

Full duplex operation in FT8 and FT4 via QO-100

Matthias, DD1US, April 9th 2024, rev. 6

Important Update:

For some time WSJT-X is now supporting full duplex operations for FT4 and FT8 modes. Thank you very much to the authors for adding this capability especially for QO-100 operations. This means you do not need the below mentioned special setup any more unless you want to receive FT4 and FT8 in parallel. This is still interesting in order to monitor the operations in both modes and try to find new stations you may not have worked yet. To enable full duplex operations you simply have to enable that function in the drop down menu "Decode" by clicking on "Full Duplex Mode". The settings are saved after termination of the program and you do not have to re-enable it every time you restart WSJT-X.

Original description:

FT4 and FT8 are getting very popular digital operation modes on QO-100. Most radio amateurs seem to use the software WSJT-X in combination with SDR-Console.

Even though those digital modes need very little uplink power (ERP) we can often see, that many users are transmitting with excess uplink power.

Unfortunately WSJT-X does not support full duplex operation which helps to monitor the own signal, adjust the uplink power and in addition check the signal quality. Also, in full duplex mode possible collisions of the transmission with other users can be detected and the uplink frequency can be accordingly adjusted rather than increasing the uplink power.

Searching for a solution I contacted Uwe DG2YCB, who is part of the development team of WSJT-X. Uwe was very responsive and helpful and recommended to use 2 instances of WSJT-X. It turned out that this is a very nice solution not only helping to monitor the own signal but also enabling to monitor the same frequency simultaneously for FT4 and FT8 emissions.

Below I will explain how to setup the software. Many thanks to Uwe DG2YCB for his helpful advice. By the way Uwe is the source for the versions "WSJT-X_improved" and "JTDX_improved".

You can always run multiple instances of WSJT-X (or "WSJT-X_improved") or JTDX (or "JTDX_improved") at the same time. They will then work independently of each other.

To track your signal on the QO-100, you only need to run a second instance using your downlink signal from the satellite as audio source. In fact, the two instances of WSJT-X can share the same port of a virtual audio cable. I am using VAC from Eugene V. Muzychenko.

I assume that you start WSJT-X via a hyperlink on your desktop and work with Windows, but with Linux or macOS it works in principle analogously.

The instances work as follows:

- Copy the "WSJT-X" screen hyperlink and paste it twice somewhere on your desktop, so that you now have a "WSJT-X - Copy" and "WSJT-X - Copy(2)" hyperlink there as well.
- Right-click on the "WSJT-X - Copy" link and open "Properties". There you will find the path where you installed the program, e.g. C:\WSJT\wsjtx\bin\wsjtx.exe. Now add an instance name with --rig-name= ... an instance name, e.g. C:\WSJT\wsjtx\bin\wsjtx.exe --rig-name=TX.
- Do the same with "WSJT-X - Copy(2)", except that for Destination you enter e.g. the following: C:\WSJT\wsjtx\bin\wsjtx.exe --rig-name=RX.
- Rename the two new screen hyperlinks, e.g. WSJT-X - TX and WSJT-X - RX.
- Now you can start and run both instances completely independent from each other.

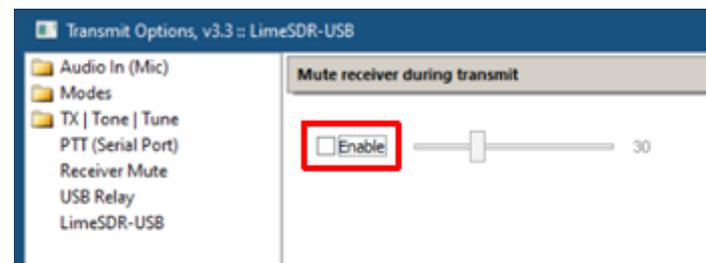
Of course, now both of your new instances will start with fresh settings, so you would have to re-enter all your data. But you can also easily copy the existing data. This is how it works:

1. Open your very first instance (the "zeroth", so to speak, the one you open via the normal "WSJT-X" hyperlink). Click there on "Open log directory". Technically the (normally hidden) system folder "C:\Users\USERNAME\AppData\Local\WSJT-X" opens in the explorer now. Your settings are respectively in the file WSJT-X.ini, and your logbook in wsjtx_log.adi.
2. Copy these two files (or all of them). Now click on the arrow up in the explorer, so that you get to C:\Users\USERNAME\AppData\Local\. You will now see two folders "WSJT-X - TX" and "WSJT-X - RX" next to the "WSJT-X" folder. Open the folder with TX and copy your copied files into it. Rename the file "WSJT-X.ini" to "WSJT-X - TX.ini" (overwrite the existing one).
3. Close your very first WSJT-X instance (so to say the "zeroth").

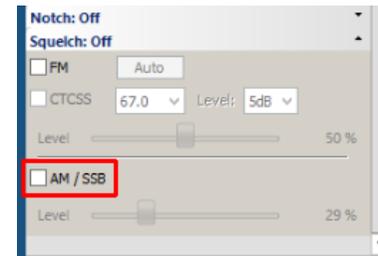
4. If you now click on your new "WSJT-X - TX" screen hyperlink, the new "first" instance of WSJT-X will open, but it now looks exactly like your previous one ("zeroth"). From now on work only with this one and adjust the settings under Settings -> Audio regarding the paths for Save Directory and AzEl Directory accordingly.
5. Repeat steps 1-5 for your second instance, the one that opens when you hyperlink to the "WSJT-X - RX" screen.
6. Now only a few small things are missing.
7. Close your zeroth and your first instance.
8. Open your second ("RX") instance again, which now looks the same as your first ("TX") instance. Go to the Settings menu and change the audio source, if necessary, so that it takes over the downlink signal of your Sat-RX.
9. Move the two windows for WideGraph and the main menu a bit to the right.
10. Start your new first ("TX") instance again, which can now be opened and closed completely independent from the second one.
11. Move the windows for the two instances so that they are arranged sensibly next to each other.
12. Finished.

From now on, work only with your new two instances, because starting the "zeroth" instance at the same time would "shoot down" the other two. Of course, the "zeroth" instance will continue to work as usual, as long as the two new ones are not open. You can run only two instances independently of each other, if they are started with the extension --rig-name=XYZ).

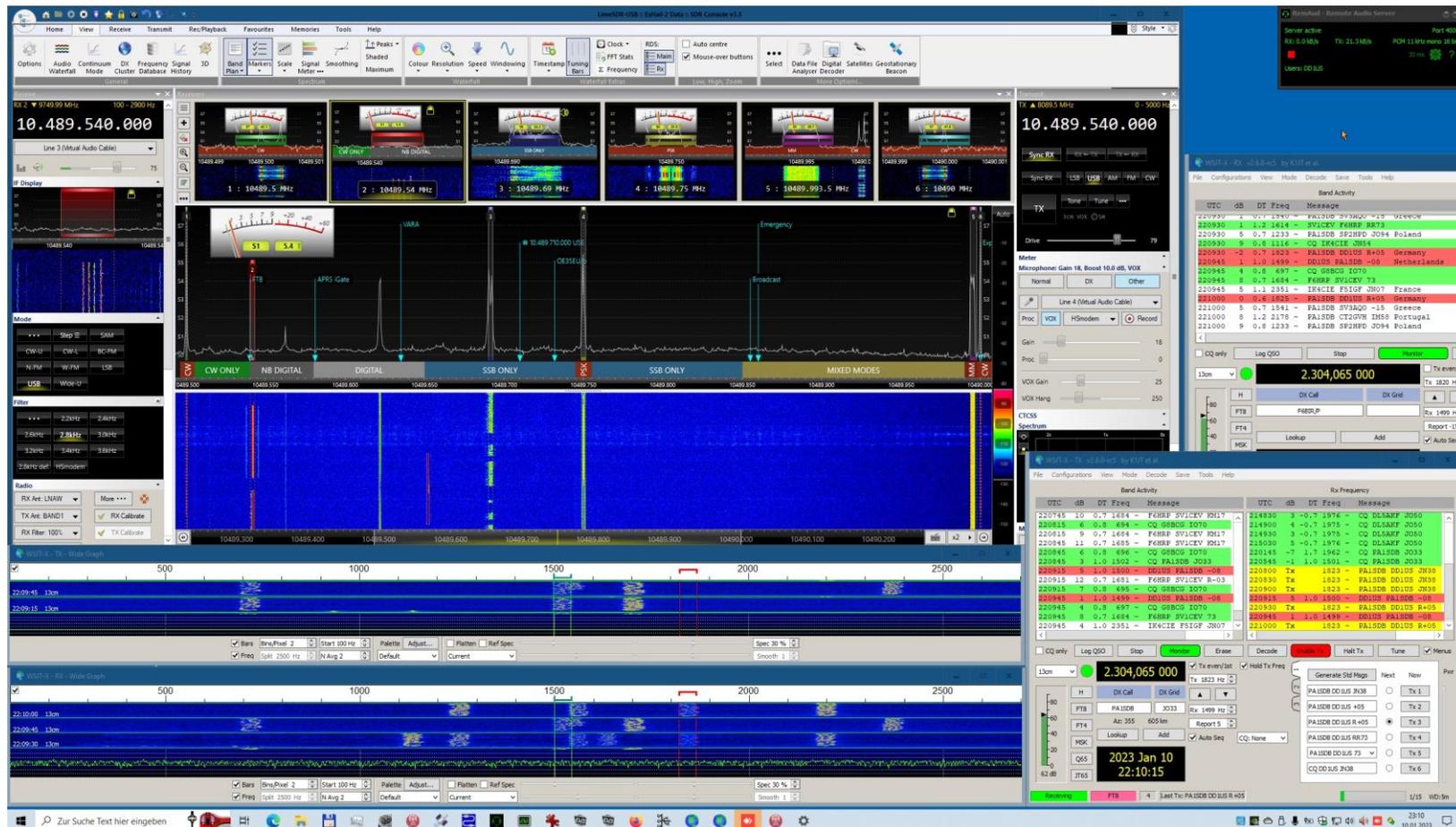
If you are using SDR-Console and have enabled in "Transmit Options" the option "Mute receiver during transmit", then the spectrum and waterfall display will be muted or dimmed according to the set volume reduction. It is better to disable the option "Mute receiver during transmit" when operating FT4 or FT8 in full duplex mode.



Also, make sure that the receiver you are using does not have the squelch function enabled.



Here are some screenshots how my setup looks like. I am using 6 receiver windows to monitor the two CW beacons (10489.5 and 10490.0MHz), the PSK beacon (10489.750MHz), the Multimedia beacon (10489.9935MHz), listen to a SSB-QSO (10489.690MHz) and to operate in FT4/FT8 (10489.540MHz):



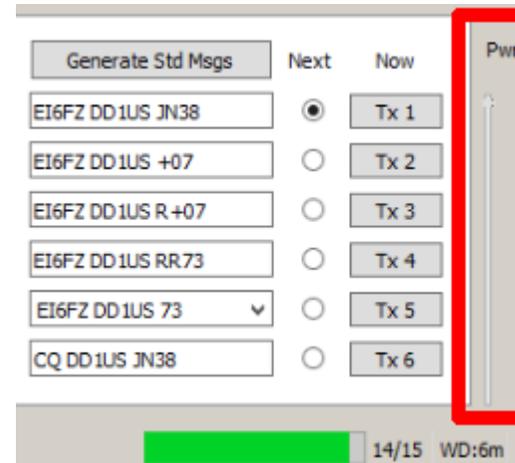
When operating in SSB mode I am using the Transmit setting “Normal”, when operating FT4/FT8 I am using the setting “Other”. Thus, I can adjust my output power (by drive and gain settings) for each mode and switch simply between them. At the same time also the ports of my virtual soundcard are switched accordingly.

The screenshot displays the WSJT-X software interface. The main window shows a waterfall plot with a frequency range from 10,489,000 to 10,490,000 Hz. The transmit frequency is set to 10,489,540.000 Hz. The transmit mode is set to SSB ONLY. The transmit power is set to 79 dBm. The transmit filter is set to 2.8 kHz. The transmit mode is set to SSB ONLY. The transmit filter is set to 2.8 kHz. The transmit mode is set to SSB ONLY. The transmit filter is set to 2.8 kHz.

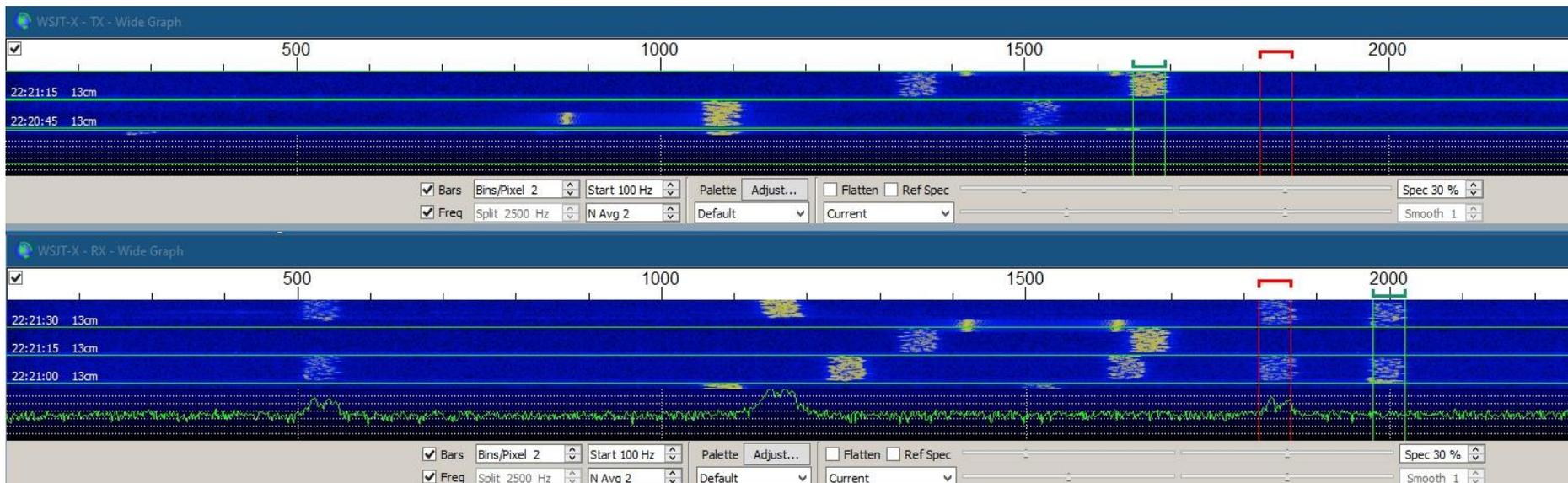
The right side of the interface shows the Band Activity window, which displays a list of stations and their frequencies. The current station is 2,304,065,000 Hz. The band activity window shows a list of stations with their UTC, dB, DT, Freq, and Message. The current station is 2,304,065,000 Hz. The band activity window shows a list of stations with their UTC, dB, DT, Freq, and Message. The current station is 2,304,065,000 Hz.

UTC	dB	DT	Freq	Message
222045	-1	1.1	1501	F6RHP PALSDB RR73
222045	12	0.7	1065	SP2HPD OMSABC RR73
222100	7	-0.6	1975	CQ DL5AKF J050
222100	2	0.8	512	CQ DL6MI JN58
222100	13	0.5	1233	OM5ABC SP2HPD 73
222100	3	0.6	1825	OM5ABC DD1US JN38
222100	7	1.4	1617	PALSDB F6RHP 73
222115	5	0.7	1331	IK4CIE SV3AQO -09 Greece
222115	14	0.7	1645	DD1US OMSABC -03 Slovak Rep.
222130	5	-0.7	1975	CQ DL5AKF J050
222130	5	0.8	510	G4GIR DL6MI -08 Germany
222130	3	0.6	1825	OM5ABC DD1US R+14 Germany

Another option is to change the transmit power in the WSJT-X GUI (slider on the right).



You have now two waterfall windows, the upper called “WSJT-X – TX” and the lower “WSJT-X – RX”. In the lower window you can see your own transmit signal (marked with the red bar) and also signals from other users transmitted while you are transmitting. You can thus avoid transmitting on a frequency which is already in use or which is disturbed.

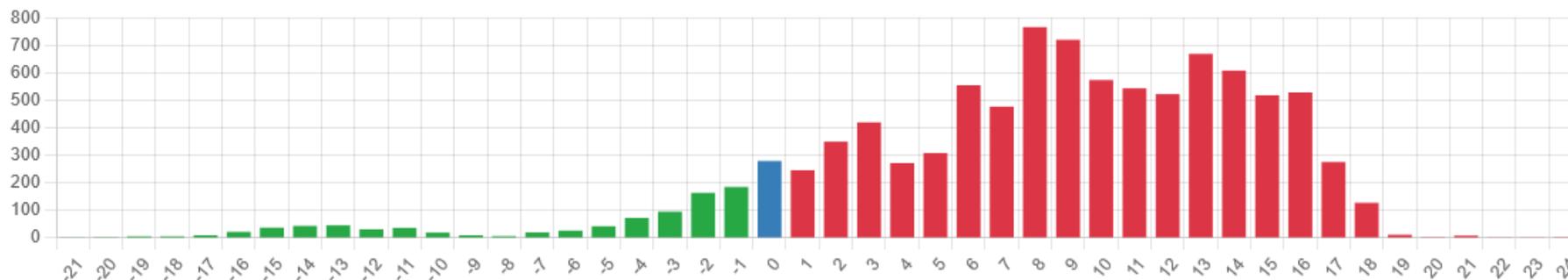


If you are not in a QSO you can also use the “WSJT-X – RX” instance to monitor a second digital mode. For instance, you can use the instance which is used for transmit (“WSJT-X – TX”) to monitor FT-8 signals while the other instance (“WSJT-X – RX”) is used to receiving signals in FT-4. If you then find an interesting station, you want to have a QSO with, you simply switch both windows in the same mode and use the “WSJT-X – TX” instance to make the QSO.

FT8 and FT4 are meant to be weak signal modes, especially also on QO-100. Unfortunately, the majority of operators are using too much uplink power. If you have problems receiving the signals from QO-100 please improve your receive performance rather than increasing your EIRP.

On the QO-100 Dx Club website <https://qo100dx.club> you find a nice section about FT4/FT8 called “Skimmer”. Besides the last decoded messages, you can find there also a 24h histogram of the recorded signal strengths. Many thanks to Francisco Costa CT1EAT/M0HOJ and Hugo Silva CT7AOV for organizing the QO-100 Dx club and maintaining the website. The guideline is to use power levels below 0dB. A level of -10dB should be still enough to get copied by every mediocre station on QO-100. Levels down to -21dB are possible. You can see there is a strong need for improvements.

Signal Strength Histogram



I hope this description will help others to optimize their operations in FT4/FT8 via QO-100.

Many thanks to Uwe DG2YCB as well as to Francisco Costa CT1EAT/M0HOJ and Hugo Silva CT7AOV for their kind support.

Questions are always welcome. Please send them to my Email address given below.

Kind regards

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