much the same as the original, with a few component value changes. The Driver transistor Q7 has been changed from a 2N3553 to a BFY51, and the value of the compensation capacitors C50,51 increased.





Complete circuit diagram of Transverter.



Output Filters

It is necessary to have suitable low-pass filters on the output of the PA to reduce harmonic output. Here lies the only slight problem in the conversion from the three higher frequency bands.

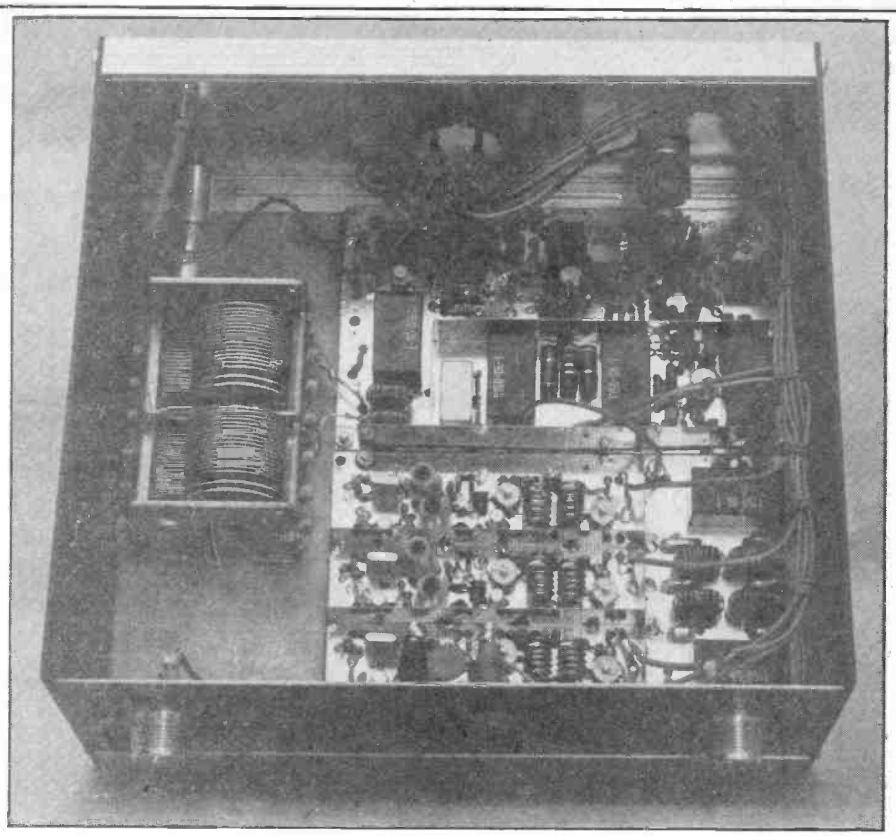
The original circuit needed only two low-pass filters to cover the three bands, as it is possible to use the same 30MHz cut-off filter for both 21 and 28MHz.

One 160, 80 and 40 metres, three filters are needed, one for each band, but space for only two is provided on the PCB. To avoid changing the PCB layout, the extra filter has been accomodated on the three-way switch used for band-changing, with suitable connections to bypass the relays when required. The PCB filters are used for 80 and 40 metres (switched by RLY5/6) and the 160 metre filter is wired on the switch.

In order to avoid having to use a number of connections to the 2-metre rig, RF-sensed switching is used to get from receive to transmit. A small amount of transmit power is fed to the detector circuit Q1, and used to switch the relays over via Q2. Adjustable hang time is provided by RV1 to avoid relay chatter on SSB. If preferred, it is possible to hard wire a connection from the PTT line on the microphone, or a special output if one is provided on the rig, direct to the base of Q1, via a 27k resistor, to provide 'hard' switching. If the PTT line is used, most rigs have this going to ground when activated, so a simple inverter would be required to give a positive voltage for the base of Q1.

Construction

The transverter is built on two double sided PCB's — one carried the three local oscillators and low pass filters, the other the remainder of the circuits. In the original design, the two boards were mounted on top of each other with a screen in-between, and the preselector tuning capacitor mounted on the side of the screen. If desired, the units can be mounted more conventionally in a case as shown in the photograph. If this is done, it is essential that a screen is made of to fit between the two boards so that the oscillator circuits cannot "see" the other board.



Procede with the construction as follows:

1. Start construction by inserting 1mm PCB connection pins at the points denoted in the layout drawings.
2. Next, taking the main PCB, assemble the components located between RLY4 and RLY1, starting at the top edge of the board and working down as far as Q4 and the 1n capacitors. It is important that the bodies of vertically mounted components are in the positions shown on the drawings. Keep all leads as short as possible. Transistors should sit in the PCB with their undersides about 4-5mm above the PCB surface. Be careful that the orientation of polarised capacitors is as shown — tantalum capacitors do not take kindly to being reversed!

Q2 has its emitter lead soldered directly to the top foil, and R40/41 are mounted under the PCB directly across the pads (they are *not* shown on the overlay).

3. Continue working around the board until all components except the transformers are inserted. Pin 1 of the SBL-1 is at the end of the package which has the letter "M" of the "MCL...." legend stamped on it.

Transformers

The block toroids used in the design are surplus types, and come with windings already on them. These must be removed — they cannot be used as they are!

When winding the transformers, one turn is defined as a wire passed through one hole and out of the other. Therefore for those transformers with primaries and secondaries, one pair of wires will emerge from one end of the core, and another pair from the other end. The tapped windings are probably easiest made using two lengths of wire twisted together with the join as the tap. The space within the cores is fairly limited so keep the windings neat and tight, but avoid stripping the insulation in the process.

The centre tapped 8 turn winding requires two lengths of wire each of 15cm, four turns about 15cm, and two turns 9cm of wire to wind. The 5 turn chokes use 10cm of wire. Make sure you know which end is which after winding (mark a P on the primary end).

Note that Q5 has one lead soldered to the top foil, and the same is soldered to the underside as well.

Q7/8/9 should each be mounted so that the underside of the case is no more than 3mm above the PCB to avoid instability. Each of these transistors must have a heatsink (TO5 push on type). L1 & L2 are made as per the drawings. Once wound and in place, and after correct operation has been vertified, the cores are held fast using epoxy adhesive with a seperation between the cores of 5mm. The 53 turn windings need 82cm of wire each, and the 3 turn windings 9cm.

A tinplate screen should be fitted last (or use double sided PCB), 15mm high to isolate the input and output signals from each other. Don't forget to solder in the coax link (use miniature cable) between the two points both marked A on the layout (or you won't receive any signals).

Oscillator/LPF PCB

The oscillator section is identical to the HF version (except for crystal frequencies), and the low pass filters are similar in layout but with changed values. Also, the cores used for the latter are a different grade for the lower frequencies.

1. The PCB is not difficult to assemble — start by inserting the connection pins. Then commence with the top oscillator section; all the three sections are identical, with the exception of the 160M oscillator where L3 has a lower inductance (blue coil — the others are white) and the two air spaced inductors (L5/6) have one turn less than the others. Again keep leads as short as possible and orientate leads of vertical resistors in the positions shown.

It is important that when winding L5 and L6 (two for each oscillator) the winding direction must be correct if the tap is to end in the right place. Each soil is wound by taking a 15cm (14cm for 160m) length of 19swg (1.25mm) enamelled copper wire, and winding around a 7/32" drill so that the winding progresss anticlockwise from left to right. If you start the winding by having the wire under the drill, and then bring it up over the back towards you, continuing to wind to the right, you will get it right.

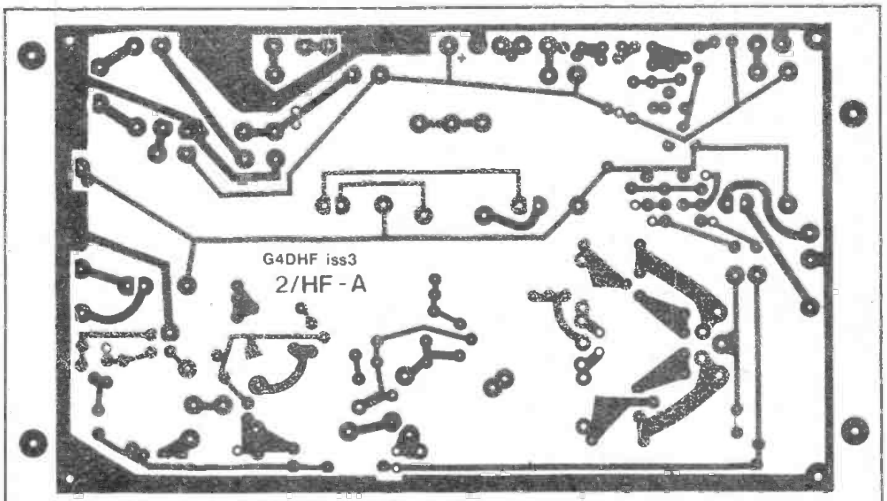
Four of the six-turn coils, and two five-turn coils are required if you are running all three bands, with the insulation scraped off at 1.25 turns from the end nearest the 1nF decoupling capacitors. Tin the exposed copper before putting the coil into place with its underside about 2mm above the PCB. Then solder the diode into place, with the banded (yellow or black) end against the PCB (it won't work if they are the wrong way round). The other end can then be clipped off just at the point where it meets the tap made earlier, and then soldered.

Low Pass Filters

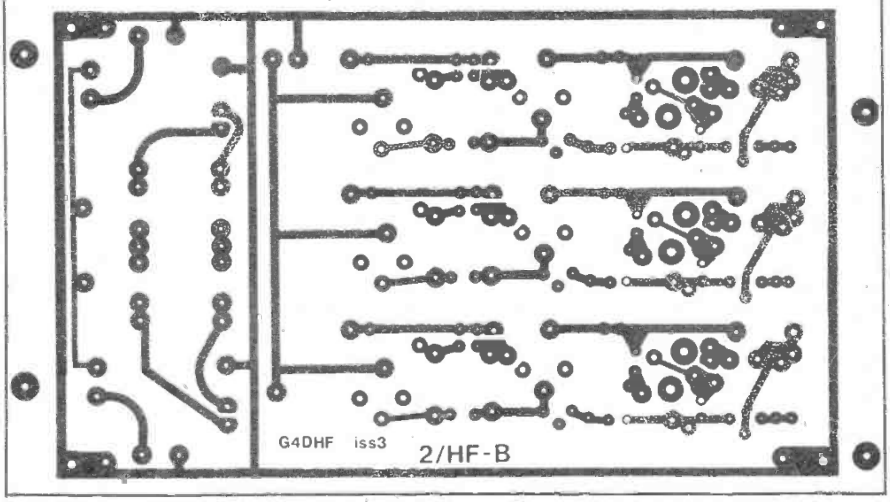
These are wound on T50-2 (red) toroids)rather than T50-6). L8 and 9 (80 metres) need 36cm of wire for winding, and L10 and 11 (40 metres) need 26cm. The 160 metre inductors (L12 & L13) are wired directly across the bandswitch (see diagram). They require 50cm of wire each for winding. Note that C29 comprises two capacitors wired in parallel to get the correct value. Polystyrene capacitors are used in this version of the transverter.

Screens are required between the oscillator sections as shown, again 15mm high.

If the transverter is constructed as the original, an 18swg aluminium screening plate cut to the same size as the PCB's is required between them — this is sandwiched between the two PCB's as shown in the drawings. In the prototype VC1 was also mounted on this screen, using an additional sidepiece which had been bent at right angels to the main screen — whether this can be done depends on the type of capacitor used. If the leads from the capacitor to the preselector



Foil Patterns — Please note they are 75% full-size.



connections are more than a few centimetres long, then a screen will need to be fitted so that the two leads cannot "see" each other, and spoil the preselector rejection.

The leads feeding +12V to each oscillator need to be run in screened audio cable, and short lengths of miniatur coaxial cable should be used for the inter-PCB wiring.

Alignment

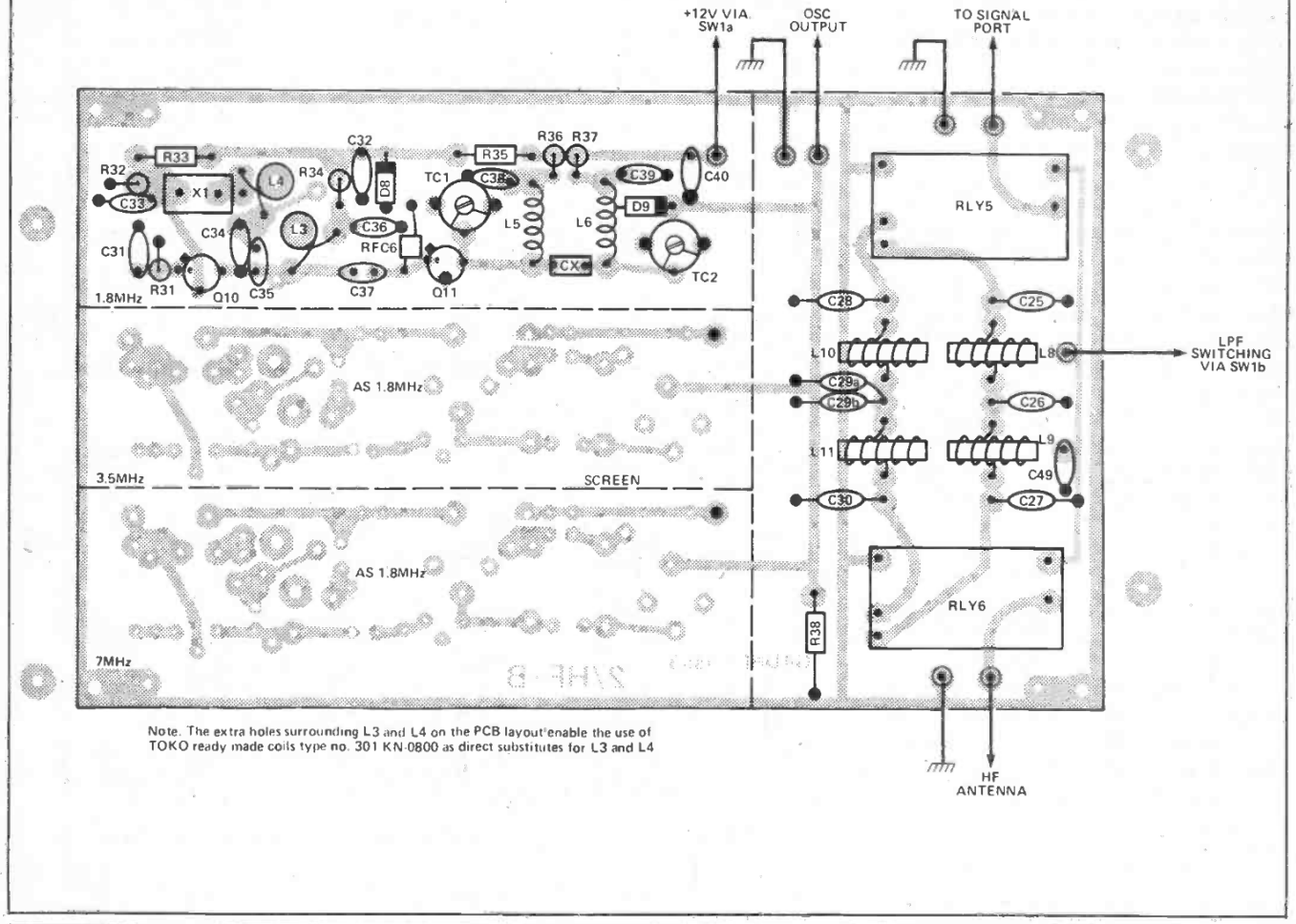
There are two ways of aligning the unit. The first, if you haven't any test equipment, is purely to tune up for best received signal. The better way is to firstly adjust L3 until oscillation occurs (monitor the current taken by the +12V line for a sudden peak), then back the core off slightly so that the oscillator fires reliably when switched on and off. With a diode probe connected ro the oscillator output, adjust TC1 and TC2 for maximum reading (the trimmers will be near minimum

COMPONENT LISTING

RESISTORS

All resistors 0.25W 5% carbon film unless noted otherwise.

R1,2	47R 1 watt
R3	3R3 1 watt
R4	330k
R5,14,22,23,37*	1k
R6,38	4k7
R7,8,18,21,34*	100R
R9	56R
R10	100K
R11,17,33	10K
R12	22K
R13,36*	390R
R15,29,30	1K5
R16	not used
R19	18R
R20	150R
R24	27R
R25	27R
R26,35*	220R
R27,28	4R7
R31*	330R
R32*	2k2
R39,40	10R
R41,42	68R



Note. The extra holes surrounding L3 and L4 on the PCB layout enable the use of TOKO ready made coils type no. 301 KN-0800 as direct substitutes for L3 and L4

capacity). L4 controls the oscillator frequency and should be adjusted for the correct output frequency.

If the oscillators tend to self-oscillate, resistors Rx and Ry should be added, using the highest values which will cure the problem — too low a value will reduce the drive to the PA chain.

On transmit, the only adjustment needed is to the delay of the RF sensing circuit, and VR1 should be set to give a comfortable delay when talking normally.

Power Inputs

A note of caution which equally applies to the 20/15/10m version. Most rigs have a means of reducing power down to 1 watt or so, and this is the preferred sort of level for driving the attenuator. However, not all rigs reduce power in all modes when this option is selected. The FT-480R is a case in point, and does not reduce power on SSB. This will result in considerable overdriving of the balanced mixer, and consequential splattering.

So, check that your output power DOES reduce when you select low power. Also rigs give more output power than their specifications would indicate, so an

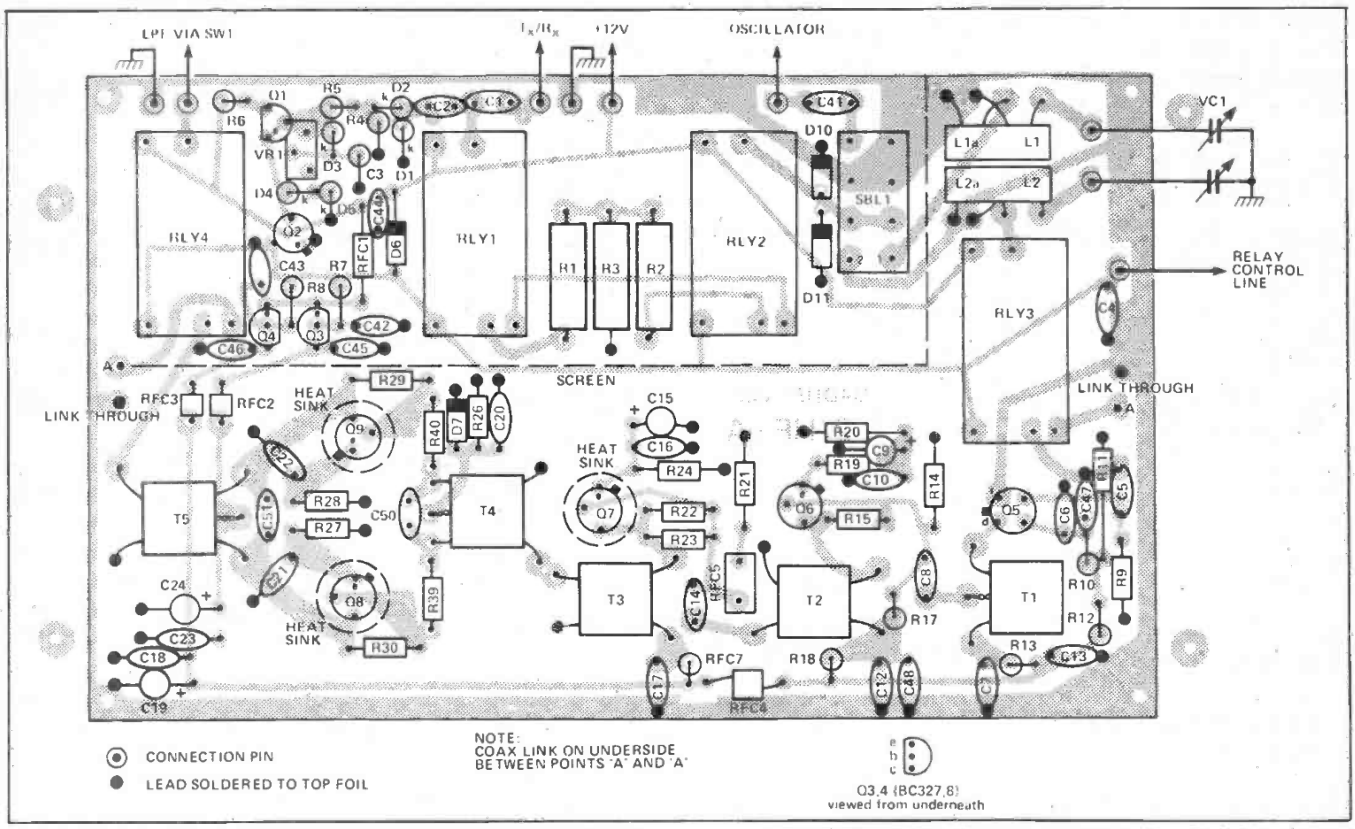
Rx	22k (mounted underside across L4)
Ry	10k or lower (see text-mounted underside L5, see text)
VR1	47 or 100k preset, vertical mounting

CAPACITORS

C1,4,31*,32*,36*,38*,39-*,40*, 41-49	1n0 ceramic
C2	8p2
C3	10u/16v min tant
C5,6,7,8,10,12,13,14,16,-17,18,20,21,22,23	10n ceramic
C9,15,19,24	2.2u/16v min tant
C25,27	820p polystyrene
C26,52,54	1n5 polystyrene
C28,30	470p polystyrene in parallel
C33*	27p ceramic
C34*,35*	22p ceramic
C37*	6p8
C50,51	220p ceramic
C52	3n3 polystyrene
Cx*	2p2 ceramic
TC1*,2*	2 to 22 or 36pF trimmers
VC1	dual 450/500pF max air spaced

CHOKES

RFC1	4u7 or 10uH axial type
RFC2,3,4,-6*,7	5 turns 0.25mm of Cu wire through ferrite bead.
RFC5	10uH TOKO type 7BA or BS



attenuator of slightly greater value than theoretically required is a good idea. The values given on the circuit diagram are for an actual drive level of 2-3 watts.

If you find it necessary to use 10 watts to drive the transverter, then the PCB will not accomodate the high wattage resistors needed to attenuate this to the correct level. In this case, take two lengths of coaxial cable from the input and output of the attenuator on the PCB, and amount the resistors externally in the case. Information on attentuator values and computer program for determining them can be found in Radio Communication, November 1982, page 1046.

Drive Control

A drive control to vary the output power can be added by changing R11 to a 10k potentiometer mounted on the front panel. Note that this in no way compensates for too much drive reaching the mixer. The connections to the PCB should be made using screened audio cable.

KITS

A complete kit of parts for this project is obtainable from WPO Communications for £74.00 including three crystals (£61 ex crystals). The kit includes all components for three bands, wire, switch, air-spaced, capacitor, connectors, but no screens or case. Individual crystals are £5 each.

The HF version (20/15/10) is still available at £72.75 complete with three crystals or £61 without. Individual crystals are £5 each for 20 & 15 metres, and £3.71 for 10M. All prices include VAT & p&p.

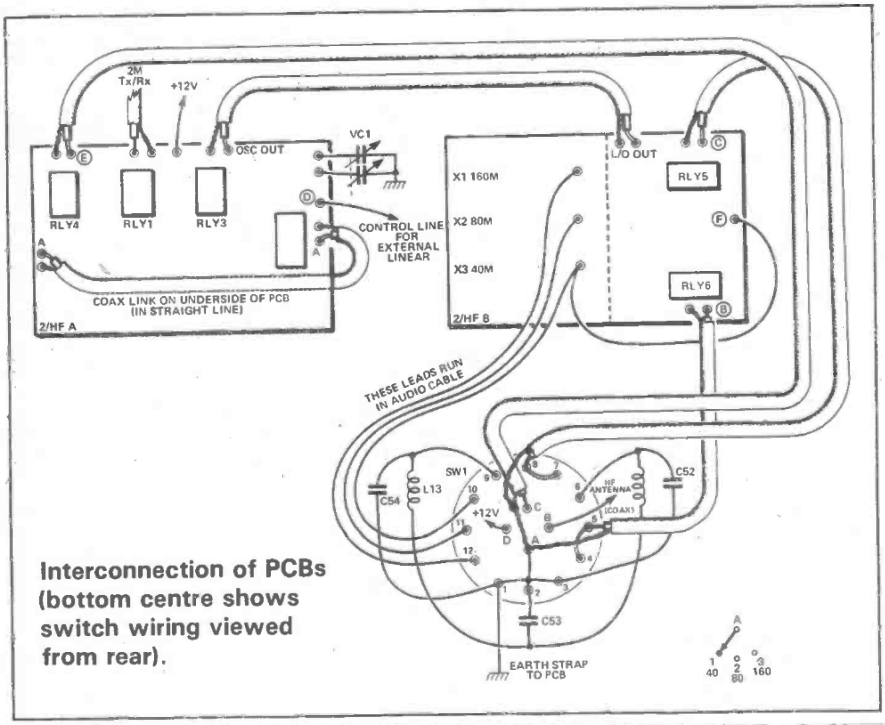
SEMICONDUCTORS

Q1	BC238 or 239
Q2,7	BFY51
Q3,4	BC237 or 238
Q5	3SK34 or 3SK51
Q6,10*,11*	BSX20 or 2N2369A
Q8,9	2N4427
D1,2,3,4,-5,7,9*,10,11	1N4148
D6	1N4001
D8*	10V 400mW Zener

MISCELLANEOUS

Crystals:	160m (tuning 144.8 — 145.0MHz) 71.500MHz 80m (tuning 144.5 — 144.8MHz) 70.500 MHz 40M (tuning 144.0 — 144.1MHz) 68.500MHz
All HC18/U types, series resonance 5th overtone.	
RLY1-6	type 1150-060-1 ex J Birkett
T1-T5	wound on 10mm square block ferrite toroids (see text)

8 off Amidon T50-2 toroids; SBL1 balanced mixer; Switch 3 pole 4 way rotary; PCB connection pins; miniature coaxial cable (50 ohm).



Interconnection of PCBs (bottom centre shows switch wiring viewed from rear).

COIL DATA

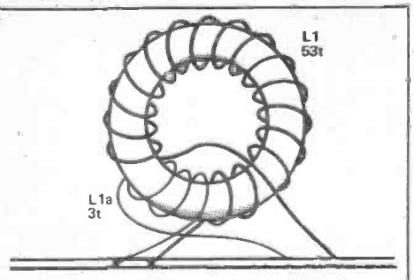
L1,2
53 turns of 0.25mm dia en Cu wire wound on T50-2 core.

L1a, L2a
Wound on the main toroid next to L1/2. Three turns 0.25mm wire.

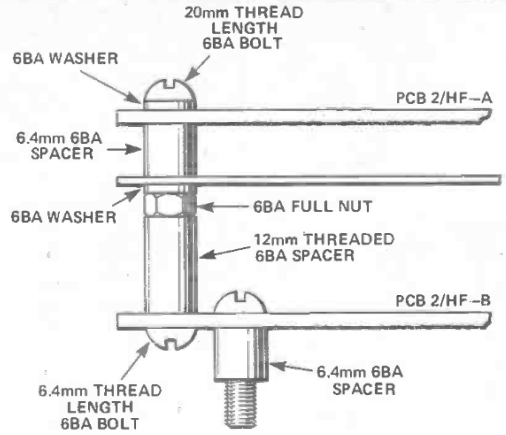
L3,4
For 160mm L3 & L4 are TOKO type 301-KN-0600 (Ambit part No 35-10603)
For 80/40m, L3 & L4 are 301-KN-0800. (Ambit 35-10803)

L5,6 (80 and 40 metres)
Six turns of 18swg (1.25mm) en Cu wire wound on a)16" drill. Self supporting approx 1cm long. Diode tap on L6 1.25 turns from earthy end.

L5,6 (160M)
Five turns as above.



WINDING LAYOUT FOR L1 & 2



Original method of mounting Transverter PCBs.

T1 to T5
All wound using 1cm square ferrite toroid with 0.25mm wire. The wire is passed through the holes in the manner of a conventional transformer.

T1	Eight turns centre tapped
T2	Four turn primary, two turn secondary
T3	As T2
T4	Four turn primary, four turn centre tapped secondary
T5	Four turn primary centre tapped, four turn secon-
L8,9	20 turns 0.56mm en Cu wire on T50-2 core.
L10,11	14 turns en Cu wire on T50-2 core.
L12,12	26 turns 0.56mm en Cu wire om T50-2 core.

(L12 & L13 are mounted directly across the band-s w i t c h .)

Additional Attenuator Pad Details

For 100mW O/P, R1, 2 = 33R, R3 = 22R, all 0.25 watt.
For 300mW o/p rig, R1, 2 = 39R, R3 = 10R, all 0.5 watt.

Note that all the components marked with a * are for just *thv* oscillator, and you will need to order three of each of these (you will also need to make three each of L5 and L6).

PROP: A L BAILEY G3WPO 07918 6149
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WEST SUSSEX BN6 8NS

WPO COMMUNICATIONS

This month. we thought we would give a resume of all our products — if you want more data, please ring, or drop us an s.a.e. (9 x 4" or larger).

2 METRE FM RECEIVER — one of our early and popular kits. costing only £30.65. For this you get a 6 channel monitor receiver with <0.2uV sensitivity, no coils to wind (all pre-wound), 3 filters used and it works off +12v. We have a matching Transmitter to follow soon.

CAPACITY-ADD-ON UNIT — Whats this? A clever design which enables a Digital Frequency Meter to turn into a Digital Capacitance Meter. Measures from 1 pF to lots of uF's. Only two connections needed to your DFM. Complete kit with case & pcb only £14.50. Works off +5 — —15v supply.

VHF PRESCALER — the cheapest kit on the market @ £6.50! Divide by 10 prescaler which will raise the upper limit of your counter to 150MHz plus (typically 200MHz). Small, and comes with case.

ANTENNA MATCHING UNIT — the only kit on the market. Suitable for SWL's or QRP (up to 5 watts). Covers 1.5MHz, and intended for end-fed antennas or G5RV types. Match your aerial to your Rx and get more signals through. Easy to build and complete with case. £25.32.

SIX METER CONVERTER — this one isn't available until December, but to whet your appetite it has a 28MHz i.f., is very sensitive, 20dB gain (variable) and easy to align. All coils prewound. PCB and components mounted on it are £14.00, or complete with diecast box and BNC connectors @ £19.00

LOW COST TRANSCEIVERS — OUR MOST POPULAR kits with hundreds sold. Two versions — the DSB80 for 3.5-3.8MHz, and the DSB160 for 1.8-2.00MHz. Superb receiver (lots of people have been very complimentary about it) with on-board audio amplifier (1 watt). Double sideband (DSB) transmitter and CW with 3 watts or more output. VFO controlled and +12v operation. All built on one pcb and the kit is complete with slow motion drive, but no speaker or mic (crystal). Price for either kit is £37.45. We also have a punched case for the rig @ £21.65 including hardware, and if you want to go all the way, a Digital Readout (ready built and which will fit the case) @ £24.10 including mounting bezel. All three items for £77.00. IDEAL FOR BEGINNERS or QRP enthusiasts. comprehensive instructions are included. DISCOUNTS for Club purchases of 5 or more.

GET ON TO HF WITH OUR TRANSCEIVERS — if you have a 2 metre multimode transceiver, then you can use all its facilities (memories, scan etc) on the HF bands BOTH TRANSMIT AND RECEIVE. We have two versions, one for 160/80 & 40 metres, and the other for 20, 15 & 10 metres. Either version just plugs in to the VHF rig, and the unit converts to 2 metres on receive, and down to HF on transmit. Rf sensing for changeover avoids any mods to your rig. Very sensitive (average is <0.5uV at HF when used with most 2M rigs) and offers 2 watts minimum on Transmit — usually 3 watts (any mode your 2M rig has). compact unit built on 2 printed circuit boards. It also offers direct frequency translation from your VHF rig dial i.e. 14.213=44.213MHz. Kits come complete with the 3 crystals required. Priced at £72.75 for the 20-10M version, and £74.00 for the 160-40M type. (pcb pair only for either version @ £8.50).

PROJECT OMEGA — we have had an overwhelming response to these kits for a High Performance HF Transceiver, as being described in this magazine, and over 100 people are well into constructing it. Its a bit too complex to describe in full, but offers all HF bands in 1MHz segments, and most of the facilities found on far more expensive rigs. Intended for full break-in CW, but SSB option also available. If you would rather know what goes on in a Black Box, then try building this project. We would not suggest that raw beginners attempt building it though! It is not cheap, but you should be proud of the result. Briefly, kits available so far are: Central IF Processing Unit (69.50). Preselector (11.00). Notch Filter (11.20). Active Filter (15.45). Synthesised VFO (104.00 inc crystals). Frequency Display (31.00). QRP PA (21.00). Logic/Antenna Switch (solid state — 15.45) and Low Pass Filters (29.50). To come are the SSB adaptor, 100W PA, FM and AM units, VHF transverter, In-Line SWR bridge, and a ready punched and screened case. Diecast boxes for modules are available separately. PCB's are also available separately for all modules. Full instructions and corrections included. We have a MAILING LIST/NEWSLETTER for this project — ask to be put on it if you are interested.

70CM PREAMP — a low noise, very small preamp which could be built into most rigs if needed. Either built @ £7.90 or a kit @ £5.90.

2 METRE PREAMP — again, very small and low noise. Kits at £4:50 or ready built for £6.50. Ideal for Phase III satellite reception.

All prices include VAT & Post/Packing. Allow 1-4 weeks for delivery if not ex-stock. All kits are complete with components, pcb's (drilled and tinned), wire and comprehensive instructions. Alignment/debug service available. EXPORT — please write for prices. CASH WITH ORDER — MAIL ORDER ONLY. Catalogue and more details on receipt of s.a.e. (large), or phone us.