

**GE – Ericsson - M/A-COM – Tyco Orion 900 MHz
Amateur Radio 902-928 Hardware Modifications
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DOC Rev 2.0

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Background

The Orion Mobile is one of several radio members in the EDACS product group. The Programming tools used on Orion's in the early day were DOS based tools. There were 2 versions, EDACS3 and a CONventional equivalent. The current software used for these radios is called Programmer and Programmer CNV. These newer windows based tools are licensed currently by Tyco and are beyond the scope of this document. If you have a legitimate version of these tools you may have other software solutions to get to amateur but these or similar hardware mods will still be required. We will confine our discussions in the software realm to the DOS based tools which are for the most part available and not restricted or protected per-se by the current owners of Tyco.

(Editors Note: Information regarding Using EDACS3 or CNV DOS based software to move these radios into amateur frequencies is published in some places on the internet. The methods of doing this are not publically approved, authorized or supported by Tyco/ M/A-Com TAC Support in Lynchburg... DO NOT CALL THEM for assistance!!!! I REPEAT DO NOT CALL THEM TO ASK HOW TO MOVE RADIOS OUT OF BAND. You will not get an answer that you want to hear... The Factory in no way publically or officially supports or assists Out-of-Band modifications outside of commercial activities for commercial customers. Period!!!) The older DOS based software is available in the wild and in general is not scrutinized nor is it supported by the Factory... Special Configuration files can be used with these DOS based software tools to program Out-Of-Band amateur frequencies.

Assuming you have been able to program 902-927 frequencies into your 900 Orion, you have probably noticed that simplex works and RPT (902) TX gives a synthesizer unlock. This is absolutely correct and applies to all EDACS3 radios I have tried except the MRK 900 which works fine, as it only has 1 segment.

The problem is simple but a little difficult to find a solution for. What occurs is a firmware quirk which probably came from the software engineer never considering use on anything besides 896-902 and 935-941 which are the commercial band segments (He or She must not have been a ham). SO ... he or she, as the case may be, took some shortcuts in decision making steps for the IC702 CPU.

There are 2 VCO band segments in the hardware for selecting the low range or high range in Transmit mode. ALL EDACS3 radios in 900 make one of 2 decisions that being either (1) anything below 935 is the low VCO or (2) anything above 902 is the high VCO.

This varies by model but the results is the same, on either 927 TX or 902 TX one will work or one will not because our band 902-928 segment is in between these limits. In the specific case of the Orion the decision made is anything above 902.0000 is sent to the high VCO so the radio tries to use this high VCO segment to operate and consequently unlock occurs.

A hardware solution is in order. The mod discussed in this document will provide a manual over-ride switch function to correct this hardware condition. In software a button on the front of the radio will be mapped to do this RPT and T/A switching as well as enabling or disabling TR716 "OUT1" to switch the segment. Option 1 and Option 2 use identical software setup except the active condition of Out1 is HIGH or LOW based on which version of the modification. The choice will be described later but are HIGH for Mod option 1 (Josh's) and LOW for option 2 (Doug's). Josh worked out the Macro function programming for the button. I give him all the credit on that as I never knew it could even do that ☺ ...

Even I can learn a thing or 2 about Orion's!!! And the setup is pretty cool. It is elegantly simple but highly effective.

The actual schematic designator of the VCO segment selectors on the 900 Orion transmit involved is the "SYNTH BAND 1" circuit. This lead needs to toggle HIGH when the low VCO segment is needed and is held LOW when the TALKAROUND mode or high segment is needed. This signal comes from the Microprocessor (IC702) which is on the System Control/Logic Board. The signal starts at IC702 and passes through a choke SMT assy (CX702 in a ceramic IC package) and then through pin 25 of P501 to the Synthesizer/Receiver/Exciter board. Basically the lead is never switched to high when we operate out of band in 902-

928 because of the above described firmware logic. We need to fix that.

The OPTIONS

We propose 2 different modifications depending on the skill level and desire of the builder and his or her confidence level. No egos allowed here... check it at the door. Mistakes can kill the board. Do not attempt the second option unless you are ready to cut a tiny foil and have a soldering pencil tip in 1mm region, as well as a magnifier and patience. The cut requires cutting 1 foil with a lot less than 1mm of clearance to everything around it. A precision X-acto knife, a magnifier and a steady hand are a must. You have been warned!

Josh proposes a single wire installation with no cuts or major surgery. It does also require drilling one little hole through the chassis frame. We will refer to his as Option 1.

I (Doug) propose a 1 wire, 1 cut, and 1 resistor mod if the operation of the mod proposed by Josh does not suit your liking. We will refer to mine as Option 2.

The decision is an operational one, now on to the decision discussion.

The Reasoning for which Option Solution

Based on a firmware glitch, or feature, depending on your perspective, the OUT1 transistor device, TR716, always powers up in the OFF mode (it is an open collector NPN device and powers up in the open floating condition) upon power "ON" or reset of the radio. The relevance of this dictates which Option you will choose to follow.

If you use Josh's mod, the transistor (TR716) will power up open collector (floating) and activate the T/A or SIMPLEX segment select mode until the "Talkaround" button is toggled (discussed later) which causes a synthesizer unlock condition in RPT mode if you try to transmit on RPT before the Talkaround/RPT button is cycled. The display will indicate RPT mode but the transistor will be latched in TALKAROUND and activate the talkaround VCO segment until cycling the T/A button twice. If you try to TX it will give an unlock condition on an RPT freq and in the wrong state.

This may or may not be reason to contemplate my more complex mod (option 2) which inverts the situation making the radio always power up with the transistor in the open state but instead because we invert everything, it will be in RPT mode and will let the radio TX work immediately without cycling buttons as long as the radio was in RPT mode when power was shut off.

You NEED to decide if this issue is an issue or not. The main difference is that if you are using the radio in RPT mode (which is after all why we are doing this mod) most or all the time, that power on and power off is a 1 switch function my way (option 2), and you additionally need to toggle the "Talkaround" button twice before using on RPT using Josh's simpler non invasive mod (option 1).

This document includes both. The difference is where we tie to the Band Select lead and which logic level is default. The logic line inverts before it gets to the Band Select of the VCO so we can attack it at either side of the inverter. The connection points are on 2 different boards depending on option 1 or option 2. In either case the OUT 1 transistor TR716 is still the other end of the wire.

Modification instructions start here:

1. You need to address the programming of amateur frequencies first and verify operation on simplex before we get started.. This is important because after you start making modifications, if something goes wrong it will be hard to tell why if we did not check the radio out first. Do not skip this step!!!!

2. When you have the radio programmed on the ham bands, and working on 927 MHz TX and RX simplex, you will see that the radio unlocks the VCO, indicating "VCO Unlock", if you attempt to TX on 902 or basically anything below 925 or so..

Next you need to, and are ready to, modify the hardware of the radio.

Use ESD safe work practices so you don't fry the radio you are trying so hard to make work.

Other than basic hand and soldering tools, you will need one item to complete this version of the mod....

A piece of small gage wire!

Teflon insulated wire is best, for abrasion resistance, but use what you have. It will have to pass through a hole in the frame of the radio so make sure it can handle a little chaffing...and is small enough. You will need to drill accordingly.

1. Remove the PA and set it aside to get it out of the way.
2. Remove the top and bottom covers and internal shields.
3. If it is a dash mount radio, remove the control panel from the front.
4. Disconnect and remove the LOGIC circuit board and set it aside for option 1 or prep it for option 2.

Here we deviate for Option 1 and 2, first will be the modification instructions for Option 1

5.1 Remove the VCO circuit board and set it aside.

6.1 On the Logic side of the chassis you will see a raised boss that is the heat sink for the 7805 regulator chip. Set the chassis in front of you with the boss to the right. On the side of the boss facing you (towards the front of the radio) drill a 1/16" hole right along the boss on the front side about 1/8-3/16" of an inch from the end of the boss. This is where the VCO control wire you add will pass through the chassis.

7.1 Place the VCO board front and center on your bench, component side down with the connector to the Logic board closest to you. The VCO adjusting caps should be towards the bench on your right hand side. Locate the surface mount resistor and capacitor near two plated through holes in the board. These will be towards the right edge with nothing between them and the far side of the board. They will be near one of the holed for VCO board shield mounting. The cap is marked 102 and the resistor marked 472. They share a

common connection. This line is the "Synth Band 1" line from the micro. The resistor is the current limiter for the transistor this line drives. It is high for talk around VCO and low for repeater input VCO. We will be pulling this line low to make the radio lock at 902-903MHz. We can do this without damage to the micro since this resistor is in the circuit. Carefully solder a length of small, insulated wire to the right hand side of the resistor (the trace leading to the cap and the plated through hole).

8.1 Run the wire through the hole you drilled in the chassis and reinstall the VCO board. Do not let the wire loop up or collect under the VCO board. Gently pull it as you place the board.

9.1 On the Logic side of the chassis, run the wire around the 7805's heat sink boss and out the cutout in the chassis for the PA connections. Reinstall the Logic board, keeping this wire out of trouble under the circuit board.

10.1 With the Logic board side up, and the front of the chassis towards you, locate TR716 on the Logic board, near the back of the radio. There are two identical transistors in front/back of each the other. TR716 is the one farthest to the back. They have 3 leads on the right side, and one larger one on the left. Bring your wire up and around the back of the board and solder it to the center pin on the right side. This is "Output 1" that you will use to control the VCO. (Editors note: the large lead on the left is internally connected to the center pin on the right, which is the collector of the "Output 1" transistor.)

11.1 Locate J703 and consider cutting the traces that lead to pins 3 and 4. "Output 1" appears on pin 22 of the 37 pin connector. By cutting the traces, you ensure that nothing will be connected and damage the modified circuit.

This is NOT mandatory, but suggested, as the voltages you might apply accidentally on this pin externally could blow things up in the future... Cutting the pin loose will prevent the possibility.

12.1 Reinstall the shields and covers. Reinstall the PA deck.

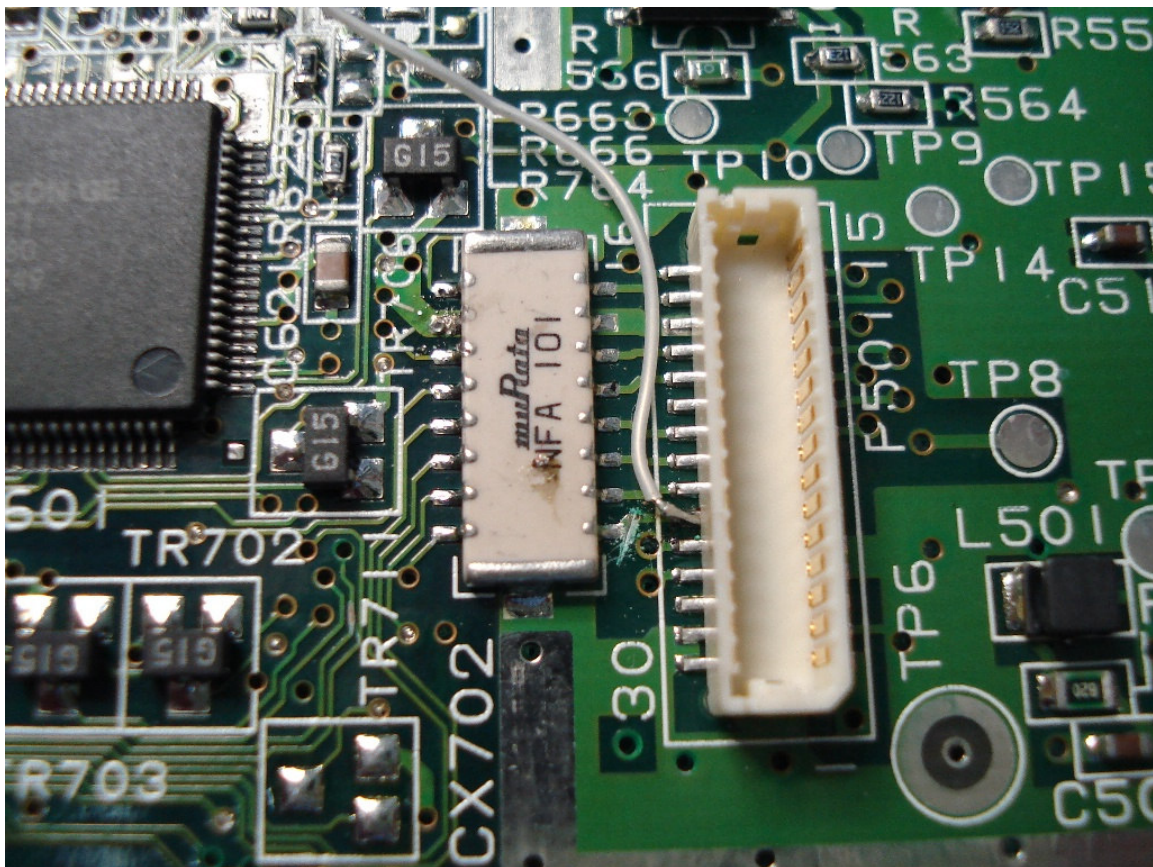
Next are changes to instructions to modify using the alternate Option 2

5.2

You will need a 1.2k or so 1/8 or 1/4 watt resistor. A very sharp X-acto knife. A magnifier lens of some form, a steady hand, and a piece of small gauge Teflon wire that will have to pass under the board. I use Teflon wire wrap wire. Lastly a fine tip soldering pencil... 1mm or so.

6.2

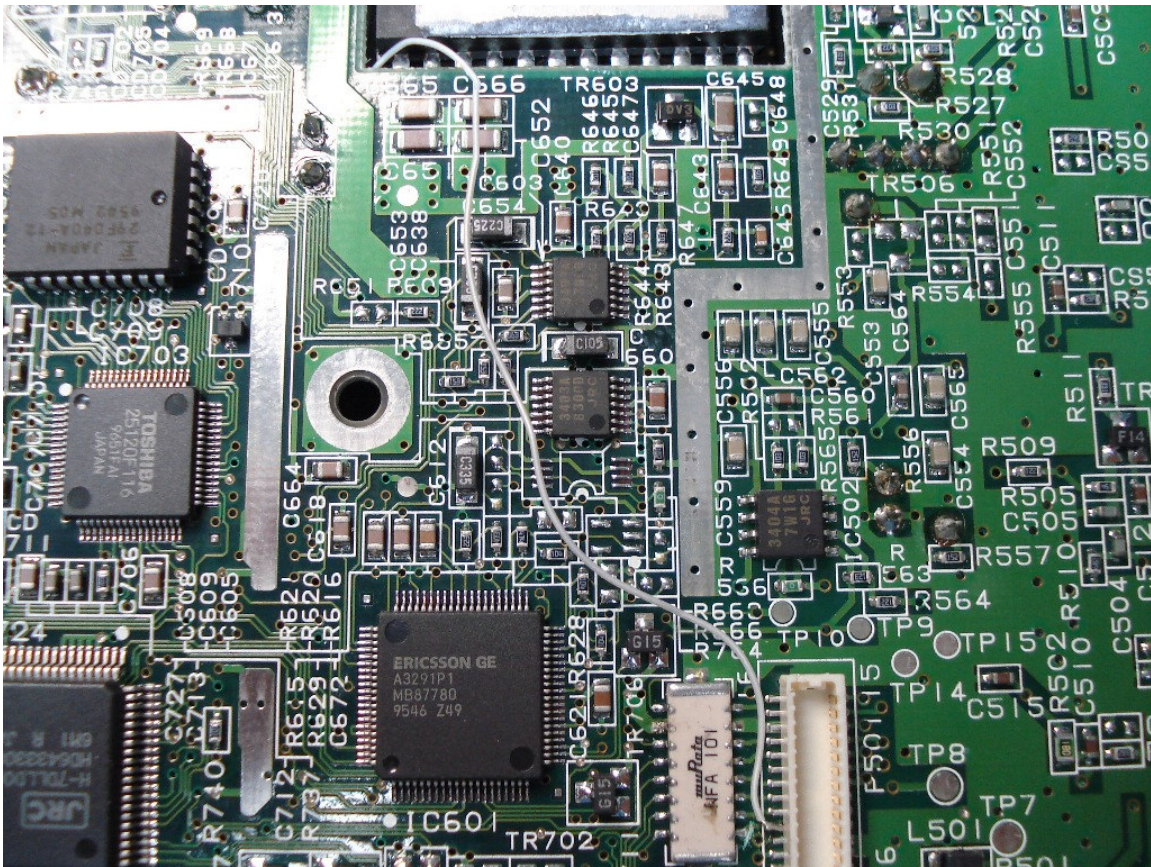
The foil cut is on the MCU Logic Board in between the CX702 device and P501. The foil is connected to P501 pin 25 and the corner pin of CX702 on the bottom solder side of the logic board. If it looks too tight to for you to work... STOP! Go back to modification Option 1. This is the hardest part so if you can do it the rest is down hill. Assuming you cut this and only this, you have just disconnected the CPU from the band select lead.



The foil cut and solder connection at P501 pin 25

7.2

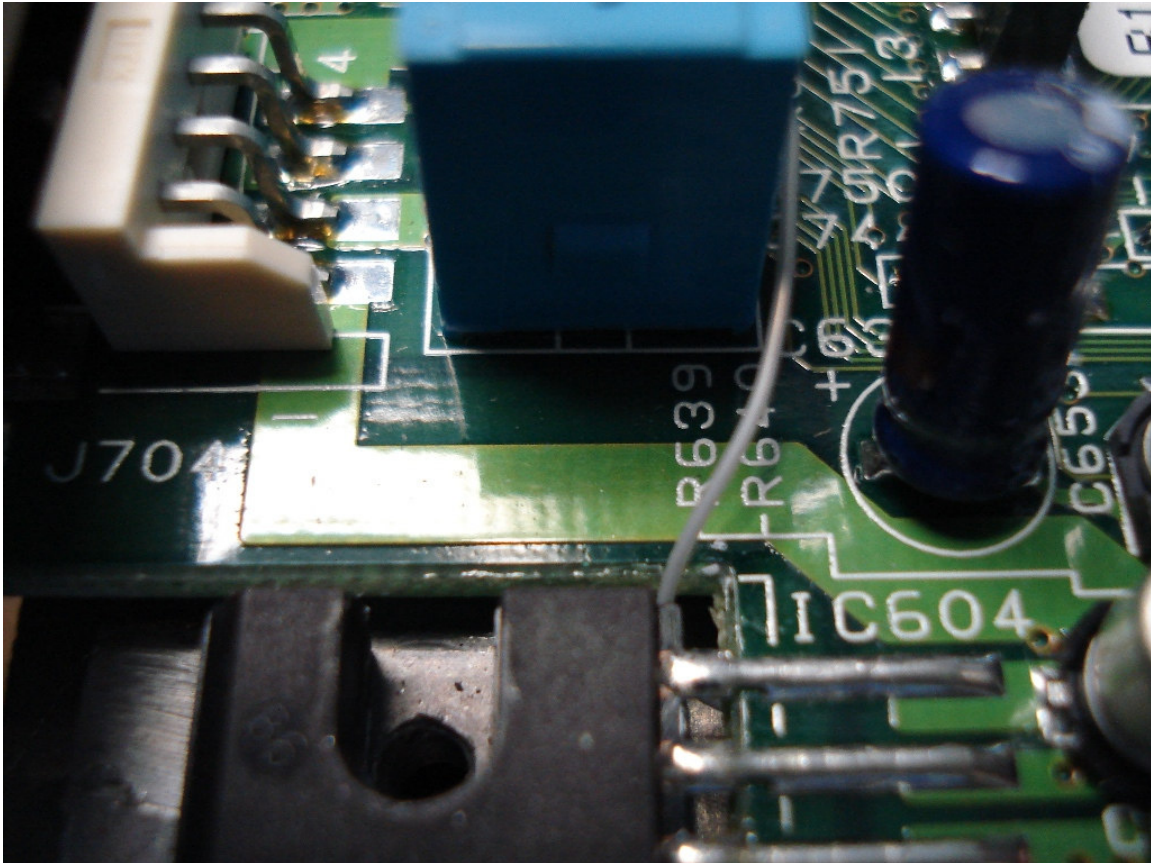
Next you will need to solder the teeny tiny wire wrap wire to P501 pin 25 on the bottom side of the logic board. Make sure not to connect to the CX702 side... it is close space but just be careful. Carefully route the wire against the bottom side of the logic board so it will pass next to CX702 in the shield cutouts of the Orion chassis frame which sits directly under the area we are working when you re-assemble the unit. Route it back to where the Audio PA hybrid mounts and pass it up to the top side of the board in the corner of the PCB cutout for the audio hybrid. Be aware of the shield boss's which the board sits on and make sure you do not put the wire in harms way. There is plenty of space assuming using something small like 30 gauge.



Wire routing on bottom of Logic board avoiding pinch points where ground boss's will touch the board.

8.2

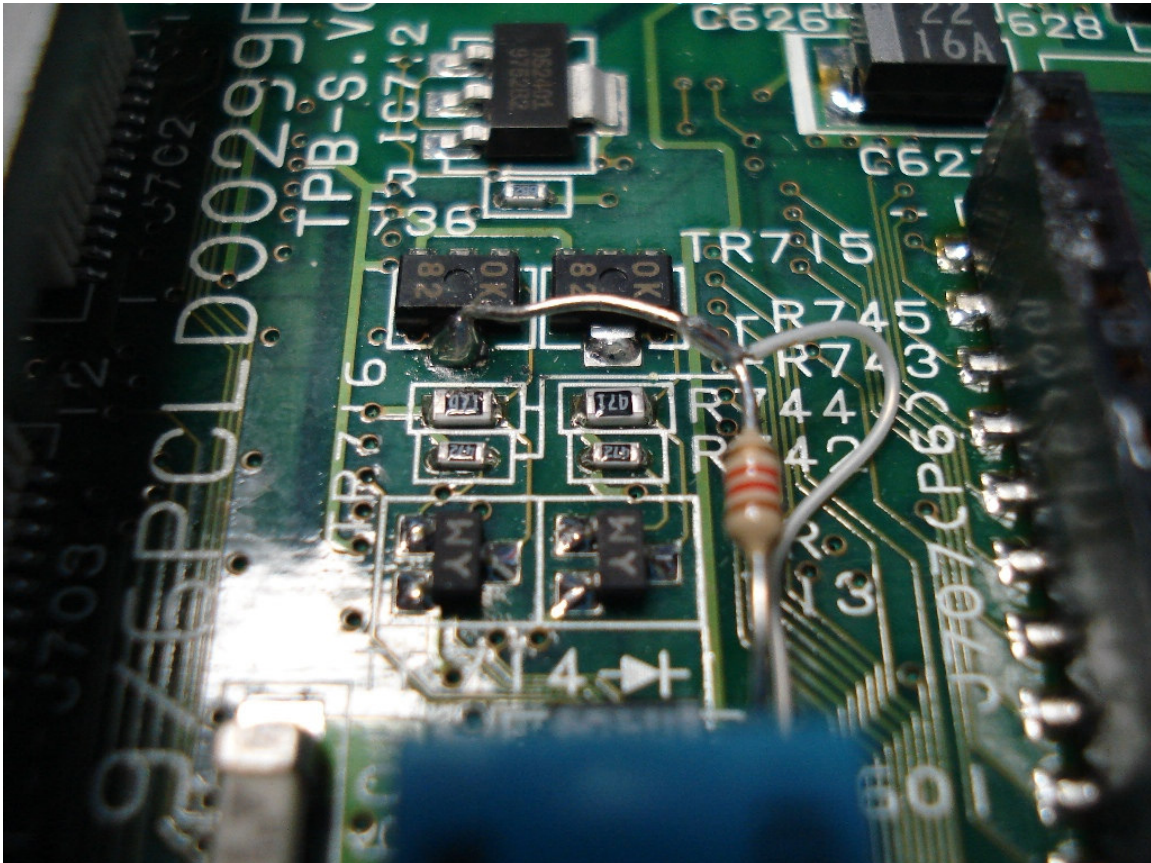
Set the board upright with the wire routed how it will be in the final re-assembly. And drape it over the top for now. We should now be looking at the top component side of the board. We now will solder the 1.2k resistor flying lead style from the collector of TR716 to the anode of diode CD601. See the pictures and the LBI diagrams for the Logic Board to sort this out.



Routing Wire up through the open space of the cutout around the Audio Amp IC.

9.2

Lastly solder the wire from P501-25 to the end of the 1.2k resistor which connects to the Collector of TR716.



Wire connection topside of board to resistor connection on TR716 side. The resistor is soldered to collector tab on TR716 and cathode of CD601R which is switched 9v.

RADIO PROGRAMMING:

(No, not out of band. You already did that on your own)

This is to enable the hardware button functionality that we just wired together..

Conceptually, we are using the Output 1 driver transistor to manage the Band Select lead when we toggle between RPT TX on 902/903 and T/A TX when we are on Simplex of the high side. These steps will set that up.

1. Under "Control Unit Keypads" select the control unit your radio has an assign one button to "MAC1" (macro 1). You will use a macro to select "Talkaround" and toggle the VCO.

2. Under "Macro Keys" select "macro 1" and "press". In the box next to the number one select "Talk" and "Press & Release". This selects the talk around mode. In the box next to the number two select "AUX1" and "Press & Release". This will toggle the output line we use to control the VCO.

3.1 For Option 1 use THIS setting.

Under "External IO" in the area that relates to AUX 1 select "Follow WHC Icon", "Aux 1 output = 1", "Aux 1 active = **HIGH**", and finally check the "aux 1 repeat" box.

3.2 For Option 2 use THIS Setting

Under "External IO" in the area that relates to AUX 1 select "Follow WHC Icon", "Aux 1 output = 1", "Aux 1 active = **LOW**", and finally check the "aux 1 repeat" box.

4. Save and Program the radio with this information.

This completes the radio programming for the VCO control.

RADIO OPERATION:

When you press the key you assigned to "macro 1" you will hear two beeps. The first one is the radio going into "Talkaround"; the second is the output changing state. Press it again to go back to repeater mode and ground the VCO control line we added. This function toggles on and off with each press of the button and latches until reset.

See how easy. Not bad for a couple hours of work.

73 de K6ZRX and/or KD8B