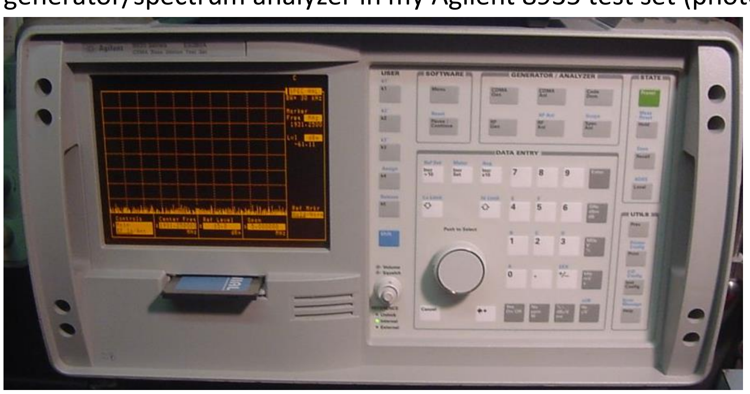
Eddystone S.820 Revisited – Gerry O'Hara VE7GUH

Background

Having worked my way through most of my remaining collection of Eddystone sets earlier this year during the Covid-19 'lockdown', I thought it was probably time to give my Eddystone S.820 AM/FM tuner the 'once-over' as well. I last worked on this little guy in 2007 – mainly cosmetic work, constructing a case from acrylic (photo, above), and realignment, but I also replaced some resistors and installed fuses. I had not powered it up for several years, mainly because it is a 240vAC unit and therefore a little inconvenient to set up here in Canada (120vAC power), so I tend to use one of my refurbished QUAD tuners, which are set for 120vAC operation, when I feel like listening to FM stations through my 'HiFi'. I did recall that the last time I had it running – probably five years or so ago - it did not seem as good as when I had restored it. So here it is on the bench again. An article on my earlier restoration work can be viewed here (I cannot believe it was 13 years ago!).

Testing, Testing...

Before I started any component checking on the S.820 tuner, I decided to learn how to work the tracking generator/spectrum analyzer in my Agilent 8935 test set (photo, below), so I could check the tuner's



10.7Mhz IF response with it[1]. I have had this unit for several years (I was given it my a friend 'in the business'), and its a real 'Swiss Army Knife' for testing radios. It's designed for checking older cell phone base stations and likely became obsolete around 15 years ago for that purpose as cellphone technology overtook this model's design parameters. Its a large heavy unit and

[1] I also have a home-brew wobbulator I can use for this purpose, as well as an HP8601A sweep generator and a recently-acquired matching HP8600A DFM/digital marker unit that are good for this also

its cooling fan is very loud - to the point of being overbearing in a small workshop - similar to those really large old Tek 'scopes from the 1950's - but at least it does not generate as much heat as those 100-valve monsters...

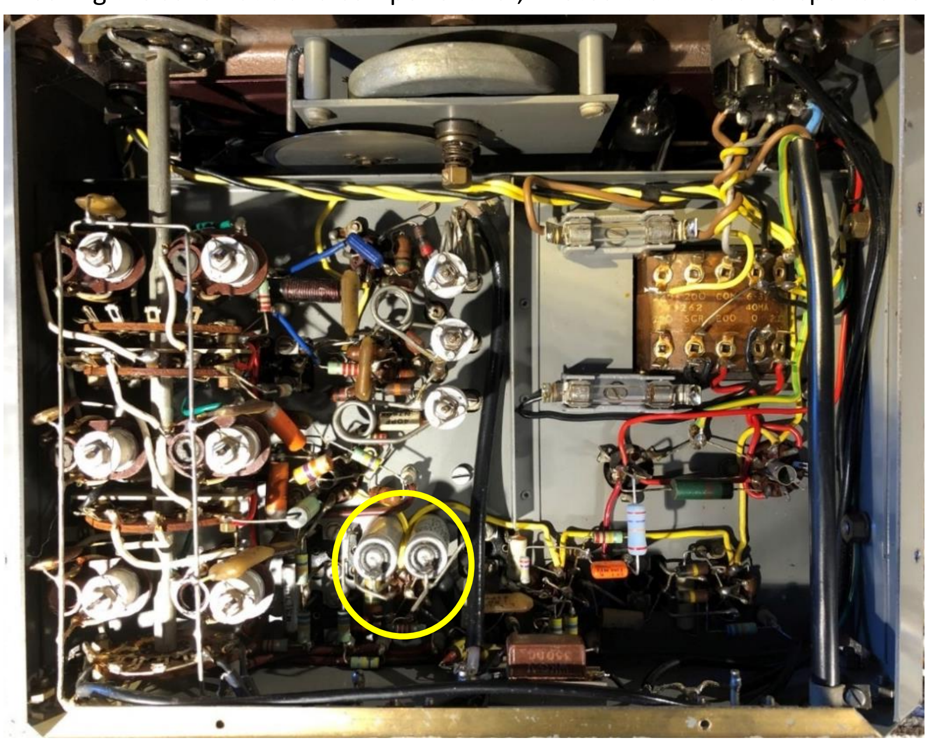
The noisy fan has put me off using it as my ‘go to’ instrument(s) of choice where something else (quieter) will do the job, plus the manuals are really poor in explaining how to set the instrument up for many types of measurements. The combination of these two things have made me only turn to using it when I really needed to, eg. when my other test equipment simply will not do what I want, such as generating stable and accurate VHF/UHF signals. However, after keeping myself amused on those long Covid-19 nights watching YouTube videos, it occurred to me that YouTube may have some stuff that could help - sure enough it did, not so much on the Agilent 8935, but certainly some useful stuff on its predecessors, the HP8920 and HP8921A, including an hour-long HP training video (this is very 'late-1980's' in appearance and the sound quality sucks, but I found it useful). There are other videos of folks describing setting up the tracking generator and spectrum analyser for checking filters, etc, eg. here. Although these two instruments are different (the Agilent 8935 is a later model with a generally higher spec., eg. it has a second frequency range above the 0.4 - 1GHz of the HP8921A, covering 1.7 - 2GHz), many of the controls, functions and menus are the same or very similar. A list of the differences can be found here. The display technology is also different: the earlier HP-manufactured versions use a CRT, whereas the Agilent 8935 uses a monochrome (amber on black) 'electro- luminescent' display. The Agilent 8935 is also weatherproof, and so instead of the nice push-buttons sported by its predecessors, it has a rather less-than-tactile membrane control panel. Also, more annoyingly, all the connectors/ports on the Agilent unit are located on a panel on the side (photo, above), making it awkward to use on the bench. To overcome this I built a couple of ‘breakout boxes’ to facilitate making connections at the front of the unit (visible to the right of the Agilent and the Drake MSR-2 receiver in the photo, right).

It turns out that the spectrum analyser menu allows the user to 'jump' to the RF generator menu while still using the spectrum analyser, and change the mode from 'fixed' to 'track'. It also includes sub-menus for the markers and other functions. Another 'quirk' of the Agilent is the input/output facilities: signals can be input via the 'Ant' and the 'RF In/Out' ports, and the RF generator can be routed to either the 'RF In/Out' or 'Duplex Out' ports. These options are all software-selectable in the appropriate menus. This is to accommodate the many different receiver/transmitter testing options available – some quite specialized to cell phone applications. For example, the 'RF In/Out' port can handle up to 100W transmitter output as well as being used for all but the most sensitive input signals. The unit can even be used as an AM/FM/SSB receiver when an antenna is connected to the (more sensitive) 'Ant' port, however, the maximum reverse power into this and the Duplex port is only 60mW, though warnings/protection are provided. Altogether this is an impressive[2] piece of kit, but somewhat confusing when trying to learn how to use it from the manuals. One good feature I discovered is that it can save a particular test setup of the instrument so the positions of the various screen settings can be quickly recalled. A large number of these can be saved by the user, recalled by a menu system, and then re-loaded quickly. This, plus user-defined shortcut keys, help to quickly navigate the often convoluted menus. I really must keep using it to keep up my proficiency (I find donning a pair of noise cancelling headphones helps…).

S.820 Check-out

So, with my recently-honed Agilent test set skills in my back pocket, off came the home-brew acrylic case on the S.820 and I powered it up using my Sencore PR57 combined Variac/isolation transformer unit, coupled to a 120/240v step-up auto transformer, feeding the audio from the tuner into a pair of old computer speakers. It was working , but not that well: AM reception was ok, if a little 'deaf', but FM reception was really poor: low sensitivity, especially across the lower half of the band, two signal peaks were present when stations were tuned in, and the audio sounded distorted.

Checking the schematic and component list, I noted that the tuner sports a total of 24 tubular paper



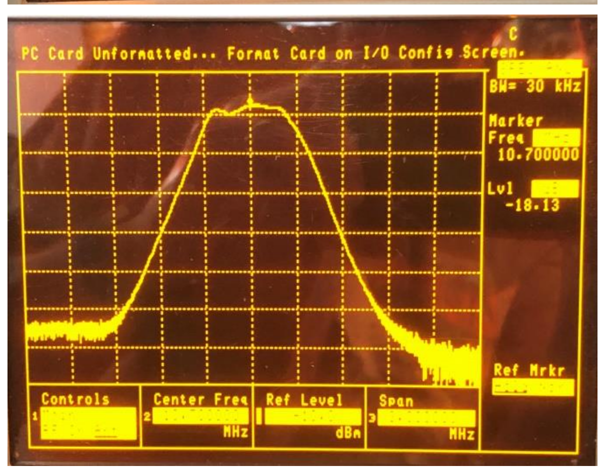
capacitors. On inspecting the chassis (photo, left, before any re-work), I noted that five of these are metal-cased, with two of these being chassis-mounted types (circled yellow in photo). One capacitor, shown as tubular paper (C16), was actually a tubular ceramic, and another (C38) was a silver mica (thank goodness, as its in a tuned circuit!). Unfortunately the remainder of the tubular paper capacitors are the

[2] As was the price tag - the unit I have with its options and software cost over $90,000 when new in 1999. They can now be bought on eBay and from a company specializing in these test sets for a lot less than that!

small 'rat-crap' type that tend to age poorly… Given that the tuner was working well 13 years ago, I initially thought maybe one or two of these had failed to a point where they were affecting the tuner's performance, eg. there are three of the rat-crap capacitors across the AGC line, and any leakage through these would degrade the AGC performance. Other candidates for changing out would be where the capacitors were stressed by higher voltages, eg. in anode or screen bypass duty, where leakage would increase current draw through the associated resistors, possibly causing these to drift or fail, or those in anode to grid coupling duty, where leakage can positively bias the grid and cause damage to that valve and/or a transformer in its anode circuit. On the other hand, leakage in capacitors bypassing cathodes or heater supplies is much less critical. It should be noted that the original dual can electrolytic capacitor was also still connected and working well - in my experience, the ones used in Eddystone sets tend to be very reliable, however, if I leave these in place, I usually fit an additional fuse in the HT supply for added protection.

Before I started any refurbishment work, I decided to check out the tuner's 10.7MHz IF response curve using the Agilent 8935. To do this, I connected the 'Duplex Out' port to the grid of the VHF mixer valve in the S.820 via a 0.022uF capacitor, and the 'Ant' port to the discriminator transformer secondary via a x10 'scope probe, disconnecting the antenna from the S.820 and setting the centre frequency of the spectrum analyzer/tracking generator to 10.7MHz.

The resultant response curve – as set some 13 years ago by me, following the procedure in the tuner's manual (a simple peaking for maximum output method) - was not that good (upper photo, right), showing some marked asymmetry. This could be the result of age-related/component drift , or, of course, me doing a crappy job 13 years ago. I decided to see if I could improve the response curve using a visual technique with the Agilent 8935 connected. Indeed I could – see lower photo, right.



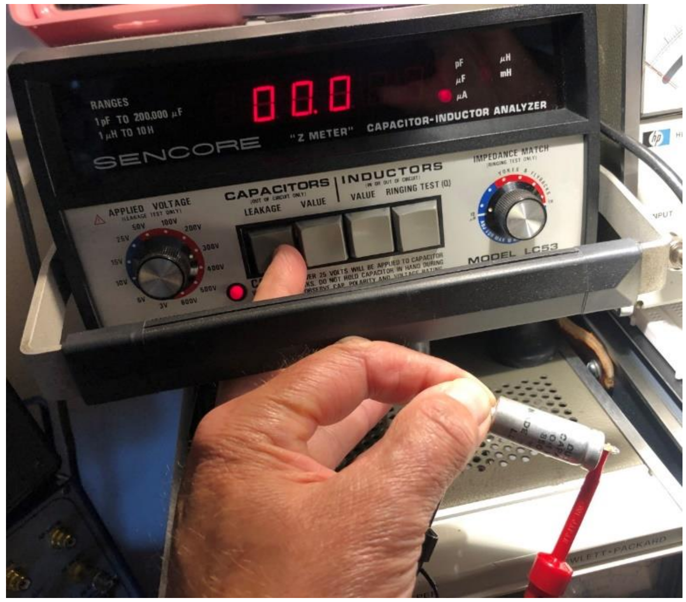
This proved an interesting experiment and now I felt I had at last mastered at least some of the Agilent's controls(!). The tuner definitely sounded better after this - around 20 mins work tweaking all six 10.7MHz IF transformer slugs a little and repeating until an almost flat-top and reasonably steep-skirted response was obtained symmetrically around the centre frequency of 10.7MHz. I did not tweak the discriminator transformer slugs.

So, now onto some real work…

Refurbishing

Nothing much needed to be done cosmetically or mechanically – the work I had done 13 years ago was holding up ok reasonably well – all I had to do was re-glue one of the feet and a front panel captive securing nut back onto the acrylic case. So, onto the chassis…

I started by checking the AGC capacitors ('rat-crap' types) – one was almost perfect: spot-on its marked value and very low leakage, one was open circuit, and one showed a leakage resistance of 300Kohms, so a real 'mixed-bag' – I tested these at 50v on my Sencore LC53 L-C analyzer. I replaced these and moved on to the anode and screen decoupler capacitors, finding the same types of issue. Testing the two chassis-mounted (0.1uF) metal-bodied capacitors showed these to be in very good condition – no measurable leakage on the Sencore when testing at 300vDC (photo, right), and spot-on the capacitance value. However, the smaller metal-bodied ones showed leakage. I also found some other the rat-crap types had never been soldered properly – the leads just unravelled from the connection points in the circuit. Given all of this, I decided to replace all of the rat-crap capacitors and the three smaller metal-bodied ones, plus a 'Wima' branded capacitor that someone had fitted as a bypass in the VHF amplifier (not the best choice) – the photo left shows the removed capacitors. Changing-out several of the rat-crap capacitors is quite a chore as they are tucked in behind/ underneath several other components, often in tight spaces, making selecting/placing replacements critical regarding physical size and lead dress. I used mainly plastic film capacitors as replacements, though decided to use disc ceramics for bypass in the VHF RF amplifier stage where these were a better physical fit and likely have better bypass characteristics at VHF. I also added an X-Class 0.047uF safety capacitor across the dual pole power switch, and while I was at it, I checked most of the resistors and, thankfully, all of these checked within their tolerance ratings, so none were changed.



I then tested all the valves using a Precision 10-12 tester. All tested very good for emission and shorts, except the hexode section of the ECH42, which tested at only 56% emission, and the EM80, where the display brightness is a bit lacking. I will buy a NOS ECH42 and see if it makes any difference to performance and an EM80 to make the front panel sparkle again. Interestingly all the 6AM6 and the 6AL5 valves are 'Osram' brand (photo, above), and the remainder are

'Mullard', except the 12AT7, which is 'Brimar'. I suspect that some (or all) of these, being of UK-manufacture, may be original fitment.

Voltage Checks and Re-alignment

With the re-capping work completed I undertook some voltage checks at critical circuit nodes (table in the manual) - all were within the stated tolerance (or very close) - so I then proceeded with re-alignment. I decided to follow the (conventional) method described in the manual 'to the letter', then to use the Agilent 8935 spectrum analyzer/tracking generator facility to see how accurate it was in obtaining a satisfactory 10.7MHz IF response curve.

Set-up of the FM circuitry this way requires a 50-0-50uA meter - I have a nice large one of these that I don't think has been used since I last re-aligned this tuner 13 years ago. It is first used to peak the 10.7MHz IF section while feeding in a 10.7MHz signal, and then to set up the discriminator (photo, right).

The AM IF alignment is done simply by injecting 465KHz into the mixer and peaking all the 465KHz transformer slugs. I had to remove several of the powdered iron slugs from the 10.7MHz IF transformers and the discriminator transformer, clean small fragments of broken slug material out and then lube the slugs with ROCOL 'Kilopoise' high viscosity grease prior to re-inserting them. Before I did this, peaking the transformer responses was somewhat erratic, especially on the discriminator stage - after this 'clean-up' and lube was completed they all adjusted perfectly.

The FM RF alignment comprises tweaking three 'beehive' trimmers while operating the tuner near the upper end of the FM band (local oscillator, mixer and antenna). If any adjustment is needed at the lower part of the band to obtain good tracking across the dial, the coils have to be tweaked by pulling/pushing the turns apart/together - I did not have to do this as the tracking was very good. Alignment of the AM RF section is limited to setting the local oscillator and antenna trimmers/slugs for the three pre-set station positions: two on the Medium Wave band ('Broadcast Band' in the US/Canada), and one on the Long Wave band (not used in North America for broadcast stations as far as I am aware).

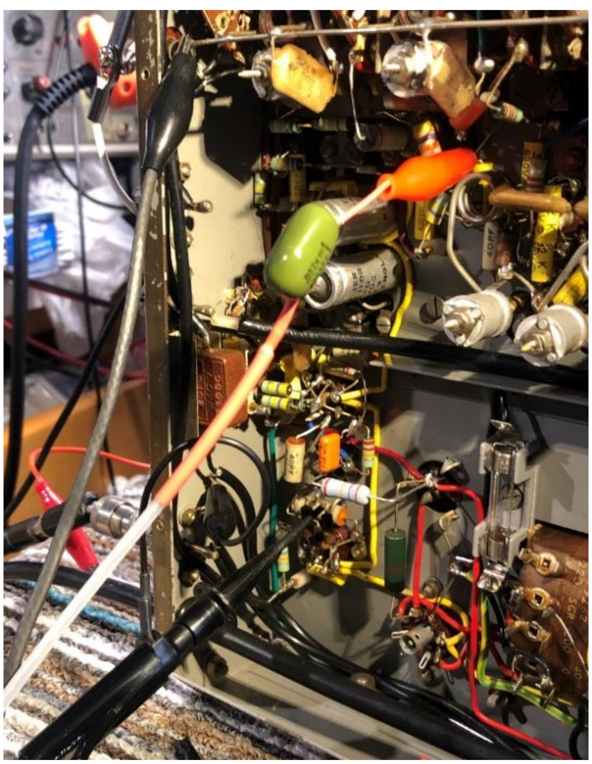
The tuner does not have any facility for automatic frequency control (AFC), however, drift, even at the highest VHF frequencies, was hardly noticeable once the tuner had warmed up for half an hour or so. Also, it does not have a 'local/distant' switch like some of its contemporary tuners had, eg. the LEAK Troughline, and so my only 'complaint' is that the EM80 'Magic Eye' is too sensitive, as on strong local stations it closes fully and thus becomes virtually useless.

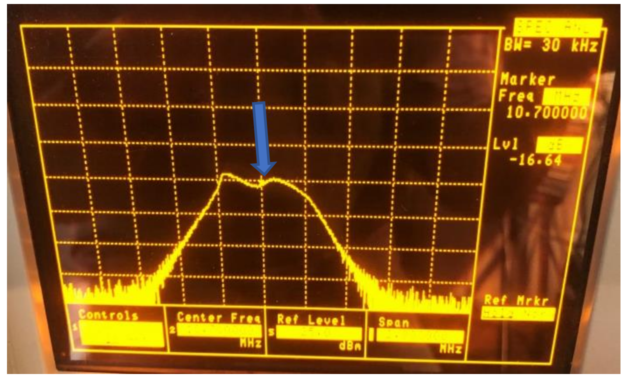
On completion, I connected the Agilent as I had before (except I used the less-sensitive 'RF In/Out' port), and the spectrum analyser showed that the 10.7MHz IF response curve was not 'perfect', but was very similar to the best I had obtained using the Agilent before starting the work on the chassis (lower photo on page 4), and the tuner sounded so good that I was loath to try to tweak it! See the captioned photos, right, which show the response obtained, showing a nice, symmetrical response.

A short demo video of the tuner working through the small computer speakers can be viewed here.

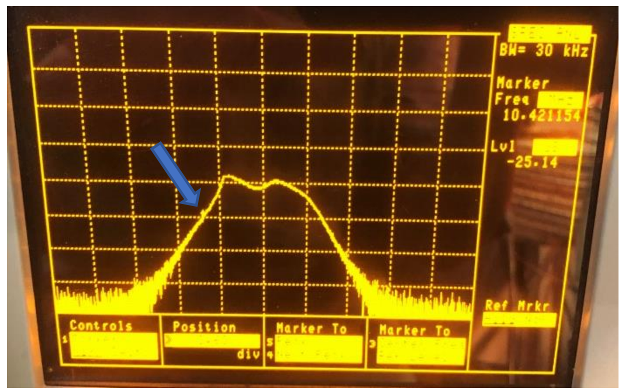
Closure

This 'revisit' work on my S.820 tuner has certainly been worthwhile. Although I tested the tuner using a couple of small computer-type powered speakers, I later connected it to my refurbished QUAD II/QC22 amplifier and decent speakers. The sound was, in my opinion, as good as my refurbished QUAD FMII tuner, with crisp, clear audio, little sibilance and low distortion.

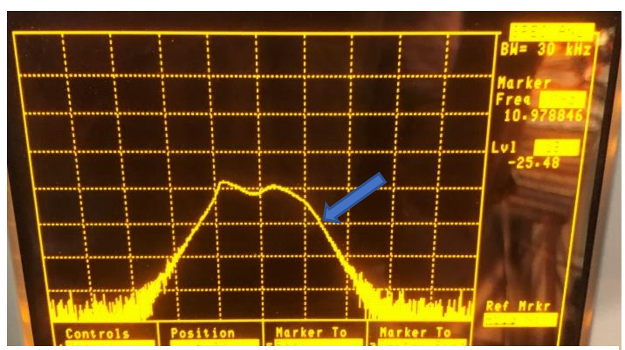




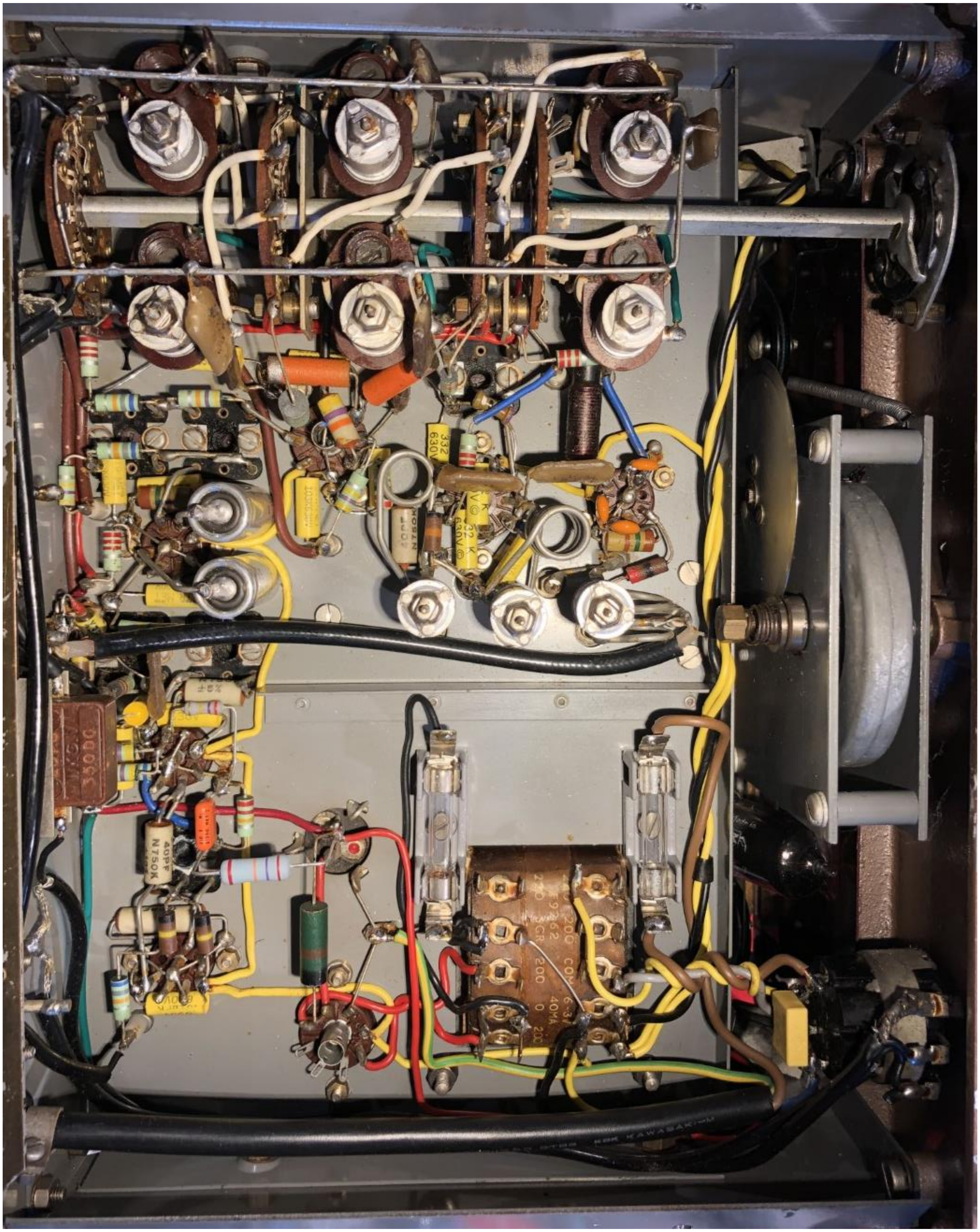
Above: 10.7MHz IF response with marker pip at 10.7MHz (centre of passband), showing a signal level of -16.64dB



Above: 10.7MHz IF response with marker pip at 10.421MHz (~280KHz low of centre), showing a signal level of -25.14dB, ie. 8.54dB down at -280KHz



Above: 10.7MHz IF response with marker pip at 10.979MHz (~280KHz high of centre), showing a signal level of -25.48dB, ie. 8.9dB down at +280KHz.
Left: connections for the spectrum analyser - the tracking generator (Duplex port on the Agilent 8935) connected to the mixer valve grid via a 0.022uF capacitor, and the secondary of the discriminator transformer connected to the RF In/Out port of the Agilent 8935 via a x10 'scope probe



Above: under-chassis view of re-capped tuner