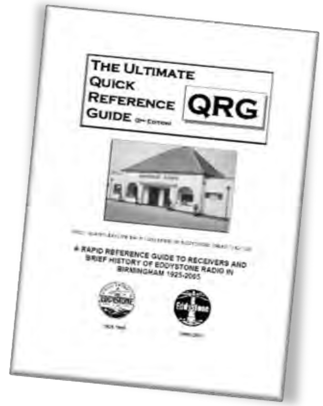
Refurbishing an Eddystone Model S830/2 Communications Receiver – Gerry O'Hara

I have had the privilege of owning or refurbishing (or both!) several Eddystone S830 receivers over the years. The sets I have owned were all the S830/4 variant (see articles here, here, here, and here) – these were made for the Canadian government, so are the most commonly available here in Canada, and (annoyingly) lacked the main segment of the Broadcast band. This variant had an additional LF band instead, allowing continuous LF/MF coverage from 120 – 560KHz, with HF coverage from 1.5 – 30MHz. However, I have also had the opportunity to work on and operate two other S830 variants, the S830/2 and the S830/7.



The Eddystone S830

The very successful S830 range included 13 variants in total, most listed in the Eddystone User Group's UQRG[1], page 38[2], and the model was manufactured over an eleven year period from 1962 – 1973. The UQRG indicates that 200 units of the original S830 were produced in 1962, with 200 units of the S830/2 produced in 1963. Appendix 'A' in the S830/1,2,3 version of the S830 series manual notes "*The 830/2 is the general production version of the '830'*…" and then lists the differences between these two variants. The UQRG also notes that 415 of the S830/4 'Canadian models' were made. The S830/10 is also noted as being a 'Canadian Model', but does not identify how many were produced, or how it differed from the S830/4. Apparently, the S830/6 variant is the rarest, with only 3 being produced in 1966 ('World Cup Specials'[3]?).

Background

A decade ago (2015), I carried out some limited refurbishment on an S830/2 variant for a friend (photo, left). That work included replacing 24 paper capacitors, 4 electrolytics and 18 resistors. The end result was a much-improved set that the owner enjoyed using.

Fast-forward a decade, and the same friend asked if I could refurbish his other S830/2 (I guess you can't have too much of a good thing!), but this time he asked for '*the works*' – ie. in effect, he desired the set to almost be rebuilt, as he wanted to see how such a receiver had performed when it was new, some 63 years ago. This set was working, but had a number of issues, including an annoying rattle on the tuning shaft when

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[1] 'Ultimate Quick Reference Guide' (2nd Ed.) on Eddystone receivers and related products, authored by Graeme Wormald (G3GGL, SK) for the Eddystone User Group (EUG) in 2005

[2] The list of variants in the UQRG does not include the S830/1 or S830/3. The S830/1 variant is mentioned in Appendix 'A' to the S830/1,2,3 manual, noting *"… differs only in the type of knobs used for 'SELECTIVITY CONTROL', the 'SIGNAL MODE SWITCH', and the 'AGC/NL SWITCH'. Small 'beak' knobs are fitted in place of the standard chromium plated levers."*, as is the S830/3 variant, here noting "…*the only difference being the type of knob used for the RF gain control.*"

[3] Or maybe this variant was the '*Nobby Stile*'… ?

the tuning knob was spun, intermittent instability on some bands, and poor sensitivity/dial calibration. Also, the crystal calibrator push-switch did not work, the AF gain control was noisy, the RF gain control was only partly functional (working over part of its track then cut out), and the AF gain control sported an 'imposter' knob (photo, above right). The owner also wanted the speaker output to be a standard ¼" jack socket rather than have to use a 12-pin Jones plug on the rear apron, and to have a 'modern' (IEC) power connector installed instead of the 'kettle plug' that Eddystone fitted to sets of that vintage.

The Eddystone Model S830/2

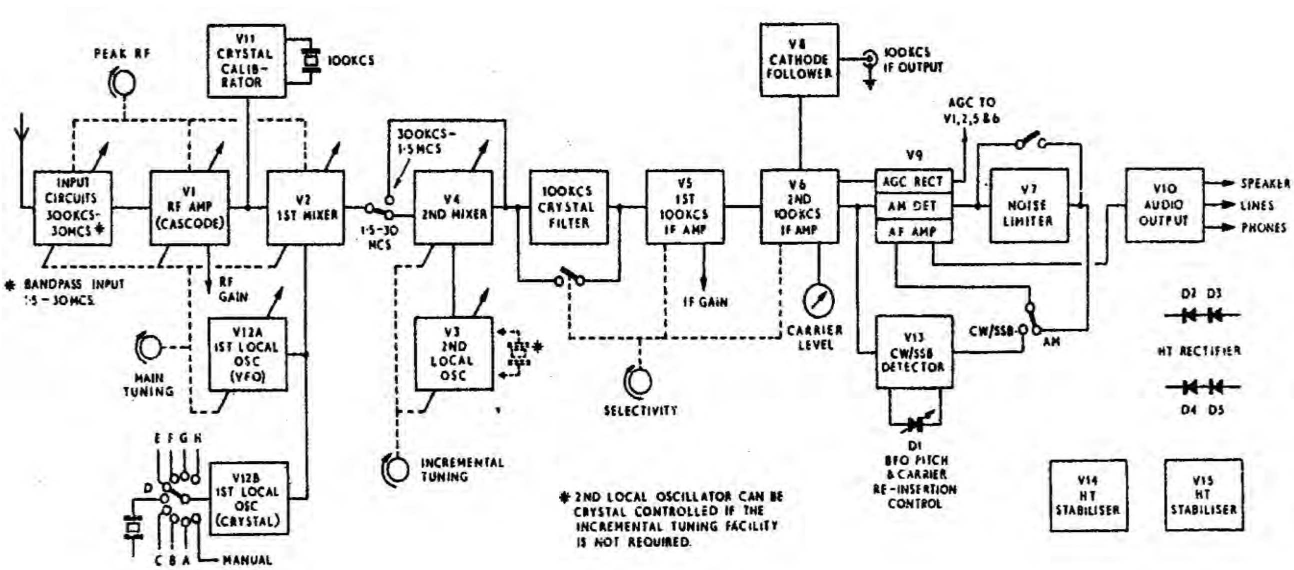
The S830/2 is a 15 tube general coverage, dual-conversion receiver covering 300KHz – 30MHz in nine (slightly) overlapping ranges, intended for the professional market. It is mains powered, but with facility to be powered by an external source(s), requiring 250vDC, at 160mA and 6.3vAC or DC, at 4.8A. Provision was also made to power accessories from the internal power supply (250vDC at 15mA and 6.3vAC at 1.2A).

The set is dual-conversion on Bands 1 through 6, covering 1.5MHz - 30MHz, with a 1st IF of nominal 1350KHz and 2nd IF of nominal 100KHz. Bands 7 through 9, covering 300 - 1500KHz, are single conversion, with an IF of nominal 100KHz. The 2nd local oscillator and 1st IF are tunable +/-100KHz either side of the nominal 1st IF frequency to provide an 'Incremental Tuning' facility on these bands, giving a 1KHz or better frequency resolution when used in conjunction with the crystal calibrator. The 2nd local oscillator can be crystal controlled for maximum stability if desired. The 1st local oscillator can also be crystal controlled, with facility to switch up to eight crystals in place of the VFO.

Circuit

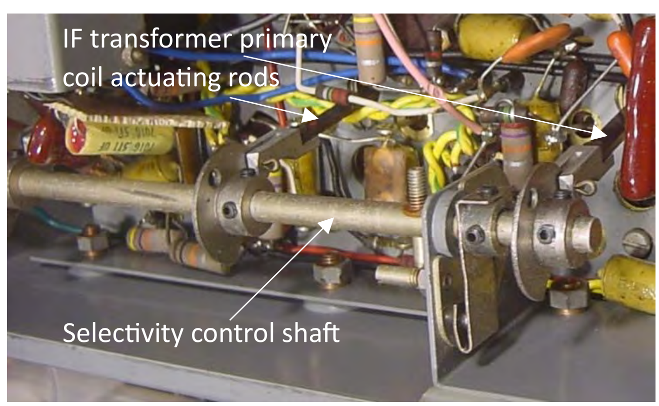
The block diagram of the S830/2 is shown at the top of page 3 and in the Appendix, and this should be referred to while reading the following overview of the S830/2 circuit. The full schematic is provided in the Appendix, and a more comprehensive circuit description can be found in the S830/2 manual.

The antenna circuits are double-tuned on Bands 1 through 6, and single tuned on Bands 7 through 9. The RF amplifier is a double triode tube (ECC189) in cascode configuration, which couples the signal to the 1st mixer stage (6AK5) via single-tuned transformers on all bands. The variable frequency 1st local oscillator is the pentode section of a 6U8 tube, and when crystal control is desired, the triode section of this tube takes over to provide the 1st local oscillator signal to the 1st mixer stage. A crystal bank with 8 HC6/U style crystal sockets is installed, the crystal of choice ('A' through "H') being selected by a metal lever located behind, and concentric with, the band selector switch knob. The ninth position on this lever, 'M', at the fully CCW position, selects 'manual' (VFO) control of the 1st local oscillator.

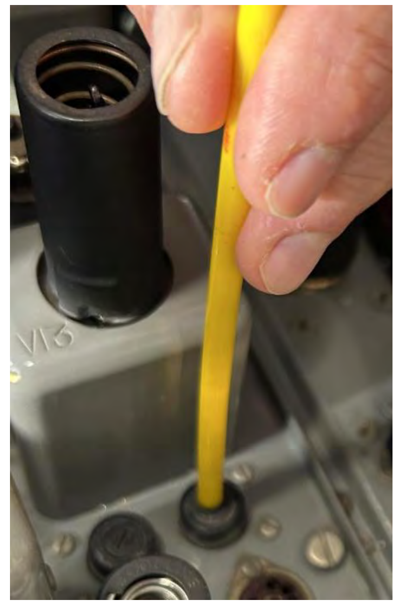


In single-conversion mode (Bands 7 through 9), the plate of the 1st mixer tube is connected to the B+ supply through the primary winding of the 1st 100KHz (2nd IF) IF transformer. This transformer is double-tuned, with its secondary connected to the 100KHz crystal filter and (pre-set) crystal phasing capacitor. The crystal is shorted out in all selectivity settings except 'N'. The output of the 1st 100KHz IF transformer is loosely capacitively-coupled to the 2nd 100KHz IF 'transformer', which is actually a single parallel-tuned coil, the 'hot' end of which is capacitance-coupled to the grid of the 1st 100KHz IF amplifier tube (6BA6). The plate of this tube is connected to the B+ supply through the primary of the 3rd (double-tuned) 100KHz IF transformer, the secondary of which is capacitively-coupled to the grid of the 2nd 100KHz IF amplifier (6BA6). The plate of this tube is connected to the B+ supply through the primary of the 4th (double-tuned) 100KHz IF transformer, the secondary of which is directly coupled to the AM detector diode (one diode in a 6AT6 tube), and capacitively-coupled to the other diode in the 6AT6 tube, which provides the AGC voltage, and also to the grid of a cathode-follower stage (6AU6) that provides a low impedance buffered IF output at 100KHz for external use, eg. by a panadapter.

The output of the AM detector is passed to the AF gain control via the mode switch when in 'AM' mode, which controls the audio signal level being fed to the triode grid of the 6AT6 tube, acting as the 1st AF amplifier. The plate of this tube is capacitively-coupled to the grid of the audio output tube (6AQ5). A simple (switchable) series noise limiter (6AL5) is provided in the 6AT6 tube's' grid circuit in 'AM' mode. The output transformer has provision for 2.5ohm speaker and 600ohm (balanced) line output via a Jones plug on the rear apron of the chassis.



The three double-tuned 100KHz IF transformers have variable coupling between their primary and secondary windings, this being achieved by a ganged mechanical linkage mechanism that converts rotary motion of the Selectivity control to vertical movement of actuating rods that move the primary windings in these three IF transformers (photo, right): the transformer windings are over-coupled for the wider bandwidth ('AM') setting (Selectivity control fully CCW), and under-coupled for the narrowest bandwidth settings of the Selectivity control[4]. A (normally closed) microswitch is also operated by the Selectivity control – this switch is connected across the 100KHz filter crystal, and opens when the 'N' selectivity position is selected (Selectivity control fully CW). The signal strength meter[5] is connected in a resistive bridge arrangement in the screen circuit of the 2nd 100KHz IF tube. The RF amplifier and 1st 100KHz IF amplifier stages have separate manual gain controls, and the RF amplifier, 1st mixer, and the two 100KHz IF amplifier stages can be controlled by the AGC. The time constant of the AGC is automatically lengthened when either 'LSB' or 'USB' modes are selected, and the AGC action is delayed by the cathode bias arrangement of the 6AT6 tube.



The output of the 4th 100KHz IF transformer is also capacitively-coupled to the control grid (g3) of the self-oscillating heptode product detector tube (6BE6). When 'LSB', 'USB' or 'CW' modes are selected, voltage is applied to the screen grid (g2) of the 6BE6, and the audio output from the plate circuit of this tube is connected to the AF gain control in place of the output from the AM detector. The product detector oscillator ('BFO', or 'CIO', ie. carrier insertion oscillator) frequency is controlled by a combination of a capacitor/inductor tuned circuit in the oscillator grid (g1) of this tube, plus a varicap diode (100SC2), the reverse-bias voltage on which is used to control the frequency: the slug in the inductor sets the centre frequency to 100KHz with the BFO pitch control (a pot mounted on the front panel), centred for CW operation, and two preset pots adjust the varicap diode voltage to provide fixed +/-1.5KHz offsets for USB or LSB operation[6] (photo, right). The front panel BFO Pitch control allows for around +/-3KHz adjustment of the BFO frequency in CW mode, and also minor adjustment of the BFO frequency in LSB or USB modes (around +/-100Hz).

In dual-conversion mode (Bands 1 through 6), the plate of the 1st mixer tube is connected to the B+ supply through the primary of the 1st IF (1350KHz) transformer, a tap on the secondary of which is capacitively-coupled to the grid of the 2nd mixer tube (6AK5). The output of the 2nd local oscillator (6C4) is capacitively-coupled to the cathode circuit of the 2nd mixer tube. The primary and secondary circuits of the 1st IF (1350KHz) transformer, along with the 2nd local oscillator, are tunable over a 200KHz span, centred on 1350kHz, this providing the 'Incremental Tuning' facility on Bands 1 through 6.

The crystal calibrator operates at 100KHz, and when it is switched on, by a momentary action push switch, the RF amplifier stage of the receiver is desensitized to allow the (weaker) high-order harmonics to be heard. The output from the calibrator is loosely-coupled into the 1st mixer stage grid.

The power supply comprises four silicon rectifiers in a half-wave arrangement (two diodes are wired in series to increase their PIV rating), and this provides four B+ voltage supply lines: one unregulated

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[4] Only around $^{1}/_{4}$" of vertical movement of the rods moving the primary windings is needed to vary the 100KHz IF -6dB bandwidth from 6KHz to 1.3KHz. The Selectivity control is continuously variable, but has detents at the 'SSB' and 'CW' positions

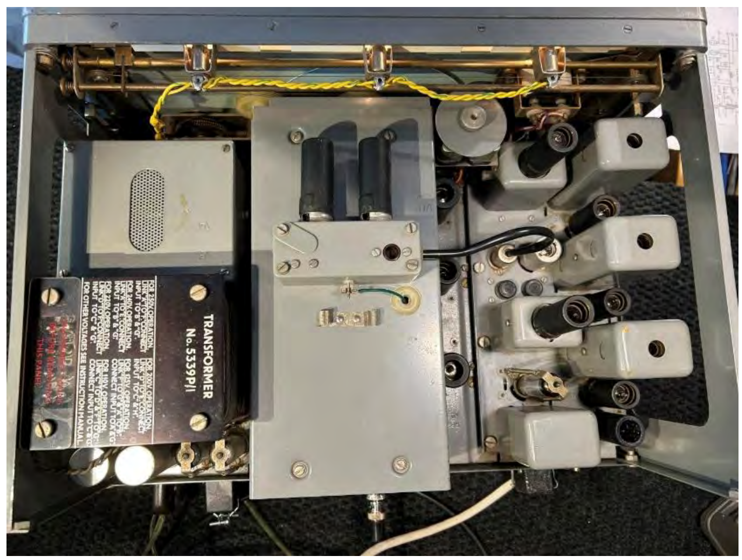
[5] The signal strength meter is marked in arbitrary units 0 – 10, not in true 'S-units' or dB

[6] Some variants of the S830 (S830/5, /6, and /7) used a variable capacitor for BFO pitch and trimmers for LSB/USB offsets in place of the varicap diode and front panel pot and pre-set pot arrangement

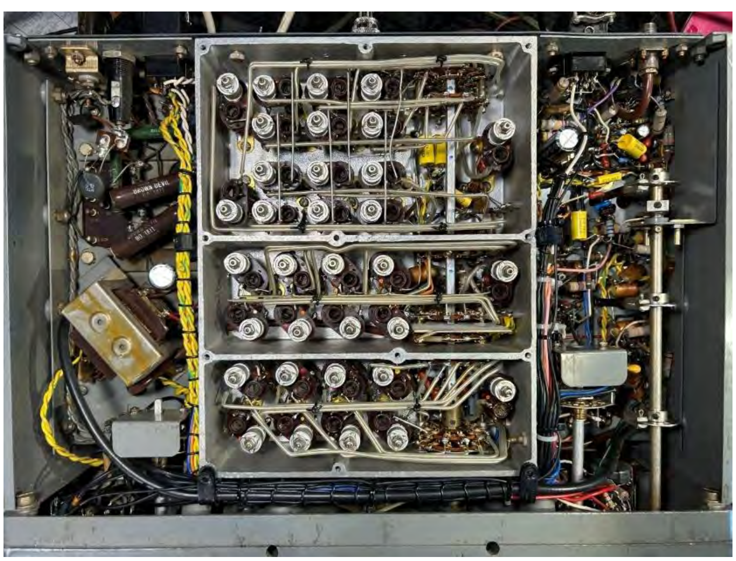
240vDC (general) B+ supply, 2 x 150vDC supplies - these being regulated independently by two OA2 tubes, and provide plate and screen voltages to the local oscillators and screen voltage to the product detector, and an unregulated 200vDC supply, providing the plate voltage to the product detector and 1st audio stages. The power transformer includes three 6.3vAC centre-tapped heater windings, though one of these is not used. One of the other heater windings supplies only the 6AL5 noise limiter tube, and the centre tap of this winding has a small positive voltage on it, derived from a voltage divider from one of the 150vDC supplies, to mitigate hum induced from the cathode of the 6AL5 tube. The heater supplies are coupled into the circuit via connections in a 12-pin Jones socket on the rear apron of the chassis – this allows for an external supply to be connected, but also means that jumpers must be installed in a mating Jones plug for the set to operate (or shorting wires added to the rear of the Jones socket).

Mechanical Construction

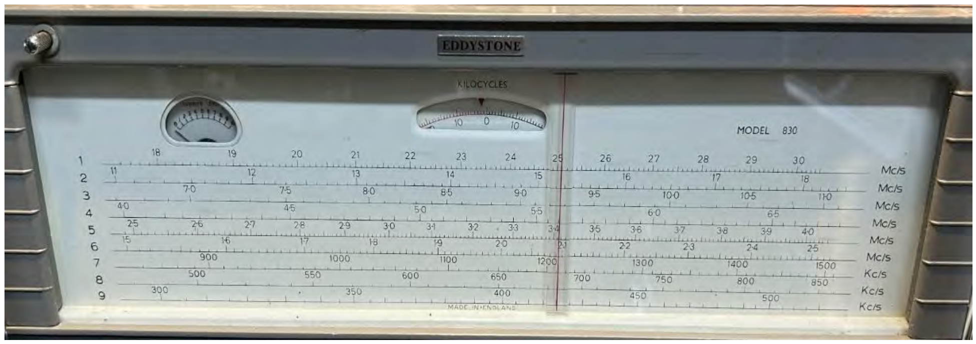
The S830 sets have a very robust construction, mainly of heavy-gauge painted steel. Photos of the S830/2 prior to refurbishing, are shown right (top of chassis), and below (under chassis with the coil box cover removed). The Appendix includes above and below chassis layout diagrams.



The chassis comprises the following major components: pressed-steel side panels, front panel (cast aluminum), 2nd IF/AF (pressed steel) sub-chassis, power supply (pressed steel) sub-chassis, coilbox (cast aluminum with steel cover plate), 2nd mixer/2nd local oscillator sub-chassis (painted brass plate), calibrator (painted cast aluminum), tuning gang cover (pressed steel), rear apron (steel) and a one-piece welded steel cabinet with inset perforated steel sections to provide ventilation. The front panel is attached to the front of the coilbox with four tapered 0BA screws. The painted/silk-screened aluminum fingerplate, drilled for the various control shafts to pass through, is attached to the front panel with double-sided sticky tape and several of the control pot securing nuts, and must be removed to access the tapered bolts if the front panel needs to be removed.



The 2nd mixer/2nd local oscillator sub-chassis is mounted on the top side of the power supply chassis adjacent to the power transformer, and the calibrator unit is mounted on the top of the tuning gang cover. The product detector components are mostly located in a screening can mounted on the top side of the 2nd IF/AF sub-chassis, along with the four 100KHz IF transformers and the (fully-shrouded) audio output transformer. The B+ filter choke is located on the underside of the power supply sub-chassis.



The main tuning scale (photo, right) is a large and impressive slide-rule dial with a vertical plexiglass pointer, which runs on two brass guide rails. The main tuning mechanism (when not worn and when adjusted properly), is silky smooth in operation, and comprises a friction drive and brass gear arrangement driving two plastic spool pulleys that are connected to a metal dial cord. The Incremental Tuning mechanism is a brass gear train (photo, left), coupled both to the 1st IF transformer/2nd local oscillator tuning gang, and the circular Incremental Tuning indicator dial, this being visible through a cut-out at the centre-top of the main tuning scale (photo, above). The 'Peak RF' trimmer gang is connected to the front panel control via a flexible (neoprene) belt. The (rotary) mode and AGC/noise limiter switches are mounted on brackets bolted to the 2nd IF/AF and power supply sub-chassis respectively.

Stout chrome-plated steel carrying handles are bolted through either end of the front panel and these bolts secure the front panel to the side plates of the chassis, these also being bolted to the outer sides of the 2nd IF/AF and power supply sub-chassis, the opposite sides of which are bolted to the sides of the coilbox. Two removable side 'cheeks' form part of the front panel, either side of the main tuning dial – these are removable, along with the dial light securing strip, to allow for the dial cover glass to be removed for cleaning without further dismantling of the set.

Controls

The front panel controls (photo, below) comprise: RF gain, IF gain (these are concentric on the same shaft), BFO Pitch, 'Wavechange', Crystal (1st local oscillator VFO/crystal select) lever,

Cal. (crystal calibrator push-button), Peak RF (this trims the antenna, RF amplifier, and 1st mixer stage tuned circuits on all bands), (main) Tuning, Incremental (tuning), AF gain, Selectivity (AM/SSB/CW/N), Mode (AM/CW/USB/LSB), AGC/Noise Limiter, Mains toggle switch (power), and a high-impedance ¼" jack 'phones socket that defeats the speaker when a jack plug is inserted. A small knurled metal knob at the top left of the front panel (photo, top of page 6) allows for minor mechanical correction of the pointer position on the main tuning dial. The signal strength meter is visible through a cut-out on the upper left of the main tuning dial, and the signal strength meter zero adjust preset is located on the rear apron of the set.

Initial Testing and Inspection

After receiving the S830/2, as the owner had noted it was working, I powered it up – to be met with silence – I then realized there was no Jones plug in the external/accessory supplies socket with the required shorting links fitted. I had a suitable plug in my junk box, and wired it up accordingly (the owner had been operating the set, so likely has the correct plug in his possession). With the jumpers in place, the set was working in an 'ok' way, but could certainly do with some 'TLC' as noted previously.

I then confirmed with the owner as to the scope of work he wanted on this set. He noted that "...I *would like the Eddystone S830/2 to be the best you can make it, that is the full refurbishment treatment. This quality receiver deserves no less, in my opinion. If you can supply the missing bits, I would really appreciate your help on this*...."

Sounded like a plan(!) – I started with a careful inspection of what work had already been done to the set...

The owner (or a previous owner) of the S830/2 has replaced quite a number of components (under-chassis photo on page 5), comprising some paper capacitors, electrolytics and a few resistors, but missed replacing several critical paper capacitors in the coilbox (the well-hidden, almost impossible to get to grey Dubilier or 'rat poop'-shaped ones), and the resistors around the cascode RF stage – especially the two 100Kohm bias resistors on the 2nd triode grid, which, if drifted significantly apart and/or high in value can make the set very 'deaf'.

It looked like the dial lamp holders had shorted at some time, as the wiring to them had partially-melted insulation (photo, right). Although the dial lamps were currently working, this damaged wiring needed to be replaced for long-term reliability. I also noticed that a resistor had come adrift off the rear of the calibration push-switch, although this was not the cause of the calibrator switch not functioning (I tested the switch and it was open circuit - a common issue with these sets). The wiring in that area of the chassis, ie. around the calibrator switch and RF/IF gain controls, had been hacked quite a bit.

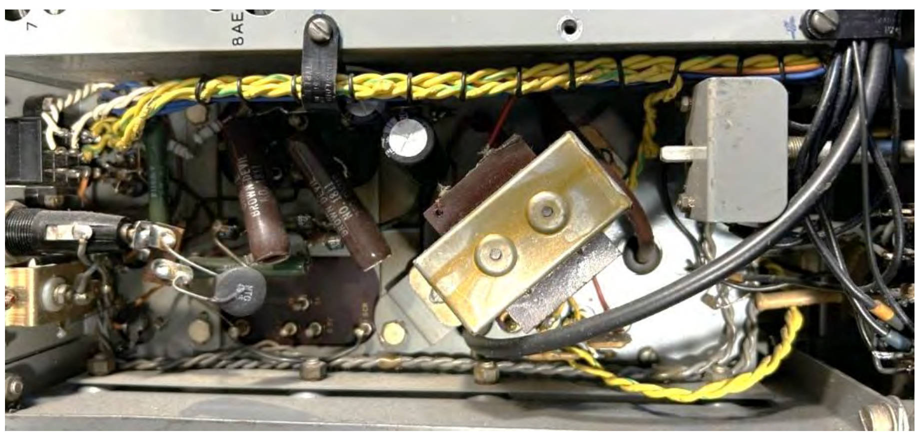
Given the owners expectations, I decided to replace (almost) all resistors and any remaining paper and electrolytic capacitors in the chassis, and make an overall much tidier job of things (component and lead dress, etc.) - the power supply section was a real 'dogs breakfast', and some wiring in it was 'hanging loose in the breeze'... Also, the insulation on some of the wiring was brittle, especially in the power supply sub-chassis, with bare wire exposed where it had broken and fallen off. All that said, this inspection confirmed that the set was a reasonable candidate for refurbishment.

Refurbishment

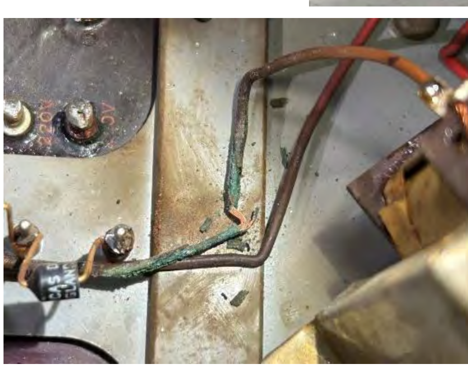
Power Supply

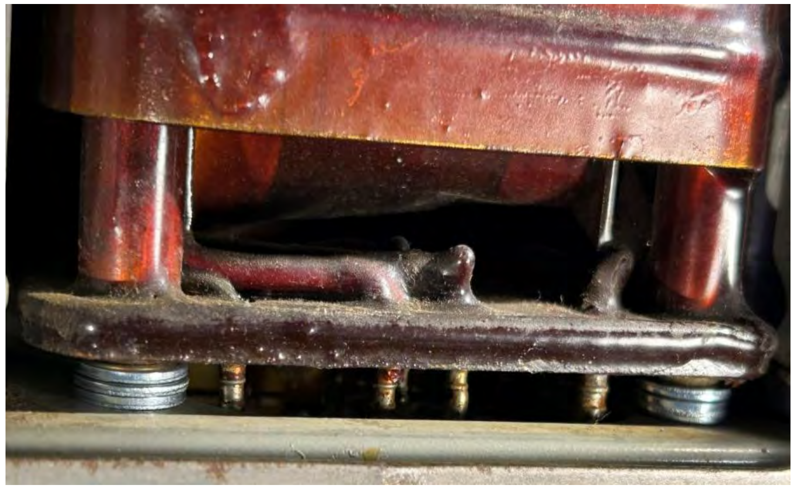
The first job was to replace the 'kettle plug' on the rear apron with an IEC chassis plug (photo, right), and wire it into the circuit, including the ground connection. No chassis butchering was involved in this changeout, the chassis-mount IEC plug (removed from an old computer power supply) being installed on the inside of the rear apron, and the existing holes re-used for the securing screws. An IEC line plug fits neatly through the original hole used by the 'kettle plug'.

The next order of business was to replace the 6.3v supply wiring to the dial bulbs. Inspecting it after removal from the loom showed that it was in much worse condition than I had thought, with several sections where the insulation had completely melted away, sometimes forming large blisters - over time, this could easily have resulted in more shorts within the wiring loom. I ended up replacing three sections of this wiring - one twisted pair in the loom, one twisted pair from the power transformer to the Jones plug, and one twisted pair running to the dial light string.



I then removed the two large 'Brown Devil' power resistors (photo, right) - these connect the B+ winding on the power transformer to the rectifier diodes. The value of these (previously replaced) parts was incorrect (250ohms, should be 140ohms), so would be replaced. Removing these resistors allowed a closer inspection of the power supply compartment revealing significant heat damage. This reminded me of the first S830/4 set I owned and refurbished, ie. toasted, cracked, or discoloured insulation, with bare wire exposed where the brittle insulation had fallen away (photo, left). This damage is a result of inadequate ventilation to allow the heat generated by the four power resistors in the compartment to escape – bearing in mind these sets were often used 24/7 for many





years. To mitigate this in the future, I inserted spacers (three thick washers) between the base of the power transformer and the chassis (photo, right) - this provides a gap that allows the heated air under the power supply sub-chassis to flow upwards and out of the compartment by convection. I have done this in several receivers and, while not a perfect solution, it definitely helps.

Another mitigating action is careful component placement and leads dressing. I decided to replace most of the wiring, the rectifier diodes (these tested ok, but were now over 60 years old and have had a hard life in that heat!), some resistors, and the electrolytics. I also cleaned up several insulation posts and added a coat of 2-part epoxy to them in case the heat had aversely affected their integrity.

The original B+ filter electrolytics comprise a single 50uF 450vw can, and a dual 32uF 450vw can, both located above the chassis. These cans are very slender and can be a PITA to restuff, especially the dual can. So instead, I decided to disconnect them and leave them in place for cosmetics, and install replacements below the chassis. The 50uF capacitor was already out of circuit, replaced with one of the radial leads parts dangling on its long legs. I replaced them with a dual 32uF 500vw (JJ) can electrolytic and a single 47uF 450vw (Nichicon) tubular electrolytic. However, placing these capacitors inside the power supply compartment needed some careful thought to avoid them being overheated, leading to premature failure. I therefore placed the large dual can electrolytic as far away from the heat sources (power resistors) as possible (photo, left), and the single 47uF part (105C rated) some distance away as well, both clamped to the side of the chassis.

A chassis-mounted fuseholder, fitted initially with a 200mA slow-blow fuse, was fitted under the power transformer, connected from the rectifier diodes to the B+ filter choke. I decided to run all wiring away from being above the power resistors (when the chassis is right side up) so convected heat would not directly affect the insulation.

While I was at it, I re-wired a thermistor that a previous owner had installed between the line input socket and the line fuseholder, and added some heat-shrink to the IEC socket wiring and fuseholder solder lugs. Further work on the power supply included:

- Completing replacing all wiring that was showing signs of insulation (heat) damage;

- Replacing two 1W resistors - these form a voltage divider from one of the two 150vDC stabilized B+ supplies that provide a nominal +3.6vDC bias on the centre tap of the 6.3vAC heater winding that supplies only the 6AL5 noise limiter tube (6AL5 tubes in this application are prone to picking up hum from the heater supply and adding a positive voltage to the heater mitigates this issue);

- Installing a new 25uF 25vw electrolytic (smoothing capacitor for the +3.6vDC bias on the 6AL5 noise limiter heater supply) – strangely, someone had replaced the original 25uF 25vw capacitor with a 33uF 450vw part(!);

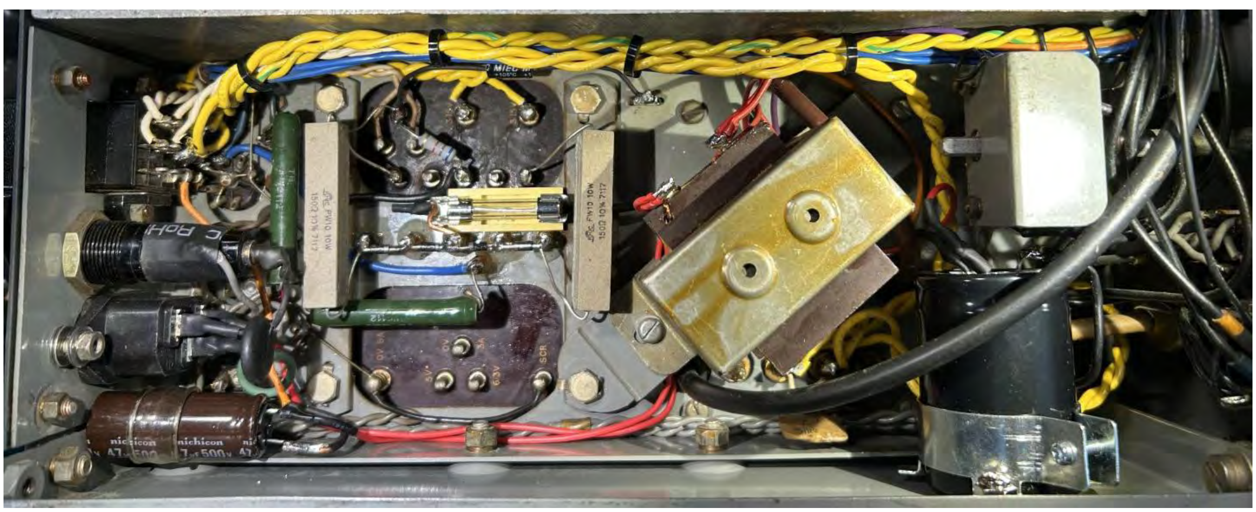
- Installing four new 1N4007 silicon rectifier diodes. The original circuit design uses two DD006 silicon diodes (in series) in each leg of a half-wave rectifier circuit to reduce the PIV on each diode of the early rectifier types used. I kept the same arrangement though it is not needed when 1N4007 rectifiers are used (1000PIV each) - but why not, they cost cents each!

- Installing two new 150ohm 10W power resistors in the B+ secondary circuit of the power transformer (in place of the 250ohm 'Brown Devils');

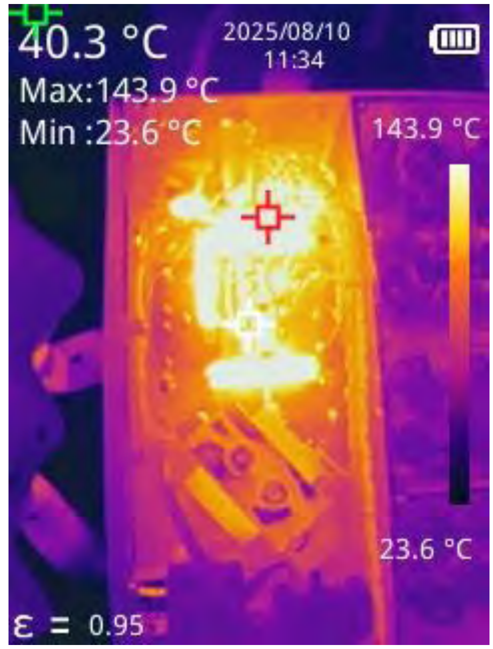
- Completed wiring to the dual 32uF can electrolytic, and fully securing its clamp to the side of chassis: I did not drill any holes to mount this or the 47uF 450vw electrolytic, instead, I used existing chassis screws and one 4BA nut epoxied to the inside of the chassis side; and

- Double-checked all wiring (rebuilding power supplies is a dangerous game!) - all was ok. I also measured the DC resistance from the B+ line to ground - around 5Kohms (seemed ok).

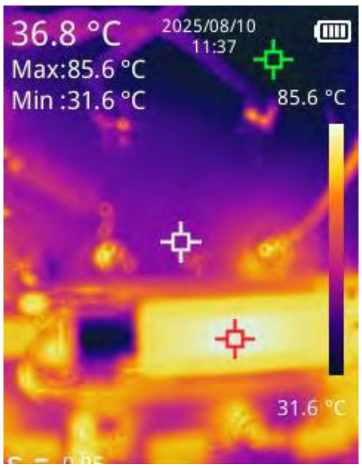
The re-built power supply compartment is shown in the photo, below.



I then powered-up the set using a Variac while monitoring the B+ voltage on the choke - no B+ voltage at all(!). OMG, what had I done?... I soon found the culprit: the (brand new) 200mA slow-blow fuse was open circuit, even though the fuse element was intact! I replaced the fuse with another (from the same batch) that tested ok. The B+ voltage now came up as expected and the set sprang to life. I checked the four B+ voltages: +240vDC, 2 x +150vDC (both stabilized by separate OA2 tubes), and +200vDC (derived from a 10Kohm dropper resistor off the 240vDC supply). All were ok except the +200v supply, which was reading around 238vDC with the BFO off and 234vDC with the BFO on (this supply is only to the plates of the product detector and 1st audio tube) - I decided I would investigate this later if needed, following the remainder of the component replacement.



After the set had been operating for an hour or so, I took some thermal images of the underside of the chassis, especially the rebuilt power supply section (image, right). All looked ok, with the hot spots being the four power resistors (two as surge limiters in the B+ secondary of the power transformer feeding the rectifiers, and two as dropping resistors to the two 150vDC OA2 voltage stabilizer tubes). These resistors were running between around 122C and 152C, which is ok. The B+ choke windings were running at around 35C, which is good, and the power transformer was hardly warm to the touch (Eddystone generally over-spec'd their power transformers after a problem they had with the first version of the S680 receivers just after WWII...!). I was surprised to see that the fuse element was running at 85C (image, left), even though the current draw through the fuse was measured at 133mA: the 830/2 spec. notes that if an external power supply is used, this should be able to provide 160mA B+ current at 250vDC, so 133mA seems reasonable current draw, though a little lower than I was expecting, hence my selection of a 200mA slow blow fuse rating. I then left the set on soak test for a few hours more to make sure everything was running reliably.



Calibrator Switch

I found an identical-looking momentary-action push switch to replace the calibrator switch with (photo, right), but when I tested it, I realized that it was not configured correctly to use in that application: the S830 calibrator switch has a normally open and a normally closed contact set, whereas the switch I was going to use as a replacement had two normally open contacts. In the circuit, the normally open set of contacts switches on the full plate and screen voltage supply to the calibrator tube (a 2.2Mohm bypass resistor across these switch contacts keeps a few electrons flowing when the calibrator is not in use, mitigating cathode poisoning of the calibrator tube). The normally closed contacts are across a 47Kohm resistor in the cathode circuit of the cascode RF amplifier tube, in series with the RF gain control pot. Thus, when the calibrator is activated, the 47Kohm resistor is added to the cathode circuit, desensitizing the RF amplifier while a calibration marker is sought by the operator, making it easier to identify the weaker higher-order harmonics. So, it was back to the 'drawing board' (or, rather, the junk box) for another switch…

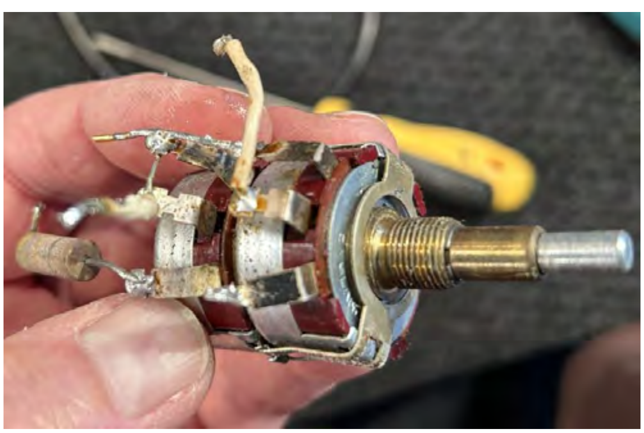
I found a NOS spring-loaded DPDT toggle switch that would serve the purpose in my junk box. However, I found that this switch was too large to fit in the space available behind the front panel. So, I did a really 'deep dive' into my junk box and found three Burgess (UK) manufactured momentary action push microswitches (shown in the photo, right, along with the toggle switch). Luckily, these microswitches had the required normally open and normally closed sets of contacts, and were much smaller than the toggle switch, so were ideal for the calibrator switch replacement.

One of these switched had a black button, so I decided to use that one, as the original push switch button was also black. The microswitch had two pairs of each type of contact set, so I wired them in parallel to provide some additional current capacity/redundancy, and then pre-installed the two associated resistors onto the switch lugs.

RF/IF Gain Controls

Before installing the calibrator switch, I thought I would take the opportunity of having better access to look at the concentrically-ganged RF/IF gain control pots. These are located above the calibrator switch, and are therefore partially obscured when the calibrator switch is in position, as is the wiring around these components, which was a real mess. Also, I had noticed that the RF gain control was not working properly (cutting out part way around its rotation), and its action felt a little 'rough'.

The RF and IF gain pots in the S830/2 are identical wirewound 10Kohm parts, both connected as rheostats (the 'cold' end of the tracks connected to the respective pot's wiper). They are, however, unusual in that they have pseudo reverse log-tapers, the track being wound using three different lengths of nichrome wire of different resistance characteristics to give the required taper/control action. As this type of pot is totally 'unobtanium', especially being concentrically ganged, I decided to open up the RF gain pot and check its condition/clean the track/wiper.



The RF gain control is the rearmost of the two pots (photo, left), however, the entire dual pot assembly must be removed to gain access and remove it from the front (2nd IF gain) pot body. Once I had the pot disassembled, I found that the joint between two of the wirewound sections in the RF gain control track was damaged, and that the pot was open circuit when the wiper was rotated past that point on the track (around a third travel from the 'hot' end of the track). I had a new 10Kohm linear wirewound pot in stock that could work (but not ideal with a linear taper), but to couple its shaft to the small diameter inner shaft of the pot assembly, and support the pot body correctly behind the IF gain pot, would not be an easy task. So, instead of trying to install that pot, I decided to try to repair the track in the original RF gain pot.

Nichrome wire will not solder, so, I decided to use some conductive paint (as used for repairing old style car rear window demisters) - I had a small amount of this paint left over from a repair I did on a Jeep some years ago. I carefully cleaned the inside of the track either side of the (broken) joint using naphtha, and then IPA on Q-Tips, and then applied three coats of the conductive paint across the joint. Once dry, I applied two coats of clear nail polish over the conductive paint to provide some protection and mechanical stability (photo, right).

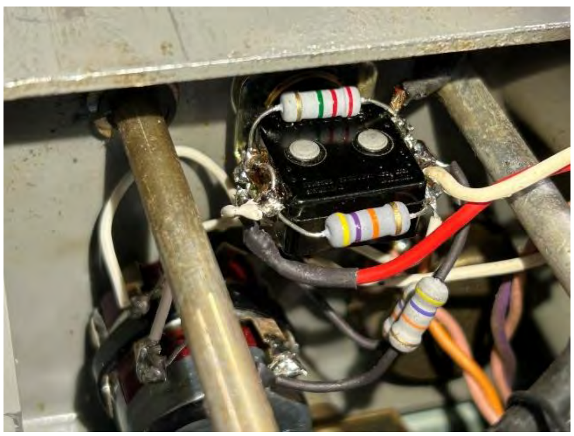
Next, I cleaned the nichrome track, wiper and the wiper contact track with a Q-Tip soaked in Deoxit D5, and then applied a light smear of Vaseline along the track. I then checked to see if there was continuity across the break in the nichrome track – there was (phew!). However, my jubilation was short-lived as while doing this, the entire rear pot assembly fell apart in my hands(!), and it took some figuring out how it all went back together – especially as to how the shaft was secured into the body of the pot. I eventually managed to reassemble the rear pot, re-test it (thankfully still working ok), and reconnect it with the front (IF gain) pot. However, one of the two lugs that bend over to hold the U-shaped clamp securing the two pots together snapped off as I was bending it back into place. Luckily, there was just enough of the lug left to hold on to the clamp if the clamp was held tightly against the front pot body – I did this using a stout cable tie around the front pot (photo, left).

The IF/RF gain pot assembly was re-installed in the chassis ready to be wired into the circuit, along with the replacement calibrator switch. Before I did this, thinking about the situation some more, I decided that if the RF gain pot operation was not satisfactory, it would be possible to swap the wiring between the RF and IF gain pots, thus having the pot that is in better shape (the front one) as the RF gain control, and the rear one as the IF gain control: I found that I generally had the IF gain fully advanced on my S830 sets, and only ever used the RF gain if needed to reduce the gain on a very strong station. The owner agreed that swapping the RF and IF gain pot functions would be appropriate.

Speaker Jack

To accommodate the owners request for a speaker output jack, I suggested removing the (never used) IF output BNC socket and installing a ¼" jack socket in its place to serve as a speaker output socket instead of having to use a large Jones plug for this purpose. Doing this would allow the installation of the jack socket without any butchering of the chassis, and would be easily reversible if anyone ever wanted an IF output socket, eg. to use a panadapter. The owner liked this idea, so I removed the BNC socket and its associated short length of coax, and then had a rummage around in my junk box, luckily finding a new ¼" 'skeleton' type jack socket small enough to fit in the available space where the BNC socket used to be on the rear apron of the receiver. As I was about to wire-up the speaker jack on the rear apron, I thought I may as well replace the components that lay underneath it and the S-Meter zero pot while I had good access, ie. the 100KHz IF cathode-follower components. I did that, finding the cathode resistor on the cathode-follower stage had drifted significantly out of tolerance and that the output capacitor was very leaky, so, although this circuit will not be used by the current owner, its now 'ready to go' if anyone wants to use it in the future (it is also used during the alignment procedure).

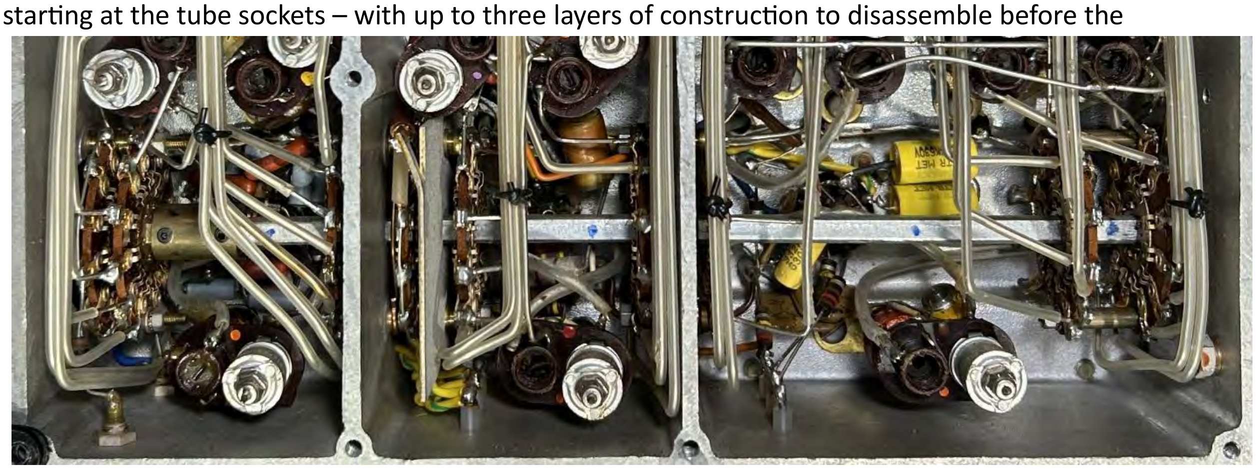
I then wired-up the speaker jack (photo, right), the RF/IF gain pots and the replacement calibrator switch (photo, below). As agreed with the sets owner, I reversed the pots, ie. the front pot (coupled to the rearmost/larger of the concentric control knobs) was now the RF gain control and vise-versa. This allowed the pot in better condition to be the one likely to be used the most while operating the set, ie. the RF gain control, used to back off RF gain in the presence of very strong signals to mitigate any cross-modulation/overloading, and the pot I repaired as the IF gain control (usually left at maximum in my experience of operating this model of receiver). The wiring to these controls is interlinked with the calibrator switch wiring, so some careful wire tracing was needed to ensure the pots and the switch functioned correctly.



Once wired-up, I tested operation and found that the calibrator was now operational when the switch was pushed in, with the receiver desensitizing as it should, and that both the RF and IF gain controls were functioning correctly. The repaired pot seemed to be working just fine, but I think the decision to relegate it to being the lesser-used control was sensible for long-term reliability.

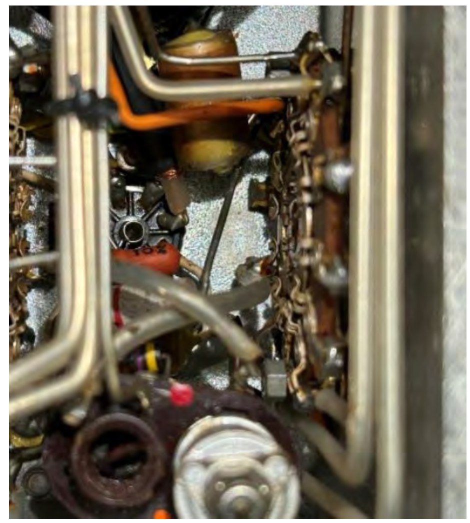
RF Sub-Chassis

The RF amplifier, 1st mixer and 1st local oscillator stages of the S830/2 (photo below, before rework), are by far the most difficult areas to work in due to the way Eddystone constructed these stages, ie. in layers starting at the tube sockets – with up to three layers of construction to disassemble before the

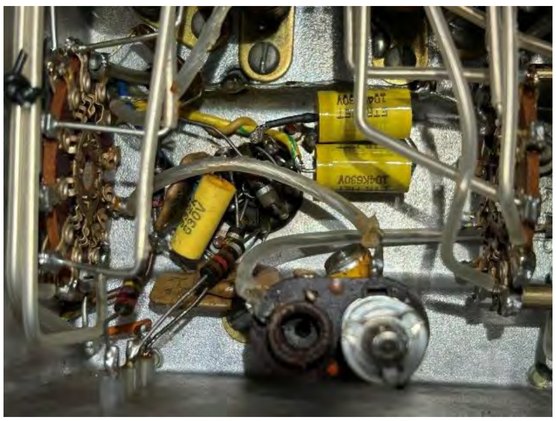


components right next to the tube sockets can be reached. Also, the space available to work in is very limited. especially in the 1^{st} mixer and 1^{st} local oscillator compartments, and there are several wires connecting the tuned circuits to the band change switch wafers running across these compartments, which are better not disturbed if possible.

To gain reasonable access, the band change switch shaft and coupler to the switch detent mechanism need to be removed, and then it's a case of 'slowly, slowly, catchy monkey'. In order to meet the owners expectations, and to mitigate having to access these areas of the chassis again for some time (hopefully!), I decided to replace all paper capacitors and resistors, leaving only the (generally very reliable) Philips 'mustard' (polyester dielectric), silver mica, and tubular ceramic/disc ceramic capacitors in place.



The easiest of these RF compartments to work in is the RF amplifier stage – the photos below show before rework (top)

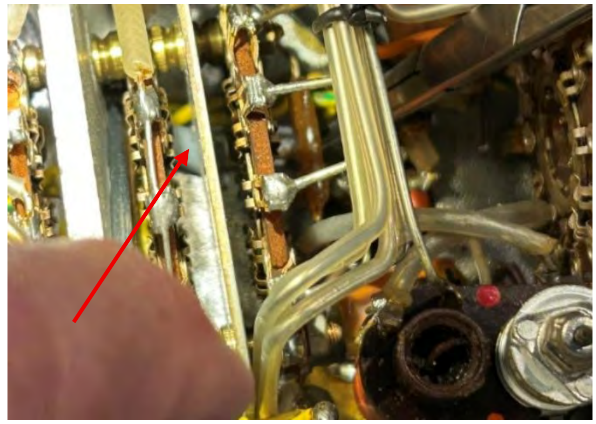


and after rework (bottom). The next most difficult is the 1st mixer compartment (more cramped, but fewer components) - the photos right show before rework (top) and after rework (bottom).

The 1st local oscillator compartment, which has the most components and is very cramped, is the most difficult to work in, but the single most difficult part to replace is arguably the coupling capacitor between the 1st local oscillator and the 1st mixer stage (C164, a 0.01uF grey plastic-encapsulated Dubilier metalized paper part[7] – almost impossible to see as its hidden under two switch wafers in the 1st mixer compartment) – tip of red arrow on the photo at the top of page 16. One lead of this capacitor passes between one of the switch wafers and the side

[7] On some S830 builds, including the last S830/2 I worked on, smaller, even worse, metalized paper capacitors were used (Hunts manufacture?), these looking exactly like rat droppings…(!)

of the compartment divider, then through a small hole in the divider, then around a switch wafer in the 1st local oscillator compartment, before attaching to the 1st local oscillator tube socket (pin 6). I honestly think this was the first component Eddystone installed in these chassis, and then built the rest of the radio around it(!).



Eddystone used one of the capacitor's leads to pass through the compartment divider, but doing that with heatshrink or PVC sleeve over the capacitor lead as re-work is virtually impossible and still be confident that the insulation remains intact. So, instead, I used a length of Teflon-insulated wire to pass through the hole (Teflon is very tough), and soldered the replacement capacitor to one end of the wire in the 1st mixer compartment, and the other end of the new capacitor to pins 2 and 3 of the 1st mixer tube socket.

I estimate that removing this one capacitor and installing the wire and new part took around an hour – it was definitely worth it though as the original capacitor measured 83pF – photo, above (should be 0.01uF), though, on the bright side, it was not leaking. The values of the other replaced Dubilier capacitors were also 'all over the map', eg. another 0.01uF part measured 320pF, and one 500pF part measured over 1000pF, and the resistors had all drifted out of tolerance, one by over 100% (screen resistor to the 1st mixer). Rebuilding the local oscillator section took around 3 hours to complete as there are 6 capacitors and 11 resistors in a piece of chassis real estate measuring around 1.5" square, and with very limited access.

The photos, left, show the 1st local oscillator compartment before rework (above) and after rework (below) – a total of 11 resistors and six paper capacitors were replaced in this compartment.

To complete the component replacement in just these three compartments took a total of over 5 hours, with a couple of breaks to go for a walk in the park and do some tidy-up in the yard. That did not include the prep time, which included carefully studying the schematic and trying to locate all the components in the chassis: some parts are very well-hidden, including the 0.01uF 1st local oscillator/1st mixer coupling capacitor as noted above, and the 500pF capacitor in the 1st local oscillator stage. Also, several resistors located around the 1st local oscillator stage tube socket cannot even be seen until components hiding them from view are removed (see the 'before rework' photo on page 16). The prep also included finding all the required components in my stock, and sorting them into three containers - one for each of the three stages. I find that when working on intricate reworking like this, particularly where several components may have to be removed at a time, it helps to place the removed components next to replacements until the replacements are fitted. This avoids confusion by making is easier to see what parts have been replaced already, and what parts are left to install. It also helps to tick each of them off on the schematic as the work proceeds.

It is good practice to leave the work once completed and re-inspect it with 'fresh eyes' another day: when I did this, I found I had missed replacing:

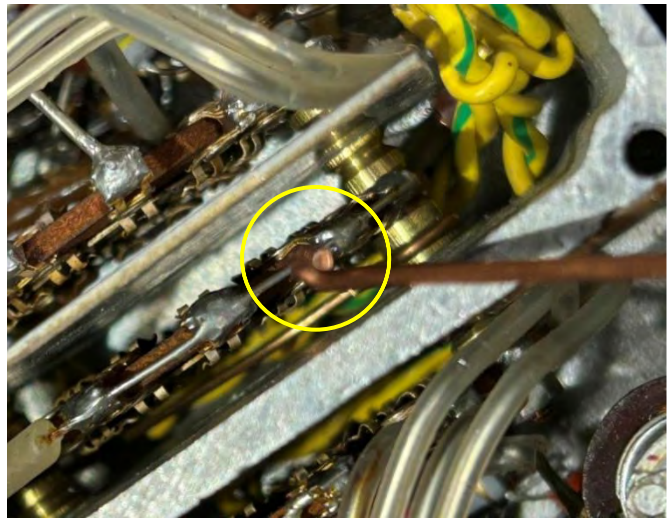
- one 'rat poop' paper capacitor in the 1st mixer compartment (hidden under the top of the L24 coil former (circled yellow on photo, right). One of the Eddystone S830/4's I used to own, and another S830/2 I worked on, used these awful parts in place of the grey Dubilier capacitors that are used in this S830/2. These small brown capacitors were amongst the worst components ever produced(!) - I think by 'Hunts' - but whoever the manufacturer was, they were too embarrassed to put their name on them. This piece of 'rat poop' should be a 500pF capacitor[8] (Band 9 RF stage to 1st mixer stage coupling), but measured only 7pF after removal from the circuit (not leaky though!). I had to remove the coil former for access, and I used a silver mica capacitor as the replacement;

- the grid leak (connected to the AGC line) in the mixer stage - this resistor was completely hidden under a 'mustard' capacitor; and

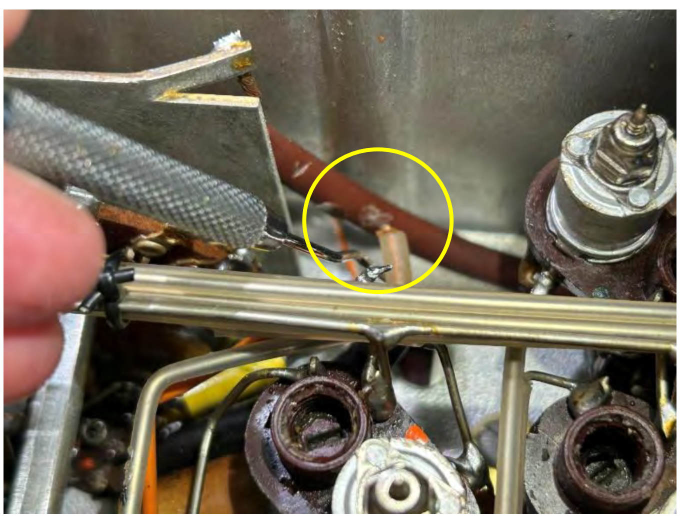
- two resistors in the 1st local oscillator compartment (not actually part of the local oscillator circuit, but associated with connecting the 150v stabilized (HT3) supply to the plate of the 2nd local oscillator and screen of the 2nd mixer stage when the set is switched to Bands 1 through 6 via one section of the band change switch (S1g). When I removed one end of one of these resistors, it was apparent that the other end was not connected (it had never been soldered – photo, left). This was a 2.2Mohm resistor that maintains the flow of a few electrons through these

[8] Amended to 800pF in Appendix 'A' of the manual

tubes when switched to Bands 7 through 9 to mitigate cathode poisoning. It was very awkward to solder the end of the replacement resistor to the tag on the switch wafer that had not been soldered previously, and I had to temporarily move the L26 coil former assembly out of the way for access.



With the above completed and re-re-checked, I re-installed the band change switch shaft, having to make a tool out of a length of stout wire to pull some of the detent springs into place (tip of this tool circled in photo, right). I then carried out some resistance/continuity checks of the RF sections - all checked out ok, apart from the plate supply connection to the 1st mixer tube – this was open circuit. I traced the fault to the connection from the short piece of coax that runs from the plate of that tube (6AK5, pin 5) to a section of the band change switch ('S1f'). The contacts on this switch wafer change the source of the plate supply to the 1st mixer tube from through the 1st IF (1350KHz) transformer primary (L34) when in dual-conversion mode (Bands 1 – 6), to the primary of the first of the 2nd IF (100KHz) transformers (T1), ie. bypassing the 2nd mixer stage, when in single conversion mode (Bands 7 – 9).

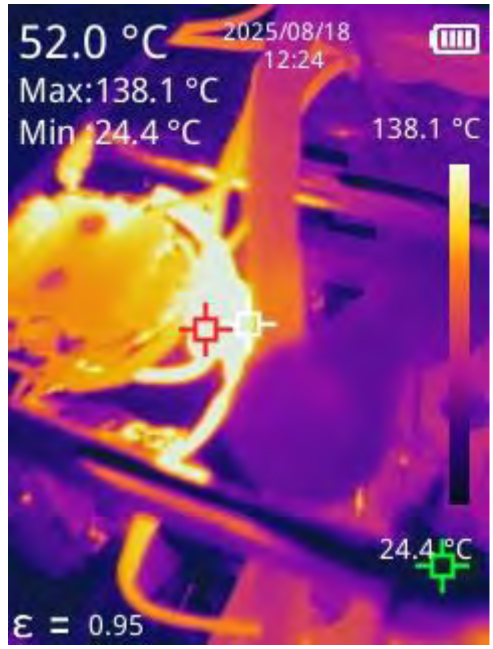


The inner of this short length of coax had detached from the wiper lug on the 'S1f' switch wafer – circled in photo, left (probably while I was manipulating the nearby coupling capacitor between the 1st local oscillator and the 1st mixer stage out of its 'hidey hole' to replace it). Unfortunately, this lug is in the same orientation as the one I had to access on switch wafer 'S1g' to install the replacement 2.2Mohm resistor – and just as awkward to access (or even see!). To gain access to the end of the coax and the wiper lug on the 'S1f' switch wafer, I had to remove another coil assembly (L17), which allowed sufficient (but still very tight) access to strip a short piece of insulation from the inner coax wire and solder it to the lug on the switch wafer. I then re-installed L17 and wired it into the circuit. All resistance/continuity checks were now ok.

I then powered-on the set and it was working on all bands. There was considerably more RF gain than before all the rework – so much that the AF gain control would not now fully quiet the set, even with the AGC active[9].

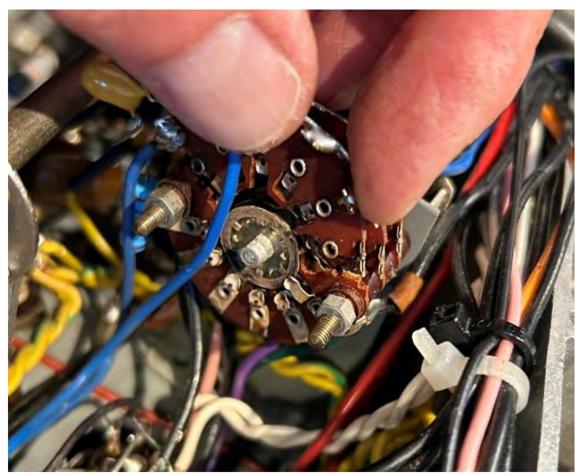
[9] This is a well-known problem with the S830 series sets, caused mainly by internal capacitance coupling between the (AM) detector diode and 1st AF amplifier triode within the 6AT6 tube. There are ways to mitigate this, to be addressed when working on that section of the chassis

The chassis was placed on soak test for a few hours to make sure everything was stable and working ok in the RF sections – all seemed ok, though some thermal images taken identified that the two 47Kohm 1W resistors from the 240vDC B+ supply to the RF and IF gain controls were running very hot (138C) – image, right. I calculated that these were dissipating 1.2W. Why Eddystone under-spec'd these parts is a bit of a mystery – anyway, I replaced them with 2W parts for reliability. I also cleaned the band change switch contacts before leaving the chassis on soak test for several more hours. The only issue noted, apart from the inability to fully defeat the audio with the AF gain control, as noted above, was some intermittent instability (parasitic?) when both RF and IF gains were fully advanced. I decided to leave troubleshooting this until I had completed component replacement in the IF/AF stages and checked alignment.



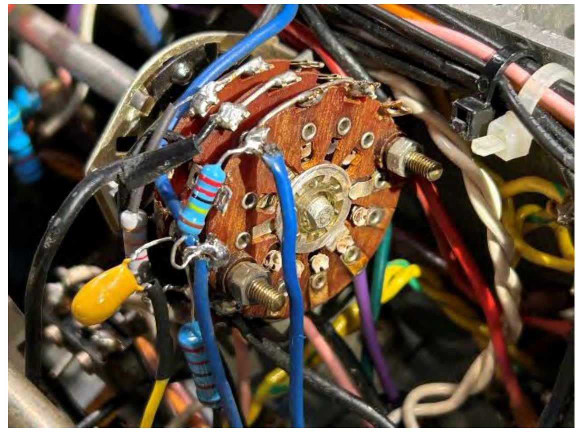
2nd IF/AF Sub-Chassis

As I was replacing components in the 2nd IF/AF sub-chassis, I found an error in the work someone had undertaken previously - they had replaced a 0.047uF decoupling capacitor with a 43pF silver mica part. I think they must have misread the schematic: this can be a bit confusing around the product detector circuit, as some components are in the main 2nd IF/AF section of the chassis, some around the three-wafer rotary (mode) switch, and some in a can (with the product detector tube mounted atop it), located above the chassis. Apart from sorting this out, all went fairly smoothly until I tried replacing the resistors located around the mode switch (used the switch between AM, CW, LSB, and USB). To access three of these resistors, the metal bracket that this three-wafer switch is mounted on needs to be removed from the chassis, the switch shaft pulled out of the front panel, and the assembly angled away from the chassis to expose the lugs the resistors are soldered to.



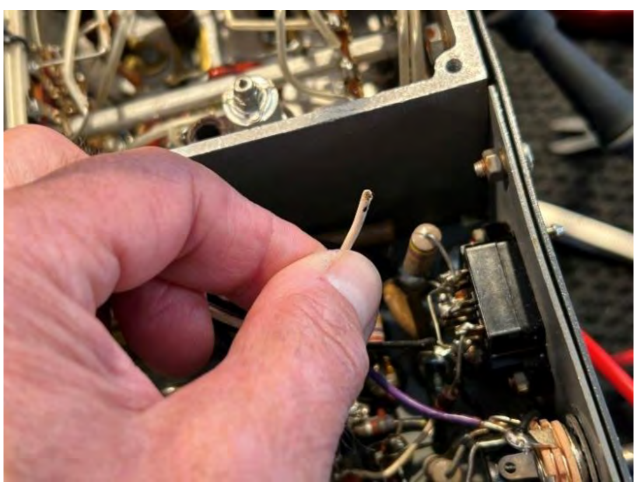
Removing the screws/nuts securing the mode switch bracket to the chassis is not easy (and replacing even more difficult!), but once I had done this and removed the angle plate at the rear of the assembly for access, as I was manipulating the switch assembly, the rear (phenolic) switch wafer broke in half (photos above and left). I think it must have already been cracked as no force was applied to the wafer that would have caused this to happen. I was thinking of trying to glue the wafer back together, but then recalled that I had some similar switch

wafers in my 'junk box'. Amazingly, I found a set of four genuine NOS Eddystone switch wafers (marked 'EC10'), individually sealed in plastic bags[10]. These were the exact replacement wafers I needed (what are the chances of that!).



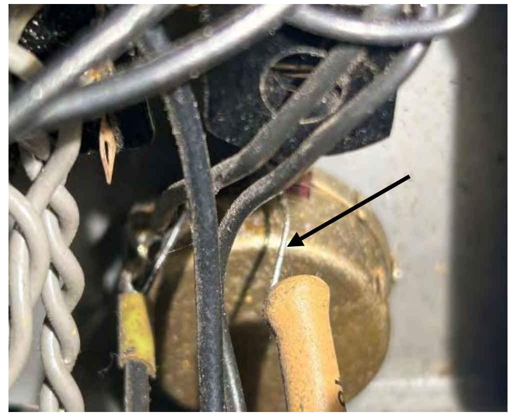
I had to remove several wires from the switch wafers to allow the tip of the soldering iron to access the solder lugs to remove the original resistors and install the replacements (and it was a bit confusing identifying which wire went to which tag afterwards!), but, after losing (and later finding) a nut and washer from the bracket in the chassis, the switch was successfully reassembled and the switch mounting bracket screwed back onto the chassis (photo, right).

The following day, I double-checked all the wiring to the mode switch, both visually and by making resistance/continuity checks between several circuit nodes with the mode switch and the AGC/noise limiter switch in various positions. All seemed ok, so I powered-up the set - to be met with (almost) total silence(!) - oh, boy, what had I done now... I checked that the audio section was working - it was, so I then did a little signal tracing, starting by injecting a modulated 100KHz signal into the grid of the 2nd 100KHz IF tube - that produced lots of audio on all modes. I then injected the same signal into the grid of the 1st 100KHz IF tube - virtually no audio. I then made some voltage measurements on the 1st 100KHz IF tube, and found that there was 245vDC (the B+ voltage) on the cathode(!) - no wonder the tube was not conducting.



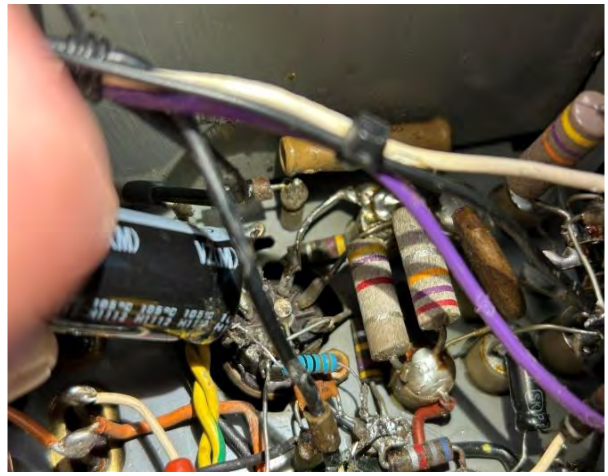
At first, I thought I must have disturbed the wiring around the calibrator switch/RF/IF gain controls when I was manipulating the mode switch shaft out of the front panel, so out came the calibrator switch (again!), but the wiring was ok. I re-installed the switch, and it dawned on me that the only way the full B+ voltage could be present on the cathode of the 1st 100KHz IF amplifier tube (and the RF amplifier tube), was if the line to the mute connection on one of the Jones sockets on the rear apron was not grounded - sure enough, the wire from the IF and RF gain controls to ground (via the muting link to ground) had detached from the lug on the Jones plug – photo, above left (not obvious when focusing on wiring in the 2nd IF section). With this wire detached, the 47Kohm 'pull-up' resistors that apply up to +47vDC to the cathodes of the RF amplifier and 1st 100KHz IF tubes when the RF and IF gain controls are fully CCW (minimum gain) give the full B+ voltage on these tube cathodes as the voltage divider resistance to ground is not present. Hooking up this wire to the Jones plug fixed this issue (it had probably become detached during the work on the mode switch somehow – likely fatigue on the wire strands).

[10] I think I must have purchased these from Ian Nutt of the EUG several years ago



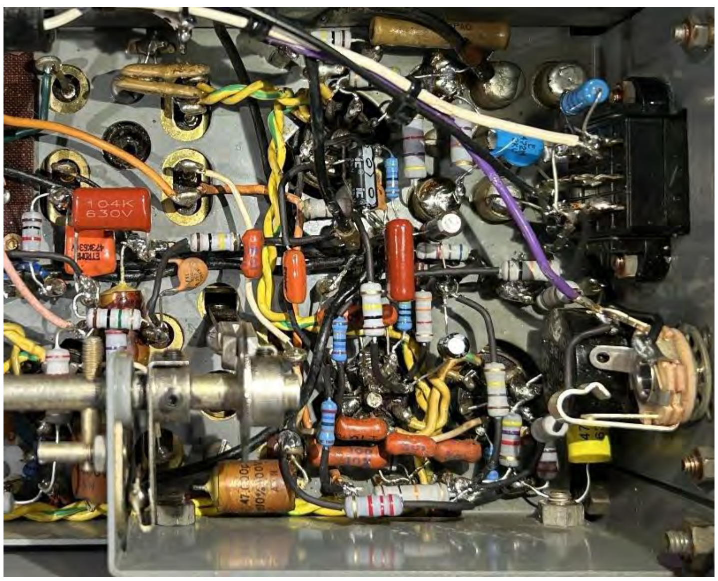
With that fixed, signals were again passing through the radio, but I noted that the audio was much lower than it should be, and that the AF gain control had minimal effect on the audio level. Again thinking it was likely due to a wiring error on the mode switch, I repeated the resistance checks between circuit nodes, and all still seemed ok. However, as I was doing this, I noticed that the wire from the coupling capacitor to the 'hot' end of the AF gain pot was resting against the body of the pot (tip of arrow in photo, right) - lifting the wire away from the pot sorted out the low audio problem (ironically, I had probably disturbed the wiring during the resistance checks!).

That said, how come there was as much audio passing through the set as there was with the AF gain control shorted? Surely that could not all be due to internal capacitance coupling between the AM detector diode and grid of the triode in the 6AT6 tube? I then started to suspect that there may be an issue in the audio stages. So, next, I completely re-built this area of the chassis - several components had already been replaced (photo, left), and the workmanship and component dress was really bad, with shorts occurring with the slightest movement of some parts or wires, and several components were completely obscuring the underside of the 6AT6 tube socket. I took my time and tried to replicate the original factory (very 'regimental' and neat) component dress, replacing all resistors and paper/electrolytic capacitors. I also had to remove/strip and re-attach a couple of the miniature screened leads as the braid was frayed, and was almost shorting to the inner wires. While doing this rework, I found that someone had made an error in the wiring during previous component replacement, such that the cathode of the 6AT6 was not bypassed correctly. I have found in all S830 sets I have worked on that providing good cathode bypass is essential to minimize the audio breakthrough in the 6AT6. The original circuit has two cathode resistors to this tube in series (3.3Kohm and 6.8Kohm) providing the delayed AGC action, the 3.3Kohm resistor bypassed with a 10uF electrolytic and the 6.8Kohm resistor bypassed with a 25uF electrolytic. This results in these cathode bypass capacitors being in series, giving in an effective bypass capacitance of only around 7uF. I have found that increasing the value of these capacitors significantly reduces the audio breakthrough in the 6AT6. I had to use values up to 220uF in place of the 25uF part on one set, and add a 100uF directly between the cathode and ground on another to fully 'quiet' the set with the AF gain control turned fully CCW. The optimal values seem to vary with each set, so I started out here by doubling the original values, ie. with a 22uF and a 47uF capacitor in place of the 10uF and 25uF parts. These parts are easily changed-out if this is needed, especially if radial lead parts are used. Another odd mistake made by someone, this time in the audio output stage, was that a 33uF 450vw electrolytic had

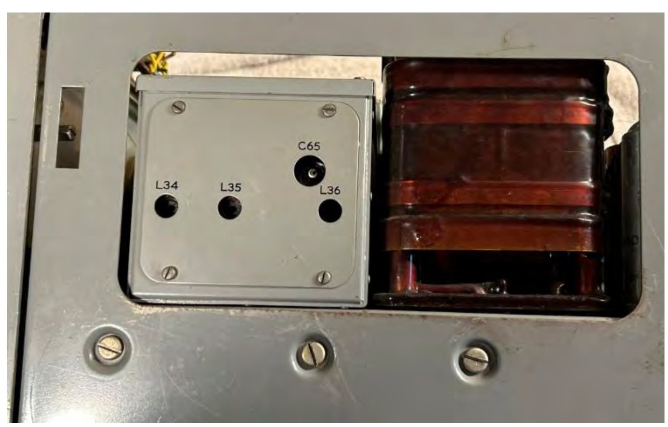


been installed as the cathode bypass capacitor – photo, right (it only has around +12vDC on it!) - perhaps they only had a 450vw electrolytic on hand at the time?

The next day I re-checked my work before switch on. All seemed ok, but on switch-on (you guessed it!) - silence. A few voltage checks soon identified the issue - I had installed a 22Mohm resistor in place of a 2.2Kohm resistor in the plate supply of the 2nd 100KHz IF tube (I must have been really tired the previous evening!). Installing the correct value resistor brought the set back to life, but now there was severe instability, especially with the AGC active, but only on AM and CW. This was soon traced to another (tiredness-induced) error - I had forgotten to install the 0.1uF AGC bypass capacitor (this is located in the audio stages and had been removed for access). When the set is in LSB or USB modes, a 10uF (tantalum) AGC bypass capacitor is switched into circuit to increase the time constant - slower is more suitable for SSB, and this prevented the instability. Installing a 0.1uF AGC capacitor (faster time constant for AM and CW) fixed the instability issue. I left the chassis on soak test for a couple of hours and all seemed ok. The photo, left shows the reworked audio stages.

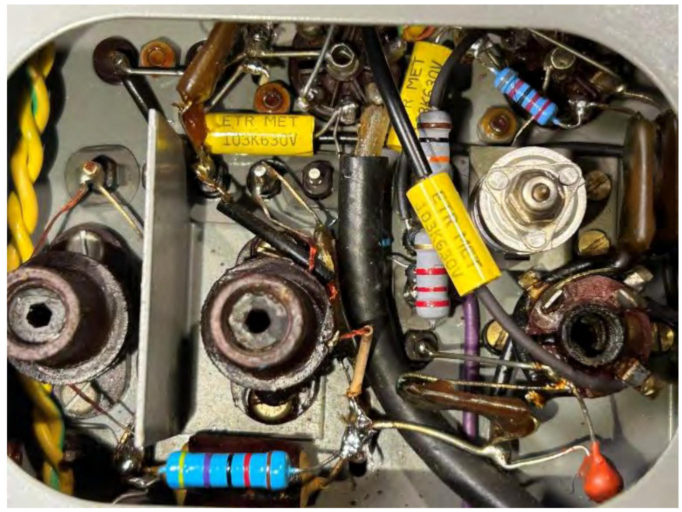


2nd Mixer/2nd Local Oscillator



On opening up 2nd Mixer/2nd Local Oscillator compartment, noting that the outer (side) cover plate was absent, only the inner alignment plate being present (photo, right), I found that the paper capacitors had already been replaced with 'yellow jackets', along with one resistor (photo, top left on page 23). I decided to leave the replaced capacitors in place as they are out of sight, and only replace the remaining original resistors. I was mindful to dress the two 2W resistors carefully to avoid heating the (original) Philips 'mustard' capacitor – photo, top right on page 23 (the original 10Kohm and 47Kohm resistors had been positioned such that this capacitor was heated unnecessarily). I then cleaned/re-lubed the incremental tuning

capacitor gang and drive mechanism, and tested the two tubes (6C4 and 6AK5) that are housed in this compartment. Both tubes tested very good, though I noted the 6AK5 had been subbed with a '5591' (aka '403B'), which is a special quality version of a 6AK5 with a slightly lower heater current draw (this one made by Ericsson in Sweden). I tested all was well before I installed the side and top covers, leaving the set tuned to WWV on 10MHz for an hour.



As I was replacing the 2nd local oscillator/2nd mixer compartment covers, I noted that one of the (6BA) screw sockets on the top cover was missing from the compartment – someone had simply glued the head of this screw to the top cover to make it look like there were four screws installed(!). I fixed this by epoxying a 6BA hex spacer into the corner where the missing socket should have been (circled in photo, left) – now all four screws could be secured properly. I also replaced the screws with cheese-head 6BA screws as the screws that had been fitted were not BA types.

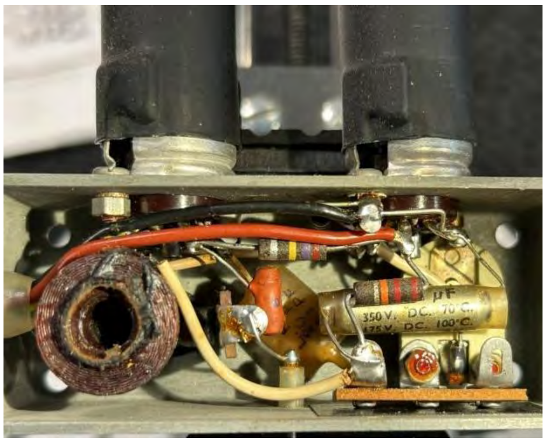
Product Detector

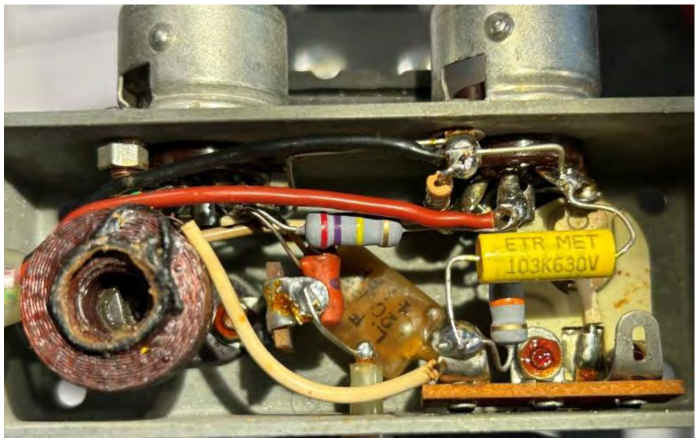
Next, I removed the product detector assembly (can with the 6BE6 tube on top) from the chassis for refurbishment. One 10Kohm resistor located in the can measured almost 15Kohms (screen resistor to the 6BE6 tube). I was surprised to find that someone had been in there previously and replaced the metalized paper and the electrolytic capacitor, as well as one resistor: a 47ohm grid stopper on the 6BE6 tube (photo, right) – strange, as these low value resistors hardly ever drift significantly. I replaced all the remaining original resistors and also installed a fresh electrolytic in place of the previously replaced one, plus added heat shrink to some of the leads.

The photos, right, show the reworked product detector unit prior to reinstallation in its screening can. I then re-installed the assembly onto the chassis, wired it into the circuit and tested its functionality on CW, LSB and USB – all ok.

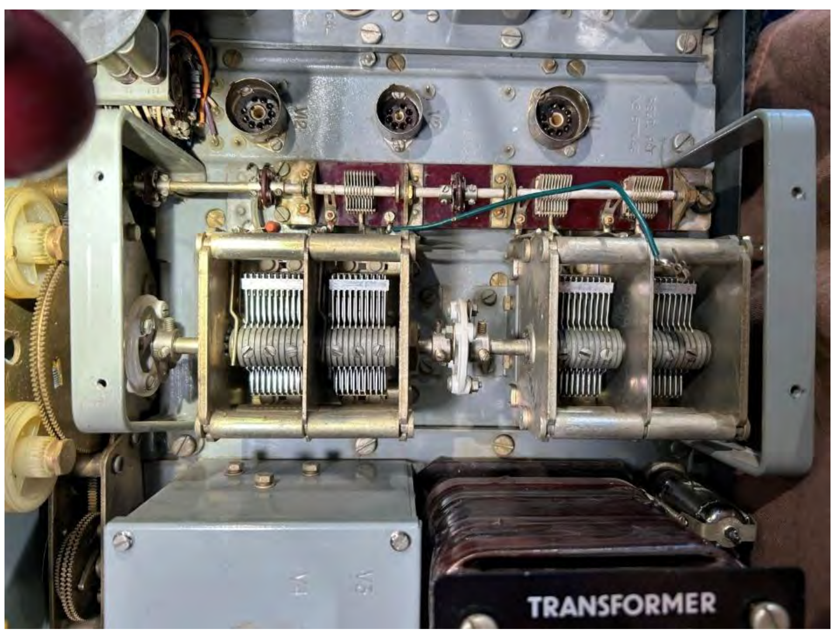
Crystal Calibrator

I then removed the crystal calibrator box from the top of the main tuning gang cover and replaced all resistors and the (original) metal-bodied tubular paper capacitor, refitted the box to the tuning gang cover and tested it – it was working well (photos below left, before rework, below right, after rework).





Additional Cleaning



Next, I removed the main tuning gang cover and spent some time cleaning the chassis underneath and either side (as removing this cover provides better access) – photo, right), replaced the resistor mounted on the rear wafer of the crystal select switch, as well as servicing the tuning gang and the antenna trimmer capacitor gang – the gangs being cleaned, contacts surfaces wiped with Deoxit D5, ball bearings greased, and a drop of light machine oil added to the plain bearings. I also cleaned and re-lubed the pointer guide tracks and parts of the main tuning mechanism above the chassis.

Following further soak testing and operating the receiver, I noted three issues to the owner:

- The first issue is that the power transformer had a very slight buzz/fizz noise that can be heard with your ear right next to it, the audio is turned right down, and when the room is silent (I only noticed it because I had by head right next to the transformer while the set was powered-up as I was checking-out the 2nd local oscillator/2nd mixer compartment). The power transformer runs cool and does not seem to radiate any RFI, and given that these transformers were really over spec'd, it is probably ok – something to be aware of though. I recorded an audio file of the noise to send to the owner - recorded with the mic of my iPhone held right onto the transformer;

- The second issue was that very little signal appeared to be passing through the (GEC) 100KHz crystal when this was switched into circuit, ie. with the Selectivity control at maximum selectivity position 'N' (narrowest selectivity position, for CW in difficult reception conditions). The microswitch operated by the Selectivity control shaft was working ok, so I removed the crystal and tested it using a NanoVNA. It seemed to have low-activity compared with another (Marconi) 100KHz crystal from my junk box, though swapping it for the other 100KHz (GEC) crystal from the crystal calibrator gave similar results. I was now thinking that the lack of signal could be that the 100KHz IF was misaligned - the re-alignment should tell if this was the case; and

- The third issue was some intermittent instability when operating the 'RF Peak' control, but only noted on Band 7 – I figured that realignment may resolve this, but if not, I would troubleshoot.

The good news was that following the rework of the audio stages, the 6AT6 audio breakthrough was now minimal and the audio could now be (almost) silenced when the AF gain control was fully CCW.

Tube Testing

I next tested all the tubes on a STARK 9-66 tester (photo, right). All tested very good, except the 6AT6 AM detector/AGC/1st audio tube, in which the triode section was weak. All the 6AT6 tubes I could find were 'pulls' and the best of them tested around the same as the one in the set, so I left it in place. It seemed to work ok, but I noted to the owner that if he had a better one, he may want to install it. I also cleaned all the tube pins and replaced two of the smaller tube shields with the correct size ones from my junk box.

Mechanical Work

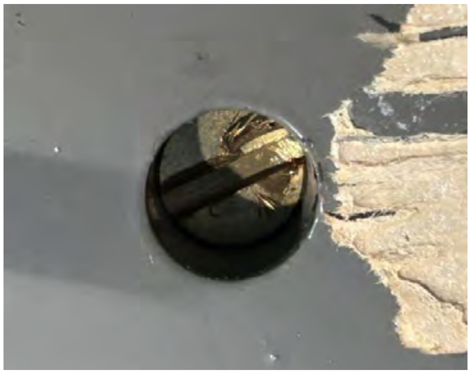
I re-installed the coil box cover – sorting out some better self-tap screws than the ones that were in there (and some were missing), and then started work on the receiver 'mechanicals'. After some checking, I confirmed that the rattling and 'rough' main tuning action was the result of a worn brass bearing on the

tuning shaft. Luckily, I had a new (repro) one in one of my Eddystone parts bins (photo, right), and was able to fit it without removing the front panel (the four tapered 0BA screws holding it to the chassis would not budge – see below).

I had bought two of these repro bearings many years ago[10] when my Eddystone S940 had the same problem (see page 18 of my S940 article here), and the spare one has been waiting for this day ever since(!). Fitting the new bearing, lubing (using 'Superlube' oil in the bearing and a

little 'Superlube' grease on the washer between the flywheel and the rear of the front panel), along with some careful adjustment of the end play, resulted in the very smooth tuning action as is expected from an Eddystone slide rule dial set (see video, here, and article on Eddystone tuning drive mechanisms, here). The repro bearing did not have a lube hole in it (the original ones do), so I drilled one through the bearing to match the original prior to fitting it to the chassis (photo, left).

I had removed the fingerplate to access the four tapered screws holding the front panel to the front of the coilbox (no easy task as someone had used amazingly strong double-sided tape to hold it in place). Once I had the fingerplate removed, I could tell someone else had also tried to remove the tapered screws as one of them was badly gnarled (photo, right). I think the only way to remove these screws in this chassis would be using an impact driver, and that is not good for the radio(!), so that would be the last resort if it HAD to be removed. The bearing is retained by three 6BA screws that screw into a metal ring with 3 x 6BA tapped screw holes in it. This metal ring is located on the rear of the front panel (hence me trying to remove the panel), and is hidden by the flywheel located in front of the friction drive



mechanism. Of course, removing all three of the bearing retaining screws at once would allow the metal ring to fall between the flywheel and the front panel, and it cannot then be positioned to accept the screws to secure the bearing. However, I figured out a way of holding the metal ring in place without removing the front panel: by changing out the bearing using a very long 6BA screw to hold the metal ring in place while allowing the old bearing to be removed and the new bearing installed (photo, left).

Tidying-up

While I had the AF gain pot and 'phones jack loosened from the front panel, I checked out a loose wire that was hanging near the 'phones socket, and I found a broken 2.2Kohm resistor attached to the phones socket lugs (photo, right). Investigation showed that the 'phones socket had been re-wired by someone, and they bodged it such that it did not function as Eddystone had intended. I suspect that the 'phones socket had been replaced at some time with one that had the (usual) switching arrangement on the tip, whereas the socket needed to match the schematic must switch the sleeve (normally ground) connection – this allows high impedance 'phones to be used, and breaks the ground lead to the (low impedance) speaker connection when the 'phones jack plug is inserted. I was able to convert the jack socket to the correct switching configuration and return the wiring to its intended configuration, as well as installing a new 2.2Kohm resistor (part of the voltage divider to the 'phones socket). I also added some heat-shrink to the lead from the coupling capacitor to the 'hot' end of the AF gain control, ie. the lead that had previously shorted to the metal case of the pot and grounded the audio, so that problem would not occur again. I then squirted some Deoxit F5 into the pot as it was a little noisy over part of its travel.

With the fingerplate and knobs/switches re-installed on the front panel, I added a red marker line to the larger of the concentric RF/IF controls to match the colours indicated on the front panel lettering, so the owner would not get confused as to which is which when operating the set (photo, left).

I then removed the dial glass by removing the dial light bracket – (I had already removed the two panel cheeks), and then cleaned the dial, pointer and glass, and then reassembled the dial.

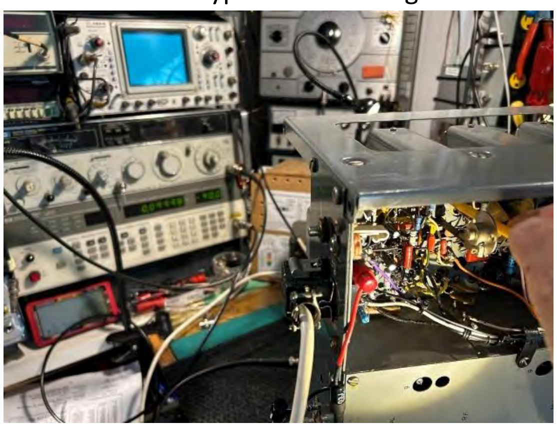
I removed the crystals from the 1st local oscillator crystal bank and cleaned the remnants of the foam from them (now a sticky, corrosive dust – photo, right), and from the underside of the round cover plate. I planned on attaching some new foam to the cover plate before re-installing the crystals.

Realignment

Following completion of the major component replacement work (a total of 92 resistors, 7 electrolytics, 16 tubular paper/film capacitors, 3 disc ceramic capacitors, 2 silver mica capacitors, and four silicon rectifiers so far – not counting already replaced parts I kept in the circuit), I left the set on soak test for a day - all seemed to be ok, so I started setting up for the 2nd IF (100KHz) alignment.

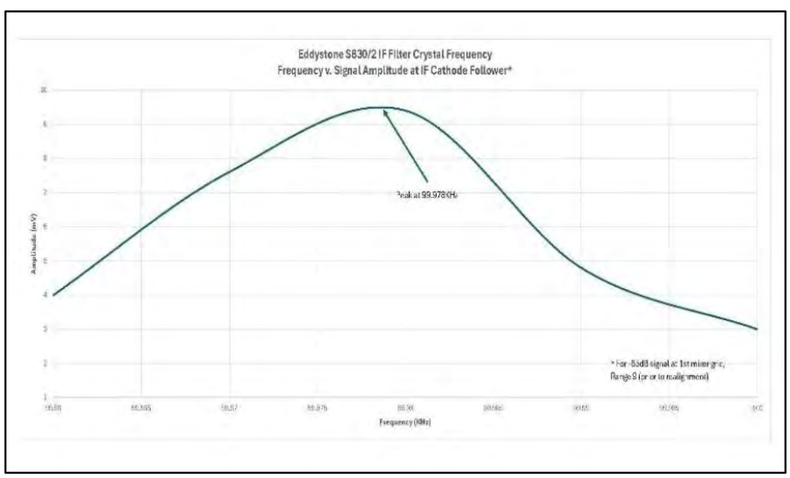
I thought I would try using my HP8640B analogue signal generator fed to an HP11710B down converter to obtain the nominal 100KHz signal for this stage of the alignment (the RF signal generator section of the HP8640B only goes down to around 448KHz) – photo, right: the HP11710B is at the top left and the HP8640B at the bottom right.

The HP11710B down-converts a signal in the 50 – 61MHz range from the HP8640B to the 10KHz – 11MHz range with the same output signal strength and modulation type as the settings on the HP8640B.



This worked ok, but I found that this setup was not suitable to find the resonant frequency of the 100KHz filter crystal in the S830/2 – at least within a reasonable warm-up period of the HP11710B/HP8640B combo (45mins) – as the frequency of the down-converted signal was not quite stable enough. This was likely due to the OCXO in the HP11710B not being at temperature equilibrium, as this unit is meant to be powered-on at all times, but as I only occasionally use it, it had not been. Also, although the HP8640B can be GPS locked once the desired frequency has been set, the unit cannot be locked while tuning it to find the crystal resonant frequency[11], ie. it is a free running oscillator in this condition, and HP note it takes at least 2 hours to stabilize.

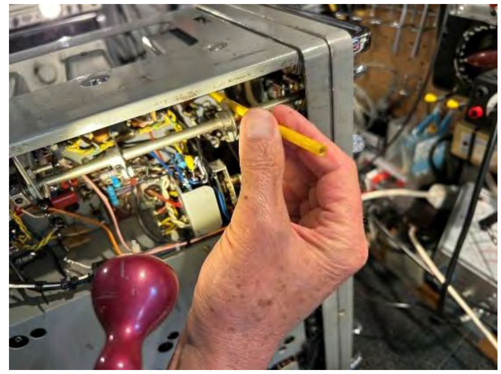
So, instead, I used my HP8656B (digital, GPS-controlled) signal generator to determine the crystal frequency (photo, above). However, this unit has a frequency step of 10Hz, so to accurately determine the resonant frequency of the crystal, I plotted the output level of the 100KHz IF cathode follower stage against frequency. A plot of the results is shown right, which indicated that the series resonant



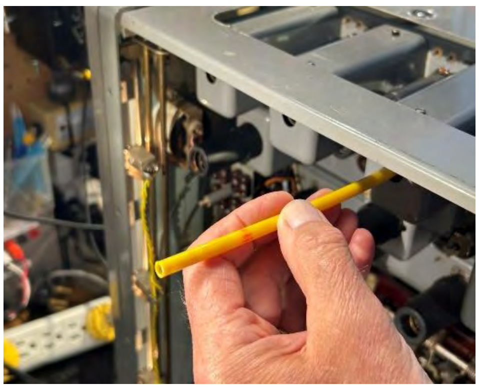
[11] Either to the GPS or the OCXO output of the HP11710B

frequency of the crystal to be 99.978KHz (coincidentally, this is the same resonant frequency as the 100KHz crystal in one of the 830/4 I owned and measured back in 2011).

2nd IF Alignment

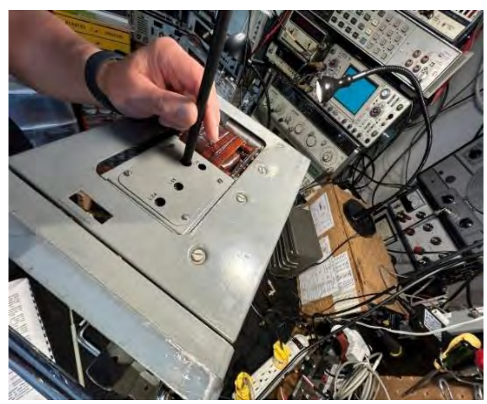


I began the 2nd (nominal 100KHz) IF stage alignment using 99.978KHz as the centre of the nominal 100KHz 2nd IF passband – I used my HP8656B for this, set to 99.98KHz – only 2Hz off the interpolated peak. I planned on using my Siglent spectrum analyzer to check the shape and symmetry of the 100KHz IF later, but for now I followed the procedure in the manual, ie. peaking all the 2nd IF slugs, though omitting the (rather crude) checks on the IF passband symmetry.



The four 100KHz IF transformers peaked nicely (photos, above and left), with four of the slugs being significantly off resonance – especially the primary and secondary slugs in T3. This brought the overall sensitivity of the set up considerably. I then set-up the BFO on CW and on LSB and USB (photo, page 4), the latter being set using +/1.5KHz offsets on the HP8656B signal generator rather than the crude method described in the manual.

1st IF Alignment



I then moved on to the 1st (nominal 1350KHz) IF stage alignment. This stage is tunable +/-100KHz using the 'Incremental' tuning control on Bands 1 through 6, allowing 1KHz frequency resolution on these bands. I found that the centre frequency of the incremental tuning dial was around 8KHz 'off', and this discrepancy increased to around 11KHz at the either end of the incremental tuning range. I followed the procedure to correct this in the manual, and after numerous iterations of the trimmer (C65 – photo, right)) and corresponding inductor (L36), I finally achieved good frequency tracking across the 200KHz tuning range of this stage.

So, all was going well, until I started to adjust the slugs in the tunable (1250 - 1450KHz IF stage transformer, L34 and L35, along with their associated trimmers (C74 and C77) to peak the signal at the low and high end of this tuning range. L34 peaked nicely, but the slug in L35 was jammed in the coil former, and I noted that the hex hole in the centre was well-rounded, plus there was a crack in one side of the slug (photo, left), indicating someone had tried (hard!) to turn it and failed. I eventually managed to coax this slug outwards from its initial stuck position by dribbling some Deoxit D5 down the sides of the screw thread, between the slug and the coil former, and using a hex alignment tool with an elongated hex section, but it was so stiff there was no way it could be used for adjustment, so it had to be removed. After around a half hour of coaxing, the slug almost poked its top above the lip of the coil former and then jammed again. This time it was stuck tight and no amount of coaxing would budge it…. it would need to be destroyed to remove it from the coil former.

So, I spent the next hour carefully breaking the slug apart in-situ (photos right) – I think it was ferrite, as it was very hard and brittle, not breaking-up relatively easily as iron dust slugs tend to do (remnants shown in photo, below). Inevitably, the top section of the coil former broke away while I was doing this (centre photo, right), but that actually helped in removing all the pieces of broken slug from the former. With the pieces of the slug removed, I cleaned-up the screw threads in the coil former using a mascara brush – photo, below (these are great for this job!), and then glued the broken piece of the coil former back into position using quick-set 2-part epoxy. I held the coil former together while the initial set of the epoxy occurred, then allowed a couple of hours for the epoxy to set hard.

I pulled out a selection of slugs from my junk box: two tubs of the slugs were genuine Eddystone parts: one tub contained some slugs recovered from an Eddystone S940 chassis (marked 'RF' and 'IF'), and the other some NOS slugs bought from Ian Nutt[10] many years ago as spares. Most of the slugs were the larger diameter/course thread type as used in the L35 coil former, but none had the hex alignment tool hole – all were for flat-blade alignment tools. Before I tried one of these in the coil former, I slipped a small cable tie around the section of

the former that had been glued to provide some additional tensile strength to the glued joint. I repeated the thread-cleaning exercise with the mascara brush, and then slowly started to screw in one of the new slugs – I did this a few threads at a time, then withdrawing, cleaning and repeating until I could screw the slug fully through the former without any binding. I then added a little 'ROCOL' Kilopoise high-viscosity (thixotropic) grease to the slug and re-inserted it into the former (photos below and right). Finally, I cleaned around the outside of the coil former with IPA and added a ring of epoxy glue around the coil former to hold the cable tie firmly in place.

Once the epoxy had set, I warmed the set up for an hour and then re-aligned the 1st IF per the manual procedure – I tried a few different slugs in the L35 coil former, including one of the 'RF' (ex-S940) slugs and a couple of the NOS ones. I found the NOS ones worked better than the 'RF' one, ie. they had a higher peak at resonance, likely indicating that the slug material was more suited to the 1st IF frequency application (1350KHz +/-100KHz), so I left one of those slugs installed.

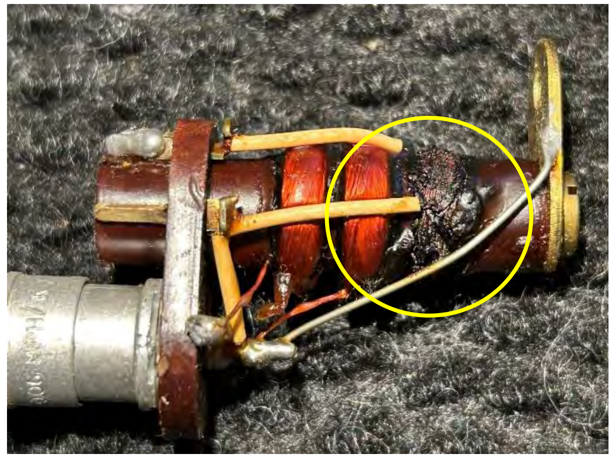
While the set was warming-up, I mixed some 2-part epoxy modelling putty ('Milliput') and placed some around the 6BA standoff I had epoxied into the corner of the 2nd local oscillator/2nd mixer compartment previously, then when set, I painted the putty grey so it looks less of an obvious repair.

I re-checked the 2nd IF alignment and confirmed all was ok, so I re-installed the top cover on the 2nd local oscillator/2nd mixer compartment. I then glued a piece of expanded polythene foam to the underside of the crystal bank retaining plate, and re-installed the 6 crystals in the crystal bank. I also re-installed the tuning gang cover and set things up for the RF alignment.

RF Alignment

I followed the RF alignment procedure per the manual, except I did not use the calibrator to check the frequency accuracy of the dial – much easier to use the GPS-locked HP8656B(!). The procedure went well on all bands and no problems were encountered with the slugs or trimmers on any band – several of the bands were 'way out' of alignment and others were almost 'spot on'. However, I noted that the sensitivity appeared to be significantly down on Band 7 compared with all the other bands.

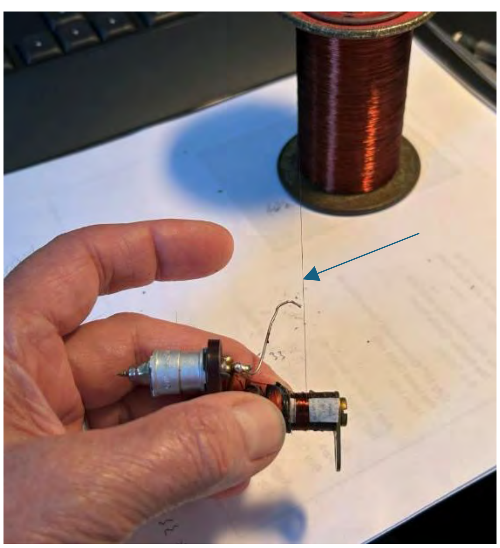
When I had completed the alignment, suspecting there may be an issue with either the band switch or a Band 7 coil, I did some resistance/continuity checks between the antenna socket and the antenna transformer on Band 7. I found that the primary winding of the antenna transformer was open circuit (the resistance from the antenna to ground was around 1Mohm, which is the value of the static



discharge resistor) – that explained the low sensitivity. So, I removed the Band 7 antenna transformer assembly and sure-enough, the primary winding was a black mess (circled in photo, right) – it had been well and truly 'zapped'.

Luckily, the primary and secondary windings of the antenna transformer are separate on the coil former, not wound concentrically: the secondary winding located near the top, and the primary winding near the bottom. Also, only the secondary winding is tuned by the antenna trimmer, and the primary winding is not wound with Litz wire, but a fine gauge enamel-coated 'magnet' wire, making it much easier to repair. I tried to see if I could tease the primary winding apart to rescue the winding, but it was 'too far gone'.

So, the only thing to do was to reverse-engineer the winding and rewind the primary. To do this, I cut the winding off the former so I could measure the wire gauge with a micrometer (photo, left) – it measured 5 thousands of an inch = #36AWG. I then teased out all the strands from the winding (photo, right) and counted them – I made it 52 turns (+/- a turn or two given the condition the remnants of the coil were in), so I needed 52 turns of #36AWG wire. I checked my junk box, and the nearest wire gauge I had was #38AWG, which is around 4 thousands of an inch diameter – good enough.



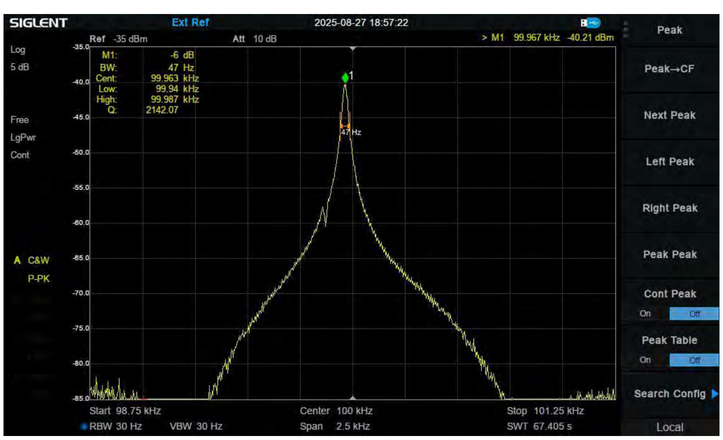
I cleaned-up the part of the coil former where the original primary winding had been located, and hand-wound 52 turns of the #38AWG wire around the former (photo, left – tip of arrow indicates the wire) – I could not wind 'honeycomb' style per the original, just four layers of 13 turns each. I secured the coil with masking tape as I was winding it, and applied some coil dope once completed. The completed winding had a DC resistance of around 2 ohms. I wired the coil into the transformer, and re-installed this into the RF compartment of the coilbox assembly (photo, top of page 33). Next, I realigned Band 7 again (I was surprised how much adjusting was needed with the antenna coil repaired), and on testing afterwards, the sensitivity on Band 7 was now much better.

I then used the HP8640B to do a rough sensitivity check on all bands, with the minimum discernable signal levels as follows - all around the middle of each band, plus at the top of Band 1. Also, Band 9 was measured at 450KHz as this is at the lower end of the HP8640B frequency range:

	AM	CW
Band 1 (30MHz):	<0.15uV	<0.02uV
Band 1 (23.5MHz):	<0.1uV	<0.015uV
Band 2 (14.5MHz):	<0.075uV	<0.02uV
Band 3 (8.8MHz):	<0.075uV	<0.01uV
Band 4 (5.3MHz):	<0.075uV	<0.01uV
Band 5 (3.2MHz):	<0.15uV	<0.035uV
Band 6: (1.95MHz):	<0.075uV	<0.015uV
Band 7 (1.12MHz):	<0.05uV	<0.015uV
Band 8 (650KHz):	<0.06uV	<0.015uV
Band 9 (450KHz):	<0.1uV	<0.015uV

This indicated that the repair to Band 7 antenna coil was successful, with this band now having a similar sensitivity to the others – and no hint of the instability noted previously.

I then coupled the receiver to the Siglent spectrum analyzer (photo, right), and checked the 2nd IF (100KHz) response curves. The shape of the widest curve ('AM' on the Selectivity control) was initially rather asymmetrical, but a little tweaking of the slug in IF transformer T2 (as suggested in the Eddystone manual) corrected this, and the resultant (-6dB) bandwidths were measured as follows – all with excellent symmetry, and, of course, continuously variable between 5.367KHz and 1.233kHz, due to the mechanical (variable winding separation) method used in this receiver:



AM:	5.367KHz
SSB:	2.7KHz
CW:	1.233KHz
N (crystal):	47Hz

Plots illustrating the above are included in the Appendix. The sharpness of the crystal resonance (plot, left) is very impressive – no wonder the NanoVNA was having trouble checking it!.

Final Tidy-up, Tweaks and Checks

I completed cleaning the remaining switches and parts of the chassis, including the AGC/noise limiter rotary switch, and the couplings and bearings on the selectivity control shaft, as well as adding some additional cable ties to the wiring looms to tidy things up.

I also replaced the AF gain pot (photo, left), as the Deoxit F5 was not working at the lower part of the original pots travel, and the audio output level was annoyingly intermittent at low volume levels.

I then aligned the crystal calibrator – both for maximum output at higher frequency harmonics and for frequency – now exactly 100KHz. I also checked operation of the Incremental tuning control – it was working well (see brief demo video here).

With all that completed, I checked the (AM) SNR on each band using my Agilent 8935 (E6380A) CDMA test set, outputting 3uV of 30% AM modulated carrier at the same frequencies as I used for the minimum discernable signal tests (except on Band 9, where I used 400KHz, as the Agilent test set can go down to this frequency) – photo below, right. Results as follows:

Band 1 (30MHz): >16dB

Band 1 (23.5MHz): >20dB

Band 2 (14.5MHz): >21dB

Band 3 (8.8MHz): >21dB

Band 4 (5.3MHz): >21dB

Band 5 (3.2MHz): >19dB

Band 6: (1.95MHz): >21dB

Band 7 (1.12MHz): >22dB

Band 8 (650KHz): >23dB

Band 9 (450KHz): >22dB

The published spec. for this receiver is for a SNR of >15db with a 3uV signal on all bands – this set was now easily meeting that, and exceeding it by a very large margin across most of its range (up to 8dB better than spec. on Band 8), with a 1uV signal achieving an AM SNR of >12dB.

Final Testing

After further soak testing, I made four short videos:

- The first video illustrates how the signal to noise ratio (SNR) was measured using the Agilent 8935 test set. I actually measured slightly better SNRs on the video than noted above on the frequencies I illustrated the technique with. This video can be viewed here;

- The second video describes the variable selectivity control, and illustrates the change in bandwidth as the control is operated, including when the crystal filter is switched into circuit. Prior to making this video, I made some further minor tweaks to the 1st IF (primary) and 2nd IF transformer slugs to broaden and flatten the peak of the widest (AM) bandwidth to give the correct 6KHz spec. for this setting (the top of the response curve now flat within 2.5dB). Work undertaken on the underside of the chassis is also described briefly in this video as the set is sitting on one end. This video can be viewed here;

- The 3rd video is a general demo of the set operating on the Broadcast band and receiving WWV on 2.5MHz, 5MHz, 10MHz and 15MHz – the Broadcast band was absolutely packed with signals, even using my small (internal) active magloop antenna. This video can be viewed here; and

- The 4th video is a demo of the set receiving SSB on the 20M ham band, and can be viewed here.

Also, I tried fitting a larger (Eddystone) main tuning knob to the set (photo, right) – I had done this on one of my S830/4s and found it better to use than the original, smaller, main tuning knob. I asked the owner of the set if he would like me to leave it fitted – he did, but I will return the original smaller knob with the set, so he can re-fit it if he ever wants to. I also fitted an Eddystone knob in place of the 'mongrel' knob on the AF gain control - not the longer, fluted type, but the type to match the RF/IF gain control knobs, as this is all I had in stock (photo, below) – the owner could swap the correct knob from his other S830/2 if he wants.

I also fixed three small chips on the outer edge of the large tuning knob I installed. I used some quick-set JB-Weld to do this, plus some careful trimming with a craft knife and then some light sanding using 800 grit paper (photo, left).

I cleaned-up the cabinet and gave it a light buffing with Novus #3 and #1 to bring a little shine back to the paintwork. However, there are several deep scuffs and minor scratches present that could not be buffed out, and it would really benefit from being powder coated - I suggested that to the owner.

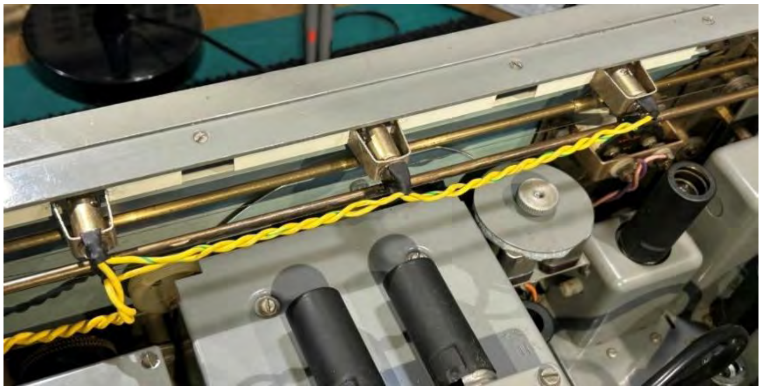
The set was then left on soak test for a few days, operating on and off throughout each day for several hours, providing background music when I was around the workshop.

Finishing-up

During the soak testing, I measured voltages around the chassis – all were close to those shown in the manual, however, I did note that the heater voltage at the power transformer was 5.9vAC, not 6.3vAC – this is due to the power transformer primary winding being set for 125vAC operation[12], and the line

[12] The power transformer primary taps allow for line voltages of 100, 110, 115, 125, 200, 210, 220, 230, 240, and 250vAC

voltage at my location is 117vAC (a 7% lower voltage). The heater voltage at the tube bases ranged from 5.87 to 5.8vAC, which makes sense (93% of 6.3vAC = 5.86vAC). In an effort to help a little, I removed the 6AU6 100KHz IF cathode follower tube, and replaced the three #44 dial bulbs (0.25A) with #47 bulbs (0.15A), thus saving a total of around 0.5A heater current. This made no difference to the heater voltage, demonstrating that it was not the current capacity of the power transformer winding or heater wiring, but the low power transformer primary voltage. The power transformer primary taps could be reconfigured for 115vAC[12], but as the set was performing satisfactorily, I opted not to change this as the slightly lower voltages will be less stressful on the tubes and other components (the owner can change the voltage taps if he wants to). While I had the dial bulbholders out, I adjusted them slightly, and re-wired them to include heatshrink over their connections as they are prone to shorting either to the bulbholder body, the pointer traveller (see tip of arrows in photos, right: top, before, bottom, after), or even on the inside of the case. The photo, below, shows the dial bulb string after rewiring and adding the heatshrink.



I measured the B+ current draw and it was between 155mA and 165mA, depending on the AGC action (this is normal as the AGC cuts off the RF amplifier and the two 2nd IF amplifier tubes on strong signals). The set did blow the 200mA B+ slow blow fuse after a 12 hour session (photo, right) – likely due to fatigue, as it was operating very close to its rating. I replaced it with a 250mA slow-blow cartridge and no further failures occurred after many hours use.

I also repeated the sensitivity/SNR tests on all bands using the Agilent test set after a couple of days and obtained very similar results as shown on page 34 and in the Appendix. The set was found to be remarkably stable after around 30 minutes warm-up, even on the highest frequency band (Band 1), although I noted that the BFO took a few seconds to stabilize on switch-on, but was rock solid after that.

Closure

The Eddystone S830 series is known as the 'Jewel in the Crown' of the Eddystone tube radios[13] – and for good reason: it is very sensitive, has a low SNR, is not prone to cross modulation or overload, its frequency stability is very good, is capable of <1KHz frequency setting accuracy, and provides

[13] Arguably, the 22-tube S880 /2/3/4 models were a more sophisticated design, however, these were specially developed for government intelligence agencies where minimal local oscillator radiation, highly accurate frequency resetability, and long term stability were needed

continuously adjustable selectivity settings from 6KHz to 1.3KHz, plus a very narrow 'single signal' reception capability when the crystal filter is in circuit. The front panel ergonomics are good, the controls are intuitive and very easy to operate, the large, clear, slide rule dial is superlative, and the tuning action is up there with the very best.

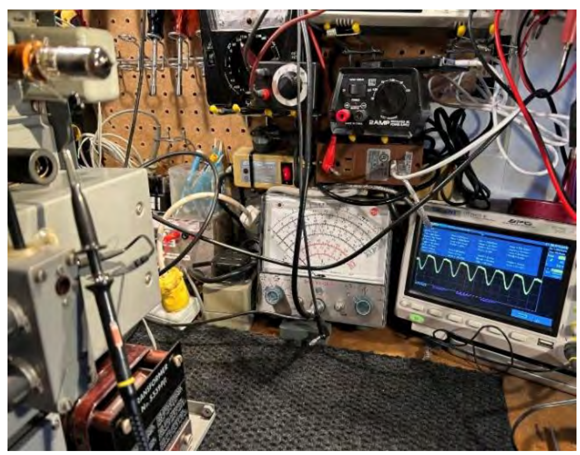
Weighing-in at 49lbs, the overall build quality is also excellent, albeit many of the passive electronic components used have not stood the test of time too well. However, once the failing components are replaced with modern parts, along with attention to component/lead dress, a set of good tubes, and a careful re-alignment, these sets can be brought up to perform at least as they did when new.

All that said, in my opinion, there are a couple of construction design 'flaws' – the main one being the lack of ventilation in the under-chassis power supply compartment, the second is the lack of insulation on the dial bulbholders and their proximity to the pointer guide rails and traveller. Both of these issues have been rectified on this unit during the refurbishment.

This particular example, now meeting critical aspects of its design spec., should provide its owner with what he desires for many years.

Postscript

The S830/2 had been on soak test all week after I completed working on it. After using the set quite a bit, I was not happy with the BFO/product detector, I noticed that the BFO tone was becoming 'coarse', the frequency drift after switching on to CW or SSB seemed to be more prolonged, and with occasional minor jumps in frequency.



Given this, I decided to revisit the product detector assembly. First, I inserted a socket extender and monitored the waveform at the grid of the 6BE6 tube – I found it to be somewhat more distorted than I would have expected – photo, right (though BFO's rarely generate a 'good' sinewave) – this could be the reason for the 'course' tone. All fixed resistors relating to the product detector, both inside the product detector can and external to it, had been replaced as noted this article, as well as the three paper capacitors, and the small electrolytic located inside the can, and all paper capacitors external to the can. That left two disc ceramic, three tubular ceramic, one polystyrene, and one silver mica capacitor located inside the can that could affect the circuit. The disc ceramics are used in bypass applications, one of the tubular ceramics is the audio output coupling capacitor, one tubular ceramic forms part of the 100KHz input circuit, and the other is a small (N750) temperature compensation capacitor in parallel with the (200pF) polystyrene capacitor, these two capacitors forming part of the BFO tuned circuit, along with the (adjustable) BFO coil (L38) and varactor diode. The silver mica capacitor is

the grid coupler in the BFO circuit. Rather than troubleshoot the circuit, which is a PITA due to it having to be reinstalled in the chassis to test it, I decided to replace all these parts.

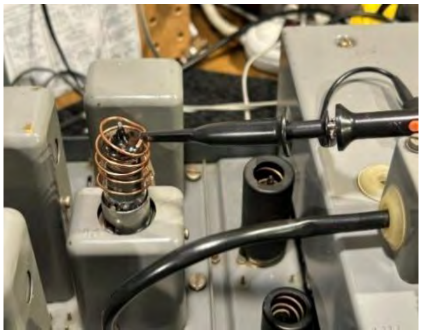
I replaced the two disc ceramics and the audio output coupling capacitor with polyester or polypropylene film parts, and all the other capacitors with new silver mica parts (photos, above). On testing the removed parts, I found that the (20pF) negative temperature compensating (N750) tubular ceramic capacitor actually had a positive temperature coefficient, ie. heating it up (using warm air a hairdryer) caused the capacitance value to increase(!): this capacitor measured 20.8pF at 74F (23.3C) and 23.3pF at 144F (62.2C) – photos above right and below right. I therefore classed this as a failed part. All the other capacitors measured close to their nominal values and with no measurable leakage.

The 20pF N750 part was the only part I was considering re-using due to its temperature compensation function, but as it was faulty, and having no 20pF N750 ceramics to hand, I replaced the combo of this and the 200pF polystyrene capacitor with a single 220pF silver mica part. Silver mica capacitors are very stable with temperature (< +/-50ppm/C), and I considered that in this application it would likely render the BFO more stable than the faulty N750 part, providing the BFO frequency was adjusted once the product detector can had reach working temperature (it is located quite close to the audio output tube on the chassis, which runs fairly hot, and therefore the product detector can heats up over the first hour or so of operation).

After replacing the parts, I reinstalled the product detector can and tested operation of the BFO – all seemed ok, so I left the chassis running for a couple of hours and then adjusted the BFO on CW (zero beat at centre position), LSB (-1.5KHz), and USB (+1.5KHz) using the HP8656B signal generator. I also measured the voltages on the varicap diode on LSB (12.3vDC) and USB (16.7vDC), which confirmed that the offsets were correct – the capacitance value of the varicap diode decreasing with increasing voltage, giving a higher BFO frequency[14]. This work brought the total parts replaced count to 92 resistors, 7

[14] Page 9 of the manual explains why the sense of the BFO offsets on LSB and USB may seem counter-intuitive

electrolytics, 17 tubular paper/plastic film capacitors, 5 disc ceramic capacitors, 3 silver mica capacitors, 3 tubular ceramic capacitors, and four silicon rectifiers.



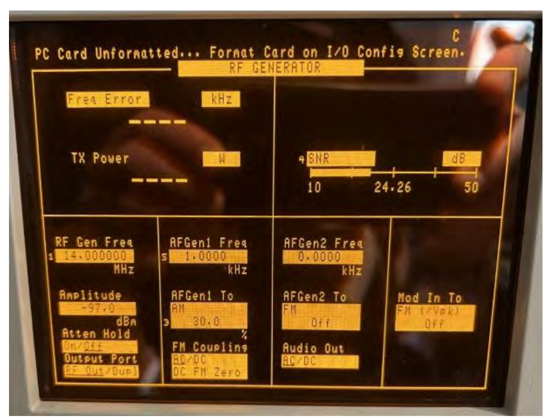
I then temporarily re-installed the socket extender and monitored the BFO waveform – again, not a 'perfect' sine wave, but no sign of the distortion noted previously. I found that even using a 1pF coupling capacitor to the grid affected the frequency of the BFO, so I used a small coil of wire placed around the 6BE6 to pick up the BFO signal (photo, left) – a bit noisier than a direct connection to the grid of the tube with the 1pF capacitor, but good enough to check the frequency and overall BFO waveform, albeit with some low frequency mixing products likely added in, distorting the 100KHz waveform, as I did not switch off the signal generator while viewing the signal on the 'scope.

I then re-installed the chassis into the cabinet and ran it for another couple of hours – all working well, with good frequency stability. There was still a minor change in BFO frequency for a few seconds after switching the BFO on, which I suspect is an artefact of the 'ancient' varactor diode characteristics when the reverse bias voltage is applied, but then it was rock solid, and the tone was now much 'sweeter'.

And finally…

During subsequent soak testing, I also:

- added a couple of drops of 'Superlube' oil into the oiling hole I drilled through the new main tuning shaft (brass) bearing now that the bearing had 'run in' a little after many hours of tuning around the bands;
- re-checked the waveform of the BFO section of the product detector circuit, this time with the signal generator switched off. As I had suspected, the waveform was much better (photo, above right), the distorted sinewave observed previously being due to low frequency mixing products affecting the waveform;
- re-checked the SNR on the 20M ham band, this measuring better than 24dB for a 3uV signal on AM (much better than spec.) – photo, right;
- removed and cleaned all the knobs (the BFO Pitch and Peak RF controls were very grimy); and
- changed-out the weak 6AT6 tube (1st audio amplifier and AM/AGC detector) for a NOS one after I noted some minor audio distortion when listening more carefully to music programming on a local station on the Broadcast band. The NOS 6AT6 tube tested much better (GM of >1000), than the Gm of <725 that the (UK 'Brimar' branded) tube installed in the set had tested at.

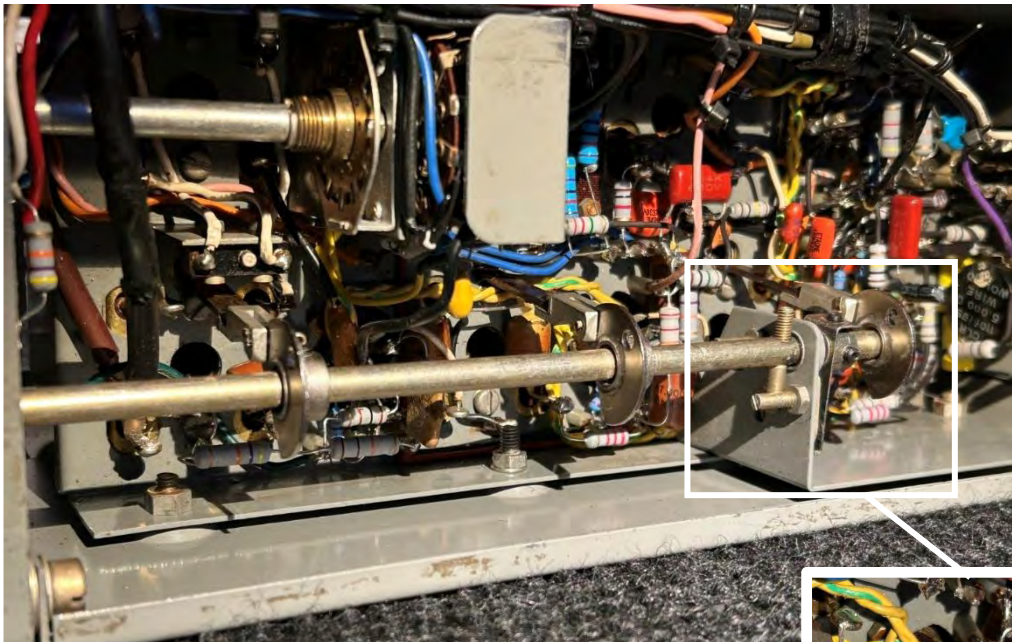


Another couple of examples in this postscript as to why extensive soak testing is useful – especially when so much work has been undertaken on a receiver!

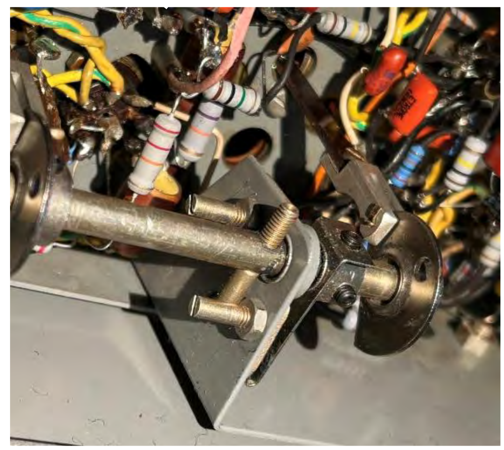
Above left: close-up of the replacement crystal calibrator momentary push switch. Above right: close-up of the band change ('Wavechange') switch and (1st local oscillator) crystal selector lever. Left: close-up of the carrier level meter – no 'S-Units' or dB here! Below left: close-up of the 'Incremental Tuning' dial - this is inset at the top of the main tuning scale. The Incremental Tuning dial is marked in KHz, thus:

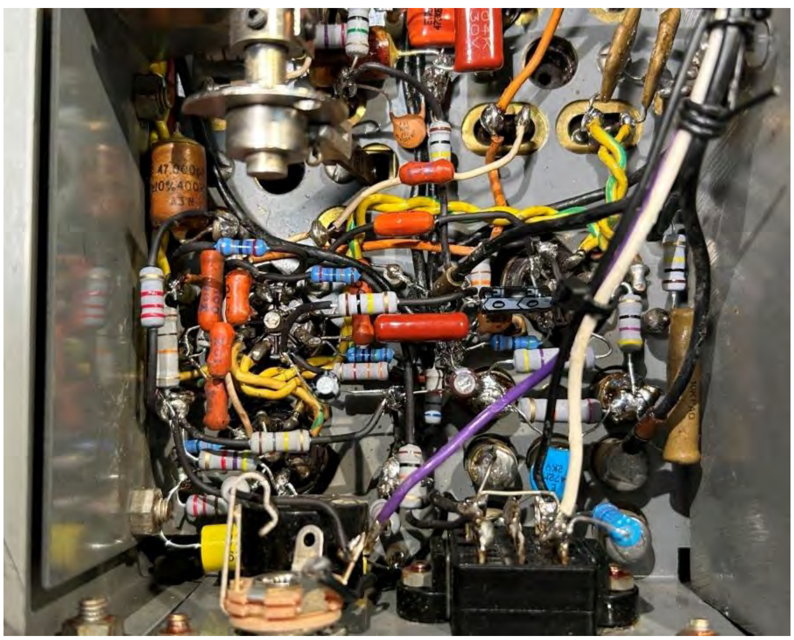
100 - 90 - 80 <<< 30 - 20 - 10 – 0 – 10 - 20 - 30 >>> 80 – 90 - 100

The (KHz) numbers in the red section of this dial are added to the frequency shown on the main tuning scale, and the numbers in the black section are subtracted. Bottom left: Close-up of the speaker jack (now in use – here with jury-rigged connections to the workshop speaker) – this jack is fitted in place of the I00kHz IF output BNC socket. Below: close-up of the larger main tuning knob – much better to operate than the standard smaller one

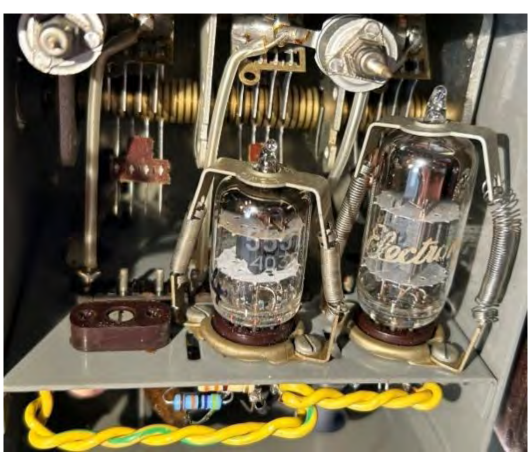


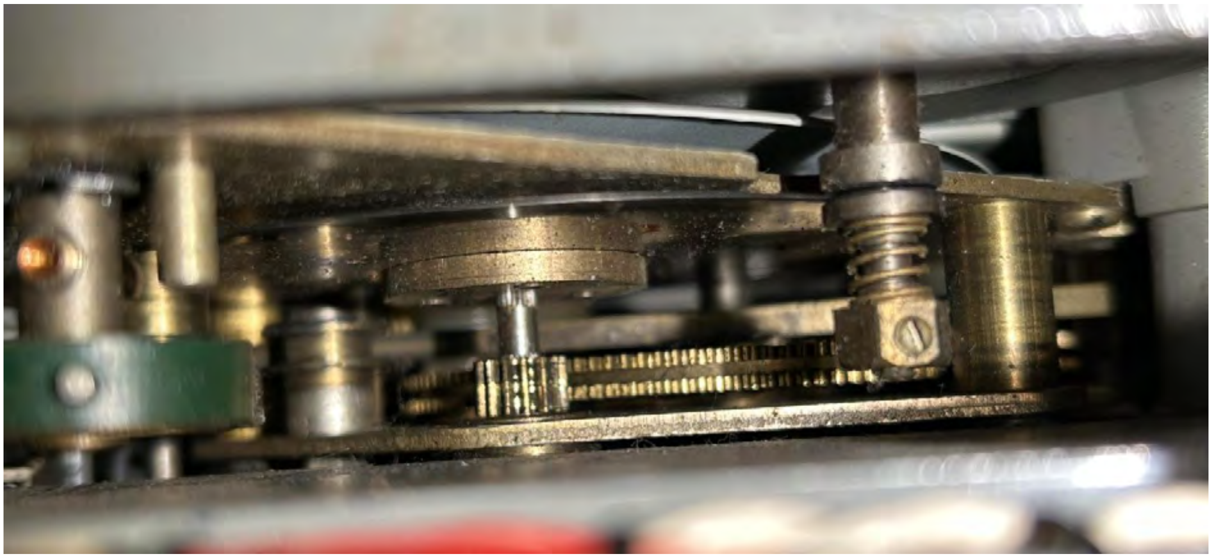
Left: 100KHz IF compartment after rework, showing layout of the mechanical selectivity mechanism. Inset (below): close-up of the selectivity position indent plate and stop bar on the selectivity control shaft



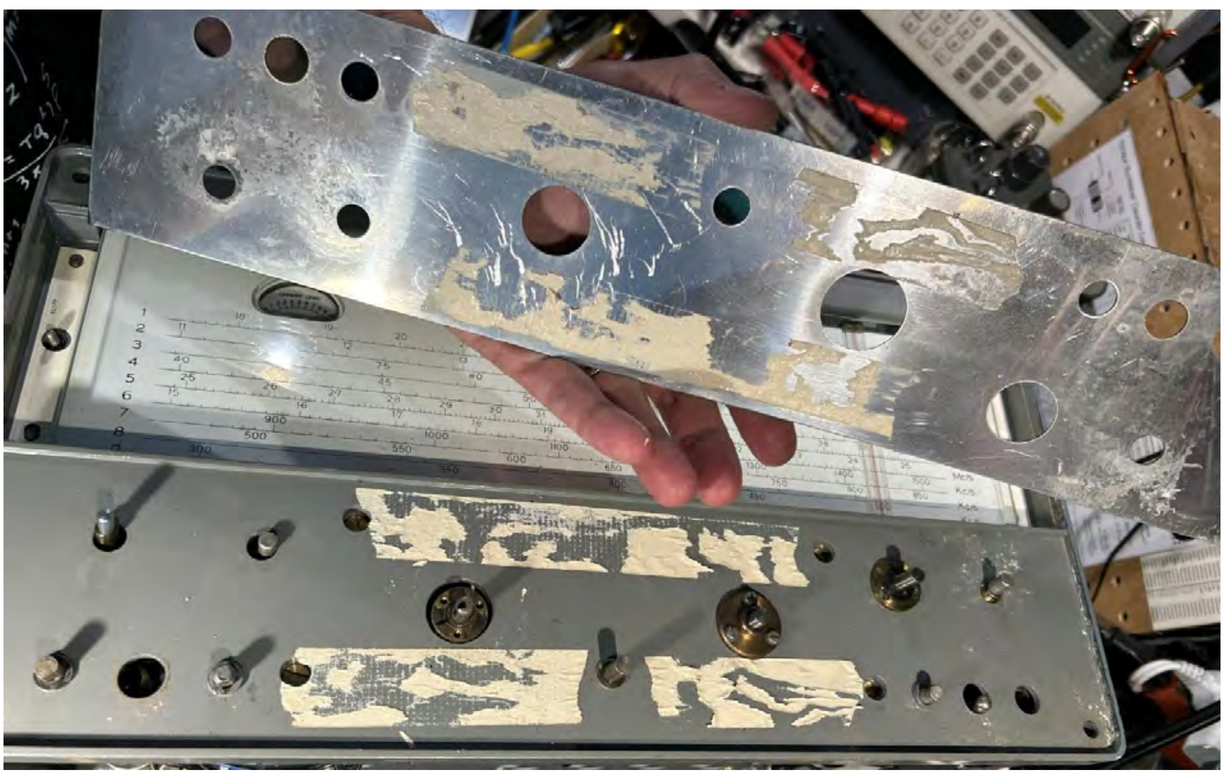


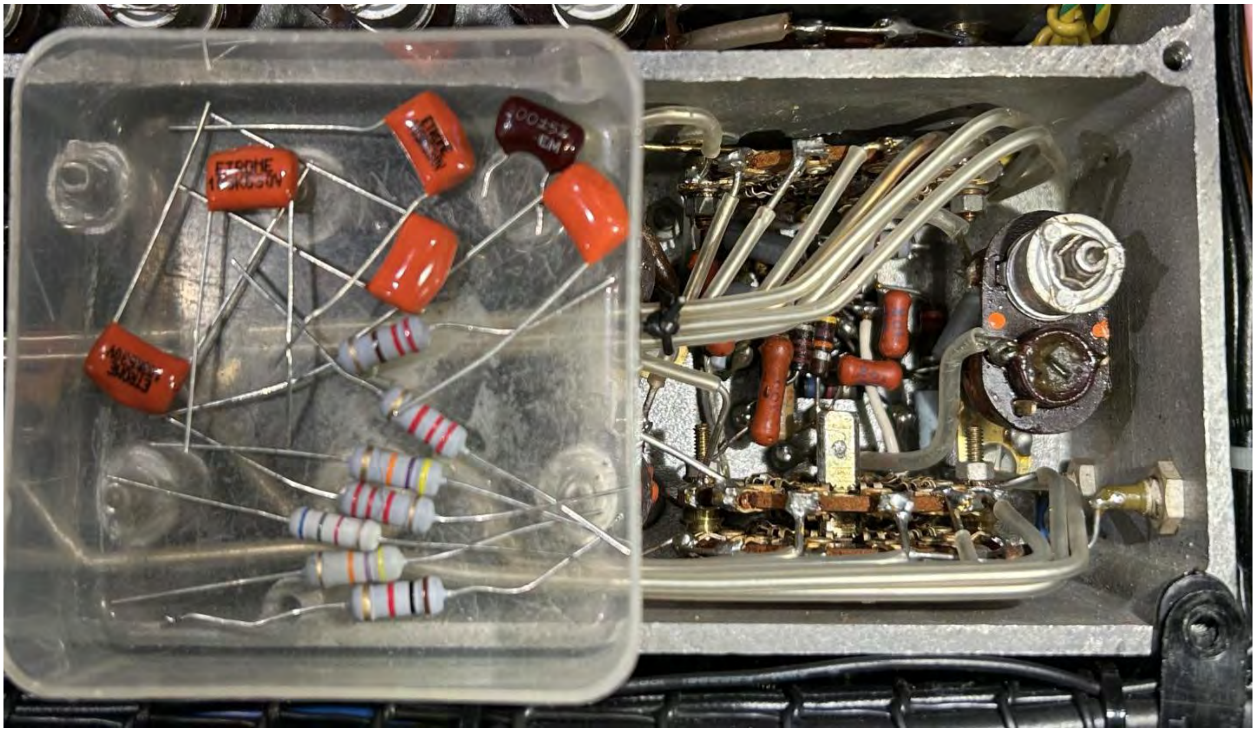
Left: Close-up of the audio stages and 100KHz IF cathode follower stage after rework. Below left: the 2nd local oscillator/mixer compartment showing the crystal socket that can be used to fix the 2nd local oscillator frequency. Below: 1st local oscillator crystal bank





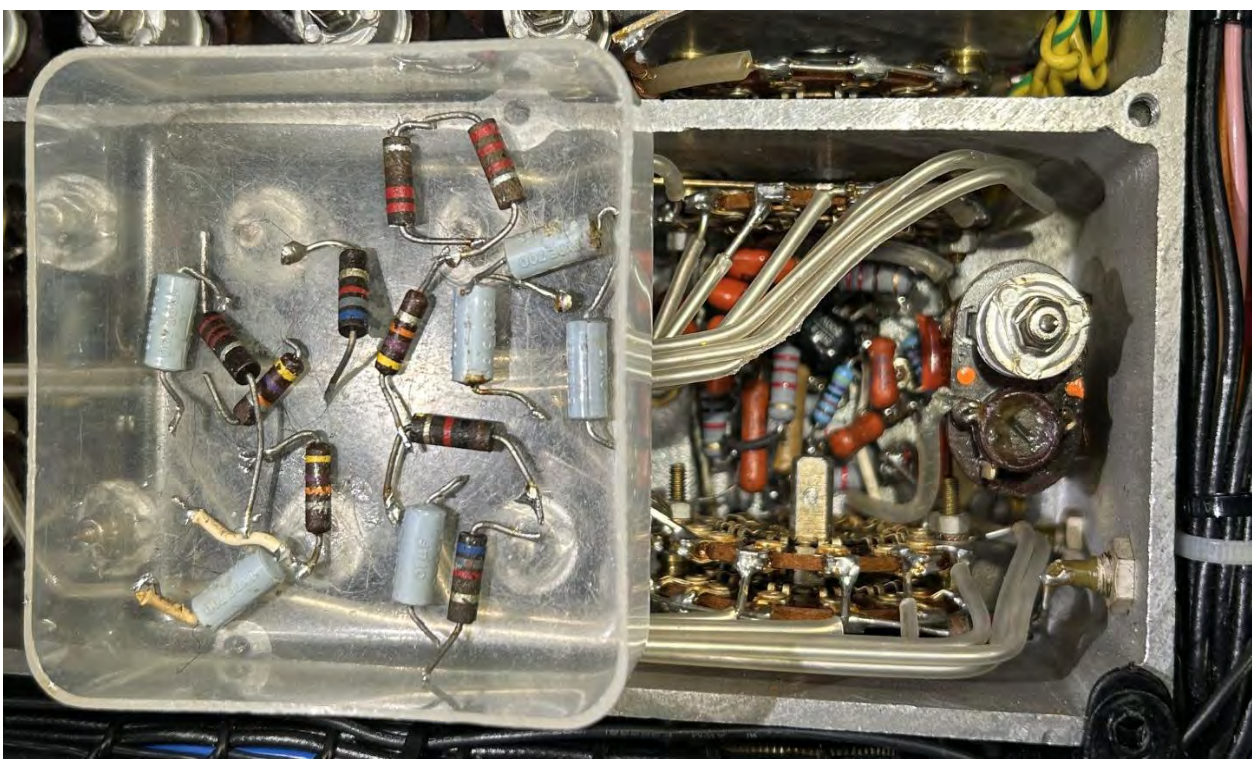
Above: close-up of the main tuning drive viewed from underneath. Far left: removing one of the side cheeks from the front panel. Left: removing the crystal select lever. Below: Removing the fingerplate from the front panel

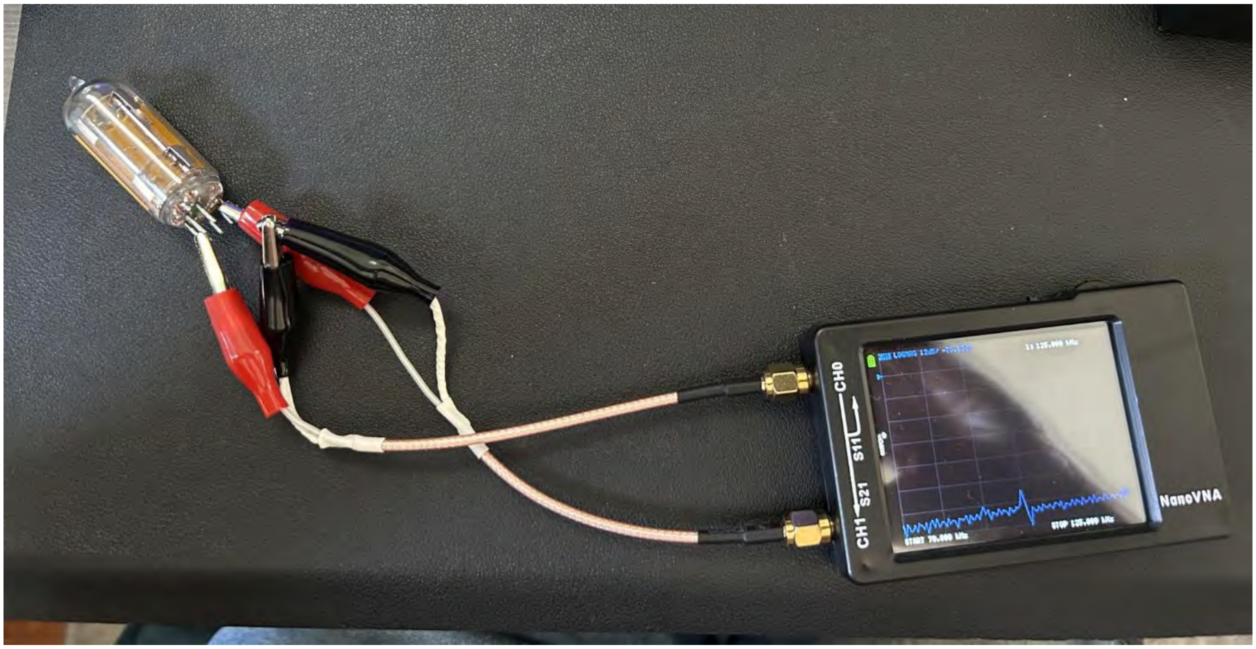




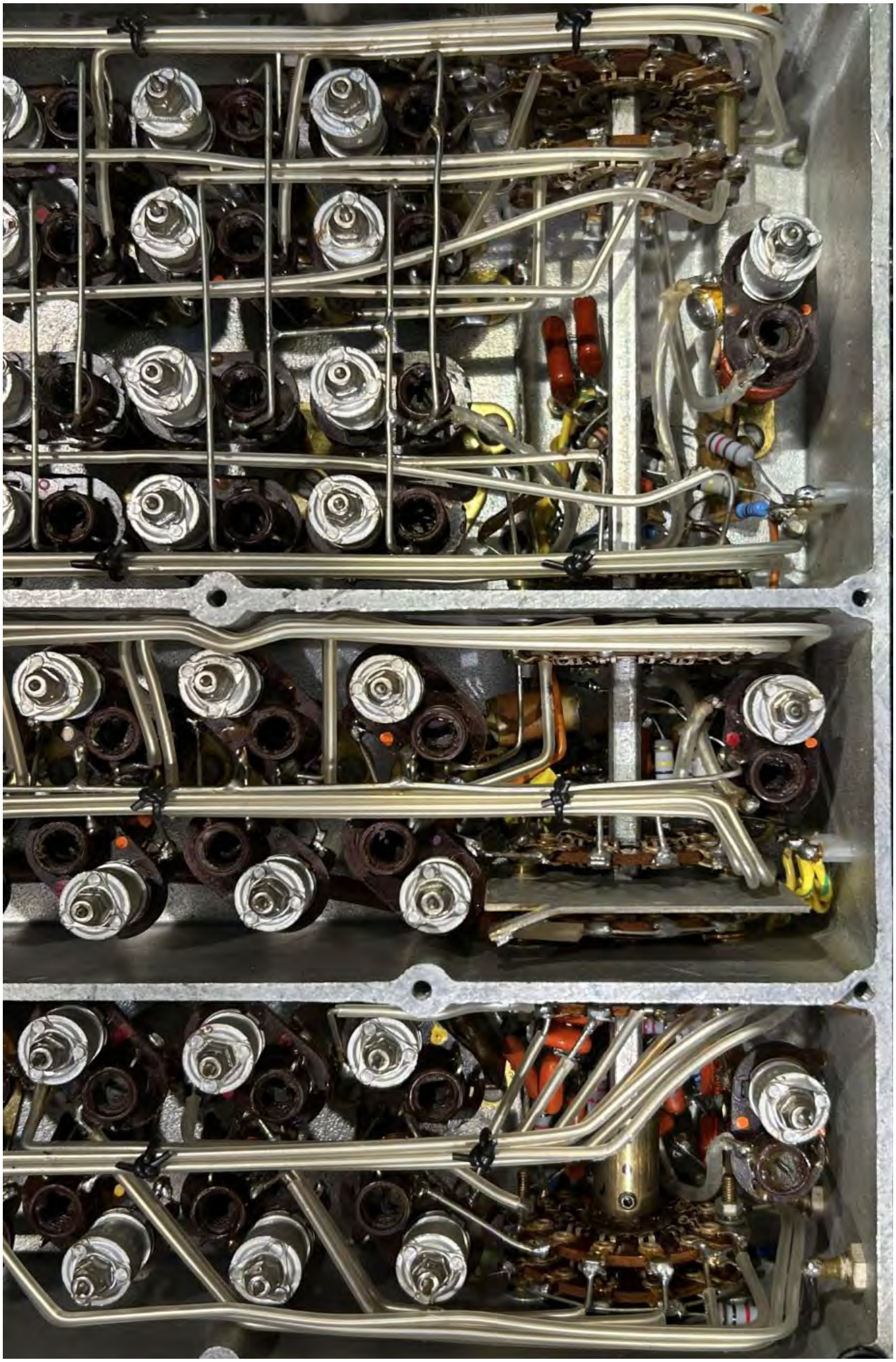
Above: replacement parts ready for installation in the 1st local oscillator compartment

Below: some time later(!) – the parts have miraculously swapped places… (and two more resistors were needed to complete the job!)



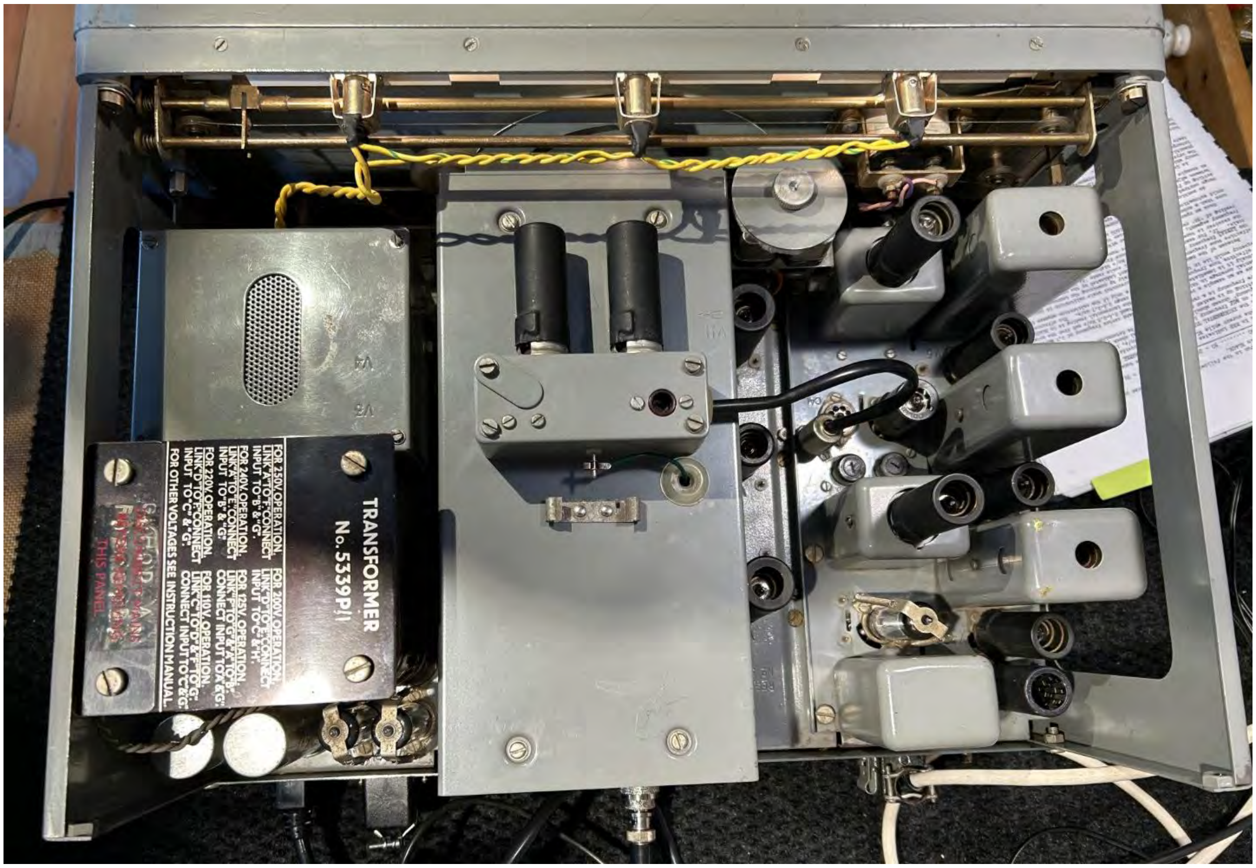


Top of page: testing the 100KHz crystal using a NanoVNA (not very successfully due to limited resolution of the NanoVNA!). Above left: the GEC 100kHz crystal used for the IF filter in the S830/2 (left) and a spare (Marconi) 100KHz crystal used for comparison. Above right: parts removed from the S830/2 (most of them). Left: some previously-replaced parts that were removed can be re-used in other projects. These were removed as they were either the incorrect value, incorrect type, or their leads were too short to dress correctly in the chassis



Above: The 'business side' of the coilbox after refurbishing, before refitting the cover

Above: Underside of the refurbished S830/2 chassis



Above: Above-chassis view after refurbishment. Below: rear view of the receiver after re-fitting the cabinet

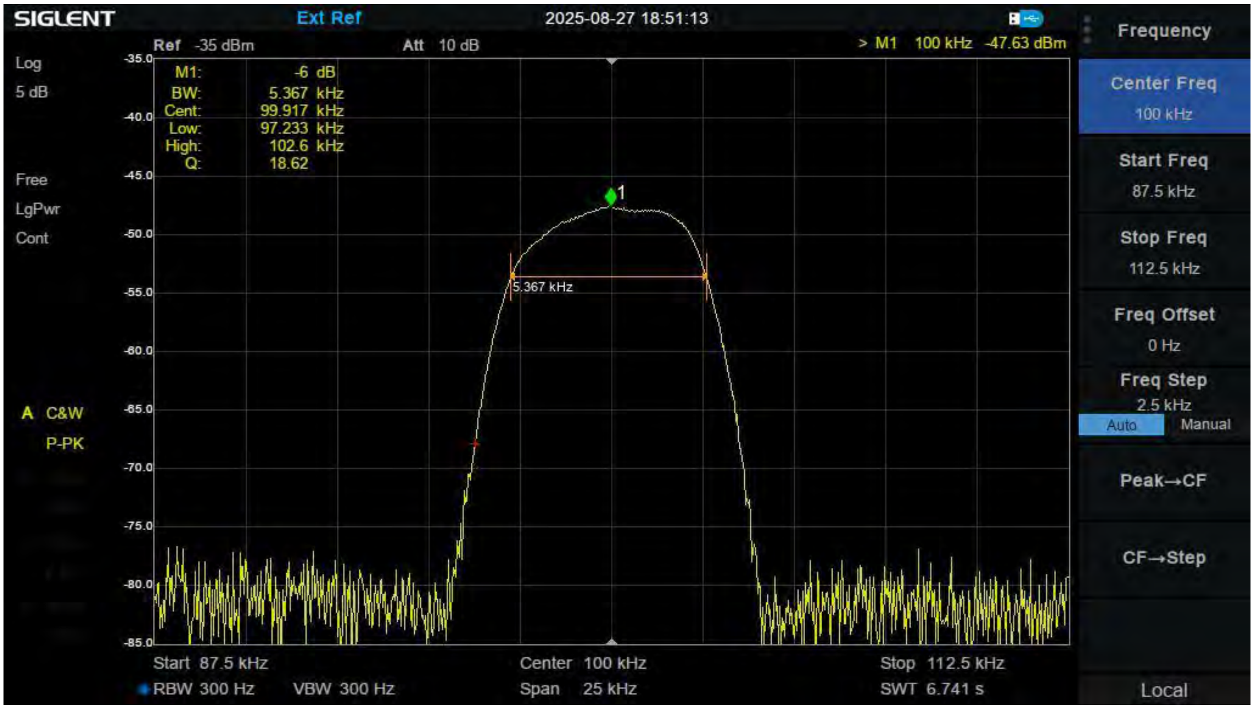
Above and below: the S830/2 installed in its cabinet – which is my best side…?


EDDYSTONE
MODEL 830
KILOCYCLES
MADE IN ENGLAND
A.F. GAIN
PHONES
MAINS
ON
INCREMENTAL
TUNING
PEAK R.F.
WAVECHANGE
CRYSTAL
B.F.O. PITCH
R.F./I.F. GAIN
SELECTIVITY
CAL.

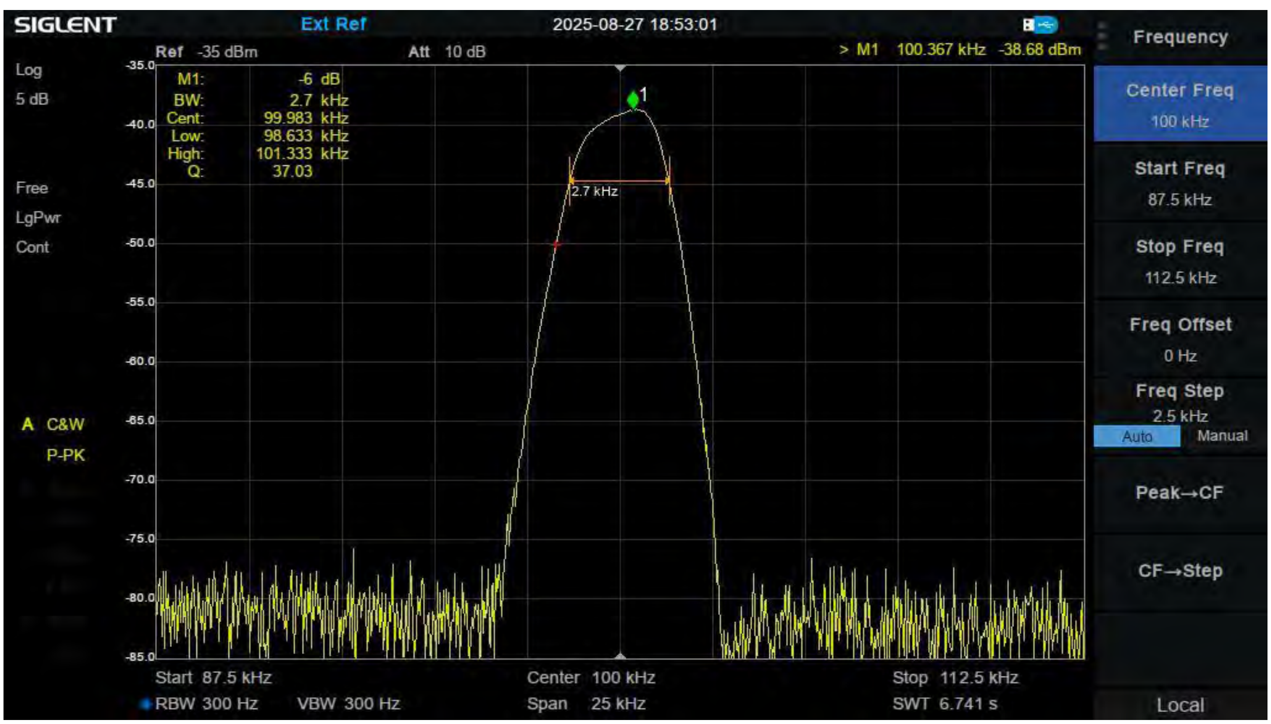
Appendix

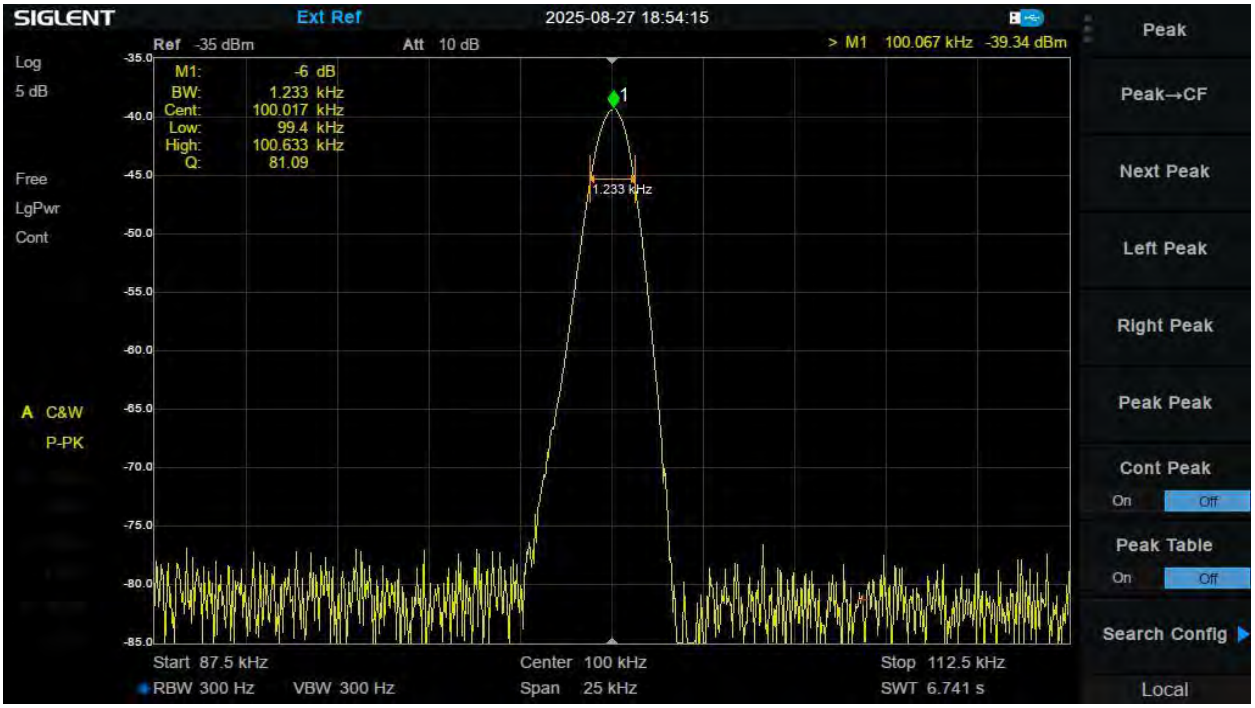
- 2nd IF Response Curves
- Signal to Noise Measurements
- Thermal Images
- Block Diagram
- Chassis Layout Diagrams
- Schematic

IF Response Curves

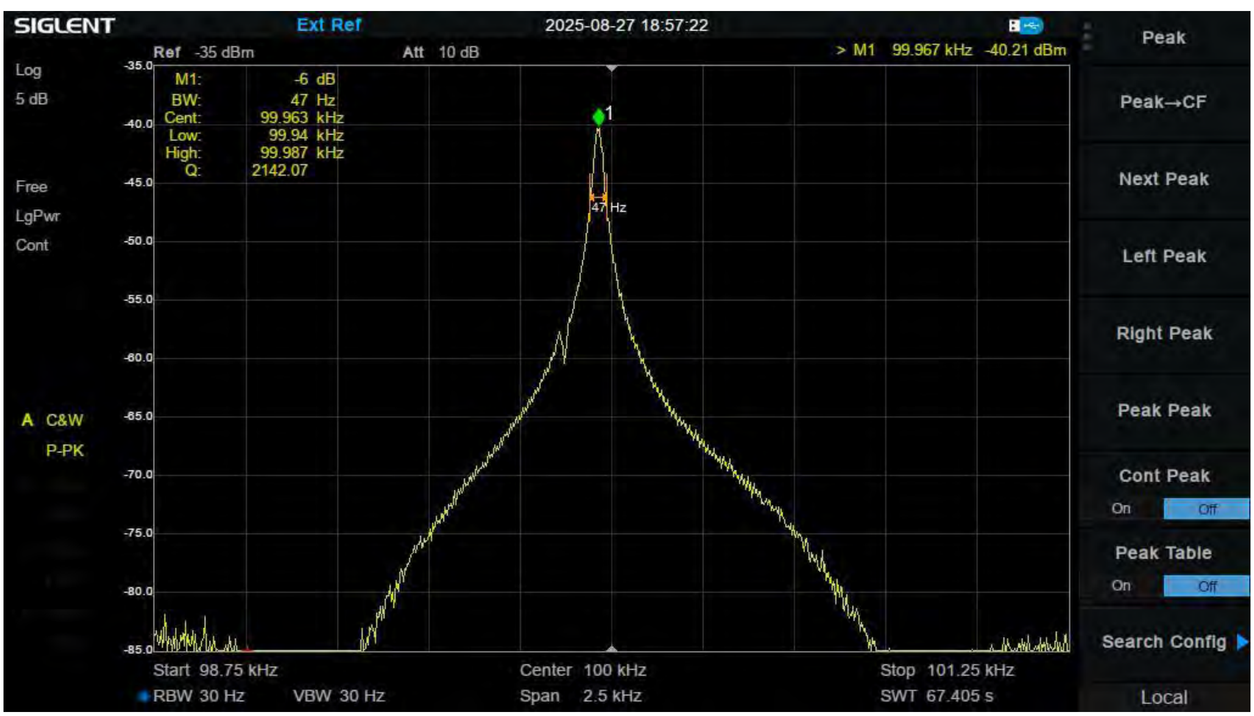


Above: 100KHz IF response on 'AM' setting of the Selectivity control (5.37KHz @ -6dB). This was subsequently tweaked to provide a 6KHz bandwidth and a flatter top to the response curve. Below: 100KHz IF response on 'SSB' setting of the Selectivity control (2.7KHz @ -6dB)



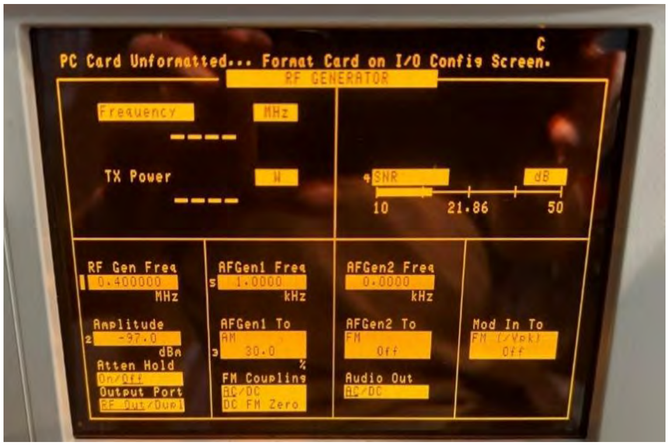


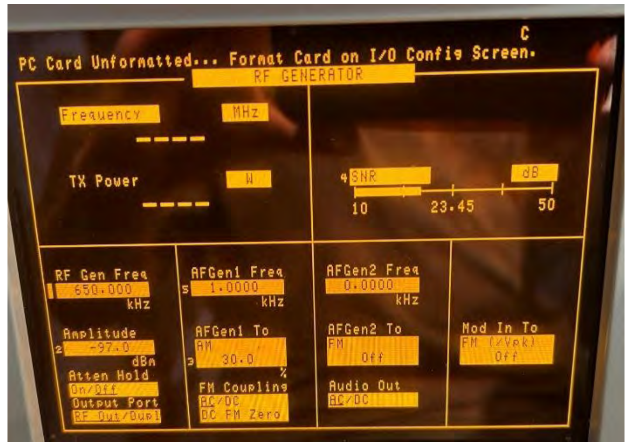
Above: 100KHz IF response on 'CW' setting of the Selectivity control (1.23KHz @ -6dB). This was subsequently tweaked to provide a 1.3KHz bandwidth. Below: 100KHz IF response on 'N' (crystal) setting of the Selectivity control (47Hz @ -6dB). This was subsequently tweaked to provide a slightly wider (73Hz) bandwidth.



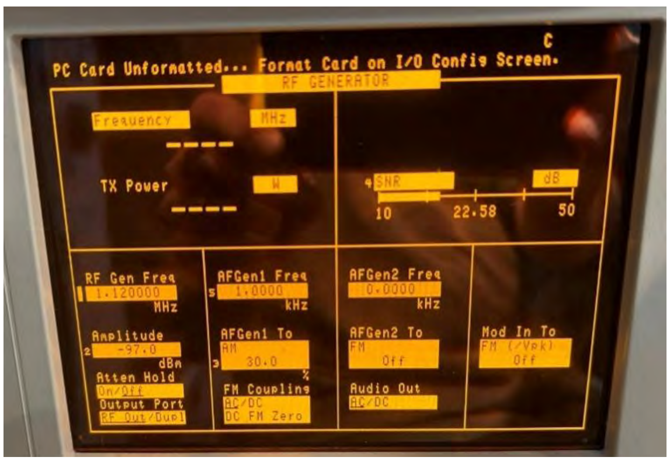
Signal to Noise Ratio (SNR) Measurements

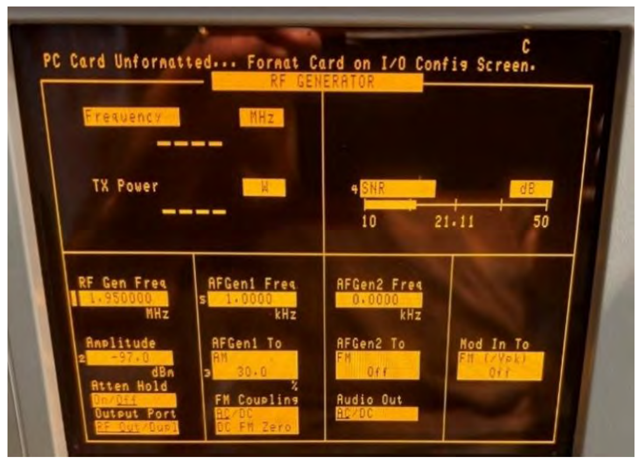
An Agilent 8935 (E6380A) CDMA test set was used to measure the signal to noise ratio of the receiver at a frequency near the centre of each band, as shown on the following screenshots. The S830/2 manual notes "*With an IF bandwidth of 3kc/s* [KHz, approximating to 'SSB' on the Selectivity control]*, the sensitivity is better than 3uV for a 15dB signal to noise ratio at all frequencies throughout the range*."



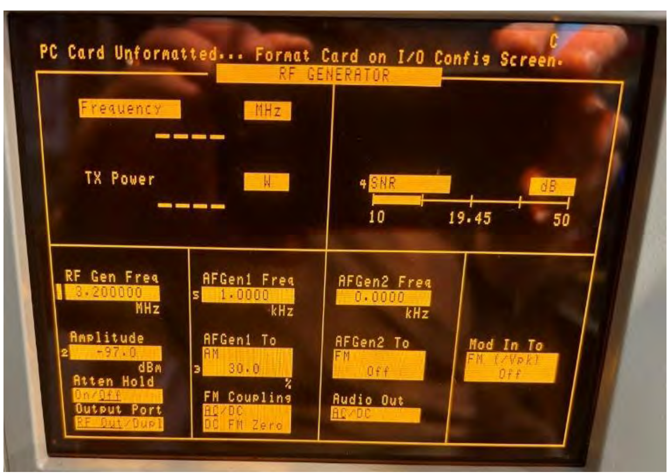


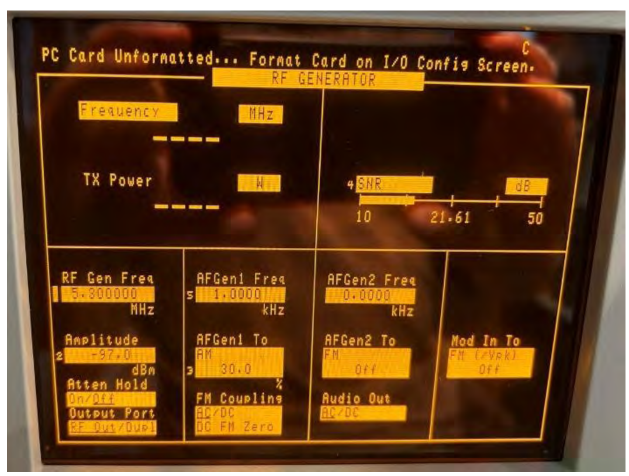
Above left: SNR on Band 9 (400KHz) = >21dB Above right: SNR on Band 8 (650KHz) = >23dB



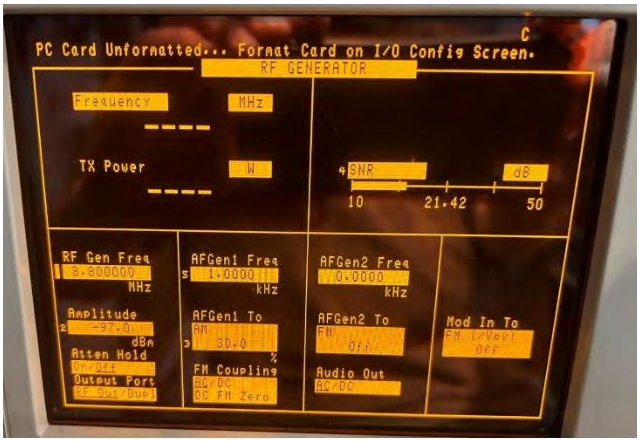


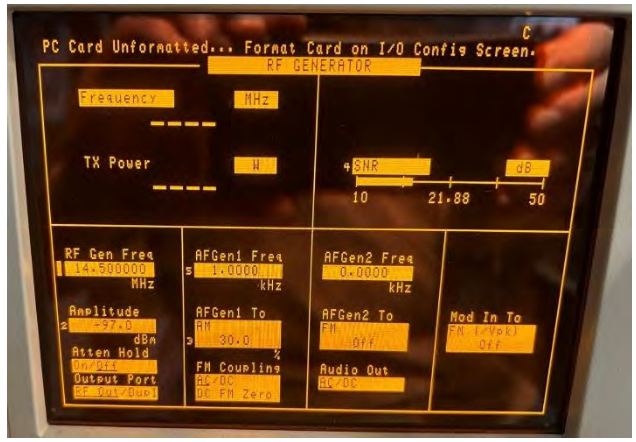
Above left: SNR on Band 7 (1.12MHz) = >22dB Above right: SNR on Band 6 (1.95MHz) = >21dB





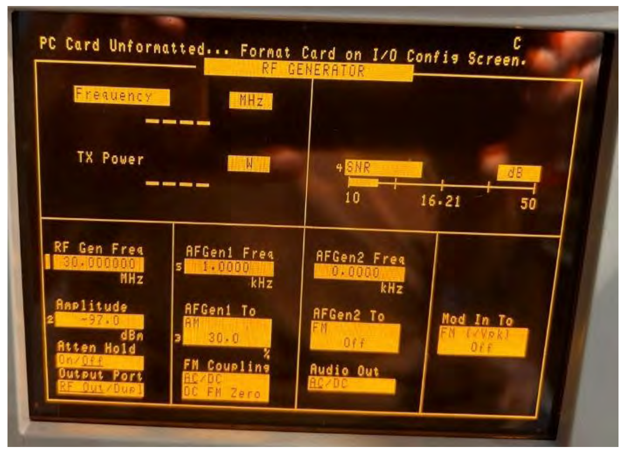
Above left: SNR on Band 5 (3.2MHz) = >19dB Above right: SNR on Band 4 (5.3MHz) = >21dB





Above left: SNR on Band 3 (8.8MHz) = >21dB

Above right: SNR on Band 2 (14.5MHz) = >21dB

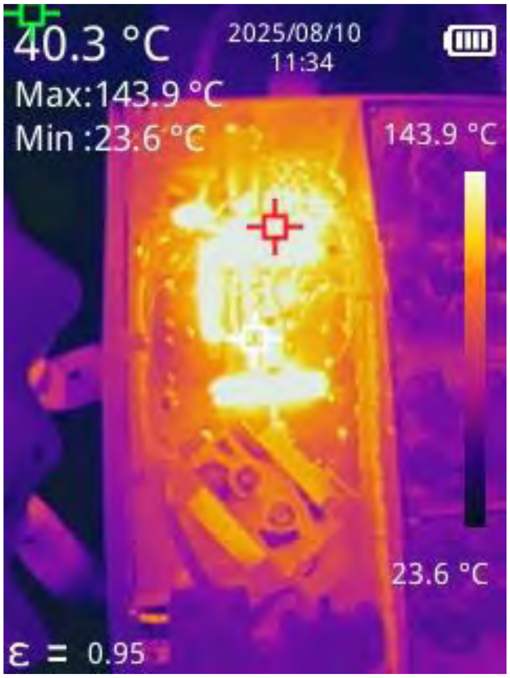


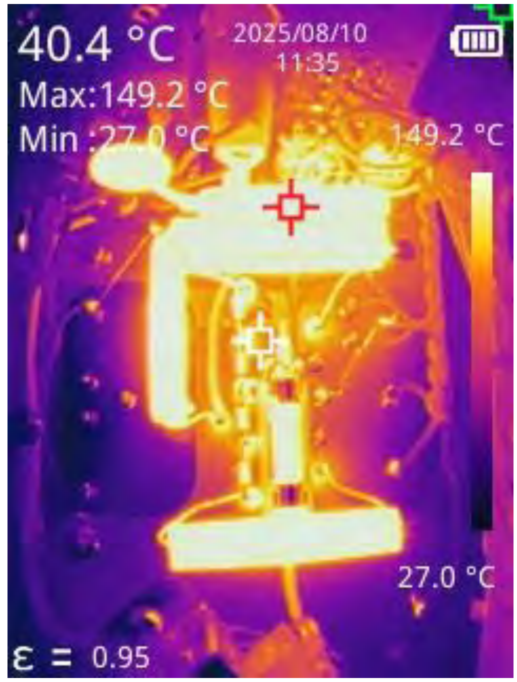
Above left: SNR on Band 1 (23.5MHz) = >20dB

Above right: SNR on Band 1 (30.0MHz) = >16dB

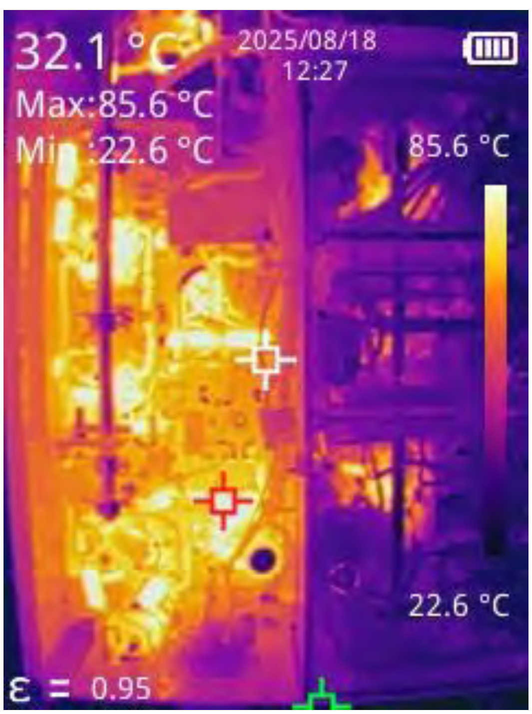
Thermal Images

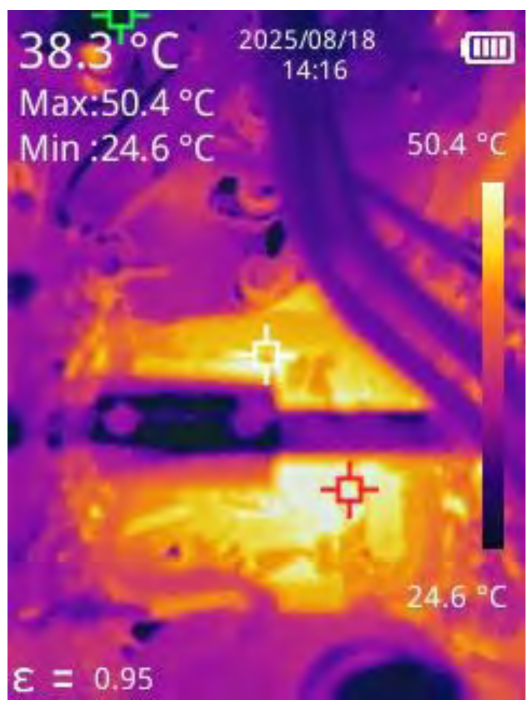
These thermal images were taken using a Topdon TC004 handheld thermal camera after approx. 2 hours operation (chassis inverted).



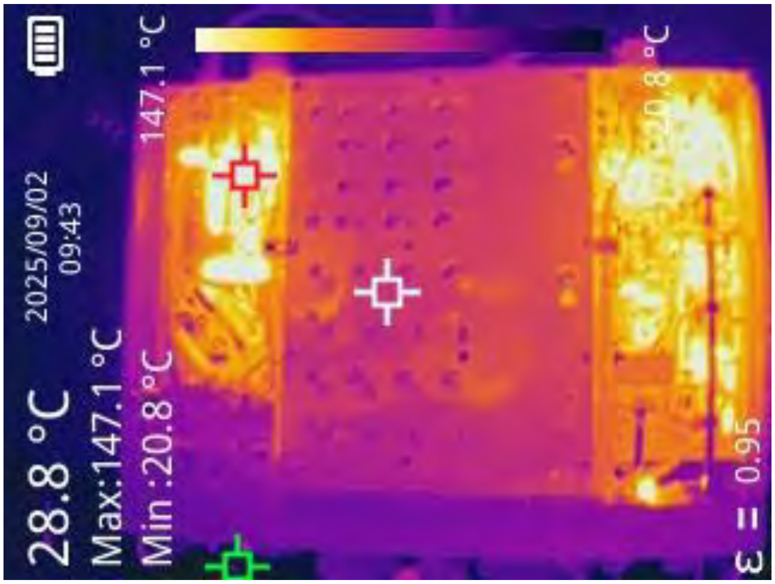


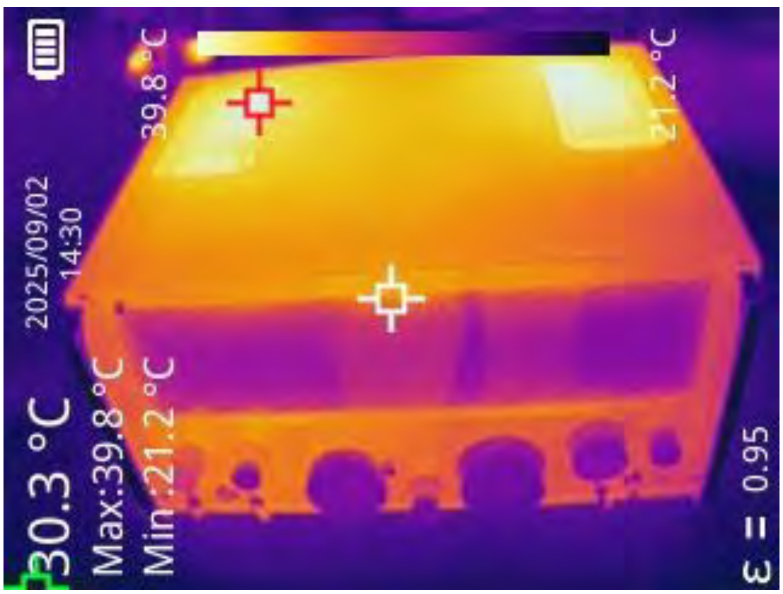
Above left: Power supply compartment. The hot spots are the four power resistors. Above right: Close-up of the power resistors in the power supply compartment. The hot spot (149C) is one of the dropper resistors to one of the OA2 150v stabilizer tubes



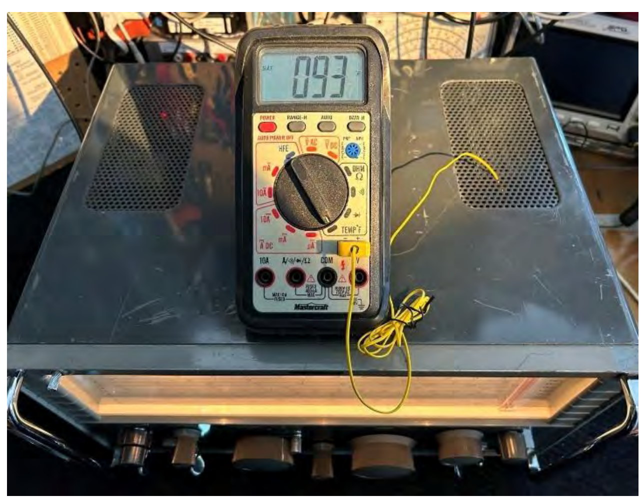


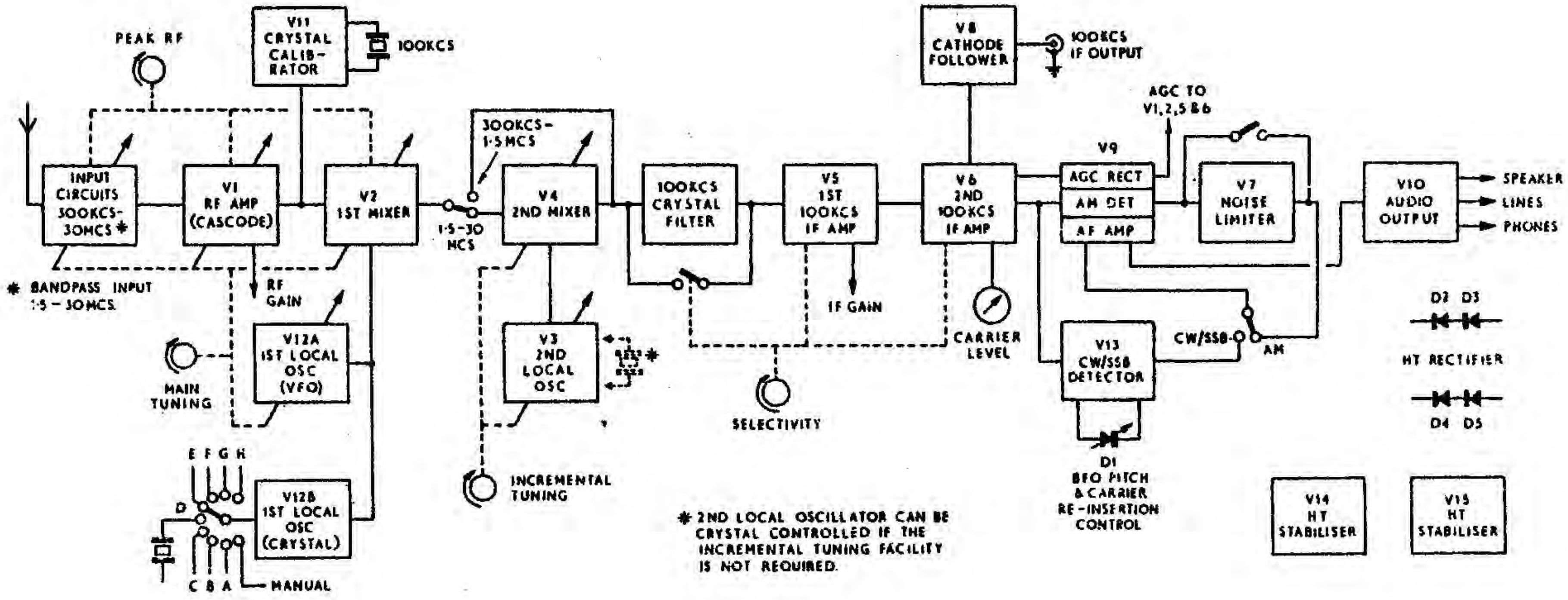
Above left: The 2nd IF/AF compartment – the hot spot (85C) is a 2W resistor in the audio output stage. Above right: Close-up of the 1st local oscillator compartment – the hot spot (50C) is a 1W resistor



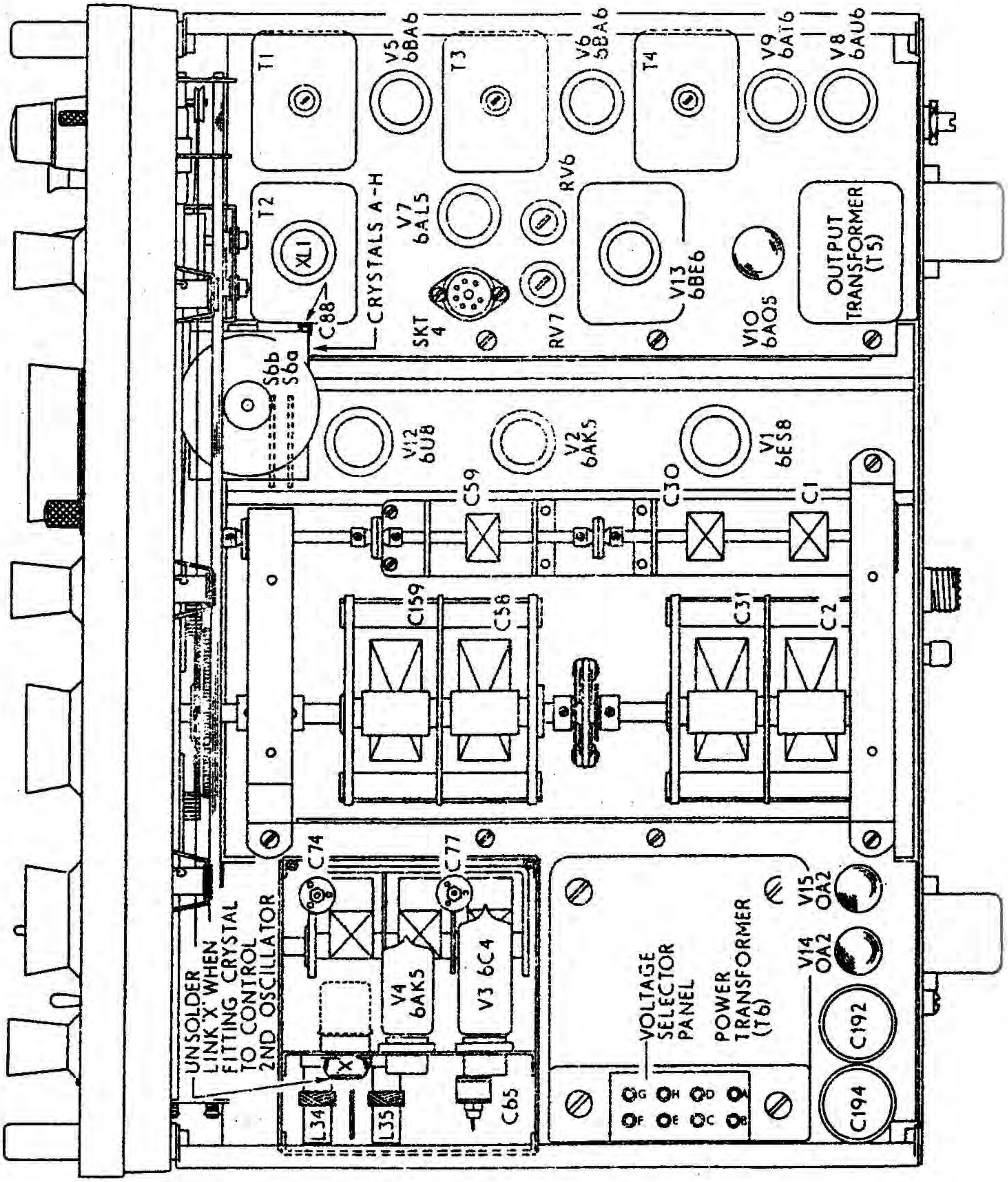


Above left: thermal image of the underside of the (inverted) refurbished chassis after 2 hours operation. The hot spot is one of the dropper resistors to one of the OA2 150v stabilizer tubes (around 147C). Below left: thermal image of the refurbished S830/1 in its cabinet after 2 hours operation. The hot spot is the perforated ventilation plate above the audio output tube (around 40C). Below left: thermocouple measurement of the inside case temperature above the 2nd IF/AF sub-chassis after 2 hours operation in the cabinet (around 40C, 105F). Below right: thermocouple measurement of the inside case temperature between the power transformer and the 2nd mixer/2nd local oscillator sub-chassis after 2 hours operation in the cabinet (around 34C, 93F).

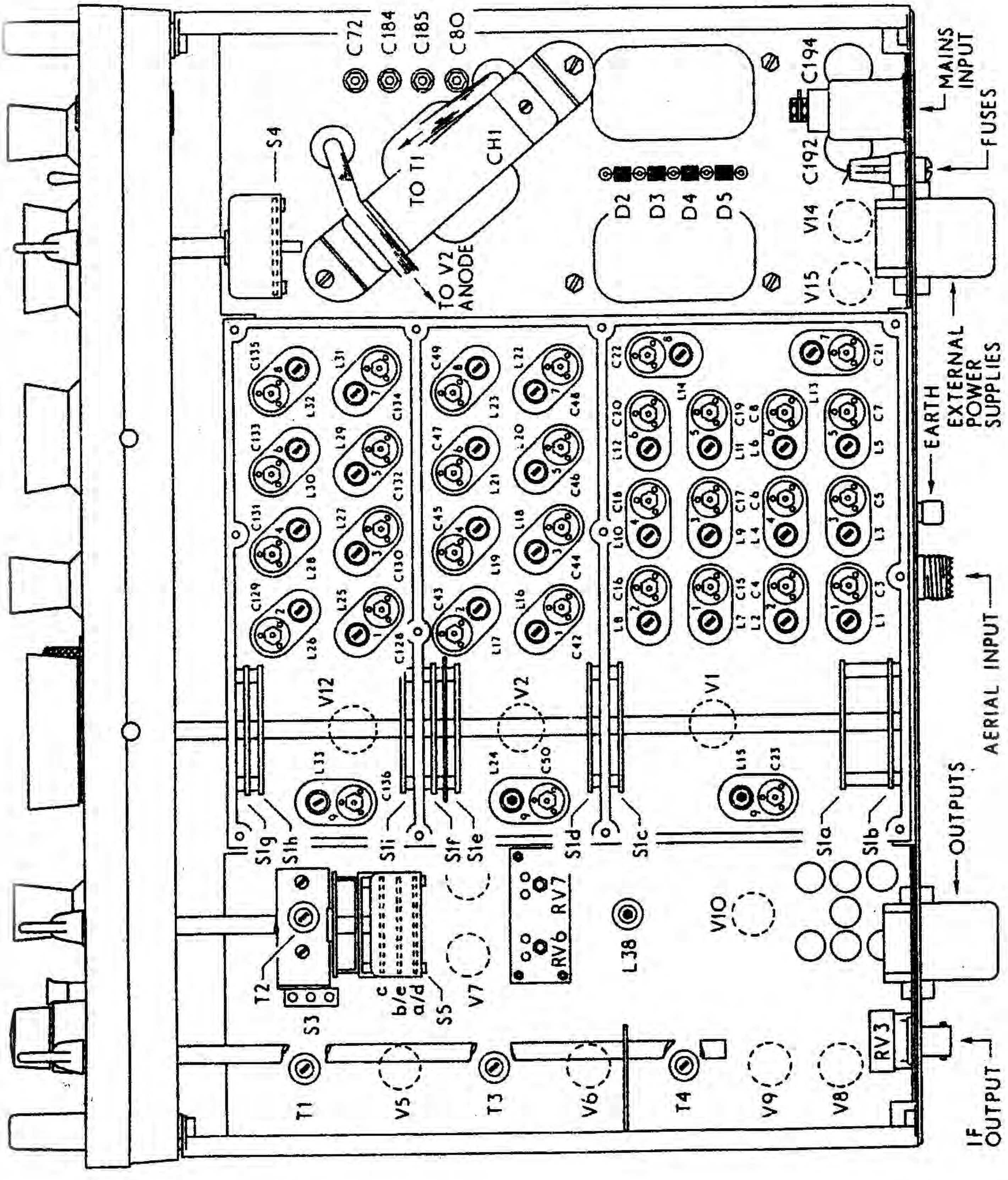




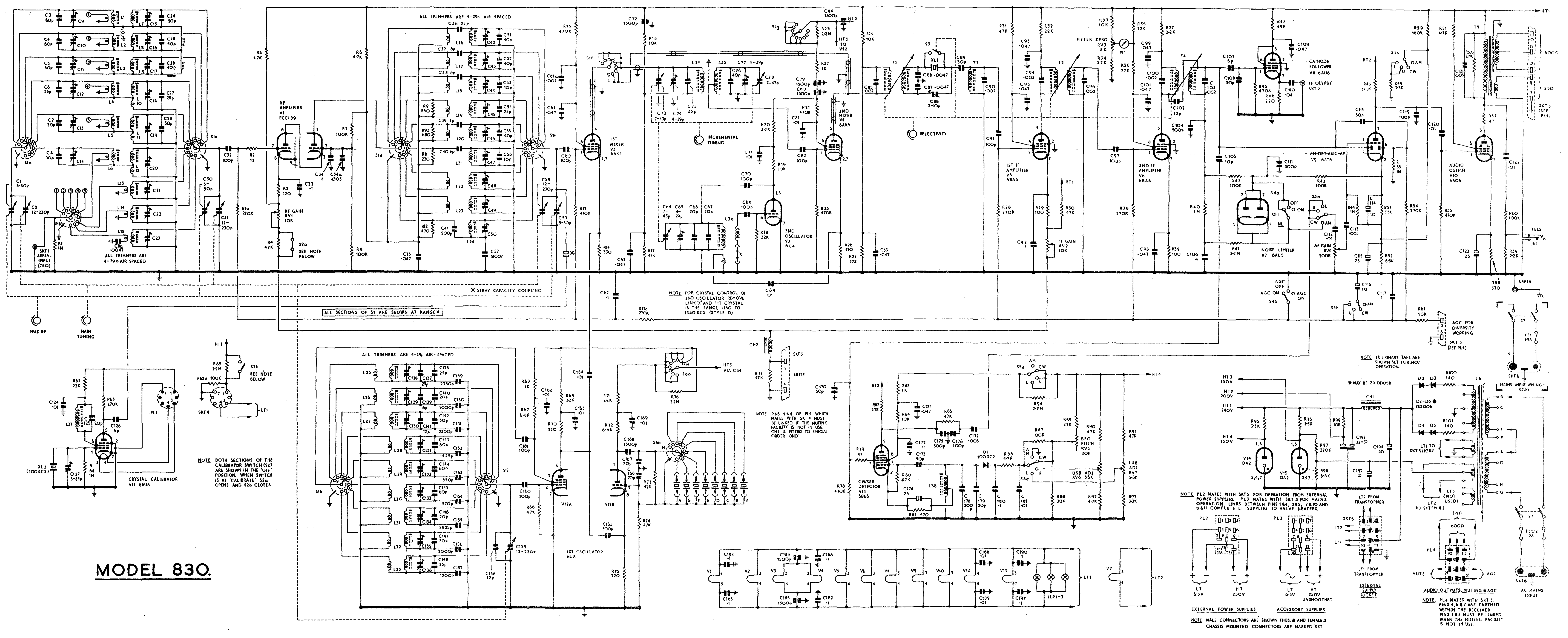
Block Schematic Diagram of Model 830.



Plan View of Standard 830 Receiver.



Underside View of Standard 830 Receiver.



MODEL 830.
ALL SECTIONS OF S1 ARE SHOWN AT RANGE '4'
ALL TRIMMERS ARE 4-29p AIR SPACED
ALL TRIMMERS ARE 4-29p AIR-SPACED
* STRAY CAPACITY COUPLING
NOTE FOR CRYSTAL CONTROL OF 2ND OSCILLATOR REMOVE LINK 'X' AND FIT CRYSTAL IN THE RANGE 1150 TO 1350 KCS (STYLE D)
NOTE BOTH SECTIONS OF THE CALIBRATOR SWITCH (S2) ARE SHOWN IN THE 'OFF' POSITION. WHEN SWITCH IS AT 'CALIBRATE' S2a OPENS AND S2b CLOSES.
NOTE PINS 1 & 4 OF PL4 WHICH MATES WITH SKT 4 MUST BE LINKED IF THE MUTING FACILITY IS NOT IN USE. CH2 IS FITTED TO SPECIAL ORDER ONLY.
NOTE - T6 PRIMARY TAPS ARE SHOWN SET FOR 240V OPERATION.
* MAY BE 2 X DD058
NOTE PL2 MATES WITH SKT5 FOR OPERATION FROM EXTERNAL POWER SUPPLIES. PL3 MATES WITH SKT 5 FOR MAINS OPERATION. LINKS BETWEEN PINS 1 & 4, 2 & 5, 7 & 10 AND 8 & 11 COMPLETE LT SUPPLIES TO VALVE HEATERS.
EXTERNAL POWER SUPPLIES
ACCESSORY SUPPLIES
EXTERNAL SUPPLY SOCKET
AUDIO OUTPUTS, MUTING & AGC
NOTE: MALE CONNECTORS ARE SHOWN THUS: ▪ AND FEMALE ▫ CHASSIS MOUNTED CONNECTORS ARE MARKED 'SKT'
NOTE PL4 MATES WITH SKT 3. PINS 4, 6 & 7 ARE EARTHED WITHIN THE RECEIVER. PINS 1 & 4 MUST BE LINKED WHEN THE MUTING FACILITY IS NOT IN USE
MAINS INPUT WIRING - 830/2
AC MAINS INPUT
AGC FOR DIVERSITY WORKING
RF AMPLIFIER V1 ECC189
1ST MIXER V2 6AK5
2ND OSCILLATOR V3 6C4
2ND MIXER V4 6AK5
1ST IF AMPLIFIER V5 6BA6
2ND IF AMPLIFIER V6 6BA6
NOISE LIMITER V7 6AL5
CATHODE FOLLOWER V8 6AU6
AM-DET-AGC-AF V9 6AT6
AUDIO OUTPUT V10 6AQ5
CRYSTAL CALIBRATOR V11 6AU6
1ST OSCILLATOR 6U8
CW/SSB DETECTOR V13 6BE6
PEAK RF
MAIN TUNING
INCREMENTAL TUNING
SELECTIVITY
METER ZERO RV3 5K
RF GAIN RV1 10K
IF GAIN RV2 10K
AF GAIN RV4 500K
BFO PITCH RV5 20K
USB ADJ RV6 56K
LSB ADJ RV7 5·6K
SKT1 AERIAL INPUT (75Ω)
IF OUTPUT SKT 2
TELS JK1
EARTH