At the Repair Bench – Yaesu CD-41 – April 2025

A while back, one of my fellow Club members **John O'Connell K2QA** brought a unit to me for repair of a strange condition. The unit was a Yaesu CD-41 lithium-ion battery rapid charge cradle (Figure 1). John has a couple of these devices, which are used to charge the batteries on several different Yaesu handheld transceiver models, including the FT-2 and FT-3 radio families. The problem that was exhibited by one of his charging cradles was that under any operating conditions at all, the green *Fully Charged* indicator LED would remain illuminated, and the cradle would fail to charge any battery placed into it.

Figure 1 - Yaesu CD-41 charging cradle

This charging cradle uses a three-contact system for monitoring and charging the battery. One of the three contacts connects to the battery positive terminal, one connects to the battery negative terminal, and the third contact connects to a battery monitor terminal. This third contact is key to the charging process, as it transmits the battery condition to the charger, allowing the charger to decide if and how to flow a charge current into the connected battery.

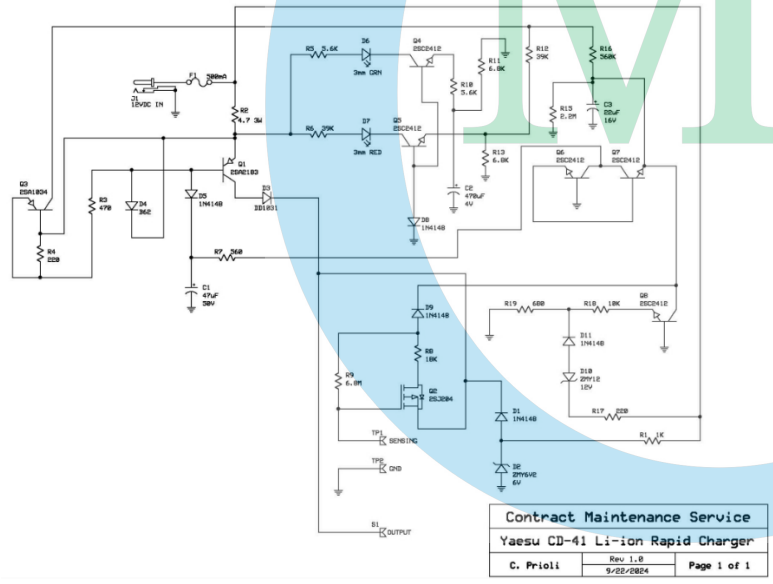

Figure 2 - CD-41 schematic diagram

Not having any factory service or support documentation for the CD-41, I followed my normal routine of first drawing out a schematic diagram of the unit (Figure 2). Then, using the new schematic, I was easily able to break the complete unit down into its functional blocks, which include:

- a power input section;
- an output regulation and isolation section;
- an annunciator section;
- an over-voltage protection section; and
- a state-of-charge monitoring section.

Let's take a quick look at just what each of these individual sections or blocks actually does in the overall circuit, starting with the power input section. The power input area provides a convenient connection point to the printed circuit board (PCB) for the current from the regulated "wall-wart" type of power supply, which is critical to the operation of the CD-41. Of the two cradles that John left with me, the specification labels are marked slightly differently. One of them (the operational one) is labeled as ***Input: DC 12 (10.5) – 16V 600mA*** and as ***Output: DC 8.4V 600mA***. The second (failed) unit was labeled as ***Input: DC 12 – 16V 600mA*** and as ***Output: DC 8.4V 600mA***. What makes this something that I would discuss is the fact that the

operational unit is paired with a regulated power supply (Yaesu model SAD-25) rated at ***10.5V 1.0A*** for its output, while the failed unit is paired with a different regulated power supply (Yaesu model SAD-24) rated at ***12.0V 0.5A*** for its output.

The next functional block is the output regulation and isolation section. This consists largely of a 4.7Ω 3W wirewound resistor, a 2SA2183 PNP silicon power transistor, and a DD1031 isolation diode. The transistor controls the current flow into the battery when it is turned on, with the flow depending upon the degree to which the transistor is biased "on". The diode prevents draining the battery back into the charging circuit if the battery is left on the charger after charging.

Next up is the annunciator section. This section consists of two LED's, one red and the other green, a pair of transistors to switch the LED's on or off, some resistors, and a 470µF electrolytic capacitor. The green LED is supposed to illuminate gradually, as the 470µF capacitor charges up, once the battery has reached full charge and the charge current is switched off. The red LED is meant to illuminate while the battery is charging, with its steady-on state changing over to a flashing state as the battery nears full charge.

The over-voltage protection circuit includes two transistors configured to form a Darlington pair, as well as a 12V Zener diode and several resistors. Its job is to prevent overcharge of the battery and over-current and over-voltage conditions throughout the charger.

Finally, we come to the battery sensing circuit. This section includes a P-channel enhancement-mode MOSFET, some more resistors, and a 6V Zener diode. The task set for this circuit is to measure and monitor the battery voltage, and then to trigger the series pass 2SA2183 transistor in response to battery conditions. It is this circuit that is the Achilles' heel of this charger.

The MOSFET, which is an extremely static-sensitive device, is installed in such a manner that the user can come into contact with the MOSFET *source* terminal quite easily, thus imparting an electrostatic discharge from the user directly into the MOSFET. Such ESD will very easily pierce the insulating oxide layer within the MOSFET, causing immediate failure of that device.

It did not take very long to isolate and identify the MOSFET as the failed component in this situation, circled in red in the Figure 3 illustration of the charger PCB. Some basic voltage and resistance measurements at various points around the overall circuit was all that it took. When all voltages in the other functional blocks turned out to be as expected, the problem was quickly narrowed down to the state-of-charge monitoring section of the circuit, and then to the MOSFET.

Interestingly enough, this was apparently a problem that became known to the engineers at Yaesu, as the second CD-41 that John left with me used a different part number for the MOSFET, which may or may not be meaningful. However, something that was *very* meaningful was the fact that that second CD-41 also had a P6KE18A transient voltage suppressor (TVS) diode connected across the MOSFET, from the battery sensing contact to the ground contact, for the purpose of ESD protection.

Ultimately, the repair of this charger involved replacement of the failed MOSFET, which I did by installing an IRLML6402TRPBF P-channel enhancement-mode MOSFET in place of the original 2SJ204 type, which is no longer available. The second CD-41 uses an STJ828K device, but I had the 6402 on hand and its specs were right, so I did not even attempt to source the STJ828K.

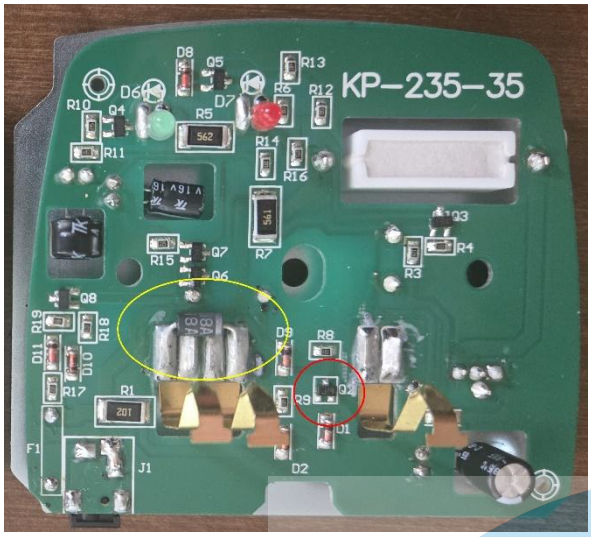

Figure 3 - CD-41 printed circuit board

Of course, no proper repair fails to include a fix for the underlying problem, so I made sure to install a P6KE18A diode across the MOSFET, circled in yellow in the Figure 3 illustration, thus providing the same level of ESD protection that the second CD-41 had from the factory.

Post-repair, the cradle successfully charges the battery, and the annunciator LED's work as expected, but only to a certain limit, which I attribute to the difference between the original MOSFET used and the replacement device that I installed. While the red LED glows during charging, and blinks or flickers as the battery nears full charge, and the green LED illuminates at the fully charged point, the green LED nonetheless turns off after a certain period of time. From testing that I performed, I believe that this new MOSFET provides the proper charge current, but shuts down the charging circuit completely when the charge state is full, thus turning off the LED. The original MOSFET maintained a "holding" charge current after full charge was reached.

The upshot of this job is that it illustrates how sometimes, failure is *designed into* a piece of equipment, and a proper repair will correct for the poor design as well as replace the failed component parts.

See you next month!