

Replacing the Finals on an FT-817

Mike Perry, PA7XG

Contents

Introduction

For some months, my FT-817 could only provide half output power on any band and with a supply voltage of 13.8 V. The cause was not, as some know-all on a user group suggested, inept use of the menu system; the rig consistently gave half the output power specified for whatever the menu setting. The rig also ran hot, particularly during a long rag chew on 2 meter FM. Then, at the start of a QRP CW session on 80 meters during a vacation (November 2006) at a /P location, the rig gave up the ghost altogether and would only give a few milliwatts of RF power on any band. I had joined the BFC (blown finals club).

Now I have worked only with solid state rigs since I got my HF ticket at the end of the 1970's and never blown a final stage before. In fact, for this unfortunate session the antenna system had first been tuned up using a battery-powered antenna analyser (of reputable manufacture) and so this setback came as a disagreeable surprise. Furthermore the rig was stone cold when it died, which (in my opinion, puts a dent in the theory that overheating was the cause of failure. This note describes, step by step, how I carried out a repair some weeks later.

Information sources

In my opinion, an experienced amateur constructor should have little difficulty with this repair, but I would not recommend it for a beginner. If you are contemplating doing the repair yourself, I can recommend some very useful background reading on the home page of KA7OEI, Clint Turner at www.ka7oei.com/ft817pg.shtml and also in an article "Defekt Eindstufe am FT817 zelbst reparieren?" written by M. Zwingl, OE3MZC, *Funkamateur*, May 2006, p 567). A visit to the website www.mods.dk is also worthwhile.

Why buy a complete Finals Unit?

The radio frequency output stage of FT-817 comprises two MOSFETs in push-pull. This stage is used for all bands from top band to 70 cm. The actual transistors are located on a tiny 'drop-in' module measuring about 4 x 3 cm (1.5 x 1.3 inches) whose replacement is the subject of this memo. There are several good reasons why I chose simply replace the Finals Unit and not attempt to change the transistors themselves.

- firstly, a push-pull stage needs two transistors whose characteristics are matched to ensure good cancellation of even harmonics; the matching criteria and the permitted tolerances were not known to me;
- One would probably have to buy several devices in order to find a suitable pair; the rest would represent superfluous expenditure which could exceed the price of a new board;
- the device packages and their side connections are physically small and I was unenthusiastic about building a measurement jig to hold them for comparing their characteristics;
- removing the old devices without damaging the printed circuit board would be difficult.

My local hamradio dealer told me he didn't stock the replacement unit and referred me to the local importer, who did not react to my e-mail request for quotation. So I phoned the service department of Yaesu-Vertex in England to seek advice. The folks at Yaesu were friendly and helpful and confirmed that they would sell the spare part to me against payment by credit card. Since I had purchased my rig in 2001, the service technician recommended I order a "Finals Unit, CE type", part number CB-13333002. (If your rig is of more recent manufacture or if it was intended for use outside the European Union it might be wise to

determine which replacement part is appropriate in your case.)

Equipment needed.
Before you begin, make sure you have the following items at hand:
- 3 Phillips (cross-head) screwdrivers sizes 0, 1 and 2 (diameters: 5 mm, 3 mm and 2.5 mm). (1 mm = 40 thousands of an inch);
- a good quality pair of tweezers with a 45 degree bend just before the tip or a pair of needle-point pliers;
- a small pot or tube of thermally conducting heat-sink paste;
- a temperature controlled soldering iron with a fine tip (1.5 mm, 60 thou diameter) which can be grounded. And some fine solder wire.
- a grounded conducting wrist strap and lead. (You can improvise by removing about 15 cm (6 inches) of the insulation from a 3 foot length of hook-up wire and binding the bare wire around your wrist.)
- a grounded conducting work surface - for example a piece of aluminium sheet or a piece of hardboard/thin plywood covered with aluminium foil. This should be about 60 cm (2 feet) square.
- a good grounding point close to the work bench. I used the grounding connection of a 230 V wall socket.
- d.c. multimeter for measuring currents in the range 0 - 100 mA and voltages around 11 to 12 V dc
- adjustable dc power supply (ideally with internal protection and current limiting) and a power lead for the FT-817. Also the microphone.
- a sufficiency of leads and (crocodile) clips;
- a relaxed atmosphere, good illumination and sufficient time (reckon on two hours or so)
- (for senior citizens a magnifying glass may be useful).

Not essential, but possibly useful:
- pencil, paper and ruler;
- camera.
- small pot or tray to hold screws and other parts removed during disassembly.

The importance of grounding
MOSFETs are very sensitive overvoltage between the gate and the channel. Overvoltage can be caused by the build up of static charge or induced voltages from the ac supply mains. If the (recommended) maximum voltage is exceeded, there is a risk that the gate insulator will rupture and the device will be irreparably ruined. This damage occurs a thousand times faster than lightning and prevention is the only cure. Don't let robust CMOS logic devices confuse you; they have internal protection diodes which cannot be implanted in RF dvices.

Although the circuitry of the pre-assembled module provides a certain amount of in-built discharge protection for the MOS devices, meticulous grounding will not hurt and constitutes a "better safe than sorry" approach. Use the conducting work surface as the central point to which all grounding wires are connected (the soldering iron, the solder wire, your wrist, the connection to the grounding point and, in due course, the chassis of the FT-817.)

Opening the box
The top and bottom covers of the FT-817 are held in place by a large number of small black screws which can all be removed by a no. 1 Phillips screwdriver.

At a casual glance all these screws look alike; at a closer look at the under side of the head, you will see that some are slightly rounded (countersunk) and some are flat. As you remove each screw note carefully which type it is and where it came from.

Remove the two side brackets to which the carrying strap is attached.

Remove the remaining 5 screws around the edge of top cover. It is not necessary to loosen the two screws at the side of the loud speaker so don't do it. Gently prise the top cover off the rig and unplug the lead connecting the loudspeaker to the printed circuit board.

On the underside of the rig, remove the cover of the battery box and unplug and withdraw the battery or battery holder if either of these is fitted. Using the smallest (Nr. 0) Phillips screwdriver, remove the screw which holds the plastic retaining clip for the battery box. Remove this clip.

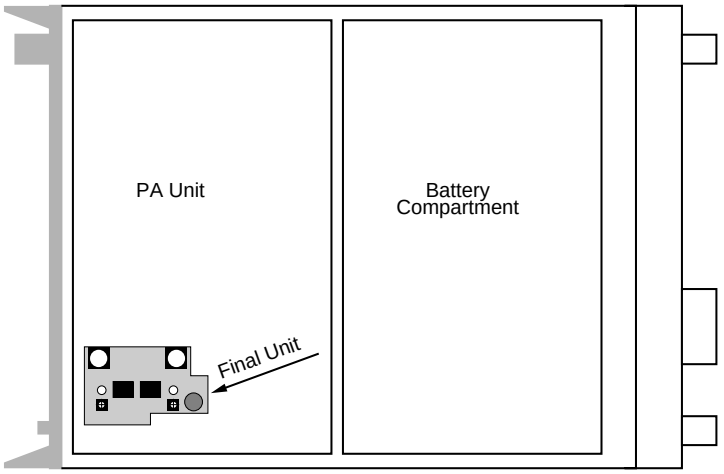
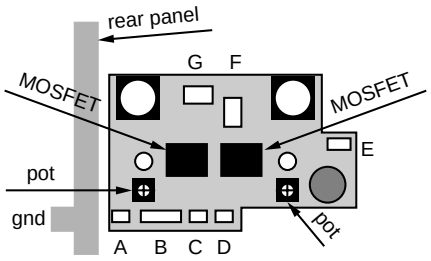


Figure 1. FT-817 The PA Unit; view from underneath



Solder pads

A Tx/Rx (Tx5)	E +12V
B ground	F green coax, centre
C grey coax, centre	G green coax, braid
D grey coax, braid	

Figure 2. FT-817 The Final Unit

Remove the screw located in the centre of the lower cover by the edge of the battery compartment and then remove the 5 screws around the edge of the cover. Gently prise the cover away from the chassis.

Attach a grounding wire to the earthling screw on the rear of the rig and connect the other end to the grounded work surface.

At the rear of the rig, on the underside, is a compartment about 5 cm (2 inches) wide which is covered with a rather fragile black plastic adhesive shroud. This cover must be opened, but need not be completely removed. Start by gently peeling the cover away from the sides of the chassis and then peel away the edge along the rear panel of the chassis. Fold the shroud back along the central rib of the rig to reveal the PA Unit (Figure 1). This might be called the mother board. Identify the 'drop-in' Final Unit (Figure 2).

With an eye to possible future work, this is the time to get to know the FT-817, making notes and taking photos as necessary.

Removing the old Finals Unit.
With reference to Figure 2, note the position of the two retaining screws and the position of the 7 solder islands and the connections to these. Desoldering the connections requires a steady hand, a fine-point grounded soldering iron and the tweezers. Before staring work make sure that your wrist strap, the soldering iron and the chassis of the rig are all grounded and place the rig on the grounded work surface.

Start by de-soldering the grey and green miniature coaxial cables (pads C,D,F,G) gently pulling the wires away from the molten solder with the tweezers. Then desolder the wire bridge for the transmit/receive line from the drop-in board (pad A), prising it upwards; leave the other end attached to the mother board. In a similar way remove the wire bridge forming the +12V connection (pad E).

Now remove the two cross head screws which secure the drop-in board to the chassis.
Finally heat the solder connection to the foil bridge (ground, pad B) and gently slide the drop-in boards up and away from the bridge. Note that the copper spring leaf on the underside of the drip-in board and the angle at which it hangs down.

Clean away the old heat-conducting paste from the thermal transfer island on the chassis. A soft scraper and a paper tissue are useful for this.

Installing the new Finals Unit
Remember that the "grounding regulations" are particularly in force.

Take a small amount of fresh heat-conducting paste (about the size of an apple pip) and smear it evenly over the thermal transfer island on the chassis.

Bend down the foil earthling spring on the underside of the drop-in unit and then insert the unit carefully in place, taking care not to harm the foil connection to pad B. Replace the two screws in the drop-in board and tighten them up.

Work the earthling foil back over pad B and solder it in place. Replace the wire bridge to pad A and then replace the coax. connections to the RF transformers (pads C,D,F,G), leaving them exactly as they were before.

Now take a thin piece of bare wire about 1 cm (4 tenths of an inch) long and bent it into an "L-form" about 3 mm (one tenth) from one end. Solder the short section of this wire onto the +12V island E. Do NOT complete the bridge.

Finally locate the two miniature potentiometers on the drop-in board and set both of these fully anti-clockwise.

Setting the quiescent current.
Set the adjustable power supply to about 11.5 to 12 volts output and then switch it off.

Connect the power supply to the FT-817. Switch the FT-817 on and set it into CW mode on the 1.8 MHz band. Power the rig off.

Now connect a milliammeter across the open 12V bridge between pad E on the drop-in board and the motherboard. You may need some miniature clips for this purpose. Connect the microphone. DO NOT USE A MORSE KEY for this operation, since it is not intended to send an RF signal to the final stage. Power the rig on again.

Press the PTT switch on the microphone and adjust one of the potentiometers for a reading of 38mA ±2mA in the milliammeter. Thereafter adjust the other potentiometer for a reading of 76 mA ±4mA.

Power the rig off, and uncouple the milliammeter, the microphone and power lead.

Remove the small L-shaped wire from pad E and reconnect the +12V bridge.

Closing the box
Take care to press the shroud firmly and accurately in place around the output section and then replace the cover for the under side of the rig. The rest is the reverse of the procedure given above for opening the box.

A final check on the rig showed that nominal full RF output power was available on all bands (4.85 W measured).

Acknowledgements.
I am grateful to Dan, PA1FZH who directed my attention to the article by OE3MZC and also to Peter, PE1DCD who pointed me to the home page of KA7OEI.

I am also indebted to Clint, KA7OEI whose home page convinced me that I could do the job.
And finally thanks to the folks at Yaesu-UK for their good customer service.