

New Life for an Old Friend

QSK (and Other Updates) for the Kenwood TL-922

This project all started when my friend Dale, WU7X from Spokane wanted me to install QSK into his Kenwood TL-922 linear amplifier.

I did quite a bit of research on the internet and found several different variations of the theme of QSK for the TL-922. All of which had great ideas. The meter lights of Dale's amplifier were all out and they have a habit of not lasting very long. So I knew I wanted to convert them to LEDs. The Standby and Transmit lamps also need to be changed out to LEDs.

Kenwood uses two very large, noisy and slow relays in the bias and antenna switching arrangement of the TL-922. They also use a set of contacts on one of the giant relays to change the status of the Standby and Transmit lamps on the front panel. There is also no step start in the TL-922 which is always a good idea in a linear amplifier.

So the circuit was designed, tested and built on a small perforated "perf" board and installed into Dale's amplifier. Overall, I was very pleased with the performance of the switching circuit; meter lamp LED replacements, the Standby and Transmit LED replacement and the step start circuit. I really liked the quiet vacuum relay and reed relay operation.

When Steve, K7AWB got wind of Dale's amp upgrades, he had to have them too! There has to be a better way to duplicate this effort! After the "perf" board route, I wished for a better way to build the circuit and have repeatability of the design and construction. This little project is the result of that wish. I put out some feelers on the AMPS reflector, <http://lists.contesting.com/mailman/listinfo/Amps> for some assistance and ideas on coming up with a circuit board design and manufacturing process. A fellow ham said she was willing to help! I scanned the schematic and e-mailed it, gave her the maximum dimensions, and the rest is history! She used the free software from Express PCB for the layout of the board and Express SCH for generating the associated schematic. I downloaded the free software from <http://www.expresspcb.com/>, opened the documents she crated and bingo! With a few minor changes, I placed an order through the Express PCB supplier, PCB Express with their automated ordering process included in their software. In about 3 days, I had the **top quality** boards in hand! I quickly constructed the circuit and it worked just as designed.

The relay switching design was based Rich Measures, AG6K's writings on adding QSK to various amplifiers. The adjustable bias supply was gleaned from Ian, G3SEK, and the late W4ZT.

Since my original design of the circuit board, I made a couple of changes. On the AMPS reflector recently, there was quite a discussion about using zener diodes verses a series diode string, vs a large 50 watt zener diode. Someone posted some info on using the TL-431 programmable shut regulator along with a pass transistor. They said that Tony King, W4ZT (SK) had designed a zener diode replacement circuit based on this device. I researched his info along with several other users (Paul, W7DS and Ian, G3SEK) of this device for linear amplifier, grounded grid bias supplies. This discussion generated version 2 of my circuit. Having the continuous adjustment of the bias voltage was a bit more useful to accommodate the use of this circuit in other amplifiers and compensate for lower or higher plate voltages or the desire to set the bias to your liking. The relay switching design was based Rich Measures, AG6K's writings on adding QSK to various amplifiers.

This board fits into the TL-922 chassis where the original zener diode was mounted under the chassis. The old diode and heat-sink is removed and the new board mounted in its place. I simply threaded the existing holes with a 6-32 tap. The board is mounted on a ¼" tall 6-32 steel spacer. Q7, the Darlington pass transistor is mounted with a 6-32 screw a ceramic heat transfer pad which also acts as an insulator just to the side of the board. I also had to "saw off" one of the filament transformer mounting bolts. I used a Dremel tool to do this. You can simply remove the nut, and break off the stud with a big pair of pliers, Vice Grips or end nippers. Three bolts are more than enough to hold down the filament transformer.

The LED replacement of the meter lamps was simply removing the incandescent bulbs and using silicone glue/sealant to mount the new LEDs in place. See the photograph of how I mounted them. I used a small file to "blunt" the tip of the LEDs so the light was more defused and even. You can experiment with the LEDs before installation just to be sure you like the way they look. These LEDs are very bright! The manufacturer cautions you about looking directly into them. The circuit board has dropping resistors that can be changed if required to suit your particular LEDs. The resistor values listed, are for the LEDs in the parts list. The Transmit and Standby LEDs are simply mounted just like the original incandescent lamps. I used a small amount of silicone to hold them into the rubber grommets. The dropping resistors for these LEDs are also included on the circuit board.

The input RF relay is a small Panasonic reed relay with a 12 volt coil that is virtually silent. It easily handles the 100 watts of drive power. It can easily handle a 200 watt exciter in the by-pass mode as well. The output RF relay is a vacuum relay with a 26 volt coil. I like to use the silicone encapsulated Jennings RJ1A-26N969. This relay is available from Max Gain Systems at: <http://www.mgs4u.com/RF-Microwave/vacuum-relays-SPDT.htm>. The silicone encapsulation makes the relay just that much quieter. It's also easier to mount inside of the TL-922. I simply glued the reed relay and the vacuum relay in with silicone. I used short lengths of thin copper strips to hook the very stiff and rigid RG-142 coax cables to the relay. I tried to hook the relay directly to the stiff coax but the vacuum relay was not as quiet as I had

hoped. The stiff coax was acting like a sounding board carrying the relay noise to the chassis. You can also use small braid or even solder wick to connect the relay. Be careful not to get too much solder on the braid or it will defeat the purpose of isolating the relay from the coax.

I replaced the existing coax cable in the amplifier with Teflon, RG-142 or RG-400 for the high power cables and used RG-188 which is also Teflon for the low power cable. You can use RG-174 for the low power side as well. If you use the non Teflon RG-174, be careful not to melt the center conductor dielectric and short the cable. The smaller cable is necessary for hooking to the small reed relay used for the amplifier input RF switching. The RFC that was originally across the large antenna relay has been relocated directly to the output tank circuit where the output coax is connected. The spark gap has been removed. According to the service manual, the spark gap was used in case the amplifier was "hot switched" (RF flowing when the relays were engaging). With this circuit and relay modification, the relays will not hot switch. Also notice C11 installed across the input to output of the relays. This capacitor, (value not critical) cancels out the inductive reactance caused by the relays and the interconnect wiring. Most amplifiers have a high SWR on the higher bands, 10 and 15 meters, when the amplifier is in bypass mode. This capacitor eliminates this problem.

Both of the relay coils are wired in series with a parallel 200 ohm resistor across the reed relay coil since it has a 12 volt coil and the vacuum relay has a 26 volt coil. The resistor equalizes the current through the reed relay.

The new circuit also includes a transistor so you can key the amplifier with a high going signal from your rig. Many rigs have a keyed voltage (goes high when transmitting) as well as a relay PTT output. I strongly recommend that you do not use the internal relay in your rig for keying the amplifier unless you know it's FAST! The Icom IC-751 and 751A uses a fast reed relay with less than 2 ms closure time which is fine. The 751 has about 8 ms from closure of the key until RF starts flowing. More than enough time for these QSK relays in the TL-922.