

Q65 Sensitivity in MAP65 3.0

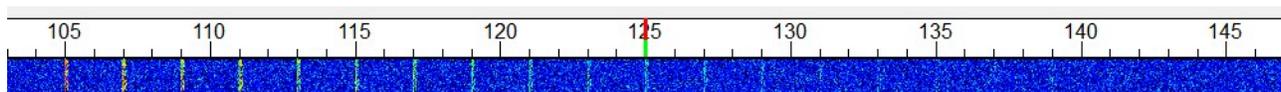
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Members of the **MAP65 3.0** test group have keen interest in the program's decoding sensitivity for Q65 signals. This brief document addresses several sensitivity-related questions posed by group members and provides some instruction on how to take best advantage of MAP65 decoding features.

Part of our normal development procedure for a new digital mode is to write a software simulator that can generate signals with known message content, frequency, drift rate, Doppler spread, and signal-to-noise ratio. We have two such simulators for the Q65 modes: one generates .wav files for WSJT-X, and the second generates .tf2 and .iq files for MAP65.

An example .iq file generated by the MAP65 simulator has been posted here: https://physics.princeton.edu/pulsar/k1jt/000000_0001.iq. The remainder of this document takes the form of a brief tutorial covering Q65 decoding features in MAP65 3.0. To get full benefit of these capabilities, I strongly encourage you to work carefully through each step of the tutorial.

1. Download the example file and put it in a convenient directory.
2. Start MAP65. The example file contains single-polarization data, so make sure that the **Xpol** box on the **Setup | Options | Station** tab is unchecked.
3. Select submode Q65A and hit the **F4** key to clear the **DX Call** and **DX Grid** boxes.
4. Navigate to **File | Open** and select the example file 000000_0001.iq.
5. The example file includes 21 signals in submode Q65-60A on the additive white Gaussian noise (AWGN) channel. The signals are spaced every 2 kHz from 144.105 to 144.145 MHz. Signal-to-noise ratios start at -15 dB and decrease progressively by 0.715 dB per signal, from lowest to highest frequency. SNR for the signal at 144.145 is -29.3 dB. A properly adjusted waterfall should look something like this example, in which signals are visible up to about 144.133 MHz. The six highest frequency signals are difficult or impossible to see on the waterfall, but as you will see they are still decodable.



6. At program startup the green Rx frequency cursor is at the passband center frequency, in this case 144.125 MHz. Decoding takes place first at this frequency, and the following line should appear in the main window:

```
125 -2 0 0001 2.6 -22 : CQ K1ABC FN42      q0
```

7. Wideband decoding results appear in the **Messages** window. Opening the example file automatically produces decodes at 14 of the 21 generated signal frequencies:

```
105  0 0 0001 -15 CQ K1ABC FN42      :
107  0 0 0001 -16 CQ K1ABC FN42      :
109 -1 0 0001 -16 CQ K1ABC FN42      :
111  0 0 0001 -17 CQ K1ABC FN42      :
113  0 0 0001 -18 CQ K1ABC FN42      :
115 -1 0 0001 -18 CQ K1ABC FN42      :
```

```

117  0 0 0001 -19 CQ K1ABC FN42      :
119  0 0 0001 -20 CQ K1ABC FN42      :
121 -1 0 0001 -20 CQ K1ABC FN42      :
123  0 0 0001 -22 CQ K1ABC FN42      :
125  0 0 0001 -22 CQ K1ABC FN42      :
127 -1 0 0001 -22 CQ K1ABC FN42      :
129  0 0 0001 -24 CQ K1ABC FN42      :
133 -1 0 0001 -25 CQ K1ABC FN42      :

```

- Notice that the signal at 144.133 has been decoded, but the slightly stronger one at 144.131 has not. Such behavior is not unusual at signal levels close to the decoding threshold. The signals at 131 and 133 kHz were generated with SNR = -24.3 and -25.0 dB, respectively. It's clear that the threshold sensitivity for automatic wideband decoding of Q65-60A signals with low Doppler spread is around -25 dB.
- Decoding by double-clicking on a signal's waterfall trace is more sensitive than broadband decoding over the full passband. To examine this effect, try double-clicking on the upper waterfall near 131, 133, 135, 137, 139, 141, and 143 kHz. Each of these actions should produce a decode in the main window, but double-clicking at 145 kHz does not.

```

131  0 0 0001 2.6 -25 : CQ K1ABC FN42      q0
133  0 0 0001 2.6 -25 : CQ K1ABC FN42      q0
135  0 0 0001 2.5 -28 : CQ K1ABC FN42      q0
137  0 0 0001 2.6 -25 : CQ K1ABC FN42      q0
139  0 0 0001 2.6 -25 : CQ K1ABC FN42      q0
141  0 0 0001 2.6 -27 : CQ K1ABC FN42      q1
143  0 0 0001 2.6 -26 : CQ K1ABC FN42      q1

```

Notice that the signals at 141 and 143 kHz produce decodes flagged with "q1" rather than "q0". If you forget what these flags mean, be sure to read the "Quick-Start Guide to Q65" again here: https://physics.princeton.edu/pulsar/k1jt/Q65_Quick_Start.pdf.

- Double-click on the callsign K1ABC in the main window, as you would do if you intended to respond to his CQ. Alternatively, you can double-click on a call in the **Messages** window. Either action will copy the callsign into **DX Call** and its four-character locator (if available) into **DX Grid**. The program also generates appropriate Tx messages with the correct signal report.
- Because the **DX Call** and **DX Grid** entry fields are now populated with information from a previous decode, subsequent attempts to decode messages from this station can benefit from *a priori* (AP) information. You can now double-click at 145 kHz to produce a decode at that frequency. It will be marked with "q3" to indicate that full AP information has been used:

```

145 178 0 0001 2.6 -27 : CQ K1ABC FN42      q3

```

- You may have noticed that the decoder's SNR estimates show more scatter as signal levels approach the decoding threshold. The graph on the next page illustrates this phenomenon and shows how much you should trust specific values of SNR estimates. Particularly at the lowest decodable signal levels, measured SNRs may differ from the true values by 2 dB or even more.

Q65-60A in MAP65 3.0

