Unusual Instability Issue on a Refurbished Eddystone S830/2 – Gerry O'Hara

The Eddystone S830/2 had been sitting beside my desk since I completed working on it a couple of weeks or so ago (see article, here), and I had been using it for a few hours most days to provide some background music – a sort of longer-term soak test after the extensive refurbishment work (and, besides, I really like this Eddystone model, and often have a pang of 'sellers remorse' about selling my two S830/4s during my downsizing efforts…).

Instability Noted

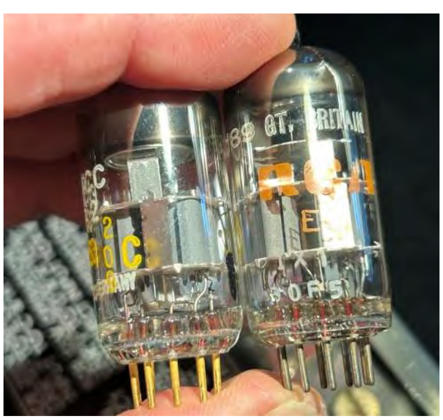
While tuning around the bands one evening, I noted that on Band 7 (upper part of the Broadcast Band), when the 'Peak RF' control was rotated to around half-way into the right-hand quadrant of its 180 degree rotation (circled in photo, right), the set started to 'motorboat' (see video here) – this is a position of the Peak RF control not normally needed, as the bands all peak around mid-travel. After some further tuning around, I noted that this instability only occurred above around 1280KHz on this one band, ie. between 1280 and 1550KHz, and only with the RF gain fully advanced. It did not matter whether an antenna was connected or not.

Troubleshooting

Tube Swapping

The first thing I tried was to swap out the RF amplifier tube, and then the 1st mixer tube, for tested 'strong' NOS tubes (I have a good stock of ECC189 and 6AK5 tubes). This made no difference to the motorboating (see video, here), other than changing its pitch, as did removing the tube shield.

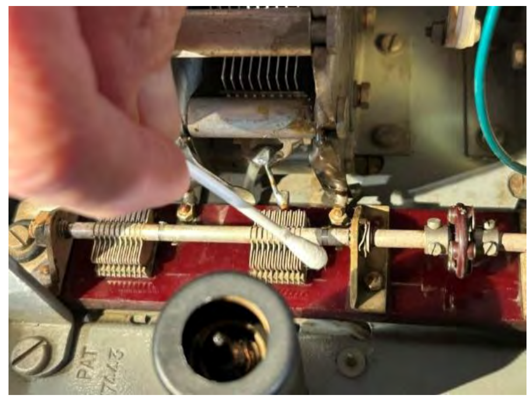
While I was swapping tubes, I noticed that the RF amplifier tube that had been fitted (and that I had tested on a STARK 9-66 tester during the refurbishment work), was actually an E88CC(!). I had not noticed this at that time - I must have been distracted, or just assumed that the correct tube had been fitted knowing how fastidious the owner of this set is. The E88CC and ECC189 (photo, left: E88CC on the left, ECC189 on the right) are similar tubes, ie. both are 'frame grid' construction and with similar characteristics, however, the ECC189 (6ES8) is specifically designed for use as a cascode amplifier – as in the S830/2, at up to VHF, and this is the tube type that Eddystone specify for the RF amplifier stage in the S830/2. The (Westinghouse) E88CC installed in the set was a 'strong' tube, with a Gm of 7000 in each triode, so I tried replacing it with a similarly 'strong' (RCA)

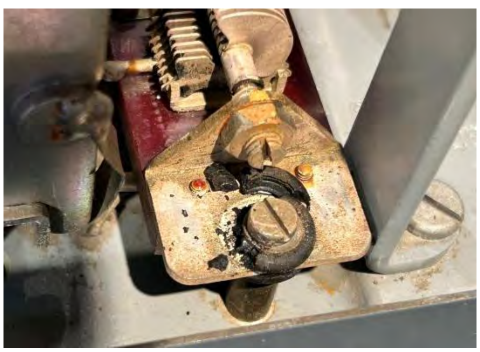


ECC189, with a Gm of around 9250 in each triode. This actually resulted in slightly degraded performance on all bands, especially the dual-conversion ones (Bands 1 through 6), ie. above 1.5MHz – I chalked this down to the receiver having been aligned with the E88CC tube installed. The motorboating was still present with the 'strong' ECC189 tube installed, however, I also tried a much weaker ECC189 (Gm around 2500 each section), and the motorboating stopped – not a very satisfactory cure though(!). I decided to re-install the high-Gm ECC189 in the set and later align the antenna, RF amplifier, and 1st mixer stages to optimize performance again once the motorboating issue was resolved.

'Peak RF' Tuning Gang

So, with the issue not being tube-related (other than a weaker tube 'fixing' it), I started the next stage of troubleshooting by checking the grounds on the 'Peak RF' tuning gang. I gave the grounding contacts a thorough clean, re-lubed the bearings, wiped Deoxit D5 onto the ground contact fingers and contact points on the tuning gang shaft (photo, right), and made sure the nuts securing this assembly were tight. I found two slack nuts – one on a grounding contact and one on the screw holding the rear bracket of the 'Peak RF' assembly in place (the nut was almost falling off, but was very hard to see, buried deep in the rear of the coilbox – barely-visible in fact), and the nut did fall off as I tried to access it(!).



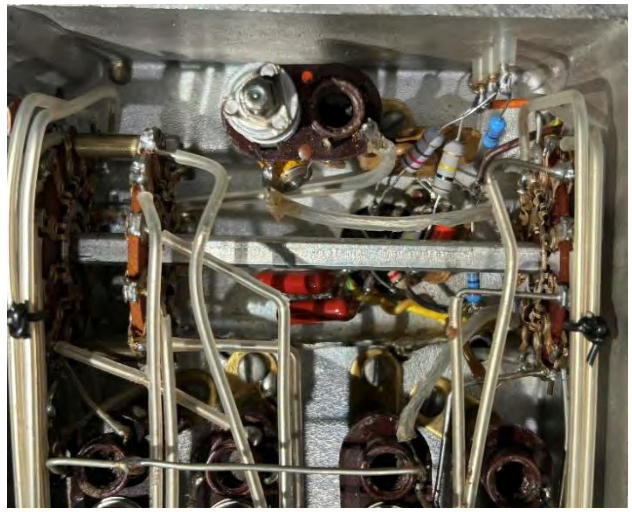


It would be very difficult to replace this nut and lock-washer due to the very poor access without removal of at least the Band 1 antenna coil assembly, and likely disconnecting several wires running to other antenna coil assemblies. So instead, I inserted the screw from within the coilbox, with the lock-washer and nut then being easily attached to the screw on the top of the chassis. The rubber grommet that the screw passes through on the end bracket of the assembly was perished (hardened) – photo, above left, so I replaced that as well (photo, right). None of this effort made the slightest difference to the motorboating (of course!), but at least the 'Peak RF' assembly is working well and secured properly on a resilient mount.

RF Gain Control

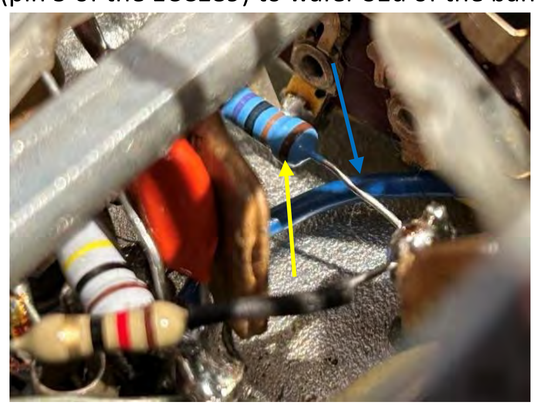
My next action was to see how much the RF gain control (a 10Kohm reverse-log wirewound pot) needed to be 'backed-off' to cure the motorboating – I measured it to be around 120ohms. So, if all else failed, the cathode resistor to the RF amplifier stage could be increased from 120ohms to 240ohms – a bit of a kludge though, and that would reduce the available RF gain slightly, so I decided to persevere to find the cause, not just deal with the symptom.

Lead Dress – The Cause (and the Solution)

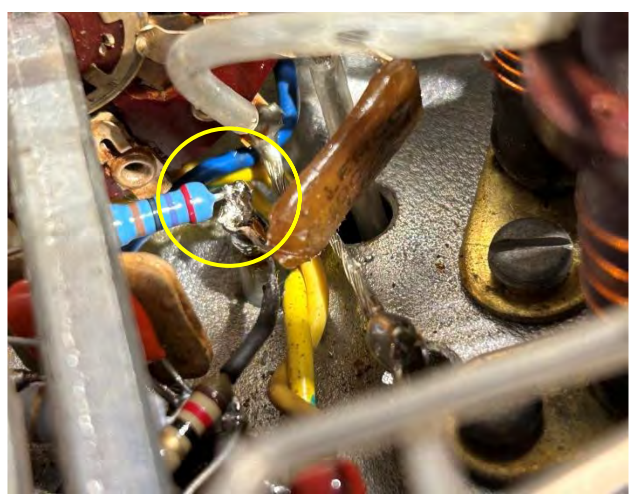


With the above work eliminating the tubes and the Peak RF tuning gang from the list of potential causes of the instability, I then turned to the possibility of poor lead dress, dry joint(s), or an ineffective (corroded) ground connection in the coilbox – especially in the RF amplifier compartment (photo, right).

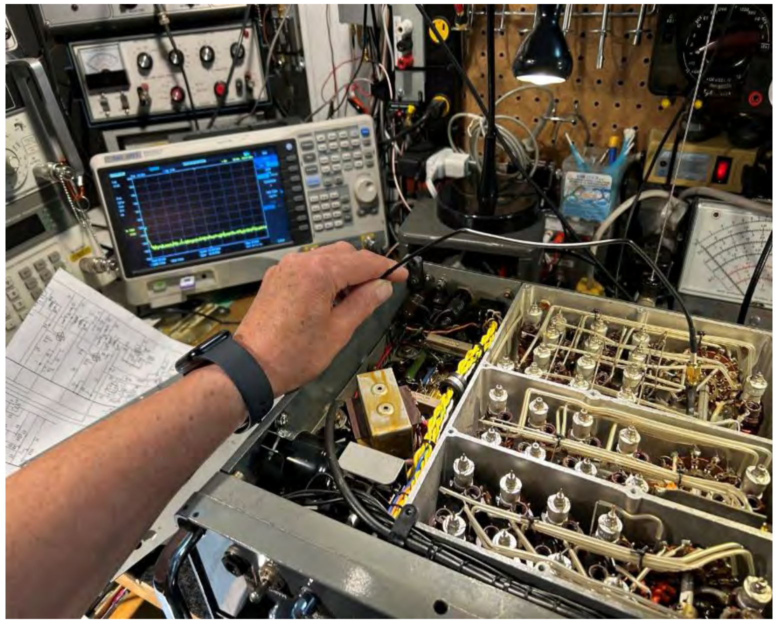
With the set tuned to around 1450KHz on Band 7 and the 'Peak RF' control adjusted to induce the motorboating, I went around the components and wires in the RF and 1st mixer compartments of the coilbox, poking components and moving wires slightly using a plastic chopstick. Just about every wire associated with Band 7 (and some that were not!) altered the tone of the motorboating. I eventually tracked the issue down to the dress of the wire connecting the plate of the RF amplifier tube (pin 5 of the ECC189) to wafer S1d of the band change switch (this is the wire with blue insulation at the tip of the blue arrow in photo, left), relative to the AGC line connection to this tube. The AGC line is connected to the grid of the RF amplifier tube via a 270Kohm filter resistor (tip of the yellow arrow in photo, left), and a 12ohm 'grid stopper' resistor – the latter to mitigate VHF instability. The other end of the 270Kohm resistor is grounded to RF by a 0.1uF disc ceramic capacitor, and connects to the AGC line that also connects to the grid of the 1st mixer tube (via a 470Kohm resistor) and to the grids of the 2nd IF amplifier stages (via 270Kohm resistors).



I found that moving the plate connection wire away from the end of the 270Kohm resistor connecting to the 12ohm grid stopper resistor cured the motorboating, but the wire tended to flex back close to its original position. To effect a more secure fix, I removed the 270Kohm resistor and replaced it with another dressed with a very short lead to the grid stopper resistor, circled in photo, right – compare this with the lead dress in the photo above (and yes, these two 270Kohm resistors appear to have different markings in the photo, but they do not – I also checked their values using a DMM). In this slightly revised configuration, the very short lead connecting to the grid stopper resistor is much less liable to RF pickup from the plate connection wire, and any RF picked up by the other (longer) lead of the resistor that is closer to the plate connecting wire, is grounded to RF by the 0.1uF disc ceramic capacitor, and



isolated from the grid by the 270Kohm resistor. I also dressed the resistor body further away from the plate connecting wire. The result was a much more satisfactory fix, even if the plate wire 'creeps' towards its original position over time.

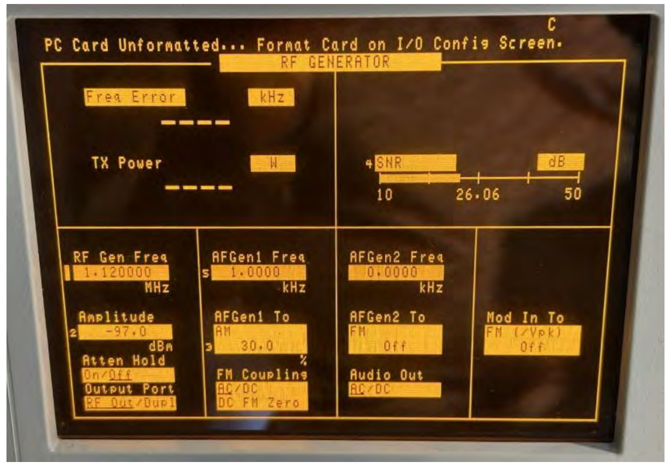


Following this, I 'sniffed around' in the three coilbox compartments using an e-field probe and the Siglent spectrum analyzer to see if any other unusual RF signals were present that could indicate instability at various setting of the 'Peak RF' control (photo, right) – nothing untoward was observed.

Realignment and Testing

With the instability issue resolved (see video, here), and with the correct type of RF amplifier tube installed (ECC189), I carried out a realignment of the antenna, RF amplifier and 1st mixer stages using an HP8656B signal generator. Not surprisingly, some tweaking was needed, especially on the HF bands (above 4MHz).

Following the realignment, I re-checked the SNR of the receiver at the same frequencies on each of the bands as I had previously, and obtained almost identical results on the dual-conversion bands, and significantly better results on the single conversion bands. This is likely due to the ECC189 having a higher gain/lower noise than the E88CC in this application, giving the improved results on the single conversion bands, the additional noise added by the 2nd mixer stage tending to mask this in the dual conversion results. That said, all the results easily exceed the S830/2 spec. of 15dB for a 3uV signal on AM with a 3KHz (SSB) selectivity setting. So, using the correct dual-triode in the RF stage is definitely recommended, especially if interested in frequencies below 1.5MHz. Results as follows, together with a comparison to the previous results, obtained with the E88CC tube installed (all with a 3uV signal from an Agilent 8935 test set as noted in the refurbishment article referenced earlier – photo, right):

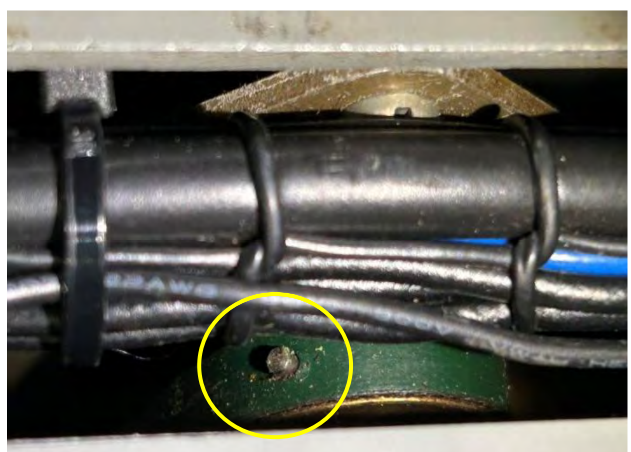


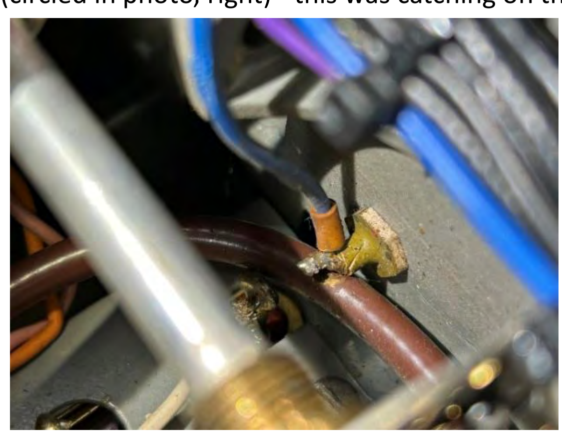
	E88CC	ECC189
Band 1 (30MHz):	>16dB	>17dB
Band 1 (23.5MHz):	>20dB	>20dB
Band 2 (14.5MHz):	>21dB	>20dB
Band 3 (8.8MHz):	>21dB	>21dB
Band 4 (5.3MHz):	>21dB	>21dB
Band 5 (3.2MHz):	>19dB	>20dB
Band 6: (1.95MHz):	>21dB	>21dB
Band 7 (1.12MHz):	>22dB	>26dB (screenshot of Agilent SNR measurement on this band above)
Band 8 (650KHz):	>23dB	>26dB
Band 9 (450KHz):	>22dB	>26dB

After some further checks on the alignment, I applied a small drop of red nail polish (my favourite!) between the top of the rotor and the stationary (screw) it contacts on each of the 'beehive' trimmers in the coilbox to mitigate any movement due to vibration, as several of the rotors are adjusted close to the end of the stator screw threads and therefore are not quite as tight as they should be. I like to use nail polish for this purpose as it can easily be removed with an acetone-soaked Q-Tip if needed, though the nail polish 'bond' is weak enough to give way if the rotor is rotated with a tool (or by hand) anyway.

Other Minor 'Fixes'

I also fixed a few other things I had noted while working on the set. The first was that there was something catching the 'Peak RF' control as it was rotated. This turned out to caused by the small locating spigot on the pully mounted on the Peak RF control shaft that engages with the neoprene/ fabric drive belt to the Peak RF tuning gang (circled in photo, right) - this was catching on the top surface of the wiring loom that runs in front of the coilbox. I added a couple of additional small cable ties to pull the loom out of the way to fix this.

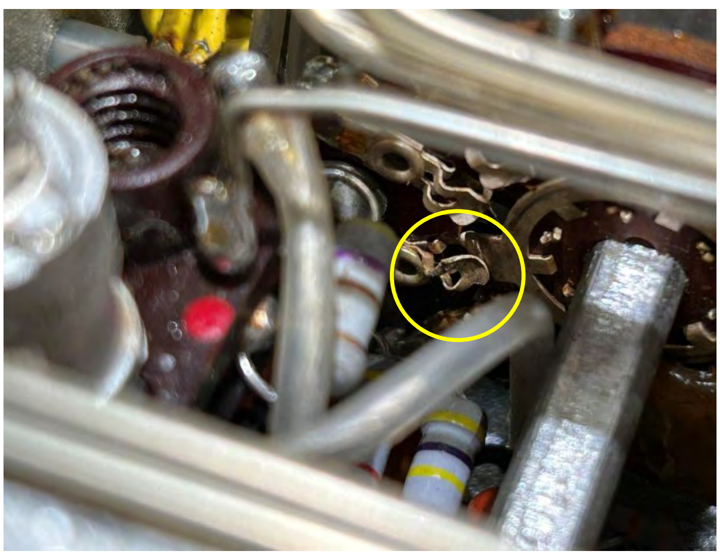




The second was a repair to a feed-through capacitor in the coilbox wall, noted during my close inspections of the wiring during the troubleshooting (photo, left).

There was a small crack and chip on the ceramic body of this capacitor– so, I cleaned-up the ceramic body using IPA, and then added some 2-part epoxy around the body to make it secure.

Finally, when I was closely inspecting the RF amplifier compartment to locate the source of the instability problem, I had noticed that the upper stator contact for Band 7 on the band change switch wafer S1c (antenna transformer secondary selection to the RF amplifier tube grid) had been bent/mangled (circled in photo, right). This most likely happened due to wear/slight misalignment of the upper stator contact, resulting in the edge of the rotor catching the edge of the upper contact while the switch was being operated (rotated clockwise from Band 6 given the way the contact was bent). This stator contact was mangled so much that it was no longer contacting the rotor, however, the lower contact was still pressing against the rotor ok, so the switch was operating normally electrically, even with the mangled upper stator contact.



I did my best to straighten and reorientate the upper stator contact until the switch was working with both the upper and lower contacts pressing against the rotor on Band 7, and such that the rotor slid between the two contacts easily from either direction as the switch was rotated (the repaired upper stator contact, with the rotor sitting between the upper and lower stator contacts, is circled in photo, left). The switch has been operated many times since and is working ok, however, the owner of the set has been advised to be aware that a similar 'crash' of rotor and stator contacts could happen again in future as I could not render the stator contact orientation 'perfect', and that rotating the switch slowly through the Band 7 position may help to mitigate this occurring.

I inspected as many of the other band change switch wafers as I could (some are hidden by inter-compartment screens), and I could not see any other switch contacts that were damaged or misaligned.

Closure

With these fixes completed, I plan on maintaining my routine of using the set regularly for background music over the next few days (or weeks!) – hopefully no further issues will develop.