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6 Jan 2010

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for

Practical Wireless

Approximately 2630 words including ‘Prices’ text box and end ‘References’
2 diagrams included as part of this Word document
(9 photos sent previously and not included here)

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Musings on a relic – the Codar AT5

by Ian Liston-Smith, G4JQT

To many older readers the Codar AT5 160 and 80 metre VFO-controlled transmitter may evoke fond memories of their early years of holding an amateur radio licence. This resilient little transmitter is still sought after by AM enthusiasts, and a fully working example can give a good account of itself - forty years later.

Memorable

The AT5 is probably Codar's most memorable and best designed piece of amateur radio equipment.

The transmitter was produced from the mid 1960s until the early 1970s, but when they turn up now they are frequently in a sorry state, having suffered various brutal modifications.

The circuit cannot be described as truly original, as it is very similar to many AM transmitter designs which appeared in the amateur radio press in the 1950s and 60s. Nevertheless, it does include a couple of clever features in a comparatively compact design.

The manual states that it has a DC input of 10 watts on AM and 14 watts for CW. With a good set of valves (all of which are still obtainable) this corresponds to a maximum RF output of about 7 watts of AM and 10 watts of CW on 160m but a little lower on 80m.

These transmitters are restorable almost regardless of condition, although any unsightly “ham holes” (unsightly and/or crude modifications executed by “hams”) are another matter…

There were also a number of Codar accessories available. The most commonly found and most useful is the matching and equally well-built mains power supply - which also contains the transmit/receive switching. Somewhat rarer are the mobile accessories.

Manual

The manual is a rather rough and ready affair with some minor drawing errors which Codar never corrected.

The transmitter had a few circuit modifications during production (described later), but most of them never appeared in the manual.

Despite these shortcomings, the text clearly describes the circuit operation, along with detailed installation and operating instructions and includes useful voltage and current readings.

VFO

According to Codar: “The VFO is a new type of modified Vackar circuit developed by Codar and is extremely stable. Temperature compensating capacitors are used to obviate frequency drift”.

After working with four AT5s over the years, their drift seems to be no better or worse than the any other VFO-controlled valve amateur equipment.

For both 160m and 80m the VFO runs from about 1.75 to 2.2 MHz. For 160m operation the VFO V1 (EF80) is followed by the buffer V2 (EF80). For 80m, the buffer is followed by the series-tuned circuit, L3/C9 which simply shorts the fundamental to earth. Thus drive on 80m relies on the VFO/buffer second harmonic, explaining the slightly reduced output on this band.

RF output stage

In CW mode, the HT is applied directly to the RF output valve V3 (6BW6). This is followed by a conventional pi-output stage, using the low-loss air-paced Codar “Qoil”, L4.

Harmonic attenuation (and the VFO fundamental “sub-harmonic” when operating on 80m) leaves something to be desired by modern standards.

The cathode keying of V3 gives a surprisingly good CW note with little or no chirp when used with the matching power supply.

Modulator

There is enough gain to fully modulate the transmitter using a crystal microphone and Codar recommend the Acos type 40.

The microphone input is followed by a two-stage audio amplifier V4A/B (12AX7) with gain adjustable via preset R14. (C18 is wired to the top of R14 with V4B grid to the wiper, not as published in the manual.)

The mystery rear rubber grommet holds R14's "control key". This plastic square-ended spigot is usually missing, but a carefully angled screwdriver works just as well.

The modulator does not use a conventional modulation transformer but a tapped choke, where the HT is fed in at the centre. One end feeds the anode of the class-A modulator valve V5 (6BW6) and the other the anode and screen of RF power amplifier V3. The magnetic effects from the standing current flowing through each half of the choke tend to cancel out, allowing use of a smaller choke than would otherwise be necessary.

This method may not accurately match circuit impedances, but works quite acceptably. It is not unique to the AT5; the Minitopper published in Short Wave Magazine August 1962 is at least one other design that uses this centre-tapped choke modulation method.

Good, undistorted modulation is achieved up to about 70 to 75 percent. Despite this, it sounds better than might be expected. Anyway, we're not aiming at hi-fi here, this is amateur radio!

I have not noticed any significant "FMing" of the carrier when listening to the output on an SSB receiver. This can be a shortcoming in some simple VFO-controlled AM transmitters.

A basic modulation indicator is included across the modulated HT feed to V3, consisting of nothing more than a neon bulb in series with a capacitor. As the modulated HT swings up and down, it causes the neon to strike and vary in brightness, thus providing a rough indication of the presence of modulation.

Unfortunately there is a price to pay for this simplicity; each time the neon strikes it puts a small "dink" of distortion onto the modulating waveform – the greater the modulation level, the greater the dink.

Dave Evans, GW4GTE, published a detailed analysis of this along with other AT5 observations in the Vintage and Military Amateur Radio Society (VMARS) magazine "Signal", issue 5, October 2007.

Although I have observed this distortion, I suspect the effect varies from set to set since the two AT5s I currently own show almost no sign of it.

Mains power supply

The separate Codar 250/S power supply uses a full-wave valve rectifier circuit using an EZ81 rectifier valve. I believe a silicon-diode version may have been introduced later, but I cannot confirm this.

The 250/S provides the 6.3 volt AC for the heaters, about 270 volts HT and a stabilized 150 volts for the VFO via an OA2 neon voltage regulator.

The power supply chassis also incorporates the antenna inputs and outputs and the NET-STANDBY-TRANSMIT control switch.

During STANDBY (receive), a simple combination of resistors and a capacitor causes another neon indicator bulb to flash. A steady glow is maintained

during NET and TRANSMIT. This neon has no detrimental effect on the performance of the AT5!

A 6.3 volt 0.3 amp bulb in the rectifier cathode acts as an HT fuse and glows reasonably brightly during transmit, although it is hidden inside the power supply. The power-supply smoothing choke is the same as that used in the modulator.

The nine-pin sockets on the rear chassis of both the 250/S power supply and the AT5 carry LT and HT supplies. The interconnecting lead therefore has a plug at each end. Beware; these voltages are available at the plug before connecting it to the AT5. You will get a nasty jolt (or possibly worse!) if you touch the HT pins of this plug if it gets pulled out of the AT5 power socket.

Incidentally, on page 7 of the manual, the labelling of pin 7 and 8 of the round voltage plug is transposed. It should be pin 7 is HT1 150 volts and pin 8 is HT2 270 volts.

Mobile use

This valve transmitter can also used mobile, with the Codar 12/MS 12-volt power supply unit. This uses two NTK401/OC28 germanium power transistors in an oscillator. The chopped 12-volt waveform feeds a step-up toroid transformer. This is followed by a silicon diode bride rectifier to provide the 150 and 250-volt HT. The 12-volt input can be wired to operate in a positive- or negative-earth vehicle.

The LT is taken directly from the car's 12-volt supply as the power socket on the AT5 is wired so that the connecting lead can be wired for running the 6-volt filaments from either a 6-volt or 12-volt supply.

The companion 12R/C switching unit takes care of switching the HT feeds and antenna connections to a receiver, and Codar's matching receiver was the 12-volt, germanium-transistor T28, which could also be mounted under the dashboard.

I have owned a couple of these receivers. Despite incorporating Mullard IF and AF modules, I can only describe the performance of the T28 as "barely adequate". This seems to be a fairly wide-spread opinion!

Modifications

Making modifications to vintage equipment can be a contentious subject, but those that follow do not change the outward appearance of the AT5, and some were done by Codar later anyway.

There were also some minor cosmetic changes, most noticeably the transmitter knobs of which there were various types.

As far as I can ascertain, Codar made only a few modifications to the AT5 circuit during production.

The most significant and useful change was the switched tapping for 80m of the air-spaced PA Codar "Qoil" L4. Before this modification, it was easy to select the wrong anode dip when tuning up on 80m. This alteration was often done by owners of early models by mounting a toggle switch through the front or side panel.

However, a much neater job can be achieved by fitting a new DPDT slide switch in place of the old front-mounted SPST slide switch, as Codar eventually did.

This switch is (or was) a standard part so should not be too difficult to source. The extra contacts in the new switch are wired to short out part of L4 on 80m.

If you wish to add this modification, the hardest part is soldering the tap onto a turn in the air-spaced coil L4. The PA coil wire is quite thin and un-insulated with very small gaps between turns and it's easy to accidentally solder a bridge between them. Slot some stiff paper each side of the chosen turn before soldering. It may be necessary to push the soldered joint inwards to clear adjacent turns.

Until March 1965, the PA anode current meter was wired into the cathode of V3, and this is how it is shown on most circuit diagrams. Later AT5s had it wired in series with the HT feed to the RF choke in V3 anode to show true anode current.

Another modification carried out by Codar was to change the value of R1 from 100k to 47k in the VFO because earlier models were said to have oscillator starting problems. In later AT5 production R1, C2, C3 and C4 are in the screening can of the VFO oscillator coil L1.

Some examples of this transmitter have a fairly weak NET signal. This makes it difficult to hear the VFO on the desired transmit frequency to which the receiver is tuned – especially if the band is quite noisy.

Codar's unusual modification added to later AT5s was to add a 22pF capacitor from the 150 volt VFO HT line directly to the receiver antenna input via the NET-STANDY-TRANSMIT switch. It requires a bit of re-wiring of the antenna changeover switch to do this properly.

If you decide to do this, use a quality high-voltage capacitor; a modern receiver will not like 150 volts on its antenna input if this capacitor fails short circuit!

While rewiring this switch, I also replaced the unscreened wiring with 50 ohm coax cable for the all leads carrying RF and joined their screens together and earthed them where they connect to the sockets at the rear of the chassis.

The AT5 was designed for a 70 ohm antenna system – or at least that's what the Belling-Lee RF sockets suggest. Using it with a 50-ohm antenna system in no problem.

Nevertheless, the Codar manual suggest that a high-voltage capacitor of between 500 pF and 1000 pF be added across the load capacitor C14 if matching is difficult.

Drift cures

Despite Codar's claimed "extreme stability", VFO drift can be a problem after forty years or so.

Unless you intend to talk exclusively to other AM stations, any stations demodulating your AM signal using SSB really won't appreciate having to follow a drifting carrier.

Heat-induced drift is reduced by putting the mains PSU next to the AT5, not above or below it.

Clean all the valve pins and holders with a suitable contact cleaner - including the neon voltage stabilizer. Check that the bulb fuse is making good contact and thoroughly clean the contacts in the NET-STANDBY-RECEIVE switch

as this can be a common cause of frequency jumps. Poor contacts here will also reduce RF output and receiver sensitivity as it also routes the antenna connections.

If L1 has loose turns or a loose core, this can also be the cause frequency stability problems.

To realign the VFO, adjust L1 at the low frequency end of the scale and the VFO trimmer C5 at the high frequency end. Access to C5 is via a blanking grommet under the chassis. This grommet should be kept in place to help reduce drift from circulating air currents.

Additional modifications

Pat, G3IKR suggested a modification to me which can slightly increase output on 80m. The L3/C9 combination is only roughly tuned and is not adjustable as it stands. Pat suggested replacing C9 with a 60pF trimmer which is adjusted for maximum output on 80m. I peaked mine in the phone section and increased RF output by about 1.5 watts.

An examination of the circuit diagram shows that there is no proper RF decoupling on the HT lines - Codar obviously relied on the electrolytic capacitors in the power supply to achieve this. Nevertheless it is good practice to place appropriately rated 0.01uF disc capacitors across any electrolytic HT decoupling capacitors in RF circuits to prevent possible instability.

I have also changed the two-core mains lead with an earthed three-core one to connect the chassis to mains earth. But beware; doing this to old equipment with a mains transformer may lead to its insulation breakdown. But as the transmitter was designed to be used with a good earth (if not actually a mains earth) this shouldn't be a problem.

If you do this, ensure that the self-tapping screw near the point where the mains lead enters the power unit does not pierce the insulation.

Consider putting an X-class capacitor (i.e. a capacitor specifically designed to be placed across the mains) of about 0.05uF across the transformer primary. This will help keep RF from getting into the mains from the PSU and help reduce voltage transients reaching the PSU from the mains.

I have also added one 0.01uF, 2kV capacitors across each half of the secondary winding of the mains transformer for the same reason.

AM today

Of course AM is relatively rare on the bands now, but it still to be found, particularly on 160m nets, and on 80m between 3.615 MHz and 3.625 MHz.

Those interested in using AM are welcome to join the VMARS net on around 3.615 MHz on a Saturday mornings. See www.vmars.org.uk

The Codar AT5 is a basic, well-built transmitter, but electronically, there was nothing really revolutionary about it - even back in the 1960s. It has its quirks; nevertheless, I think is well worth nurturing back to full health - and of course using it!

Prices

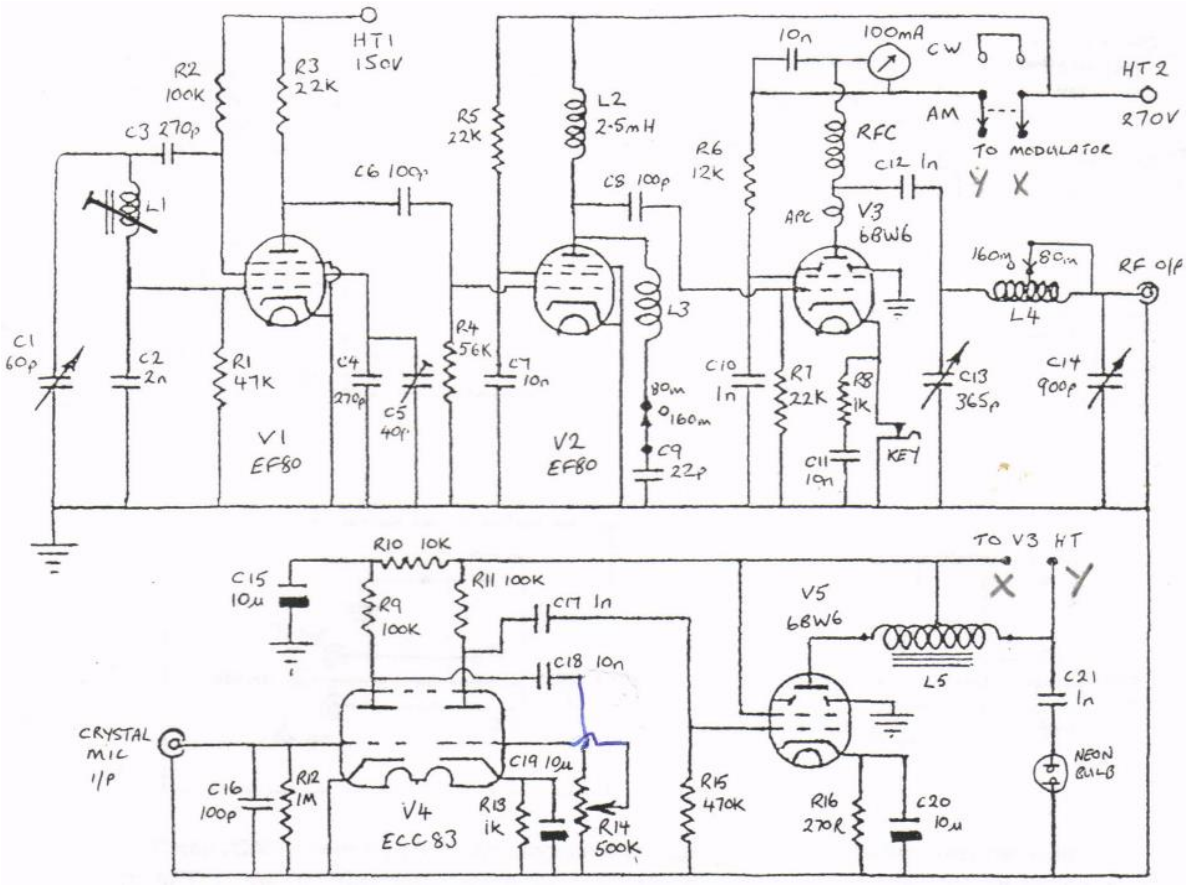
When the AT5 was launched, the price of £16-10s (£16.50) was thought to be quite reasonable by at least one reviewer of the transmitter at the time. If we take that as the 1967 price and convert it to an equivalent value today it is about £212.

The mains power unit was £8 (£110), and Acos mic £2-2s (£27).

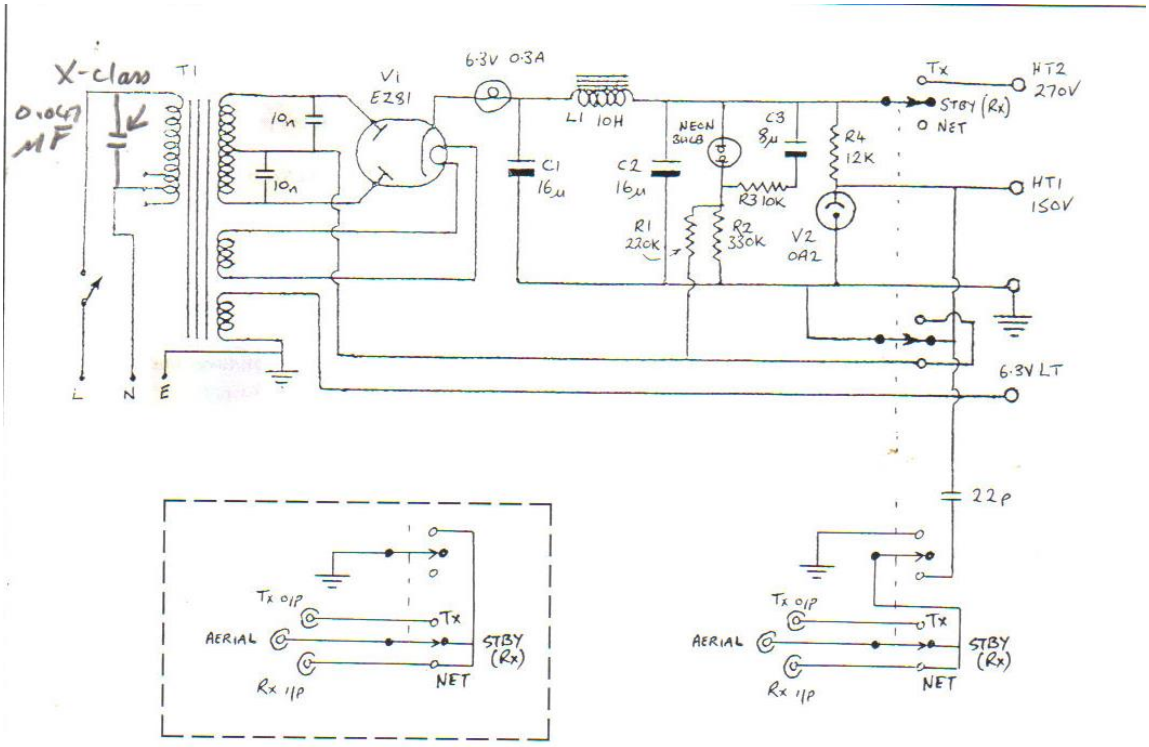
We'd expect much more for that sort of money now!

References

Vintage gear for M3s by R Hankins, G7RVI/M3RVI – VMARS Newsletter February 2003
The Codar AT5: tales and tweaks by D Evans, GW4GTE – VMARS Signal October 2007
Review: Codar AT5 transmitter by DV Newport, G3CHW - RSGB Bulletin May 1965
The AT5 – an old friend by RQ Marris, G2BZQ
www.thisismoney.com (historical inflation calculator)



(for PW redrawing) Caption to read: ***Corrected Codar AT5 transmitter circuit***



(for PW redrawing). Caption to read: ***Codar 250/S power supply. Insert shows NET-STANDBY-RECEIVE switch before improved net signal modification. Other added components are 0.047uF X-class capacitor across the mains-transformer primary winding and 0.01uF high-voltage capacitors across each half of the secondary.***