At the Repair Bench - Yaesu FTM-7250DR – Special Report

Figure 1 – Yaesu FTM-7250DR

A fellow GCARC Club member brought me a radio for repair, due to a failure of the radio to output an RF signal. When I placed the radio on the bench and powered it up, I immediately noticed an additional problem, one of which the owner was unaware. So started the odyssey of the Yaesu FTM-7250DR 2-band mobile transceiver.

The additional problem that I noted was an intermittency in the audio to the speaker, caused by a physical problem in the switching-type external speaker jack on the back of the radio. The jack had a piece, apparently part of the switch mechanism, broken loose and floating around inside the jack housing. It would obviously need to be replaced. Because the owner had always had an external speaker connected there, it was not a problem… until the speaker was disconnected. It was most likely at that point in time that the switch lever broke free inside the jack, never to work properly again.

I went ahead and began the power output testing of this radio, and I found some considerable problems in the output amplifier chain. This radio uses a three-part amplification chain for the RF output. We start with transistor Q1075, which is a RQA0004PXDQS, a high-output, high-efficiency enhancement-mode silicon N-channel power MOSFET manufactured by Renesas. That transistor is called the *"pre-driver"* transistor. Its output is directed into the driver transistor Q1101, a Mitsubishi RD07MVS1-T512 device, which happens to be a non-polarized 7-watt silicon power MOSFET. Finally, the output of Q1101 is directed into Q1150, another Mitsubishi transistor, this time an RD70HUF2-T5105 dual enhancement-mode N-channel power MOSFET rated at 70 watts. This device is used as the final power amplifier.

Injected RF signals failed to pass any of these three semiconductor devices with any appreciable amplification. Most of the operating voltages were at or near their normal levels, except that both the TXV9V+ and TXU9V+ transmit voltages were slow to rise to their nine-volt levels when the mic was keyed. These two voltages are key in operating the final amplifier in either the VHF (TXV9V+) mode or the UHF (TXU9V+) mode. Not finding anything else of concern in the radio, I decided to remove these three transistors and replace them. It was evident that none of the three devices was amplifying the RF signals fed directly into them, so that was the obvious move.

Figure 2 - Q1075 (L) and Q1101 (R)

I discussed the repair with the owner, gave him a price quote, and began to order the parts. I located the two Mitsubishi transistors at a company in California, so I ordered them there. I then located the Renesas transistor at a company in England, where I had to buy two of them to get a single piece. The speaker jack had to come from Japan, so that was the fly in the ointment.

I decided to desolder the defective transistors and speaker jack, so that I could get the board cleaned up and prepped for the new components when they arrived. I started out the whole project by doing a close-up inspection of the PCB, as it was evident that there had been some localized heat on the board, particularly in the areas of the pre-driver and driver transistors. I found that some small components were completely missing, while others were displaced on the board. For example, in the immediate vicinity of the pre-driver transistor Q1075, capacitor C1103 and resistor R1103 were both gone. Inductor L1101, resistor R1101, and inductor L1102 were displaced a short distance from their proper locations.

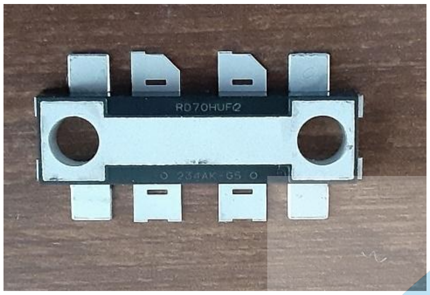

Figure 3 - Q1150

I removed the displaced components completely, which allowed thorough cleaning of the PCB and testing of the removed components. Next, I went through the PCB even more carefully, checking the component placement diagrams against the actual board. I found several listed components that were not present, which caused me to pause and think. It turns out that any component shown with a series of asterisks instead of a part number is not actually installed on the PCB. This caused me to go back and look again at the resistor and capacitor that I said earlier were missing. As it turns out, those two components were in fact missing from the radio. I identified the correct parts and ordered them in from Mouser.

Next, I reinstalled the other components that had been displaced on the PCB, placing them in their proper locations and orientations in accordance with the parts layout diagrams in the Yaesu Service Manual. Then, I set about removing the failed transistors in the power output chain.

I began by covering the work areas with Kapton tape to help hold components in place should the hot air that would be used to desolder the transistors get away a little bit. Kapton tape is very heat-resistant, and the adhesive properties of the tape will help to hold small parts in place if the solder under them goes molten. In order to remove the Q1075 transistor, I first snipped the leads that extended out the one side of the device. Then, applying focused hot air, I heated the device while applying some lifting force with a hooked pick. As the solder melted, the transistor came up like it was hinged. I then gripped it with tweezers and completed the removal with some more focused heat. Afterwards, I cleaned up the debris and the board with some solder wick, and then some 99.9% IPA. The Q1101 transistor was removed in a similar manner except that there were no leads to snip. This one was all focused hot air and gentle lifting. However, no matter how careful I was, I still had some trace lifting on one side of the device. This was a result of the heat that had been in the area of that transistor previously, as mentioned above. I completed the removal, and then I repaired the board by gluing down the lifted trace with some cyanoacrylate glue, and bridging the trace tear with some light wire. In that removal, again no matter how I prepared and tried not to, I still had one coil come up off the board. This coil, L1105 in the schematic, is fairly large and was easily re-soldered into place.

The third transistor, even though it was on the underside of the PCB, and was by itself with no parts around it on the board, was still the most difficult to remove, because it was the largest with the greatest number of solder points. I simply heated this one until it floated, and then lifted it away. Then I cleaned the board of any excess solder using solder wick, and finished the clean-up with the 99.9% IPA.

The resistors and capacitors came in from Mouser in three days. I ordered 50 each of the two devices, which are 0402-sized SMT components. The dimensions of an 0402 device are 0.040" x 0.020" (1.0mm x 0.5mm, equivalent to the metric 1005 package). Note that there is also a metric 0402 package, which is even smaller, as it is 0.4mm x 0.2mm, which is only 40% of the size of the Imperial 0402 device. It is because of the small size of these devices that I ordered a quantity of them. The actual quantity was driven by cost. The reason that the small size caused me to order a quantity of them is because the odds are pretty high that I will lose some parts in handling them. These parts are so small that they are best handled with tweezers, but that makes it very easy to send them flying off into thin air, never to be found. Squeeze the tweezers just a little bit too much or at a slight angle, and the part goes flying.

Installing these parts was probably the biggest challenge in this entire repair. Their small size and close placement led to very difficult installation experiences. None the less, I got it done, and then sat back to wait for the rest of the necessary parts to arrive.

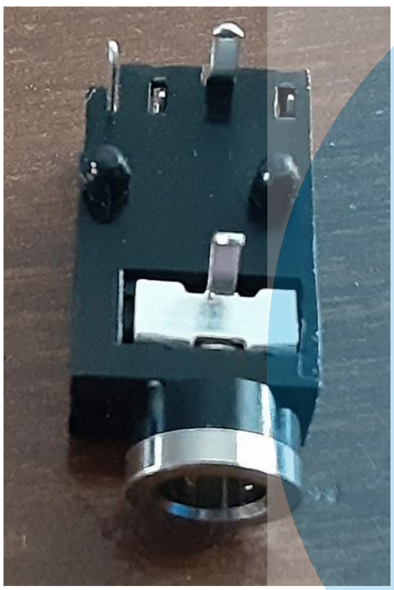

Figure 4 - Speaker jack

I started receiving the other parts about two weeks after I placed the orders, with the two Mitsubishi transistors coming in first. The first one that I installed was the Q1150 final power amplifier, as it was the largest and would require the most heat. Because of the fact that this device is soldered completely from underneath the device, including one solder point directly under the center of the device, I chose to install this transistor using paste solder and a lot of liquid flux. I applied the solder using a fine-tip syringe directly onto the pads, and then flooded the area with flux. I set the transistor down into place, and then began applying the hot air. The solder went molten, as it was meant to, and flowed nicely under the solder tabs on the transistor, bonding it to the board properly and drawing all of the solder in under the tabs. A nice finished appearance and good connections resulted. I cleaned up the flux with the 99.9% IPA, and then moved on to the top side of the PCB.

The next transistor installed was the driver, Q1101. This one was soldered in using the fine-tip pencil iron and hair-thin rosin-core solder, but with plenty of additional liquid flux applied to the board. The transistor went in with no problem, which was a relief, as this was the one with the repaired board damage. A bit of a clean-up of the flux, and I was done until the rest of the parts came in.

When I say "hair-thin" rosin-core solder, I am talking about a solder type that I commonly use when installing fine-pitch integrated circuits. The fine-pitch IC's have leads spaced at a maximum of 0.050" or 1.27mm, and often as close as 0.025" (0.635mm) or even 0.020" (0.50mm) apart. When soldering packages with such minute lead pitch dimensions, I typically use 0.012" (0.3mm) solder, and yes, even at that fine a diameter, it is still a rosin-cored solder. For sake of comparison, the standard solder size that I typically use on my bench is 0.031" (0.8mm) in diameter. That solder is much too wide to use on the fine-pitch IC's. However, I also frequently use that thin solder when installing certain SMT components, as it is easily drawn in under the component bodies with less excess solder left around to cause problems. That was the case here, with the driver and pre-driver transistors in this radio.

When the Q1075 pre-driver transistor finally arrived from Great Britain, it was time to install it. That was also done using the fine-tip pencil iron and the thin solder. In this case, however, there were actual gull-wing leads on one side of the transistor and a tab on the other side, so it was a much easier install job. Of course, “easier” is a relative term. When it is understood that the overall width of this transistor is 0.150” (3.81mm) and the lead pitch is 0.050”, “easy” takes on a new meaning. What made this particular transistor install somewhat simpler is the fact that the transistor has a tab on the one side. That meant that I could tin the pad where the tab would seat, place the transistor on the tinned pad, and heat it to secure it. Once the transistor could not move around, soldering the fine leads got much easier.

At this point, I was still missing one part, so I could not finish the job in its entirety. However, I *could* install the main PCB into the radio chassis, snap the front panel into place, and do the RF output testing. I did just that, with good results. The radio is rated at the same RF output power on either of its two transmit bands, 2 meters and 70 centimeters. The rated output power levels are 50W, 25W, and 5W on high power, medium power, and the low power settings, respectively. What was actually realized in the testing that I did, going through the Bird 43 and into a 100W dummy load, was as follows:

- low power – 4.25W on 2m and 4.00W on 70cm;
- medium power – 23.5W on 2m and 24.25W on 70cm; and
- high power – 49.50W on 2m and 48.50W on 70cm.

While these output levels were not perfect, they were near enough that I was satisfied that the repair was effective. In this case, there was no output at all before the repairs, so this was certainly a positive output. Further, there is always some inherent loss and error in the measuring system. The performance was as one would expect, but the testing was not complete yet. It was time to check for spectral purity. This was accomplished with my new Siglent SVA1015X combination spectrum and vector network analyzer, the first time that I used it on a live job. The output signal was clean, with a barely noticeable second harmonic on two meters, coming in at about -65dB. The 70cm test transmissions were clean. With that knowledge, I considered the output power repairs to be complete.

I was still waiting for the speaker jack to arrive, so I set the job aside again for a while. Unfortunately, this jack has an unusual pin placement pattern, so I was unable to substitute a standard jack in place of the original type. I was forced to source an original type jack, which was a Yamaichi LJE0357-B device, and was extremely difficult to locate on the open market.

I eventually received the speaker jack and installed it, completing the radio repair. All that I had yet to do was the final installation of the PCB into the chassis. This requires the application of thermal compound on the board in several locations, including one that is meant to transfer heat from the driver transistor Q1101 to the chassis. This is done through the use of a pad on the underside of the PCB aligned with the transistor, which in turn aligns with a pedestal in the chassis designed for the heat transfer purpose.

The board is secured by a total of fourteen screws as well as two additional fasteners that secure the final amplifier transistor to the chassis. The fourteen screws have their tightening sequence indicated on the board by circled numbers alongside each of the screw holes.

Once the board is secure, the ribbon cable from the front panel is inserted into its receptacle on the main board, and then the top cover can be installed. The top cover is secured by three screws.

Final testing, as well as re-programming of the radio, were done with the radio owner present. He had to opportunity to see the output on the Bird 4304 directional watt meter as well as hearing the radio operate on the air.

This was a situation where the cost to repair the radio was probably pretty close to the replacement value of the radio. However, the owner had a sentimental attachment to this radio, and he really did want to have it repaired. Hopefully, it will last a good long while for him,