FLUX RESEARCH

Technical Service Bulletin: FXR-13

Modifying Motorola Maxtrac VHF 136 – 174 MHz for Amateur Radio Applications in the 222 – 225 MHz Band

A FluX Research project in several phases

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Radio Model #:
Motorola Maxtrac 100
Motorola Maxtrac 300

Warning:

Please be aware that this document is currently a work in progress which may contain several omissions and or typographical errors, continue reading at your own risk.

Background:

This document expands on the original work done by Glenn Hochwalt, Jr., W8AK to convert the VHF Maxtrac into the 222 MHz band. Special thanks to Jeff Ackerman, KG6UYZ for providing the radios for experimentation.

Phase 0: Preparations

Make sure the radio to be converted is in good working order on its original frequencies before attempting conversion to 222 MHz Amateur Radio use.

Phase 1: Operating Frequency Reprogramming

I recommend Maxtrac Lab RSS R07.02.00A be used. Earlier versions were found to work fine with some versions of the Maxtrac, but would not read others.

Programming the radio is as normal how ever when entering the frequency it is necessary to enter the numbers with the shift key held down and all digit places must be entered. Example: 223.5 MHZ is entered as @@#.%))))

Phase 2: VCO

Remove the RF board from the chassis of the radio using a Torx T-10 driver.

It will be necessary to use a high heat broad tip such as a Weller 800 degree PTC to remove the coils and their housings from the board. This is best accomplished by melting the solder joints and slowly rocking the entire coil out of the board. Hole clean up is best done with the aid of a stainless steel dental pick, solder wick and solder sucker.

Remove L213, TX VCO Adjustable Coil (Yellow), and set it aside.

Remove L202, RX VCO Adjustable Coil (Orange), and install in L213 position.

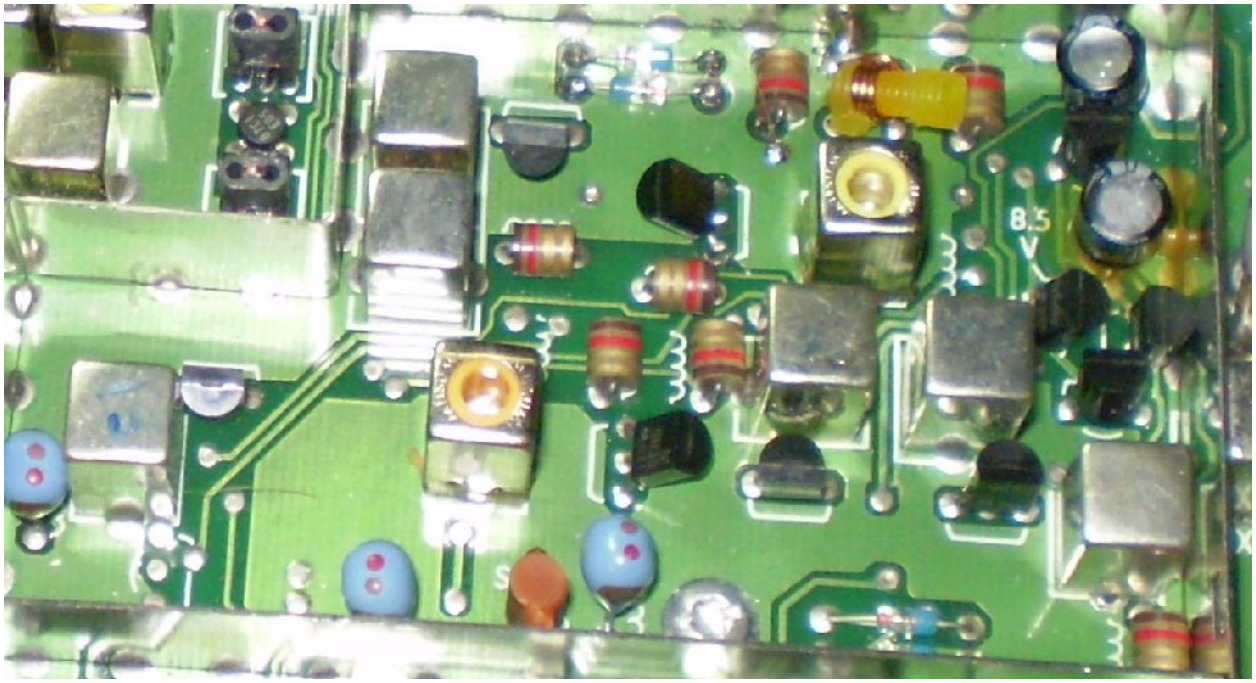
Remove L215, TX VCO Fixed Coil (Yellow), and set it aside.

Remove L204, RX VCO Fixed Coil (Orange) and install in L215 position.

Remove approximately 3 turns from the top of original L215 (Yellow), so that it has 2 ½ turns total. Cut the plastic with small flush cut diagonal pillars to release the wire. Bring the remaining lead down the side of the coil and trim to the same length as the opposite lead. Strip the enamel off of the new lead and tin with solder. Install modified L215 in L204 position.

Modify original L213. Extract plastic housing from metal shield. Disengage metal tabs by sliding a X-acto knife or small jewelers screw driver in between metal and plastic on underside of coil. Push coil out of shield by pressing center hole against a step drill bit. On the side of the coil with the most wires apply solder and short the top 3 turns together, be careful not to melt the plastic too much. Apply solder to the top 2 turns on all the other sides. Take care that the solder does not extend from the plastic too much so it will not short against the shield, if necessary reheat or file the solder down. Replace shield and install modified L213 at L202 position.

Remove L221 from board. Remove 3 turns from the top and bring the remaining lead down the side of the coil and trim to the same length as the opposite lead. Strip the enamel off of the new lead and tin with solder. Replace L221 in its original position.



Modified VCO section

Replace RF board into radio for testing purposes.

If desired a PLL unlock LED may be added to the board, take a red LED and solder a 330 ohm resistor on the anode. Slide the lead of the resistor into J6, Pin 5 and the cathode of the LED into J6, pin 11.

Test RX VCO by coupling signal in to a spectrum analyzer or frequency counter. Use a loop of wire or an antenna connected to the input of the test equipment. Connect a volt meter to “SV” test point. Tune the coil at the L202 position (Yellow) with a non metallic tool until stable on frequency LO is observed (RX frequency + 45.1 MHz). A stable voltage on “SV” should be approximately 7.8V.

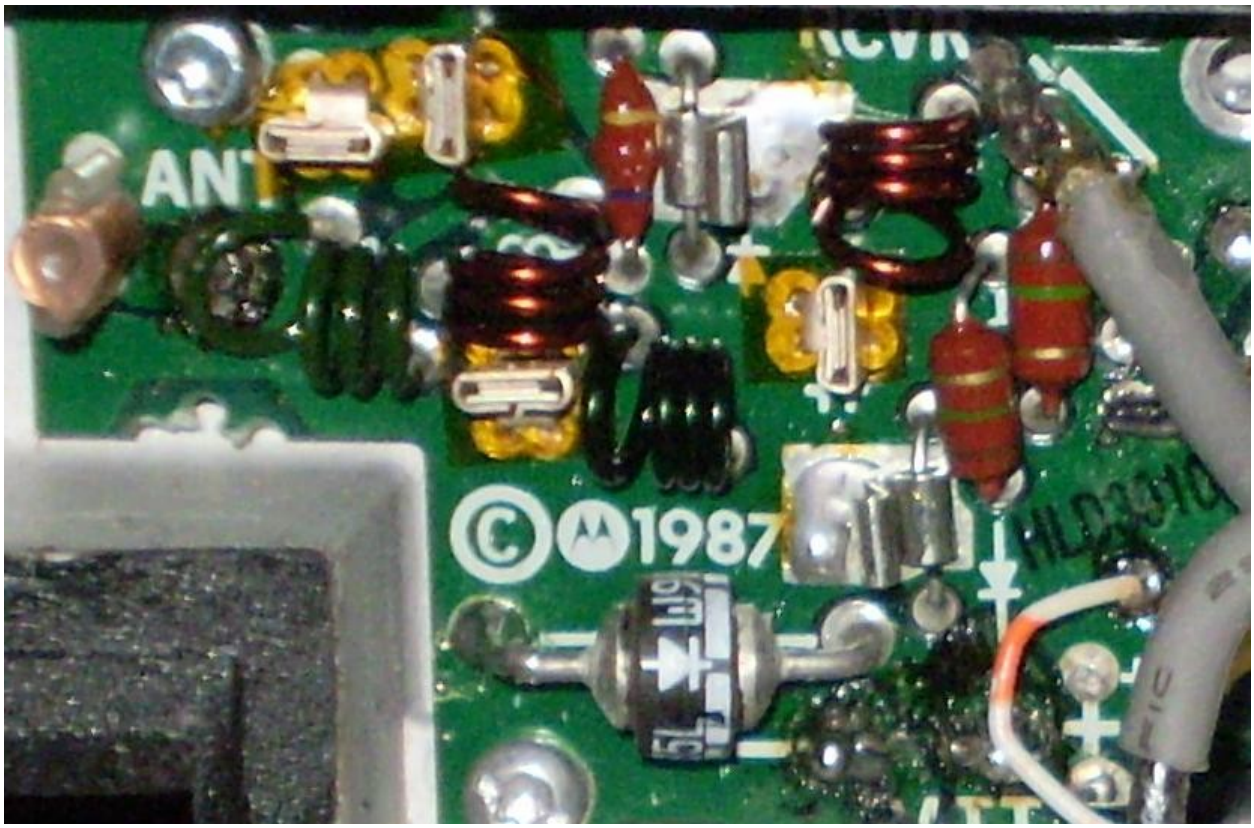
Some additional tuning range can be achieved by bending the coil at L215 on its side.

Take a 47 ohm resistor and bend one lead so both leads are on one end. Trim leads so center the center one comes out approx 3/16” and the side one is flush with the end of the body. Insert modified resistor into the TX VCO jack on the RF board.

PTT the radio and tune TX VCO by coupling signal in to a spectrum analyzer or frequency counter. Use a loop of wire or an antenna connected to the input of the test equipment. Connect a volt meter to “SV” test point. Tune the coil at the L213 position (Orange) with a non metallic tool until stable on frequency signal is observed. A stable voltage on “SV” should be approximately 7.8V. Remove resistor from connector when testing is completed.

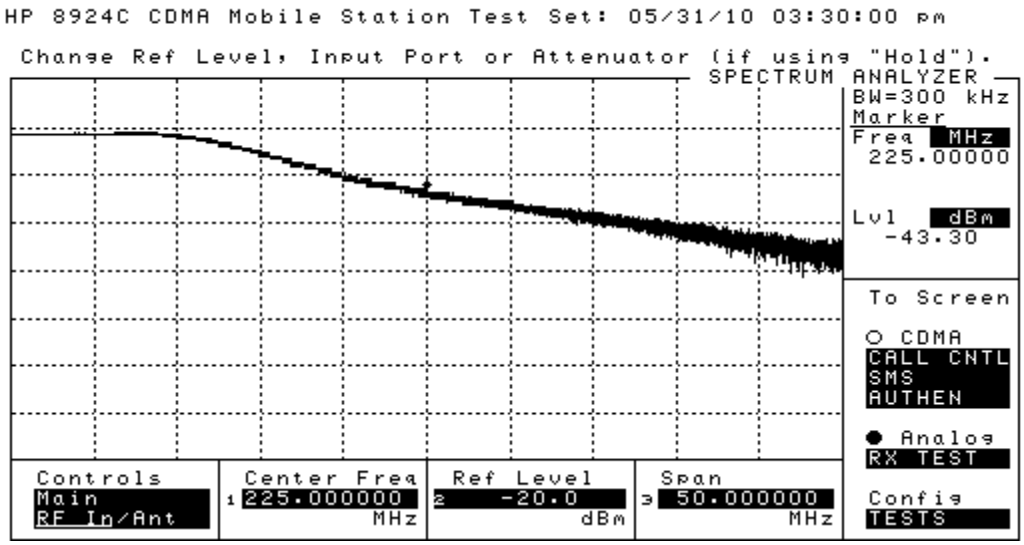
Phase 3: Low Pass Filter

The original Low Pass Filter is designed for a corner frequency of Approximately 205 MHz. Bend a turn off the end of each of the LPF coils (L2x62, L2x61, L2x60 and L2x51) and lay the turn approximately 45 degrees away from the rest of the coil. L2x62 should be nearly flat with the printed circuit board. This will bring the 3dB corner up to approximately 235 MHz.

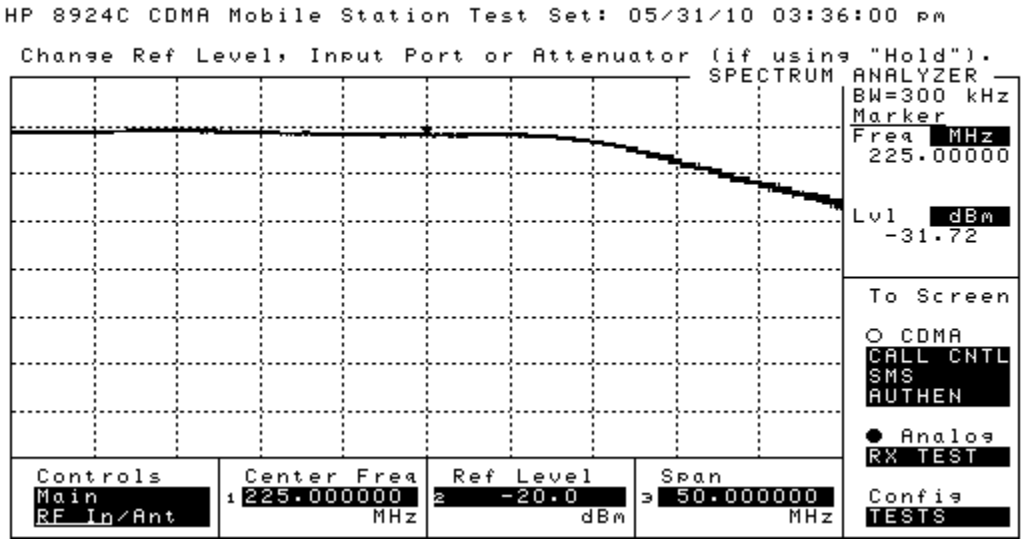


Modified Low Pass Filter (45W VHF Power Amplifier)

The filter can be optimally tuned by connecting a spectrum analyzer to the PA, sweeping into the antenna port and detecting the on the RX cable. A test jig was made by plugging the RX lead into a BNC barrel and soldering a spot of the ground ring to the BNC connector.



Low Pass Filter before modification



Low Pass Filter after modification

Phase 4: Receiver

Remove RF board from chassis again.

One coil at a time, Modify coils L1 - L7. Remove the coil and shielding using the procedure described earlier. On the side with the most wires visible, apply solder

shorting out the top two turns. Reinstall modified coil in board without the shield for initial testing and proceed to modifying next coil.

Reinstall RF board in chassis. Using a on service monitor check receiver sensitivity. Additional turns of coils may be shorted for optimum performance. My receiver came to -110dB for 12dB SINAD without any additional tuning. If satisfactory reinstall metal shields on coils.

Phase 5a: 2W VHF Power Amplifier

The 2W VHF PA should make the rated 2 watts of power at 222 MHz without any modifications. Some additional tweaking of L2362, L2361 and L2360 may be done until maximum power output is achieved as observed on a watt meter.

Phase 5b: 25W VHF Power Amplifier

See Phase 5c.

Phase 5c: 45W VHF Power Amplifier

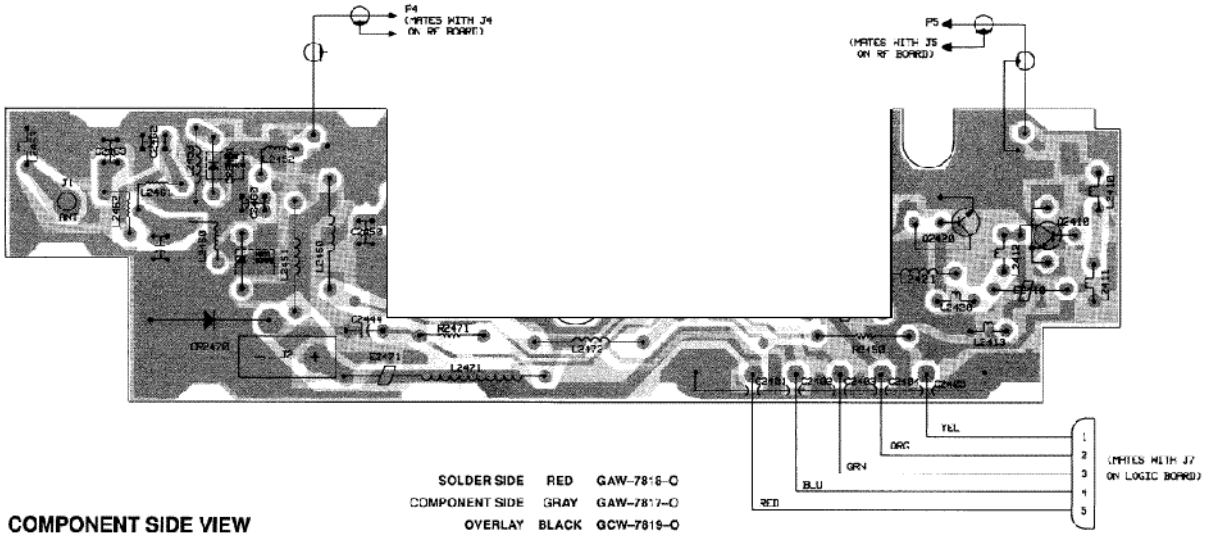
Remove the PA board from the heat sink. Desolder the power connector by unscrewing it from the heat sink, heat both pins and slowly rock it out of the board. Remove all Torx screws and the nut on the rear holding Q2430. Desolder the antenna jack and pull the board from the housing.

The 45W VHF PA would not cooperate on 222 MHz. It is believed the final transistor is not designed for operation above 175 MHz. It was determined the best course of action is to cut a section of the printed circuit board and install a power brick.

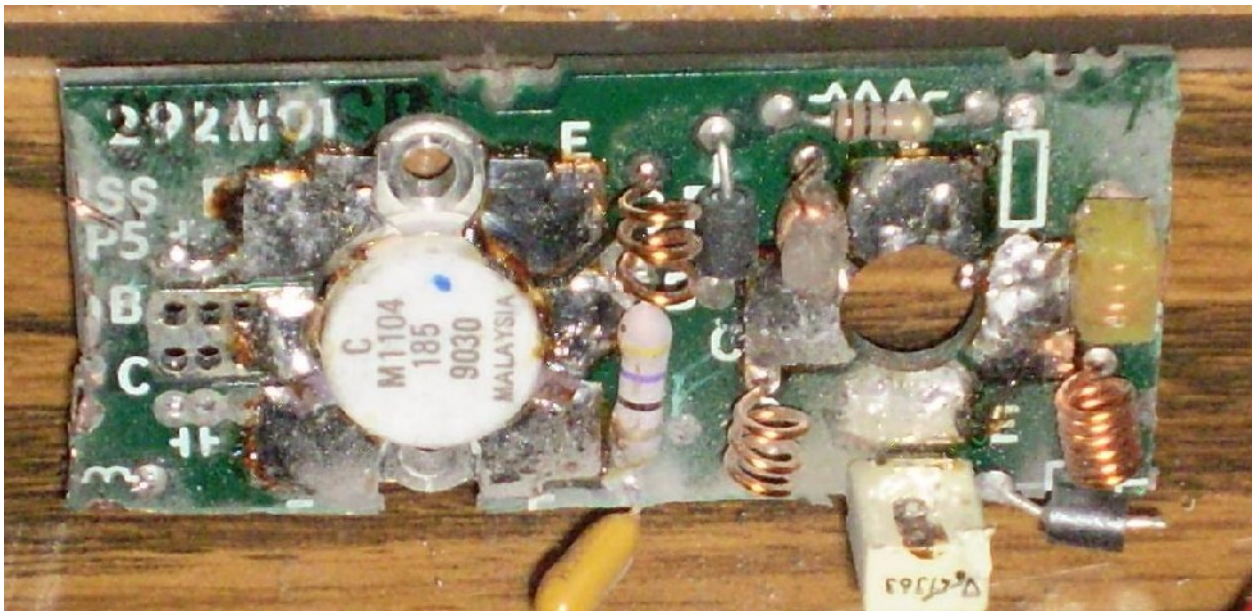
Module Part Number	Power Input	Power Output
M57774	300mW	30W (Class C)
M67712	200mW	30W (Class AB)
M68729	300mW	30W (Class C)
RA30H2127M *	50mW	30W (MOSFET)
SAV15	200mW	30W (Class C)
SAV40	50mW	30W (MOSFET)

Depending on the power module you have available will determine how much of the PA board is cut away. I used the M67712 which is easily obtainable from old 220-222 MHz ACSSB and Linear Modulation Radios. Because this module needs 200mW (+23dBm) of drive we need the first amplifier stage of the PA.

Remove Q2450, L2421 and cut the board like this:



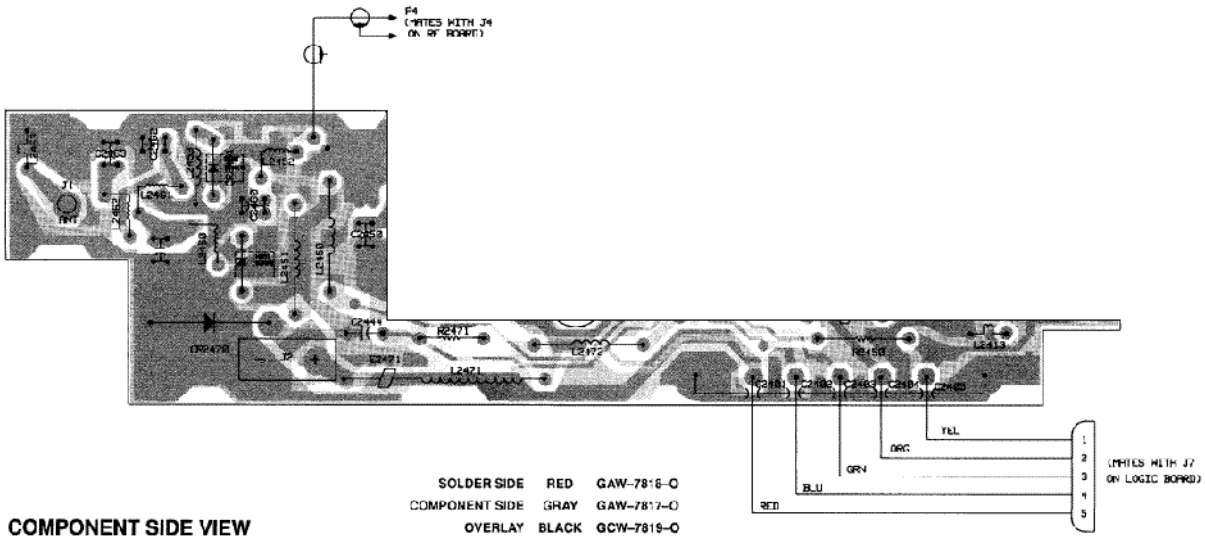
A Dremel tool with heavy duty cut off wheels is the recommended armament.



Removed portion of VHF 45W Amplifier

Salvage 3 Ferrite beads from the cut board and surrounding areas and solder them to the DC input leads of the power module. 1st VCC voltage is obtained from the Controlled B+ line, 2nd VCC is at the C2444, R2471 junction and Vbias is from 9.6T through a single 1N4004 diode to drop the voltage to 9V.

When using a 50mW input power amplifier such as the RA30H2127M the first stage is not required and may be eliminated. So cut the board like this:



Salvage 2 Ferrite beads from the cut board and solder them to the DC input leads of the power module. VCC voltage is obtained from the C2444, R2471 junction, and Vgate is from 9.6T through a 100 ohm resistor into a 1N4733 5.1V zener diode to ground diode to drop the voltage on Vgate to 5V. A 7805 may also be used instead.

Some traces were cut through so those will need to be patched with wires. Patch the Current Sense Lo line between C2444, R2471 junction and C2402, and patch 9.6T for the PIN diodes between R2450 and R2452.

The heat sink must be machined flat to accommodate the new power module. I suggest going to a machine shop for this. I used a Dremel tool with a high speed cutting bit to flatten the mounting stud for Q2430. * Note: If using the RA30H2127M, the power module should be machined flat as the surface will not conduct heat well enough, nor does it have good contact with ground.

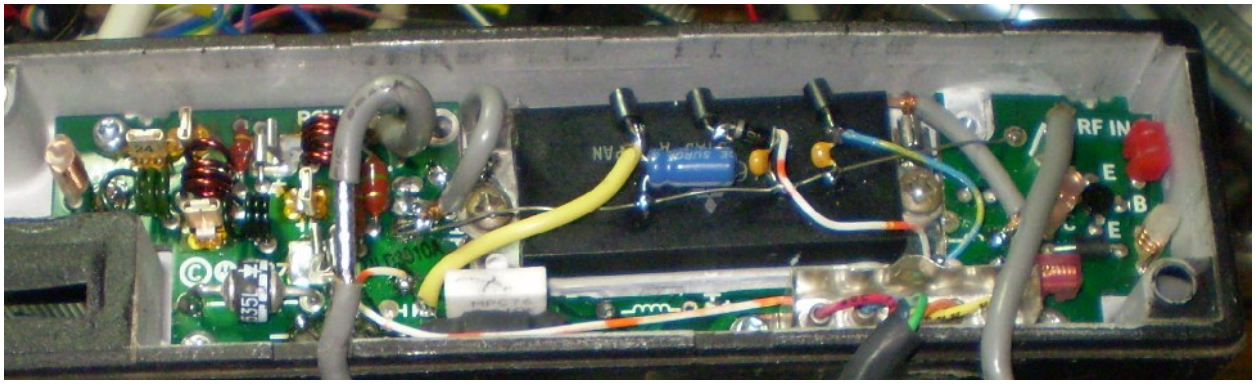
Drill 2 holes and tap for 6-32 screws for securing of the module to the heat sink. I installed the M67712 with the leads facing the side wall of the heat sink to accommodate shorter coax and power leads; you may desire to orient your module the other way.

Remove C2450 and install a short run of RG-174 mini coax to the RF output of the power module. Install a spade lug on the module end of the coax ground to attach to the screw holding the module in place.

Remove L2420 and Install a mini coax from the power input of the module to the C2421 and C2420 junction. If using RA30H2127M salvage the original RF input coax from the cut piece of board and install it on the power input of the module. Install a spade lug on the module end of the coax ground to attach to the screw holding the module in place.

Apply a fresh coating of thermal compound to the heat sink and screw the module in place as well as the PA board.

A ground wire is soldered over the power module to connect bypass capacitors to. This should probably be made from coax braid to improve ground impedance, but I used a 24ga wire as it was handy. For capacitors I used 0.1uF on both Vbias and 1st VCC, and a 10uF 25V on 2nd VCC.



Some additional tweaking of L2462, L2461 and L2460 may be done until maximum power output is achieved as observed on a watt meter.

Phase 5d: 2W VHF Power Amplifier to 30W Modification.

Cut the board and modify the amplifier in similar fashion to Phase 5c. Replace R2371 with a 0.01 Ohm 2W resistor. The junction or R2371 and C2378 will provide either VCC or 2nd VCC depending on the power module chosen.

Photographs by: Matt Krick, K3MK