UPDATE

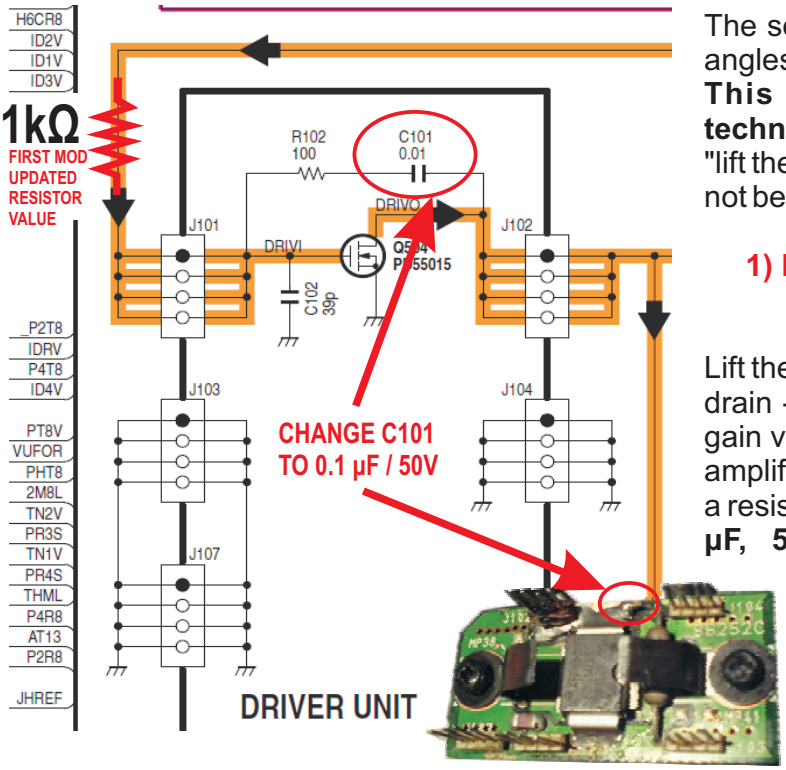
IC-7000 driver unit failure problem

After my first experiences with this problem, I had recently proposed a simple preventive measure, consisting of adding a gate series resistance to the driver unit, which apparently suffers from instability with destructive results in many cases.
This update is the result of further study of the problem. It attacks the problem in a more efficient way, taking more measures to elliminate the suspected instability but also taking measures to *possibly* prevent the destruction of the driver unit **even if the instability or other deteriorating phenomenon occurs**.
The update consists of two parts, the first about improving the original simple modification, and the second about taking extra steps to ensure better stability and protection of the transistor in the driver unit. One can perform just the first part which is very simple. The second part is quite a bit more complicated and requires lifting the PA PCB and performing more alterations and additions to the circuits - but it offers considerably more safety. **Please understand that although the mods all aim to improve the situation, perhaps better understanding of the transient underlying phenomena is needed for a full cure.** For example, there is a possibility that the failure is caused by frequency-dependent secondary breakdown of the LDMOS device, which would potentially require extensive redesign of the amplifier chain to elliminate, and may not be practically feasible in our case.

PART 1: IMPROVING THE FIRST MOD'S EFFECTIVENESS

The first version of the mod required the addition of a 10Ω resistor in series with the input (gate) of the PD55015 LDMOSFET in the driver unit. After studying the circuit's behaviour and experimenting, I finally **changed the resistor's value to 1kΩ (see the schematic below)**, which offers much more stabilising action with just a slight decrease in power output (~5%). So, if you have already done the first mod, change the resistor to 1000 Ohm. If you haven't yet done it, refer to ***www.mods.dk*** for the full description of the first mod (**use an 1000 Ohm resistor**, instead of 10 Ohm). Resist the temptation to tamper with the service menu to compensate for the small ~5% loss in output power - it's really not worth it.

PART 2: ADDITIONAL PREVENTIVE MEASURES



The second part attacks the problem from different angles. It requires considerably more effort and skill. **This part is for the more experienced technicians,** so detailed baby-step instructions (e.g. "lift the PA PCB by desoldering... and then..." etc., will not be given here. **Please be extremely careful.**

1) Modification of the drain - gate negative feedback network of the driver unit

Lift the PA UNIT PCB and remove the driver unit. The drain - gate negative feedback network flattens the gain vs frequency response of the broadband driver amplifier stage. It uses a capacitor (C101, 10nF) and a resistor (R102, 100 Ω). Change the capacitor to **0.1 µF, 50V**. This decreases the lower range of frequencies for which the network provides negative feedback, stabilising the amplifier there also. Apply a thin film of silicone grease to the heat sink's surface and tighten the driver unit's fastening screws well when reinstalling the driver unit.

Disclaimer: This mod requires delicate SMD soldering. Perform at your own risk. Although the mod is based on proven engineering techniques and worked perfectly for me, I can't guarantee that it will work for you.

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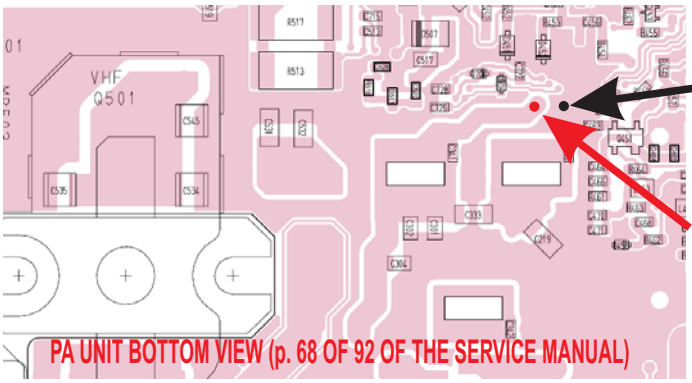
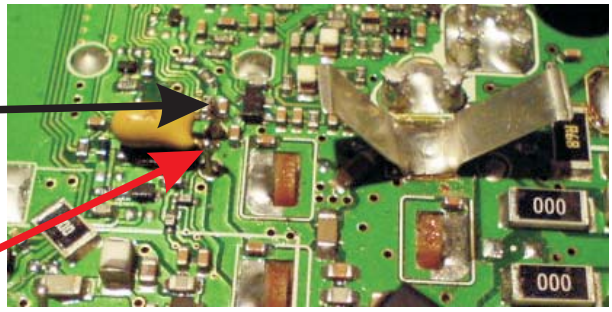
2) Addition of an extra bypass capacitor

This requires adding an extra tantalum bypass capacitor across C305 (470µF, 16V) (PA UNIT). Locate the capacitor's leads (see photo and schematic diagram) and solder a 47 µF / 35V tantalum capacitor across the electrolytic. **Observe the polarity!!**





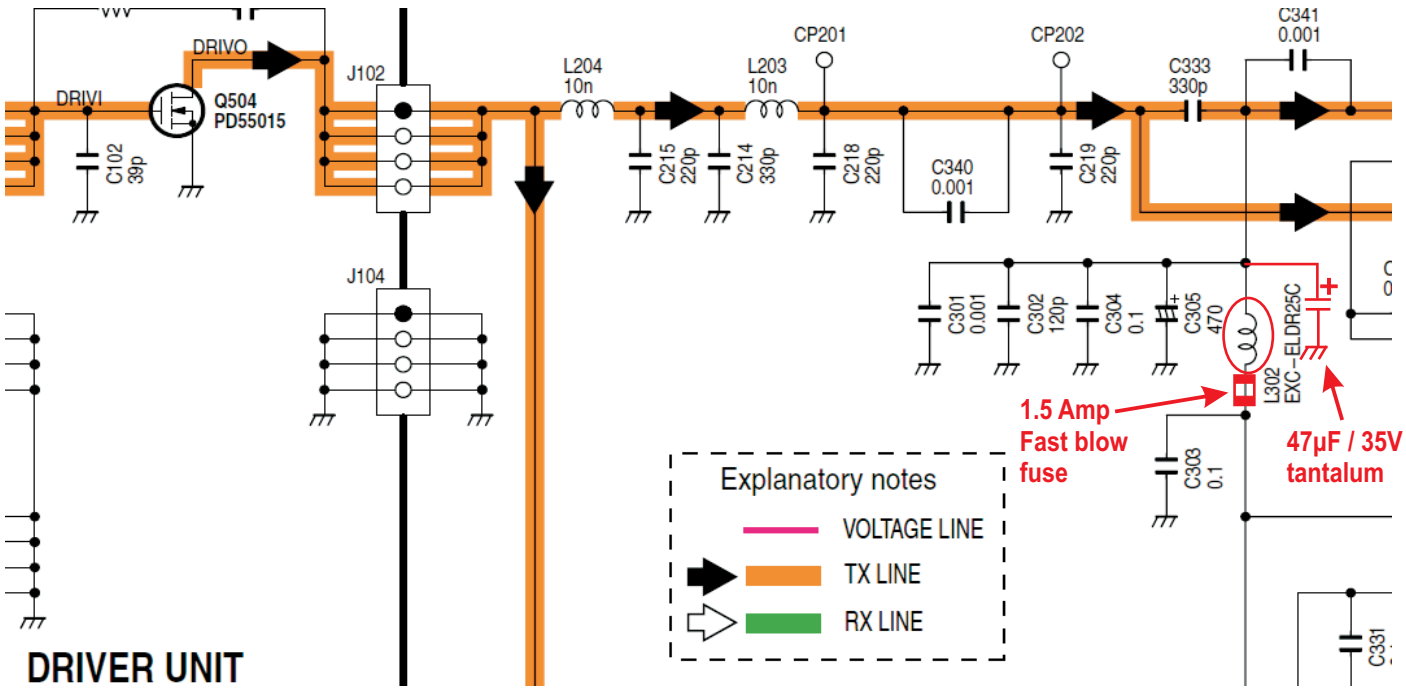
Added 47 µF, 35V tantalum capacitor (yellow colour)

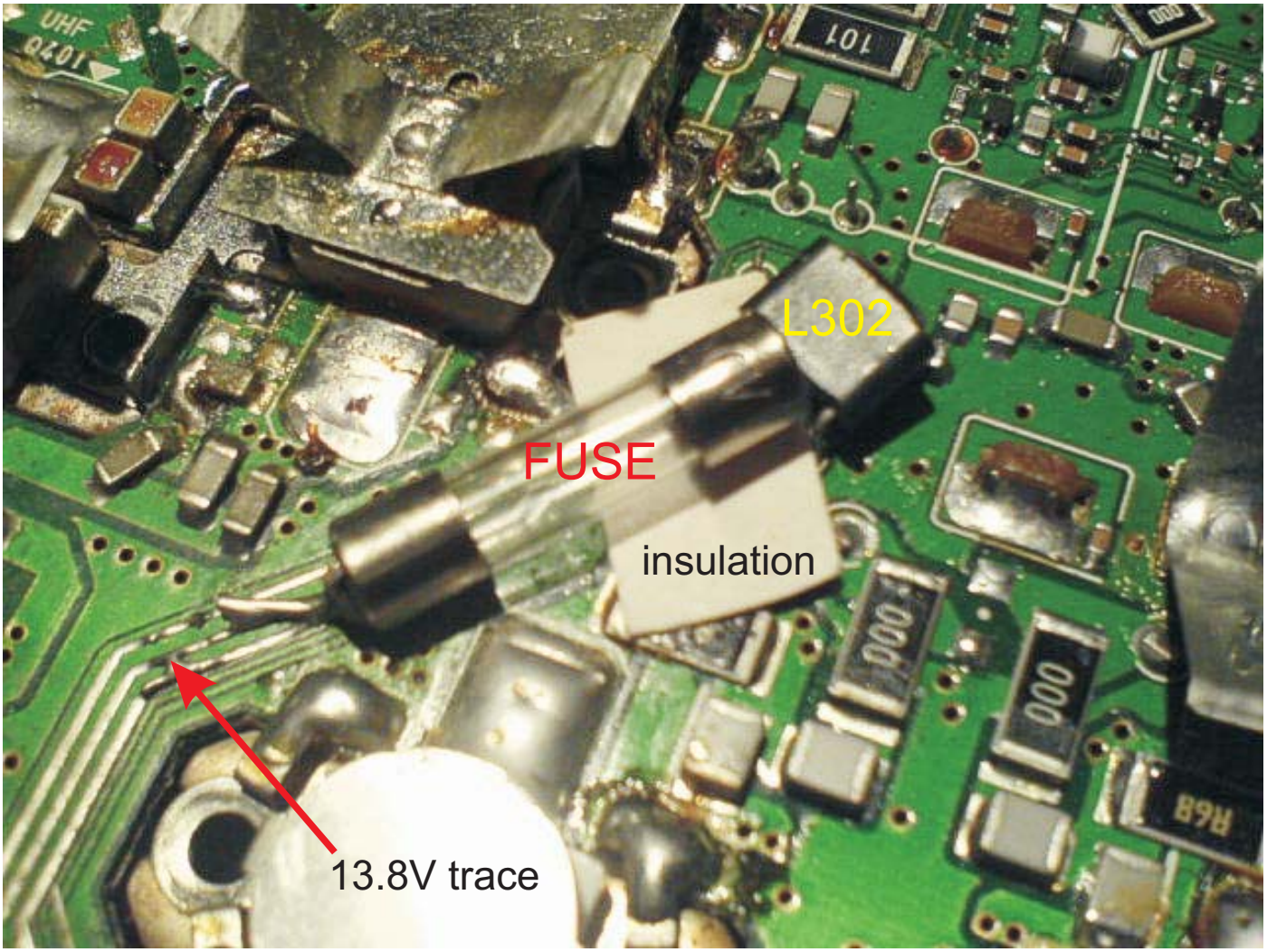
3) Addition of a driver unit protection fuse

IF YOU DON'T WANT TO LIFT THE PA UNIT PCB REFER TO PAGE 4 FOR AN ALTERNATIVE METHOD

Adding a fuse to the 13.8V DC line feeding the driver transistor's drain improves the chances that even if instability occurs, the transistor will survive. (There won't be the usual fireworks and smoke, in any case!) **Having lifted the PA UNIT,** locate **L302** on the PA UNIT (**see the schematic diagram on this page and the next pages for diagrams and photos**). Unsolder it and transfer it to the "**bottom view**" of the PA UNIT (as shown in the service manual), soldering only the lead that connects it to the node with **C305** and **L301**. Then solder an **1.5 A, fast-blow** 20mm glass fuse (or equivalent) to the free lead of L302 in the way shown in the photo, soldering the other end of the fuse to the PCB trace that L302 used to connect to (it's the "b" line with 13.8V on it). Use a small piece of wire to solder the fuse to the trace. **Don't locate the fuse elsewhere using long wires! Do it exactly as shown. Lay the fuse flat on the PCB.** Use a small piece of thick paper or plastic sheet to insulate the end of the fuse soldered to the free lead of L302 from the PCB trace under it. After you have finished, cover the fuse with a piece of electric tape to prevent shorting the 13.8V line when replacing the rig's covers.

(**Note:** *Originally, I thought about installing a current limiting circuit using two NPN transistors and some resistors in the DC line to the driver stage, instead of a fuse. This circuit would conceivably prevent a catastrophic secondary-breakdown scenario. Due to the severe lack of space and the relative complexity of this solution, I opted for the fuse. Anyway, I think this idea has merit, in the future I may try it.*)



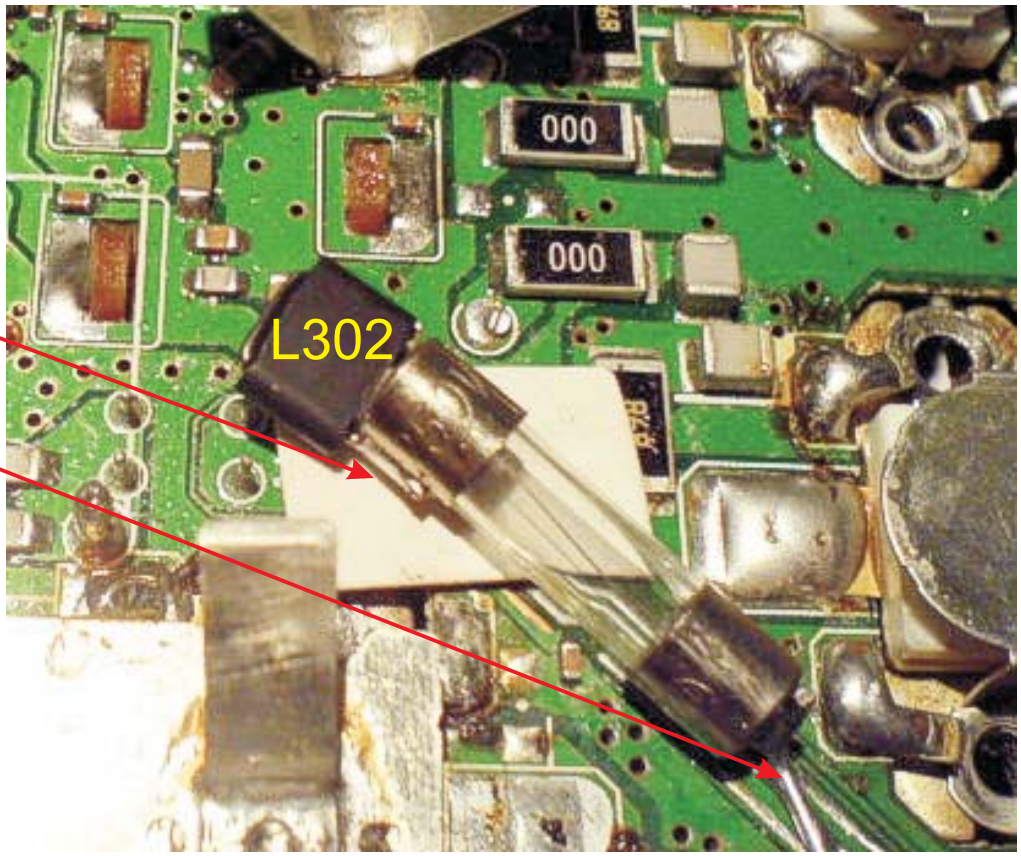


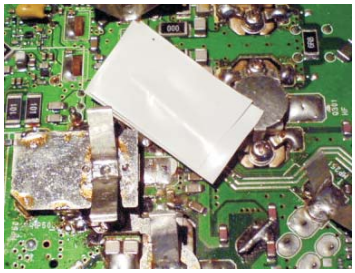
L302 is shown at its new position, on the opposite side of the PCB from where it is originally located.

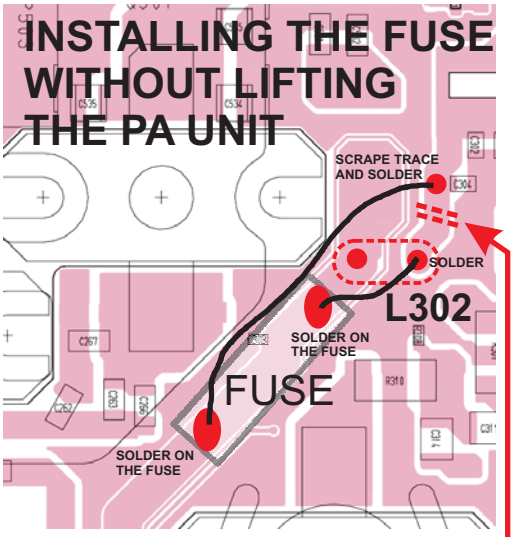
L302 SOLDERED TO THE FUSE

AUXILLIARY PIECE OF WIRE

After finishing, cover the fuse with a piece of electric tape.

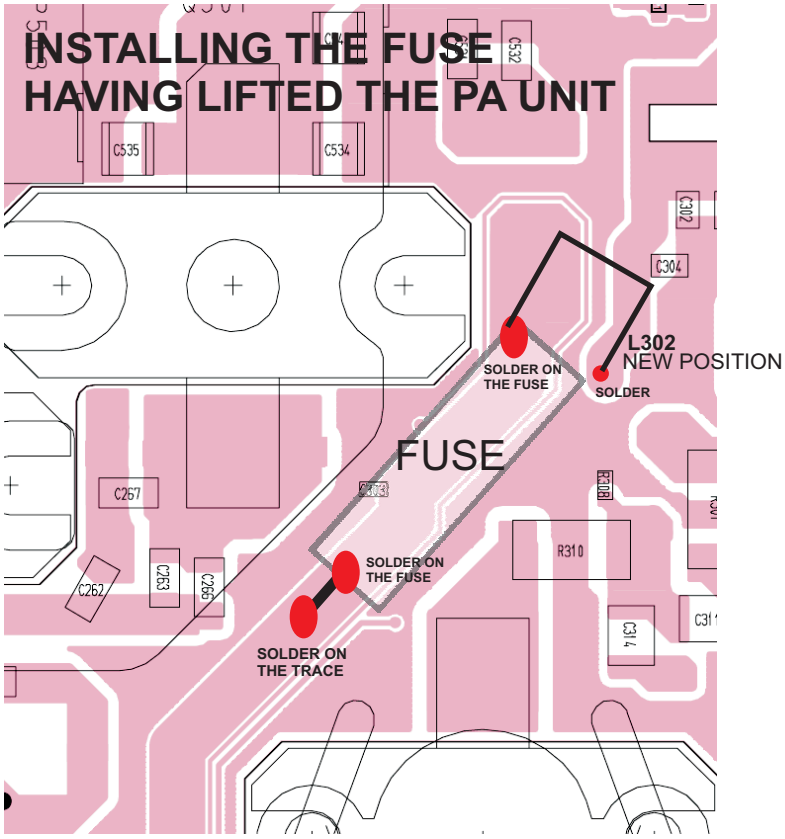






If you don't want to lift the PCB: Cut the trace **here**
and connect the fuse with short wires across the cut in the position shown in the photos. Insulate it well in a piece of heat-shrink tubing or with electric tape.
Both shown methods are equivalent.

PA UNIT BOTTOM VIEW (p. 68 OF 92 OF THE SERVICE MANUAL)



FINALLY, 4) Lowering the idle current I_{dq} of the driver unit

In order to lower the gain of the class A driver stage, also reducing its thermal strain and the possibility of secondary breakdown of the LDMOS device, without seriously affecting its linearity at the RF drive level used, we can lower the idle current via the service menu.
The service manual procedure sets the idle current of the driver unit at 1A. Reducing it to 0.6 A produces no serious ill effects on linearity (as measured in a two-tone test in SSB).

Follow the procedure at **page 4-3** of the service manual, "transmitter adjustment". Set the current at 0.6 A as per the instructions and exit the service routine.

This concludes the mods.

Good luck! Enjoy using your IC7000!

Tasos

Bibliography

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