Modifying the Yaesu FT-847
External 22.625 MHz Reference Input

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Introduction

This document describes the modification of an FT-847 to allow an external 22.625 MHz Reference oscillator to be connected to the rig.

So, why do this modification? Weak-signal experiments require a rig that is both stable and accurately on-frequency. The FT-847 derives its internal mixing frequencies from a single 22.625 MHz Reference oscillator whose frequency is effectively multiplied 20 times for the 70 cm band. The oscillator does not use any special techniques to enhance frequency stability (temperature control etc.) and so the rig can drift considerably as temperature changes during transmission (some rigs are worse than others). A stable external Reference oscillator will improve performance significantly.

However, the FT-847 also uses another oscillator on 6.7109 MHz for SSB carrier generation. This can also influence frequency stability, and will be looked at later in this document.

Description of Reference Oscillator and Mods

An extract from the Yaesu FT-847 Technical Supplement showing the internal Reference oscillator circuit is given in Figure 1.

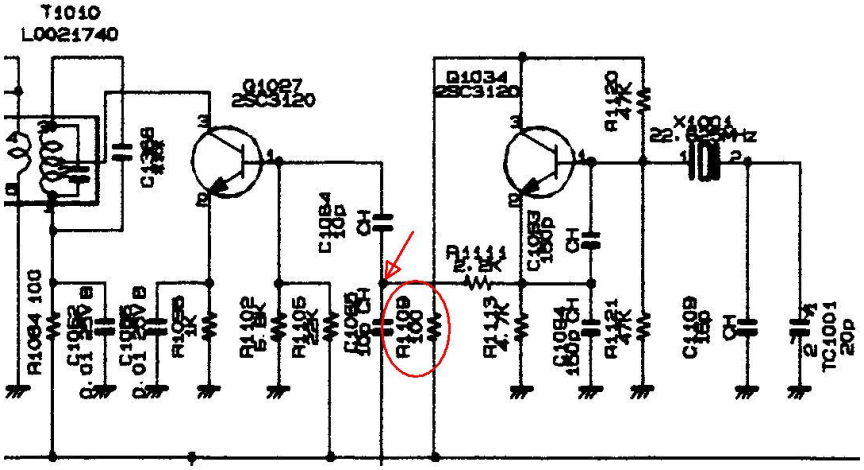

Figure 1 – Reference Oscillator Circuit Diagram

My rig seems to have some factory modifications with R1109 being 2.2K instead of 100 ohms, and a bypass capacitor from the collector of Q1034 to ground.

The internal view of the upper side of the PCB is shown in Figure 2.

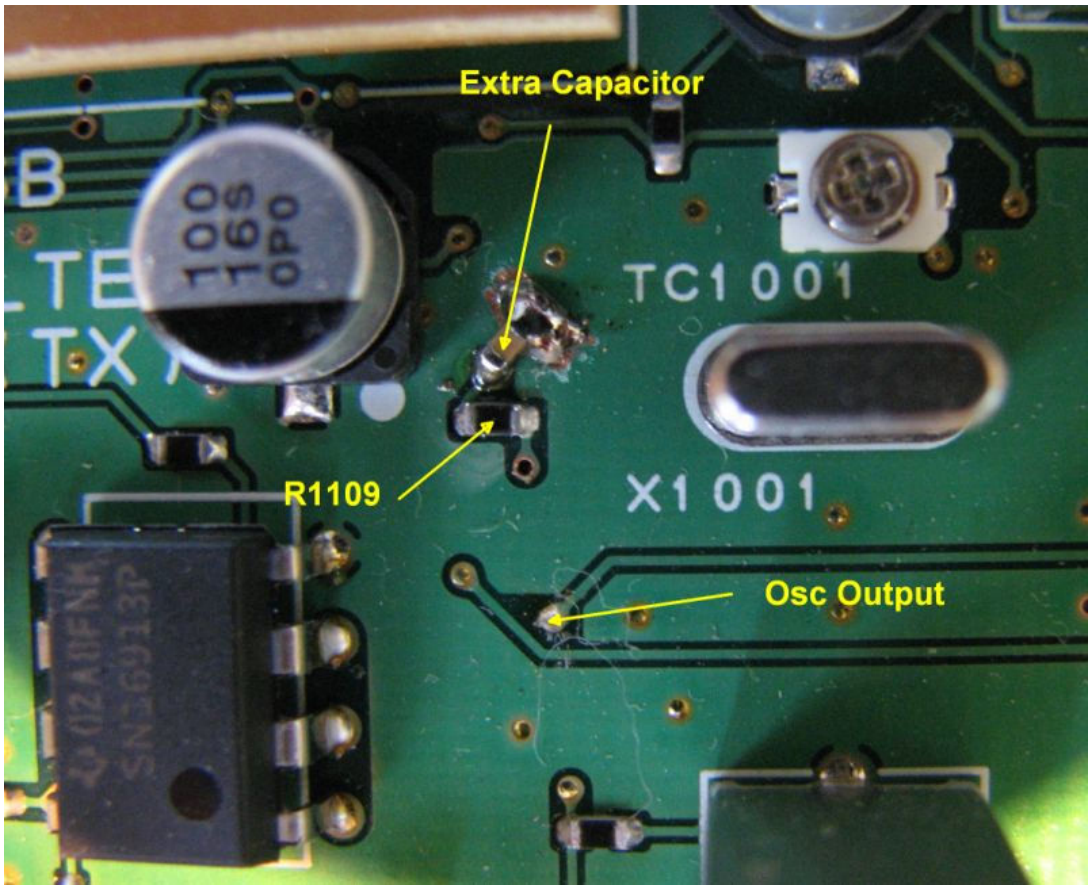

Figure 2 – Reference Oscillator Component Layout

Note that most of the components are under the board. However, we have access to R1109, which supplies power to the oscillator, and the oscillator output (the junction of R111, C1084 and C1085 – the Red arrow in Figure 1).

The simple circuit shown in Figure 3 will be added to inject the external signal into the Osc Output point, and cut power to the oscillator when the external cable is connected.

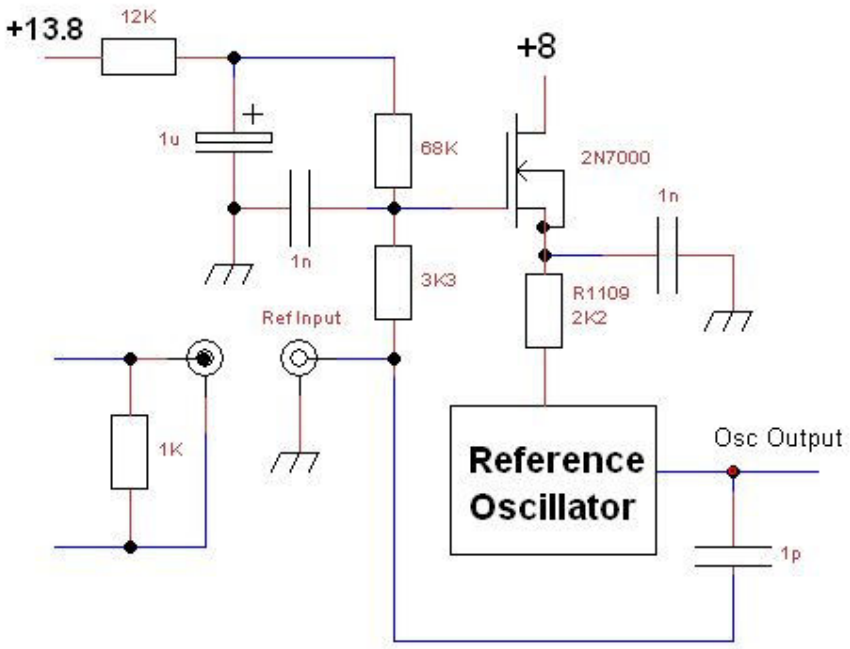

Figure 3 – Circuit Modifications

The circuit uses a 2N7000 FET to switch the 8V power to the Oscillator. A FET provides low voltage drop, but has the disadvantage that the gate must be raised at least 2.1V above the source to switch it on. Fortunately, there's a supply of +13.8V on the board. Note that the reference source needs to have an output DC resistance of less than 1K for the switching circuit to work properly,

Parts Required

1 – 2N7000 N-channel MOSFET
1 – 3.3K 1/8W resistor
1 – 12K 1/8W resistor
1 – 68K 1/8W resistor
1 – 1pF 63V disk ceramic capacitor
2 – 1nF 63V disk ceramic capacitor
1 – 1uF 16V tantalum electrolytic capacitor
1 – 500mm length of thin Teflon coax with your connector of choice

Modification Steps

1. Remove both top and bottom covers of the rig.

2. Remove the internal top cover with the speaker. Carefully disconnect the speaker lead from the board.

3. Turn the rig upside down and find the Reference Oscillator area towards the centre front of the main (AF) board (Yellow circle in Figure 4).

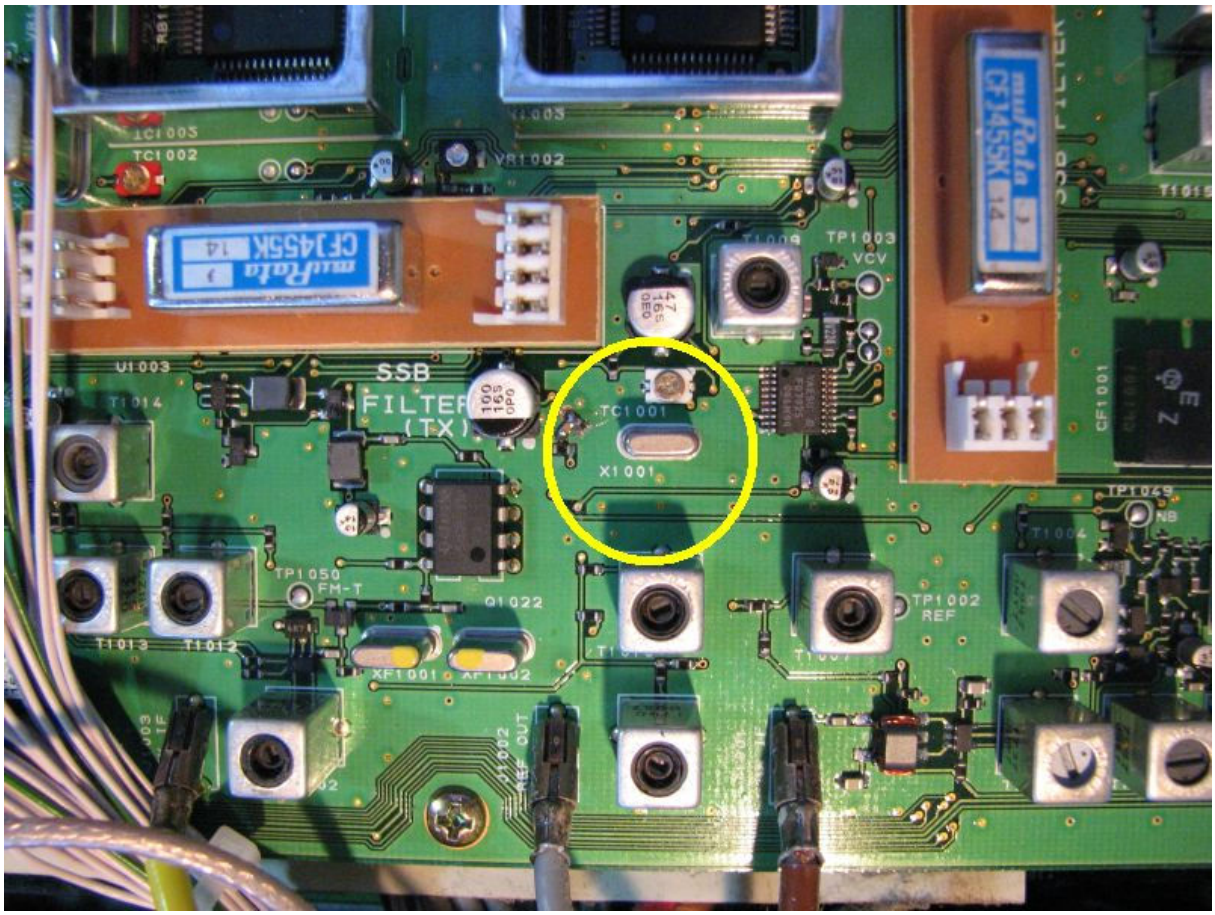

Figure 4 – Location of Reference Oscillator

4. Remove R1109 from the board (see Figure 2), preferably in one piece, because it will be re-used. This is probably the hardest step. The way I did it was to use two fine-point soldering irons to heat each end of the component simultaneously and lift it away. Another way is to carefully just snip the component in half, desolder each piece, and use a replacement 2.2K resistor.

5. Scrape away the green protective layer on the earth plane in the orange area in Figure 5. Tin the area with solder.

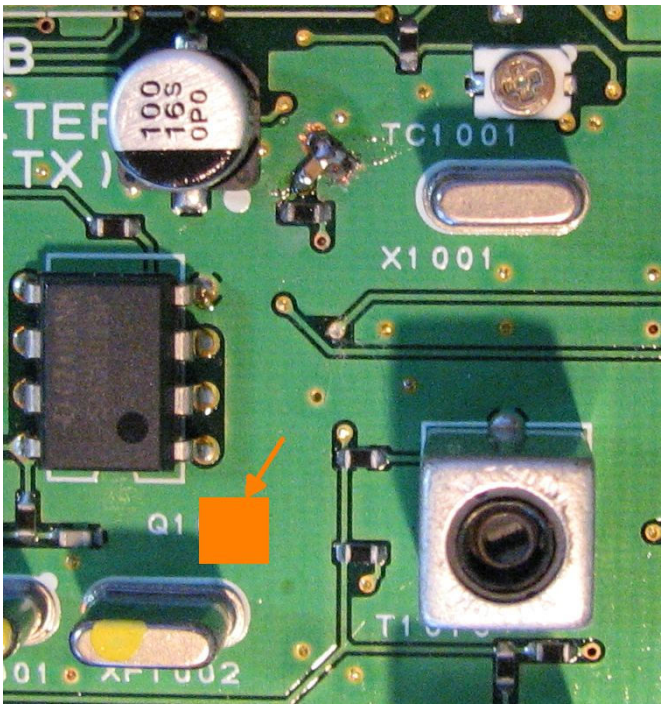

Figure 5 – Ground Area

6. Turn the rig over to the top. Thread the coaxial cable through the ventilation slot at the rear of the rig as per Figure 6. Route it along the edge of the rig, then across the front and through the gap in the middle to the underside.

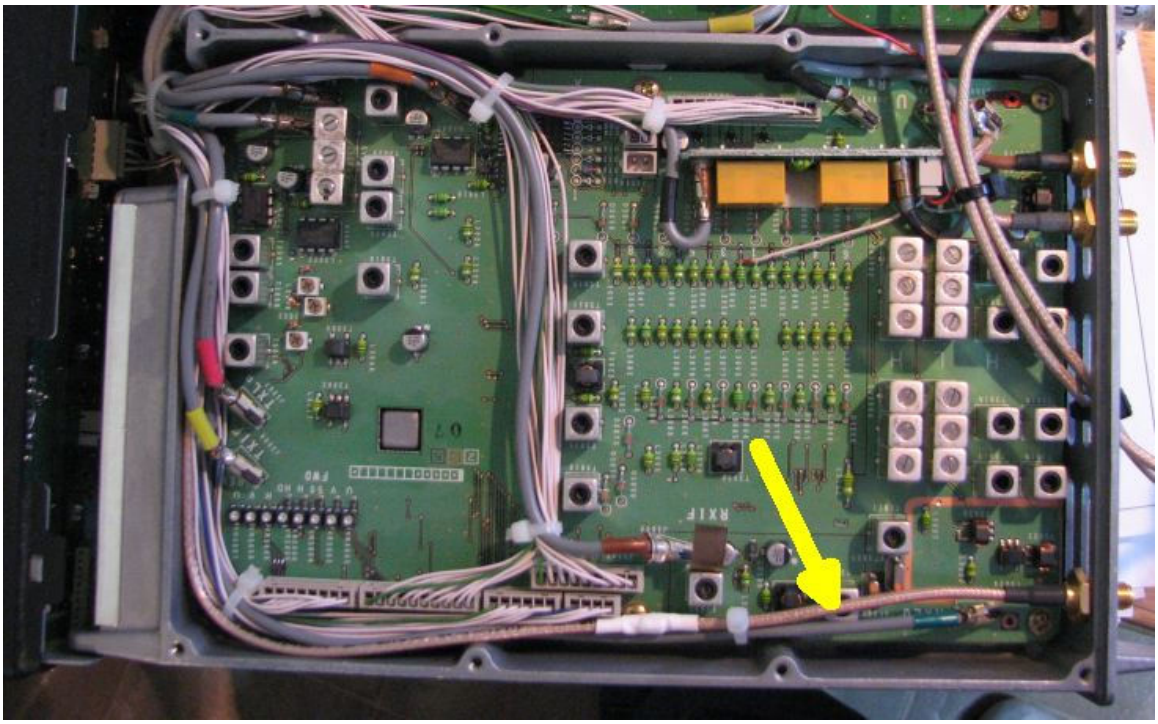

Figure 6 – Suggested Cable Route

7. On the underside again, cut and strip back approx 1 cm from the end of the coax and solder the braid to the board where you tinned the ground area in Step 5. Use a cable tie around the Ref Out connector (J1002) for strain relief.

8. Locate the audio amplifier IC in the right rear corner. See Figure 7. To get 13.8V, run a wire from pin 5 (furthest from back panel) through the wiring loom that runs around the right edge of the rig, coming out where the coax braid has just been soldered. The black wire can just be seen at the bottom of Figure 8 going through the cable tie to the 12K resistor.

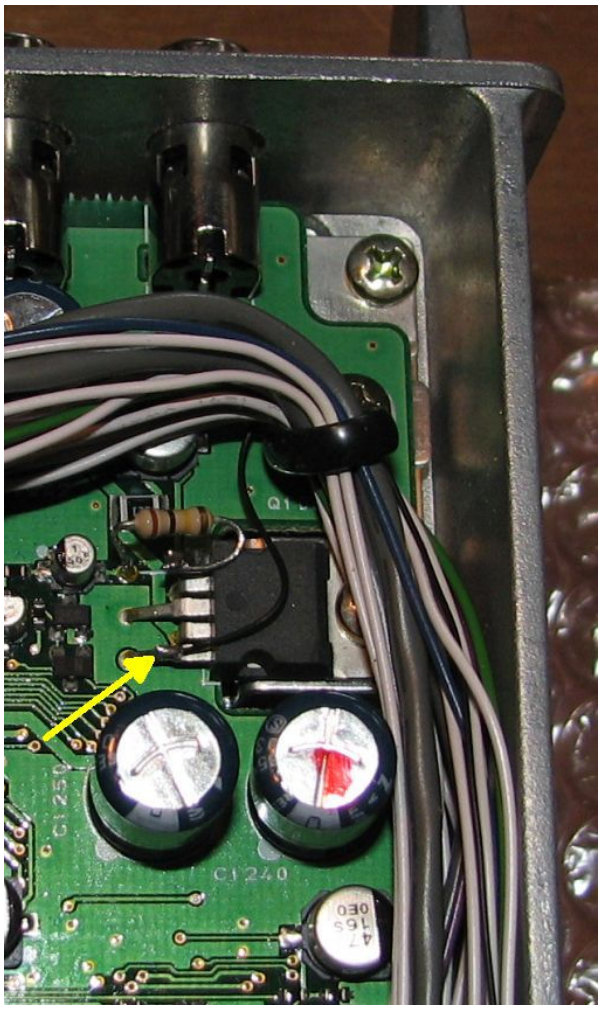

Figure 7 – 13.8V Pickup Point

9. Solder R1109 in, standing vertically, with one end soldered to the oscillator end of the existing pads (right pad in Figure 5).

10. See Figure 8. Cut one lead of each of the 1n capacitors to 5mm length, bend them and solder to ground – one to pin 4 of the adjacent IC and the other to the “factory mod” capacitor ground.

11. Solder the other end of one of the capacitors to the free end of R1109.

12. The 2N7000 now goes in vertically with the flat towards the back. Cut the Drain and Source leads and bend the tips over so that the Source just touches the free end of R1109 while the Drain just touches the pad on the board where R1109 was attached. Bend the Gate lead to the left and leave for the moment. Solder Drain and Source.

13. Solder the Gate lead to the free end of the 1n capacitor.

14. Solder the remaining components in as per Figure 8. Note that I used an SMD 1pF capacitor mounted vertically with a wire across to the end of the coax – a 1pF disc ceramic will work equally as well.

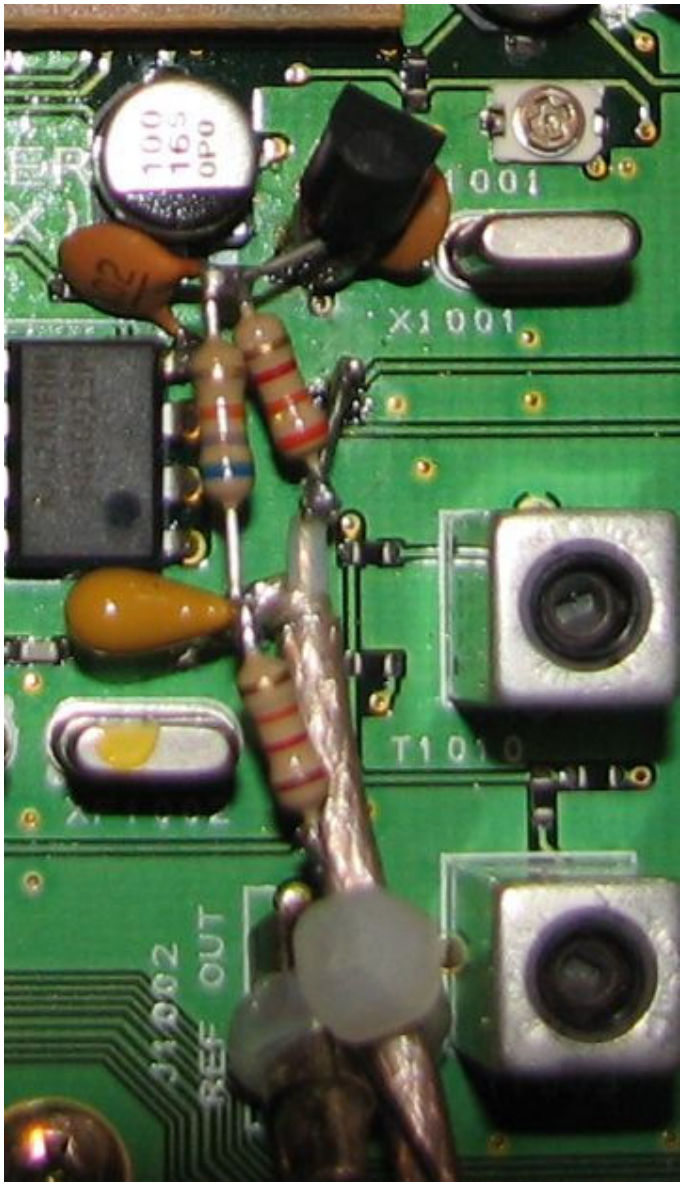

Figure 8 – Post Modification

Testing

With the bottom cover removed, and nothing connected to the Reference Input, apply power to the rig and switch on. The rig should behave normally. The voltage on the top of R1109 should be close to 8V.

Attach a 1K resistor or less across the Reference Input (or even short the connector). The rig should stop working. The voltage at the top of R1109 should be very close to zero.

While listening to a CW signal on one of the VHF/UHF bands, connect a clean, stable 22.625 MHz source to the Reference Input. Level should be around 0 to +3 dBm (1 – 2 mW). If all is working OK, you'll probably notice a slight jump in frequency. Otherwise there should be no change in signal quality.

(Reminder: the signal source must have a DC resistance to ground of 1K or less for the switching circuit to work).

Carrier Oscillator

As mentioned at the start, the FT-847 also has a separate SSB Carrier oscillator that contributes to overall frequency stability, although to a lesser extent. Therefore, it is probably worthwhile insulating the crystal from temperature changes. I made an insulating sleeve from several layers of foam tape and slipped it over the crystal (top left of Figure 9).

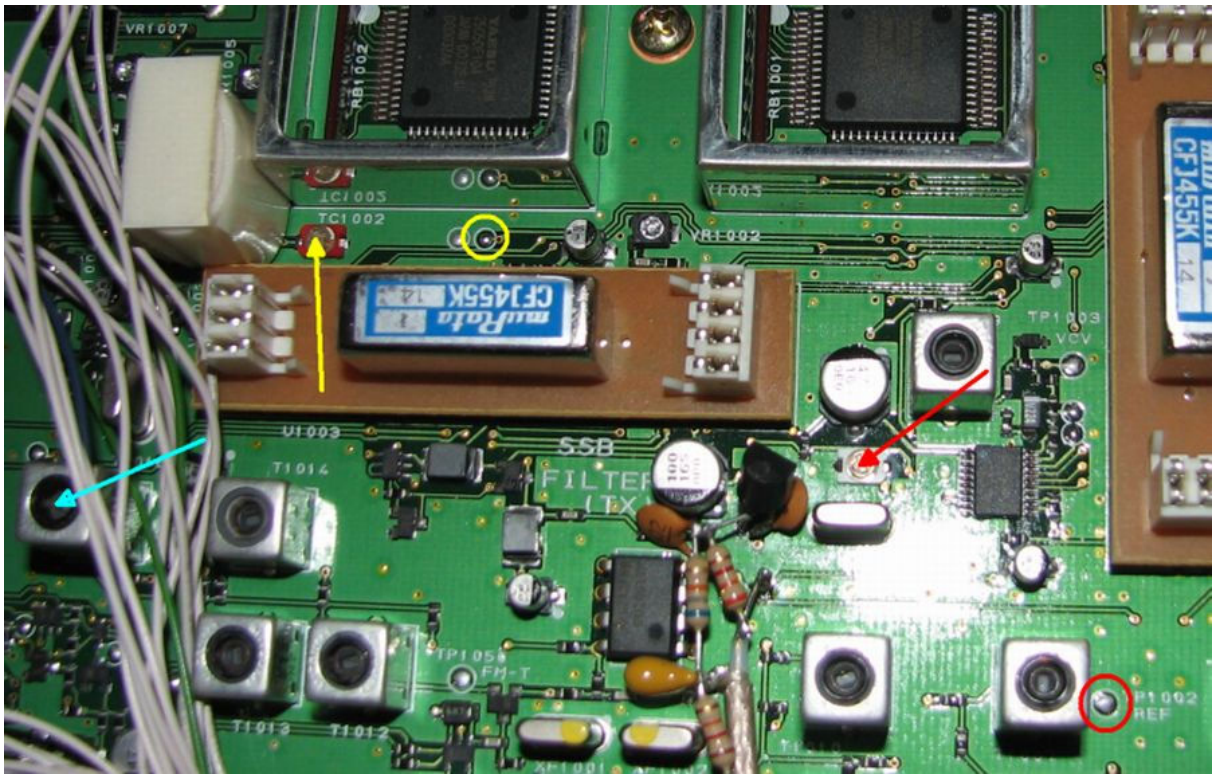

Figure 9 – Carrier Oscillator and Alignment Points

Frequency Alignment

To ensure all our good work with the External Reference oscillator puts us accurately on frequency, we need to align the Carrier Oscillator. Referring to Figure 9, the yellow arrow points to the alignment trimmer, and the yellow circle shows the test point. Warm the rig up for a while first. Then, with an accurate frequency counter connected to the test point, adjust the trimmer to give 6.710900 MHz.

While we're at it, align the on-board Reference oscillator to 22.625000 MHz (trimmer and test point shown in red). A more accurate method is to set the rig to the 70cm band on CW and monitor the output frequency. Adjust the Reference oscillator trimmer to give the correct frequency (or as close as you can get – the trimmer is very touchy).

Finally, we might as well align the FM side too. The blue arrow points to the inductor that sets the FM carrier frequency. Switch the rig to FM on 70cm and adjust the inductor to give the correct output frequency.