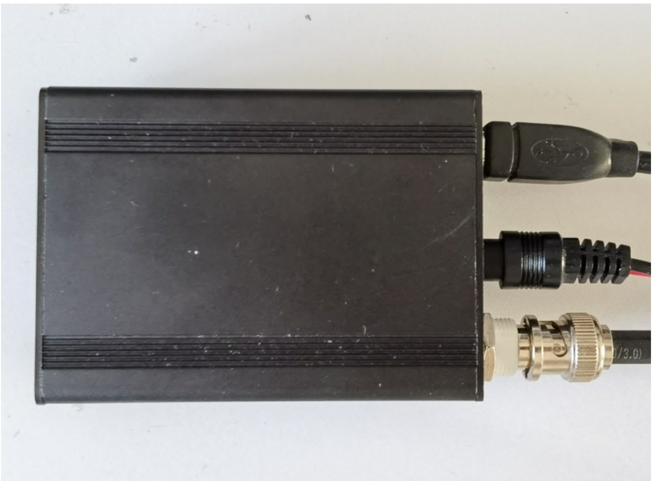
QDX-M

QDX-M: QRP Labs Digital Xcvr - Monoband

160m-specific assembly notes

--- PCB Rev 5M ---



Contents

1. Introduction

This manual is supplementary to the main assembly manual and describes specific instructions pertaining to the 160m version of the transceiver. Read the main assembly manual first.

MF and LF transceivers present specific challenges to the designer. Large inductances are required, which require either large number of turns on toroids or higher permeability cores; the latter however, suffer increasing risk of saturation as the frequency decreases, making it difficult to obtain sufficient spectral purity.

The constructor must be aware that the assembly of the MF and LF QDX-M variants is more challenging than at HF, and follow these instructions carefully.

2. Capacitors and inductors

The following table lists the capacitors and inductors specific to the 160m QDX-M:

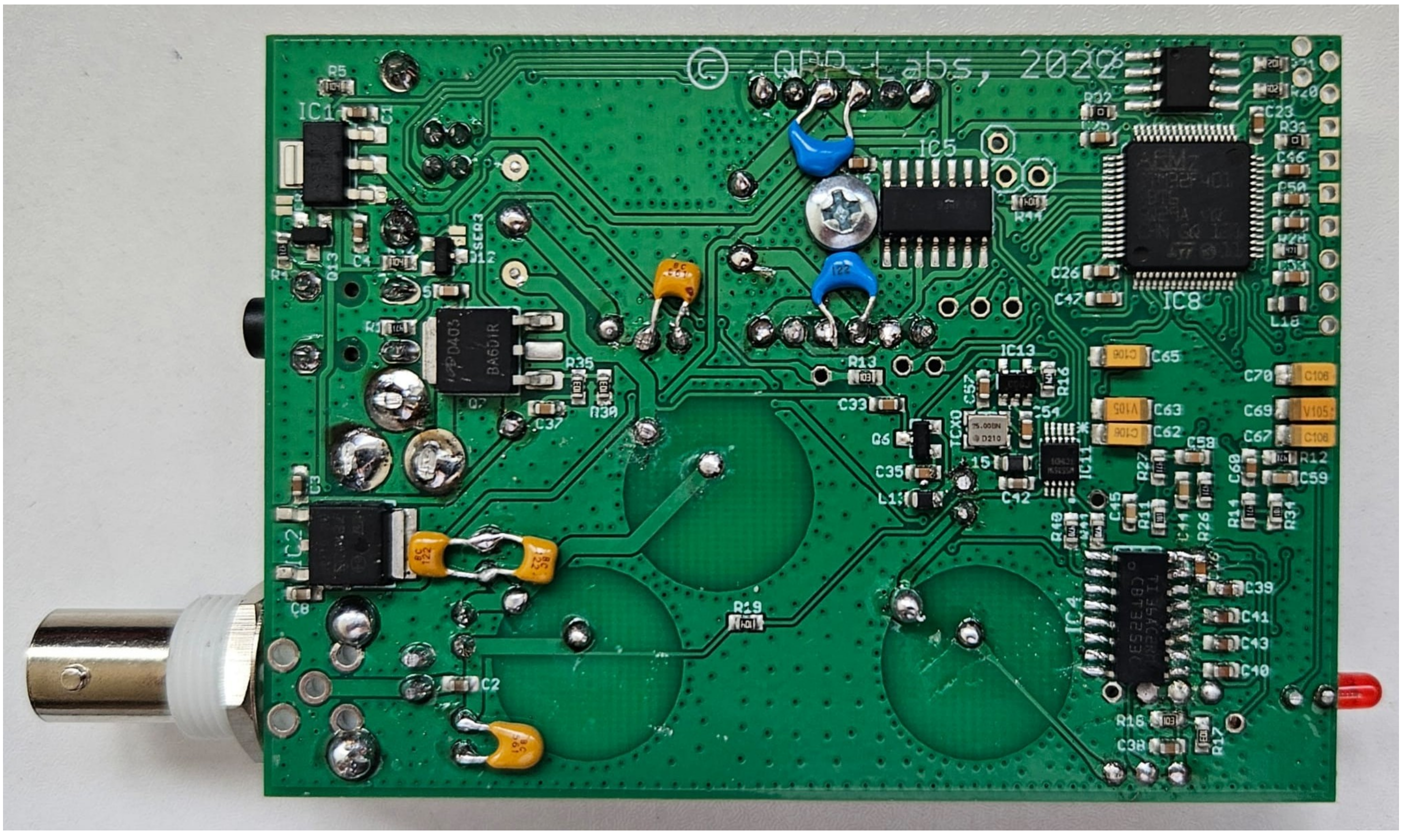
Component	Value
C7	560pF + 1,200pF in parallel (codes “561” and “122”)
C11	220pF (code “221”)
C14	Three 2,200pF in parallel (code “222”)
C20	560pF + 1,200pF in parallel (codes “561” and “122”)
C28	1,200pF (code “122”)
	1,200pF capacitor across each Drain-Source (two C’s not on main schematic), (code “122”)
L4	T50-6 (yellow) with 36 turns
L10	T50-6 (yellow) with 38 turns
L12	T50-2 (yellow) with 48 turns
L14	FT37-43 (black) with 10 turns (same as HF versions)
T1	BN61-202 WTST binocular with 7:7 turns
T2	FT37-43 (black) with 10 turns trifilar

Capacitors

Start with the installation of the capacitors since there are the smallest components. Note that some of the capacitors are made up of two or more capacitors in parallel. It is recommended to install one in the PCB in the normal way (insert component from the top, solder, then clip excess lead length); and the remaining parallel capacitor(s) on the underside of the board.

In doing so, the constructor must exercise good care to avoid short-circuits, solder blobs or dry solder joints. Inspect all work with a jeweller's loupe or other optical magnification, after soldering on each capacitor. It's recommended to have the capacitor ID labels facing upwards so you can easily check your work later. Capacitor leads should be kept short and tidy. There is not much clearance to the bottom of the enclosure, so capacitors need to be installed lying flat on the board surface. Take care to clip the wires and solder cleanly, to avoid the possibility of any leads accidentally shorting against the enclosure floor when the PCB is mounted inside the enclosure.

The following picture shows the underside of a 160m QDX-M board with the extra parallel capacitors installed.



Inductors

Next proceed with the installation of the simple inductors. L4, L10, L12 and L14 are ordinary single winding inductors. There are quite a few turns on them, take care to count the turns carefully. Each time the wire passes through the central hole of the toroid counts as one turn.

Remember when installing the inductors that the most common fault is a failure to adequately remove the enamel insulation on the wire. The insulation could be scraped off, burned off with a lighter, or burned off with a blob of solder on your iron, but it MUST be removed at the joint so that a good electrical connection can be formed. It is recommended to check each joint after installation of each toroid, both with a loupe and also with a DMM to check that there is continuity across the toroid. Which means touching the DMM (in continuity beeper mode or resistance mode) probes on the solder blobs at each end of the toroid, or even better, another point nearby connected by a PCB trace. Take care not to simply touch the DMM probe on the end of the copper wire itself, which will not check your soldering!

Trifilar transformer T2

T2 is made of 10 turns trifilar wound. Please refer to the main QDX-M for the construction, installation and testing of this component. T2 in the 160m and HF transceivers is the same.

Power transformer T1

To construct the power transformer T1, you need the document "PA transformer manual" which you may download from the main QDX-M web page http://qrp-labs.com/qdxm. However **the transformer for the 160m version has some differences compared to the manual, so read the following paragraphs carefully**.

For the 160m version of the QDX-M you must use the WTST "Weird Twisted Sisters Transformer" type described in section 3 of the manual. Do not use a simple conventional wound transformer and do not use the "RWTST" transformer. Although the WTST transformer is stated to be designed for a 9V operated QDX-M, in fact the efficiency of the 160m QDX-M is so high that it can be operated at higher voltages and powers. The section below provides performance data in this regard.

In the transformer manual, the WTST type has a turns ratio of 3:3. As in all current QRP Labs kits, 0.3mm wire is used for the transformer. But at 160m to ensure adequate inductance without causing core saturation, a larger number of turns is required. The two lengths of wire should therefore be longer, we recommend 50 and 54 cm respectively.

The turns ratio for the 160m transformer must be 7:7.

Take care not to nick or scratch the wire enamel which could causes shorts inside the transformer. The edges of the binocular core holes are sometimes quite sharp and using a large drill bit to gently de-burr the holes by hand twisting, is often a good idea.

Steps 1 to 5 of the WTST section describe winding 1.5 turns of twisted wire onto the binocular core - which becomes 3:3 turns with one winding center tapped, since the "wire" is actually two wires twisted together. In the case of the 160m QDX-M transformer, having 7:7 turns, you should continue this process until you get to 3.5 turns (7 total).

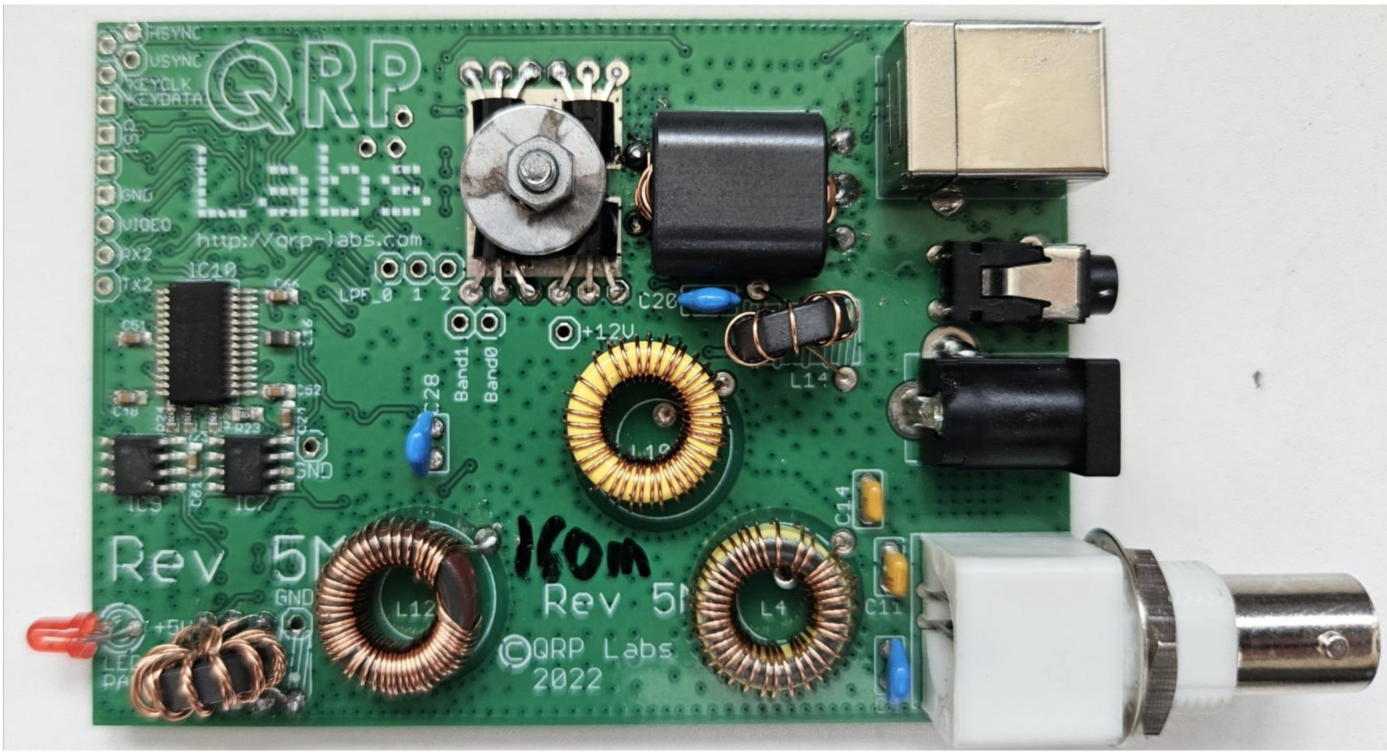
The remaining procedure for the transformer is the same as the rest of the WTST instructions, and refer to the main QDX-M manual for the installation and testing of the PA transformer; these instructions apply equally to the 160m QDX-M PA transformer.

To re-iterate:

1. The 160m QDX-M transformer must be a WTST type.
2. It is the same as the HF transformers except that it has a 7:7 turns ratio (instead of 3:3 for the HF transformer).
3. Remaining assembly, installation and testing is the same as the PA transformer manual and main QDX-M assembly manual.

Other components

Continue with the remainder of the assembly as per the main QDX-M manual (connectors, LED, transistors). Below is an example result:



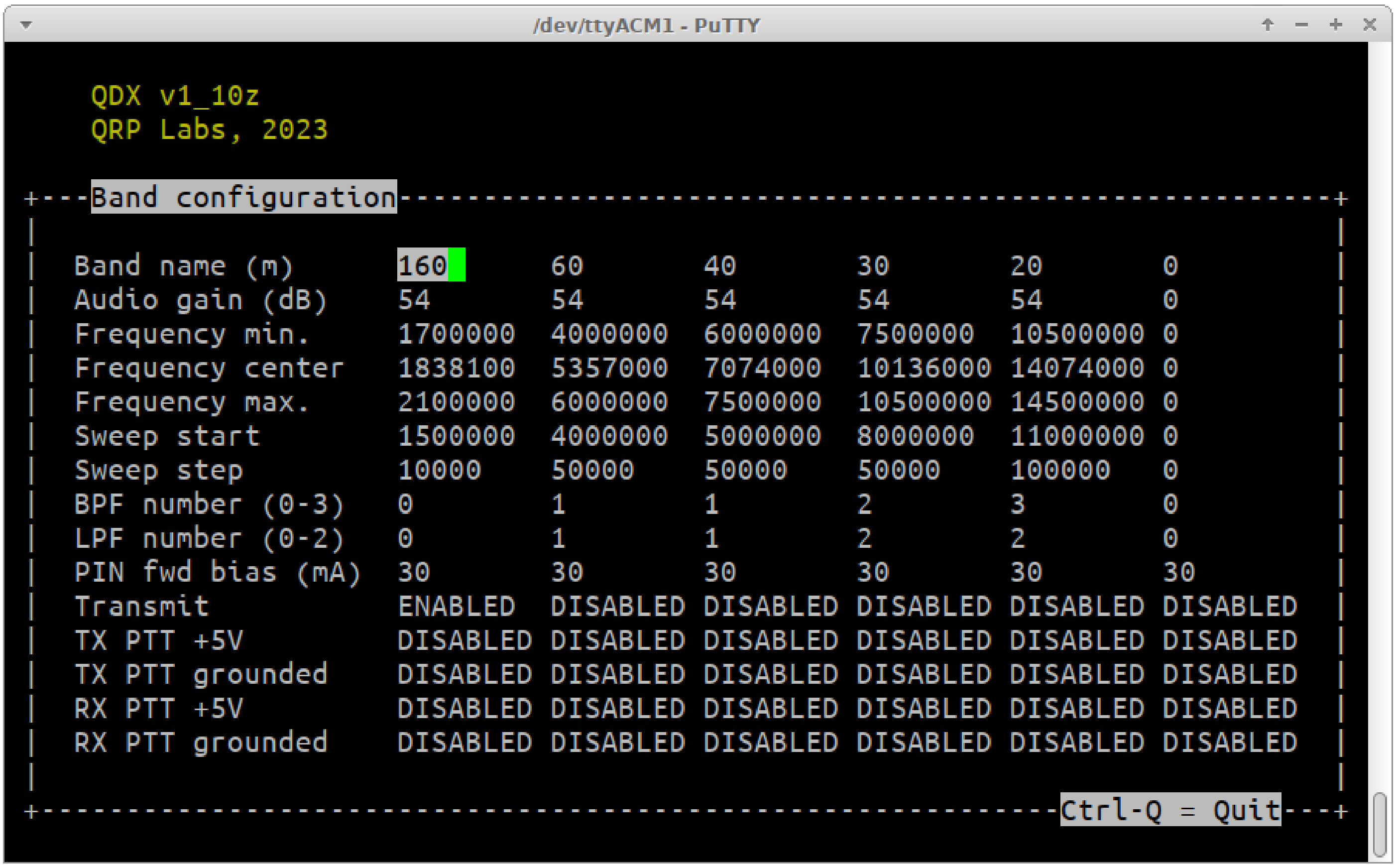
3 Configuration

The main QDX-M manual describes jumper configurations to select the band. This is not yet set up in the QDX firmware so you need to connect a terminal emulator and configure the 160m QDX-M manually. Refer to the main QDX operating manual for instructions on how to connect a terminal emulator to your QDX-M, running on a PC connected to your QDX-M with an appropriate USB cable.

You also need to make sure you are running the latest firmware version. The firmware version is displayed at the top of the terminal emulator screen. Please refer to the main QDX page http://qrp-labs.com/qdx to download the latest firmware if necessary, following the firmware update procedure described in the operating manual.

The Band Configuration screen must be edited for proper operation of the 160m QDX-M.

In the following screenshot, the 160m QDX-M Band Configuration screen had originally been populated by default as an 80-20m 5-band QDX. To configure your QDX-M for 160m, edit the leftmost column to match the data below (the column headed “160”). It will initially be headed “80” and you should delete the 80 and type 160. Similarly, delete the Freuqency min, Frequency center, Frequency max., Sweep start and Sweep step cells and re-enter them as per the column in the image below.



/dev/ttyACM1 - PuTTY

QDX v1_10z
QRP Labs, 2023

Band configuration

Band name (m)	160	60	40	30	20	0
Audio gain (dB)	54	54	54	54	54	0
Frequency min.	1700000	4000000	6000000	7500000	10500000	0
Frequency center	1838100	5357000	7074000	10136000	14074000	0
Frequency max.	2100000	6000000	7500000	10500000	14500000	0
Sweep start	1500000	4000000	5000000	8000000	11000000	0
Sweep step	10000	50000	50000	50000	100000	0
BPF number (0-3)	0	1	1	2	3	0
LPF number (0-2)	0	1	1	2	2	0
PIN fwd bias (mA)	30	30	30	30	30	30
Transmit	ENABLED	DISABLED	DISABLED	DISABLED	DISABLED	DISABLED
TX PTT +5V	DISABLED	DISABLED	DISABLED	DISABLED	DISABLED	DISABLED
TX PTT grounded	DISABLED	DISABLED	DISABLED	DISABLED	DISABLED	DISABLED
RX PTT +5V	DISABLED	DISABLED	DISABLED	DISABLED	DISABLED	DISABLED
RX PTT grounded	DISABLED	DISABLED	DISABLED	DISABLED	DISABLED	DISABLED

Ctrl-Q = Quit

The BPF number, LPF number and PIN fwd bias cells have no meaning for the QDX-M because it is single band and there is no band switching. So you can ignore those. It is a very good idea to set the “Transmit” cells for all the other listed bands to “DISABLED” to prevent any accidental mishaps trying to transmit at incorrect frequencies into the 160m Low Pass Filter of your QDX-M.

You also need to visit the main “Configuration” screen and edit the “Default frequency” cell to 1838100.

After this, power down your QDX-M and re-boot it, then re-connect the terminal emulator.

4 Adjustments and performance evaluation

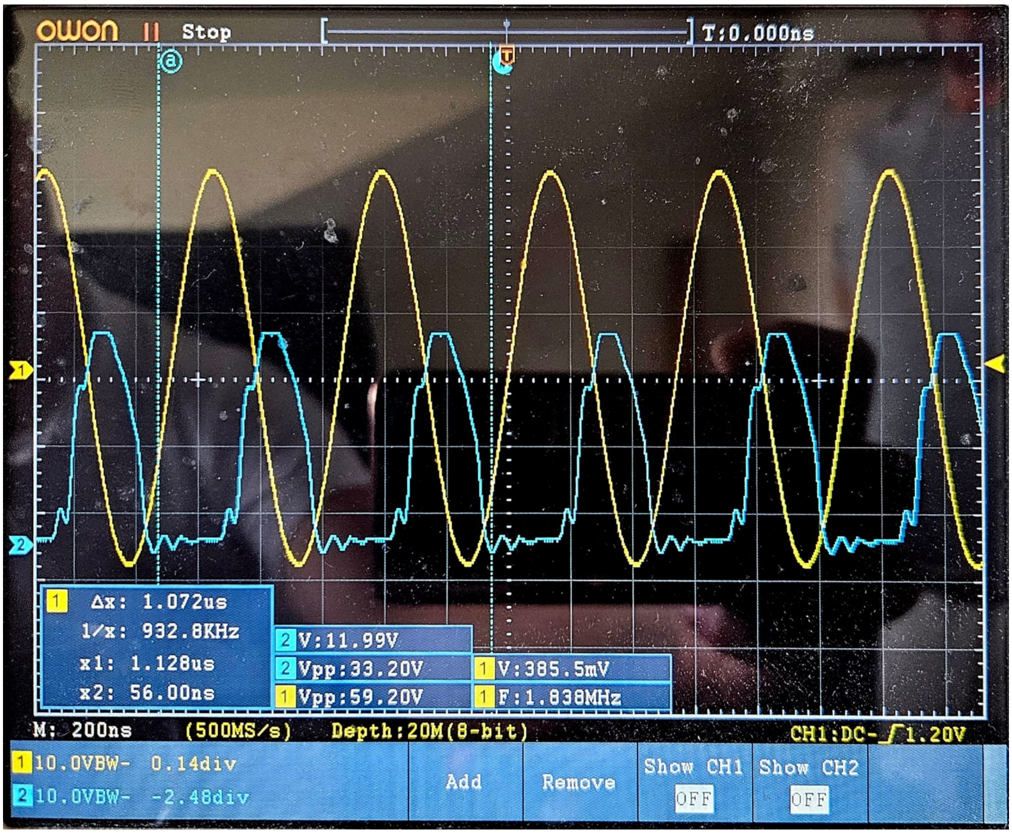
Always test the transmitter first. A 9V supply should suffice to produce approximately 5W output. Use the “Transmitter test” screen and press the ‘T’ key on your keyboard to transmit.

Measurements of one 160m QDX-M here produced:

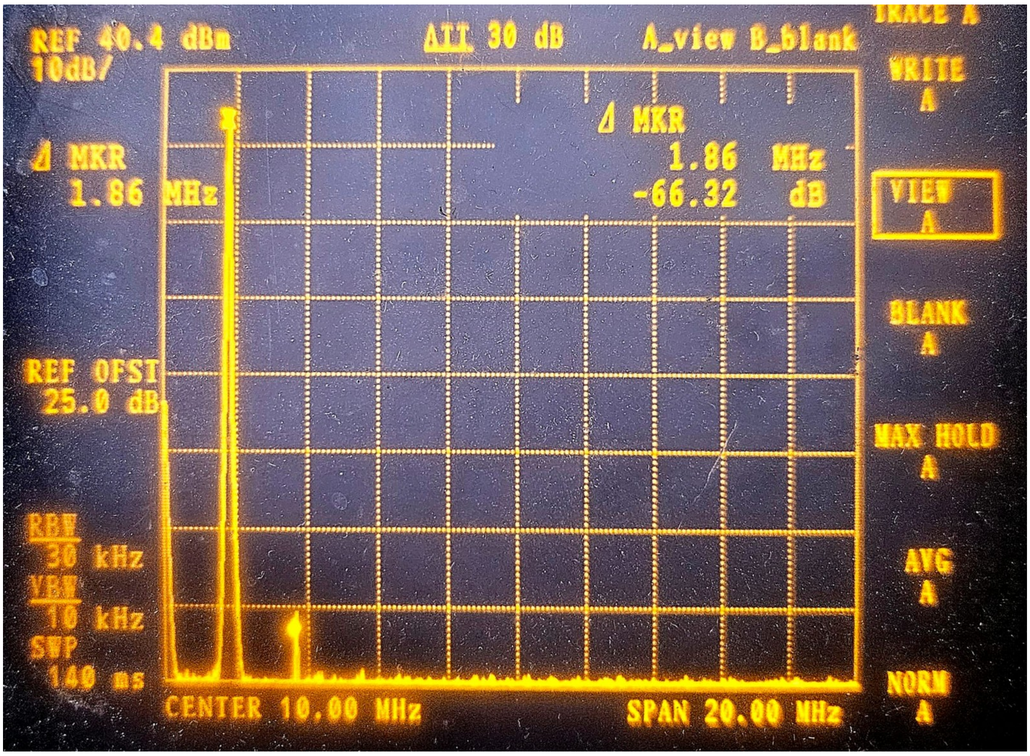
- At 9V supply: 5.0W RF output; 2^{nd} harmonic at -66.32 dBc (higher order harmonics below the spectrum analyzer noise floor.
- At 12V supply: 8.8W RF output; 2^{nd} harmonic at -60.12 dBc, 3^{rd} at -75.32 dBc and higher orders below the spectrum analyzer measurement noise floor.

The efficiency of the power amplifier is extremely high. Normally we would not recommend using a QDX-M at more than 5W output; however in this case you could probably experiment with higher supply voltages, even up to the 12V supply used for this measurement, without damaging the RF power transistors. A good indication of whether the PA transistors are under stress is to observe the current consumption during transmit. At 12V supply we measured 887 mA on transmit. If, during a prolonged key-down, this current starts to drop, this indicates the PA transistors are getting very hot, which is changing their operating characteristics, and they are under stress.

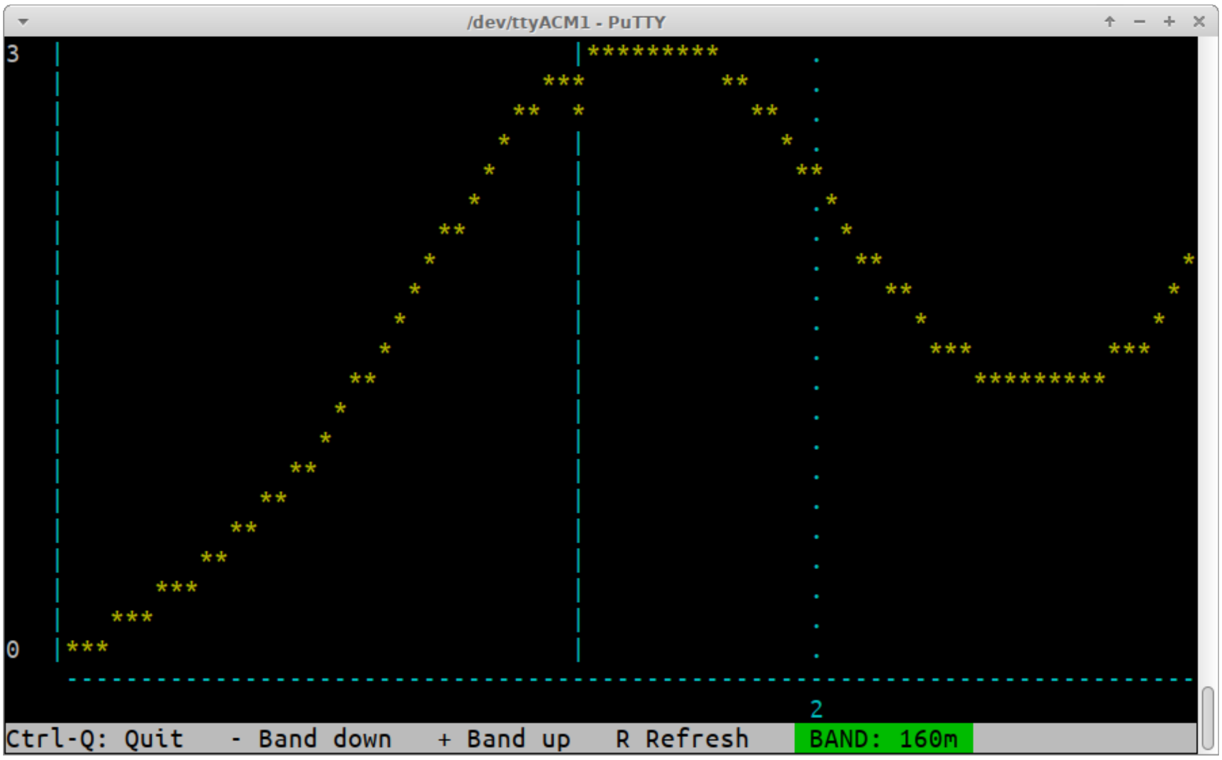
The oscilloscope photograph below shows, for the 12V supply case, the RF output (top line, yellow, sinewave shape) and the voltage at one of the transistor drains (blue line). The drain waveform is quite close to an ideal Class-E waveform which also explains the high effieincy observed.



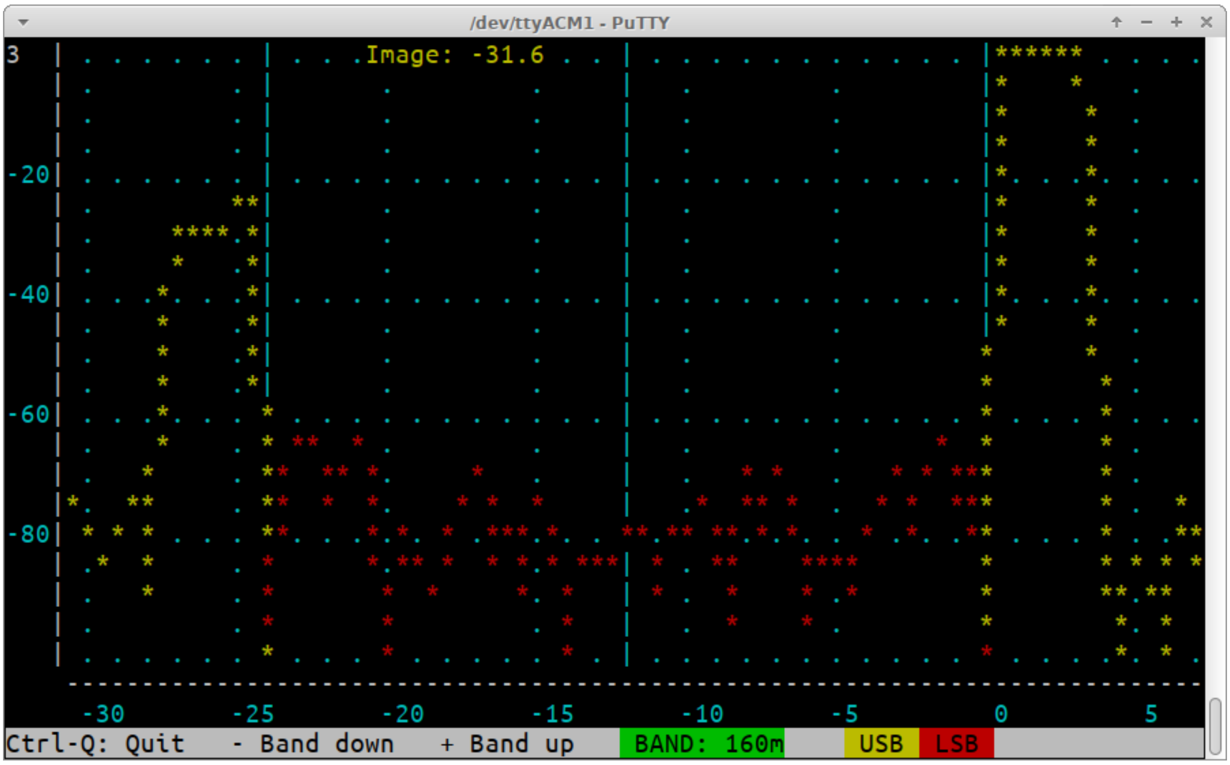
This photograph shows the spectrum analyzer result (9V supply, 5W output):



For testing the Receiver section, use the RF Sweep tool in the terminal. Use the + - keys to go up a band (though other bands are not enabled) then go back to 160m; this is because the first RF sweep in the tool has a firmware bug which causes inaccurate results. There should be a peak somewhere near the band center frequency (indicated by the vertical dashed line) as shown below. It isn't terribly critical if the peak occurs a bit to the right or left of this.



You also should run the Image sweep, to check the image rejection of the receiver. The results should be something like below. There will be quite a lot of variation in the image measurement but if you have an image rejection very low, such as -3, -4, -5dB etc., that will probably indicate a winding issue or installation issue with the T2 trifilar transformer, or perhaps a defective multiplexer IC in the quadrature sampling detector.



The remainder of the assembly and operating procedures are the same as for the regular HF QDX-M transceivers, please refer to the normal manuals for these.

Acknowledgments

I am very grateful to Ross EX0AA who worked together with me on this low frequency QDX-M, Ross has done a lot of field testing, filter design and QDX-M builds to develop the final design.

5. Document Revision History

1.00	29-Sep-2025	First version version