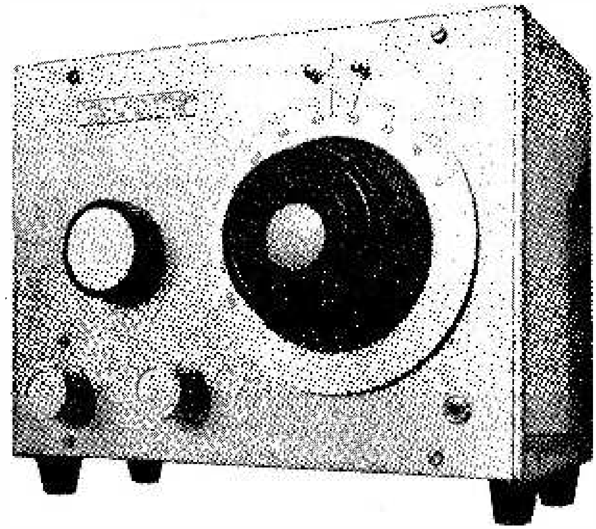
DIRECT CONVERSION RECEIVER for 80 metre SSB/CW

R.F. GRAHAM



AS anyone who has become interested in the reception of single-sideband and c.w. (Morse) signals knows, the usual type of receiver for a.m. (amplitude modulation) reception is not able to resolve these transmission. When a beat frequency oscillator is present in the receiver, s.s.b. and c.w. can be received and modern communications receivers have a b.f.o. Older communications receivers having a b.f.o. allow reception of s.s.b. but with some difficulty unless the operator is experienced.

REQUIREMENTS

To clarify requirements for s.s.b./c.w. reception, Fig. 1A shows the stages of a typical superhet. (1) is the r.f. amplifier, which amplifies signals at the received frequency. (2) is the mixer, with oscillator (3), which may be separate, or combined in a single frequency-changer. Output from this section is at a fixed intermediate frequency, and passes through the i.f. amplifier (4) to the a.m. and product detector circuits (5). With domestic type receivers, this stage is an a.m. detector only where a.m. signals are demodulated, and passed through the audio amplifier (6) to the speaker (7).

Where the receiver is intended also for s.s.b./c.w. reception, (5) incorporates a product detector and a beat frequency oscillator (8) is also provided.

When s.s.b. signals are received, the b.f.o. supplies an unmodulated r.f. input, which replaces the "carrier", suppressed in s.s.b. transmission. This local carrier and the s.s.b. from the i.f. amplifier (4) are combined in such a way as to give an audio output, which passes to the audio amplifier and speaker.

For c.w. reception, the output of the b.f.o. (8) heterodynes with the c.w. coming through the i.f. amplifier (4) to give an audio tone, is amplified and fed to the speaker (7).

Fig. 1B is a direct conversion receiver and its much greater simplicity is obvious. (1) is the r.f. amplifier, tuned to the required signal in the usual way and fed to a product detector (2) which also receives input from the variable frequency oscillator (3) which covers the band upon which reception is wanted the circuit being so designed that an audio output is obtained directly from the product detector (2), which is amplified by stage (4) and routed to the speaker.

When receiving s.s.b. only those s.s.b. frequencies which combine with the v.f.o. frequency to give an audio output are heard. Thus the selectivity of the receiver does not depend upon the r.f. amplifier or product detector signal frequency circuits but upon the selectivity of the audio stages.

Thus apparent selectivity is achieved because unwanted signals are combined with the v.f.o. in stage (2) to give outputs which are not in the audio range of stage (4). To receive c.w. the v.f.o. is tuned to one side of the c.w. carrier to give an audio output from the product detector. This particular circuit is not really suitable for the reception of a.m. signals which require the local carrier to be phase-locked to the a.m. carrier.

The receiver described here will be found to give a very lively performance. As it is assumed that anyone just becoming interested in the reception of amateur s.s.b. and c.w. may not have much in the way of calibration or test equipment, the v.f.o. is designed to use three 1 per cent tolerance capacitors and a coil with adjustable core, so that it is only necessary to set the core to give 80m band coverage. The radio frequency circuits are peaked for best reception.

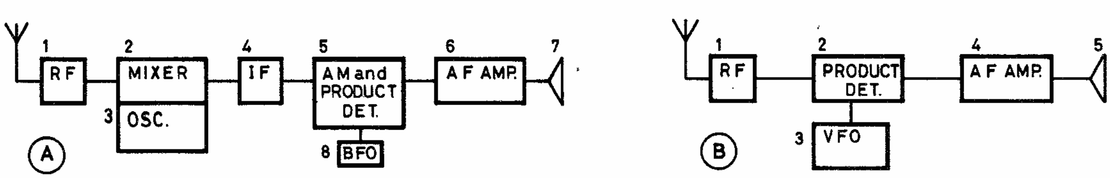
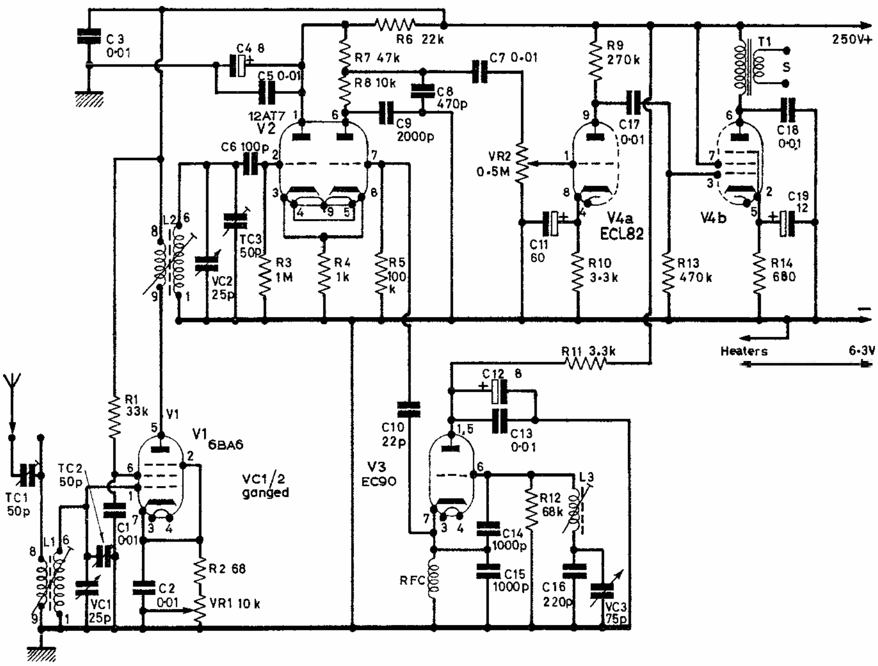
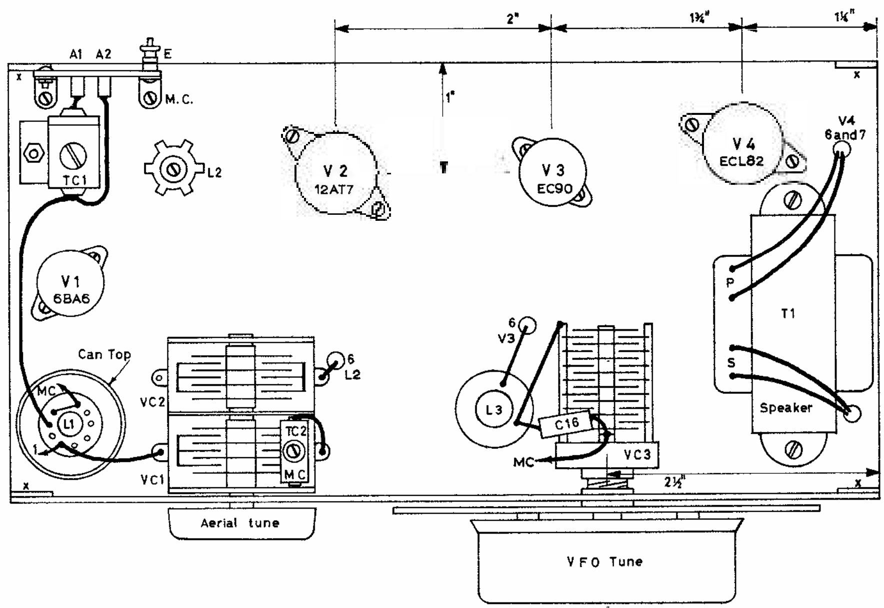


Fig. 1A shows the arrangement of the standard superhet while Fig. 1B illustrates the reduced number of stages required for a direct conversion receiver.



◀ *Fig. 2. The complete circuit of the Direct Conversion Receiver. The main tuning dial (shown in the heading photograph) drives the v.f.o. tuning capacitor VC3.*

▼ *Fig. 3. Layout of the major components on top of the chassis with important dimensions shown.*



CIRCUIT

Fig. 2 is the complete circuit. V1 (6BA6) is the r.f. amplifier, with gain control VR1. L1 and L2 are tuned by VC1/2, which is a small ganged capacitor for the r.f. tuning control.

V2 (12AT7) is the product detector, the wanted signal is present at one control grid and injection from the v.f.o. at the other grid. Audio output from the second anode passes to the 2-stage audio amplifier, VR2 being the volume control.

V3 (EC90) is the v.f.o. covering 3·5-3·8MHz, with a little to spare. VC3 is operated through a ball-drive and although tuning is quite critical it is eased by the narrow band covered by VC3. Coverage is determined by L3 and the three capacitors C14, C15 and C16, so it is only necessary to adjust the core of L3. Because of the large value of these capacitors changes in capacitance around V3 have little effect on its frequency.

C5 and C13 are r.f. by-pass capacitors with C4 and C12 in parallel with them to avoid hum from the h.t. supply and reduce audio feedback effects. The receiver is intended for use with a supply of about 220-250V at 40-50mA with the heaters drawing 1·53A at 6·3V.

CONSTRUCTION

The chassis, Fig. 3, is an 8×4in. "universal chassis" flanged member. This allows a complete case to be assembled by using two further 8×4in. members, top and bottom, with two 6×4in. members for the sides. The panel is 8×6in. and the surface of the chassis is 2in. above the bottom edge of the panel. Cut away the four corners "X" so that the 6×4in. sides fit round the chassis, allowing the box to be screwed together.

Flanges on the members listed are ready punched, and can be secured together with 4BA bolts and nuts while the receiver panel is secured to the top, bottom and side flanges with self-tapping screws. The case back should be of perforated metal, or have rows of ventilation holes.

VC1/2 is bolted to the panel, TC2 being soldered to a tag and VC1 as shown. The aerial coil L1 must be screened with the aluminium can supplied. The can lid is secured to the chassis by the fixing bush of L1. Leads for TC1 and VC1 pass out near the chassis. The lead from pin 6 passes through the chassis to tag 1 of V1. The normal adjusting screw of L1 cannot be reached because of VR1. So the core is removed, a shallow saw-cut is made across the end and it is replaced. Drill a hole in the screening can for this purpose and cut off about one-third of the screwed portion of the can, so that when it is tightly fitted it does not cut into the leads to TC1 and VC1.

TC1 is mounted on a strip of insulating material. A1 and A2 are optional aerial connections.

VC3 is fitted so that its spindle projects $^{9}/_{16}$in. The ball drive is lined up so that it rotates freely and its lug is held with a long bolt with extra nuts. The lead MC from VC3 in Fig. 3 runs to a tag bolted to the chassis near L3.

The primary (P) connections of T1 run through to pins 6 and 7 of V4. Secondary leads (S) go to a small panel jack, for speaker or headphones.

Inductors. With the "Range 3" coils listed, Blue for L1 and Yellow for L2, adjustment of the cores and TC2 and TC3 gives easy coverage of 80m and VC1/2 need not be exactly 25pF.

L3 is 30 turns of 26 s.w.g. enamelled wire, close-wound on a $^{1}/_{2}$in. diameter former with adjustable core. The winding is put near that end of the former furthest from the metal chassis and turns secured with Bostik 1.

Wiring. Wiring and components are shown in Fig. 4. The heater, grid and anode leads are run close to the chassis. Trimmer TC3 has one tag bolted to the chassis, so that it can be adjusted from the rear.

All connections should be reasonably short and direct, and run as shown. VFO wiring, especially to L3, C16 and VC3, is of stout wire, kept as short as possible.

Tag strips are used to support various small components. A 3-cored cable or coloured single flex twisted together, is employed for h.t. positive, 6·3V, and common return connections—red may be used

★ components list

Resistors :

R1	33kΩ 1W	R8	10kΩ
R2	68Ω	R9	270kΩ
R3	1MΩ	R10	3·3 kΩ
R4	1kΩ	R11	3·3kΩ 1W
R5	100kΩ	R12	68kΩ
R6	22kΩ	R13	470kΩ
R7	47kΩ	R14	680Ω

All ½W 10% except as indicated.
VR1 10kΩ potentiometer, wire wound.
VR2 500kΩ potentiometer, log.

Capacitors :

C1	0·01μF 350V disc	C11	60μF 6V
C2	0·01μF 350V disc	C12	8μF 350V
C3	0·01μF 350V disc	C13	0·01μF 350V disc
C4	8μF 350V	C14	1000pF 1% SM
C5	0·01μF 350V disc	C15	1000pF 1% SM
C6	100pF SM	C16	220pF 1% SM
C7	0·01μF 350V	C17	0·01μF 350V
C8	470pF	C18	0·01μF 350V
C9	2000pF	C19	12μF 50V
C10	22pF SM		

VC1 2 x 25pF gang. (Jackson Type 02).
VC3 75pF variable. (Jackson Type C804).
TC1, 2, 3 50pF pre-set trimmers.

Valves :

V1	6BA6 (EF93)	V3	EC90
V2	12AT7	V4	ECL82

Chassis and Case :

2 off 6 x 4in. sides, Type CU41B
2 off 8 x 4in. sides, Type CU56A
1 off 8 x 6in. plate, Type CU178
4 off Case feet, Type Z146
(all from Home Radio)

Miscellaneous :

L1 Denco 'Blue' Range 3 (valve type).
L2 Denco 'Yellow' Range 3 (valve type).
L3, see text.
Ball drive, (Jackson 4489/C) RFC, 2·5mH.
2 off B7G skirted valveholders and screens.
2 off B9A skirted valveholders and 1 screen.
Knobs, tag-strips, output jack socket.
T1, output transformer about 60:1 to carry 40mA.

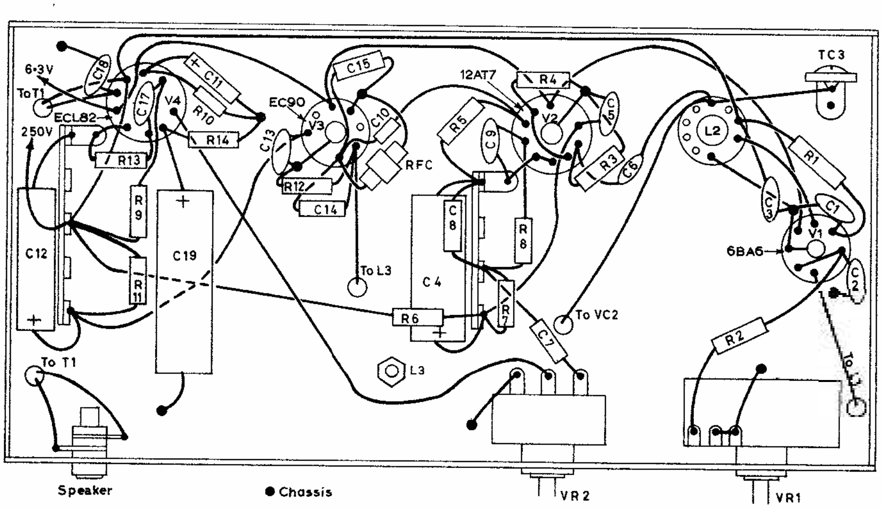
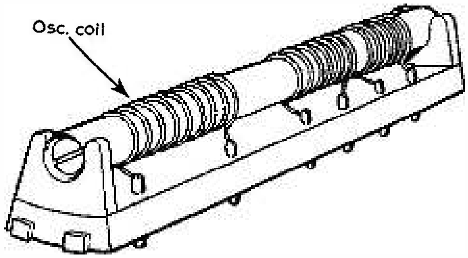


Fig. 4. Wiring guide for components underneath the chassis. Wiring around the v.f.o. valve V3 should be kept as short as possible to improve stability.

continued on page 314

found among them. The BBC station on channel 2 operates at 48·25MHz (sound). The sound i.f. for the set concerned, and which is now common for most modern t.v. receivers, is 38·15MHz. This means that the frequency of the oscillator coil was 86·4MHz. As the Rediffusion frequency was 85·725MHz., this was near enough to be within the tuning range of the coil.



Appearance of typical coil biscuit. Oscillator coil is usually the largest and contains a tuning slug.

Accordingly it was connected in series with the aerial feeder, and the interference was completely eliminated, without the need even to tune the coil.

Most t.v. workshops have old tuners knocking around, so a call at the local radio dealers could well produce a coil suitable for the purpose, should similar interference be experienced. The chart shows the frequencies of the main BBC band I television channels, and assuming a 38·15MHz sound i.f., the actual tuning range of an oscillator-coil biscuit. It will be noted that channels 3 and 4 coils will tune to frequencies within the v.h.f. radio band, so will be no use as wavetraps for radiotelephone frequencies as these are all outside this band. Channel 5 is just at the start of the medium radiotelephone band, and could easily tune to some of its lower frequencies.

TELEVISION CHANNEL	SOUND FREQUENCY	OSCILLATOR COIL FREQUENCY
1	41·5MHz	79·65MHz
2	48·25MHz	86·40MHz
3	53·25MHz	91·40MHz
4	58·25MHz	96·4MHz
5	63·25MHz	101·4MHz

Remember, too, that the range of the coil can be extended by the fitting of a different type of tuning slug. A brass slug will decrease the inductance, hence increase the frequency, while an iron-dust slug will increase inductance and decrease the frequency. If the range is still outside the interfering frequency, a couple of turns taken off the coil will push it higher, or a small capacitor of a few pF. will bring it lower, if wired in parallel. The biscuit may have two or three coils on the same former, the oscillator is the one nearest the open end and which has the tuning slug. The other coils are coupling coils and should be ignored. ■

Direct Conversion Receiver *continued from page 300*

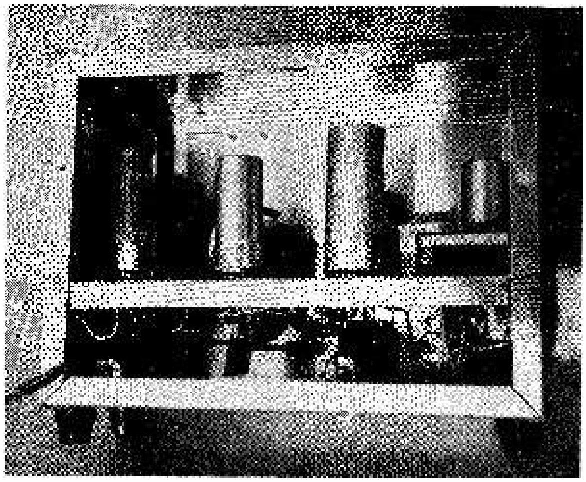
for h.t. positive, black for chassis and some other colour for the 6·3V heater supply.

ALIGNMENT

Set TC2 and TC3 about half closed and tune in any signal, with VC3 nearly open, and adjust TC2 and VC1/2 for best volume. Find a signal with VC3 nearly fully closed and peak VC1/2 for best results, then rotate the core of L1 for maximum volume.

If necessary, the core of L3 is rotated to obtain suitable band coverage with VC3. The coverage of VC3 can be checked by placing the aerial lead of a calibrated receiver near L3 and listening for the carrier produced by V3.

At all times the r.f. gain control VC1/2 is adjusted as needed for best reception even though VR1 may have to be turned back with strong signals. The cores of L1 and L2 are adjusted around 3·5MHz and the trimmers TC2 and TC3 are set near 3·8MHz. TC2 may also need re-adjustment after changing the aerial. These circuits are merely peaked up for



Rear view of the finished receiver.

best volume and are not too critical. The extent of rotation of this control needed to tune from 3·8-3·5MHz can be increased by screwing down TC2 and TC3 and unscrewing the cores of L1 and L2 to compensate.

Power Supply. Any supply giving about the outputs mentioned should be satisfactory. If a power pack has to be made, one with full-wave rectification is most suitable. This may employ a 250/0/250V 60mA, 6·3V (1·5A or 2A) transformer, with smoothing by means of two 16μF 350V capacitors and a 60mA choke.

Speaker and Phones. A reasonably large 2/3 ohm speaker is most suitable with a cabinet or baffle.

When phones are plugged in, the mis-match can generally be disregarded. Inexpensive surplus 600 ohm phones will be found to work well. It would be possible to use an external matching transformer for high impedance phones or to feed them through reliable isolating capacitors from V4 anode.

Aerials. Numerous transmissions were received with a short indoor aerial but changing to an outdoor wire tuned as for transmission purposes naturally gave a great increase in range and volume. In practice, any end-connected wire can be taken to A1 or A2 while the A2 connection is most suitable for short aerials. ■