THE EDDYSTONE EC10 Mark II
by IAN BATTY

Description

The EC10 was the first all-transistor shortwave radio made by the famous Eddystone company.

The EC10 – Front View

It's a general-coverage, single-conversion superhet, operating from batteries or a plug-in mains supply which replaces the battery compartment.

Coverage is 550 kHz to 30 MHz:
Band 1 18 MHz – 30 MHz
Band 2 8.5 MHz – 18 MHz,
Band 3 3.5 MHz – 8.5 MHz,
Band 4 1.5 MHz – 3.5 MHz,
Band 5 550 kHz – 1.5 MHz.

The IF is 465 kHz. The Mark I uses ten transistors (all germanium) and three diodes. The Mark II adds a variable-capacitance diode (varicap) to the Local Oscillator section to provide a fine tuning control

All models feature an RF gain control and a BFO for use with CW or SSB signals. There is also a switchable audio filter centred on 1 kHz to improve clarity on CW signals. Audio output is some 800 mW into the internal speaker. An external speaker can be used, and there is a high-impedance audio output for connection to an external audio amplifier.

The set operates from a variety of antennas: unbalanced, balanced or a short telescopic rod. Input impedance is 75 ohms on Bands 1 – 4 and 400 ohms on Band 5. Sensitivity is quoted as better than 5 microvolts on Bands 5 – 2, better than 15 microvolts on Band 1.

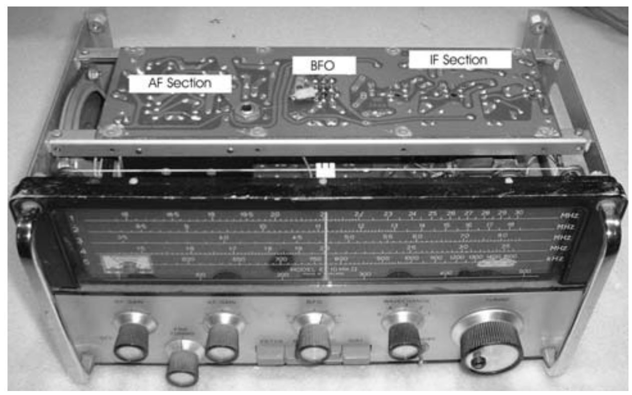
The Mark II features a signal strength meter useful for tuning. The Fine Tuning control, which operates a varicap in the local oscillator section, is essential when tuning signals in the highest band.

Construction

The set is well-constructed, with the traditional "flywheel" on the tuning knob. This allows the highly-geared tuning system to spin rapidly from end to end across the selected band.

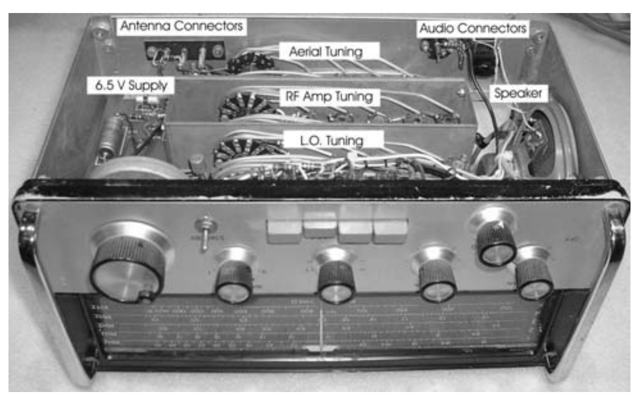
The chassis and front panel withdraw easily from the case, and internal construction is sound. Most electronic components are carried on two printed-circuit boards: RF and IF/Audio.

The IF/Audio board is mounted circuit side up on top, meaning that measurements are easily made. Unfortunately, two of the IF transformers use double slugs, so the IF/Audio board must be unscrewed and "sat out" of the set to allow access to the "inside" slugs for a complete alignment.



EC10 – Top View

The RF board is mounted component-side up on the bottom of the set, allowing easy access to all coils and trimmers during alignment. Unfortunately, this places the circuit side of the board on the inside of the set, making measurements more difficult.



EC10 – Bottom View

Circuit description

The EC10 is a conventional single-conversion superhet with an IF of 465 kHz. It uses a grounded-base RF amplifier. This has the advantage of much less inherent feedback, thus allowing more gain without neutralisation. It also allows the OC171 transistor to give maximum useful voltage gain, as its transition frequency (at which it gives unity gain in common-emitter connection) is only 70 MHz. Some FM receivers of the day used the OC171 in grounded-base up to a maximum of 108 MHz, showing the usefulness of the grounded-base configuration.

The set uses separate mixer and Local Oscillator transistors (also OC171s), and quotes drift figures of better than one part in 10^4 per degree C. As mentioned earlier, the Mark II provides fine tuning by a varicap in the oscillator circuit. Although this works well, its effect is much more pronounced on the higher bands. It gives only some +/- 800 Hz shift at 1 MHz on the broadcast band, but much more on Band 1 where it is most needed: some +/- 20 kHz shift at 24 MHz.

The entire RF section operates from a Zener-stabilised supply of 6.5 volts, to reduce tuning drift due to mains variations or battery ageing.

The two-stage IF amplifier uses OC171s in conventional common-emitter circuits. The diode detector supplies audio to the AF states, and AGC to the first IF and the RF amplifier. For added gain control the set uses the common technique of a diode that, on progressive AGC action, partly shunts an IF transformer primary – the mixer's collector winding in this case. An RF gain control varies the bias on the first IF amplifier, and can work in conjunction with the AGC circuit. The set allows the AGC to be turned off, which is desirable when receiving SSB signals.

The AF stages use a preamplifier, driver and Class B push-pull output, with transformer coupling in and out of the output stage. The AF preamplifier has an audio tuned circuit consisting of a ferrite-cored inductor and fixed capacitor. This circuit can be switched in to form a narrow-bandpass filter at about 1 kHz, and is useful for clarifying CW signals against background noise.

The BFO operates at around 465 kHz, and can be tuned above or below the signal so that either Upper or Lower Sidebands can be resolved in SSB reception. It is injected at the collector winding of the first IF amplifier.

Internal dial lights are switched, allowing power conservation during battery operation.

Mains power is switched by the RF gain control. A separate Standby switch interrupts the DC power supply (on my set), allowing the set to be quietened without altering any control settings. The Mk II circuit shows the Standby switch muting the IF section by shorting out the bias on the first IF amplifier.

History and repairs.

I bought my EC10 at auction back in the 1990s. On examination, it was pretty well "dead" in the RF section, though there was noise in the speaker.

Examination showed that the aerial coil switch had suffered a broken wafer. I unsoldered all the connections, applied a dab of superglue to each side, replaced it and rewired it.

I could now get signals, but the sensitivity was still very poor. I aligned and calibrated the RF stages, but gain was still low. On examination, the IF showed a "double hump", indicating severe misalignment. On correctly aligning the IF, the gain came up to the specified sensitivity of better than 5 microvolts on Bands 5 to 2, and better than 15 microvolts on Band 1.

There are two sizes of coil slugs in the EC10: those in the RF section with hexagonal centre holes, and those in the IF transformers with top and bottom screwdriver slots. Both types were either loose, or jammed. I carefully freed all the jammed ones, but wondered what to do so that I could adjust them to position and not have them move.

I'd long ago given up on wax, "liquid paper", or nail polish, as I hope we all have. My "magic ingredient" is teflon "plumber's tape", which I also use in my plumbing and irrigation work. With the RF coils' large threads, I found I needed to fold a length of tape over itself a few times to make the slugs fit snugly. I used a single wrap of tape for the finer-thread IF coils, as you can see in the photo.

Slug Wrapped In Tape, Ready to Adjust

I used the set for a while, and two subsequent faults appeared.

First, the BFO (needed for CW and SSB reception) stopped working. The oscillator used an OC171. This transistor had presumably succumbed to the dreaded “whiskers”, where minute crystals grow within the device and eventually stop it from working. Since the BFO operated at around 465 kHz, the OC171 was considerably under-rated. I had no spares, but an OC400 (with a lower cutoff frequency) operated just fine. I did need to adjust the circuit capacitance to bring the BFO back to the correct frequency, but it calibrated up correctly.

See the references for more on “whiskers”.

The second fault appeared with massive amounts of breakthrough of the local FM band stations into the broadcast band. I live less than 10 km from Mount Alexander, which hosts most of the FM radio and TV transmitters for the Central Highlands and Goldfields.

On examination, a wire connecting to the broadcast (Band 5) antenna coil had come adrift, open-circuiting the tuning for this stage. Given the amounts of signal flooding in on the FM band, it appears that the front end was rectifying the FM signals and allowing them to cross-modulate into the IF.

A curious thing…

The alignment guide states that injecting a signal at the input to the IF strip needs only about 4 microvolts to give 50 milliwatts audio output if the alignment is correct. This implies that the entire RF section has near-unity gain. This mirrors the advice for an Eddystone VHF/UHF set, the 770U which I’m currently working on. It appears that Eddystone do regard the RF section as a “preselector”, and rely on the IF/AF sections to provide the major part of a set’s gain.

Safety Warning

I found several manufacturing faults that anyone working on these sets should be aware of.

I have found English-manufactured equipment to have dangerous mains wiring generally.

The EC10 has a plug-in power supply, with a 4-pole plug connecting the supply to the main chassis. Two wires carry the 9 volts DC supply, the others carry 240 V mains to the on-off switch in the RF gain control. The wiring is of lightweight gauge, and its connections to the plug are NOT insulated. I can vouch for this, having found out by almost throwing the set off the bench in reaction to a nasty 240 V shock! The connections to the back of the switch are, similarly, NOT insulated.

Two yellow paper dots *should* remind the user of how to connect the plug, if they have not fallen off. Although the plug is mechanically polarised, it may be possible to reverse the plug, transposing the 9 VDC and the 240 V mains. I have not experimented with this possibility…

Additionally, the mains lead coming out of the power supply simply passes through a grommet, with no proper cord anchor.

THAT Mains Plug

I *strongly* recommend that you examine any equipment – of any manufacture, but *especially* English – for safety and proper insulation of mains connections.

In use

For the first-generation unit that it is, the EC10 works well. It is a bit noisy, and worse on the top band. While that’s probably to be expected, given that the RF amp and mixer are getting towards their limits, it does meet and exceed its specifications. Indeed, the spec quotes a sensitivity on the top band of “better than 15 microvolts for 15 dB s/n”. On test, I found I could easily get 20 dB s/n at settings of 4 microvolts - or less - all the way from 18 to 30 MHz.

On all other bands, the set was able to consistently give better than 20 dB s/n at better than its specification of 4 microvolts.

It’s a fact that MF and HF suffer from large amounts of atmospheric (QRN) and industrial (QRM) noise. Given that, the benchmark figure of 1 microvolt, which communications set designers regarded as the “gold” standard, is somewhat academic due to the high levels of ambient noise we commonly encounter.

Tuning is easy and accurate, though I do wish manufacturers would use tuning gangs with a characteristic closer to straight-line frequency. This set, like most others, suffers from crowding towards the top end of each band. Roger Lapthorne

(G3XBM) notes that the entire 10 metre band (28.000 MHz - 29.700 MHz) is only about 10 mm wide.

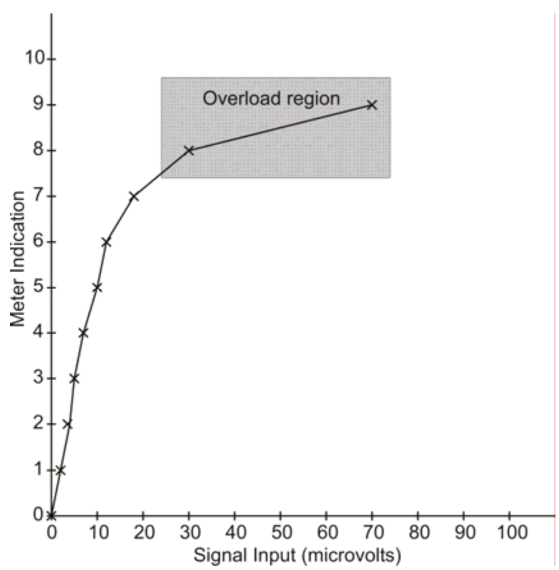
The fine tuning control does help at the higher end of each band, and especially at the top end of Band 1 (18 - 30 MHz).

The BFO works fine, and it's possible to resolve SSB broadcasts easily.

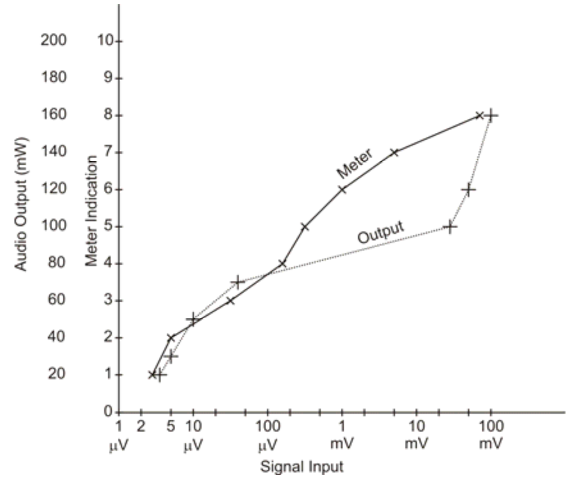
This set, a Mark II, has a signal strength meter. It appears like a great idea, but the meter itself measures the detector's DC output. With the AGC on, it's effectively measuring the AGC voltage, and this gives only a partly logarithmic response. It gives a compressed indication on signals of any strength, showing a very broad tuning peak. With the AGC off, the meter's indication loosely tracks the input signal's strength, so it reaches the "8" mark at about 35 microvolts. After this point, the signal becomes distorted, meaning that either the RF gain must be reduced, or the AGC switched in. For SSB reception, you would commonly have the AGC turned off, and use the RF gain control to adjust the set's gain.

The AGC is effective, allowing less than 12 dB rise in output for an input rise of 80 dB.

Note that the first of the following charts shows a *linear* scale for signal input voltage, the second shows a *logarithmic* scale for signal input voltage.



Tuning Meter Response – AGC Off



Tuning Meter and Audio Output – AGC On

Although the meter is not calibrated in "S" (signal strength) terms, its semi-logarithmic response does approximate that of an "S" meter. A bit more engineering, plus a calibrated "S" scale, would have added to the set's useability and its general prestige.

The audio quality is a bit "ragged". Chris Arthur (VK3JEG, www.qsl.net/vk3jeg) has suggested it's a design problem in the audio output stage. On observation, I noticed very little Class B crossover distortion. The set has a feedback loop in the audio amplifier, and the AF response seems acceptable. But I *did* notice a greater amplitude in the audio's positive half-cycles than the negative, and this appears to be a fault in the detector stage.

Improvements

Chris Arthur has tried replacing a "dead" OC171 RF amplifier with a silicon 2N2907. This improves performance somewhat, but I take the purist's line that a set should be left as original unless a component fails and there is no genuine replacement. Chris did indeed restore the original device when a spare became available.

I probably will look at the detector in detail, as the audio distortion is noticeable and annoying.

And I sure will put heatshrink over those deadly mains connections (!).

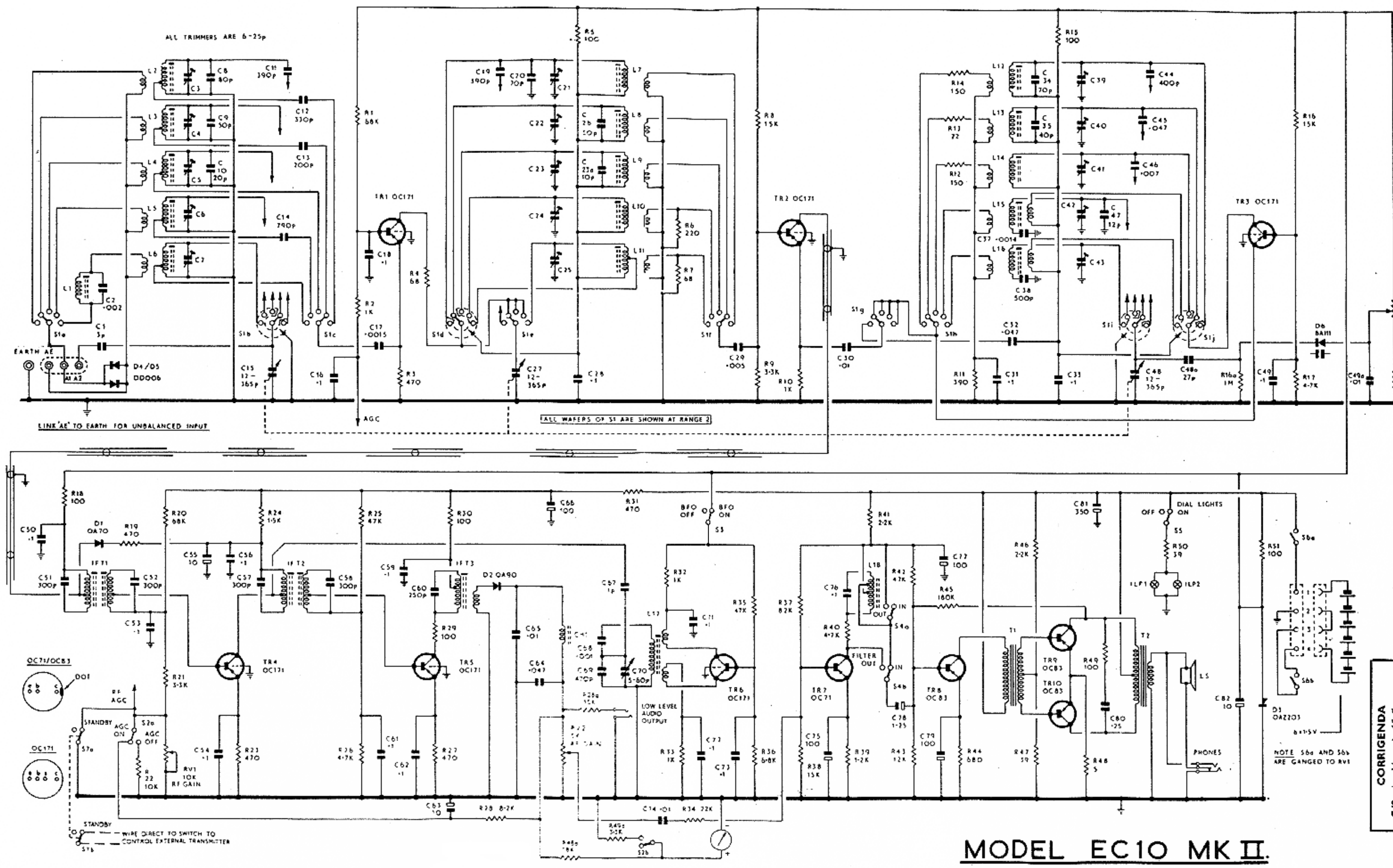
References

About the EC10

http://www.qsl.net/vk3jeg
http://homepage.ntlworld.com/lapthorn/index.htm
http://www.eddystoneusergroup.org.uk/

About germanium "whiskers" (and *much* more)

http://www.vintage-radio.com/index.html



MODEL EC10 MK II.

CORRIGENDA
C48a should read: 15pF
R23 & R27 should read: 330 Ω

Appendix: Loosening jammed slugs

1. Does the slug need alignment? If not, save the trouble and possible time involved. Tony Maher uses a “Magic Wand”, a piece of heatshrink maybe 10 cm long with a ferrite slug on one end, and a brass slug in the other.
   To test, slide the ferrite end into the coil can. If the signal improves, the coil needs *more* inductance to align correctly. If that makes things worse, try sliding the brass end into the coil can. If the signal improves, the coil needs *less* inductance to align correctly. If *both* slugs make things *worse*, the coil is correctly aligned.
2. If the slug has a screwdriver slot, and the slot is damaged, trying to screw the slug *out* of the coil towards you is worst of all worlds: you are trying to drive the slug back against the force of the screwdriver, and there may be slug debris in the threads!
   If the coil has two slugs, try screwing the *opposite* slug right out of the coil. Now that you have a (hopefully) untouched slot available on the “inside” of the jammed slug, use the good slot to carefully screw the jammed slug “in” to the centre of the coil and “out” the end you are driving from. You could also try driving the jammed slug “out” towards the “top”, but you should definitely try to clean the former’s screw threads as thoroughly as you can before trying this.
3. If you cannot get to the “good” end of the slug, Tony has also suggested trying the “fridge” move. Put the set in the fridge and leave it for a few hours.
   Differential contraction between the slug and the former may loosen it off. I have also tried (gently!) warming with a hairdryer, using differential expansion, and hoping that any grease or varnish will soften as well.
4. If the slug has a hexagonal hole (TV IF strips, Eddystone EC10 type), or a slim slot (“Neosid” type) going all the way through, it may be cracked into two or more parts along its length. This is the worst of all possibilities, and you may just have to replace the entire coil.
   Destroying the slug and shaking the bits out may be possible, but you may do a lot of damage to the coil former. In the worst case, where you cannot get an exact replacement for the windings, you may be able to find a similar, good coil former and can, warm the coils, draw them off from the jammed former, and replace them onto the good spare.
5. If you do get the slug out, use a tiny “bottle brush” or compressed air (gently!) to thoroughly clean out the former’s threads. Test with a good slug – they are often a little loose in a clean former.
6. When you replace the slug(s), use thin “Plumber’s tape” to stop the slugs from moving – it will hold them in place, but will not gum up or jam.