Retrofitting Tetrodes to the Kenwood TL922 Amplifier

INTRODUCTION

The Kenwood TL922 amplifier running a pair of 3-500Z triodes in grounded grid configuration is one of the best pieces of equipment specifically engineered for radio amateurs. It is an improved factory manufactured version of the Heathkit SB220 amplifier, which was first marketed in 1975 for home construction. Power output on the six bands from 160m to 10m is up to 1200W PEP with 100W drive, although it is capable of more.

The purpose of this document is to do two things –

(a) Discuss how to retrofit compatible tetrodes in the event the 3-500Z triode is unavailable or prohibitively expensive, and

(b) Describe some basic but necessary improvements which were not commonly employed in the era the TL922 was designed.

RETROFITTING WITH 4-250A or 4-400A TETRODES

Both of these tubes share the same socket design as well as having an identical thoriated tungsten filament rated for 5V at 14A. There are a number of variants that can be used – principally manufactured in Europe – for example the Mullard equivalents of the 4-250A are types QY4-250 and QB3.5-750. These NOS tubes are certainly cheaper than NOS 3-500Z triodes. While you can probably run them to 1kW PEP output, that should be qualified by saying ‘not fast CW and not processed SSB’. Their basic limitation is that a pair of these tetrodes have 500W plate dissipation – just half that of the 3-500Z triode pair. However, the 4-400A could be treated like the 3-500Z in terms of power output. Price-wise, NOS 4-400A tetrodes are probably not too different to the 3-500Zs and should be used where the 3-500Z is difficult to procure. The 4-400A tetrode is really just a 4-250A tetrode with enhanced plate dissipation capability, i.e. 400W versus 250W. All other parameters are identical.

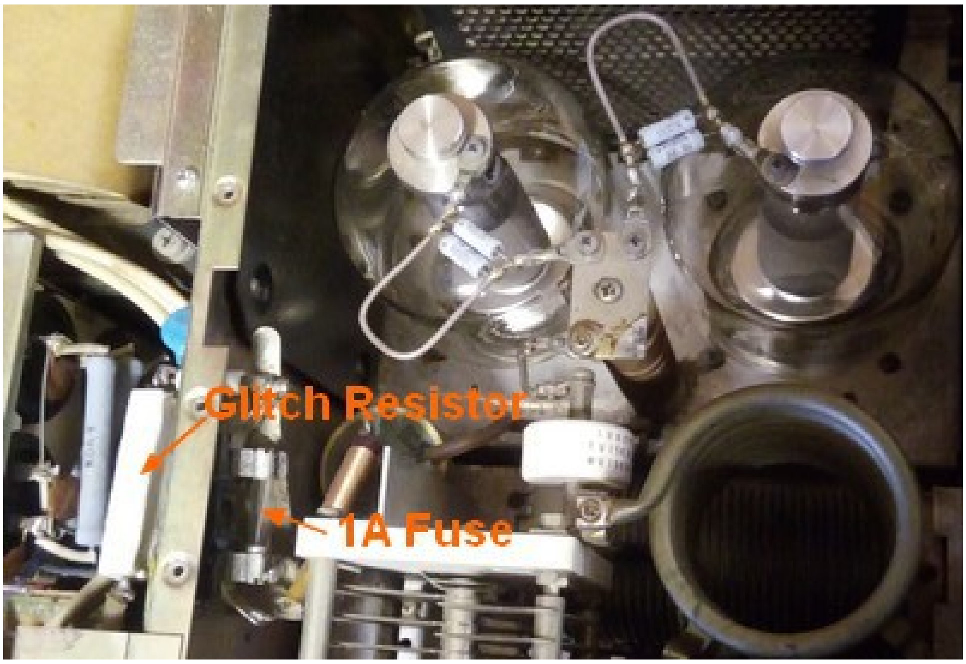
FITTING THE 4-250A TETRODE

Quite some time ago I acquired a number of NOS QY4-250 and QB3.5-750 tetrodes with the intention of constructing an HF linear amplifier for 160m to 10m. Now that I have gone down the solid state path for power amplifiers, the stock of tubes is available for other projects such as retrofitting to either the TL922 or the SB220 amplifier.

What follows is my experience in retrofitting a pair of QY4-250 tetrodes to a TL922 that came to me with very low emission triodes. The first thing I did was to test the integrity of each tetrode's vacuum with my home-brew Hi-Pot tester. Both tubes showed negligible leakage current at 5kV between Anode and filament. Prior to fitting them to the amplifier, all the socket's grid pins were grounded to chassis. This must do modification is detailed at item 4. Only then were the tubes fitted to the amplifier and the filaments run for around 10 hours before HV was applied. No flash-over occurred & so the tubes were allowed to 'soak' in operate mode with no RF drive for a further 10 hours, drawing idle current of around 60mA. Before I ran the tubes up to their limit, a number of improvements were implemented – a couple of them were already done by a prior owner.

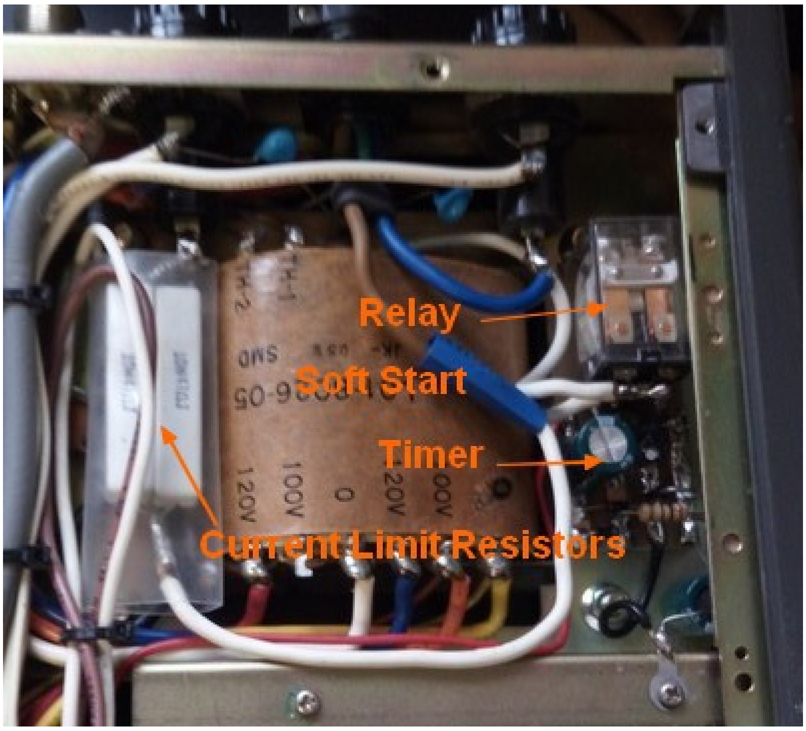
NECESSARY IMPROVEMENTS

1. All tube amplifiers should have a glitch resistor and fast blow fuse wired into the 3kV line. This TL922 had previously been fitted with an 18Ω/10W wire wound resistor and a 1A fuse. Should one or both tubes flashover, the resistor limits the current flow and the fuse quickly opens to isolate the 3kV supply from the tubes. Ideally the resistor should have a value closer to 50Ω and a power rating of 50W or more, but there is little room to accommodate a physically larger resistor, as can be seen in the lower left portion of the photograph.



Note the hairpin anode parasitic suppressors fitted to the tubes. They were part of previous modifications and are generally accepted to be more broadband in their operation than the traditional coiled choke.

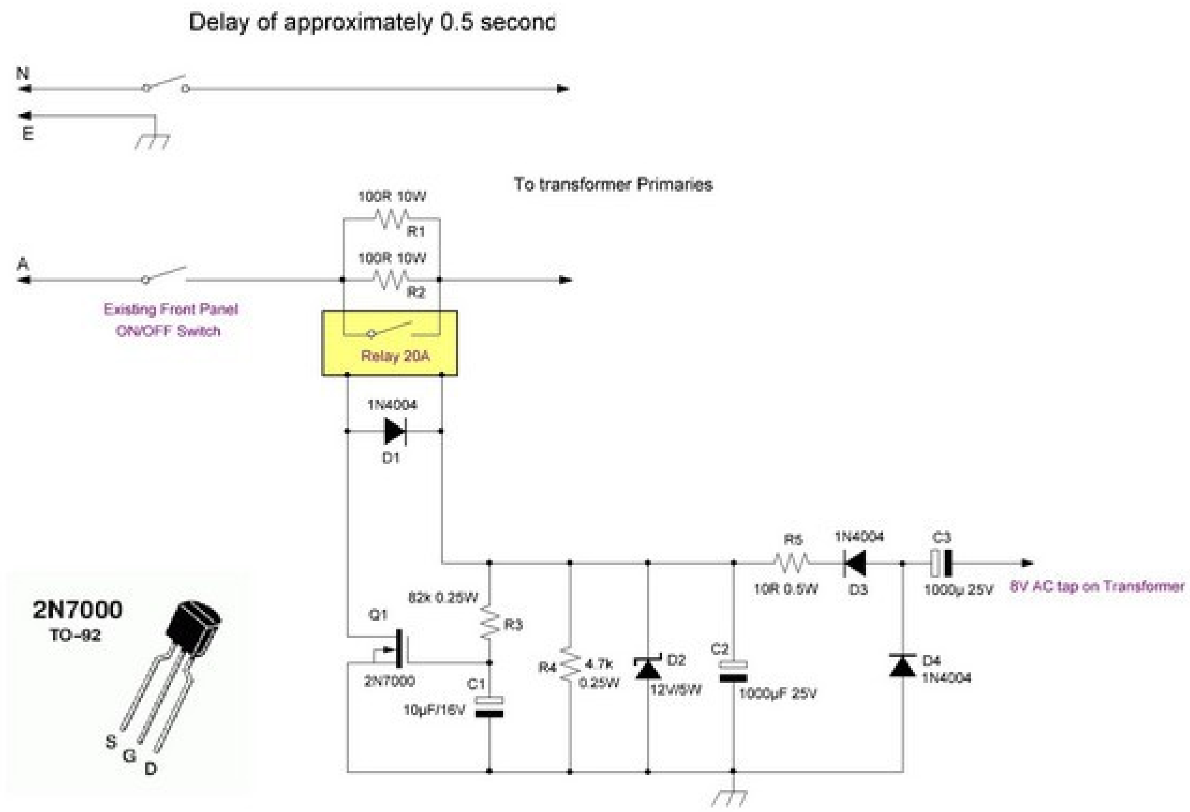
2. Next, a soft start circuit should be wired into the primary side of the transformers. The TL922 has a separate HV and Filament transformer, so I inserted a soft start of my design into the active side of the mains power inlet. Without it, house lights dimmed when switching on the amplifier, but never again after the modification which involved 'fine tuning' to select the best value of resistance.



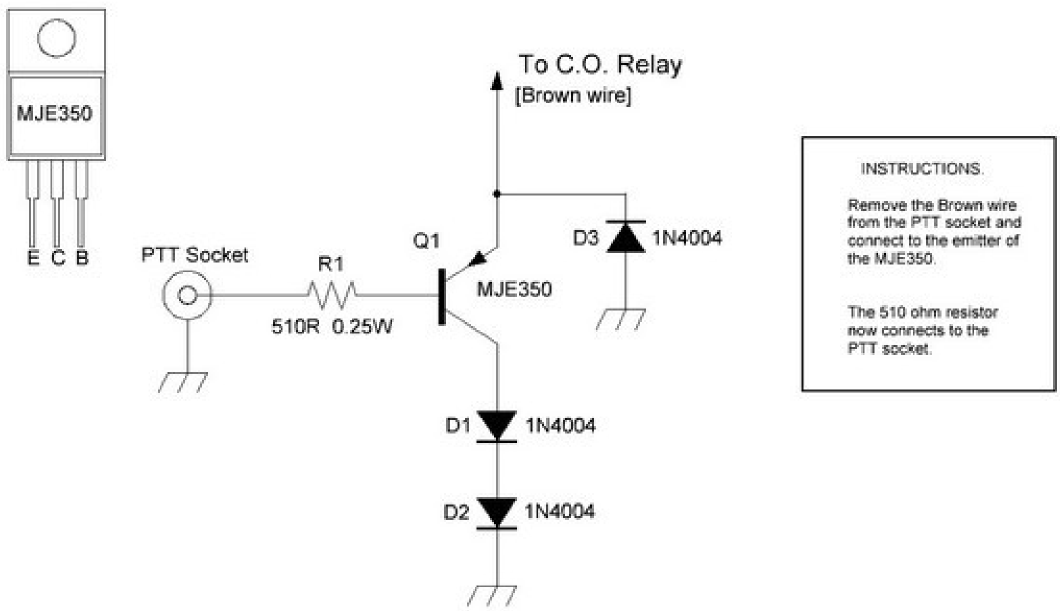
The components for the soft start circuit were mounted on a printed circuit board (using the Paddy Board method) which also supported the 12V DPDT relay and all were tucked away against the side rail of the amplifier. Both sets of relay contacts are rated for 240V AC at 10A, giving a total current carrying capacity of 20A – more than ample for its purpose. The paralleled pair of inrush protection resistors were initially 47Ω/10W wire wound units, but as there was still some minor flickering of household lights at switch on, I later swapped them out for a pair of 100Ω/10W resistors. That cured the flicker issue.

The 12V DC operating voltage for the soft start timer and relay was derived from the 8V AC tapping on the filament transformer and stepped up with a voltage doubler, smoothed and stabilised with a 12V Zener diode. This 8V tap is an independent winding used to supply voltage to panel lamps. A simple R-C timing circuit triggers the 2N7000 mosfet into conduction which then pulls in the relay. Component values are not particularly critical here, with an 82k resistor and a 10µF capacitor giving around 500mS delay. The 2 x 100Ω/10W resistors were placed inside clear heat shrink tubing and can be seen lying on the left side of the power transformer in the above photograph. Not a lot of room for hiding modifications.

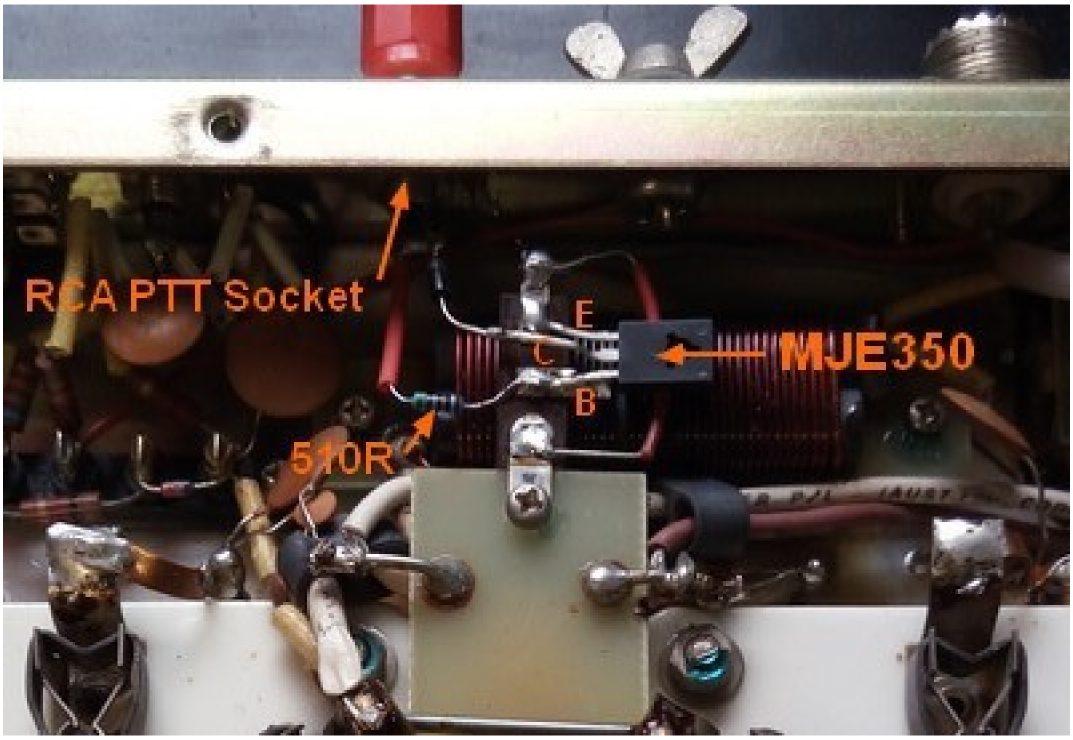
Here is the schematic of my soft start unit.



3. Here is a schematic of an easy to build PTT interface for the TL922.



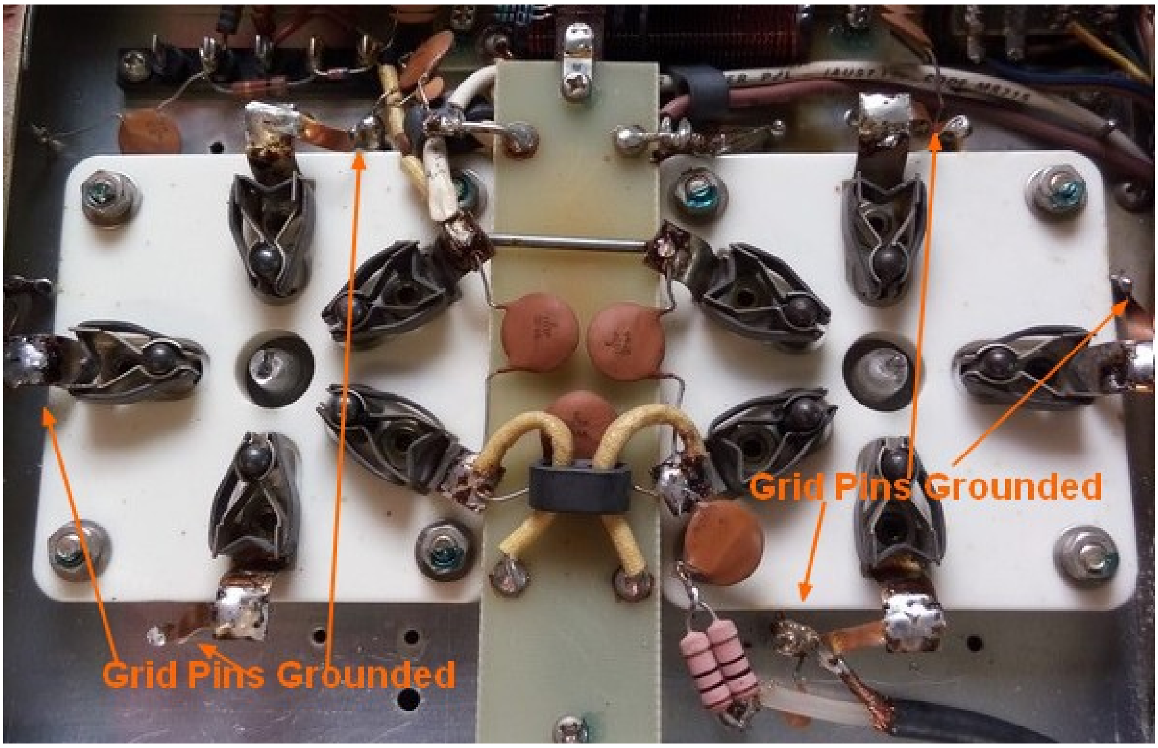
When the TL922 came onto the market in the late 1970s many transceivers had tube finals and PTT switching relays that could handle the 100V or more from the amplifier keying line. To interface with modern rigs, often an external relay or robust solid state circuit protected the rig from high keying line voltages. My design is extremely simple but effective and is wired on a mini-tag strip close to the RCA PTT socket on the amplifier as per this photograph.



4. The last modification - a mandatory one where a tetrode is going to be retrofitted in lieu of the 3-500Z, is to ground all grid pins on the sockets directly to chassis. The silver mica capacitors installed during the factory build can be removed, and if in good electrical and physical condition may be useful for other projects requiring capacitors to carry RF currents.

Where tubes are run in a grounded grid configuration, there is much discussion on the merits of grounding grids directly to the chassis rather than floating them above ground as done in the TL922. Generally it is accepted that hard grounding of grids results in enhanced stability and a little more power output.

I used copper shim rather than hook-up wire for this task. It is readily available from craft shops and EBay sources. I used strips about 5mm wide and soldered the shim from each tube pin (2, 3 and 4) to where the mica capacitors were attached to chassis pins. See the photograph below. Note also the two paralleled 10Ω resistors connecting the coax feed to the cathodes of the tubes. This provides some negative feedback that may contribute to stability of the amplifier.



CONCLUSION

The 3-500Z triode has a high µ factor and can give up to 13dB of gain in cathode driven service, although the TL922 generally shows a lower figure but it is at least 10dB gain. The 4-250A tetrode cannot match this; however I have obtained 900W PEP with 100W of drive from an ICOM 7300 radio on 20m. That has to be a fair result for a pair of relatively low cost tetrodes. The original emission depleted 3-500Z tubes gave just 350W!

I did not attempt to retune the pi input network. Modern rigs have an internal ATU which should be able to match any reasonable departure from a perfect 1:1 SWR. If there is a need to revert to using 3-500Z tubes, then no work needs to be undone. This retrofitting exercise can't deliver a better outcome than that.

Lastly, this is not intended to be a detailed modification article – it is aimed at Amateurs who have experience in working with tube amplifiers. If there is some matter that needs further explanation, please contact me at this email address: vk4ye@wia.org.au

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