STATION QRP
TUBE SHORTWAVE TRANSMITTERS

25 WATT GU-50 AM TUBE SHORTWAVE TRANSMITTER

(PART 4 of 5)

IMPORTANT: *The published circuit diagrams of Station QRP are for educational purposes only. These are offered for the furtherance of the readers' knowledge regarding Radio Frequency design and principles. At all times during operation an assembled unit must be connected to a dummy load. In most countries law prohibits the unlicensed operation of transmitters when connected to an antenna or even to have such equipment present in a fully or partially installed state. All responsibilities for the ultimate use of the diagrams are borne solely by the builder and/or operator.*

Table of Contents

Part 1

- Introduction
- Warning
- The case
- Initial design considerations
- First transmitter design
- Final transmitter design
- The transmitter circuit - RF stages
    - Figure #1 circuit diagram of the RF section of the transmitter

Part 2

- Mains distribution
- Control supplies and relay switching
    - Figure #2 circuit diagram of mains switching and distribution
    - Figure #3 circuit diagram of the control supplies and relay switching
    - Figure #4 circuit diagram of the power supply for the RF stages & mod
    - Figure #5 circuit diagram of the modulator
- RF HT power supply and modulator power supply
- Modulator unit

Part 3

- Construction of the transmitter
- Detailed construction
    - Figure #6 picture of power supply components
    - Figure #7 picture of the MOSFET amplifier
    - Figure #8 picture of the rear panel
    - Figure #9 picture of the underside of the RF deck
    - Figure #10 picture of the Top-side of the RF deck
    - Figure #11 picture of the FAT-MAX speech processor

Part 4

- Front panel
    - Figure #12 picture of the front panel
- Shoe-horning
    - Figure #13 picture of internal construction
- Cable forms
- Testing the transmitter
- FAT-MAX
- Boxing Day
- Your 43 meter band rig

Part 5

- Instant HT
- Hum-free with residue
- Possible solutions
- New appoach
    - Figure #14 picture of reed switch
    - Figure #15 circuit diagram of the voltage doubler
    - Figure #16 picture of the voltage doubler
    - Figure #17 picture of the arial changeover relay
- Ratings

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- Part 1: Click here to download PDF
- Part 2: Click here to download PDF
- Part 3: Click here to download PDF
- Part 4: Click here to download PDF
- Part 5: Click here to download PDF
- Part 1-5: Click here to download ZIP

Front panel

Figure 12. The front panel

The front panel (**Figures 9, 10 and 12**) accommodated the SO-239 socket, two BNC sockets, PA tune and PA load variable capacitors, the π-coil, meter and meter switch, the function switch and LED indicators, a second 18-way terminal block, mains input, fusing and switching for the Uni-Timer printed circuit board, modulator load stabiliser and the remaining relays.

Shoe-horning

As one might expect, there was a great deal of ‘trial and error’ during the ‘dry-build’ to accommodate all the components. There were times when the back of the unit was in place so that the layout could be viewed from the front with the base sub-chassis in place, or with the front of the unit in place so as to determine the position of the horizontal sub-chassis. Eventually, all the large components were placed and the smaller ones could then be fitted in. After drilling the case for the CPT etc., all was removed and the case was cleaned ready for repainting. There were a few inherited ‘rogue’ holes in what had become the slotted top, so a ‘repair’ was carried out. Four self-adhesive rubber feet were fixed to the bottom to allow for ventilation.

A rear view of the completed transmitter (**Figure 13**), without the rear panel connected, illustrates well the utilisation of space within the case.

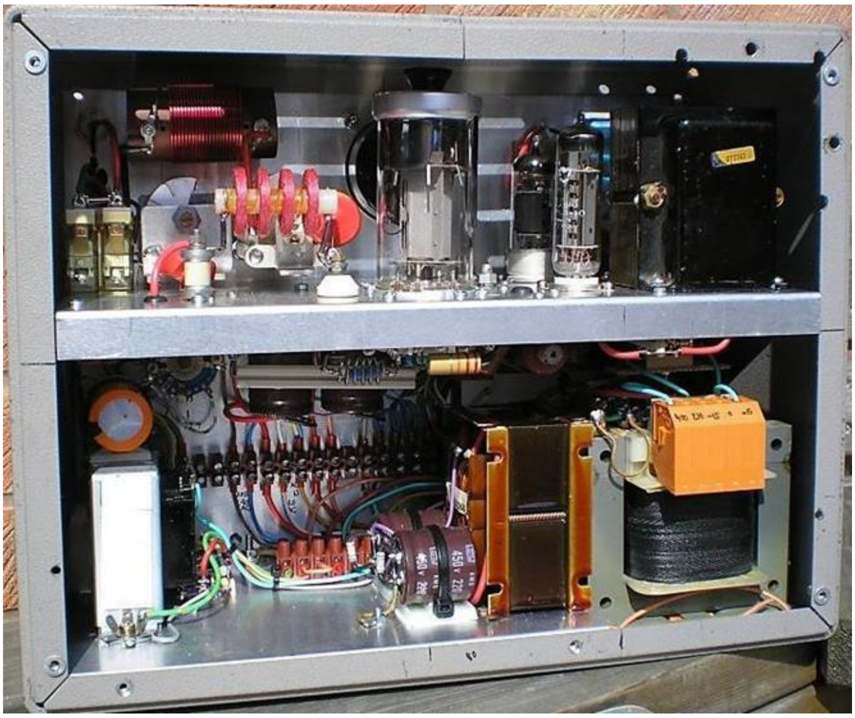

Figure 13. Rear view of the internal construction of the transmitter

Cable forms

After completion of all the chassis assembly, two ‘over-long’ cable forms with connections to and from the terminal strips were made, allowing the front and rear plates to be positioned horizontally. Safety earthing straps, additional to the cable forms, were added. Testing in stages could then be commenced.

Testing the transmitter

The power supply was tested first to establish the 12 VDC control supply and operation of the function switch, its relays and its indicators, then the Uni-Timer relay operation and mains switching to the CPT, and finally the modulator toroidal transformer.

Having confirmed that the AC secondaries were delivering the correct voltages, the RF stage HT was confirmed as 500 VDC. It is prudent at this point to check the values of DC voltage across the series-connected 220 µF electrolytics in the smoothing circuits to ensure they are balanced. The crystal oscillator appeared to be working and grid current into the GU-50 was peaked after temporarily removing its 22 kΩ, 17 W screen grid supply resistor. Contrary to normal expectation, just under 3 mA of grid current was available, whereas about up to 5 mA would be normal from such an oscillator. Also the rise and fall of grid current was erratic when going through the resonance point with a very rapid fall off in output on one side of ‘tune’. The crystals were new so it was unlikely that they lacked activity, therefore, attention was given to the construction of the driver anode circuitry.

Closer inspection revealed that the Hammarlund trimmer had vanes ‘just’ touching at some points on its traverse; this fault was rectified by judicious, almost surgical, re-bending, after which mechanical and electrical operation were smooth, but the oscillator still delivered only 3 mA drive into the GU-50. The 10 Ω anode stopper on the 12BY7A was a vintage and somewhat long ceramic- bodied component that had been connected to the ‘hot’ side of the 10 µH inductor (which forms part of the tuned circuit) using a tag on the inductor furthest away from the chassis. Good practice is to keep such wiring close to the chassis. With a modern, smaller, 10 Ω resistor to the lower tag on the inductor, and a rework of the rest of the circuit, 5.2 mA drive was now available and with symmetrical tuning on either side of resonance. The 12BY7A anode voltage was 200 V with 130 V on the screen grid.

After reconnecting the 22 kΩ PA screen grid resistor, and with a dummy load on the output, it was possible to check PA tuning and output power. With 500 VDC on the anode, an output of just over 40 W was possible. The output could easily, and with no ill effects, be reduced to the required 25 W by reducing the antenna coupling via the PA load capacitor.

The quartz crystals obtained for this project had been etched to oscillate at the stated frequency with a capacitance of 30 pF in series. Usually one adds a trimmer in series with a crystal to provide in- circuit adjustment of the operating frequency while compensating for capacitance inherent in the layout and circuit components. The output frequency was checked with a counter but adjustment to give the exact AM channel frequencies was not possible when a parallel combination of 7 pF trimmer + 27 pF mica capacitor was connected in series with the crystal to chassis. At best, the frequency was some 100 Hz high. A short circuit across the two capacitors revealed that both crystals were within 30 Hz of the channel frequency without the need for any series capacitance so the short circuit link was left in place. For this reason, no series capacitor is shown on the circuit diagram in **Figure 1**.

By temporarily placing a jumper across the ‘PTT’ link on one of the tag blocks, it was possible to power the entire rig to modulation without having to hold in the microphone ‘PTT’ switch. This arrangement permitted the testing of the MOSFET amplifier and modulation transformer alone i.e. without ‘FAT-MAX’ and the microphone. With a tone signal injected directly into the MOSFET amplifier, sinusoidal modulation could be observed on the ‘scope. The envelope was good to >100% modulation and just under 5 mA of grid drive provided the most symmetrical shape for positive and negative excursions.

FAT-MAX

Use of this speech processor was a new departure for me so it had been sensible to have proved the operation of rest of the modulator first. The original article in which the 'FAT-MAX' was described is comprehensive and it is pleasing to report that the unit worked first time and the transmitted audio sounded good. An audio signal generator was connected to the microphone input to confirm the cut-off frequency at the HF end. Indeed, as predicted with 120 pF in circuit, 2800 Hz was the HF 'cliff-edge'. Changing this capacitor to 110 pF increased the frequency response to 3000 Hz. The 'FAT-MAX' printed circuit board includes a user- selectable 'hand-bag' link to disable the limiting and compression for testing and set-up and it is important to remember to run the processor in service mode with the link out of circuit; it is easy to overlook this final 'adjustment'.

Boxing Day

After testing had been completed, the transmitter was ready to be 'boxed-up'. The cable forms were tidied, laced and shortened, and their ends terminated in crimped cable ferrules. Persuading the sections all to fit into the case was not easy but, eventually, with the modulator going in last, it was complete. Power-on revealed a transmitter that was still working with no 'frying' noises or short circuits. Particular care was taken to ensure that the mounting bolt for the modulator toroidal mains transformer did not touch the frame of the 12 VAC transformer or else a 'shorted turn' would have resulted. It is a shame that no new chromium-plated 'mushroom- head' screws were available to replace the somewhat unstylish cheese head screws on the front and rear panels.

Your 43 meter rig

It is appropriate to consider what could have been done differently. I was constrained by the size of the available case though he wanted to make a compact transmitter but, with a larger enclosure or, maybe, just a chassis, other possibilities become apparent.

The most obvious refinement is to add more bands. It would be easy to add a front panel tuning control for the driver stage, for example, a 150 pF Jackson C804 style component, and tune up with the 10 µH coil for 6925 kHz. A simple coil tap at 15 turns on the PA coil would move the PA output frequency to 40 m. There may even be room for a switch to accommodate a multi-tapped PA coil. Eighty metres could be a possibility using, for example, relay-switching of the tuned circuit in the anode of the driver with a tapped PA coil of c. 34 turns on a 1.25 inch former.

An all-valve modulator line-up is possible, but the reader should bear in mind the need for a tight HF audio response when transmitting on 43 meter. A 6BR7 or EF86 microphone amplifier into an ECC81 phase splitter and, maybe, an 815 in the modulator output stage would be tempting.

VFO control could be advantageous for other bands with a choice of either a conventional EF91-type Colpitts/Gouriet design into the 12BY7A, now serving as a buffer amplifier, or a ‘boatanchor driver’ printed circuit board, to raise the low level output from a direct digital frequency synthesiser (DDS) sufficient to drive the 12BY7A.

End of part 4