16 March 2010

UPDATE TO THE IC-7000 DRIVER UNIT FAILURE PROBLEM

By sv8ym

http://sv8ym.blogspot.com/2010/03/update-to-ic-7000-driver-unit-failure.html

THIS INFORMATION IS NOT UP TO DATE - PLEASE CHECK THE POST OF JULY 1, 2010!!

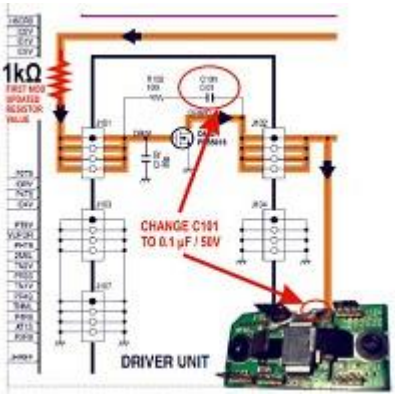
After my first experiences with this problem, I had recently proposed a simple preventive measure, consisting of adding a series gate resistance to the driver unit, which apparently suffers from instability with destructive results in many cases.

This update is the result of further study of the problem. It attacks the problem in a more efficient way, taking more measures to eliminate 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 all the mods aim to improve the situation, perhaps a 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 eliminate, and may not be practically feasible in our case.

Click on the pictures to see a large version.

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 on the left), 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, check the previous installment for 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.

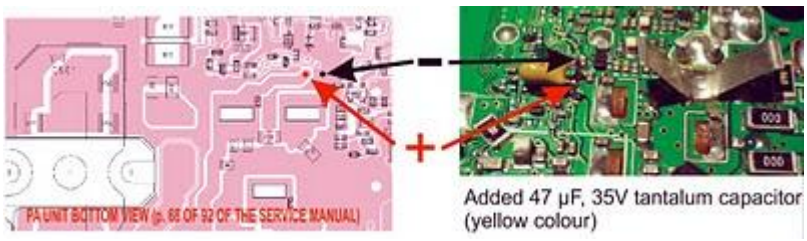
PART 2: ADDITIONAL PREVENTIVE MEASURES

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.**
You can choose to do only the parts of the mod that don't require lifting the PA Unit PCB, omitting the modification of the drain-gate feedback network that follows.

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 (see the **schematic at Part 1** above). This decreases the lower edge of the 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.

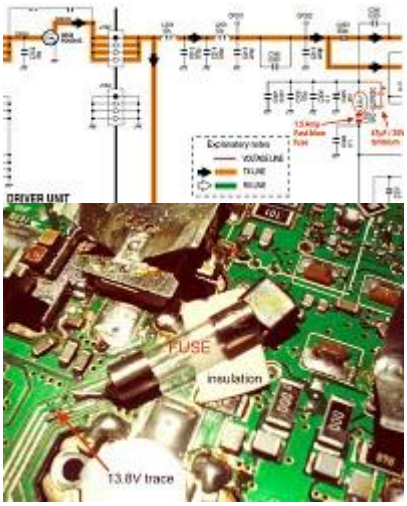
2) Addition of an extra bypass capacitor



This step 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!!**

3) Addition of a driver unit protection fuse

IF YOU DON'T WANT TO LIFT THE PA UNIT PCB, USE THE ALTERNATIVE METHOD DESCRIBED IN THE PINK DIAGRAM BELOW!



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" (the one you see after removing the rig's cover) 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.*)

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 stress 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!

Bibliography

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