Repairing a 7300

Here’s some notes on a repair I made to the 7300 belonging to a club member’s Icom IC-7300 During the recent storms his house had a leak and some water got into the radio. Martin got that out and cleaned up with alcohol which is the best thing to do in the circumstances. The radio didn't work...

He sent the radio to a UK distributor, who declared that it couldn't be repaired economically. I take that sort of statement as something of a challenge; anyway a 7300 is far too nice to be thrown away.

The 7300 has a large diecast aluminium chassis split into 4 compartments containing the 4 main PCBs. The top two contain the PA PCB on the left, and the main RF PCB on the right

the bottom two boards hold the signal processing (DSP) and general control PCB on the left with the two big ics (another is under the grey rectangle of heat dissipator), and the ATU on the right

Those photos are of my own 7300. I took the covers off it as soon as I bought it, partly out of nosiness, but mostly so I could mark it with UV anti-theft pen.

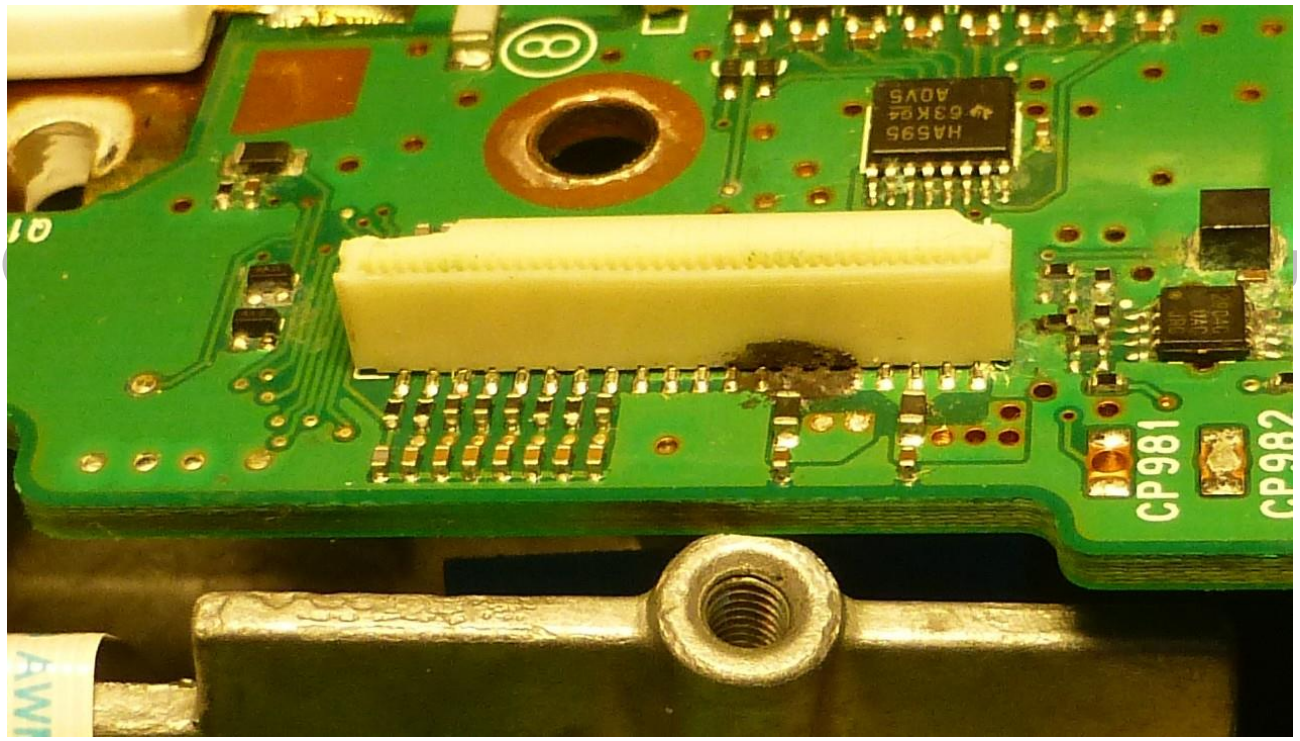
There are two sets of slots in the top cover of the radio near the front, one for the loud speaker and the other to let the warm air blow out of the PA compartment. Martin reported that the water had got on to the PA PCB. Pity, as fixing the speaker would have been easy

In common with most modern radios, quite a bit of the radio is connected directly to the 13.8v power input and is live all the time your power supply is switched on and connected to the radio. For the 7300, this includes (at least) the PA and driver transistors on the top of the radio and the microcomputer etc underneath which controls the radio. The incoming power doesn't go anywhere

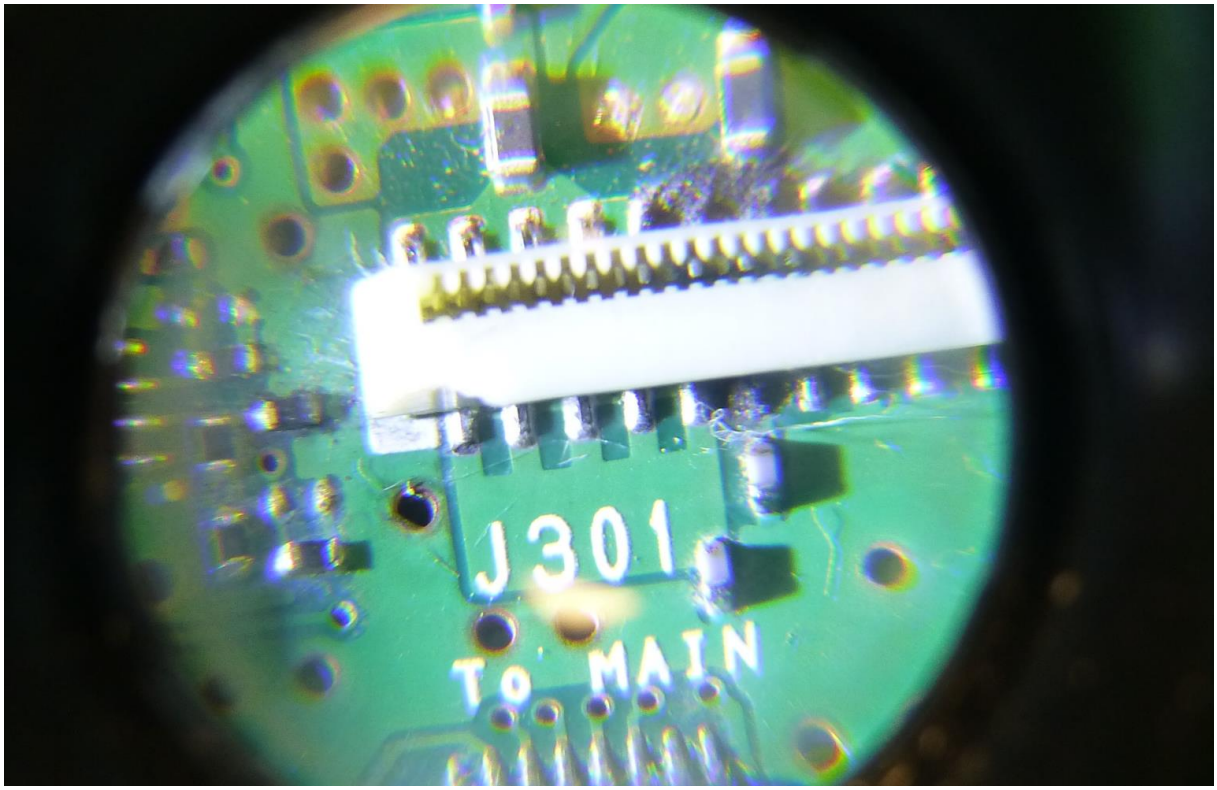
near the on/off button. The microcomputer is always running and continually monitoring that button. When you press it, there's a short pause and the microcomputer sounds a beep in the speaker, you hear a couple of relays click and the whole things powers up. So as soon as Martin switched his power supply on, there was 13.8volts permanently on several parts of the radio including where the water was.

With the top cover off, I connected the radio to a power supply via a 3amp fuse. There were no visible or audible pyrotechnics and the fuse didn't blow, but absolutely nothing happened when I pressed the on/off button.

Martin and the distributor had reported some blackening near a connector on the PA. In the top view photo above, it's the connector with the red arrow. This connector carries signals and the permanent power to the DSP/control PCB. If I was designing the radio, I wouldn't send power down one of those cables; far too fragile. Checking against the circuits confirmed that the blackening was around 13v8 power pins.



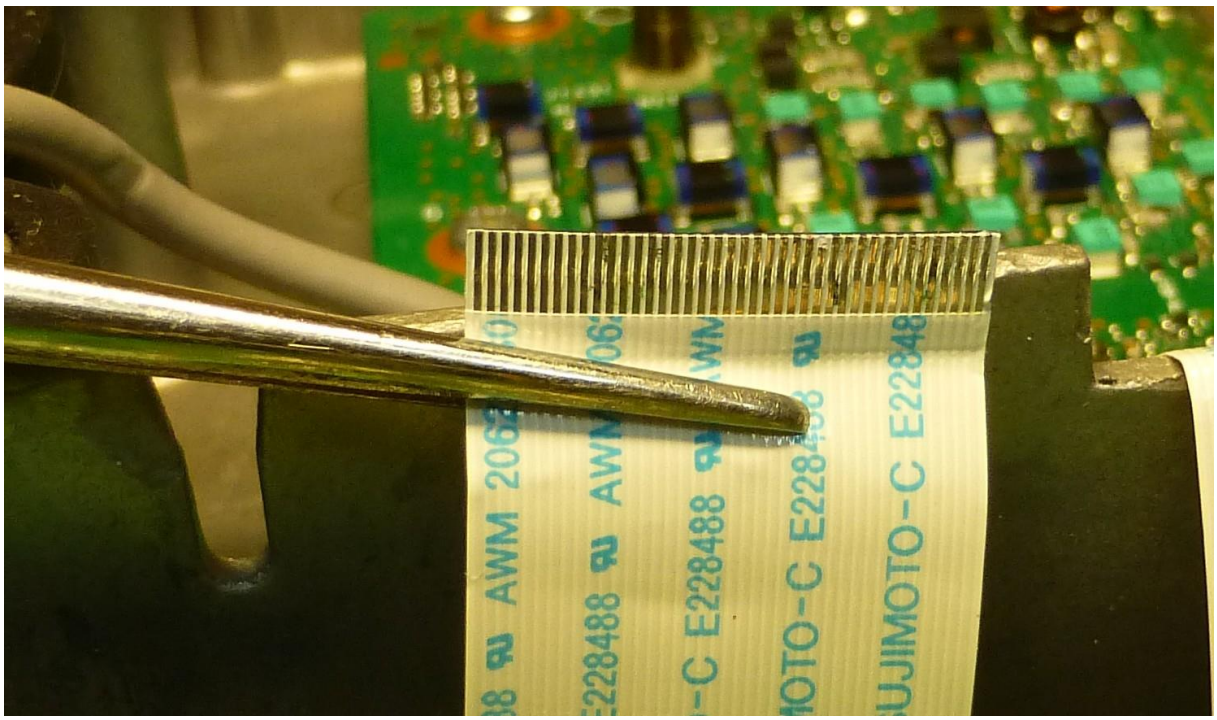
Not particularly surprising, though you may think rainwater is quite pure and hence an insulator. Not this rain it seems. The cable that plugs into that connector is a flexible PCB with 40 tracks on 0.5mm pitch. It has a stiffening piece at the very end and it's pushed into the connector which has wiping contacts to match the tracks



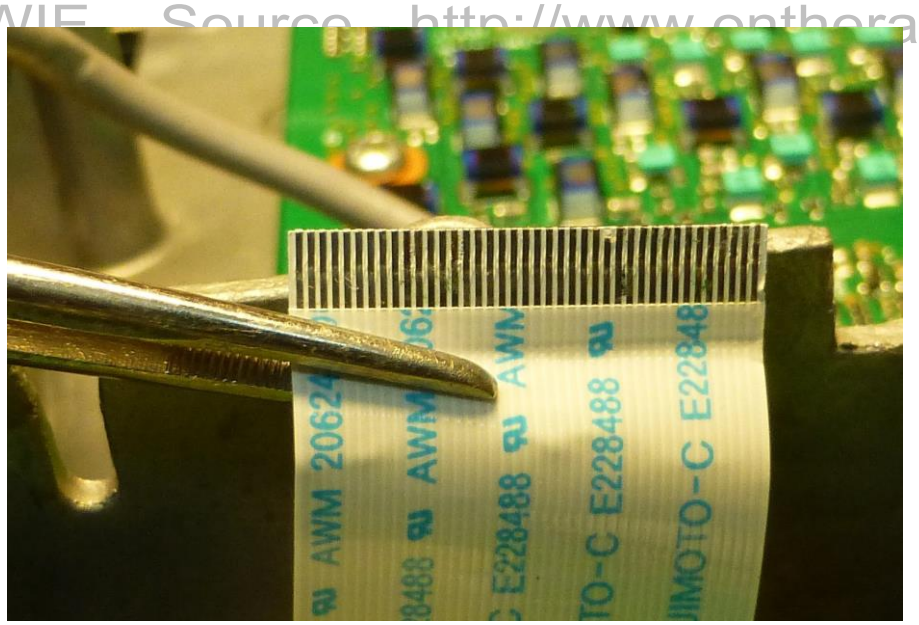
What's going on inside the connector? Here's a photo taken through an eyeglass

You can see the contacts adjacent to the black on the PCB look different to their neighbours. Luckily they still make contact. Getting that connector off the board would have been very difficult (though possible)

What about the cable? Oh dear it's suffered rather



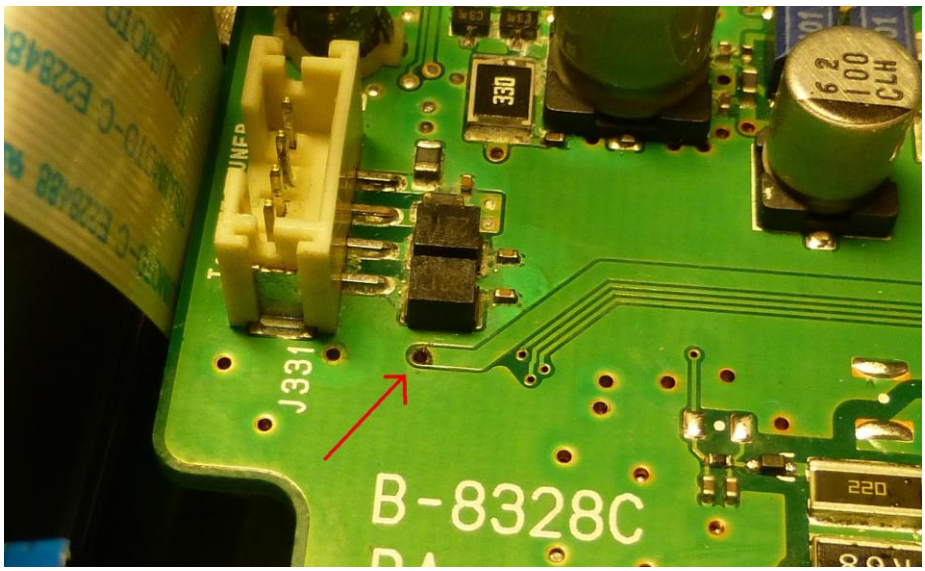
there's black between some of the tracks, and some tracks look crooked. These tracks lift off the cable substrate very easily at the best of times, and it's going to be worse as it's all been heated up. I cleaned it up as best I could - a very sharp scalpel followed by alcohol. It's pretty difficult to see



what's in a quarter-millimetre gap between quarter-millimetre tracks

(I did some more cleaning after that photo). Next I got the black off the PCB with some enthusiastic scrubbing with a fibreglass brush and more alcohol. Next, check for continuity between the tiny contacts *inside* the connector and the power input. I use some very fine probes with needle ends (and holes in my fingers to prove they're sharp). No connection. What about from the connector's pins soldered to the PCB? No connection. Sounds like a PCB track is broken somewhere. The track

from that connector runs towards the back of the PCB on the underneath, then pops up to the top and continues across towards the power input. The probe's pins are sharp enough to get through the insulating green "solder resist" that PCBs are coated with, and I found there was no connection between that top track and the connector. A good look with an eyeglass showed that the via (the name for a hole in a PCB that's copper plated to connect tracks on top and bottom of the board) had

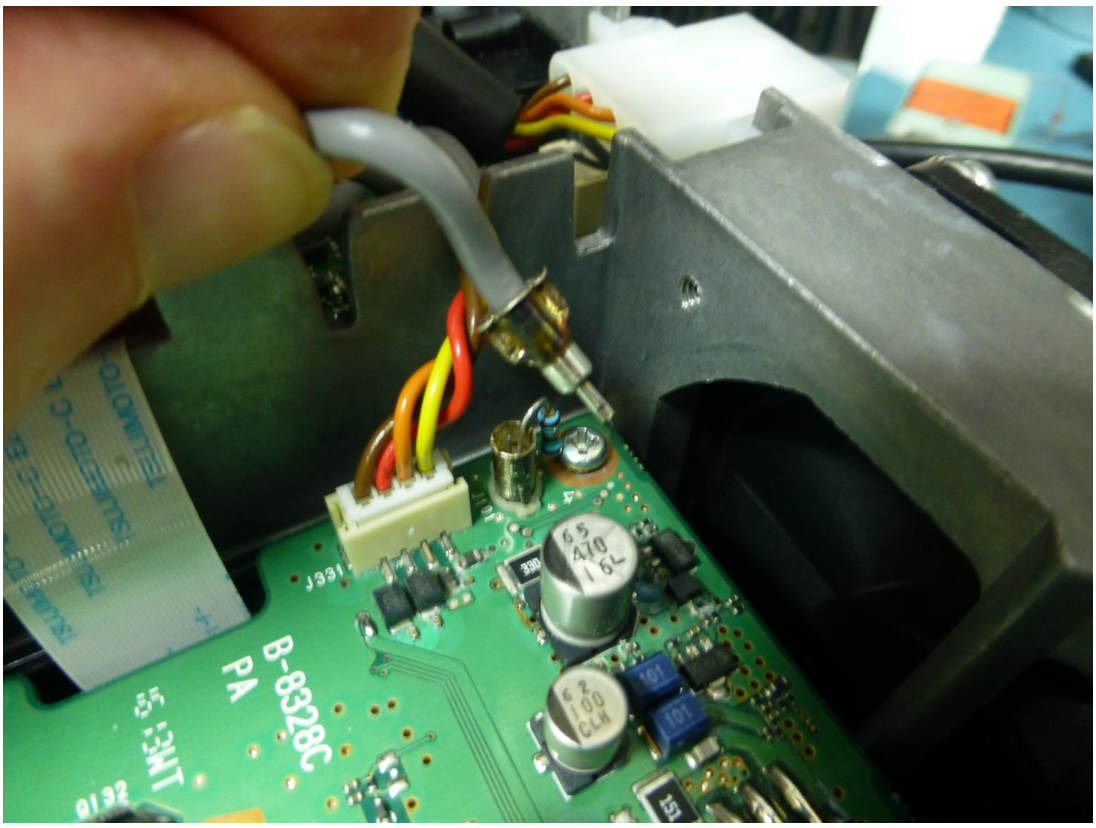


burnt away. Here it is, suitably magnified (at the end of the red arrow):

The board had to come out of the radio to fix this. Then I scraped away the solder resist on the track on top and bottom of the PCB, poked a piece of tinned copper wire through the via and soldered it to the tracks. Reassemble everything, carefully plug in that fragile flexible PCB. Check and apply power. No smoke, no fire. Press on/off button and hooray the radio powers up! There's a lot of random clicking of relays going on; sounds like the 7300’s brain is scrambled. A factory reset shuts them up (and loses all Martin's settings!). Checks with a signal generator showed that the receiver part is ok. This is a good sign as it shows that the damage is most probably limited to the PA PCB.

But it doesn't transmit. The radio appears to change over from rx to tx, the PA is taking the correct idling current (several amps!), but no RF out.

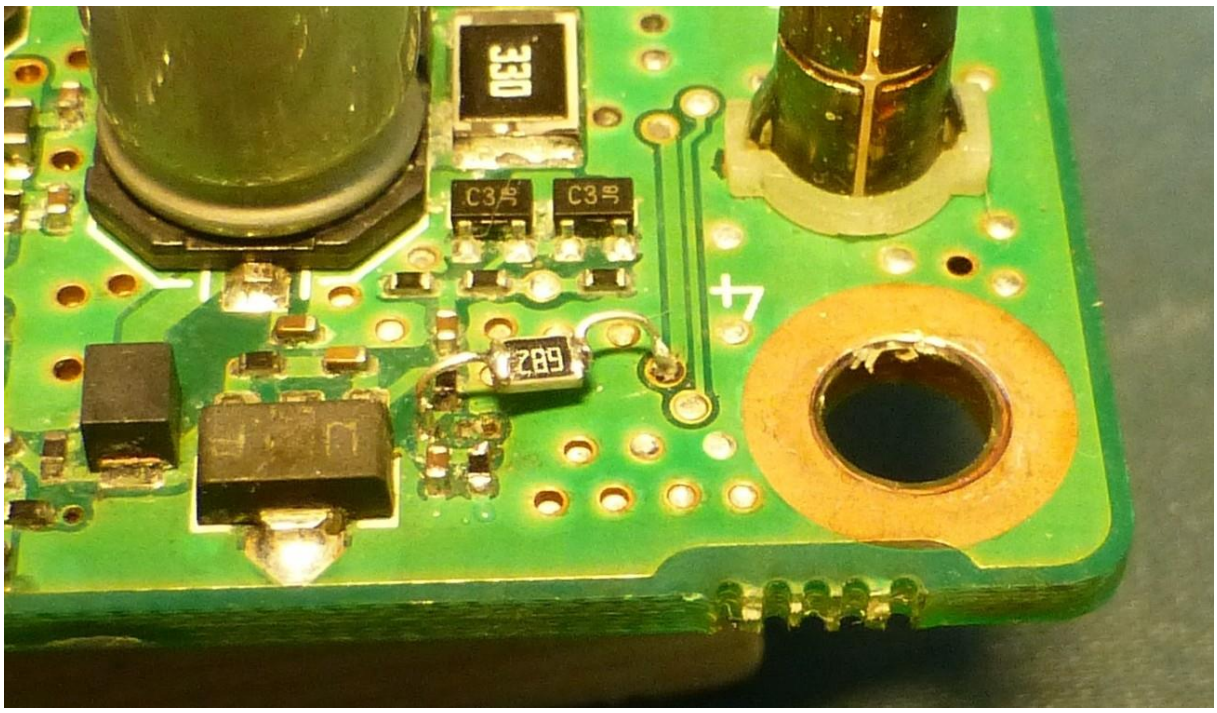
Let's see if the transmit signal is getting to the PA. Unplug the coax connector at the input of the PA and replace with a 51Ω resistor poked into the socket and grounded via a handy fixing screw. Based on past experience, the PA would have a good try at oscillating if its input is left open circuit.



Checking what comes out of the plug with a 350MHz bandwidth oscilloscope shows the RF is being generated on all bands which is a relief. Again this implies the fault is localised to the PA.

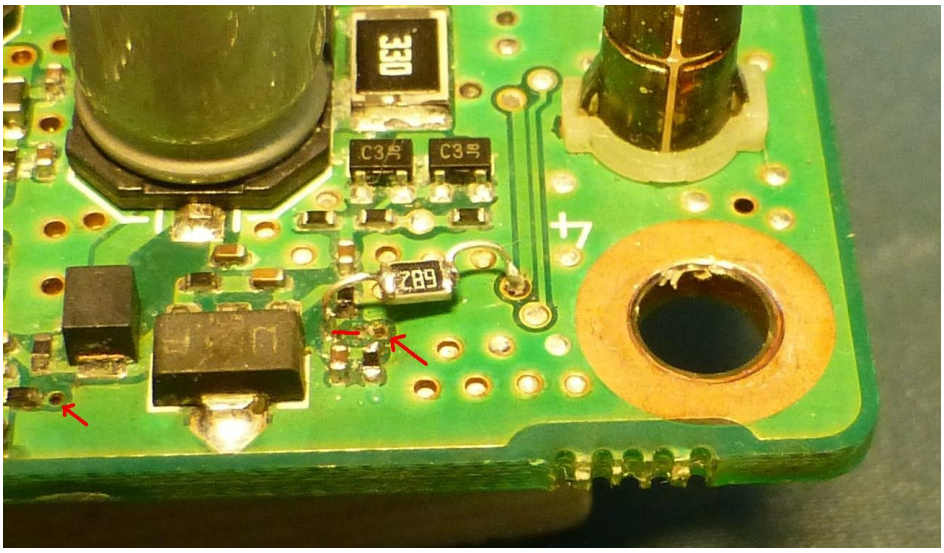
The PA board comes out again. A good look all over with magnifying equipment finds a sad-looking resistor at the back of the PCB in the low-level driver for the PA. I remove it and one of the tracks comes away. It leads to a tiny via which also looks damaged; it's another connection to the (permanent) 13v8 supply. I don't have any wire fine enough to go through the via to repair it as before. In any case, the tracks here are so fine that I wouldn't be able to scrape the solder-resist off and solder to them as they'd just lift off the PCB. A look at the circuit and PCB layout finds a more robust place and I fitted a replacement 6.8kΩ resistor on short pieces of wire.

The original resistors are the little black rectangles in that general area with a metal contact at each end. They are 0402 size which means 0.04" long and 0.02" wide - or 1mm long and 0.5mm wide. My huge replacement is 0805 (2mm x 1-and-a-bit) which is much easier to manage!

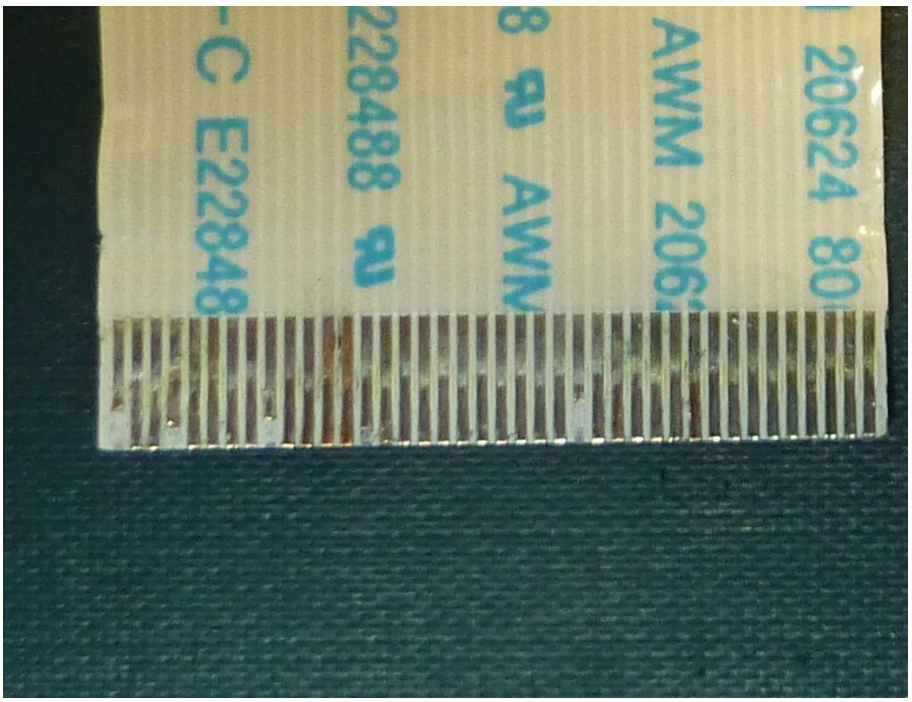


Time to have a good look around. A lot of continuity checking against the circuit diagram and PCB layout drawing seems to show everything else in that area is ok. But there is another suspect via in the photo above - can you see it? Again it's on a 13v8 supply - there's a theme here!

The short red line in the next photo highlights where the dead resistor was, with its accompanying burnt out via. The other arrow to the left is the where the suspect via is. This via does conduct ok even after poking and prodding it so I left well alone.

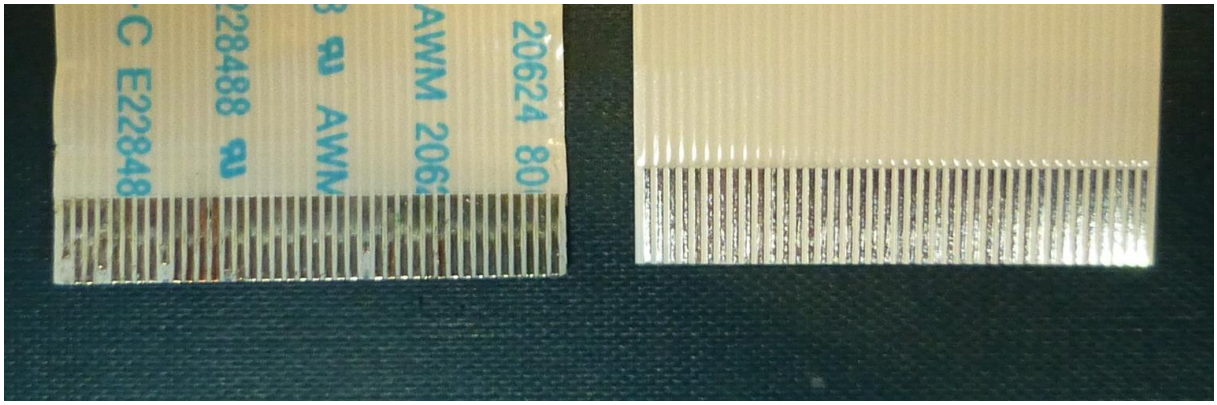


Time to replace the PCB and test the radio again. After another remove/insert in the connector, that flexible cable is looking pretty unhappy now.



Some of the other tracks had lifted when I plugged the cable back in. I cut them back rather than leaving them able to wander about and create more short circuits. Will it connect? Answer - NO. The radio behaves very oddly, changing band does not result in any clicking from the low-pass filter relays in the front of the PA PCB. A cautious try at transmitting with no RF drive shows the PA idling current has gone up a lot. I suspect the PA output isn't connected to anything (no relays closed) and it's oscillating. The cable is beyond repair.

A look at the circuits again shows that all those relays are controlled by the microcomputer via a serial data stream in the cable. I don't fancy trying to wire around the cable to fix a non-connecting track. The tracks might be shorting anyway. Time for a new cable. It has a special Icom part number, but no specification so I measured it carefully. As it happened I was ordering from Digi-key in the USA some specialist capacitors for my microwave building. I looked around their website and they sell these cables in a variety of lengths. I found one a bit longer and added two to my order. 3 days later the order turns up, which is good service from afar.



That looks better. Fit the cable, check everything, power up the radio. Receive is still ok. Change band and relays click. I went through all the bands on Martin's 7300 and my 7300, listening for clicking relays and they sound the same. A cautious transmit looks ok. Idling current ok, no signs of oscillating. More adventurous checks show 100W into a dummy load for HF and 50w on 4m - all as per spec. Try it on the air on 4m and a nearby amateur says it sounds ok on FM and SSB - the latter implies the PA is biased ok.

Quick, get the covers on and pack it away in the box before anything else goes wrong!

Even though it's working now, there could be reliability problems down the road, particularly with the connector for that cable. We'll have to see.

So a straightforward if tricky fault-find and repair. I must say I'm surprised that 13.8 volts can conduct so well that enough current flows to burn the large via. The damage was all in places where there is a via carrying that 13.8 volts with a 0v connection nearby to complete the fault circuit. It looks like the water had run along the side of the PA PCB nearest the centre of the radio, and then across the rear edge of the board. With the price of replacement circuit boards (no-one repairs to component-level any more…), the distributor was probably right that this was an “uneconomic repair” for them, as they would have changed more than just the PA board and cable.

Martin has fixed the leak in his roof.

Chris G3WIE March 2020