DIRECT CONVERSION RECEIVER for 80 metre SSB/CW

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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.

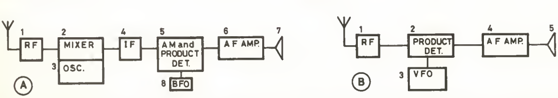
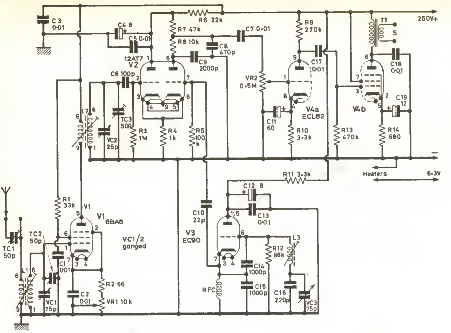
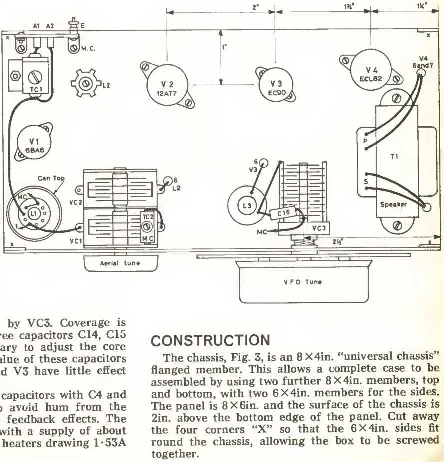


Fig. 1A shows the arrangement of the standard superhet while Fig. 1B illustrates the reduced number of stages required for a direct conversion receiver.



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

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

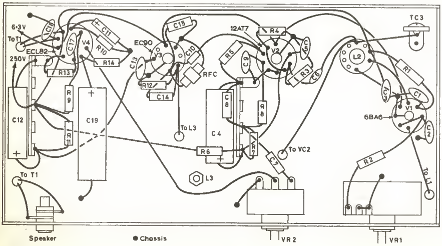


Fig. 4. Wiring guide for components underneath the chassis. Wiring around the v.f.o. valve V3 should be kept as short as possible to improve stability.

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IT is apparent that there is a good deal of interest in small transmitters for the low frequency bands. There are several reasons for this. Such equipment can be constructed at small cost, with easily obtained components, and only a modest power pack is needed to reach the maximum allowed power input of 10 watts in the case of the 160m band. Many newly licensed amateurs start with such equipment, and when using this power on the low frequency bands the chances of interference to TV are minimal.

The transmitter described here is primarily for 160m working, but will be found to be a very practical piece of equipment on 80m also, coverage of this second band being easily arranged. In addition, an end-fed aerial is often used for 160m, which will also generally perform well on 80m. The 80m band also offers greatly improved range over 160m and contacts during daylight, so it is well worth having.

to switch on the transmitter and to mute the receiver or speaker.

No external items of this kind are necessary with this transmitter, as the required switching is incorporated. This gives complete change-over from "Receive" to "Transmit" with single switch control.

The switch has four poles, section S1 switching the aerial to the tank coil L4 at T (Transmit), but transferring the aerial to the receiver at R (Receive). Section S2 short-circuits the aerial feed to the receiver during transmission, to minimise r.f. leaking through to the receiver. S3 is in series with one speaker lead, and so silences the speaker during transmission.

The transmitter power circuit is controlled by S4, which applies h.t. to all stages on transmit. S5 is a separate two-way switch, which allows h.t. to be put on V1 and V2 only. This allows the v.f.o. to be tuned to any wanted frequency, and be "netted"