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The ProgRock 2 in the TRC-77

The following modification was developed using the TRC-77 "A" models. I do not have any experience applying this modification to "non-A" models of TRC-77.

DANGER! There is high voltage present within the TRC-77 Transmitter-Receiver.

Please be aware that this project is experimental. I have yet to perfect this but can say that it does work and it is a whole lot cheaper than crystals. In fact, by the time you read this, crystals at any cost may not be an option.

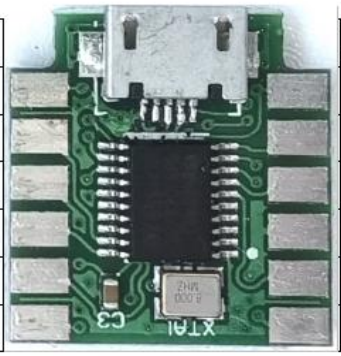
Synthesizers such as the ProgRock generate square waves that must be filtered externally in most applications. This is true of any device using the SI5351 or similar synthesizer. In this project, I chose not to use a low pass filter at the output of the ProgRock so that I could generate the signals needed for 80 and 40 meters without the need to switch filters. My assumption was that the narrow band-pass filtering at the output of the oscillators in the TRC-77 would eliminate the need for this.

The transmitter output was checked with a spectrum analyzer and it was confirmed that harmonic energy on 80 and 40 meters was at least 30 dB down after modification.

Preparing the ProgRock 2 for Installation

The photo below shows the pinout of the ProgRock 2. Note that many of the pins are duplicated for convenience.

Bottom	Top
13. USB -	1. USB +
14. SCL	2. SWDIO
15. SDA	3. GND
16. 1 PPS	4. SWCLK
17. +3V3	5. BANK 2
18. GND	6. V+



Top	Bottom
12. V+	24. CLK 2
11.BANK 2	23. CLK 1
10.BANK 1	22. RXD
9. GND	21. TXD
8. BANK 0	20. GND
7. CLK 0	19. GND

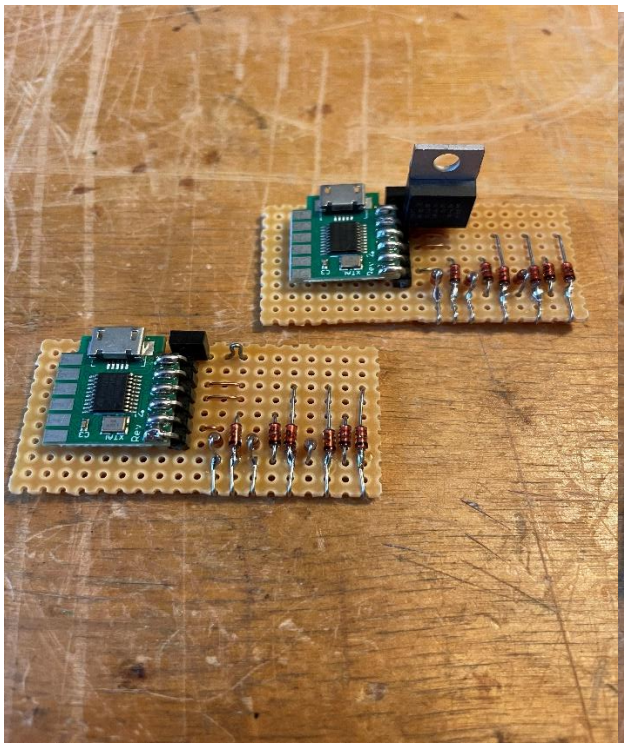
In our case, we will use the top row of terminals (7-12) on the right side. The addition of a single-row right angle header soldered to this row of terminals allows us to mount this to a piece of perforated board. We simply need to supply a 3.5 – 12 volt source with ground and extract our signal from the CLK0 port. I chose to use 5 volts. I destroyed one ProgRock by connecting directly to 12 volts.

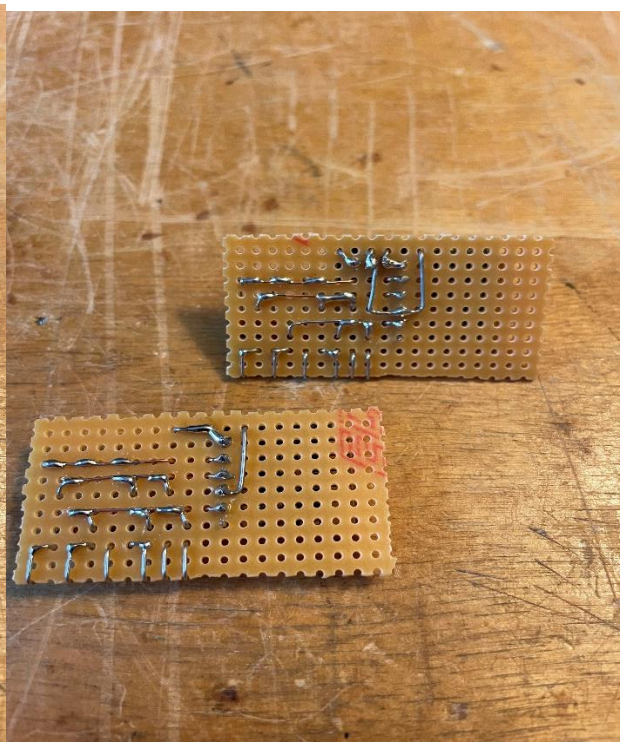
There are limitations as far as output level and load but it is sufficient for our purposes. So far, I have not needed any additional buffering to drive the circuitry in the TRC-77.

You will notice that there are three ports marked BANK 0 – BANK 2. By addressing these ports with different levels (BCD), we can select one of 8 banks (BANKS 0-7) of three pre-programmed frequencies. When all bank select ports are left floating, bank 0 is selected. I chose to wire the diode matrix to select banks 1-6. I found that it is easier to remember when programming. Otherwise it would be: bank0 = channel 1, bank1 =channel 2, etc.

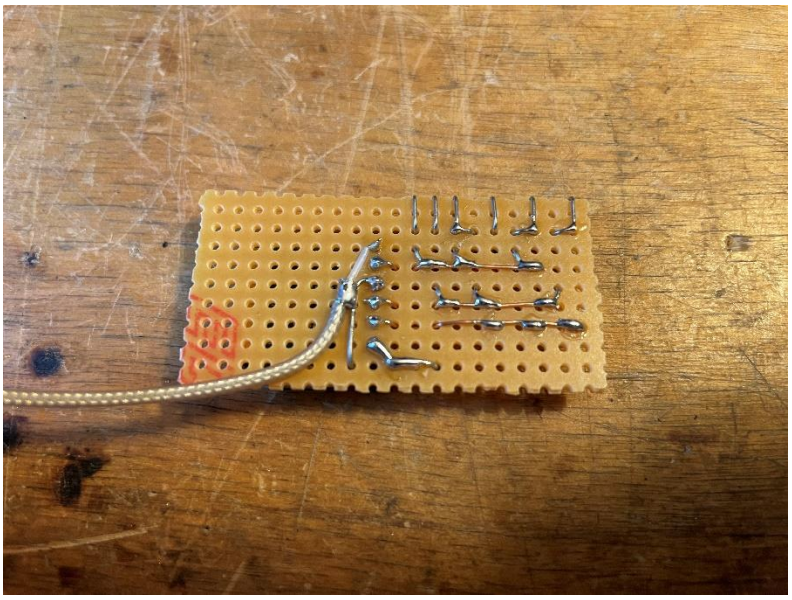
Now that you understand the connections to the Progrock, you will need to build the boards that will contain the Progrock and the diode matrix used to select the channel.

Examples of boards that I built are shown below. One board shows a 5 volt regulator on board. You can do this if you have the room, but it is probably best to remotely mount the 5 volt regulator. Do NOT use the 78L05 version of the regulator. In my experience, it will run excessively hot. I built two identical modules, one for the receiver and one for the transmitter. It may be possible to use one ProgRock to supply injection for both the transmitter and receiver if some additional switching is included. However, this method would introduce a whole new level of complexity and the cost savings is not enough to be worth it.





You will need to install a length of miniature coax to the boards as shown below. Make sure you have at least 6 inches of coax attached to the board. These will be attached to the radio later.



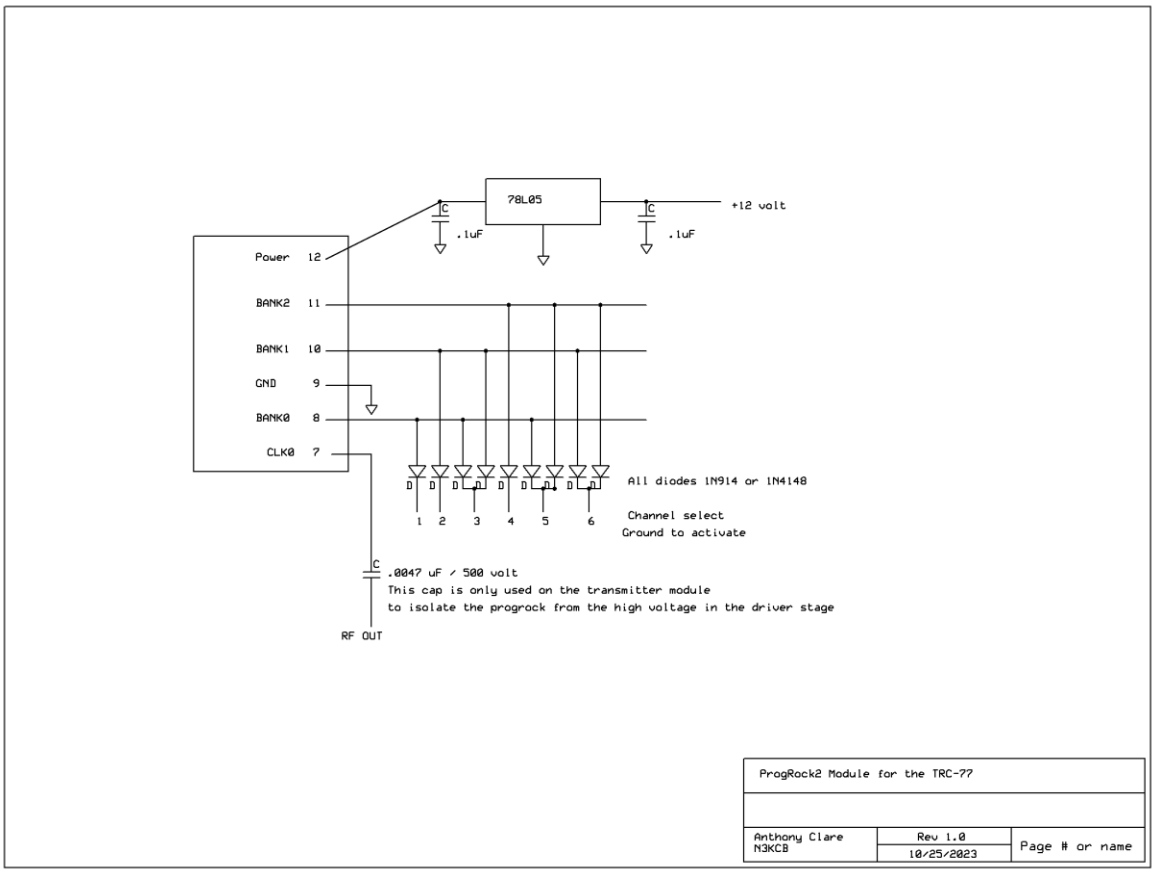
Next, you will need to prepare two 5 volt regulators. Either the 7805 or LM340-T5 in the TO-220 package will work here. I prep the regulators by soldering at least 6 inches of wire to the three terminals. You can color code these however you like but I chose the usual red and black for the 12 volt source and ground along with a white wire for the regulated 5 volt output. Make sure you heat shrink the pins!

The 12 volt input is the leftmost pin, ground in center, and 5 volt output on the right. The tab is at ground potential and should be secured to chassis for heat sinking.

The schematic shows two bypass capacitors at the regulator. One capacitor should be installed at the 5 volt input on the board and the other at the 12 volt input to the regulator where at attaches to the TRC-77. Try to keep the regulator leads as short as possible to avoid any instability. If you choose to mount the regulator to the Progrock board, you can install both capacitors at the regulator terminals.

The schematic for the module is shown here. The resolution should be sufficient to zoom in.

NOTE: The schematic shows a 78L05. DO NOT use the “L” version. It will get hot!



Installation of the ProgRock 2

Before you begin this part, you should have two of the modules assembled. Note that at least one of the modules should have a high voltage capacitor on the RF output. Be sure to use this on the transmitter. I included this to avoid the possibility of high voltage reaching the ProgRock. The voltage at the grid of the driver should not be that high, but an internal tube short could result in electrons rapidly leaking from the ProgRock. I did not use the capacitor on the receiver ProgRock since there was one in circuit that provided coupling.

You will need to find some pins that will fit the crystal sockets. Of course, I removed all of the HC-6 crystal adapters first. I used pins from either surplus FT-243 crystals or the base from an octal tube, whichever is more plentiful. I used short lengths of different colored wire from a chunk of scrap cable. I chose to match the colors present in the transceiver, but you can use whatever is available.

At this point, we should probably discuss how this is going to work. I am basically stealing one wafer on each channel switch to apply ground to the 6 channel select lines on the module. Everything that I have done is completely reversible if you should desire. You will use the salvaged pins to plug into the existing

crystal sockets and simply move one wire from the switch to a chassis grounding point. The pictures below will show where to make the connections.

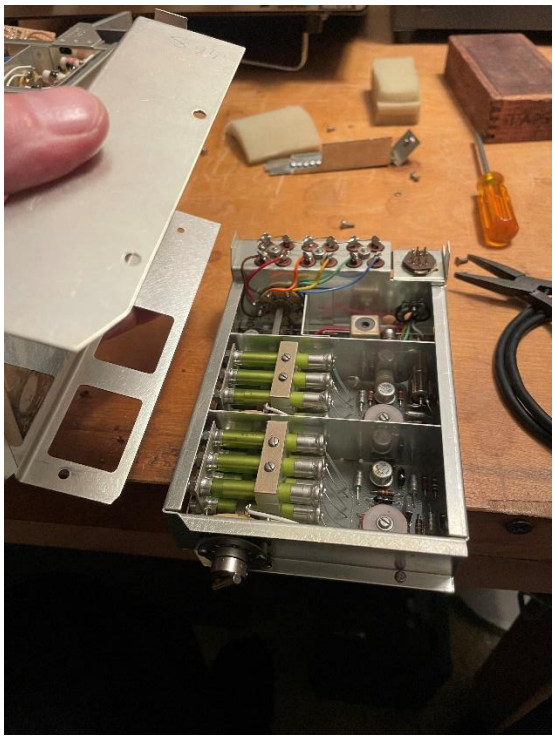
Receiver Installation

Start with the receiver for instant gratification. Hearing signals may give you the motivation to continue.

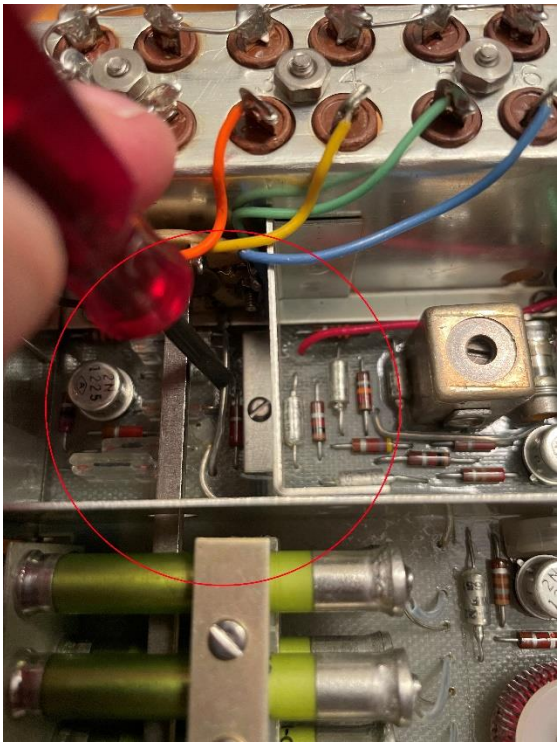
You will need to lift the front-end module out to access the component side. Remove the two screws on each side and the one in the rear to gain access. Don't lose the little Oldham coupler!

Disconnect the plug.

…and now you can remove the cover from the module.

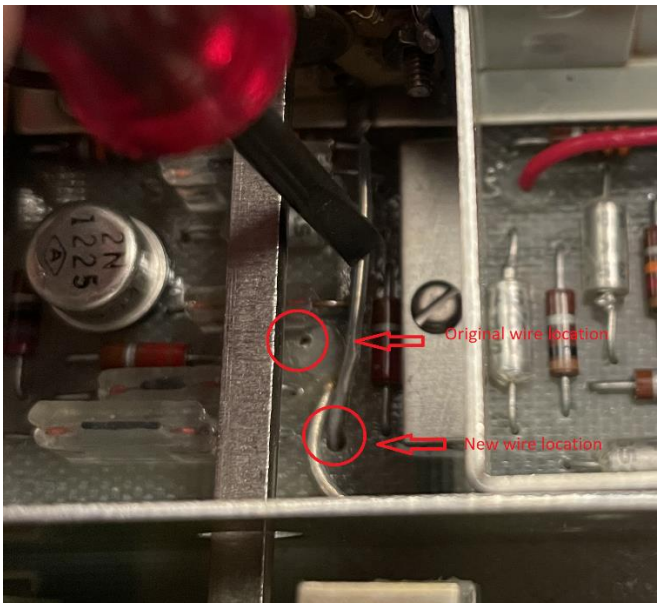


We are going to focus on the area by the rear switch wafer. This is the one that is closest to the crystal sockets. Note the circled area below.

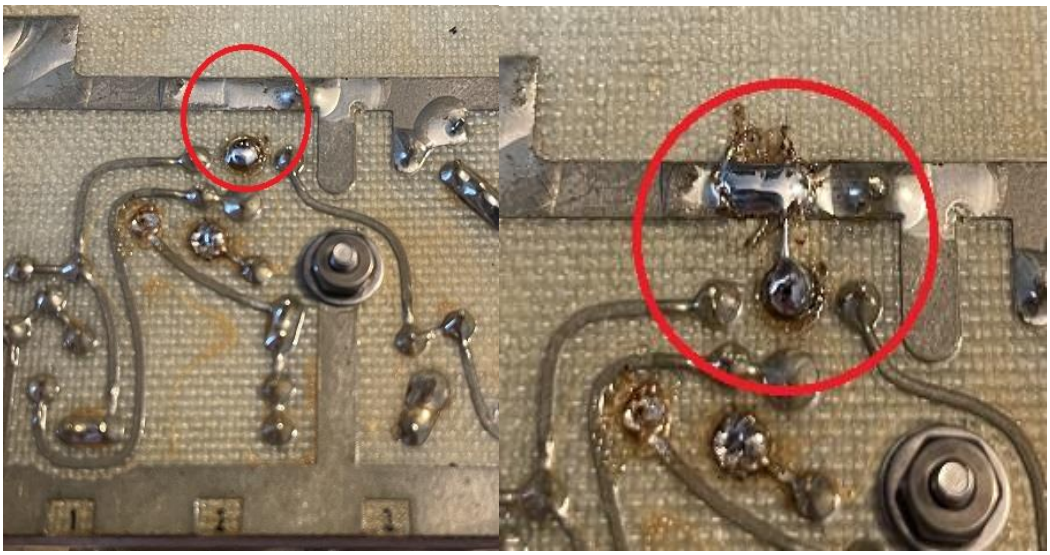


There is a lead running from the common switch terminal to the front end board as shown below. We are going to move this lead from its original location in the receiver LO to a nearby ground.

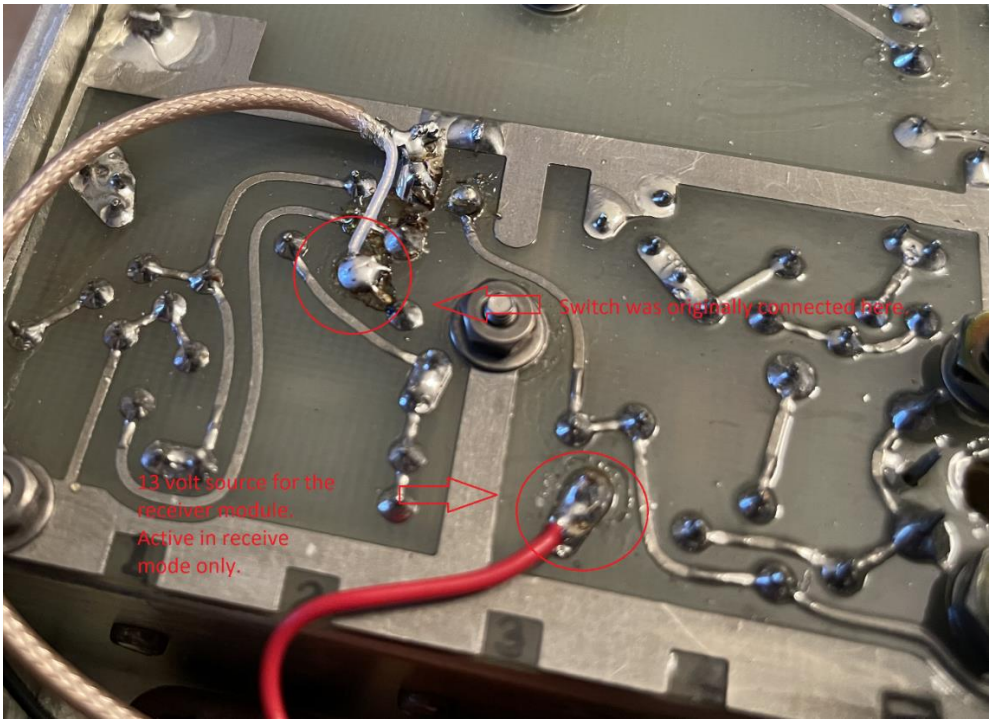
NOTE: On at least one TRC-77 that I have converted, this hole does NOT actually connect to the ground trace. If yours is like this, simply run a jumper to the ground trace from this point on the board.



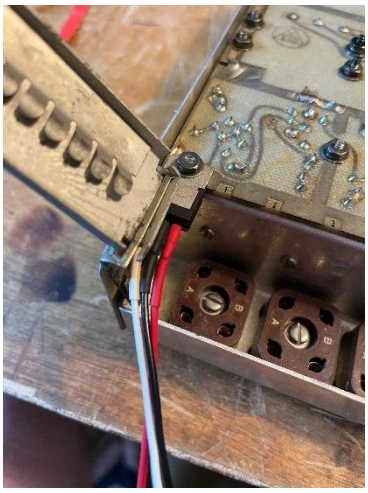
Pictured below is an example of a board without the complete ground trace. Note the jumper added to complete the connection.



On the bottom of the board, you can see the original pad that was used for the switch connection is now used for the signal injection point into the oscillator circuit. The shield of the miniature coaxial cable is connected to the same point that the switch has been grounded to.

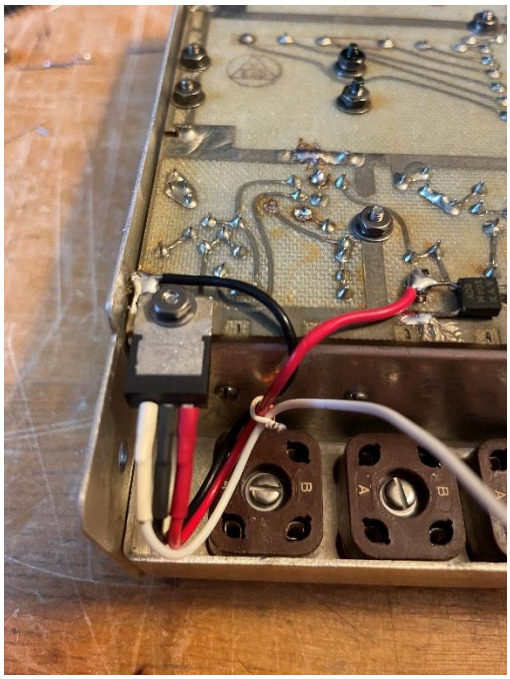


On my receiver, I chose to mount the regulator in the location shown below. The regulator is upside down to give sufficient clearance for the crystal bracket. You will need to do this while the receiver module is out and the hardware is accessible. An alternative location might be one of the screws securing the switch wafer. I avoided this since the wafer and its associated spacers do not look to be very easy to reinstall. This location may also interfere with the pins that will need to plug into the crystal sockets.



Attach the 12 volt input and ground leads to the points shown below. Be sure to install the 0.1 uF capacitor between the 12 volt point and ground as well. Ensure that the wires are dressed up away from the crystal sockets. There should be plenty of clearance underneath the regulator for the wires.

DO NOT flex or bend the regulator leads. They are very easy to break from the body of the regulator.

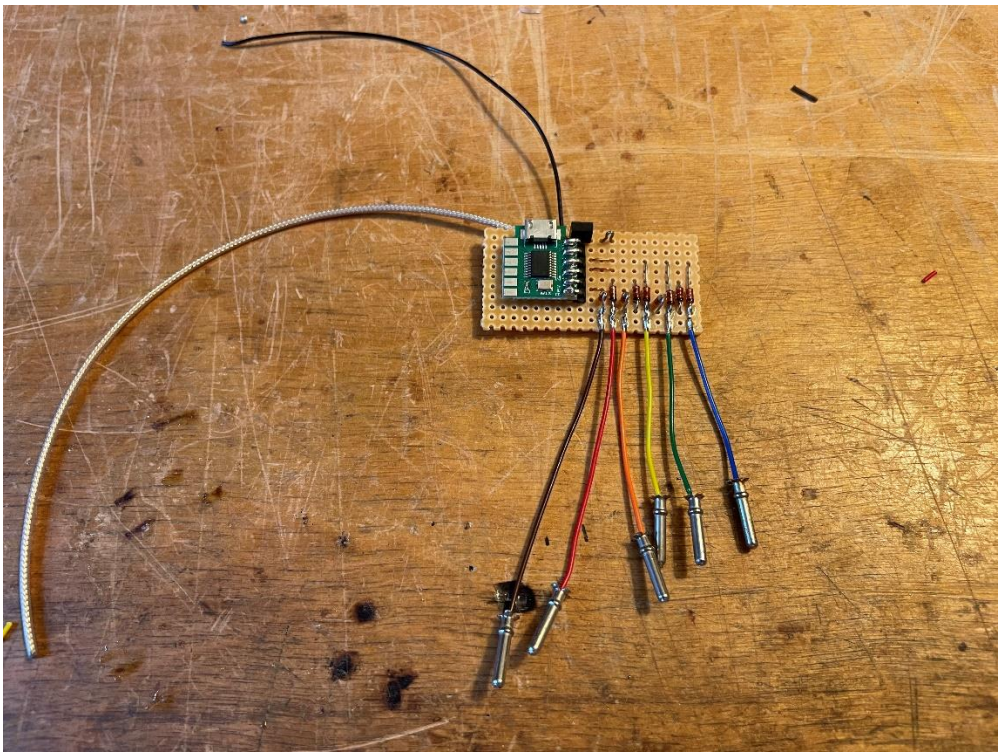


At this point, you can reinstall the front-end module back into the radio. Don't forget to reinstall the little Oldham coupler that you dropped before. You may need to crawl around on the floor to find it. You may need to rotate the knob on the front panel to line up to the switch in the front end module. Just make sure both are full counterclockwise and it should match up. Reinstall any hardware as necessary.

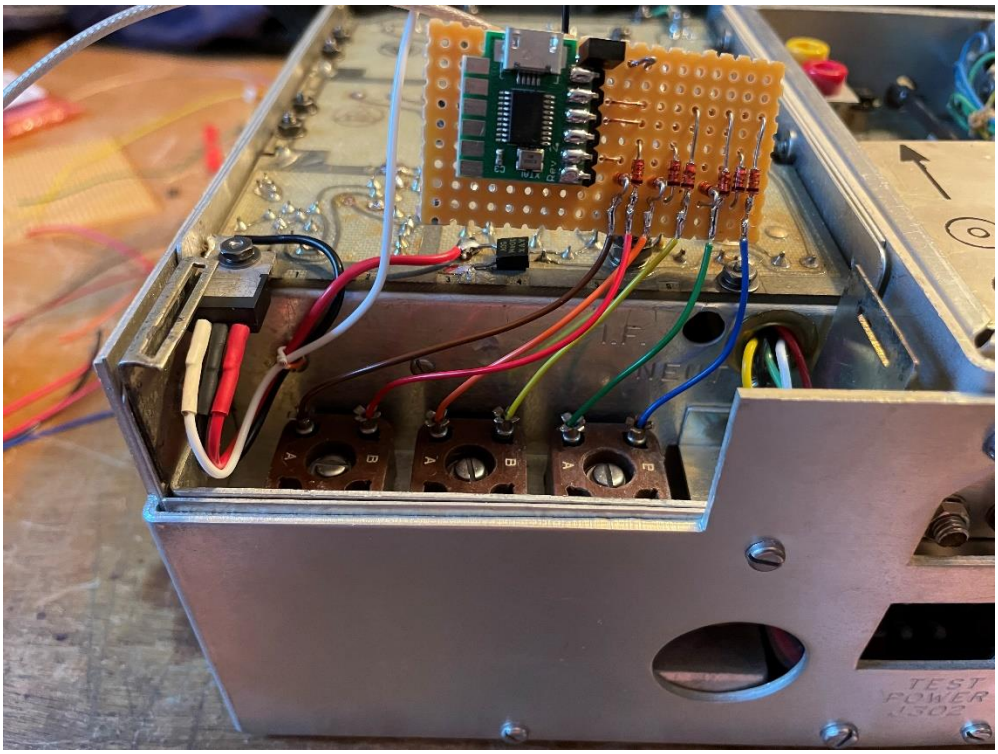
Power for this module is picked up on the front end board close to the RF connection. This is shown in the picture above in line with crystal socket 3. This a 12 volt B+ connection that is only active in receive mode. Once the radio is switched to transmit, this line goes to 0 volts and the receiver ProgRock is disabled.

To make the final connections to the Progrock, you will need some small gauge wire and the pins to fit the crystal sockets. As I mentioned before, you can either salvage these from old FT-243 crystal holders or the base of an octal tube. The wire I used is scrap multiconductor cable of about 24 gauge. I chose to match the colors to that used in the radio, but this is not essential. You can use whatever wire is available as long as it is flexible enough to install without breaking.

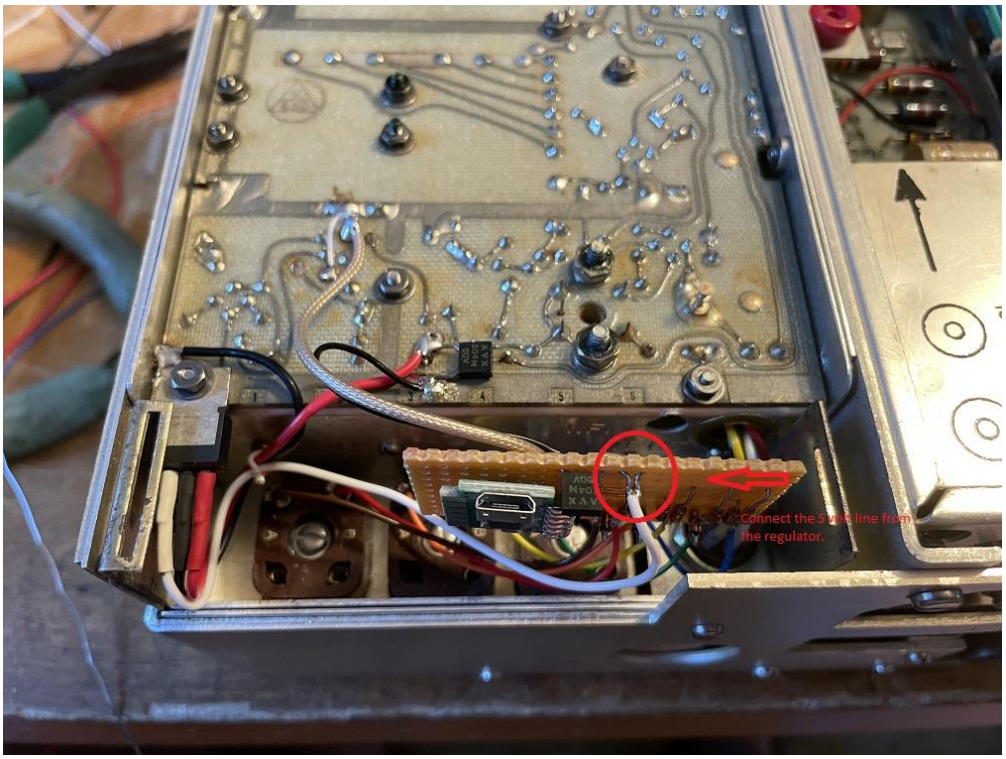
If you place the Progrock in position, you can get a good idea of how much wire you will need. The picture below is a good example of the wire lengths you will need to reach the sockets.



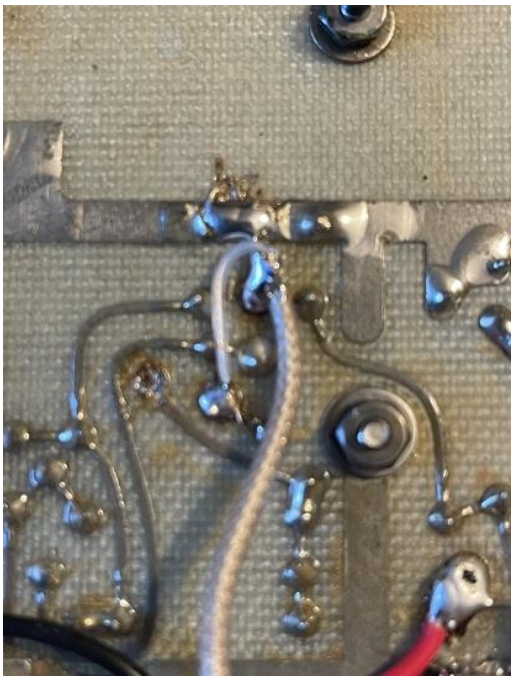
With the Progrock in place, plug in the pins as shown below.



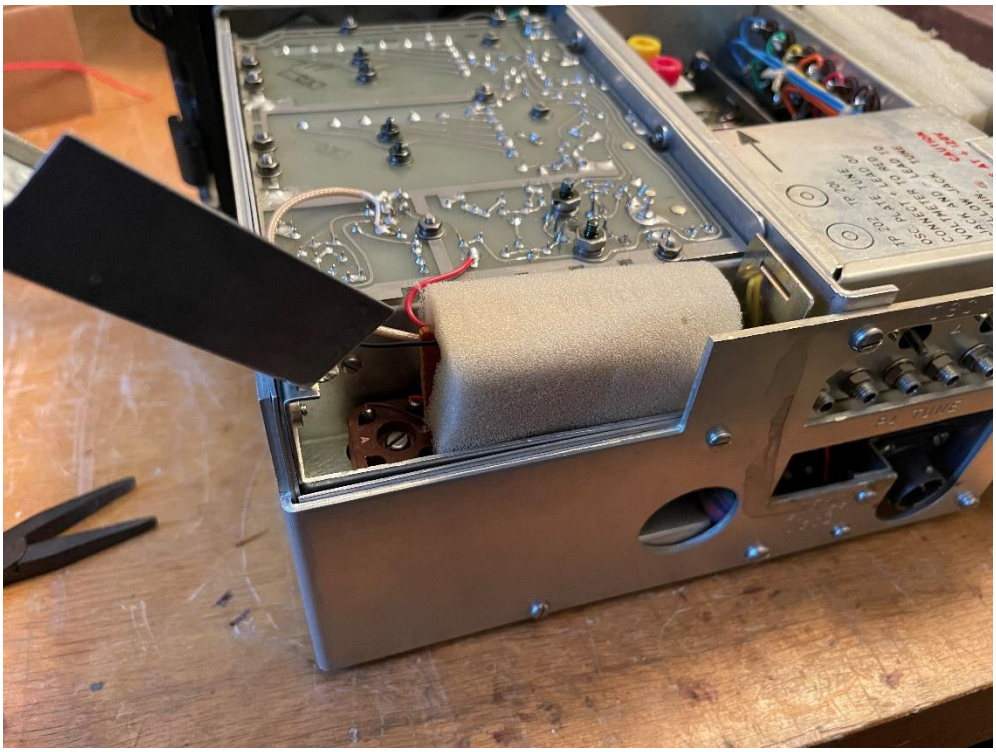
Connect the 5 volt line from the regulator and an additional ground wire from the Progrock ground to the ground trace on the front end board. This is the black wire shown below near the red power lead.



Connect the coax from the Progrock to the point shown below. This is the connection that was used previously by the channel switch. The cable can be grounded to the nearest ground trace.



To secure the module, I wrapped it in a small piece of foam insulation. The stuff I am using is probably not static safe. I recommend using some of the pink foam used to package semiconductors. Better yet, you should probably physically secure the module with real hardware. I did not want to drill any holes and some of the existing hardware was too difficult to access so I took the easy way out. The module weighs next to nothing so the foam method works just fine.



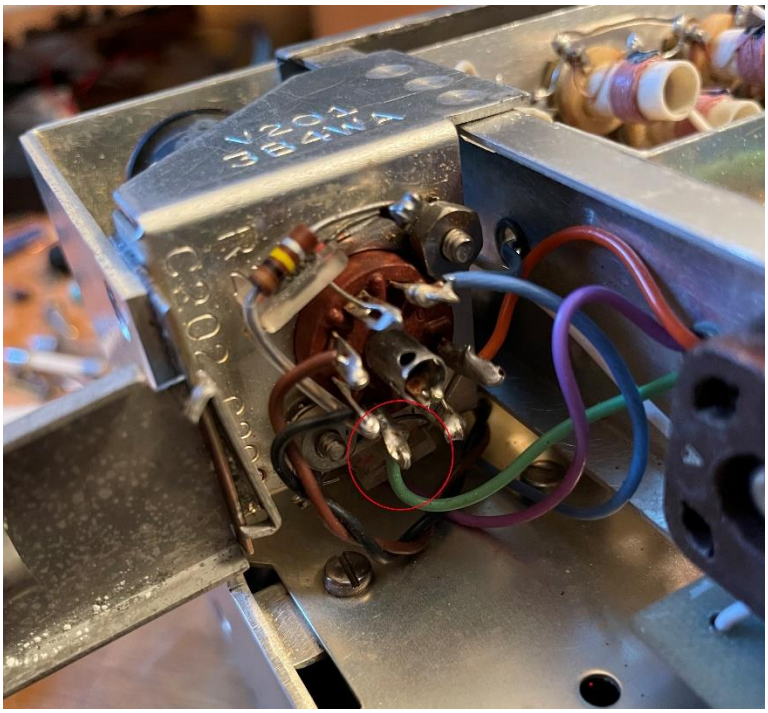
Once the little lid is closed, it is quite secure.

I will not get into the details of programming. That is covered well enough in the QRP Labs instruction manual. The position that the module is mounted in allows for easy connection to the USB port for programming. At this time, you should go ahead and program in some channels for testing. Remember, these are programmed 455 kHz above operating frequency.

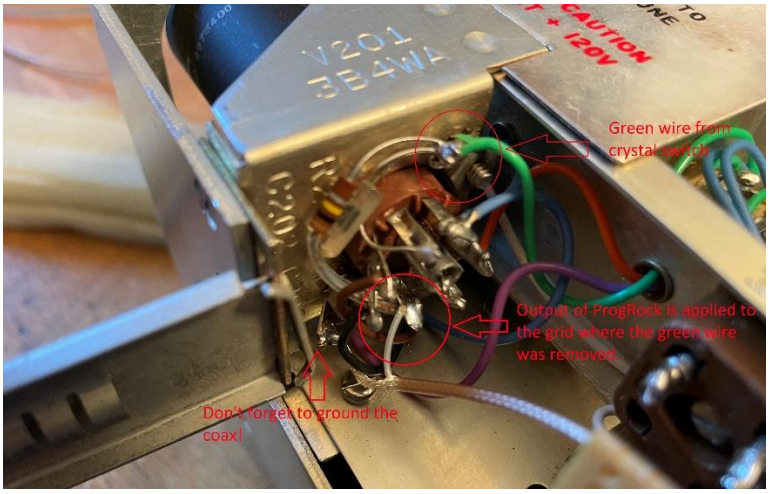
Once you have channels programmed, you can align the receiver the same as you would with crystals.

Transmitter Installation

The transmitter installation will be a bit easier since you do not have to remove any modules to get to the connections. The wire from the switch that will need to be grounded is accessible from the driver tube socket. In the picture below you will see the green wire that is attached to the grid of the driver tube. This wire leads to the common connection on the transmitter crystal switch.



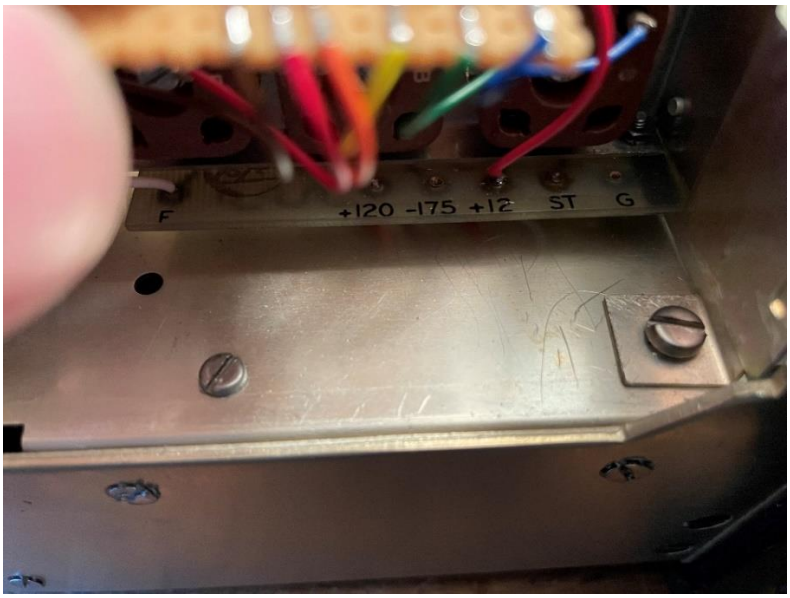
The picture below shows the wire attached to its new location on the ground lug.



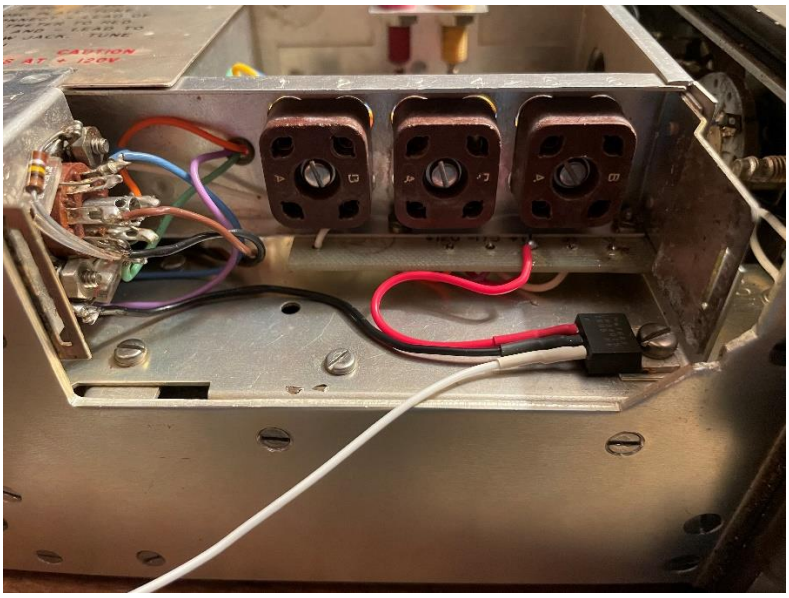
You will need to apply the ProgRock output to the grid connection that the green wire was removed from. I used miniature coax and grounded the coax shield to the bottom ground lug. Don't forget that the transmitter ProgRock module should have a capacitor on the output to the driver. You could mount this cap at the tube socket. I chose to mount it on the board with the ProgRock.

Power for the transmitter ProgRock is taken from the board below the crystal sockets. You will need to connect to the point on the board that is marked +12. This source is only active when the radio is switched to the transmit mode. This is very important, as the transmitter ProgRock is running at operating frequency directly. It would not be desirable for this module to run continuously during receive.

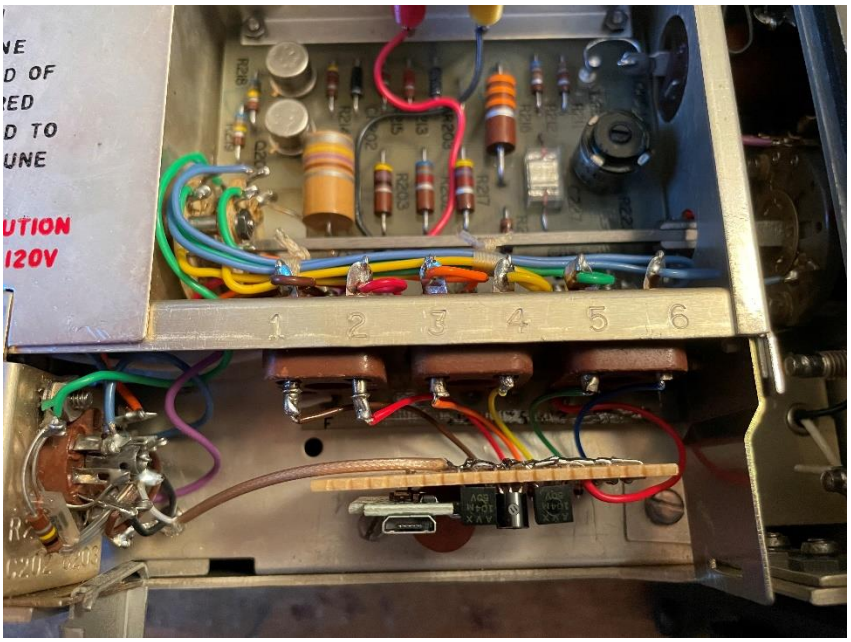
Watch out for that +120 and -175!



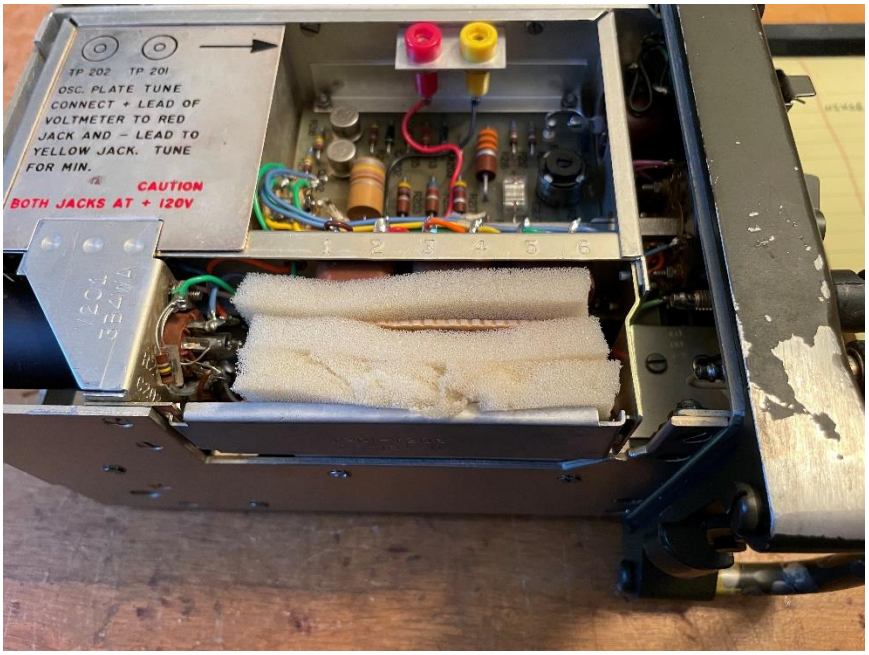
The photo above shows the power lead running to the Progrock board with an on-board 78L05 regulator. I discovered that the 78L05 was not beefy enough to run continuously without getting hot, especially in the receiver. It may be practical to do this on the transmitter, especially with a short transmit time. However, it is just as easy to run the larger 7805 here as well. The photo below shows the larger regulator installed in the transmitter. The same 12 volt source is used and the ground is attached to the lower lug on the tube socket. The screw securing the regulator is also easily accessible.



Now, you can connect the channel select lines to the crystal sockets. Be sure to use the top side of the crystal socket as shown in the photo below.



The high-performance foam packing material is used here as well. As in the receiver, it does not go anywhere when the little cover is latched.



Now that everything is connected, you can program the transmitter ProgRock and align the transmitter.

I did not concern myself with loading on the output of the ProgRock. The outputs are specified to be 50 ohm at 3.3 V pk-pk, but the manual specifies that a load of at least 1K ohms should be used for best phase noise performance. I have not yet experimented with changing the loading on either ProgRock in my TRC-77. I do know that my TRC-77 does not achieve the full power output that it achieved with crystals. I am getting at least 5 watts, which is more than sufficient for a CW rig. Although I am feeding the grid of the oscillator tube with my signal, I cannot say how much gain there is with the tube in its current configuration. There must be some gain. I cannot see the ProgRock producing enough signal to drive a 2E24 to more than 5 watts. I must emphasize that I did not approach this with any proper engineering in mind. Someone else will certainly see some room for improvement.

Programming

I know that I said that I would not be getting into programming, but I wanted to touch on a couple of important things. Something from the manual that stood out to me was a warning in regards to programming the ProgRock through the USB while it is externally powered. It sounds as though this may cause damage to the ProgRock in some circumstances. To be on the safe side, do all programming with no power applied to the radio and you should be fine. The USB programming cable will power the ProgRock.

When programming, be sure to zero out all of the other unused CLK outputs in the ProgRock. I also zeroed bank 0 on CLK 0 since I did not select that one anyway.

Anthony Clare, n3kcb

October 2023

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