At the Repair Bench – Kenwood TS-480SAT – July 2025

Figure 1 - Kenwood TS-480SAT

For quite a long while, the GCARC Remote HF Station actually sat idle most of the time, and when it did see use, it was generally at output levels of 35 watts or less, as it was customarily in use in conjunction with the Elecraft KPA-1500 RF amplifier, which has a maximum input power of about 35 to 40 watts. Recently, some additional users have been set up on the radio system. These users have a general tendency not to use the KPA-1500 and instead to utilize the higher output power capabilities of the TS-480SAT (Figure 1), often pushing it to its full 100-watt output.

The radio lives in a steel cage in the HF room at the GCARC Clubhouse. Its only cooling is by the random movement of air in the room. Most of the time, the room is unattended, meaning that there is nothing to cause any air movement in that room. In such a situation, the only movement of air is that which is caused by the convective movement due to the radiated heat of the radio and its ancillary components. As a result, the radio has a strong likelihood of overheating with extended high-power use. A common end result of such a situation is the failure of the radio's final power amplifier transistor(s). Such was the case with our radio.

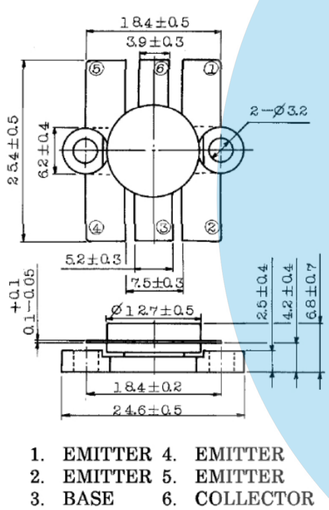

Figure 2 - 2SC2782 transistor

Preliminary output power testing showed that the output power never exceeded about fifty to sixty percent of the rated power, topping out between fifty and sixty watts, as indicated by the radio's front panel power meter. Bench testing at my shop with the Bird 43 meter showed that the output power was actually right at 51 watts, of course well below rated output.

I then did some thermal testing and some voltage spot checks. One of the transistors in the power amplifier (PA) stage of this radio is a 2SC3421 transistor in a TO-126 package, shown as Q3 and used to control the bias applied to the final amplifier transistor pair. The final amplifiers are a pair of 2SC27872 flange-mount transistors, which have six connecting leaves. The pinout of this transistor, shown at Figure 2, is rather unusual, though it is actually fairly common for power amplifier transistors used in modern amateur radio transceivers. The four outermost leaves are all connected to the emitter, while the narrower of the two center leaves is the collector leaf and its opposite leaf is the base terminal. These transistors are designated Q4 and Q5 in the TS-480SAT.

The voltage testing showed the base and the emitter of the Q3 bias transistor to both be at the same voltage of 0.69VDC. The schematic calls for the emitter to be at 0.73VDC while the base should be at 1.41VDC. I suspected that this transistor was shorted, and so I removed it for out-of-circuit testing. That testing validated the suspicion; the transistor was indeed shorted. Moving on to the finals, while the voltages at Q4 were nearly normal, the voltages at Q5 were not, with the base showing 0VDC, the same as the emitter, which is held at chassis ground potential. Furthermore, while working, this transistor was completely cold, while its mate (Q4) showed temperatures over 85°C. This transistor too was shorted, so I decided to replace the finals as a pair. I ordered in the 2SC2782 replacement transistors, and I ordered the 2SC3421 bias transistor at the same time, together with a pair of MA-27B varistors, which we will discuss next.

The finals and the bias transistor are temperature-compensated through the use of specialized varistor diodes that are thermally responsive. In each case, an MA-27B varistor is physically placed across and in contact with the upper surface of the transistor body. The diode is then encased in thermally-conductive paste designed to ensure that the temperature of the transistor is carried into the diode. The diode is then electrically placed in a controlling and compensating circuit that adjusts transistor voltages based on temperature. It is important that these diodes be checked for functionality and installed back in place against the transistors that they are meant to control at the time of any replacement of the transistors. Curiously, these diodes were marketed by Matsushita, their original manufacturer, under the trade name *"Stabistor diode"*, a hint at their intended purpose in stabilizing the operating voltages of the circuit under the control of these devices.

Transistor replacement was fairly straight-forward, with the only difficulty being the not-so-easy removal of the solder from the existing transistors. It was evident that both finals and the bias transistor had been replaced at some point, because the soldering on those components was clearly not factory work. However, when the work was done, it was done with lead-free solder, thus making removal more difficult. In such a situation, it is best to simply dilute the lead-free solder with some leaded solder, and then remove that solder a little bit at a time, repeating the dilution process until all of the solder has been successfully removed.

The 2SC2782 transistors require a special approach to removal, as they use sheet metal leaves as their contact elements. The process here involves removing as much solder as is possible, and then using the tip of a hobby knife blade to gently lift a corner of the leaf while applying heat to it. Once one corner has been lifted, grip the corner with a pair of needle-nose pliers or a hemostat, and then continue gently pulling on the leaf while applying additional heat. Be patient. Eventually, the leaf will lift free of the PCB pad with no damage to the PCB or to the transistor. Repeat this process on each of the transistor leaves in turn. It helps a bit to remove the mounting screws from the transistor as a first step in the process. Doing so reduces the level of transistor heat conduction to the chassis, which will make the removal process easier.

Contrary to the removal process, it is important to install and tighten the transistor mounting screws prior to attempting to solder the leaves to the PCB. The idea is to ensure proper alignment of the transistor with its solder pads while installing the screws.

Post-repair, the radio called for what is known as a *transmit alignment.* This is a long and tedious process that consists of numerous steps, which must all be done in the correct sequence. The alignment process also requires the removal of three coaxial interconnect cables and replacement thereof with longer cables, removal and replacement of a flat ribbon cable with a longer cable, and the temporary insertion of a service plug into the DATA port on the front of the radio.

The longer cables are to maintain inter-board connectivity while the boards are removed from the radio and separated to provide access for test equipment connections to various points on the boards. It should be noted that these are so-called *"service items"* that were once available for purchase from Kenwood. Now, all that Kenwood still offers are the three coaxial cables, at a cost of about fourteen dollars each. The ribbon cable can be substituted with a slightly longer similar cable available from Digikey at a modest three-dollar cost.

The service plug is nothing more than a 6-pin mini-DIN plug with pins 3 and 6 shorted to each other. This plug is inserted into the DATA port during a specific power-up process of the radio, which places the radio into its built-in *service mode.*

The full alignment includes a total of seventy-nine steps, one of which is a *write* step (step #76) that stores all of the newly adjusted values to an EEPROM, which then governs the operation of the radio after a normal power-up.

Quite a bit of specialized test equipment is needed for the process. I used my Motorola R2001A Communications Service Analyzer to do the job, as it has all of the necessary equipment built in. This alignment process is *not* for the faint of heart nor for the inexperienced technician. It is best left to someone who has done this kind of work before.

The Kenwood service manual for the TS-480 provides all of the necessary instructions, but the process is laborious and requires attention to fine detail to get it right. Even at that, I found myself second-guessing myself and wondering if I did get it all right the first time, especially when the radio seemed not to operate correctly when placed back into the remote station cage. However, as has been since learned, another properly-functioning radio is now having the exact same operational symptoms in that cage, so I believe that my alignment is vindicated.

This was a repair that started out as an easy one, and then turned into quite an ordeal – after the actual mechanical portion of the repair was complete! Lesson to be learned here is to research what all is involved before jumping into a job – it might just turn out to be more than you really want to tackle, or maybe more than that for which you are prepared as regards skills, knowledge, and bench equipment.