Modifying the Hi-Band QMX to a "Mid-Band" QMX.

Background: The current version of the firmware 1.00.014 for the QMX allows for custom band configurations. The REV2 PCB board is used for both the low and high band versions of the QMX build kits with the delta between the versions being the soldered in components and the toroid configurations. The firmware supports up to six band configurations with the board supporting four Band Pass Filter options (0-3) and three low-pass filter options (0-2)

Goal of the Modification: Change the QMX bands to operate more in line with typical SOTA portable operations. 40M to 15M was the targeted bands with 60M being considered a bonus since it shares band pass and low pass filters with 40 meters in the low band kit. The starting method for the mid-band modification will be to use the known components for the targeted bands in the low band version in the high band kit I was building. Components for the 12, 11 and 10 meter bands were removed from the high band build. Components used in low band kit for 40 and 30 were procured to be used in this mid-band build. The tapped toroid L401 is different between the low and high band versions. The taps and turns of the high bands toroid for L401 were modified to support the lower bands. Additionally, one capacitor was changed that was not in either kit.

Current Band Configurations for the low and high version

```
+---Main menu------+
|+---Band configuration-----------------------------------------------------+
||                                                                           |
||  Band name (m)      80        60        40        30        20        0    |
||  Audio gain (dB)    54        54        54        54        54        0    |
||  Frequency min.     3200000   4000000   6000000   7500000   10500000  0    |
||  Frequency center   3573000   5357000   7074000   10136000  14074000  0    |
||  Frequency max.     4000000   6000000   7500000   10500000  14500000  0    |
+|  Sweep start        3200000   3200000   3200000   5000000   6000000   0    |
 |  Sweep step         20000     60000     75000     110000    150000    0    |
 |  BPF number (0-3)   3         3         3         2         1         0    |
 |  LPF number (0-2)   0         1         1         2         2         0    |
 |  PIN fwd bias (mA)  30        30        30        30        30        30   |
 |  Transmit           ENABLED   ENABLED   ENABLED   ENABLED   ENABLED   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---+


QMX v1_00_011   QRP Labs, 2023
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Figure 1 - Low Band Configuration

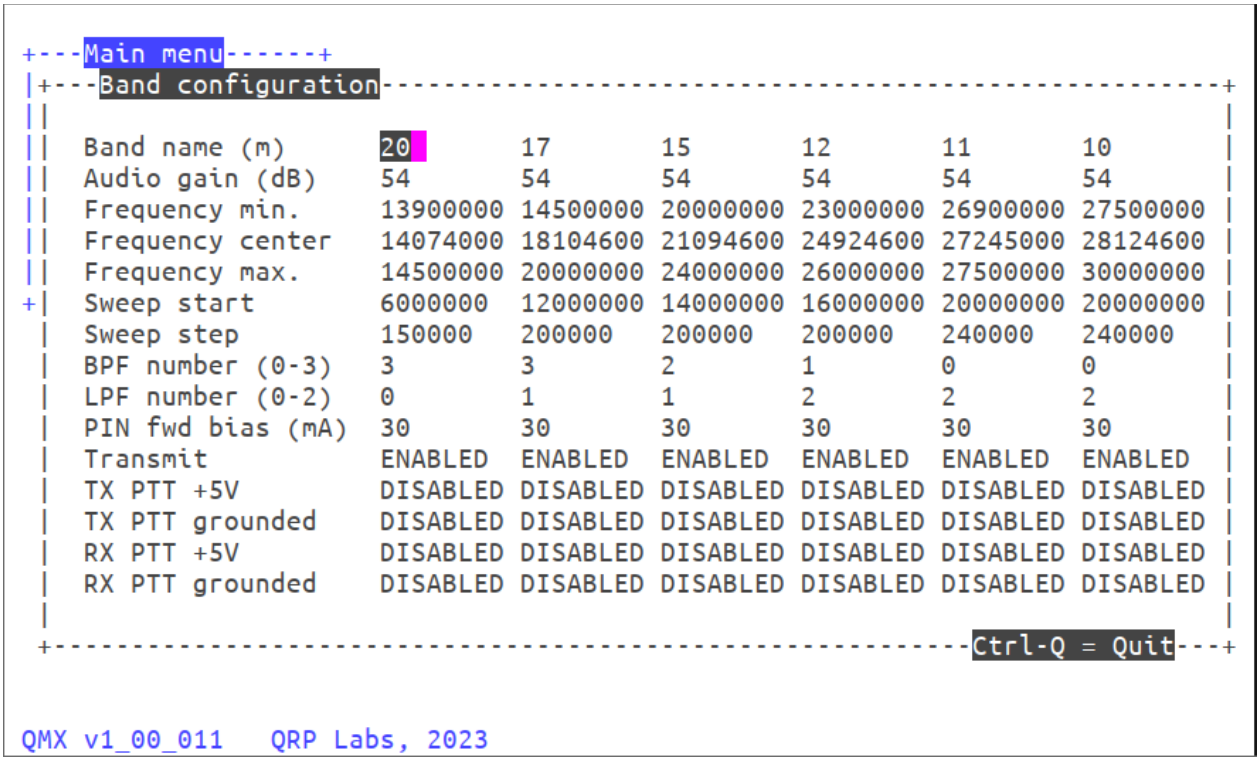


Figure 2 - High Band Configuration

Mid-Band Band Configuration changes:

Band Name	60	40	30	20	17	15
Audio Gain	54	54	54	54	54	54
Freq Min	4000000	6000000	7500000	13900000	14500000	20000000
Freq Center	5357000	7074000	10136000	14074000	18104600	21094600
Freq Max	6000000	7500000	10500000	14500000	20000000	24000000
Sweep Start	4500000	4500000	5000000	6000000	12000000	14000000
Sweep End	200000	60000	110000	150000	200000	200000
BPF # (0-3)	3	3	2	1	1	0
LPF # (0-2)	0	0	1	1	2	2
Pin fwd bias	30	30	30	30	30	30
Transmit	ENABLED	ENABLED	ENABLED	ENABLED	ENABLED	ENABLED

Figure 3 Mid-Band Configuration

Frequency Dependent Parts:

60 / 40 / 30 / 20 / 15m version of QMX:

Use the “Part of Kit (H/L)” Column to help you determine you list of needed material depending on wither you are starting with a high or low band QMX kit.

Capacitors (50V, Multi-Layer Ceramic capacitor):

QTY	Value	Description	Component cumbers	Part of Kit (H/L)
1	15pf	Lable “150”	C403	Not in a Kit
2	33pf	Label “330” or “33J”	C522	3 IN H
2	56pf	Label “560” or “56J”	C520, C401	1 IN H, 2 IN L
1	82pf	Label “820” or “82J”	C521	H
1	180pf	Label “181”	C515	H
2	220pf	Label “221”	C402, C516	1 IN H, 1 IN L

2	270pf	Label “271”	C525, C524	H
2	390pf	Label “391”	C514, C523	L
1	470pf	Label “471”	C518	L
1	560pf	Label “561”	C519	H
1	820pf	Label “821”	C517	L
1	150pf	Label “151”	C404	Not in a kit

Inductors (powdered iron Micrometals toroids):

QTY	Description	Component numbers	Part of Kit (H/L)	Wire Length
1	T30-6(yel) 17T, 1.06uH	L511	L	26cm
1	T30-6 (yel) 18T, 1.2uH	L506	L	27cm
1	T30-6(yel) 10T, 394nH	L512	L	18cm
1	T30-17(Yel/blu) 12T, 230nH	L513	H	20cm
1	T30-6(yel) 12T, 525nH	L508	L	20cm
1	T30-17(Yel/blu) 13T, 286nH (11T per recommendation vice calculations)	L510	H	20cm
1	T50-6 toroid (yel) – tapped, see text	L401	H	

MID-BAND COMPONENT CHANGES/RELOCATIONS. *I needed to write out all of these changes to keep it straight in my head. Including it here in case it helps you as well. It helps to follow along with the Schematic.*

LP0 CHANGES (The LP1 components of the low band kit become the Mid-Band LP0 components for 60/40)

COMPONENT	NEW VALUE	COMMENT (L = Low Band, M=My Mid-Band, H=High Band)
C520	56pF	C521 (L) > C520 (M)
C514	390pF	C515(L) > C514 (M)
C517	820pF	C518(L) > C517(M)
C523	390pF	C524(L) > C523(M)
L506	1.2uH T30-6 (yel) 18T	L508(L) > L506 (M)
L511	1.06uH T30-6(yel) 17T	L512(L) > L511(M)

LP1 CHANGES (The LP2 components of the low band kit become the Mid-Band LP1 components for 30/20M)

Component	New Value	Comment
C521	82pF	C522(L) > C521(M)
C515	180pF	C516(L) > C515(M)
C518	470pF	C519(L) > C518 (M)
C524	270pF	C525(L) > C525(M)
L508	525nH T30-6(yel) 12T	L510(L) > L508(M)
L512	394Nh T30-6(yel) 10T	L513(L) > L512(M)

LP2 CHANGES (The LP1 components of the high band kit become the Mid-Band LP2 components for 17/15M)

Component	New Value	Comment
C522	33pF	C521(H) > C522(M)
C516	220pF	C515(H) > C516(M)
C519	560pf	C518(L) > C519(M)

C525	270pF	C524(H) > C525(M)
L510	286nH T30-17(Yel/blu) 13T	L508(H) > L510(M)
L513	230nH T30-17(Yel/blu) 12T	L512(H) > L513(M)

Band Pass Filter Changes (The frequency dependent components of the band pass filter is comprised of C401-C404 along with tapped toroid L401. IC402 pins 10-13 (Y0 to Y3) correspond to BPF 0-3. the low band version uses a T50-2 (Red) toroid for L401 while the high band uses a T50-6(yel) toroid. This mid band build uses the high band toroid and adds turns to accommodate the 30, 40 and 60M band.

L401 Tap Configuration and BPF Caps (Based on online calculators)

	L401 Tap Turns	Calculated Value	Bands	BPF CAP(Value)	Comment
BPF 0	10T	.4uH	15M	C403(15pF)	This cap is in the high band kit
BPF 1	13T	0.7uh	17/20M	C401(56pF)	C401 value from hi band kit
BPF 2	17T	1.0uh 1.2uh (Proposed)	30M	C404(150pf)	This value cap is in neither low or high band kit
BPF 3	21T	1.4uh (Current) 1.8uh (Proposed)	40/60M	C402(220pf)	

L401 Note: L401 could benefit from another turn on BPF2 as 30M and 40M are at the low end of the peak on the RF Sweeps. This would little adjustability those bands and would slightly improve sensitivity on 60M. (See sweeps in performance section).

C403 Note: This cap was changed to a lower value that was called for in the high band kit to get the band pass up to 15M.

Performance

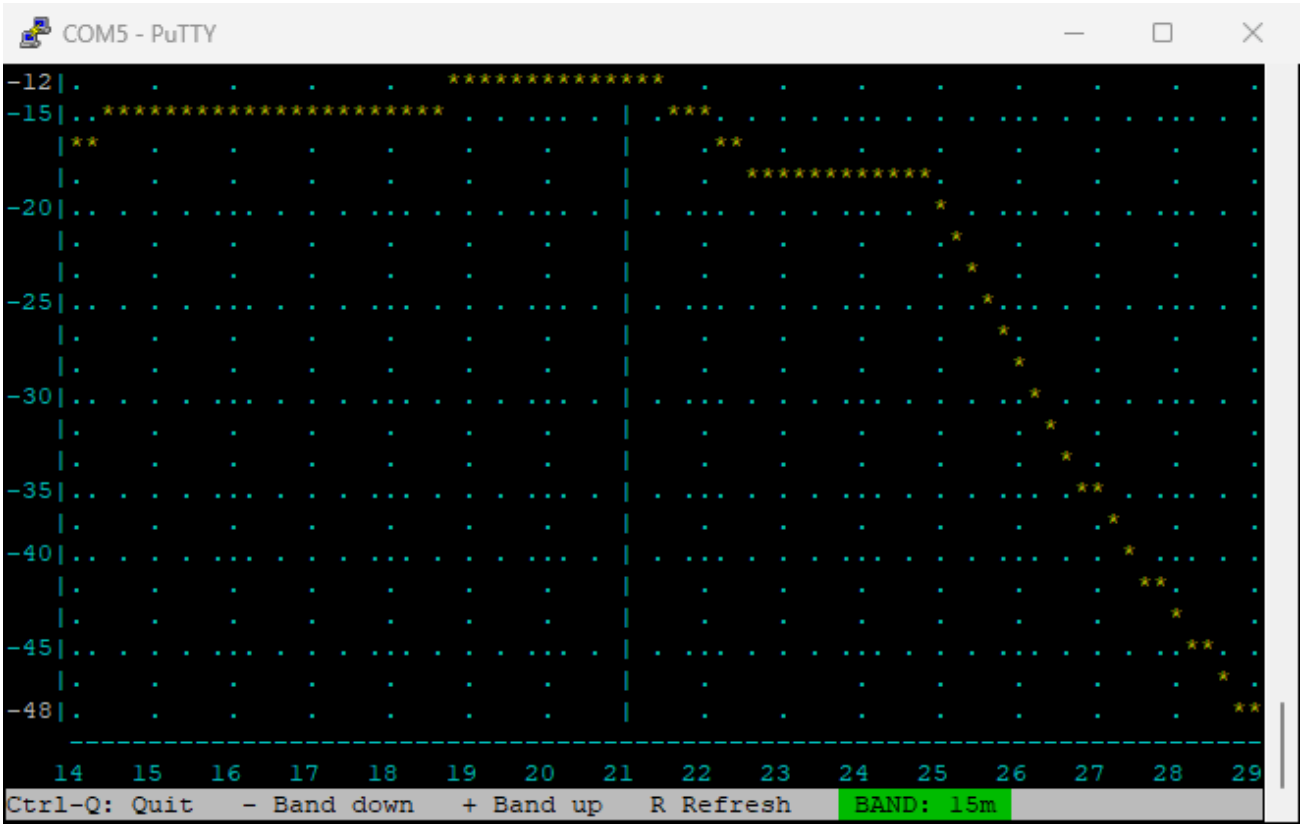
These were the measurements after the various iterations of adjustments to the LPF and BPF turns and spacing as well as changes to two BPF capacitors

Transmit Output Power (Using the Diagnostics function in the terminal app). External Power meter tracked with these.

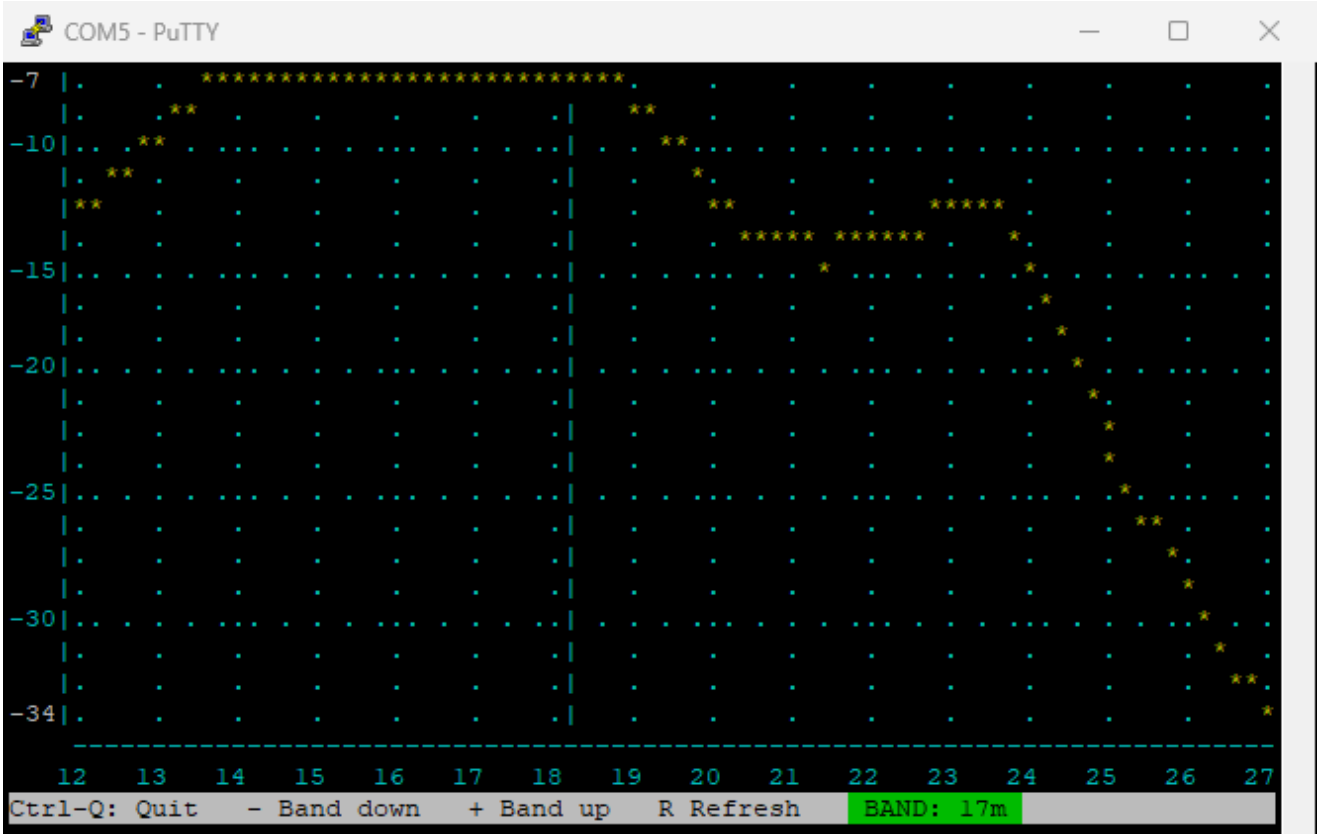
Band	Freq	Output
60	5357000	5.1W
40	7074000	4.0W
30	10136000	5.3W
20	14074000	3.2W
17	18104600	3.7W
15	21094600	4.6W

Thoughts: LP1 and LP0 can use slight tweaks

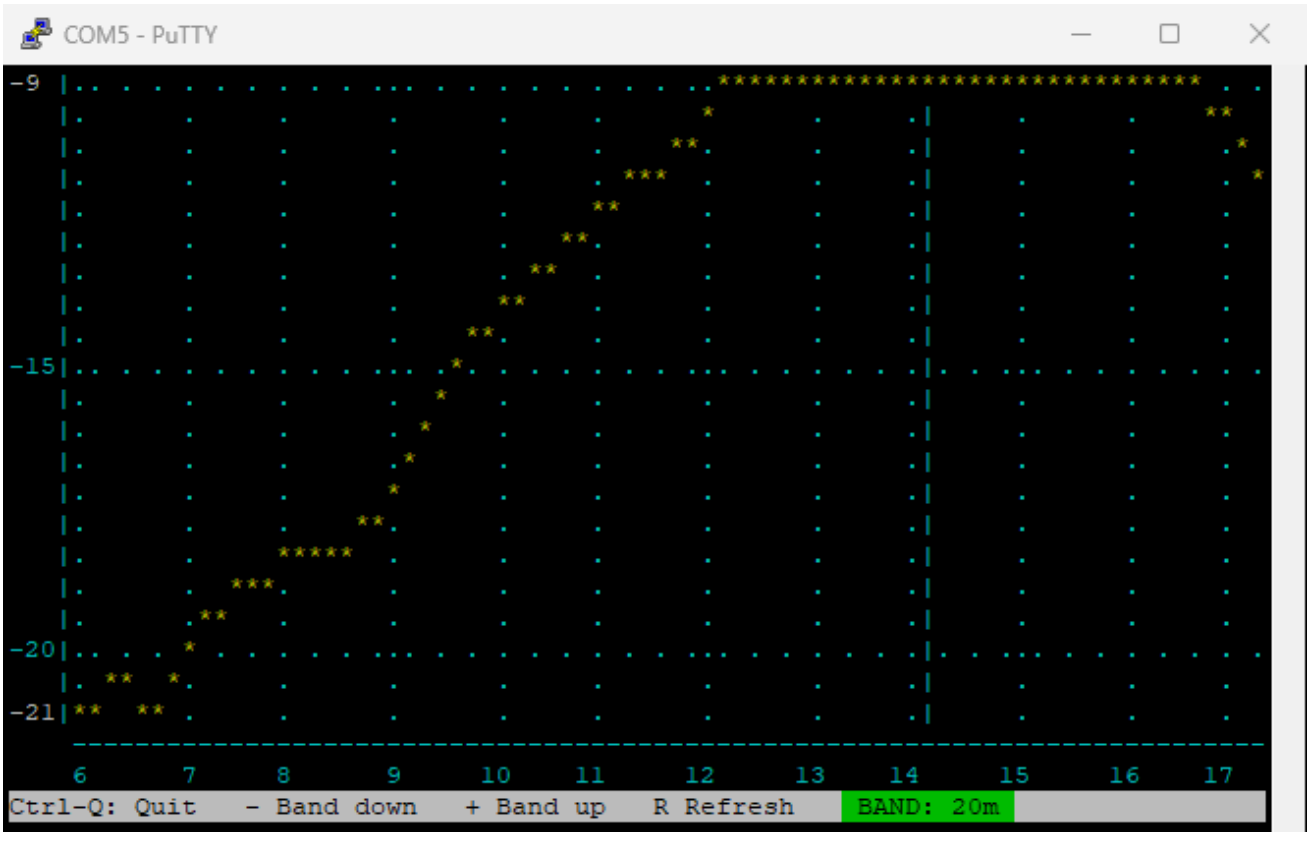
RF Image Sweeps



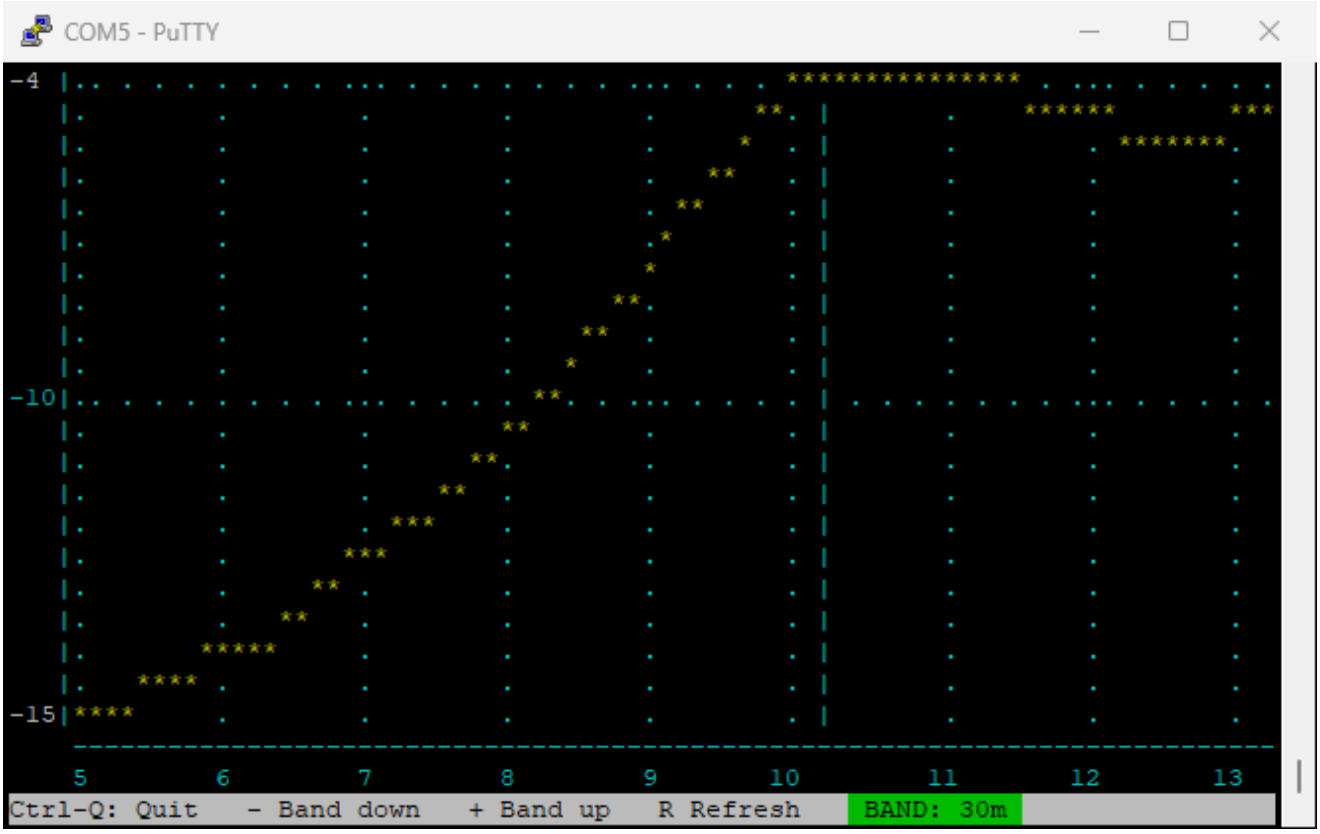
15M: (BPF0) At -12. With -8 being the “reasonable” value from the manual this is good enough.



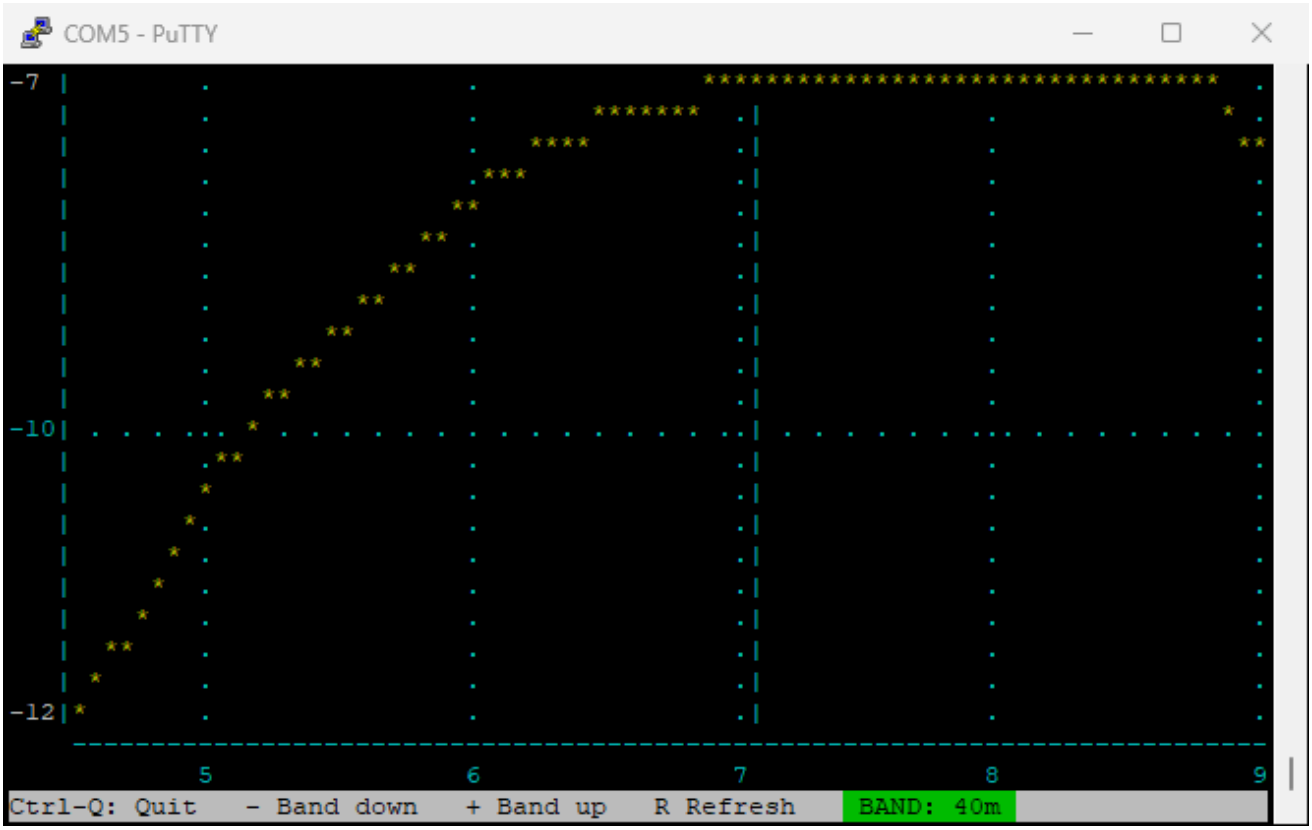
17M: (BPF1) At -7 this is good considering -5 is what is consider reasonable from the manual



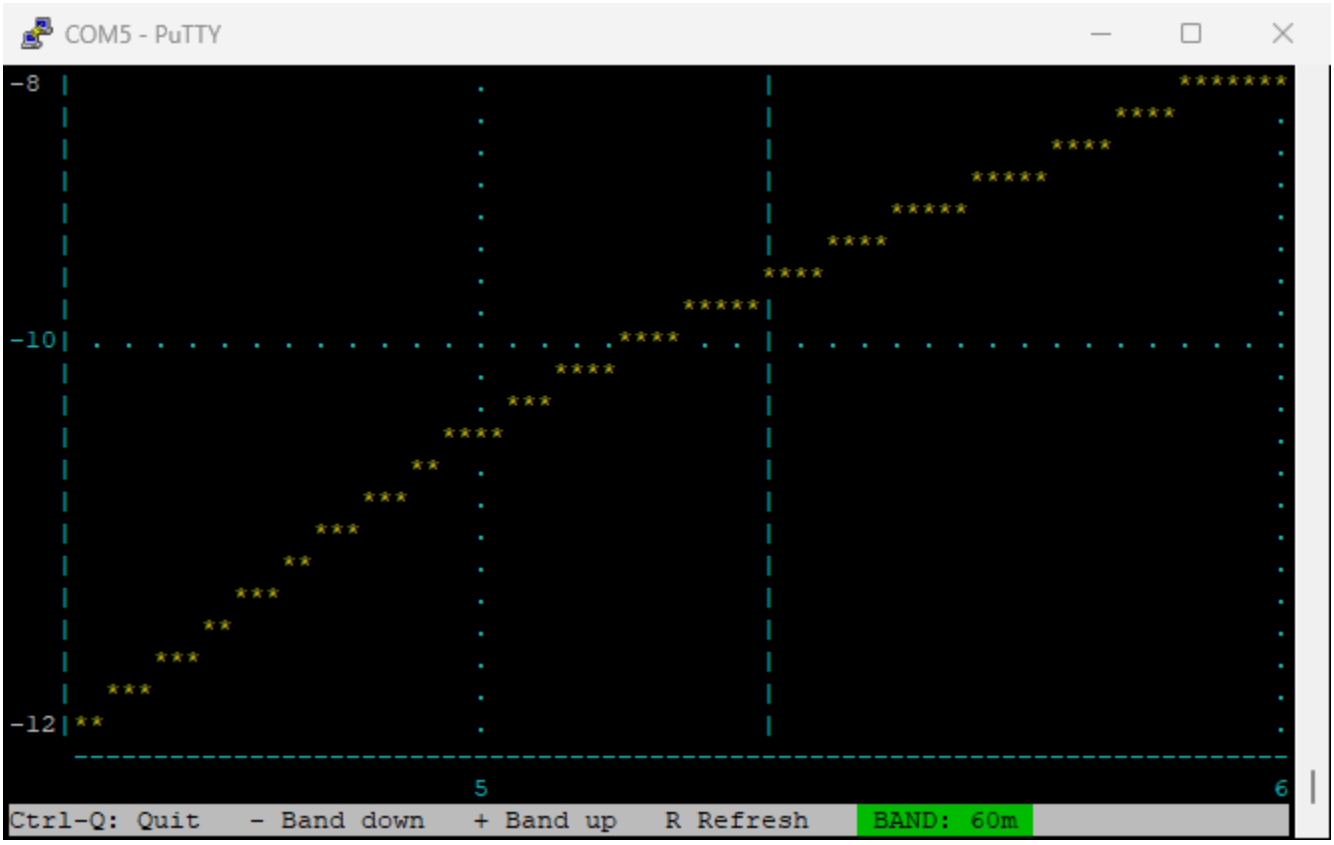
20M: (BPF1) At -9 this is fantastic compared to what the manual states as reasonable.



30M: (BPF2) -4 Is a pretty good number. This BPF could use another turn since the band is just on the low edge of the peak. This section of L401 has the turns pretty much fully compressed



40M (BPF3) The peak is a little low at -7 compared to the manual which shows -2. I think this BPF could use another turn as well as BPF2 (for a total of two “seen” at this BPF) which push the peak lower in frequency.



60M (BPF3) Low at -8 compared to the manual at -2. The addition of two turns on L401 should peak out this band.

Receiver Sensitivity Test:

Using a TinySA Ultra I injected an RF signal into the unit. I did not hookup a voltmeter to look for 3db of rise above the noise floor in the receive audio. Instead, I adjusted the generator output and listened for a tone level that was about the lowest level I think I would be able to decode a slow word per minute CW callsign. I did not add any attenuators in line with the input and -123dbm is a lowest level my signal generator would produce. Items listed as -123dbm may actually be better than that. I'm not particularly happy with the sensitivity of 15M but it is below my lower threshold of desire to further to tinker with it at this point.

Band	Freq	Level
60M	5.357	-116dbm
40M	7.064	-123dbm
30M	10.113	-123dbm
20M	14.066	-120dbm
17M	18.062	-123dbm
15M	21.062	**-106dbm**