The GRC-9 Part 2,
the journey continues....

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The Transmitter, Power Supplies and problems.

In Part One I wanted to give a flavour of the GRC-9 as a good entry-level rig and focussed mainly on the receiver. In this part I want to look at the transmitter, a suggested power supply and problems that may arise when using the rig.

Incidentally the power supply described here is one I put together to carry out testing and the final version will be more robust but please do take care if copying any circuits as I can accept no responsibility for shocks/swearing or death, don't forget there is at least 500V floating around - take care and keep one hand in your pocket!! Even switched off the capacitors carry a bite. If you have better versions send them into the Editor as we are always looking for ideas to get round the perennial problem of powering up vintage rigs.

The GRC-9 transmitter is a fairly conventional master oscillator, buffer amplifier / doubler and power amplifier design with low - level modulation. It is based on the 3A4 valve (2.8V heater.) using three for the MO, BA and modulator with a

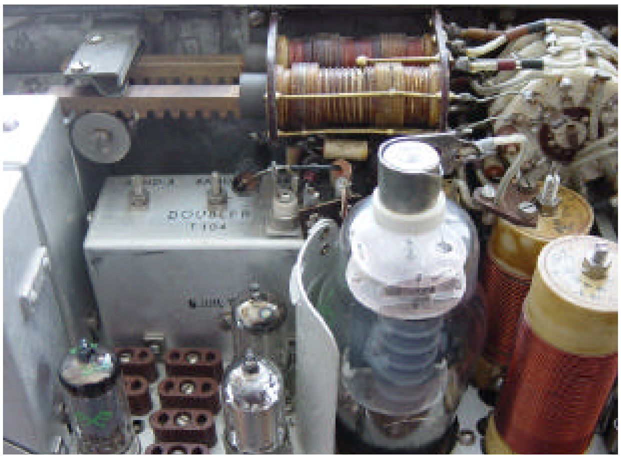
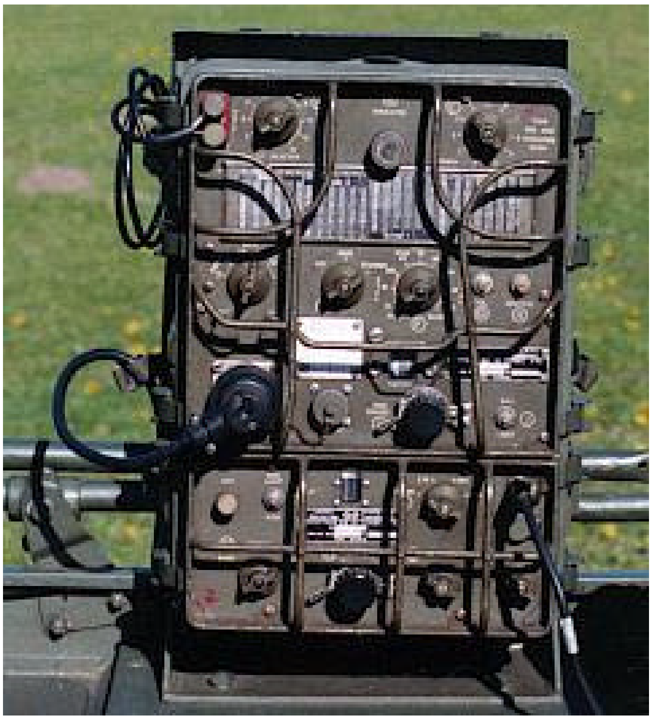


Fig. 1 The 2E22, doubler coils, Band-switch and variable permeability loading coils can be seen.

2E22 power pentode in the PA. Basic output is A.M., MCW and CW.

One word of warning is that the 2E22 is very expensive to replace (in the region of £40) as a single item so it makes sense to buy at least one Spares Kit type BX-53 from one of the suppliers mentioned in the last article as they are usually around £18 and contain spare valves including the 2E22 (check to make sure before you buy).

When the transmitter is removed from the case (remember to disconnect all power leads and the Tx to Rx lead) you can see the 2E22 quite clearly and the location of the three 3A4 valves and crystal sockets are visible once the retaining cover is removed.



The 2E22 is very hard to remove as it is gripped by screw clips and the pins are tight. Under <u>no</u> circumstances try to pull out the valve by the glass envelope, I did and it came away in my hand leaving me with the wires showing and the socket still in the holder!! A better technique is to loosen the screws and push the pins carefully, one at a time, from underneath.

There are 2 crystal positions per band (1A, 1B 2A, 2B, 3A, 3B) and the calculation is: - **2 x fundamental crystal frequency = Transmit frequency**, for example to transmit on 3.577 Mc/s you will need a crystal cut for 1.7885 Mc/s in band position 2A and if you wanted 3.615 Mc/s a crystal for 1.8075 Mc/s should be inserted in 2B. Using the chart on the front of the transmitter the Frequency Control is set to the desired frequency and the Antenna Tuning control adjusted to get maximum brightness from the indicator and a note made - in pencil! - on the crystal chart. This has to be done for each crystal for rapid changing. Crystals should be fitted that give a transmit frequency in the range indicated on the chart **(Band 1, 6.600 - 12.000 Mc/s Band 2, 3.600 - 6.600 Mc/s Band 3, 2.000 - 3.600 Mc/s)** as you can see there is some cross over, Band 2 does work on the 80M band!

It is possible to tune the higher portion of the 160m band, with my examples the limit seemed to be 1.983Mc/s but that is without any retuning or realignment. I suspect it will depend on your example and I know of models going lower.

To test out the frequency range I connected the radio set to HI CW to a dummy load, 50Ω, and Power Meter and set the antenna setting to DOUBLET and some variation of power output was noted –

Band	Doublet setting (A)	Dial (I)	Frequency	Power out
Band 3 HF	10	30 / 0	3.646	5W
Band 3 LF	9	00/0.69	1.983	15W
Band 2 HF	11	30/0	6.759	15W
Band 2 LF	11	00/00	3.546	18W
Band 1 HF	11	30/0	12.292	15W
Band 1 LF	10	00/00	7.000	5W

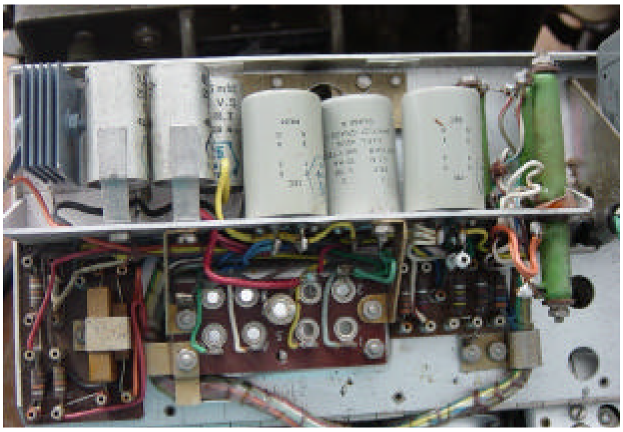


Fig. 2 Transmitter flap open, showing Rx socket

To gain access to the valve bases and components there is a hinged flap, which swings up to show the underside. I found that placing the Tx on it's front was the best way to get access after removing the screws marked "A, B, C, D" around the edge - this instruction is marked on the lid itself. If you decide to place the transmitter upside down (i.e. resting the top on the bench) just be aware that the anode of the 2E22 is very close to the bench and if there is any bits of solder, washers or other conductive material underneath you may get a nasty surprise if HT is present, also if you tilt the rig back in this position there is a high chance that you will break the cap off the valve or crack the glass - I recommend you don't do it!
In figure 3 you can see the cause of the 120Ω resistance to ground on the 500V line just below the 2E22 valve base. The left hand brown capacitor is a 0.01µF de-coupler from HT to ground and that had become low resistance; it produced a very lively bang and a lot of smoke. It is not easy to gain access to this capacitor without removing the tuning capacitor and a few other components. The manual gives clear instructions how to do this but, being lazy, I decided to leave the dead one in place, cut the leads and replace it on the upper side next to the 2E22, far easier if not so neat.
Very helpfully, there is a Meter Socket fitted that allows easy testing of the basic voltages and anode current which can speed up fault - finding. The expected voltages are marked in a table on the case and it is worth making a note separately as the anode of the 2E22 has 500V on it and moving the Tx around when live is <u>extremely risky!</u>
It is a safe bet that if you have bought a 'tested' rig you will need to check these voltages as I doubt it will have been run up on transmit even if it is working on receive. In most cases the voltages should be within a few percent (depending on what your supply voltages are) and if that is the case it's a reasonable assumption that there is nothing major wrong.
Measurement conditions in the manual are described as the transmitter is set for high power MO, CW operation with a 20Ω 20Watt resistor (non-inductive) and a 70pF capacitor dummy antenna connected - I suspect in the Reel or Whip positions and using a 20KΩ/volt meter. In the DOUBLET position into a 50Ω Dummy Load and careful loading the voltages read about the same using an AVO meter.

Brief circuit description and design features
The basis of the circuit is a Master (or Crystal) Oscillator followed by a Buffer Amp / Doubler, modulator and PA. The circuit shows a fairly standard design with no real challenges except that the supply voltages go through a relay system (K101 and K102 on the circuit diagram) and this can make tracing through voltages and signals difficult. The manual (TM11-263) is a valuable asset and until very recently I was relying on some photocopied circuits and information but I would advise getting a full copy of the manual if you can - costs are around £25 for a new one but it is a good

Metering Socket pins NB (+ / - = polarity)		**Circuit**	**Volts**
1+	**7-**	PA Filament Voltage	**+6.3**
2+	**7-**	PA Plate Voltage	**+500**
2+	**8-**	PA Plate Current (loaded)	Bands 1,2 and 3 **110mA** maximum
		Plate Current (unloaded)	Less than **30mA** on all bands
3+	**7-**	PA Screen Grid Voltage	**+275 V** maximum on all bands
4+	**7-**	PA Suppressor Grid bias (CW)	**+6.3V**
4-	**7+**	PA Suppressor Grid bias (Phone)	**-40V**
5-	**7+**	PA signal Grid bias	**-46 to -70V**
6+	**7-**	Master Oscillator plate voltage, Modulator plate voltage	**+105V**
7+	**7+**	Terminal 7 is grounded to the transmitter chassis	**0V**

it is a good investment - and an interesting read if you are into this sort of stuff as it goes into very great detail.
The modulator 3A4 (V105) is used for NET and side-tone operation in Standby / CW mode in the receiver. (Note: that the manual suggests that this feature can be used to test any suspect 3A4 valves). In CW mode the doubler and PA valve both have their anode and heater voltages applied and the MO anode is keyed (see 'problems' later). In phone mode the doubler and PA only have their HT and heater volts applied once the PTT is pressed giving an approximate delay of 2 seconds before transmitting. The relay K102 utilises the presence of a small amount of grid current in the PA to energise and this is a point where problems may occur if there are alignment or loading faults as if the relay doesn't energise then no output will be generated. It is also worth noting that the NET facility is disabled in PHONE mode - but works well in MCW and CW positions.

In Use
In use I found the neon indicator a good way of seeing quickly whether I had a match or not (after all, that is what it was designed to do) and generally the brighter and more balanced the glow, the greater the RF power going into the aerial.
Which brings me onto one major drawback of the GRC-9. On one QSO I noticed that the other station was reporting chirp on the signal and some drift (albeit slight). On the monitor receiver the note sounded more like a Dwah-Dwit Dwah Dwit rather than a nice Dah Dit Dah Dit. My first thought was that the stabilising voltage (105V from a VR105) wasn't happy or possibly the heater voltage may be dropping on key down. After testing the PSU under load this wasn't the cause and I did find a design flaw. The anode of the 3A4 Master Oscillator is keyed via a relay contact (17 on K101), bad practice and I can't think what the designers were thinking when they did that. I know the rig was primarily intended as a phone transmitter but even as a back up CW facility it didn't make sense. That would also explain the slight drift on key down though the VFO is stable after the initial contact.The only options are to a) live with it, and run the risk of not using

it as much on CW (though phone is fine) or b) make modifications to switch another part of the circuit. This is a technical and a moral question given our general view that original is best even if it wasn't very good! As I like using CW, I am looking at making removable modifications (without touching the appearance - that is beyond the pale) that will allow the MO to run continuously and perhaps key the PA but still working on that one. Having now seen the circuit explanation for this in the manual it may not be such a major task and it should be possible to 'improve' the CW performance by adding a few links, which can be removed to return it to the original state.

On Phone the heaters and HT are disconnected from the doubler and PA until the PTT is used. This means that there is a short, but annoying delay, of 2 seconds before RF appears. The draw back of that is that there is likely to be more stress on the 3A4 and 2E22 if you follow the theory that valve reliability is at its best when they are left on. Bearing in mind that these are directly heated valves I suspect that the theory is correct but is a drain on power supplies when used as a portable station and that is probably why it is designed that way. The main modification that could be carried out is to disable the heater switching side of the relay K101 (pin 15) and wire in a link. I am inclined to leave the HT side switched but will look at it again in more detail later - if anyone has carried out any modifications on the GRC-9 let us know as we are keen to share experiences.

A Simplified Power Supply

The circuit values are nominal and represent the state of my junk box at the time. T9 is a small 105-0-105 transformer capable of about 60mA and I would have preferred to fit a small choke but didn't have one at the time. This is intended as a guide but realise it's less than perfect - better ideas very welcome. For simplicity there are no fuses shown, but have been fitted since and the bleed resistors (Rb) added as a safety precaution. The strange thing is that there is no load resistor inside the GRC-9 for the VR105 regulator hence adding one in the PSU circuit.

The numbers after the voltage are the pins on the J102 socket on the transmitter itself and in the free plug.

That's it as a brief run through of the GRC-9 and I hope you have found it interesting, especially if you are a newcomer (or an old hand but have never come across one of these before) and wondering where to start. If you do decide to get one of these radios and would like to swap information then do get in contact. One word of caution is that these are very popular with Jeep owners / Military re-enactors and that can over-inflate the price for cosmetically good ones that may be duff electrically - caveat emptor and use reliable sources, the web pages given in Part One may help and there are other sources. Certainly some suppliers have brand new ones with German or Eastern European markings and these are just as good even if you can't read the text!

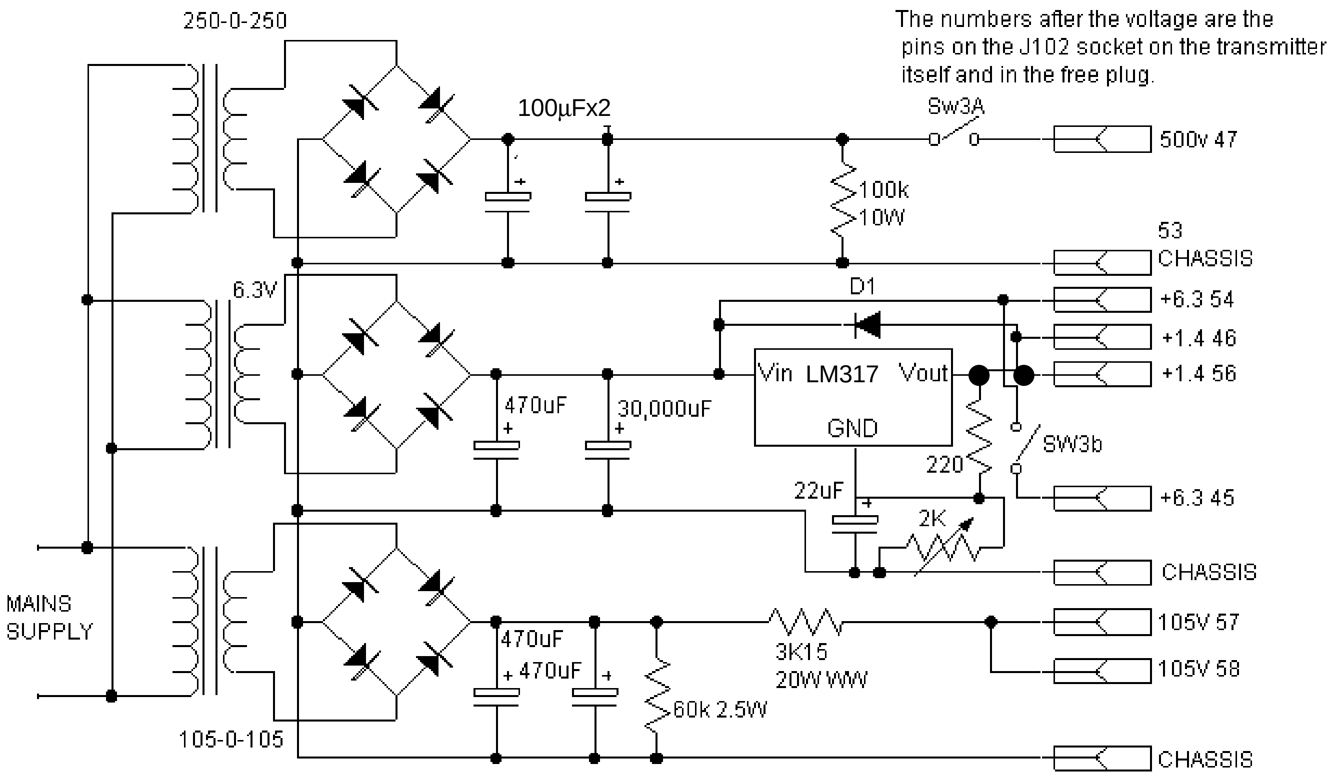


Fig. 3. The circuit of the simplified power supply as built by the author to test the transmitter and receiver.

Again we must reiterate that the voltages used in this unit can be lethal – if you have no experience of working with high voltage we strongly recommend that you obtain advice from someone more experienced!
Also we would advise putting three hefty diodes (e.g. 1N5401) in series across the 1.4V supply, negative of the diode to positive supply, to prevent a very expensive catastrophe in terms of destroyed valves, should the LM317 regulator fail – Ed.