At the Repair Bench – Heathkit® IT-3121 Curve Tracer Redux - May 2025

Back in February of this year, I reported on a Heathkit® IT-3121 Semiconductor Curve Tracer (Figure 1) that had come in for repair. That turned out to be a simple matter of shorted electrolytic capacitors in the low-voltage power supplies. I repaired it and shipped it back to its owner, and collected my fee.

Figure 1 - Heathkit® IT-3121 Curve Tracer

Here we are, three months later, and *another* IT-3121 has landed on my bench for repair, from a different owner, but one who was referred to me by the owner of the first IT-3121 that I reported on back in February. This unit had a different apparent condition. It was blowing fuses as soon as it was powered on, without even a flicker of the panel-mounted neon pilot lamp. Tracking down a problem like this can be extremely difficult, as there are no working voltages to be measured, and all diagnosis must therefore be done without reference to voltages. Instead, we tend to look towards resistances in these situations.

So… how and where to start? The Heathkit® *IT-3121 Assembly and Operation Manual* provides a starting point in that the manual offers some *"Initial Checks"* which are to be performed by the individual assembling this instrument, prior to the first power-up of the unit. These checks are located in the *Tests and Adjustments* section of the manual, and they call for resistance measurements at specific points in the power supplies, measuring from those points to chassis ground in the form of the black banana jack on the instrument's rear panel.

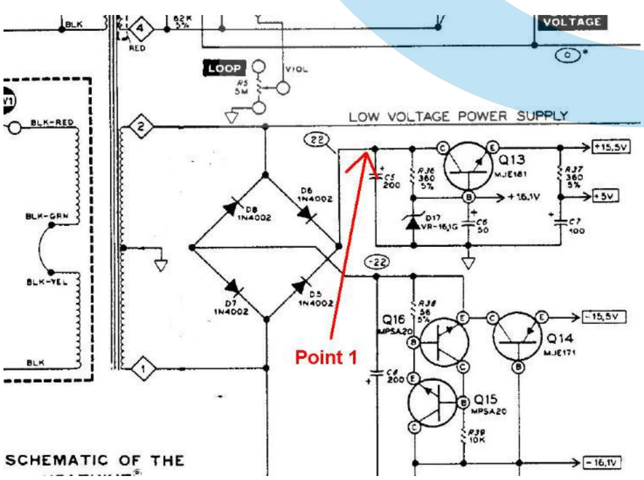

Figure 2 - Point 1 identified

The first measurement is from a point identified as *"Point 1",* which is in essence the input to the positive-going low-voltage supplies, at the DC side of the full-wave bridge rectifier formed by diodes D5 through D8 (see Figure 2), which is common to the positive side of a 200µF/50V electrolytic filter capacitor C5. The specified resistance is to be at least 10kΩ from that point to chassis ground, with the positive probe of the ohmmeter at Point 1. The reading taken was 15.6kΩ, meeting the provided specification.

Next is the measurement taken at *"Point 3",* which is at the DC side of the full-wave bridge rectifier comprised of diodes D1, D2, D15, and D16 (see Figure 3). The resistance between Point 3 and chassis ground, measured with the positive probe of the ohmmeter on Point 3, is to be at least 100kΩ. It measured 221.5kΩ, again within specified limits.

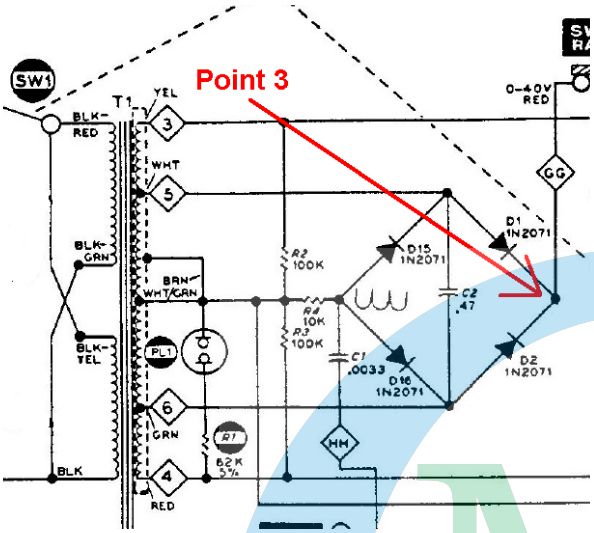

Figure 3 - Point 3 identified

The third resistance measurement was to be taken with the probes reversed, placing the positive probe on chassis ground and the negative probe on *"Point 2".* This point is located at the negative output of the low-voltage supply's full-wave bridge rectifier (the same rectifier used when measuring Point 1 above). This point is then effectively at the negative end of the 200µF/50V electrolytic capacitor C8 (see Figure 4), and it too called for a minimum of 10kΩ between that point and chassis ground. The actual reading was 17.3kΩ, making this one compliant as well.

These tests are designed to locate any direct short circuits present in the power supplies of the IT-3121, and all of the tests showed proper and normal conditions to exist. So… what's next? I decided to isolate the power transformer, to verify that the problem was not a shorted primary in the transformer. To do this, I de-soldered and removed all of the transformer secondary leads form the printed circuit board (PCB). Upon power-up, the unit showed life in that the pilot lamp would now illuminate and the fuse would not blow. This meant that the transformer primary winding was not shorted and therefore not the cause of the problem.

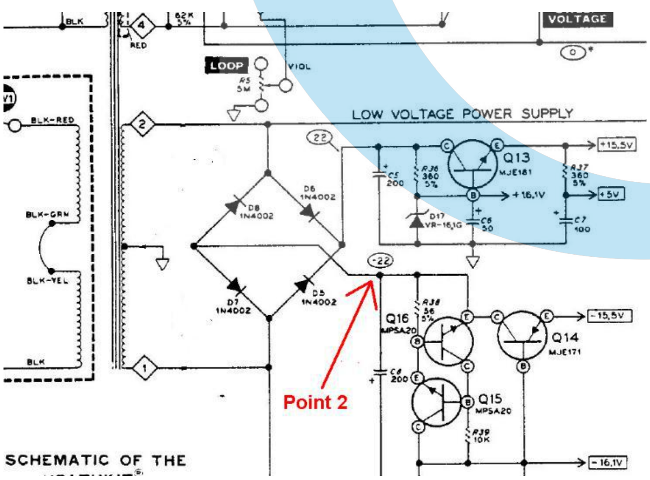

Figure 4 - Point 2 identified

In order to narrow down the location of the problem to a specific area of the unit, I decided to re-connect the transformer secondaries one circuit at a time. I first connected the low-voltage power supply input leads, a pair of blue wires and a blue with white tracer. The two blue leads were the two ends of that secondary winding, while the blue/white wire was the winding center tap, going to chassis ground. When powered up now, the low-voltage power supplies were all operational and the unit remained on. No problem there.

This caused me to take a good look at the sweep circuits and their associated transformer secondary leads. Starting out, I wanted to eliminate the supply to the sweep circuit

FWBR, which were the green, the white, and the green with white tracer wires (see Figure 4). I reconnected those three wires and powered the unit up. Once again, the unit held, with outwardly normal indications. That left, by process of elimination, the remaining wire pair, the red and yellow wires, which are connected to the two extreme ends of the sweep supply secondary winding.

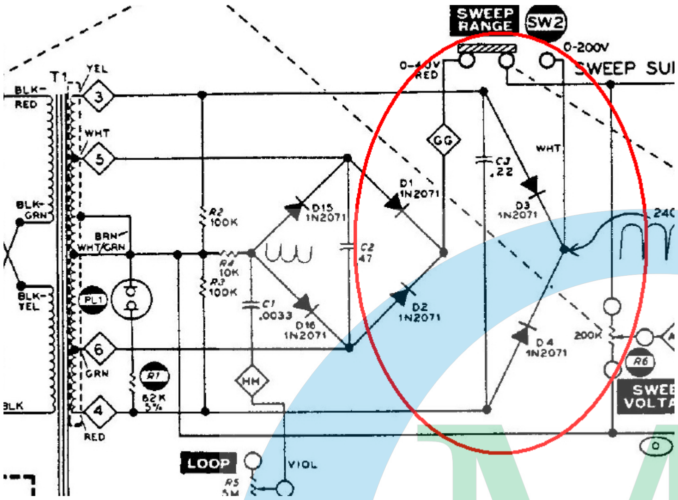

Figure 5 - Half-wave rectifier and shunt capacitor C3

Knowing that the problem *had* to be in the circuit fed by those wires, I left them disconnected and went to work with the ohmmeter. The red and green wires supply incoming AC current to a half-wave rectifier comprised of diodes D3 and D4. According to the schematic, a 0.22µF capacitor C3 (see Figure 5) is placed in shunt across this rectifier assembly as a filter device. A look at the PCB in the unit showed that somebody had been in here working on the board. This was very obvious because the 0.22µF capacitor was not there, but instead there was a pair of 0.1µF/100V metallized polyester film capacitors placed together in parallel. With the secondary leads disconnected, I should have been able to measure the capacitance of that parallel pair, and it should have showed an initially low resistance, immediately climbing high to an open circuit condition. What actually happened, however, is that the capacitance meter errored out, and the ohmmeter showed a direct short circuit when placed across the capacitor pair. I removed the two capacitors and separated them for individual testing, and found what I expected to find at that point. One of the two capacitors tested out normally, while the other one was shorted. A new 0.22µF Mylar™ capacitor, rated at 630 volts, solved the problem. With the new capacitor in place and the secondary leads reconnected, the unit powered up and *almost* worked properly.

It turned out that someone, possibly the same person, had also replaced an *"Offset"* trimmer potentiometer that is mounted to the foil side of the PCB. The original trimpot there was a four-legged horizontal-mount 0.688" single-turn 10kΩ pot, but that had been replaced by an enclosed trim pot with a 0.375" square body and short wire leads. These leads had been extended, and only one of them was actually still connected. Two of the three leads had broken free of their apparent cold-solder joinery. This trimpot is used as a null-offset balance control for balancing the input voltages on a 741 operational amplifier IC. Without this control in place and properly adjusted, the output from the curve tracer is unpredictable at best. I happened to have a Bourns 3352U-1-103 trimpot in stock, which just so happens to be the same size, value, and type as the factory part for this application. Needless to say, that component went in as a replacement for the improperlyinstalled trimpot that was there. This restored proper operation of the op-amp circuit and thus the curve tracer in general.

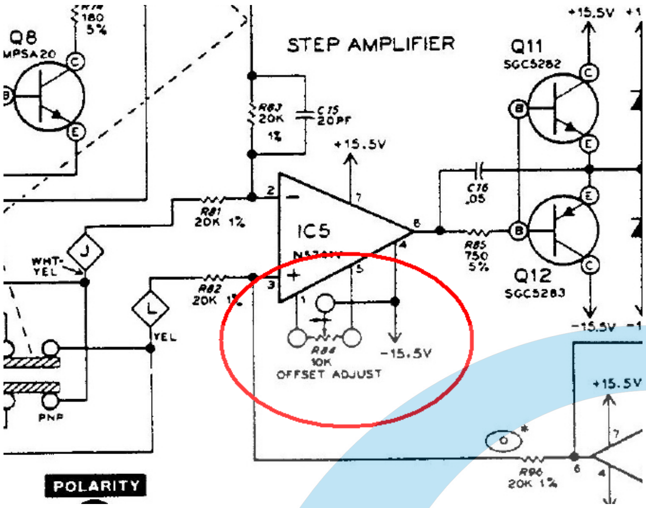

Figure 6 - Offset adjustment trimpot location

Because of the early 1980's date codes on the electrolytic capacitors in this unit, I decided to replace them as a precautionary measure while I had it on the bench. This involved the replacement of nine capacitors, five of the radial type, and four axial devices. They were all in-stock parts as well.

Total time on the bench for this repair was about an hour. It seemed as if it might be a dog of a repair at first look, but in reality, it turned out to be a simple and straight-forward diagnosis and repair. Once again, it was a simple matter of thinking through the problem, studying the schematic, and understanding the circuits involved. In this manner, only those parts that have actually failed – or can be expected to fail in the near future – are replaced as a part of the repair.

See you next month!