IMPROVING THE EDDYSTONE EC-10 RECEIVER

BETTER OSCILLATOR STABILITY —ADDING A PRODUCT DETECTOR —MUCH IMPROVED TUNING FOR SSB AND RTTY

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Our contributor is well known for his approach to the practique of Amateur Radio and over the years has offered in our pages many valuable and interesting ideas for the furtherance of the art. Here he discusses the simple matter of desirable modifications to one of his own receivers, of a type widely used in amateur circles.— Editor.

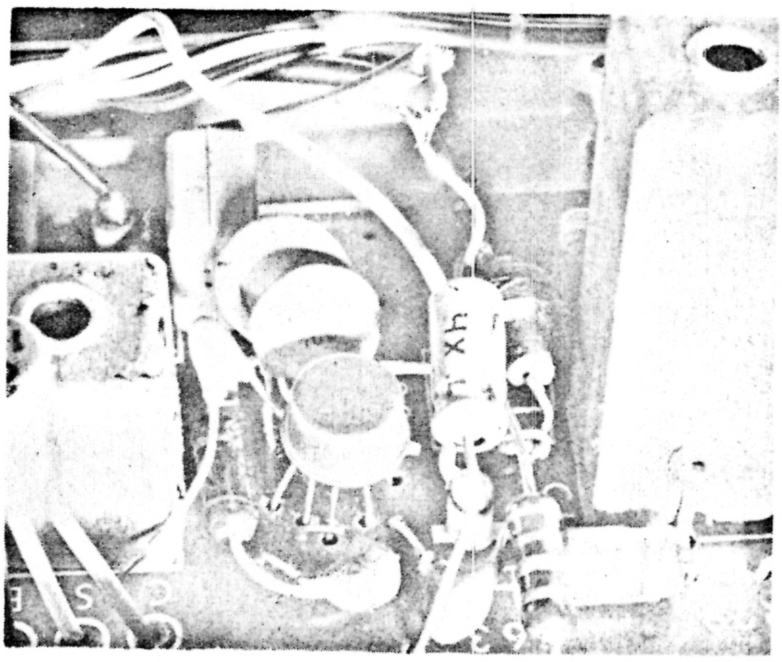
THE Eddystone EC-10 was one of the earliest battery-operated transistor receivers the engineering and coverage of which put it beyond a purely domestic market. It is widely used by amateurs in mobile and portable applications; one imagines that it is evenly more widely used throughout the world for general reception of short wave broadcasting.

However, although it has the right knobs and labels such as BFO marked USB and LSB, its performance alongside its later brethren leaves much to be desired. If the BFO is used, it is immediately apparent that drift is severe and that a tap on the cabinet sets off a noise like a Chinese gong. The reception of SSB is only just possible on strong signals and then is so difficult to hold that it is hardly worth the effort. On the credit side, it must be said that the writer has used the EC-10 as the heart of his weather satellite station (1), and that in this capacity it has given good service. The shortcomings became really apparent when trying to resolve RTTY FSK on the HF bands. It was decided to attempt to improve the stability and, if this was successful, to fit a product detector.

Improving Frequency Stability

Inspection of the interior reveals a beautifully constructed piece of equipment, with its excellent slow-motion flywheel drive. However, the weakness in the region of the local oscillator makes itself conspicuous whenever anything in the area is touched. The faults come under two headings, mechanical and electrical. The first is responsible for the Chinese gong and the second for drift. A whole lot of mods. were tried and, although it is difficult to assess the effects of each, the overall effect has been a marked improvement

On the mechanical side, the tuning capacitor is rubber mounted and separate from the main PC board, which is integral with the band switches and supports the coils. Any movement of the three-gang capacitor can alter (as it is a large earth body) the capacity to ground of sensitive points on the board, such as the collector of the local oscillator. Points on the PC board associated with the LO appear on the top side, close to the tuning capacitor and although they are screened sideways, as it were, by the earth section of the board, the large earth bulk vibrating above could be responsible for frequency modulation. Also, the leads between the tuning capacitor and the board are part of the tuned circuit. Prodding anyone of the parallel braid leads



The product detector lying neatly between the BFO (left) and the last IF stage. C5 leading to the BFO collector is seen over the resistor R3. The larger discs behind are C4 and C6, while the electrolitic to the right of the IC is C7.

used to common the capacitor earth with the board earth alters substantially the LO frequency. These leads, even in parallel, have some inductance and this is in series with the tuned circuit.

Attempts to improve the situation were twofold: First, the live lead to the LO section of the gang and all the earth braid leads were shortened as much as possible; secondly, a short piece of 18g. was soldered to the earth of the PC board in the vicinity of a very sensitive point under which the varactor fine-tune diode is placed. The wire is bent to lie between this point and the tuning capacitor to screen it off from the latter.

On the underside of the board it was discovered, by prodding with a trim tool, that two thin stranded p.v.c. leads were highly touchy. These run from the front two wafers of the band switch to the LO collector and the LO gang of the tuning capacitor respectively. They were replaced with 18g. tinned copper suitably sleeved, running, for convenience and shortness, on opposite sides of the pair of wafers. It is the impression that this simple mod. produced a greater improvement than all the others suggested here put together!

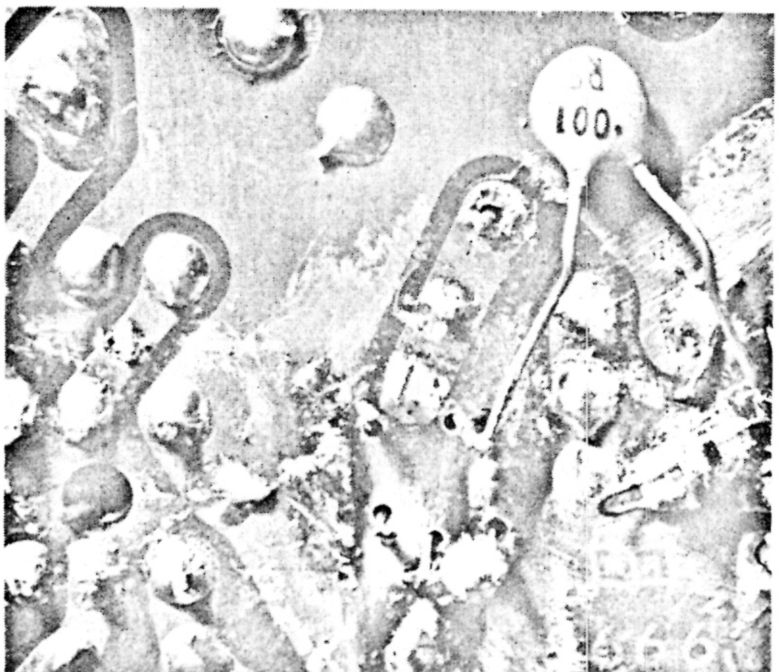
The drift is severe in the first ten minutes or so, but if one is patient it does eventually settle down to tolerable levels. This drift is surprising as in general an all-solid-state receiver does not have thermal problems. (It may be that in this case the germanium OC171 is the culprit). As the LO warms up, leakage currents vary and the collector base capacitance, acting as a varactor diode in parallel with the LO tuned circuit, does the rest. There is no proof of this, but with time one would like to try an FET or a silicon bipolar in this position. (The EC-10 used the OC171 for all positions ahead of the audio, undoubtedly a wise design if one considers such factors as servicing). An alternative approach might be to have an external VFO for the amateur bands using the existing local oscillator rewired as a harmonic amplifier.

To maintain a sensible performance over a wide range of battery voltage a 6v. zener is used to stabilise the early stages and the BFO. As the load varies, depending on the use of the BFO and on varying drain from AGC controlled stages, further stabilisation of the supply line to the LO has been contrived. This has been achieved by filing a break in the line and putting a dropping resistor in series, together with a 5v. zener across the LO. Again, it is impossible to quote the consequences without time-consuming comparisons having to be carried out. Suffice it to say the modified EC-10 now behaves so much better in terms of LO frequency stability, compared directly with a second unmodified EC-10, that it seemed worth fitting a product detector.

The Product Detector

The product detector block is shown in Fig. 1. An IC containing all the necessary transistors is now the obvious way of filling in the block(2). *Birketts* have been advertising untested double balanced modulators for around 30p. Two were obtained—the first one proved a dud and was replaced by return. For the wealthy, there is the full spec. Plessey SL640 at £2·50 to £3·50.

The modification has proved relatively simple, the circuit showing all the changes involved is enclosed within the dotted lines in Fig. 2. The double balanced modulator IC is designed for a positive 6v. supply line. R2 drops 3v. from the negative 9v. line to lead 8, the earthy end of the IC, and is decoupled to ground by



The printed circuit board after fitting the product detector. The scratch marks show where the lacquer was sandpapered away, preparatory to soldering. The disc ceramic is C1. The diode on the right should normally be inside the adjacent IF transformer. At least one incipient dry joint is embarrassingly conspicuous. The layout is, of course, that shown in Fig. 3.

Table of Values

Fig. 2. Product detector for EC-10

C1	= ·001 μF	R2	= 300 ohms
C2, C3, C5	= ·01 μF	R3	= 2,200 ohms
C4, C6	= 0·1 μF	IC	= Double bal. modulator, *Birkett* or *Plessey* SL640C
C7, C8	= 1 μF		
R1	= 4,700 ohms		

NOTE: All capacitors should be of the disc ceramic type, except C7, C8, which are 12v. electrolytic.

C6. The IC is designed for single-ended inputs, the other sides of the balanced inputs being brought out through lead 2. This point is tied to lead 8 *via* C4. The audio is brought out to lead 5 and, after an emitter follower, lead 6. C3 filters off the high frequency components from the audio; R3 is the emitter load. Lead 4, the positive supply to the IC, is connected directly to ground.

The BFO injection is obtained by connecting lead 3 on the IC *via* C5 to the collector of the BFO transistor. This provides about 200 mV of injection. The BF coil will need retrimming to recalibrate the zero-beat mark on the BFO control. The original printed circuit lead carrying the BFO to an early IF stage is interrupted by filing a break in the lead.

The signal is drawn from the last IF transformer. The output is matched by C1 and C2 to the IC input lead 7. It should be noted that the diode detector is situated inside the IF transformer screen and is kept intact to leave AGC arrangements unmodified and the AM facility available. There is an unused pin on the transformer which gives access to the IF before the diode. C1 is accordingly connected to this pin. A slight retrim of the coil will be necessary to peak up the output.

In the unmodified EC-10 the AF gain control potentiometer serves as diode load. To retain the AM and AGC, the resistor R1 was fitted as a DC load to the diode. The AF signal to the gain control can now be selected by a change over switch from C7 for CW, FSK and SSB, or from C8 for AM reception.

Constructional Work

On the EC-10 the complete IF/AF strip is held on the main chassis by four screws. The cabling is such that the strip can be turned through a right angle after removing the screws; holes are provided for refixing the strip to the main chassis with two screws. In this posture one

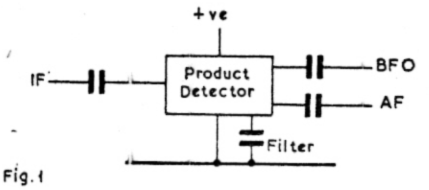


Fig. 1

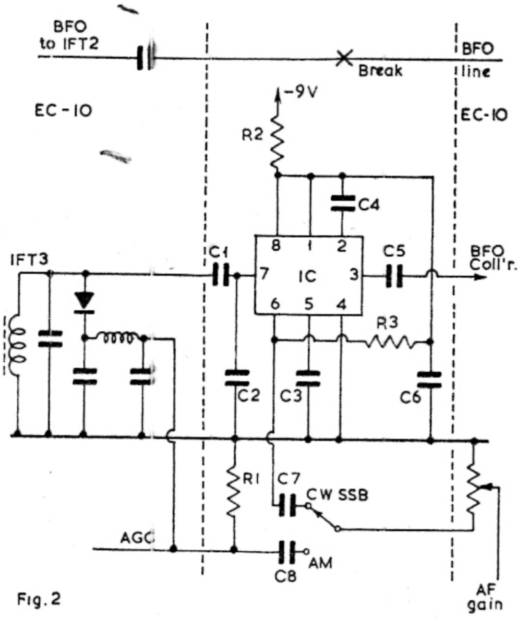


Fig. 2

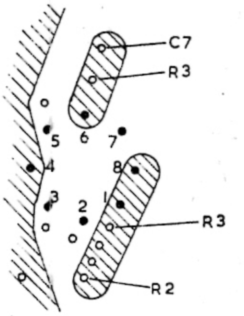


Fig. 3

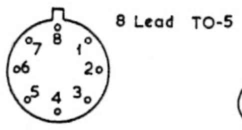


Fig. 4

Fig. 1. The basic external connections to a product detector.

Fig. 2. Circuit used to provide the EC-10 with a product detector. All wiring and components between the dotted lines new; all outside the dotted lines constitute original circuitry.

Fig. 3. An outline sketch of the EC-10 PC board between the last IF transformer and the BFO, showing how it can be adapted to take the product detector. The shaded portion on the left is earth-copper. The other shaded portions are uncommitted copper strips on the board, now put to use. Most of the holes do not exist and have to be made with a fine drill. The ring of eight holes for the IC is shown in black; the numbers correspond with the leads from the TO-5 IC package. For clarity, most wiring and component detail has been omitted; the information is contained in Fig. 2.

Fig. 4. The pin numbering on the TO-5 package of the double balanced modulator IC.

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has complete accessibility for servicing, aligning and modifying the receiver

There is plenty of room for the product detector in its natural place, between the last IF stage and the BFO. (The original designers may have foreseen the possibility of developments in this area and left room). In the centre of this part of the PC board are two unused copper strips surrounded by earthed copper screening. Fig. 3 shows how this has been exploited. Eight holes are drilled to take the IC. A small drill, about twice the diameter of the wire leads on the IC, held in a watch-maker's hand chuck, enables this to be done in a few minutes. Further holes are then drilled in the vicinity to take the circuitry of Fig. 2. For example, the hole adjacent to lead 2 takes the wire from C4. They are joined by soldering fairly close to the board. The other end of C4 goes to the copper to which the leads 1 and 8 from the IC are soldered and also R2, R3 and C6.

The IC obviously has to be threaded through the holes before any soldering can be done. This proves simple, provided the leads are splayed out and then bent individually towards the right hole. The leads should be held at the roots with tweezers before bending.

The change over switch, AM to CW/SSB, is mounted at the rear of the main chassis. An extra screened lead from C7 is run alongside the existing screened lead bringing the AF from the diode. The components C8 and R1 can be located around the switch. The BFO switch on the front panel could be altered for this purpose; it might also be adapted to switch the 9v. line to the product detector instead of the stabilised line to the BFO. The BFO could then be supplied, using a separate zener, from this 9v., thus doing it all on the one front-panel switch; BFO "On" for CW, SSB and FSK and BFO "Off" for AM.

In operation the improvement afforded by the product detector is dramatic. FSK on 20m. can be resolved and, using the EC-10 as a tuned 10m. IF for the converter, two-metre SSB is "readability five."

Reference:

(1) SWM Feb. '71 page 731, and March '71, page 19.

(2) SWM March '72, page 31, Fig. 3.

POCKET CRYSTAL CHECKER

TESTING FOR ACTIVITY

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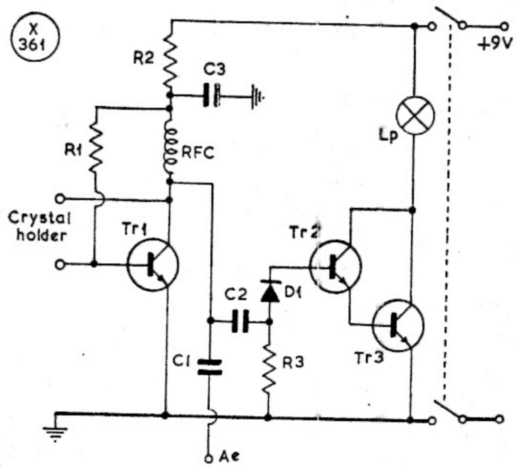
One cannot always be sure that second-hand crystals have been treated with the respect they deserve. Accordingly the test unit described was built by the author prior to a prowl around radio surplus stores for 8, 12 and 35 MHz crystals suitable for 2-metre transmitters and converters. It has also proved useful as a 1 MHz "pipper", and for finding out where, on 2 metres, the twelfth harmonic of a 12 MHz crystal comes. (Not always 12 x 12, as the reader will appreciate.)

The circuit is shown in the diagram. When a good crystal is plugged into the holder, between the base and collector of Tr1, the transistor will oscillate. Part of the RF is rectified by D1 to produce a positive voltage at Tr2 This causes current to flow through the compounded BC184's Tr2 and Tr3, which act effectively as one "super alpha" transistor, causing the bulb to glow. If the crystal is inactive the bulb will not light.

To check that the unit, when built, is working, a crystal of known quality is needed. Alternatively an LC combination can be plugged in instead of a crystal; suitable values are a small RF choke or MW coil with a capacitor of about 30 pF in series.

A terminal is fitted to Tr1 collector through ·002 μF for use as a "pipper". When the aerial coil of a receiver is connected to the terminal, D1 will be starved of RF and Tr2, Tr3 will turn off. This conserves the battery as the drain should then drop from 55 mA to about 500 μA.

The unit can be build into a 2oz. tobacco tin, or smaller if desired; but the tobacco tin does have the advantages of ruggedness, a solderable chassis, and easy



Circuit of the pocket crystal checker, for which values can be: C1, .002 μF; C2, 0047 μF; C3, .02 μF; R1, 1.5 meg.; R2, 9.1K; R3, 470K; RFC, 10 mH; Tr1, BF180; Tr2, Tr3, BC184; D1, OA81; Lp, 6v. 60 mA bulb.

availability. It is also truly pocket-size and a PP3 battery on its side fits into it snugly. An octal base was used for accommodating crystals. An FT241 fits into pins 3 and 5 and the holders at pins 2 and 8 have been squeezed together to accommodate HC/6U types. Pins 3 and 7 will accommodate ¾in. crystals.

The transistor and its circuitry are soldered directly to the octal holder and the other components fit on a 6-way tag strip. As the bulb is under-run and infrequently used, a holder for it was dispensed with and the bulb connected directly to the switch.