

FT8 Operating Guide

Weak signal HF DXing for technophiles

by Gary Hinson ZL2iFB Version 2.28



Note: this document is occasionally updated. The definitive latest English version is always available at www.g4ifb.com/FT8_Hinson_tips_for_HF_DXers.pdf Please use and share that URL or the shortened version bit.ly/FT8OP to stay current. Any copies, translations and extracts lurking elsewhere on the Web are not under my control and are probably out of date ... but equally they may be *better* than this version!

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By [Gary Hinson ZL2iFB](#)

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Recent changes to this document (the **New** stuff)

Version	2019/20	Changes made
2.28	Mar 29 th	Tip on timing for DXpeditioners . Update re JSCall v2.1 .
2.27	Oct 21 st	Tip on CQing-in-sync . Notes on recent JTDX improvements including FT4 support.
2.26	July 16 th	WSJT-X 2.1.0 supports FT4 . New tip on checking your filter widths .
2.25	July 13 th	More info on FT8 message types and GFSK shaping .
2.24	July 7 th	New tip on grid mapping .
2.23	June 25 th	Various little tweaks, nothing particularly noteworthy.
2.22	June 7 th	More advice on calling DX stations . Tweaked the FT4 notes . Mentioned the cool JTSummary digimode stats package .

1 Introduction and purpose of this document

1.1 I have been steadily compiling these notes since July 2017 in the course of making over 20,000 FT8 QSOs on the HF bands and learning how to drive the software. Some tips were inspired by suggestions from other FT8 users and by the [WSJT-X reflector](#) (worth joining). Many address **Frequently Asked Questions** and draw on my 40-odd years of HF DXing.

1.2 That said, these are just tips, *pragmatic suggestions* aimed at making FT8 easier and more effective to use on the HF bands. They are *not* rules or laws! The digital modes, protocols and programs are being actively developed, while the operating conventions or habits on-air are still evolving. Other approaches may be *even better* than those I suggest here, and that's cool.

1.3 In particular, I must point out that I am a keen HF DXer with *zero* experience using FT8 intentionally for meteor/rain/aircraft scatter, EME, topband and VLF, 6m and up *etc*. I have only used FT8 on 80 through 10 metres. Hopefully much of the advice here is useful in other contexts (*e.g.* topband DXing) but different techniques may well be appropriate and necessary, in which case please look elsewhere for guidance. Likewise for other modes such as JT9 and MSK144.

Some of these tips (such as split operating, tail-ending and using low power) are contentious and not universally adopted by FT8 users – and that's fine. To an extent, we are figuring this stuff out for ourselves as we go along, which for me is all part of the fun. These tips work for me. Your situation and preferences may differ. By all means try out different approaches ... and do [let me know](#) if they work better. 😊

I am primarily a Microsoft Windows ~~sufferer~~ user. WSJT-X is an impressive example of multi-platform coding that works on Linux, MacOS, Windows (XP and up) and other platforms, with only minor differences ... but since I only run it on Windows 8.1, please don't bombard me with rotten tomatoes if things don't quite work as described on *your* system.

RTFM! Seriously, please study the docs! The FT8 software installation instructions, [online user guide](#), built-in help and tooltip popups will help you install, configure and start using the software with your computer and rig. **Most initial issues, problems and queries are answered therein, plus there are useful tips.** This “Operating Guide” is intended to help you get the best out of FT8 from an operational perspective *after* you have it up and running. If you still have issues after all that, please **search the online support forum archives** ... and *finally* feel free to ask for help on the forum. The developers are better at designing, developing and refining the protocols and software than answering basic queries so please have some consideration!

Important disclaimer

We are all individually responsible and indeed accountable for complying with our licenses plus applicable laws, regulations and conventions that may, for instance, specify permitted powers, modes and bands/frequencies (*e.g.* on 60m), or impose obligations concerning remote operation, on-air identification (*e.g.* prohibiting “/QRP”) and logging. Just because the software allows us to do something does not necessarily mean it is legal and appropriate for us. ***Neither the development teams, nor the author of this guide, are responsible for your compliance. You are!***

2 START HERE

2.1 Use the **latest available release** of the FT8 software. You have a few program choices:

- **WSJT-X** was written by the team that *invented* the mode (*the original and best*, you might say!). In the best tradition of amateur radio, WSJT-X is open-source, hence others are developing variants (derivatives) of the program, changing the user interface and in some cases meddling with the decoding and encoding under the covers.
- **JTDX** by [Igor UA3DJY and team](#) is a stable, usable variant with several helpful tweaks to the user interface. It is similar enough to be familiar to anyone who already knows WSJT-X. Although sadly the official JTDX documentation is out of date, see [Appendix D](#) for tips on using JTDX.
- The user interface in **MSHV** by Christo LZ1HV is a little different. MSHV enables semi-rare DX stations to make several QSOs in parallel using the regular FT8 protocol (*not* fox-n-hounds DXpedition mode – more hunt saboteur mode) ... at the cost of increased transmit bandwidth (higher band occupancy) and less power per signal. The multi-QSO facility does not work in [contest mode](#) (thankfully!) and *should* not be used in the normal FT8 sub-bands.
- Logging programs (such as [Logger32](#) and [N1MM+](#)) can interface to FT8 programs, effectively using them as software-defined modems. Maybe one day the loggers will take over *all* the sequencing, highlighting and logging duties, leaving just the message coding and decoding to the relevant utilities (soft modems), but for now the programs interface to share the tasks.
- **JS8call** by [Jordan KN4CRD](#) is a derivative that re-purposes the core FT8 digital transmission protocol to enable longer free-text messages to be exchanged. This allows a more conversational style of QSOs at the same leisurely rate of about 5 words per minute. As with plain FT8 and in contrast to CW, RTTY and PSK, messages are sent *blockwise* as heavily-compressed messages, not as individual characters. IT REMINDS ME OF TELEX <STOP> Or Twitter. Or simplex traffic handling <OVER>

2.2 Software updates are frequent with all variants as bugs and flaws are discovered and fixed, and new functions are released for alpha or beta testing. If imperfect/incomplete software makes your blood

boil, give FT8 a wide berth and keep your cool. If you prefer reasonably stable and reliable software, stick with the production releases, avoiding the betas and definitely the alphas.

Aside from 'alpha', 'beta' and 'production' there are other, roughly equivalent terms. WSJT-X has its 'Release Candidates' and 'General Availability' versions. JTDX uses 'Evaluation versions', 'Step releases' and 'General releases'. Some say tomaytoe, some say tomahtoe.

It's worth checking for new versions of the software – and this guide – every so often. Make it part of your routine *e.g.* at the start of the weekend or month.

Read the [WSJT-X v2.1 User Guide](#).

Please, read it. Study it. Ingest it. Memorize it.

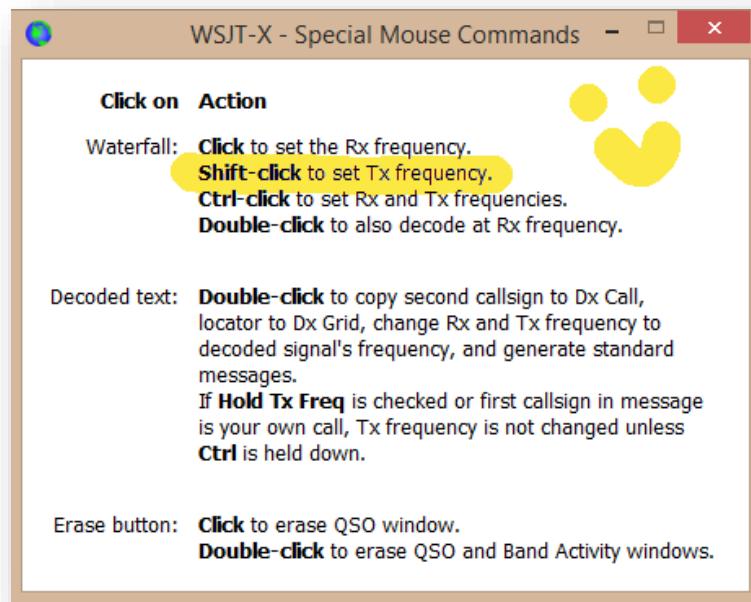
Banish dumb questions! Be like FT8 boss!

This applies even if you use JTDX.

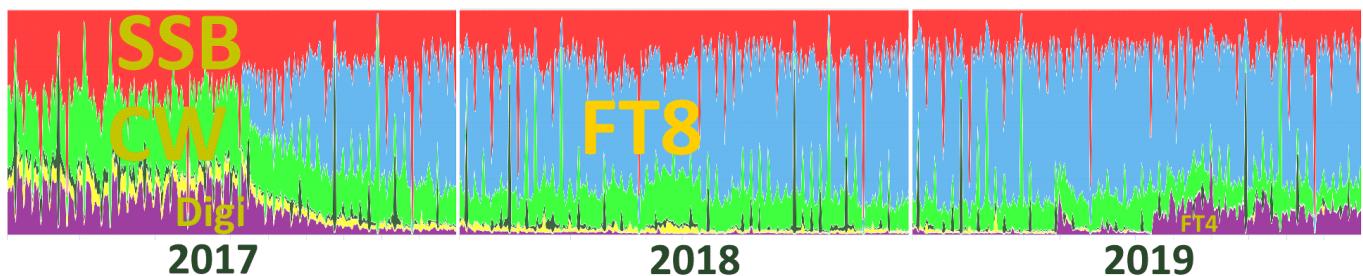
2.3 With your chosen software running, press F1 and study the help file/manual. The WSJT-X help is well written, if I say so myself. You'll discover, for instance, that the confusing combinations of shift, alt or control keys and clicks are handily explained on the screen by pressing **F5** to "Display special mouse commands". By far the most useful combination in WSJT-X is to **shift-click** on the waterfall to put your transmitted signal there (think of it as '**shift my Tx**'). If nothing else sticks from these notes, at least remember to **shift-click ... or right click in [JTDX](#)**.

Although not yet shown on the pop-up help, we can also **right-click** on the WSJT-X waterfall and then click the only option to set *both* Rx and Tx frequencies **right there**¹.

2.4 From time to time, check for updates to the digimode software, as you should for all the other software on your system. Most applications, operating systems and drivers are updated or patched occasionally, addressing bugs and flaws or adding new facilities (potentially including changes to the FT8 protocol itself). WSJT-X does not automate this for us but it's not hard to [check the website](#). New releases are announced on the [WSJT-X reflector](#) and the news soon percolates through other ham radio forums, plus on-air of course. It's much the same with [JTDX](#) and [MSHV](#): join the online communities or monitor the authors' websites to keep up with developments.



[Data](#) from Club Log, [graphed](#) by LA8AJA, annotated by [ZL2iFB](#):



¹ Why we can't simply left-click to move the Rx and right-click to move the Tx in WSJT-X is beyond me. Much more intuitive ... and works perfectly in [JTDX](#).

3 **Important: accurate timing**

3.1 Check your computer's clock. Accurate timing is quite important for FT8: **if your computer clock is wrong by more than a second or so, you will probably experience problems** e.g. few responses to your CQs and being ignored whenever you call others.

Note: despite what some may claim, extreme millisecond accuracy is **NOT** required. FT8 signals contain distinctive synchronisation sequences that the receiving systems use to identify the data portions in the received audio stream. Accuracy to the second is plenty good enough in practice.

If you see plenty of FT8 signals on the waterfall but few decodes, blobs that cross the horizontal tramlines on the waterfall and/or a distinct bias in the DT values on the decode, those are strong clues that your computer's clock may need resetting.

If your computer is Internet-connected, it's easy to check the clock by [browsing the Time.is website](#). If your clock is accurate, you should see something like this ▼



3.2 JTDX displays a rolling average of the dT values in the header to the left hand band activity window ► On a busy band, if *everyone else* seems to be a bit early or late, chances are that your own clock is wrong since many of us are using accurate atomic clock references. As noted above, an average DT value between -1.00 and 1.00 is fine in practice since JTDX can still decode reliably even with DT of 2 seconds (e.g. if a DX station's clock is a second fast while our clock is running a second slow). Beyond those values, adjust your clock.

3.3 Manually adjusting your system clock soon becomes annoying, trust me. There are better ways. For starters, pop open the computer lid and check/replace the button-cell battery that should keep the real time clock running even when the PC is powered down. Provided you have Internet access, the [free Meinberg NTP software](#) maintains clock accuracy, initially by synchronising your PC time to reference time servers on the Internet using [Network Time Protocol](#) designed for that purpose, and then micro-adjusting the clock rate to remain synchronised (rather than just periodically resetting the clock, which is the more common but cruder approach). Install, [configure](#), check, forget: it's that [easy](#) with Meinberg NTP. If Meinberg doesn't suit you, there are several alternatives such as [BktTimeSynch by IZ2BKT](#), [Dimension 4](#), [TimeSynchTool](#) and [many others](#), each with their fans.

3.4 Recent versions of Windows Server and Windows 10 offer an updated W32Time time service called [accurate time](#) with markedly better timing capabilities, claimed millisecond accuracy (under [defined conditions](#)) and [lots of configuration parameters and registry settings](#). It can be started, stopped, configured and queried from an elevated command prompt e.g.

C:\> w32tm /config /update /manualpeerlist:pool.ntp.org,0x1

... where:

- **/config** means we are reconfiguring the W32tm Windows time service
- **/update** means apply the config changes to the service
- **/manualpeerlist:** means we want to specify NTP time servers other than the Windows default server time.windows.com
- **pool.ntp.org** tells the system to choose a nearby time server from the global pool. There are several regional pools (e.g. oceania.pool.ntp.org) and country pools (e.g. nz.pool.ntp.org) or you can name one or more specific time servers instead (separate their addresses with commas)
- **,0x1** is a flag meaning use the ‘special poll interval’ for this server, where ‘special poll interval’ is a fixed value in seconds defined in the registry under this key:

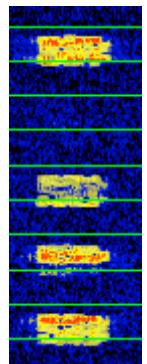
HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\W32Time\TimeProviders\NtpClient

e.g. a SpecialPollInterval of 600 decimal means poll the time server every 10 minutes.

If you are unconcerned about the accuracy of your clock but simply want to work someone with timing issues, you can deliberately nudge your clock forward or backward manually. You may notice their blobs don’t line up with the horizontal timing lines on the waterfall, as in this example ► YD3BGM’s messages were decoded OK ▼ with a DT of -2.4 seconds (i.e. he was transmitting 2.4 seconds early, relative to

013800	2	0.3	1387	~	CQ YD3BGM OI61
013815	Tx		1324	~	YD3BGM ZL2IFB -01
013845	Tx		1324	~	YD3BGM ZL2IFB -01
013900	5	0.2	1387	~	CQ YD3BGM OI61
013915	Tx		1324	~	YD3BGM ZL2IFB -01
013930	2	0.2	1387	~	ZL2IFB YD3BGM R-07
013945	Tx		1324	~	YD3BGM ZL2IFB RRR
014000	4	0.2	1387	~	ZL2IFB YD3BGM 73
014015	Tx		1324	~	CHK UR CLOCK
014045	Tx		1324	~	2.4S OFF HI
014115	Tx		1324	~	GL 73 ZL2IFB
014130	1	0.1	1387	~	CQ YD3BGM OI61

my computer clock). On the headphones, I heard his tones starting well before other stations using the same timeslots. First I called him several times without success, despite the path being wide open between us. Guessing that he



might be using software with less tolerance on timing, I clicked to open the Windows system clock ► opened the change date and time settings function, clicked the **Change date and time** button, clicked the **seconds** part of the digital clock, clicked the up arrow 2 or 3 times to advance my clock by about 2 or 3 seconds (deliberately making my system clock inaccurate!), then clicked OK to set the clock. After checking the decodes to confirm that his DT was reduced, I responded to his CQ call again and this time we completed a QSO easily. I closed with a free-text message

Tip: to move his blobs up the waterfall, click the up arrow.

“CHK UR CLOCK” ... which he evidently did a few minutes later. Meanwhile I had reset my own system clock until the [time.is website](#) showed it was within a second of the correct time ► Meinberg NTP (which I simply left running throughout the process) adjusts the clock rate to correct it gradually from there and maintains millisecond accuracy until the *next* time I run into the same situation.

3.5 From time to time, the FT8 reflectors suffer zombie outbreaks whenever someone naively asks what is the best way to set their system time, or suggests some other way to meddle with the time settings. GPS pucks, Raspberry Pies, WWV, mean(DT), clock-nudgers and other such ideas have all come up, repeatedly, been kicked around for a while before eventually slipping back to the graveyard ... until the *next* outbreak. For all home-based hams, **any suggestion not involving a definitive time reference is fundamentally unsound.** Those involving atomic clocks may be viable ... but are generally trumped by “Use an NTP time server from the pool” if you are Internet-connected, or “Use GPS” if not. How to do that is simply a matter of personal choice. There is [plenty of advice on the web](#) already.

Time.is

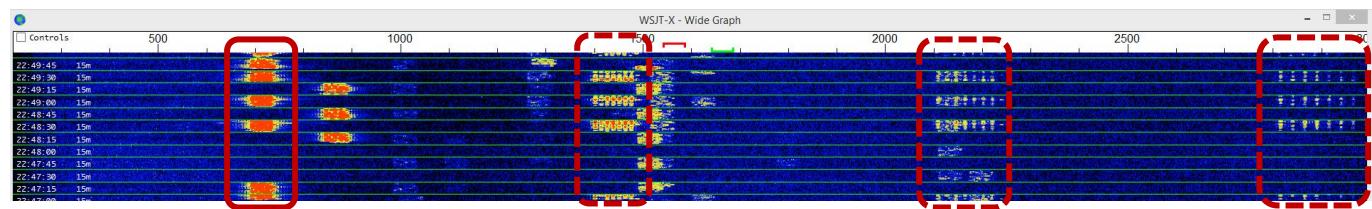
Your clock is 0.2 seconds behind.

If you are offline (perhaps clinging precariously to a mountain peak on a SOTA expedition, or on a remote IOTA DXpedition), you can use a GPS receiver or radio time standards such as [WWV](#) to check and adjust the computer clock. Even a reasonably accurate quartz watch will do provided it was recently checked against a reliable time reference *before* you set out. **New** Alternatively, simply listen to the FT8 signals on a lively band to figure out when most of them start and stop: that's your cue to set your clock. *[Thanks Rod YJ8RN for the tip]*

4 **Important:** transmit levels

4.1 Although FT8 is a constant-carrier FSK mode (unlike PSK, CW and SSB), overdriving will distort and widen your signal (making it less likely to decode) and may generate spurs. **Set the transmit levels so that the entire chain from AF generation through to RF transmission is operating linearly.**

4.2 If you set your transmit levels as badly as the FT8 station ringed in red on the left ▼ you may unknowingly be generating 'ghostly barcodes' (in the 3 dotted rings): despite looking like some obscure new digimode, these are audio harmonics caused by generating too much audio output from the PC sound card which overloads the audio input circuits in the radio: *[Tnx tip Bill G4WJS]*.



4.3 Setting your transmit levels is a bit more complicated than it seems: **simply adjusting the rig's power output control is not sufficient** as even QRP signals can be rotten if the rig's audio is overloaded and distorted.

4.4 Take care adjusting the audio output level from the sound card and audio input level to the rig: **consult your radio manual** to find out how to set the audio drive level properly. On some rigs, the ALC meter is, in effect, a distortion meter: *any* non-zero ALC indication is bad news. On rigs that use ALC to control the power output (e.g. Icoms), high ALC indication is normal at QRP levels, so it's not much help for setting the audio input. On the Elecraft K3, set the PC sound card output (using the sound card headphone level slider and/or the "Pwr" slider on the WSJT-X/JTDX main window) and the K3's line input level (confusingly, using the front panel "MIC" control) to indicate 4 blobs on the ALC meter with a flickering fifth blob indicating the onset of ALC action ►

Sorry I can't be more specific here. If you are unsure, err on the side of caution: **keep your PC audio output level low**, just enough drive to generate some RF output (you don't need much!).



Listen to your transmitted audio using the rig's monitor function – maybe not *all* the time but it pays to listen occasionally just in case, for some reason, you are transmitting distorted audio, PC bleeps, DX announcements, wideband noise, coughs or whatever. Watch your power meter too for clues that something might be amiss.



◀ The [Spinal Tap approach](#), also known as Mediterranean Syndrome (“All knobs to 11”) will create more mayhem and complaints than FT8 QSOs. Resist the urge.

With many FT8 stations using QRP, someone running, say, 100 watts or more stands out from the crowd ... but not in a good way, especially if they are not hearing callers. Similarly, those running 50 watts to large beams on a wide-open band: that's a lot more ERP than most FT8ers. However, QRO may well be necessary and appropriate on marginal paths.

4.5 Aside from QRO being antisocial and usually unnecessary, if your signal is *too strong*, it may be dirty and may overload receivers and audio cards at the DX end, preventing your signal from decoding reliably. Take your cue from the signal reports you receive: if you are getting positive reports, you can probably do just as well (maybe even better) with a fraction of the power. Remember: decibels are logarithmic. Cutting your power in half will reduce average reports by just 3 dB; cut it by half again to lose another 3 dB, and so on. If you are receiving mostly negative or zero reports, you are in the right region. I normally adjust my transmit power to get reports between 0 and -10 dB. If you receive a 58 report ► but you're *not* using SSB, something may be seriously amiss!

Automatically report callsigns and reports to PSK Reporter by selecting **F2 Settings → Reporting → Network Services → Enable PSK Reporter Spotted**. On the [PSK reporter map](#), if others receive you much stronger than you receive them, your receive capabilities need some attention, and/or you may be running excess power. [Tnx tip Martin GOHDB]

001615 -12 0.2 1665 ~ AL2V AE5JH EL07	
001615 -12 0.2 1804 ~ CQ DX KW4JY FM05	~U.S.A.
001615 -10 0.3 2169 ~ K5AGC K4HVF 73	
001615 58 0.8 1448 ~ CQ N2NL EL97	~U.S.A.
001630 -11 0.2 240 ~ W5TCB K7AHF RRR	
001630 0 0.7 375 ~ CQ NE N2DPF EM12	~U.S.A.
001630 -11 0.4 803 ~ N8TL AC9E -08	
001630 -13 0.4 832 ~ CQ AK W7IGC	~U.S.A.

4.6 If you are routing transmit audio from the sound card to the front-panel microphone input on the rig, be sure to turn off the radio's speech processor and any audio shaping/profiling when using digimodes to avoid distorting your signal. Radios with a rear-panel line-level input especially for digimodes, or a special 'data' mode that automatically disables the processing (such as the K3), tend not to suffer issue. [Thanks for the tip Joe W4TV]

“These modes are not designed for long conversations or ragchewing. Rather they concentrate on efficient exchange of such basic information as call signs, Maidenhead grid locators, signal reports, and acknowledgements at the lowest possible signal-to-noise ratios, in the space of a few minutes or less.”

[“Work the World with WSJT-X, Part 1: Operating Capabilities”](#)

4.7 Although FT8 is a weak signal mode, not a QRP mode *per se*, **please keep your transmit power down**. Be nice! Generally on HF, *if a path is open*, just a few watts will do. Put your amplifier on standby. Turn down the wick to QRP levels. Try it! If you don't get any responses at all, try 10 watts, maybe 20 or 30. If you find that you *routinely* 'need' 100 watts or more, that is a strong hint that your feeder and antenna system are inefficient, or you are flogging dead bands. Check for corrosion and loose connectors. Try making a simple halfwave dipole as a comparison antenna. You will find that you can receive better if your antenna is in good shape, and – trust me – good reception is *kinda useful* for DXin'.

4.8 Near the low end of the range, **Signal-to-Noise Ratios** are of dubious value due to how they are calculated ►

The SNR figures compare the strength of the signal (50 Hz wide in the case of FT8) to the noise across the 2½ kHz bandwidth typical of an amateur SSB receiver: that's 50 times the signal bandwidth (17 dB). So a -17 dB SNR FT8 signal is on a par with the noise, making it virtually inaudible. For comparison, CW is copiable by ear down to about -15 dB, slightly above the noise ▼

There are situations where QRO, up to your license limit, is both appropriate and necessary, for instance CQing on a closed band, hoping to catch DX as the band opens, or calling someone weak (below, say, -20 dB). Occasionally, we experience one-way propagation as if there is a giant diode in the ionosphere: DX stations are loud but cannot hear us. Maybe they have high QRM their end. Maybe there is a tilt in the ionosphere. Maybe they have badly designed or operated systems.

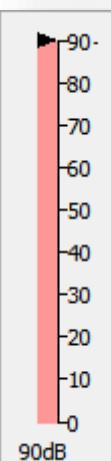
"All SNR values from the decoder limit down to minus infinity lie just below the decoder threshold and estimates of SNR near that threshold can have huge variance despite only being a few percent different in signal strength. The WSJT-X decoders limit these potential outlier estimates to an artificial floor which is known to be just below the lowest possible true SNR value achievable from the mode as determined by rigorous application of information theory." [Tnx Bill G4WJS]

Weak-Signal S/N Limits

Mode	(B = 2500 Hz)
SSB	~+10 dB
MSK144	-8
CW, "ear-and-brain"	-15
FT8	-21
JT4	-23
JT65	-25
JT9	-27
QRA64	-27
WSPR	-31

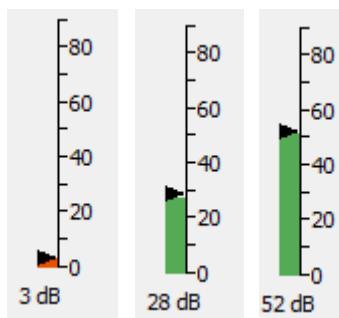
The cough gauge ►

"I also noticed by accident that when I cough the gauge goes up into the red."
Ah, that'll be because your PC microphone is active. Try selecting the soundcard connected to your rig. Or does up on cough syrup.



5 **Important:** receive levels

5.1 The bar graph audio level meter in WSJT-X or [JTDX](#) should normally read *about 30 dB* on a 'dead' band, increasing to about 50 dB on an active band with about a dozen stations QRV simultaneously, higher still on an HF band buzzing with life and lots of strong FT8 signals. If the level goes too high and turns red, you are reaching the compression point in your sound card and may be over-driving it, causing distortion and sampling errors in the ADC (Analogue to Digital Converter) that, in turn, reduce the ability to decode FT8 signals. You might even damage your sound card.

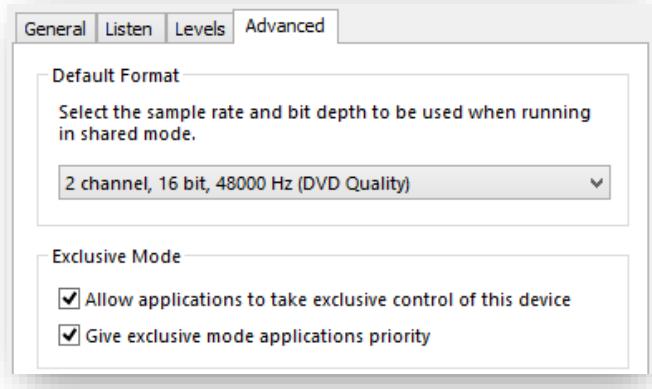
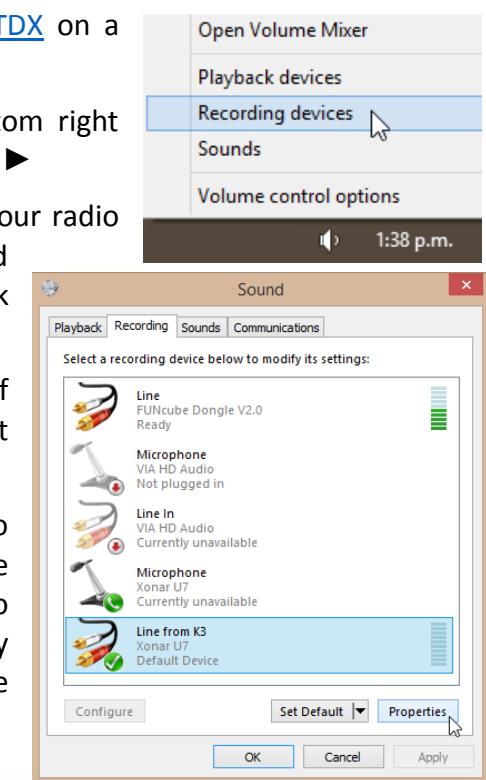


▲ The WSJT-X bar graph is curiously reminiscent of Star Trek's medical bay 😊

The bar graph bar should normally be green, showing acceptable levels. If it turns red, the level is probably too high (causing distortion, apparently wide signals and poor copy) or too low (no input meaning no signals to copy!).

5.2 Here's how to set the audio input level to WSJT-X or [JTDX](#) on a Windows system, step-by-step:

- Right-click the Windows loudspeaker icon at the bottom right corner of your main screen and select *Recording devices* ►
- Select the sound card input that receives audio from your radio (preferably a "line" input if there is one on that sound card, otherwise the "microphone" input) then click *Properties* ►
- Select the **Levels** tab and set the slider near the middle of the range. Hopefully it is most linear in this region. Trust me, it doesn't need to be *precisely* in the middle.
- If there is a balance control, set both audio channels to the same level. On a radio with dual-receivers feeding the left and right channels on a stereo output, or with two radios, you may want to monitor each channel separately with two instances of WSJT-X or [JTDX](#), for example monitoring FT8 and WSPR simultaneously.
- Click OK to close the **Levels** tab, then open the **Advanced** tab ►. Check that the default format is 48000 Hz (DVD Quality), the preferred sampling rate for WSJT-X and [JTDX](#). The *default* default rate is often 44100 Hz (CD Quality): converting that to 48000 Hz wastes CPU cycles, creates resampling errors and degrades decoding - best avoided if 48000 Hz is available and works on your system (it may not). 16 bits are sufficient: more is OK.



- Click **OK** and **OK** again to exit the Windows sound settings.
- Launch WSJT-X if it is not already running². With your radio OFF, check the bar graph at the bottom left corner of WSJT-X main screen. The level should be at or near zero, flickering red. There may be a few dBs of noise generated in your sound card, or a little stray pickup on its input (e.g. some AC hum if it is poorly shielded). If you see a lot of input, something is wrong. Check that you have selected the radio audio input to WSJT-X under **F2 Settings → Audio**. The input should show the sound card line or microphone input from the radio that you checked/adjusted above.
- Now turn ON your radio and tune to a quiet band, with the attenuator off, RF gain up high and preamp set as normal. You should hear just a little background noise on the radio - band noise plus noise generated in the receiver itself. **The bar graph in WSJT-X should be read about 30 dB**. You may need to adjust the audio output level from the radio (the Line Out level if you have that facility, otherwise the AF level) and until WSJT-X shows *about 30 dB*.
- If your radio has a *fixed* (non-adjustable) line level output or one that cannot be reduced to *about 30 dB* on a dead band, have you plugged the radio *line* output into the *microphone* socket on the PC sound card by mistake? Or have you selected the microphone input rather than the line input on the sound card? Check the labels on the sound card inputs and the sound card settings. If there is no "line in" but only a "microphone" input, and no way to turn off the microphone preamplifier in the sound card settings, you might need an external attenuator (e.g. a potentiometer) in the audio lead from your radio to reduce the audio level feeding into your PC sound card, or you may need to use the radio's headphone output rather than the line out, using the radio's AF gain control to set the quiescent level on the WSJT-X bar graph to (yes, you guessed it) *about 30 dB*.
- Now tune to band that has some life in it, using the band selector on the WSJT-X main screen. You should hear FT8 signals on the radio and see signal blobs on the waterfall. The WSJT-X bar graph should read about 40 to 70 dB³, still in the green, and after a period or two you should see some decodes appear.

Clap your hands or shout out: if you see the bar graph level flick up, you may have selected the PC's microphone rather than the radio input! Oops. Easily done.

In contrast to VHF/UHF, there are usually *lots* of strong FT8 signals on the HF bands at peak times: "weak" HF DX signals are generally only weak *relative* to other HF signals, rather than weak in absolute terms relative to the noise floor, so strong signal handling and dynamic range tends to be more important than sensitivity on HF.

It might be worth comparing different USB ports for your USB sound system or rig connection: some are noisier than others in my experience.

If there is so much band activity that the bar graph is near the top of the scale and turning red, turn off the radio's preamp, turn on the attenuator and/or reduce the RF gain to bring the levels back down to the green zone.

That's it, you're done! To avoid having to repeat this whole process, you might like to make some notes about the settings though, just in case 'someone' fiddles with 'something'.

² If your radio has a built-in sound card and USB interface, you won't be able to use the sound card while the radio is switched off ... but to simulate no audio input, maybe you can tune to a dead band and disconnect your antenna? [Tnx tip VE3AND]

³ The dB values here are decibels relative to a reference level, the digitized signal value 0001.

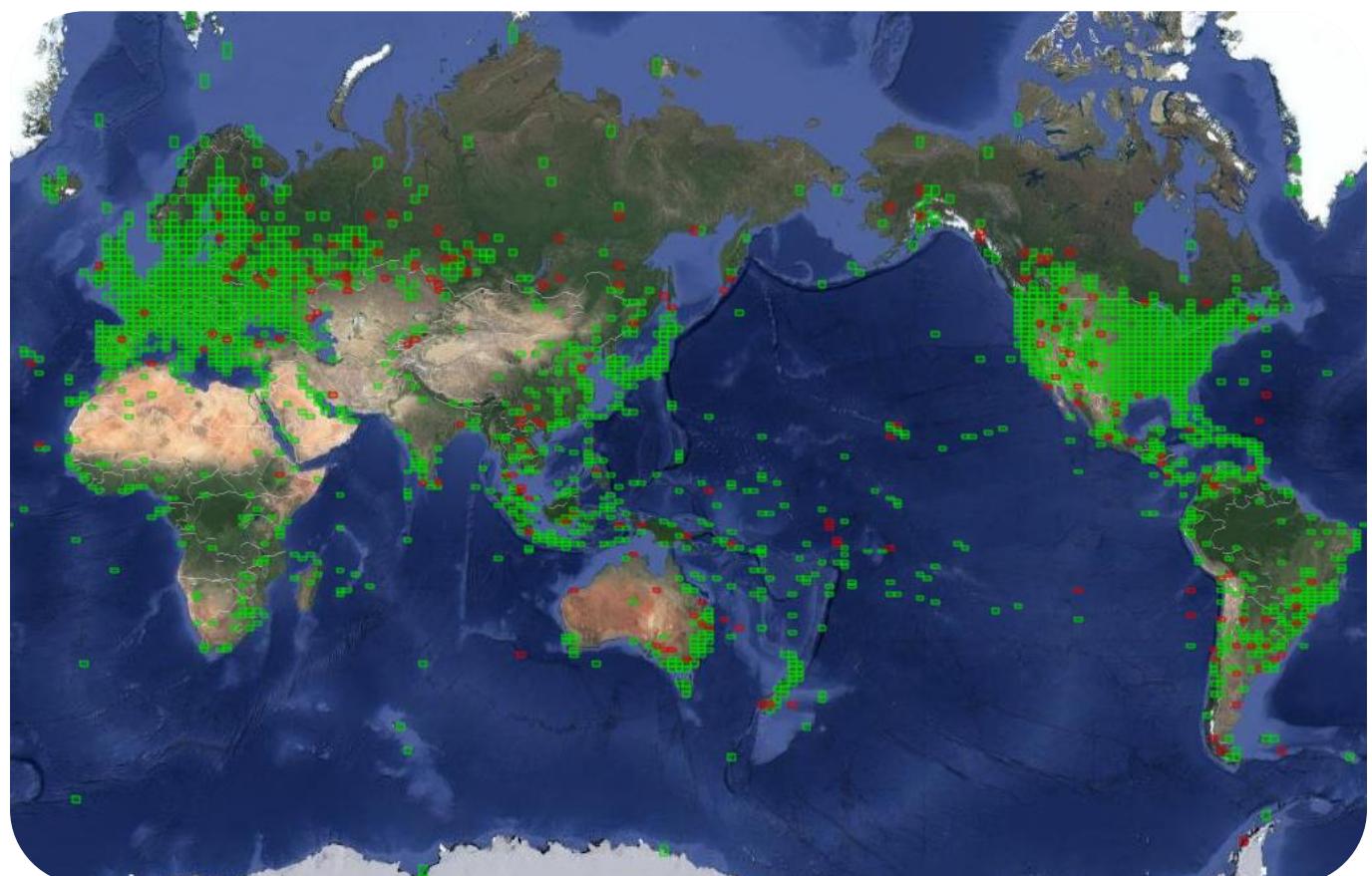
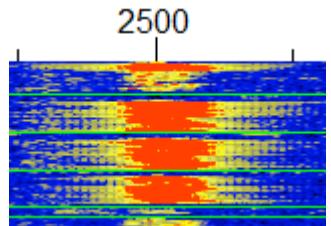
5.3 Even having set up your receive levels carefully, and if you are using a high quality modern rig with a high dynamic range, particularly strong signals often *appear* wider than others ... but don't be too quick to blame it on someone running excessive power and splattering. They may be locals, and if they are DX it could just be that the path happens to be wide open between you.

When conditions are favourable, I've often seen genuine QRP DX signals showing plenty of red on my waterfall. Remember, FT8 is *designed* for weak signal DXing.

The yellow fuzz either side of a solid red blob like this ► is probably just a display artifact *i.e.* low-level skirts on the digital filter that generates and colours the waterfall. Despite appearances, most FT8 signals are clean in fact. That said, I would avoid CQing close to a strong signal like

More tips about using your [filters](#) and [AGC](#) below.

this (in the fuzzies), even if I chose to transmit at the same time as him. There are generally better places elsewhere.



“Many amateurs have completed WAC, WAS, DXCC, and other awards using these modes, often with low power and simple antennas.”

[Work the World with WSJT-X, Part 1: Operating Capabilities](#)
K1JT, K9AN and G4WJS, QST October 2017

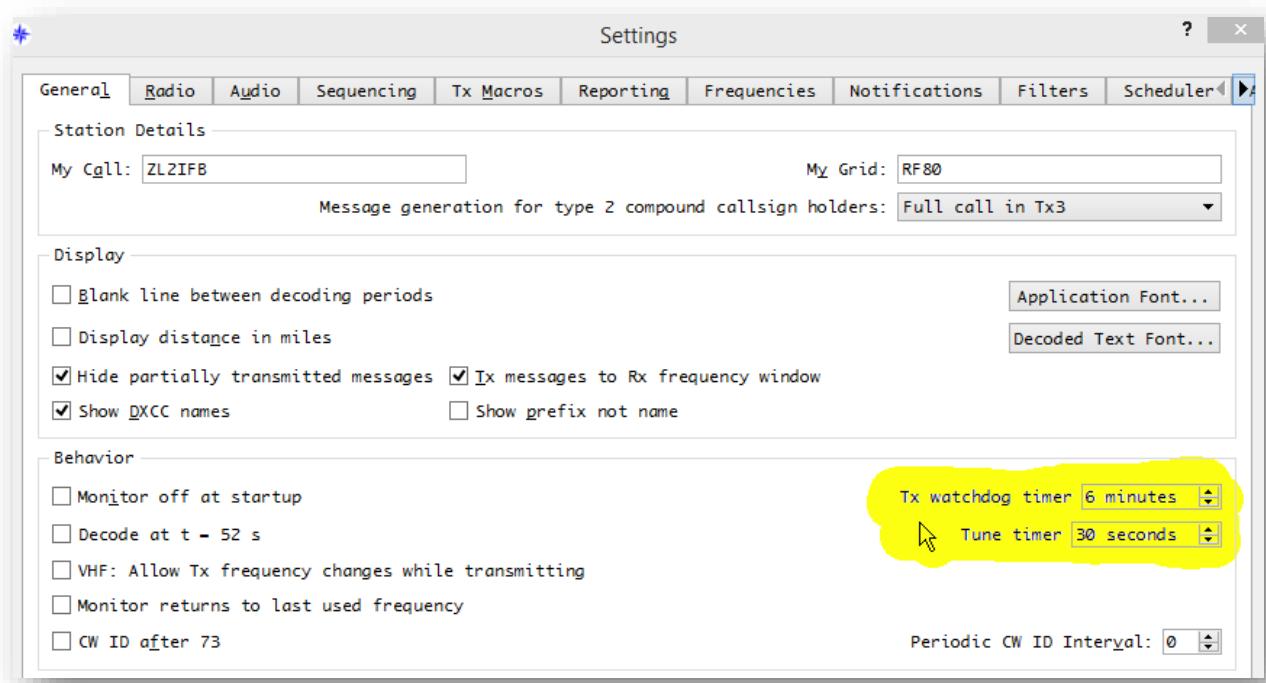
6 Other software settings

6.1 In WSJT-X, select (tick, check) the **Hold Tx Freq** option. In [JTDX](#), click the **Tx/Rx Split** button to turn it green. Leave it selected to avoid your transmit frequency being continually jumping or being pulled around by successive callers⁴. Even with **Hold Tx Freq** or **Tx/Rx Split** turn on, you can still put your Tx where you want by **shift-clicking** the WSJT-X waterfall or **right-clicking** the [JTDX](#) waterfall, and you can call someone on their frequency (simplex) if you really must: simply hold Ctrl as you double-click their CQ message, or **shift-click/right-click** your Tx to their frequency, or click the up-arrow button to move your Tx frequency.

6.2 The watchdog (WD) timer is a [vigilance control](#). If the operator appears to have dozed-off during a defined period, the trusty automatic watchdog springs to life, shutting off transmissions that would otherwise continue indefinitely, displaying a red warning message. There are two things you can do to stop this:

1. Kick the watchdog! A click anywhere in the window (even *between* the buttons) tells the watchdog you are still awake and unexpired, resetting its countdown timer.
2. Give yourself more time. You'll find the starting value for the countdown under **F2 Settings** then **General** for both Tx watchdog and Tune ▾

It's not good practice to transmit for too long without a break: I recommend taking a breather after 5 or 6 minutes max. The WD timer counts down in the bottom right corner of the main window. When the time is up and the Tx disables, it's worth checking that your transmit frequency remains clear of QRM at the times you would be transmitting. In fact, it's not a bad idea to QSY anyway since you may be QRMed by someone too weak to see, or perhaps coincidentally they have been bitten by *their* watchdog at the same moment as you!



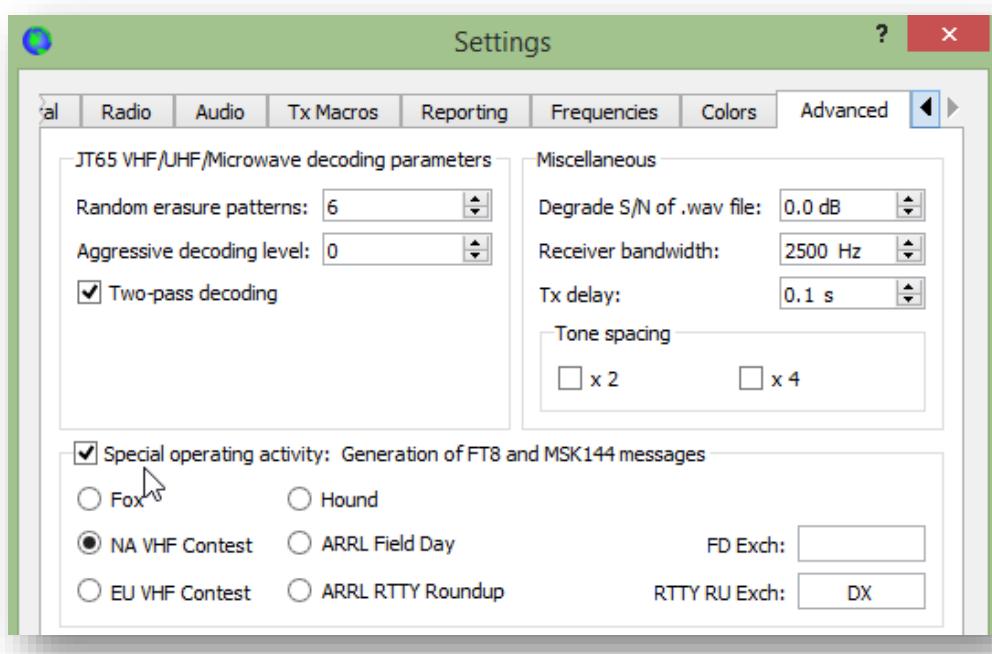
⁴ Keep an eye on it. After changing to fox-n-hounds mode and returning to normal, the option was silently deselected due to a bug in one version of WSJT-X.

6.3 In DXpedition mode with WSJT-X, the hounds' watchdog timers are fixed at 3 minutes. After calling the fox 6 times, our transmitters are automatically disabled if we haven't had a reply. We can simply click **enable Tx** to continue calling the fox ... but it's a good idea, first, to take a moment to check that our Tx frequency remains clear during the even periods when we would otherwise be transmitting.

We are more likely to be heard by the fox on a clear frequency. This is *DXing 101*.

6.4 If you inadvertently select one of the [Contest options](#) under **F2 Settings → Advanced**, you will be perplexed to discover weirdness in your generated messages and sequences▼ Deselect **Special operating activity** to resume normality.

Stop tinkering with random settings or you'll be sent to the naughty step!



6.5 Select **Auto Seq**. Auto-sequencing works well with FT8, reduces operator stress and cuts down on newbie operating errors (e.g. not selecting the next message in time, or not the correct one anyway). If **Auto Seq** gets it wrong, override the auto-selected message by quickly clicking the Tx message button for your choice of message during the first few seconds of your transmission: this may be needed to recover from a sequence error.

Alternatively, there's the 100% manual option ►

6.6 Pick a readable font type and size under **F2 Settings → General** tab, particularly for the decodes. Personally, I prefer *sans serif* fonts with the slashed zero such as Consolas. Your monitors, eyes and preferences may vary, so fiddle with the fonts and font sizes until you're happy. FT8 is an experimental mode after all!

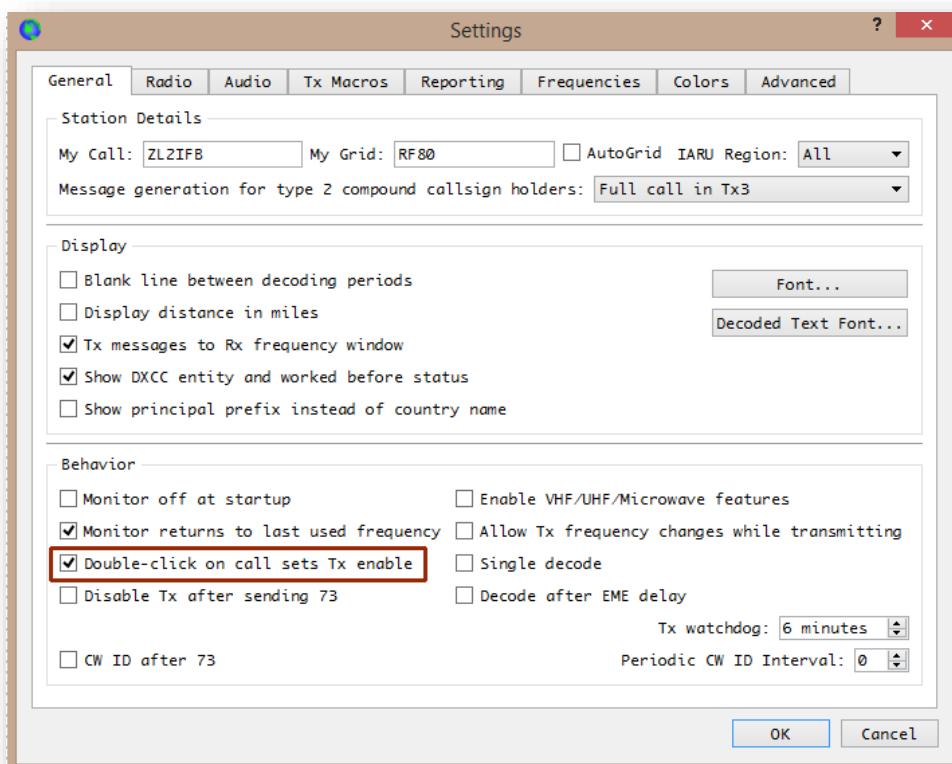
"The auto sequencer is doing the equivalent of double-clicking each response from your QSO partner ... A QSO will be 'correctly' sequenced by double-clicking each of your QSO partner's responses as they arrive. This is how you would normally use the application in modes without auto-sequencing like JT9 and JT65 although, of course, you can click through the next message manually as well: automation is an aid not a necessity." [tnx Bill, G4WJS]

7 How to respond to a CQ, or call a specific station

7.1 First set things up:

- Set up WSJT-X or [JTDX](#) to control the rig using CAT;
- Set the [receive](#) and [transmit](#) audio levels and the rig's [power](#) level correctly;
- Find a clear slot on the waterfall and **shift-click** (WSJT-X) or **right-click** ([JTDX](#)) to set your transmit frequency there;
- Enable/select **Auto Seq** and **Hold Tx Freq**;
- Check the **WSJT-X F2 Settings** → **General** and select **Double-click on call sets Tx enable** ►

Show **DXCC entity and worked before status** highlights decoded CQ messages that are new ones for you on the *Band activity* pane.



Double-click on call sets Tx enable makes it dead easy to respond to a standard CQ message: when you double-click a decoded message, WSJT-X does several things for you:

- It puts the other station's callsign and gridsquare (if they sent one) into the **DX Call** and **DX Grid** boxes on the main window, displaying the short path beam heading (if they sent a grid);
- It generates the standard messages you will send, with their callsign and your report to them inserted;
- It selects the appropriate transmit period, even or odd according to the period the DX station is using;
- It copies the decode you clicked to the bottom of the Rx frequency pane on the right;
- It selects message Tx 1; and finally ...
- It sets **Tx Enable** so you will start transmitting when it's your turn.

Select **Tx messages to Rx frequency window** to see your outbound and inbound messages in contrasting background colours on the righthand pane. The [example QSOs in Appendix F](#) show this.

7.2 Before you double-click a decode to call someone, select a suitable transmit frequency. **Shift-click** (WSJT-X) or **right-click** ([JTDX](#)) on a clear space on the waterfall to put the red goalpost there.

“The CQing station doesn’t need to say up 3 or anything else. He will decode all stations in the audio spectrum. You can call him at 300Hz or 2300Hz and it won’t make any difference. They all display. You don’t have to (and don’t want to) move to his frequency. If there is more than one station calling him, they will hopefully be spread all over the audio spectrum, not causing QRM to the station trying to make a QSO or each other. If a bunch call on his frequency, they just QRM each other and the guy CQing will be working those who are *split*. Additionally, if he starts a QSO with someone close to your transmit frequency, your transmitter will be disabled so you don’t cause him QRM. If you are transmitting further away, you can keep calling him and he should pick you up as he works through the list of callers.” *[Tnx Gary AGON]*

A strategy for picking your Tx frequency

1. “Pick a clear spot at your own end, and hope it is clear at their end ... your initial strategy. Good for day time, low bands, not completely overloaded band conditions; fails too often on high band, super crowded conditions.
2. The frequency the DX station uses for Tx was probably clear when the DX started, but that frequency is also going to get clobbered by all the stations that do not operate split Tx/Rx.
3. If the DX station doesn’t hear you, pick a different frequency for the next transmission. If the contact appears to break down in mid-QSO, move your transmit frequency.
4. If you are going back and forth with a DX there is a sign he can’t hear you, move to the DX Tx frequency, it may be clear because other stations are standing by waiting for your QSO to end.
5. Pick frequencies near the edges of the band 200-500 Hz, 2200 to 2700 Hz, they tend to be less crowded. If the DX is near 2000, pick the high end and vice versa.”

[Tnx Jeff, WA1HCO]

7.3 You can call anyone you like ... but you’ll find it more productive to call stations you can actually copy, at the right moment. ‘Stations you can actually copy’ are the ones sending the *second* callsigns in messages containing two callsigns e.g.

There is a silent DE in most messages. “S9A ZL2iFB RF80” means “S9A **DE** ZL2iFB RF80”.

These messages were all sent by ZL2iFB:

S9A ZL2iFB RF80
S9A ZL2iFB -21
S9A ZL2iFB RR73
TNX NEW 1 73

These messages were all sent by S9A:

ZL2iFB S9A JJ30
ZL2iFB S9A -23
ZL2iFB S9A RR73
TNX TIPS GARY

If you intend to call S9A, the best way is to browse through the lefthand *Band Activity* pane to find a **standard message sent by S9A** (i.e. one with some other callsign first, *then* S9A, ending with a locator, signal report or RR73 message) and double-click that. Your system will normally start calling him at the start of his next listening period. If he is in QSO with someone, your transmission will be sent at the same time as the station he is working ... which may cause QRM unless you are transmitting on a clear frequency (hence the previous advice). If so, quickly click **Halt Tx** to stop transmitting and wait until the QSO is over before clicking **Enable Tx** to start calling.

7.4 If you cannot find a message sent by the DX station in your *Band Activity* lefthand pane, that's probably because you are not receiving him well enough to decode his messages⁵. There is little point calling him as you will probably not copy his response, if he hears and responds to you.

Please, only call stations you can copy! From the DX perspective, it is very frustrating to be called by people that are evidently not copying us. We waste our valuable time pointlessly responding to them when instead we could be working the deserving. Remember that DX stations are often in remote, low-noise locations, hence they hear pretty well. If you live in a town or city surrounded by nasty switchmode PSUs and other hams, you will struggle to hear the DX ... so wait patiently until you decode at least one message from the DX, and spend the time wisely. Try turning your beam, improving your station, locating and replacing those nasty switchmodes with nice linear supplies, or persuading your significant others that rural life is *wonderful*. The grass really is greener out in the countryside.

7.5 If the other station copies you calling him and responds to you, you'll see his response (usually your-callsign his-callsign his-report-to-you) appear at the bottom of the Rx Frequency pane, and **Auto Seq** will automatically select your next message to send (Tx 3 - with an **R** before the report confirming that you have Received his report to you). He'll respond with an RRR or RR73 message, and you will send your 73 message. The box will pop up prompting you to log the QSO and **Enable Tx** will be unset, and that's it, you're done!

7.6 If double-clicking a CQ message doesn't do anything, that is usually because the DX station is (perhaps inadvertently) using a free-text message rather than one of the standard predefined message types. The auto-responder doesn't recognise it as a CQ message, so doesn't know how to respond. Even if a free-text message happens to contain the string "CQ" (such as "CQ ZL2 MONKR"), it still isn't interpreted as a CQ message. The solution is either to double-click a different decoded line from the same DX station in the hope that it is a standard message, or manually type his callsign into the **DX Call** box, click **Generate Std Msgs**, select your Tx 1 or Tx 2 message⁶, and click **Enable Tx** to start calling him. This is a reminder not to get too fancy with your CQ calls.

7.7 Aside from **shift-clicking** the waterfall, another way to *shift* your Tx frequency is to nudge it 60 Hz LF using **shift-F11**, or 60 Hz HF using **shift-F12**.

If you change your mind after QSYing, these fixed-step nudges are readily reversed, whereas there is no easy way to revert automatically to your previous Tx frequency after **shift-clicking** or **right clicking**.

7.8 Keep an eye on the decodes while you are calling someone. DX stations sometimes disappear, perhaps temporarily or permanently going QRT, dropping in QSB or QSYing. If you notice other stations calling the same DX you are calling, stop transmitting for a cycle or two to figure out what's going on: maybe the DX has swapped between even and odd slots to evade a stalker. Make sure you are calling him when he is listening! Maybe he has moved a few kHz away to use DXpedition mode (fox-n-hounds).

Although there's a lot going on in the minute or so it takes for an FT8 QSO, most of it is automated ... and, trust me, it gradually becomes less stressful as you log more QSOs and gain confidence.

⁵ Browsing back through the *Band Activity* pane is a pain because it resets to the bottom as each new batch of decodes is displayed. We can stop it updating by de-selecting the *Monitor* button or turning off the receiver. One day maybe we'll persuade the developers to let us freeze the pane by mousing into it, thawing it when we click a decode or mouse away.

⁶ If you forget to select Tx 1 or Tx 2, WSJT-X will send your CQ message Tx 6 instead. Probably not what you wanted!

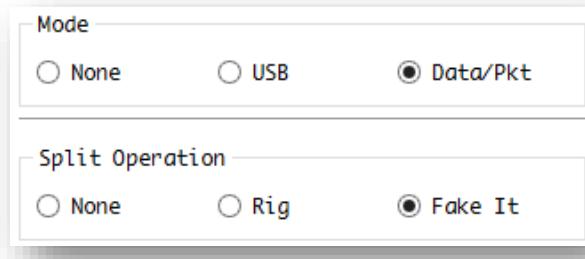
7.9 In order to set your primary⁷ Rx and Tx audio frequencies, pick one of these options:

1. Click somewhere on the waterfall to put your Rx there⁸.
2. In WSJT-X **shift-click** or in [JTDX](#) **right click** on the waterfall, to put your Tx there.
3. In WSJT-X **right-click** on the waterfall for the option to put *both* the Tx *and* Rx there.
4. Uncheck **Hold Tx freq** to have your Tx jump to another station's frequency as you double-click their CQ message (not a good idea, at least not by default and especially not on a DX station).
5. Enter your choice of audio frequency directly into the Tx or Rx box.
6. Click the teeny up or down arrow buttons next to the Hz label in the Tx or Rx frequency box to shimmy up or down 1 Hz per click. Click and hold to send a staccato series of clicks.
7. If necessary click to put Windows' focus on the main WSJT-X screen or the waterfall, then press **F11** or **F12** to slide your Rx left or right respectively. Press the Ctrl key to increase the rate of slide from 1 Hz to 60 Hz per click.
8. Click to focus then hold **shift** and press **F11** or **F12** to slide your Tx left or right⁹.
9. Double-click a CQ message from someone specifying an auto-QSY VFO frequency (not recommended on HF).
10. Stay put while you [read the online user guide](#) or press **F3** and read about the shortcut keys, or **F5** to read about the special mouse commands (commands for special mice!).

7.10 Two distinct things, working together, determine your transmit and receive RF frequencies:

1. Your transceiver's VFO frequencies on transmit and receive. Normally these are the same ('simplex') but they may be different ('split' or 'crossband'); *and*
2. The audio frequencies generated by the selected PC sound card as directed by WSJT-X or [JTDX](#).

When you select a band in WSJT-X or [JTDX](#), it commands your CAT-connected rig¹⁰ to set the VFO to the specified frequency such as 14074 kHz for 20m, and optionally sets the mode according to the **F2 Settings → Radio** tab ►. If your radio offers a data mode, try that. If not, use USB (on all bands) but be sure to disable any speech processing.



⁷ I say 'primary' because the software attempts to decode all the signals it finds, wherever they happen to be across the entire audio bandwidth as seen on the waterfall. The green Rx frequency marker allegedly indicates the region that is decoded first and deepest, although in practice on the HF bands I don't notice any difference. It is safe to ignore the green marker.

⁸ I find no reason to do this. See previous note. The software supposedly moves the Rx marker to the audio frequency of whoever we are working but on my system it often doesn't ... and yet I make QSOs just fine. **Ignore the green marker!**

⁹ Be lucky: on my system, the shift F11/F12 thing stops working after WSJT-X has been running for a while. Just my luck.

¹⁰ If your rig is not CAT controlled, you'll have to change frequencies the old-skool way using its knobs and buttons.

7.11 The red goalpost marker above the waterfall shows the audio frequencies of the tones that *would* be generated *if* you transmitted on the chosen VFO frequency ... but ... if you have sensibly selected one of the **Split Operation** options under **F2 Settings → Radio**, and positioned the red goalpost marker towards the left or right sides of the waterfall, things may get interesting:

- The **Rig** setting can use the rig's built-in split function to move the transmit VFO (usually VFO B) relative to the receive VFO (usually VFO A) if it needs to compensate for a difference in the audio frequencies generated (see below);
- The **Fake It** setting can QSY the main VFO on transmit if it needs to compensate for a difference in the audio frequencies generated (see below), and QSY back to the original VFO frequency on receive¹¹.

The 'difference in audio frequencies generated' comes about because very low or very high audio frequencies are likely to be attenuated by your transmitter's audio filtering¹². Most amateur sideband transmitters have a restricted audio range of approximately 200 Hz to 3 kHz, sufficient for intelligible speech, similar to the telephone, but their filters attenuate or roll-off audio frequencies at the lower and upper edges of the range.

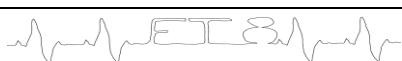
Using **Split Operation**, WSJT-X and [JTDX](#) can move the transmit VFO HF or LF in 500 Hz steps while generating audio at the same number of 500 Hz steps *in the opposite direction*. See the diagram on the next page ►►

"FT8 targeted multi-hop sporadic E propagation on 6m and possibly higher VHF bands. The key constraints that were considered were a shorter T/R period than JT65 or JT9 due to the sometimes very short openings. The sensitivity was not needed to be as good as JT65 or JT9 since signals are usually relatively strong on these paths so sacrificing sensitivity for speed was one design trade-off."

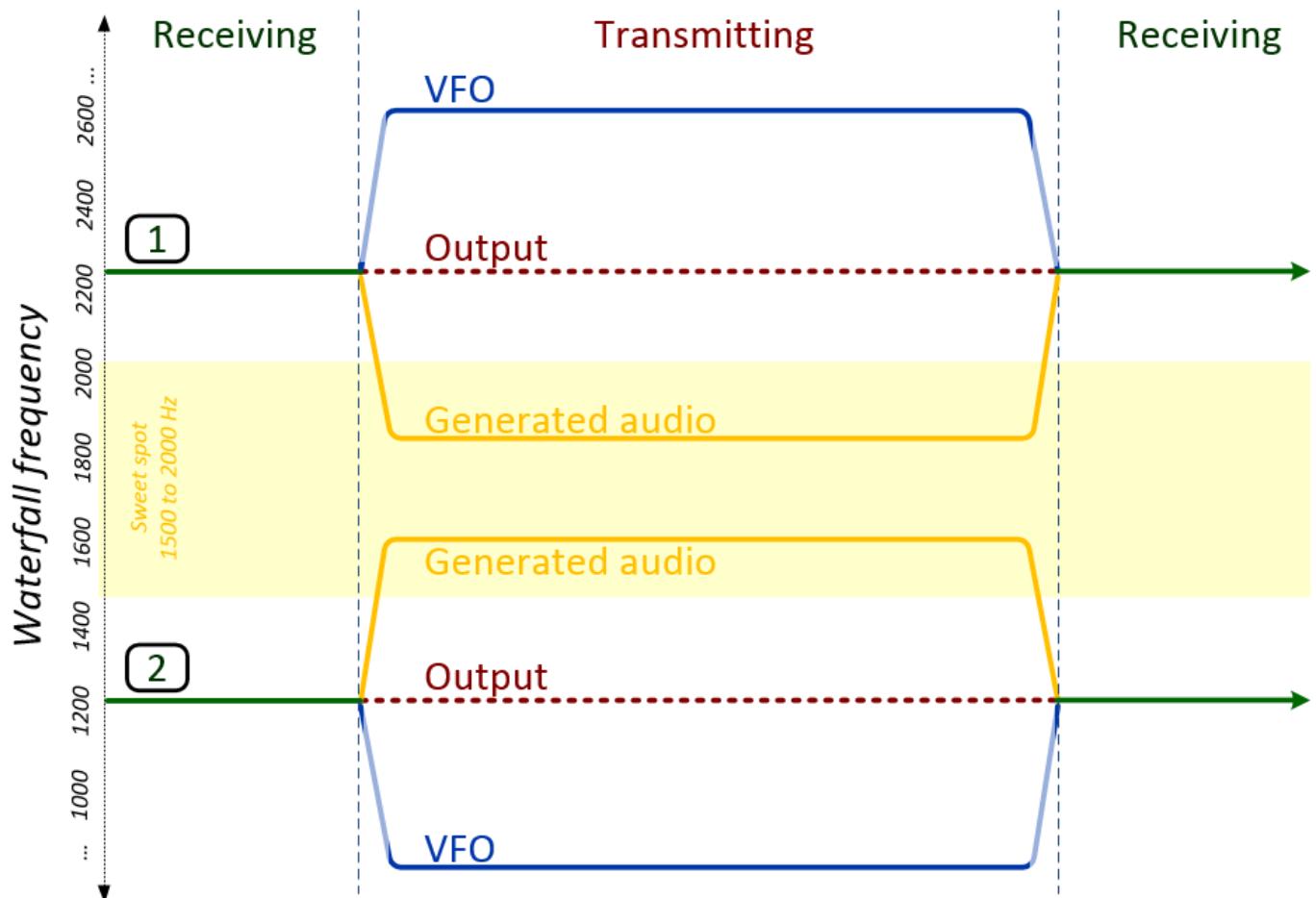
Bill, G4WJS

¹¹ Fake it works even on single-VFO radios provide they are CAT controlled. If you are using a boat-anchor or basic rig without CAT, it's a good idea to keep the red Tx marker away from the left and right ends of the waterfall. Keep to the safe middle ground.

¹² Naïve ops who notice low rig ALC levels [when they are transmitting from either end of the waterfall] sometimes increase the PC audio output to the point that the transmitter's microphone input is overloaded, causing them to transmit audio harmonics that we see as ghostly barcodes. 'Rig' or 'Fake it' reduces this possibility.



This is how the **Split Operation** function works with **Fake It**:



Example 1 shows someone with the red goalpost sitting just above 2200 Hz on the waterfall. At that frequency, the rig's sideband filtering may start to roll-off the audio, reducing his output signal strength. Therefore, the software shifts his transmit VFO 500 Hz HF and *simultaneously* drops the generated audio 500 Hz LF to just above 1700 Hz, right in the sweet spot between 1500 to 2000 Hz where the rig's transmit audio passband is likely to be flat. The net result of those two shifts is that his output signal emerges as if by magic just above 2200 Hz, at full strength.

Example 2 shows what happens when the red goalpost is below 1500 Hz on the waterfall. The VFO and audio both shift by 500 Hz in opposite directions to keep the audio frequency in the sweet spot while again the output signal ends up on the intended frequency at full strength.

The sweet spot is deliberately restricted to the upper part of the rig's flat audio passband such that if the audio stages are accidentally overdriven, any audio harmonics should be attenuated by the filtering, producing cleaner signals.

So, don't panic if you see your rig's VFO change when you transmit: it's all under control¹³.

¹³ Well, *usually* it is under control. There are occasional reports of the rig 'walking' a further 500Hz LF or HF on each over – presumably something screwy in the CAT comms. Cue the IT help desk: "Have-you-turned-it-off-and-on-again?".

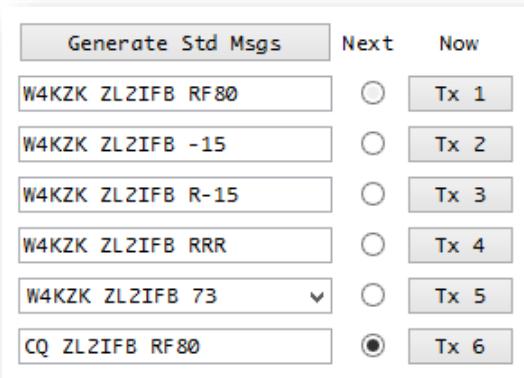
8 How to call CQ

8.1 Hopefully by now you have your system working on both receive and transmit. Get ready to call CQ by:

- Setting the **Hold Tx Freq**, **Auto Seq** and **Call 1st** options on the WSJT-X main window, or **AutoTX**, **AutoSeq** and **Tx/RX Split** in [JTDX](#);
- Clicking the Tx 6 message box or button, or hitting **F4**, to select your CQ message if not already selected: look for the *Next*¹⁴ selector blob ►

8.2 Before you start calling CQ, study the waterfall for at least a couple of cycles. Look for two things: (1) a suitable space in which to transmit, ideally a clear column; and (2) any strong/local stations already transmitting. If you're lucky, there will be no angry red blobs on the waterfall from signals strong enough to trigger your receiver AGC, and none radiating wideband noise or audio harmonics to interfere with your reception and decoding of weak DX signals. If you are having trouble from one station, it helps to synchronise your transmissions with him so that both of you transmit and listen at the same time – so choose the same even or odd cycles. That's not always possible, for instance if there are strong or poor quality signals from both even and odd-cycle transmitters. So, do the best you can. Fiddle with your radio settings if that helps *e.g.* reducing RF gain or adding attenuation; turning your beam away from the QRM; using high/low-cut filters or a notch; turning off the AGC. Perhaps take a break or try a different band. Above all, keep your cool. This is all part of the challenge – and the 'fun' – of DXing. Rise above it. Be like DX boss.

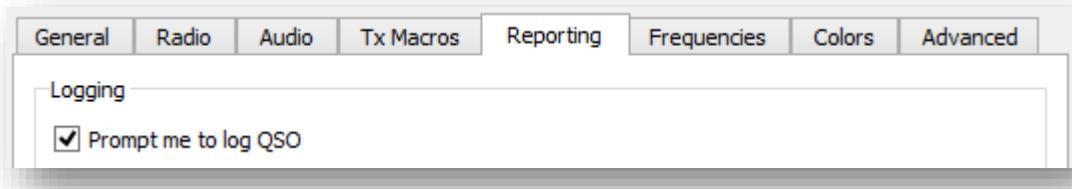
8.3 Now, to CQ, simply click the **Enable Tx** button to start calling CQ. That's all there is to it! If everything goes to plan, within 15 seconds or so the rig will go into transmit and you'll see the CQ message at the bottom left of the main WSJT-X window being transmitted.



The software can only 'Generate Std Msgs' if you double-click a decoded message, or enter a callsign into the DX Call box first: otherwise the only message it can generate is Tx 6, the CQ message with your own callsign, assuming you have configured that under **F2 Settings → General** tab.

¹⁴ Being able to pre-select the *next* message to be sent can be handy during the course of a QSO, for instance to send a specific free-text message at the end of the current QSO, even while your RRR or RR73 message is being sent. However, neither WSJT-X nor JTDX handle this very well. In particular, our chosen or custom-written free text messages are often reset to the default boring 73 message, summarily erasing our planned message without warning. It's a bit of a juggling act, sometimes, manually wrestling with the autosequencing logic. It can help to turn off the autosequencer temporarily – just remember to turn it back on afterwards!

8.4 When someone responds to your CQ, **Auto Seq** takes you through the conventional QSO sequence, automatically. It sets up the messages with both callsigns, and sends them their report using message Tx 2, or Tx 3 if they have already sent you your report. Next one of you sends RRR meaning ‘all received’ or RR73 meaning ‘all received, best wishes and thanks for the QSO’. Either of you may send Tx 5 containing the standard 73 message or something bespoke – just 13 characters, though, similar to SMS/TXT messages. Provided the message you transmit contains the string “73” somewhere, WSJT-X interprets that as the final message of the QSO and pops up the logging panel for you, assuming you are using the **F2 Settings → Reporting** option “Prompt me to log QSO” ▼



At the same time, **Enable Tx** is automatically *unset*¹⁵, giving you a moment to savour the QSO ... or click **Enable Tx** to start the sequence again with a fresh CQ.

The requirement to click **Enable Tx** to re-start the QSO sequence is not an accidental oversight in the software but a deliberate, conscious choice by the team behind FT8 and WSJT-X. *By design*, WSJT-X will not robotically fill your logbook for you.

8.5 If someone else has called you already (a [tail-ender](#)), you can double-click their decode to respond without sending another CQ first, but you *must* wait until the previous QSO is complete and your final message is sent: if you double-click too soon while your 73 message is still being transmitted, the 73 message will be aborted and you’ll start calling the tail-ender instead, perhaps transmitting a corrupted and undecodable message. That’s not cool.

8.6 **Call 1st** automatically responds to the first decoded caller – literally, the caller whose message pops out of the decoder first, anyone from anywhere who responds to your call: if you want to choose which callers to QSO, turn off **Call 1st** and double-click the decodes from the callers you want to work, ignoring the riff-raff. You have more autosequencing options with [JTDX](#), so read the notes and try them out.

8.7 If the auto-responder responds to someone but you would rather have responded to or called someone else, within the first second or so of your transmission you can hit **F4** to clear the current respondee, then double-click a decode from the wanted station. The **F4** step is necessary, unfortunately: it would be easier if we could just double-click the decode to respond to that one, even with **Call 1st** selected, but without **F4** the double-click is ignored.

With both **Enable Tx** and **Call 1st** selected, WSJT-X will automatically respond to the first decoded station who calls you *after* you have logged the previous QSO, even if you don’t send a CQ. It doesn’t queue up callers though, so they have to call you at the end of your QSOs. [JTDX](#) does appear to queue premature tail-enders.

¹⁵ This happens if you have chosen **Disable Tx after sending 73** in **F2 Settings → General**, or if not and you also have **Call 1st** selected. Personally, I think that’s a bug in WSJT-X. I find it inconsistent and disconcerting to discover that the **Call 1st** option affects the *end* of QSO behavior. Maybe it’s just me.

8.8 Customize your CQ calls by editing the Tx 6 message in the format “CQ XXXX ZL2IFB RF80” where XXXX consists of **UP TO FOUR LETTERS** *e.g.:*

- A continental indicator such as AF, AS, NA, OC or SA, or two such as AFEU or NASA (!), or DX¹⁶, UK, USA, ASIA, AP or APAC (Asia/Pacific), or your antenna direction such as EAST or NNW, or EULP or JALP, or LEFT (as in left coast) ...
- An explicit exclusion such as NOEU, NOJA or NONA
- One or two state indicators such as VT, RI, NDSD ...
- One or two letter-only prefixes such as PJ, JA, VKZL, VP ...
- SPLT, SPRD or BLOB meaning “*Please call me split not simplex!* All I see is a nasty red blob on my Tx frequency!”
- A Q-code such as QRZ, QRO, QRP, QRM or QSY, or an abbreviation such as AGN or WEAK
- IOTA, SOTA, TEST, IGC *etc.* indicating that *you* are operating from an island or summit, or in a [contest](#) or challenge, and/or would prefer to contact someone who is
- An abbreviated club name such as CDXC, ARRL, JARL, RSGB or NCDX maybe

Be careful with this: you only get to play with those 4 letters. If you enter 5 letters or include numbers or punctuation, your CQ call becomes a free-text message with the 13-character maximum: on receipt it is *not* automatically interpreted by WSJT-X as a CQ message, hence nothing happens if a recipient double-clicks it. So don't do it!

Q codes *etc.* may be handy if you notice someone apparently responding on your Tx frequency to your CQ but you cannot decode their messages.

Custom messages tend to evaporate when the software regenerates the standard messages *e.g.* when you log a QSO. Don't blame me!

8.9 If recipients double-click any valid CQ message, their systems will generally respond *regardless* of their locations. Rude hams evidently don't read or don't care about targeted CQs, calling even if they are nowhere near the target. It is up to the CQer, then, to decide whether to make a QSO with them ... or wait patiently in hope of a call from someone in the bullseye.¹⁷

“As someone who has a very limited location for antennas (they are all in the loft!) and for DX (I live in a valley), I've found FT8 a brilliant way of achieving QSOs that would be quite impossible with most other modes.”

Bryan G4KRO

¹⁶ DX means whatever the sender thinks it means. There is no formal or universal definition. Oh HF, it *may* mean another country, another continent, the far side of the world, a top N most wanted DXCC, anything vaguely exotic, or something else entirely. For those using microwatts, a mile or two may qualify as DX! For EMers it could mean little green men from Mars.

¹⁷ JTDX gives us the option to auto-respond ONLY to targeted callers ... but even JTDX doesn't understand “CQ DX”!

8.10 It's entirely up to you whether to transmit, what to transmit, when and where ... but some hams get their knickers in a twist if you do something unexpected or unconventional. It is *conventional* but not *mandatory* to end HF QSOs with the [exchange of 73 messages](#).

A simple golden rule is to **log the QSO whenever we send an R message.**

If you do not receive a 73 from the other party, tough: perhaps it got lost en route, swallowed up by the ionosphere. Get over it! If they stop sending or start CQing, it's fair to assume they believe the QSO is complete so you are *probably* in their log.

Some FT8 users feel snubbed if they don't receive a 73, stubbornly refusing to log the QSO on principle. It's their choice. It's only a hobby.

8.11 The **Halt Tx** button is immediate – it aborts the current transmission in progress (if any) and de-selects the **Enable Tx** button so it won't transmit at the start of the next sequence. De-selecting the **Enable Tx** button, however, allows the current transmission (if any) to continue normally to completion. You don't need to click it at the very end of the transmission or wait until the receive period – click it whenever you don't want to transmit in the *next* transmit period.

When you want to take a break, de-select **Enable Tx** at any time during or following your final transmission. If you can, keep an eye on the screen for a while longer in case of a delayed response when your call reaches the head of the fox's queue. He might bite anyway.

"[Although] WSJT-X requests audio sample streams at 48000 Hz 16-bit depth, that does not mean that other sample rates and formats are not supported. The operating system and audio subsystem will convert to or from the nearest available hardware sample rate. While sample rate or format conversions are undesirable, they are not necessarily problematic, e.g. some conversions are trivial computationally such as reducing bit depth from say, 24-bit to 16-bit, which only requires low order bits to be discarded, likewise down/up converting the rate by an integral factor is also trivial such as converting a 96000 Hz or 192000 Hz input stream to 48000 Hz. OTOH converting a 44100 Hz input stream to 48000 Hz involves complex re-sampling which is expensive and inaccurate and could even cause audio dropouts on a slow PC. WSJT-X currently down samples to 12000 hz as a first processing step on Rx, this is sufficient to support an audio bandwidth of up to 6000 Hz which is all that is needed for the modes supported by WSJT-X. We request a 48000 Hz stream as this is commonly available all almost all audio codecs of suitable quality for WSJT-X use. Using higher sample rates adds no benefit, it simply adds unnecessary computation for no gain in performance whatsoever. The same applies to bit depths greater than 16-bit."

Bill G4WJS

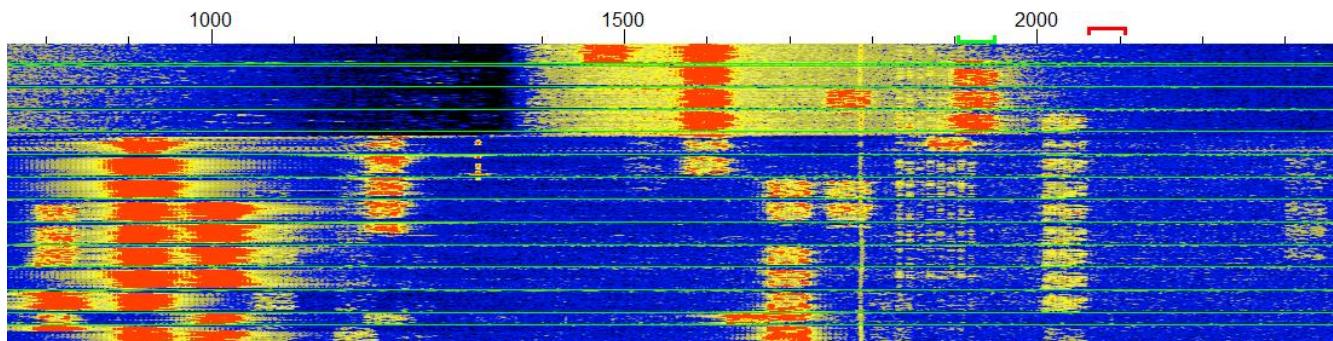
9 Hinson tips: miscellaneous FT8 operating tips

This chapter is an assortment of answers to Frequently Asked Questions, blended with a bunch of helpful hints contributed by experienced FT8 HF DXers.

9.1 Generally speaking, it's best to turn off the rig's noise blanker, narrow filtering and fancy DSP Noise Reduction for digimodes: let the sound card and computer software do its thing, extracting signals from noises ... but ... you may like to experiment with the settings (e.g. IF shift, high- or low-cut or your notch filter may reduce overloading and AGC depression caused by strong signals such as W1AW news broadcasts or over-the-horizon radar). Some users report good results with the rig's DSP noise filtering (e.g. +5 dB with NR on an Icom IC-7200 according to Hans DK2XV, in the presence of switchmode PSU QRM). There's no harm in finding out for yourself. Compare the results with and without DSP – see what works best for you, producing the clearest waterfall, the most decodes or the highest average reception reports.

“Don't ignore that narrow CW filter in your radio! A CW filter will pass narrow digital modes just fine. While it is generally a good idea to listen wide so you can see all the traffic in the band segment, when you are trying to dig that weak one out through the cacophony it can help to put your narrow filter on him. Try it!” (Tnx Jim, NUOC).

Here's an example of the value of narrow filtering, captured on my WSJT-X waterfall ▼



The big red blobs on the lower left of this waterfall are a couple of local ZLs with massive FT8 signals on a wide-open 20m at peak time (one of them over-driving his rig's audio input, causing the ghostly barcodes around 1870 Hz). The red blobs at about 1850 then 1900 Hz towards the top of the waterfall were from a Kazakhstan station calling me via the long path. I quickly raised the lower edge of the K3's filter to cut off the locals, preventing their signals from depressing the AGC, causing the black/dark speckly area up to 1400 Hz with no big red blobs. At the same time, the signals in the passband, including the UN7, became markedly stronger and we completed our LP DX QSO.

This filtering trick works for any signal that you can locate on the waterfall. The waterfall itself shows the effect of narrowing the rig's filters and shifting the filter centre frequency. If your rig's filtering is not so flexible, using the RIT to shift strong signals out of the passband may help.

9.2 If you change the free-text message in Tx 5 but want to revert to the default message, simply double-click the Tx 5 button. The other Tx messages can be regenerated on demand by clicking the “Generate msgs” button (“GenMsgs” in [JTDX](#)) *provided* the DX station's call is still in the DX Call box.

9.3 Messages are appended to the left and right hand windows in the sequence they emerge from the logic. They are not sorted according to frequency, callsign, country, strength, distance, worked before status, needed status or anything else and sometimes appear distinctly disordered:

- Messages emerge from each round of decoding, first the 'easily' decoded signals, then the ones that took deeper analysis. Magic is happening here in the decoder algorithm – don't knock it!
- Your transmit message might be sent to the encoder and displayed on the screen with its current timestamp *before* a deep decode from the *previous* period is, belatedly, appended with its earlier timestamp;
- When you double-click a message, it is repeated at the bottom of the righthand window.

9.4 Especially when the band is humming and the DX is busy, spread out! Any decoded message containing your callsign will be displayed on your Rx frequency pane, *wherever it is being transmitted on the waterfall*, so **there is no need to work simplex**. Unlike the legacy modes, calling or working simplex is generally not a good idea on FT8, especially with any popular station since others will generally be doing the same, QRMING each other. Hasan NOAN put it very well:

Calling someone simplex while they are in QSO with someone else is rude and inconsiderate. If you do it to me, I may *deliberately* ignore you. If you were in the shack, I'd give you a slap.

Don't call me on my Tx freq, as it is full of callers

Unlike conventional legacy modes, **split operation is preferred by most FT8 DXers**. The idea that split operation on FT8 "ties up two frequencies for one QSO" and is therefore an inefficient use of spectrum is a naïve misunderstanding. ►

Split operating is not a hard-and-fast rule. It's not the law, just a tip that experienced FT8 DXers find works better in practice than simplex. Try it!

Rather than zero-beat to call someone on their working frequency, take a moment to **shift-click** your Tx signal (the red goalpost above the waterfall) elsewhere on the waterfall, somewhere quiet.

Don't forget that each party to an FT8 QSO transmits in sequence. **Even and odd periods are orthogonal and should be considered separately.** Within each period, each party is using one thin slice of spectrum, just 50 Hz wide. After they end their transmission, the frequency is released for anyone else to use during the next 15 second period. See [Appendix E](#) for a more elaborate explanation.

What does make inefficient use of our shared spectrum is when several people all pile up on the same frequency, QRMING each other, leading to repeats, delays, abandoned QSOs and intense frustration. Another inefficient practice is calling continuously or out-of-turn, especially calling right on top of a QSO in progress – again something that is made worse by multiple people attempting to use the same working frequency simultaneously. It's not so much that zero-beat simplex operating is inherently bad and patently it does work, rather that split works *even better* on FT8.

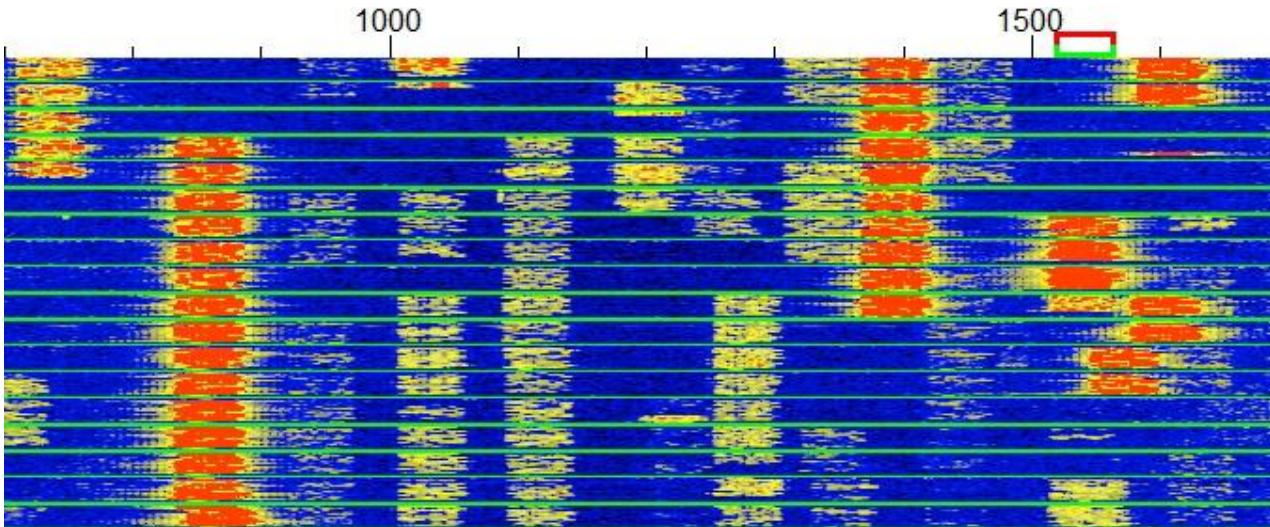
If the station you are calling is very weak, others who cannot hear him may inadvertently cause QRM by choosing his frequency to CQ. You might try sending a message or two simplex to let them know the frequency is in use. [*Tnx tip Olaf DK2LOJ*]

9.5 Higher transmit frequencies towards the right of the waterfall are *slightly* advantageous for two reasons:

- (1) Harmonics caused by overdriving something in the audio chain are more likely to be blocked by your rig's transmit filters [don't rely on this though! Keep your audio level down!]; and
- (2) On a busy band, decodes in the band activity pane scroll past quickly in frequency order, so anyone CQing towards the left of the waterfall is more likely to scroll off the top of the pane¹⁸. However, don't go too far to the right of the waterfall ►

9.6 Having said that, if someone you are calling seems to be ignoring you, it *may* help to move your Tx frequency closer to theirs¹⁹, perhaps even simplex (not a good idea if they are DX). It is possible they are not receiving FT8 signals across the full sub-band shown on *your* waterfall, for example they may be using filters or may have their VFO offset. Maybe your chosen Tx frequency is busy with local QRM at their end.

9.7 Especially when the band is busy, monitor for a couple of minutes before selecting your Tx frequency. Look for a continuous blank column on the waterfall, ideally, and **shift-click** (WSJT-X) or **right-click** (JTDX) to move the red goalpost there. Here's part of the waterfall around 18100kHz one lazy Sunday lunchtime in ZL, beaming at NA ▼ Not bad for low power DXing on a seemingly deserted band! If I was planning to transmit in this range, I'd probably choose 1140, 1490 or 1650 Hz.



9.8 You may need to shift your Tx every few minutes on a busy band if other stations encroach on you so the stations you are trying to work can't copy you. Keep an eye on the waterfall.

If your transmissions are being reported on PSKreporter by stations in whatever part of the world you seek to work, your Tx frequency is presumably reasonably clear there.

¹⁸ It helps to stretch the WSJT-X window towards the full screen height: I can see about 40 decode lines that way. In JTDX, there's room for about 45 decodes AND I can still see the waterfall showing about 6 periods right across the top of the screen.

¹⁹ If for some reason you are not using CAT control of the radio hence the "Rig" and "Fake it" split options are unavailable, remember to keep the red goalposts in the central area of the waterfall.

9.9 If you CQ, transmit in the same period as the strongest signal/s on your waterfall to minimize mutual interference. Transmit when they transmit, receive when they receive. Dance the DX dance in-step.

I gather on 6m and other UHF bands (!), there are conventions on which slots to use when beaming East or West ... but what do I know? I'm an HF DXer. On HF, we cope. We muddle through.

9.10 Keep an eye on what's going on. It's tempting to set the **Auto Seq** and **Call 1st** autoresponder options, then start CQing or calling someone and wander off ... but the sequencing function is easily confused by custom messages, or by messages received sequence out of.

As with regular DXing, the key is to listen more than you transmit. It's nature. Two ears, one mouth, remember.

9.11 If you are CQing, making a run of QSOs or calling and working several people, take a break every so often to check that your Tx frequency and period remains clear. In WSJT-X, the easy option is *not to re-Enable Tx* immediately after you log a completed QSO - skip a Tx period. The lazy option is to wait for the watchdog timer to kick in. By taking a break, you may see other stations transmitting on 'your' frequency and period, or encroaching on it ... so **shift-click** yourself somewhere else on the waterfall. If you don't take a break, you might think 'your' Tx frequency is clear whereas in fact someone else is sharing 'your' slot.

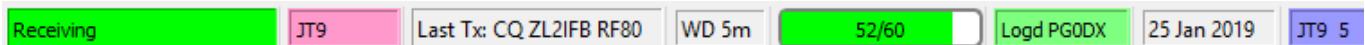
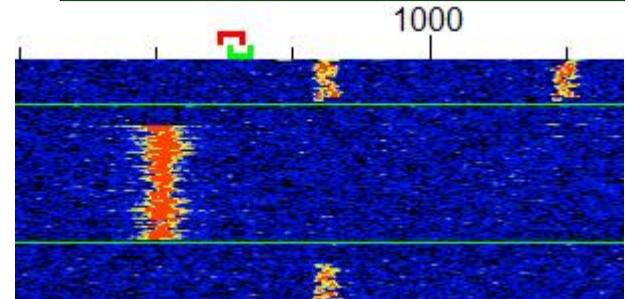
FT8 is *extremely* good at un-knitting interwoven and overlapping signals, but weak signals are more likely to decode reliably on a reasonably clear frequency.

"Another technique I've found useful is, while transmitting, press **Halt Tx**, wait a couple of seconds then press **Enable Tx** and look at the waterfall on your Tx frequency. Frequently if 'your' frequency remains open, others will be able to decode your transmission in spite of user-induced QSB." [Tnx Bill AE6JV]

9.12 The assorted screenshots in this guide are from my PC with my radio and my preferences. Yours may vary ... so if you are going to make configuration changes, you might like to make a note of the changes as you make them so you can restore your original settings if the changes don't work out.

"When I play with settings, I grab my phone and grab a quick screen shot of the setup screen so I know I can get it back without hassle." [Tnx tip Gary AGON]

9.13 If, when you start transmitting, you hear what appears to be a single, plaintive, wavering tone in the headphones (similar to **Tune**), check on the lower status bar ▼ that you are not in, say, JT9 or WSPR mode. Narrow goalposts above the waterfall are another clue ►. WSJT-X and JTDX both support several modes. Try 'em!



9.14 If for some reason you neglect to log a QSO and forget the details (e.g. if someone emails you about a QSO with a missing confirmation and they aren't in your log), the QSO info is *probably* stored in your ALL.TXT text file. Messages you have received and decoded, plus your transmitted messages, are saved sequentially to ALL.TXT by default. It's a plain text file. If you are very active on FT8 with WSJT-X, the file grows quite large: rather than simply deleting it, it's a better idea to archive it occasionally in case you ever need to search for missing QSO info. [JTDX](#) makes this easier by opening a fresh ALL.TXT file each month e.g. in August 2018, as if by magic my ALL.TXT became C:\Users\Gary\AppData\Local\JTDX\201808_ALL.TXT

9.15 Don't worry too much about your Rx frequency: you can safely ignore the dead green goalpost above the waterfall, leaving WSJT-X to move it around for you. The software is decoding the entire waterfall, all at once, right? Well, yes and no: apparently it focuses on the area under the dead green goalpost, decoding first and more deeply there. So you might want to set the Rx frequency manually if you are monitoring some juicy but weak DX, waiting for him to complete QSOs so you know when to call. Also, on a busy band, the band activity screen scrolls too fast to 'read the mail', whereas, with fewer messages, the Rx Frequency pane scrolls at a far more sedate pace.

9.16 Use the rig's AGC or take care to adjust the RF gain control and attenuator whenever there are strong signals on the waterfall. Overload in the receiver and/or sound card can mess with any digital signal processing in your rig and on the soundcard including, WSJT-X's decoding and waterfall display. AGC is the easy option, preferably on a slow setting since the software copes admirably with fading FT8 signals. Consider [using your rig's filters](#) too.

9.17 *Please* don't continuously call someone who is calling or working someone else, even if you are calling them off-frequency²⁰. Be nice: wait your turn! It's polite to wait until the DX sends RRR, RR73, 73 or CQ before calling them. If you call continuously, or try to barge-in on a QSO in progress (especially simplex), you will simply waste watts, create QRM, cause delay, and you may even be blacklisted by the DX.

9.18 Use the waiting time wisely. Look at who else is QRV and where they are on the waterfall. Maybe **shift-click** (WSJT-X) or **right click** ([JTDX](#)) your Tx to a different, clear frequency. If you simply continue calling, you may be missing out on even more exotic DX stations who are transmitting at the same time as you!

9.19 ... Talking of which, don't reflexively double-click to call that unbelievably exotic DX station you just decoded - wait for another transmission to double-check his callsign, meanwhile looking him up on QRZ or Google. If it seems too good to be true, it is quite likely a false decode, "CQ XIXIMARIA" for instance, or "7T4W?0D A+ O2", or "8WL??GN10S77"! That said, there are some weird and wonderful novice and special-issue callsigns QRV on FT8, so don't dismiss them *all* as freaky decodes. *[Thanks John NA6L.]*

The software should automatically stop you calling someone simplex if they respond to someone else, but you should be keeping an eye on things ... and simplex operating is not recommended anyway.

The educated AP (*a priori*) guesswork that can help dig out deep deep decodes is more error-prone than the usual decoding so you'll see more exotica if you enable AP decoding.

²⁰ JTDX is polite enough to stop us calling someone if they respond to someone else, regardless of our Tx frequency. WSJT-X only stops us calling if we are transmitting on or close to the station we are calling. I consider that rude.

9.20 Tail-ending with FT8 is a bit awkward: first type the DX callsign into the **DX Call** box and click **Generate Std Msgs** to set up the appropriate messages (or double-click the DX station's CQ message and quickly hit **Halt Tx** to abort your transmission if now is not the perfect time to call). Remain on your carefully chosen clear Tx frequency to call and make the QSO (**Hold Tx Freq** should be selected, remember): if you start calling the DX off-frequency then suddenly shift your Tx to his frequency (simplex) when he calls you, you will be joining the big red blob of other callers, causing QRM.

If you find your Tx being “pulled” around on each QSO, select **Hold Tx Freq** to stay put.

9.21 In a DX pileup situation, a shortened message sequence helps maximise the QSO rate. To set things up for this, double-click message Tx 1 to skip it (it will be greyed out). Now when you double-click a decode to call someone, you will start with Tx 2 instead *i.e.* sending both callsigns plus the report, rather than both calls plus your grid. Next, double-click Tx 4 to toggle from the conventional RRR message to RR73, short for ‘Yup, got it, thanks, let’s end the QSO right here: there is no need for us to swap 73’s as well. Good luck with the rest of the pile, CUL, please QSL on LoTW...’.

Toggling works on Tab 1. If you use Tab 2, switch to Tab 1 to toggle Tx 1 before returning to Tab 2.

9.22 Shortening QSOs is a contentious practice, raising numerous intertwined issues:

- The protocols for making QSOs (digimode QSOs particularly) are only partially defined and still evolving, and anyway the protocols are not universally agreed and followed in practice.
- Some hams send RR73 just once at the end of a QSO and evidently (for various reasons) aren’t bothered whether the other party receives it or not. Too bad, that’s their choice.
- Some hams send RR73 repeatedly, anticipating a response, and a few of them get upset if they don’t receive it. Too bad, that’s their choice too.
- Some hams send RRR once or repeatedly in the same way as RR73, and may or may not follow that with a final message, that may or may not contain the string 73, and may or may not be automatically logged (yes, a load more uncertainty there).
- Some messages are sent but not received due to the vagaries of radio propagation, technology and gremlins. This point, at least, I think we can all agree on!
- Some dogmatic hams have fixed/definite ideas about what constitutes a QSO and hence may or may not log QSOs that others believe complete. Too bad, that’s just how it goes.
- Some amateur QSOs are technically incomplete, for example relying on non-amateur back-channels or databases or guesswork to pass QSO information that was not successfully passed on-air to the satisfaction of all parties. We’re exploring the limits of radio technology here.
- Logged QSOs may or may not match if submitted to LoTW, Club Log, QRZ or other online logs, depending on a multitude of factors, many of which are beyond the control of the individuals concerned. Aside from checking for matches in real time, insurance QSOs are an option ... but a few hams bitterly resent duplicate QSOs. It’s a no-win situation.
- Generally, we can’t tell for sure what our QSO partners are thinking unless they tell us (which is unlikely to happen on-air during an FT8 QSO) hence we can only guess at their position re ending and logging and confirming a QSO. ‘Good practice’ is not fixed or guaranteed.
- Some hams see red if someone else dares to express differing opinions to them and appear intransigent or intolerant, coercive even. A few come across as belligerent bullies or trolls.
- Some hams are simply bewildered by the whole thing, don’t understand the issues or really don’t care since, after all, it’s only a hobby. C’est la vie! Instead of complaining, work more DX.

9.23 The default FT8 frequencies are suggested, not mandatory. Aside from DXpeditions using other chunks of the HF bands to separate their pileups from the regular users, JS8 users are using separate chunks too, and FT4 as well.

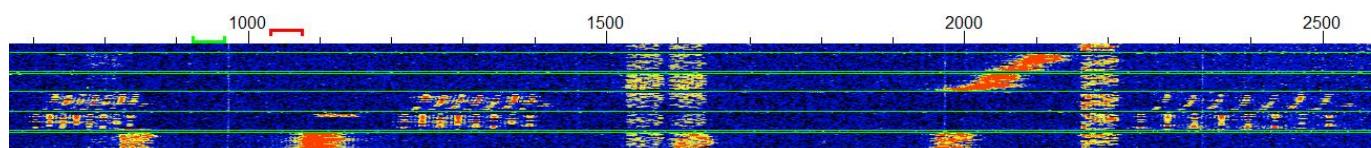
I've noticed some regular FT8 users transmitting on low audio frequencies at or even beyond the left edge of my waterfall, while few use high frequencies near the right edge, so I may shift my VFO down by about 100 Hz from the usual dial frequencies. Editing the default frequencies for each band is a good idea.

9.24 Stretch the waterfall graph to display the full FT8 subbband out to about 3000 Hz, and open up the filters in your radio. The entire displayed region of the spectrum should normally show a similar background colour: if there are dark patches to the left or right, your radio is probably attenuating low or high frequencies, making it less likely that you will decode weak stations there²¹.

My K3 automatically resets the filter width whenever I change bands or radio modes. It's worth stepping through each of the FT8 frequencies, checking that in DATA mode the filter is wide open (to 4000 Hz on mine) and centred correctly (at 1500 Hz) on every band.

9.25 Why do we use "RR73" instead of "R73"? Good question! One R is sufficient, but the two R's plus two decimal digits make a string in the same format as a grid square, hence the FT8 coding scheme that normally passes grid squares using the minimal number of digital bits can handle RR73 in the same way, as if it were a grid. If instead you edit the text in message Tx 4 to R73, that change turns the message into a free-text message type with a limit of 13 characters in total ... which is often insufficient to pass both callsigns plus the space and R73. We're left with a paradox. Question: "When is RR73 shorter than R73?" Answer: "When we are counting bits in FT8".

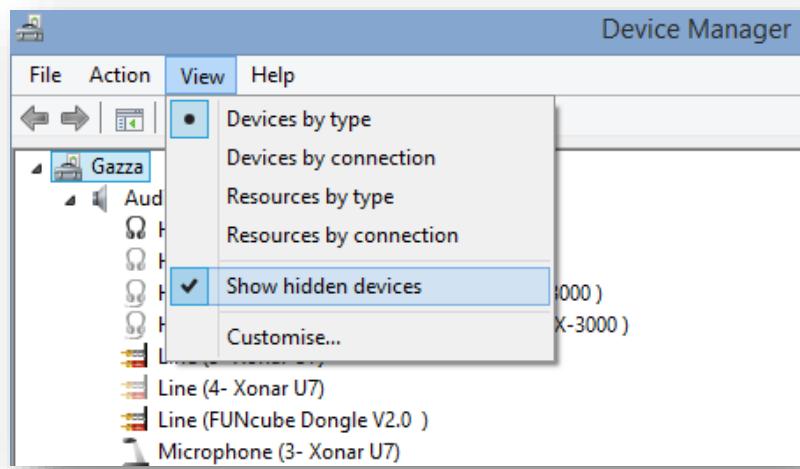
Since many of us are using QRP, it might be nice to use RR72 to indicate that, in the same way that some QRPer sign-off QRP legacy mode QSOs by exchanging 72's. It might also remind others to keep their power down, where possible. That would however require a change to the software.



This curious series of three spaced-out MSK signals followed by a steeply-sloping strong FT8 signal on my waterfall indicated *someone* had a serious problem with their transmissions, so serious in fact that they were undecodable, hence I wasn't able to contact them to let them know. Shortly afterwards, they went QRT. Maybe they spotted smoke.

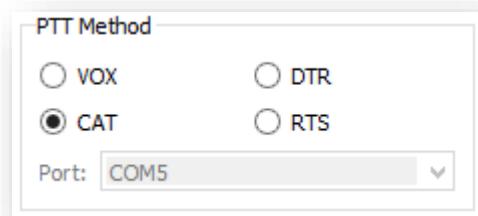
²¹ Selecting the "flatten" option – one of the controls under the waterfall - makes the spectrum *appear* more even but decoding is unaffected (I believe). It's just eye-candy.

9.26 Hardware devices of all sorts are identified and handled at a low level by Windows. Windows provides **Application Programming Interfaces** through which drivers access the devices, and the drivers, in turn, are used by application programs to do stuff. That's a complex and problematic arrangement. Device drivers are privileged yet bug-prone (raising security concerns) and can conflict. Windows selects 'default' devices (generally whatever was most recently connected) and hides devices from us that it believes are no longer attached, while at the same time retaining the associated drivers allowing them to spring back to life instantly if they are ever reconnected. Application programs sometimes *insist* on using devices that are no longer physically present. To spring-clean your devices, open Control Panel, right click Device Manager and select Run as Administrator. In the Device Manager menu click View then **Show Hidden Devices** ► Expand the device tree by clicking the small arrow next to, say, *Audio inputs and outputs* or *Ports (COM and LPT)*. One-by-one, right-click any devices that are no longer needed and select *Uninstall*. If a window shows up with a check box to delete the driver, **do not** check this box as the driver might be needed for another device: uninstall the device only. Reboot then check that unwanted devices are gone. [Tnx tip Bruce N7XGR]



9.27 Broken something? **No transmissions?** There are several possible reasons, so check things systematically:

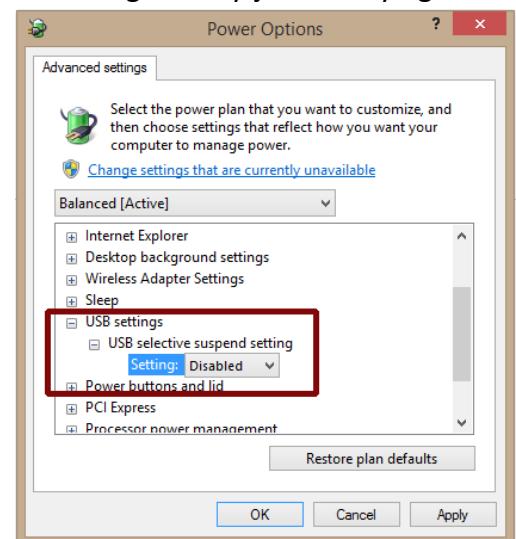
- Is the radio going into transmit? Does the little red light glow? Does the power meter indicate any RF power out? If not, that's an issue! Check the PTT method section under **F2 Settings → Radio** ► If you manually press and hold the PTT button on your microphone, or the footswitch or use the front panel TRANSMIT button, does the radio transmit the FT8 tones during a transmission? If you are using VOX, make sure the radio's VOX sensitivity is high enough to trigger reliably at the audio level you are using, and hold-in for the entire over.
- Talking of audio level, make sure enough audio is reaching the rig from the sound card – neither too little nor too much. See the section on [setting transmit levels](#) for tips on that. If adjusting levels doesn't resolve it, check the cable from the sound card to the line-in or microphone input on the radio. Try plugging headphones or PC speakers into the sound card output to make sure it is actually generating tones, then figure out why the audio isn't getting to the radio. Is the cable broken? Is it plugged in, to the right places?



- Check for USB devices and hubs that automatically power themselves down due to apparent inactivity. This function *may* be a useful power saver but it is generally just annoying when sound cards or rigs mysteriously disappear from the system. Using *Windows Device Manager*, deselect “Allow the computer to turn off this device to save power” for each of your USB devices and hubs ▶



Also in Power Options under Control Panel, disable the USB selective suspend ▶



9.28 Broken something else?
No decodes? You'll probably find that the program is not dead, just resting. Check these ▶:

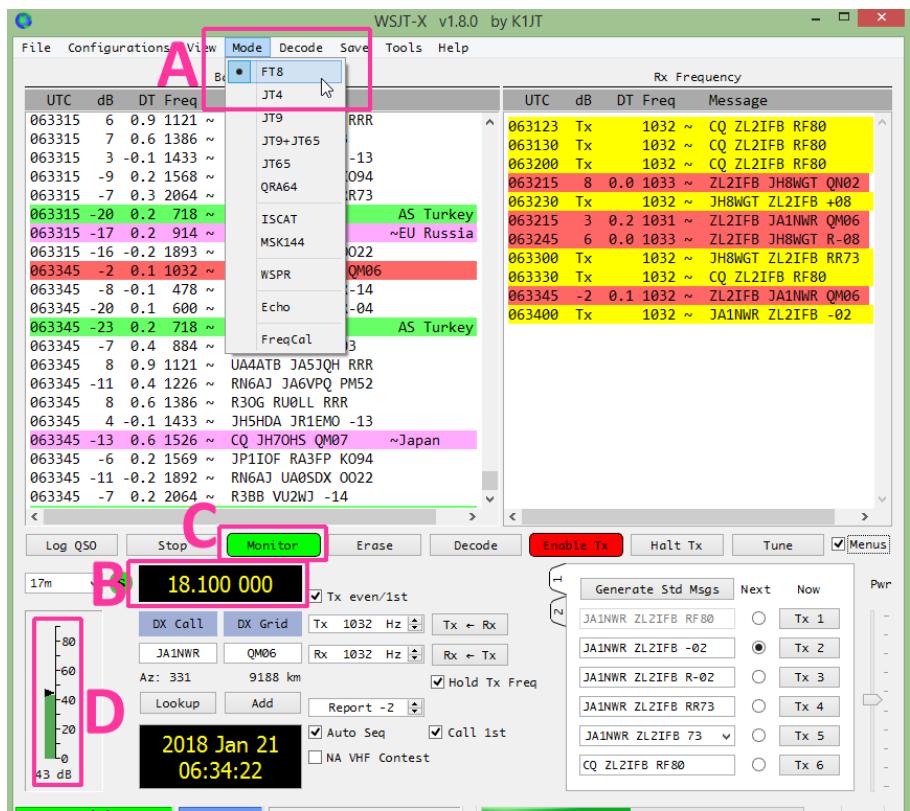
(A) Set to **FT8 mode** [*tnx tip Jacky ZL3CW*];

(B) Rig on an **FT8 frequency**, on a band that is open and active, in **data** or **USB** mode;

(C) **Monitor** enabled (button bright green);

(D) Sufficient **audio** reaching the software. The thermometer tricorder indicator thing on the left should also be green with the level around mid-range or higher when the band is busy.

Also check that the CPU is not overloaded: is your computer underpowered? Isolating and decoding FT8 signals takes quite a lot of processor oomph. If there aren't enough CPU cycles available, it won't be able to decode and display messages. Time to upgrade?



Do you see a smattering of yellow and red blobs on the waterfall? Is the rig on the correct mode and antenna? Can you hear the *weeeeeeee* of FT8 signals on your receiver? Is the rig on? FT8 is a *weak-signal*, not a *no-signal* mode!

9.29 The stock DXing advice to LISTEN, LISTEN, ***LISTEN*** applies equally to FT8 and other digimodes, well almost: I normally have the Rx audio turned right down, the headphones sitting on the desk, so the digimode version is WATCH, WATCH, ***WATCH***. Learn to interpret the waterfall and decodes to figure out what's happening. Are the DX stations CQing, searching-and-pouncing, or just quietly monitoring the band (in which case they may appear on [PSKreporter](#), and if you call them speculatively they may just respond!)? Notice how the signals grow stronger (redder) as you turn your beam towards directions where there is better propagation. Magic!

JTAlert and some logging programs can highlight new DXCCs and new grids as they appear in the decodes.

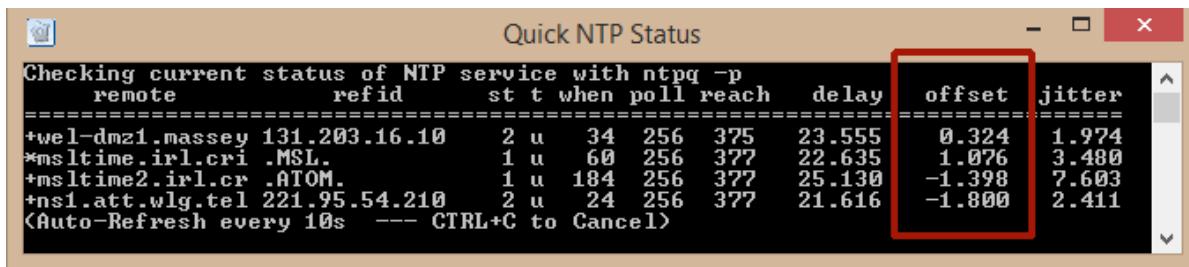
9.30 Call patiently. If someone is QRMing you, you may struggle to make or complete a QSO until they stop. After 2 or 3 failed calls, try **shift-clicking** your Tx to a different clear frequency and continue calling. If that still doesn't work, maybe your signal is just a little too weak, so try turning your beam, or wait until conditions improve. Hey, that's DXing.

9.31 The waterfall settings take some trial and error to customize for your system, screen, eyes and preferences. Please read the [user guide](#) for details on the waterfall controls, and bear in mind that some changes are instantly obvious while others only become apparent later as the waterfall is re-painted under various band conditions.

Click to select a slider then use the keyboard arrow keys to make fine adjustments: it's easier than dragging the slider with the mouse.

9.32 If a stalker is perstering you for a QSO, constantly calling but never sending you a report when you respond, or perhaps having started a QSO repeatedly sending the same message over and over and over like a stuck record, here are a few things you can try:

- Be tolerant. It is not easy to master FT8! The caller may have accidentally unselected **Auto Seq** and neglected to select the next message manually, and may not even realise he is causing problems. Hopefully he will soon catch-on. Perhaps he is distractedly [reading the help file](#) or looking up these very tips ... well, we live in hope! Try sending a free-text message such as "NEXT MSG PLS" or "CHK AUTO SEQ".
- Be patient. It is possible he is persistently sending the same message simply because your acknowledgements are not getting through (e.g. your signal has dipped down in QSB or QRM), so the next message is not appropriate. Personally, I'd give at least 2 or 3 repeats, up to 10 if I'm keen to complete a DX QSO, especially if conditions are poor and signals are weak.
- While you wait, browse to [Time.is](#) to double-check that your computer clock is set accurately, especially if this is a frequent occurrence. Is your NTP software running? If you are using Meinberg, under the Windows Start menu, select *Meinberg* then *Network Time Protocol*, then click the *Quick NTP status* to display a text listing of the time servers it is using. Are there any error messages, or is it all normal? The *offset* (time error) should typically be just a few milliseconds e.g. somewhere between +2 and -2, as here ▼



```

Quick NTP Status
Checking current status of NTP service with ntpq -p
  remote          refid      st  t when poll reach      delay    offset   jitter
  =====
+wel-dmz1.massey 131.203.16.10    2 u   34  256  375   23.555    0.324  1.974
*msltime.irl.cri .MSL.          1 u   60  256  377   22.635   1.076  3.480
+msltime2.irl.cr .ATOM.         1 u  184  256  377   25.130  -1.398  7.603
+ns1.att.wlg.tel 221.95.54.210   2 u   24  256  377   21.616  -1.800  2.411
(Auto-Refresh every 10s --- CTRL+C to Cancel)

```

- Check your beam heading and power: perhaps your signal is simply too weak for the stalker to decode. Try beaming directly at him (short or long path) and maybe give it a few more watts. Open boiler door, add anthracite. Tweak your dilithium crystals. Do the DX waggle dance.
- Conversely, deliberately beam away from the stalker and turn your power down, in the hope that having noticed you disappear from his waterfall, he'll crawl away to his cave while you continue working other people.
- Take a break: maybe someone else is transmitting on top of you. Skip a transmit period to check whether your Tx frequency is deserted without you.
- **Shift-click** (WSJT-X) or **right-click** ([JTDX](#)) your Tx elsewhere on the waterfall. If all that achieves is to drag the stalker to your new frequency (probably because he has unwisely chosen not to select **Hold Tx Freq**) and he is *still* not responding to you, QSY again but this time toggle the **Tx even/1st** option to swap periods, transmitting your CQs at the same time as the stalker is plaintively calling you. Maybe before long when he notices that you have disappeared from his waterfall, and stops to listen for once, he'll see you already making QSOs with other savvier hams, and the penny may finally drop.

Last resort: give up!
Change mode or band.
QRT. Make a cup of tea.
Walk the dog. Stroke the cat. Poke the fire. [Browse the online help](#). Hug a stranger. Tidy the man-cave. [Email Gary with better tips](#).

9.33 New versions of WSJT-X and [JTDX](#) install themselves with new Windows start menu shortcuts, leaving the old shortcuts there, cluttering up the place. To Spring-clean your start menu, open File Explorer then copy and paste the following string into the address box:

```
%ProgramData%\Microsoft\Windows\Start Menu\Programs
```

You may see something similar to this ► The redundant [JTDX](#) entries are directories containing shortcuts to nowhere. With admin rights, I simply delete them apart from the current version – although even that could go too as I normally use a desktop or taskbar icon to launch [JTDX](#), not the start menu. For bonus marks, create a desktop shortcut to that directory to make it easier to find again.

	JTDX 2.0.1-rc117	01/01/2019 12:46
	JTDX 2.0.1-rc122	05/01/2019 06:18
	JTDX 2.0.1-rc125	20/01/2019 17:17
	JTDX 2.0.1-rc128	04/02/2019 17:15
	JTDX 2.0.1-rc129	09/02/2019 17:36
	JTDX 2.0.1-rc130	26/02/2019 11:33

9.34 Don't get *too* carried away with the custom messages and shortcuts. There is [clever programming under the hood](#) to optimize communications with the standard messages in FT8, which means some compromises. On top of that, you only have 13 places to fill in each free-text message from a very limited character set (just numerals, capital letters, spaces and a few punctuation characters)²². In particular, you will soon discover that most users are reliant on **Auto Seq**, which is easily confused by anything out of the ordinary.

Try it! There's more to the hobby than swapping calls, grids and reports!

Custom final messages are less of an issue though. Free-text (Tx 5) messages containing "73" normally trigger **Auto Seq** to realize the QSO is over and should be logged - although clued-up and patient ops can

continue conversing using 13-character free-text messages indefinitely, holding back on the 73 until the conversation is about done.

It is worth composing and storing a few free-text messages in the Tx 5 quick-select list (under **F2 Settings** → **Tx Macros**) especially if (like me) you are not an accurate typist under pressure e.g.

PLS SPLIT 73

TNX SPLIT 73

UR WELCOM 73

TNX 4 GRID 73

LOGGED TU 73

CHK UR CLOCK

WEAK TRY AGN

QRM PLS QSY

and perhaps TNX TIPS GARY

9.35 Once you have things set up, maximise use of your screen and minimise the temptation to fiddle with the settings by hiding the waterfall controls and menus. Simply ◀ clear/unset these two boxes ►

In JTDX, the F2 key only brings up the settings if the Menus are shown

9.36 With so little information exchanged in each 15 second over, a sequence of even the most efficient and succinct QSOs in FT8 hardly qualifies as running - more of a jog. The pace is easy enough once you get the hang of it (it took me a few hundred FT8 QSOs). Here's a screenshot during a leisurely 30m jog one ZL evening ▼

WSJT-X V1.8.0-RC2 by K1JT									
62145	-6	0.4	1252	~	CQ DG7NFX JN59	-German	^	621015	-4
62145	6	0.8	1518	~	ON7BJ VK2ZQ QF55			061045	-4
62145	6	0.2	1619	~	VK1DW F6EQZ R-15			061115	-4
62145	-10	0.3	1671	~	CQ SM7OYP JO66	Sweden		061215	-14
62145	-2	-0.0	1741	~	VK7AP SP3HYK JO82			061245	-9
62145	7	-0.1	1941	~	CQ SS2D JN76	Sloven		061245	-16
62145	-7	0.2	2018	~	VK7AP LX1HD JN39			061245	-9
62145	-1	0.7	1506	~	VK3FZ F4FSY 73			061445	-8
62145	-3	0.1	1518	~	ON7BJ VK2AKB QF56			061515	-6
62215	3	0.3	779	~	ZL2IFB EC7DWP 73			061615	-2
62215	4	0.1	647	~	VK5RM N7AED DM34			061645	1
62215	-8	0.2	935	~	SQ9HZM IK8IJN JM78			061715	3
62215	-11	0.4	1252	~	CQ DG7NFX JN59	-German		061745	-17
62215	11	0.7	1518	~	ON7BJ VK2ZQ R-04			061945	-15
62215	4	0.2	1621	~	VK1DW F6EQZ 73			062015	-13
62215	-8	0.7	1741	~	VK7AP LX1HD R-14			062115	4
62215	8	-0.1	1941	~	CQ SS2D JN76	Sloven		062145	5
62215	-10	1.0	647	~	CQ IK7XNF JN81	Italy		062215	3
62215	-15	0.5	936	~	SQ9HZM RW6AB KN95				

²² The JT-mode character set consists of A-Z, 0-9 and the characters + - . / ? and space. The characters @ # < and > have special meanings and are not transmitted. They are reserved for testing or otherwise as described in the WSJT-X User Guide. The slash is best avoided except as a callsign separator, although it and the full-stop (period) let us send *short* URLs. Use a redirector to shrink longer URLs down to less than 14 characters e.g. BIT.LY/FT8OP

I started by finding and then CQing on a clear frequency with **Auto Seq** and **Call 1st** both selected as usual. The program automatically responded to a decoded caller, taking us through the conventional sequence of overs until the Log QSO pane appeared when I received a 73 message signalling the end of the QSO. All I had to do then was click the OK button to log the QSO then click the **Enable Tx** button to have the program re-start CQing after it had finished sending my 73 message. If another caller called me (before or after my CQ), **Auto Seq** generated the standard messages and started a QSO with them. Meanwhile, I was easily able to work, catch up with emails, browse QRZ.com etc. on the other screen on my dual-screen Windows desktop.

9.37 Are you as confused as me over whether a station is transmitting on the odd or even timeslots? If you normally start a QSO by double-clicking a decoded CQ call, it doesn't matter: WSJT-X automatically selects the appropriate timeslot in which to call them. But what if you want to call someone who is not CQing, perhaps just finished working someone else? What if you start calling someone but they disappear without a trace? It's worth checking that you're transmitting in the correct even/odd period, not doubling with them. Mike W9MDB pointed out a simple way to tell is to look at the final digit of the timestamp for their transmissions: if the times end in a zero, they are using the even slots, so we need to call them on the odds. Times ending in 5 indicate they are odd (!). If that's still too hard to figure out in the heat of the moment, here's a Hinson tip. Simply make sure the **Tx even/1st** selector resembles the last digit of the timestamp *e.g.* if it is 5, the selector box should be filled like this , if zero the selector box should be empty like this ▼:

JTDX colour-codes the time box and odd/even selector to make it even easier.

UTC	dB	DT	Freq	Message
000030	-14	0.2	1382 ~	CQ YL2NX
060900	-12	0.2	1382 ~	CQ YL2NX
060930	-16	0.2	1382 ~	UT7QF YL2
061000	-14	0.2	1382 ~	UT7QF YL2
061030	-13	0.2	1382 ~	UT7QF YL2
061510	-2	0.1	1788 ~	CQ HBOWR
061610	-2	0.2	1788 ~	CQ HBOWR
061630	-9	0.2	1788 ~	ZL2IFB HI
061700	-7	0.2	1788 ~	ZL2IFB HI
061730	-5	0.1	1788 ~	ZL2IFB HI
061800	-6	0.2	1788 ~	CQ HBOWR
061815	4	0.6	1788 ~	HBOWR EA7
061830	10	0.2	369 ~	LY3BG UT7
061845	-9	-1.0	369 ~	UT7QF LY3
061900	6	0.2	369 ~	LY3BG UT7
061915	-10	-0.9	369 ~	UT7QF LY3

9.38 Keep an eye on the waterfall. If you notice FT8 signals shifted towards the left or right side, check that your rig's VFO frequency is correct for the band you're using.

9.39 If you find yourself sending many repeated messages and failing to complete QSOs because the other stations disappear or abandon you to work someone else, you may not have enough radiated power. If your signal is *too* weak, other people will get partial copy and will miss some decodes. Experienced DXers will hopefully notice that your signal is weak, and will patiently persist as long as you are trying to complete a QSO ... but inexperienced or impatient DXers tend to give up too soon when conditions are tough. So, the answer is:

- Make sure as much of your generated power as possible is actually radiated – ideally with a short run of low-loss feeder and an efficient well-matched antenna (no need for an ATU). If you want to work DX, you will do best with an antenna that has a low angle of radiation such as a quarter wave or half wave vertical, a fullwave loop, or an inverted-L or T (top-loaded vertical) ... or of course some sort of beam (the hexbeam for example – small, lightweight, works well). As a bonus, a good DX antenna will increase the strength of DX signals you receive, so there will be more DX on your waterfall to work!
- Make the best of conditions and propagation. As you change bands, notice whether the waterfall is 'lively', busy with loads of signals, or 'quiet', or 'dead'. It takes more luck and often more power to work stuff when the band is not in good shape. For this reason, it helps to be able to use several HF bands, choosing whichever one happens to be the best at the time you are on the air.
- Rather than just CQing, try calling stronger stations, the ones with more red on the waterfall. Make full use of the tips in this guide *e.g.* transmitting split on a quiet frequency, at the right moment (when someone is CQing or has just completed a QSO, not *during* their QSOs) with everything carefully adjusted (*e.g.* accurate clock, audio levels in the green). Some stations won't hear you or won't want to work you, some will ... so be prepared to call several stations for each completed QSO. This is a normal part of DXing.
- Be patient and persistent yourself.

Maybe you nudged the big knob. Maybe the software kicked the CAT.

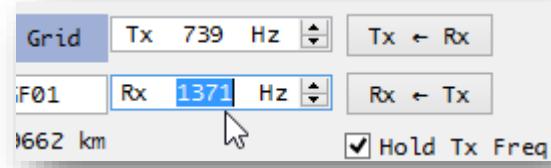
DXing is a bit like fishing – we cast out *many* CQ calls to catch the odd DX fish, and bagging the occasional 'big one' makes it all worthwhile. Personally, I enjoy the 'fighters' most of all – QSOs that are challenging to make due to poor conditions, QRM etc. are all the more satisfying to complete and log. It's a real achievement! The fisherman is just as important as his tackle: every time we get on air is a chance to practice and hone our skills, occasionally trying new tricks. It's not only about bagging the catch – enjoy the chase!

"FT8 is designed specifically for propagation conditions such as multi-hop sporadic-E at 50 MHz – circumstances where signals are weak and fading, openings short, and quick completion of reliable, confirmable contacts is particularly desirable."

"Work the World with WSJT-X, Part 2: Codes, Modes, and Cooperative Software Development", K1JT, K9AN and G4WJS, QST November 2017

9.40 Setting the dead green goalpost Rx marker to monitor a specific DX station can be awkward:

- If you can find him on the waterfall, simply click the left edge of his signal – that's the easy bit but quickly locating his signal on a busy waterfall can be tricky.
- Alternatively double-click one of his decodes to set up your messages and start calling him (unless you hurriedly click **Halt Tx**).
- Or type the audio frequency listed on his decodes into the Rx frequency box on the main WSJT-X or [JTDX](#) screen²³ or if you are close, click the up or down arrows to fine-tune ►



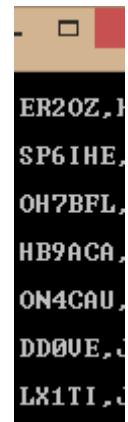
Double-click to select the numbers in the Rx frequency box, then type the frequency numbers using the numeric keypad, ending with *Enter* or *Return*.

9.41 While you are CQing and waiting for a response, keep an eye on the decodes for DX callsigns on the left. You won't decode DX stations that are transmitting at the same time as you, but you may decode their callers during your reception periods.

9.42 If you *need* a QSO with someone who is calling CQ to a different area, pick one of these:

- Call them anyway, once or twice, on a different frequency (split) so as not to QRM any callers they may have from their target area. Don't call them continuously, especially not simplex;
- Instead of calling them specifically, make directed CQs to their area in the hope that they will see you and respond to you if they wish;
- Patiently wait and watch. If they stop CQing, or drop the specified target, pounce: call them!

9.43 With so much going on, especially when the band is busy, I sometimes got confused over who I've just worked and logged. Thanks to an idea floated on the WSJT reflector, I wrote a [simple batch file](#) to call Windows PowerShell to display the last few QSOs from the WSJT-X log, updating itself as each new QSO is logged. With the black and grey PowerShell window shrunk down to just a narrow strip at the edge of the screen, it shows the callsigns I have most recently logged ►



To do this for yourself, the Windows PowerShell command line is:

`powershell.exe get-content %LOCALAPPDATA%\WSJT-X\wsjtx.log -tail 3 -wait`

Courtesy of VE2EVN, the Linux equivalent is:

`tail -n 3 -f ~/.local/share/WSJT-X/wsjtx.log`

JTDX shows us the last callsign "Logd" on the lower status line ▼



²³ The text "Rx" and "Hz" currently *within* the frequency setting white boxes should really be *outside* the boxes. That simple change would make it even easier for us to click or double-click anywhere in the box and enter the audio frequency number, without having to worry about the Rx and Hz text also being selected.

9.44 WSJT-X routinely writes a WAV file of received audio to disk while it processes it. Even if you configure WSJT-X *not* to save its WAV files using the obscure option “None” under **F2 Settings → Save ►**, it still does. The reason is that normally the WAV file is deleted automatically by WSJT-X about 10 seconds after the processing is completed (giving us time to save it if we decide to do so). However, when you exit WSJT-X, the current WAV file is abandoned, remaining orphaned on disk. If you start and stop WSJT-X repeatedly, you’ll eventually discover an orphanage full of abandoned WAVs, cluttering up your hard drive. Some users have reported *hundreds* of orphaned WAVs.

It’s worth clearing out the orphans from time to time, either manually (using the housekeeping function on the **File** menu ►) or using a simple batch file with the following Windows command line (perhaps the very same batch file that [displays the end of your WSJT-X ADIF log](#)):

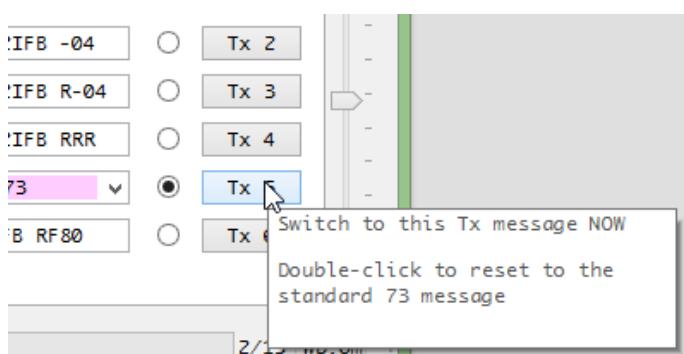
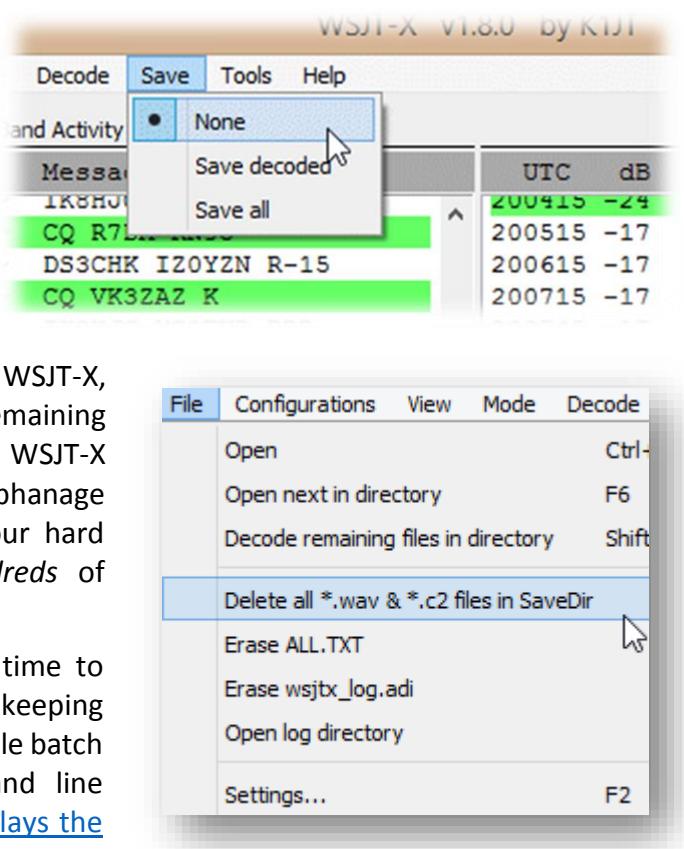
```
del %LOCALAPPDATA%\WSJT-X\save\*.wav
```

9.45 If you change your mind or mess up your typing while hurriedly editing the free-text message Tx 5, you can instantly reset it to the standard 73 message by double-clicking the Tx 5 box ► but be careful about precisely when you do it: annoyingly, the double-click also changes immediately to sending that message if you are transmitting a different message at the time, and offers to log the QSO.

9.46 Show the grids you’ve worked on a Google map using an [online mapper by WG7J](#). The mapper accepts ADIF log files up to a certain size above which it fails silently so, if you have a large log, you’ll need to pre-process it using [this grid extractor utility by W9MDB](#) to generate a much smaller ADIF containing just one QSO per grid. Green grids are confirmed, reds aren’t, yet. Mouse over for info.

Note: some hams give out and even confirm the wrong grids ► It is fairly obvious when their grids put them in the sea, unless they were /MM at the time. Or swimming. Walking on water perhaps.

Do us all a favour: [double-check your own grid square](#), please, especially if you are confirming it via LoTW.



9.47 What constitutes a valid, complete QSO is another zombie topic, one that has been raised, discussed, kicked around and buried on the WSJT-X reflector many times. Cutting to the chase, there is no consensus among the ham community on this ... hence when we are in QSO with someone, we don't know which way they think. Some of our QSO partners will steadfastly *insist* on exchanging 73s with us, some won't even send 73s, and quite a few more are in the 'don't care either way' bracket. A few don't even bother logging their QSOs (license conditions notwithstanding). Specifying and coding the software for such ambiguity on the part of the people we are contacting is, let's say, challenging. Even if we were able to set our own preferences with a tick-box somewhere, we still don't know what's happening at the other side of the QSO, so it's left to the operator. Personally, I consider my QSOs complete when we have made a connection sufficient to copy each other's callsigns and exchange a few more bits of information such as our reports. On FT8, when I've *sent* an RRR or RR73 message, I log the QSO.

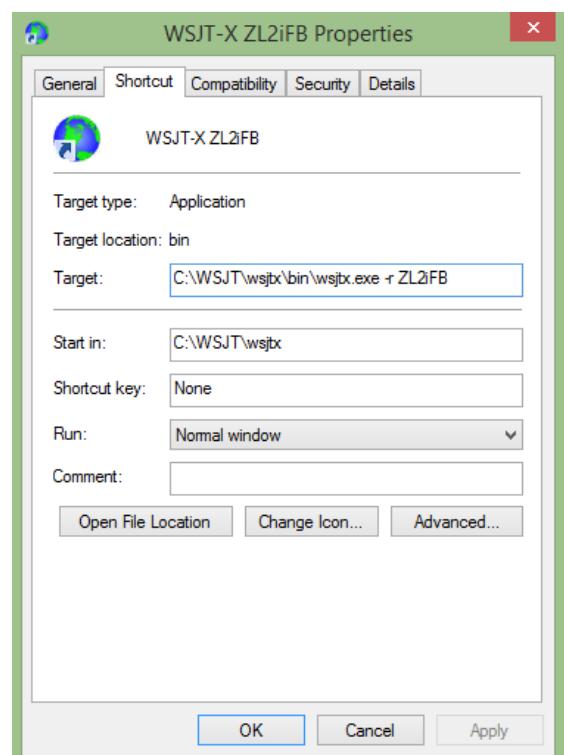
If you believe a QSO is complete, log it and hope that the other guy also logs it. If you believe your QSO is incomplete, wait and hope that the other guy keeps on trying to complete as long as you, and then logs it.

9.48 Different amateurs sharing the same station can set up personal WSJT-X or [JTDX](#) profiles to suit themselves, using the **-r [name]** command line modifier originally intended for using alternative rigs with different settings. [Name] is just a handy label for the profile, such as the callsign (no spaces).

For example, if I launch WSJT-X using **WSJT-X -r ZL2iFB** it sets up an environment just for me, with a ZL2iFB subdirectory to hold my ADIF log, ALL.TXT and .WAV files, plus the .INI configuration file holding the default settings which I would then customize to suit my preferences (or more likely copy across from the unnamed profile I already have). It reminds me that I am using a custom profile for ZL2iFB by showing that name on the window title.

If I close WSJT-X and then re-launch it using **WSJT-X -r ZM4T**, it sets up *another* environment for the club, with its *own* log, WAVs etc. in a *separate* ZM4T subdirectory. We can then choose between the two setups whenever we launch WSJT-X, with any config settings being saved to the respective profile.

The easiest way to choose between profiles is to append the **-r [name]** modifier to the *Target* for the icon that launches WSJT-X, renaming the icon accordingly ►



9.49 Does RF get into your computer and mess things up when you transmit? The ideal solution is to reduce the amount of RF in the shack, for example by siting and feeding your antennas some way away using balanced line, or good quality coax with a balun or choke at the feedpoint of a balanced antenna. Earth bonding at the shack end can also help, as well as running QRP.

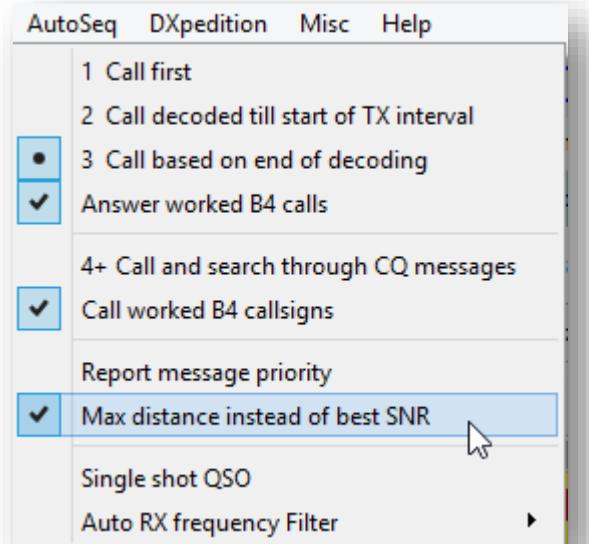
If that's not enough, try putting suitable ferrite chokes²⁴ on the PC cables. Split-core clamp-on chokes are easy to fit²⁵. Physically routing the cables, and perhaps re-siting the whole computer, further away from your radio, amp and feeder may help too.

In [JTDX](#), there are additional autosequence options to determine how the system responds to callers. Look under AutoSeq on the main menu bar and feel free to experiment ► AutoSeq3 ("Call based on end of decoding") suits me. I prefer "Max distance instead of SNR" to respond to more DXey callers first, and I'm perfectly happy to work people more than once: I'm friendly like that.

9.50 If you use a dual-monitor setup with WSJT-X running on one monitor, leaving the other for logging and other stuff, WSJT-X *usually* remembers but sometimes forgets which monitor it belongs on when it launches. It's annoying to have to drag or Windows-arrow it to the other monitor each time. Fixing that annoyance is a bit hit-and-miss. Here's the trick that works for my USB-connected second monitor:

- Temporarily disable the second display in Windows Device Manager;
- Launch WSJT-X. It should open on the working display;
- Re-enable the second display in Device Manager;
- Drag or windows-arrow the WSJT-X main window and waterfall to the other monitor;
- Close and restart WSJT-X to check that it has got its monitor memory back. If it hasn't, you're on your own, sorry!

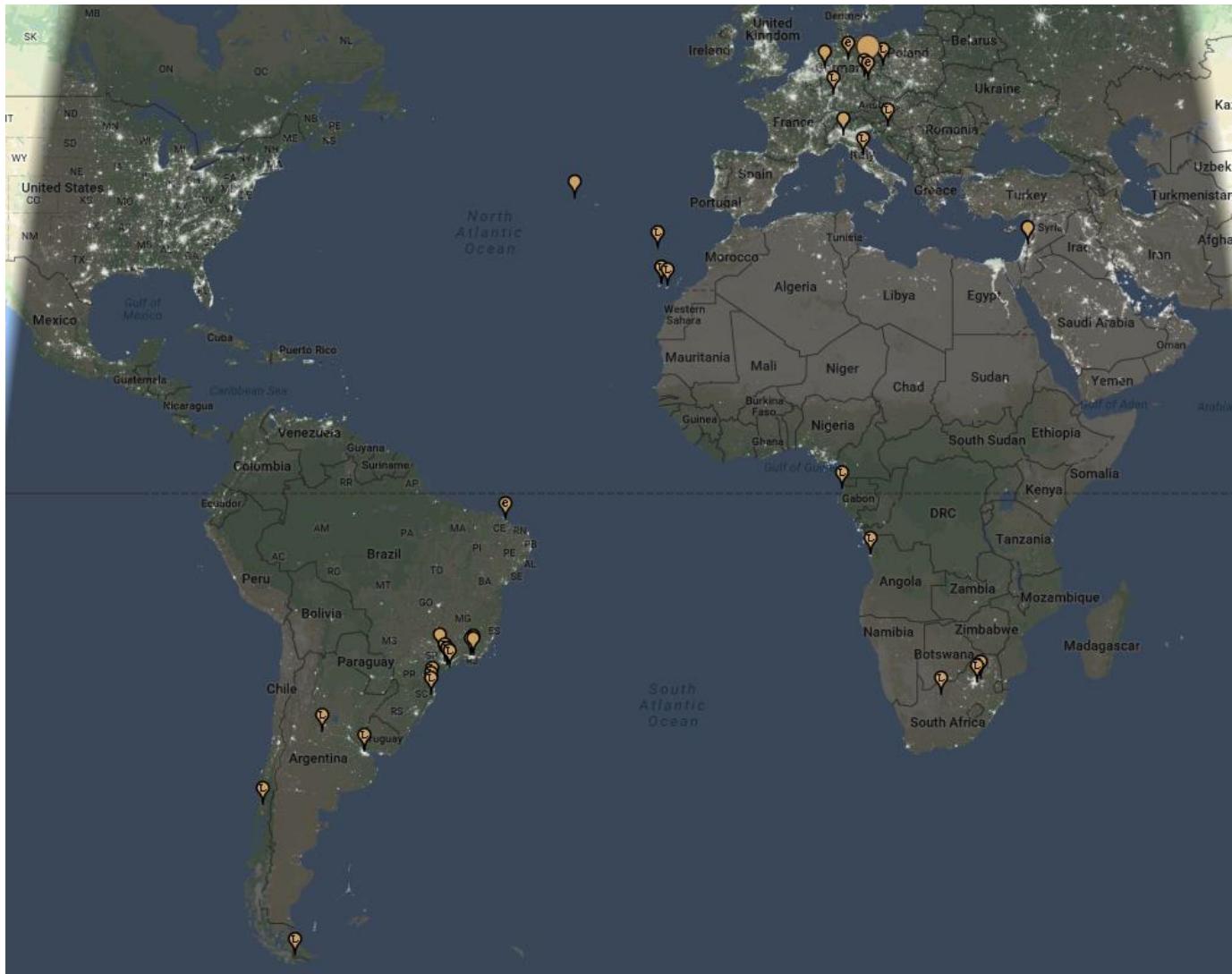
While you mess around with earthing, baluns and chokes, order some well-shielded USB cables with copper braid giving more than 95% coverage. Gold- or silver-plated contacts, and maybe a few \$ more, suggest above average performance for USB cables, and audio cables too for that matter. Don't bother with **Oxygen Free Copper** though: last time I checked, plain old copper conducts very nicely, thank you. I have no problem with my timbre and sound field.



²⁴ Choose an **HF-rated** ferrite mix with an A_L value of at least 2,000 to add enough inductance. With A_L values in the low hundreds, VHF-rated ferrites are cheaper (often free!) but add little impedance at HF.

²⁵ The larger HF-rated cores, including man-sized circular toroids, are better as you can pass the cable through them several times. The choking inductance increases in proportion to the number of turns *squared* e.g. 2 turns have 4 times the inductance of 1 turn. Use thin, flexible cable with small or no connectors to squeeze more turns into a given core.

9.51 Most of us choose to upload the callsigns and locators we are decoding to PSKreporter.info, where they can be flagged on a map. The PSKreporter screenshot ▼ for instance, shows roughly 25 yellow blobs - FT8 stations across South America, Africa and Europe being received by a German station on 17m in the preceding 15 minutes.



The map is dark because this was in the wee small hours of his morning ... when he wouldn't normally expect to be working DX on the high bands.

“The duties of a travelling watch inspector for a big railway system are much more arduous than one might imagine. One system pays \$18,000 per year for this purpose only. It takes the assistant inspector two years to visit all the inspection points on the lines and each test of a watch lasts 72 hours. If it varies six seconds in that time, it is rejected.”

*[Popular Mechanics, January 1905]
[In today's money, \$18k is worth about \$1.5m]*

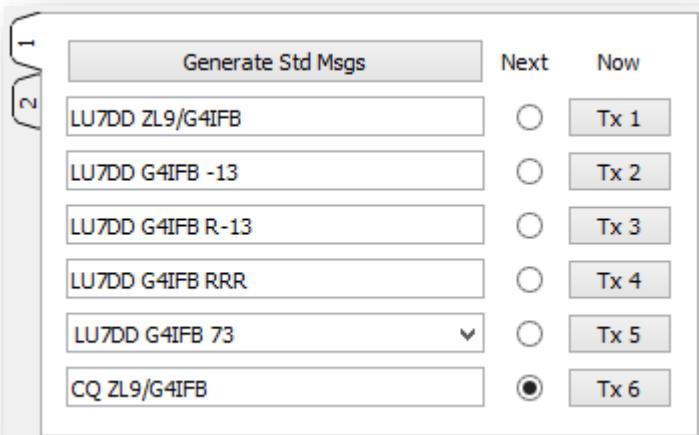
10 Special callsigns

10.1 Deep within the technical specification of the FT8 protocol itself, the format of “standard callsigns” is defined quite specifically and narrowly ►. This reduces the variety of callsigns that the protocol needs to handle, hence limiting the number of digital bits required to code them. However, some **special event, compound and commemorative calls** are so “special” that the *original* FT8 protocol simply could not accommodate them within the 28 bits reserved for callsigns in most of its messages (e.g. CQ calls, reports and RRR or RR73 messages)

10.2 Although special callsigns of up to 13 characters can be included in free-text messages, they are not interpreted as callsigns: they are simply arbitrary text strings. If someone double-clicks one of those decoded free-text messages from some exotic DX in the hope of calling them, they would be out of luck, even if the free-text message includes “CQ”. The software does not know what to do with the message except display it to the frustrated user! It does not automatically enter the full callsign in the **DX Call** box, nor does it include it in the generated messages for their response due to the bit-shortage.

10.3 Standard callsigns with *some* conventional **location modifiers** (e.g. typical CEPT-type compound calls with ITU standard/DXCC-approved country prefixes followed by a slash) are handled by the software, passing the full callsign in Tx 1 and Tx 6 but only the home callsign part in the other messages. If I were to nip over to, say, Auckland Island, my callsign might be ZL9/G4iFB so my generated messages for a typical QSO would be these ► Notice that the ZL9/ prefix is only sent in my Tx 6 (CQ) and Tx 1 (initial response to caller) messages. The list of prefixes and suffixes that are treated in this way is available from the **Help** menu on the WSJT-X main screen (with **Menus** selected). Those specific “type 1” prefixes and suffixes (about 350 of them) are encoded and sent in as few bits as possible, allowing two full callsigns to be included in some generated messages. Some unlisted “type 2” compound callsigns (such as /M, /MM and /W3) may be sent without the other callsign in some messages.

“A standard amateur callsign consists of a one- or two-character prefix, at least one of which must be a letter, followed by a digit and a suffix of one to three letters. Within these rules, the number of possible callsigns is equal to ... somewhat over 262 million ... Since 2^{28} is more than 268 million, 28 bits are enough to encode any standard callsign uniquely.” [WSJT-X User Guide]



Other uncommon situations are not explained in the help e.g. if a station has *both* a prefix and a suffix, or if two compound-call stations are in QSO. Perhaps you’d care to experiment to find out what happens, in which case please [let me know](#) how you get on.

10.4 According to Claude Shannon's [information theory](#), the total number of digital bits in the payload determines the amount of information that can be conferred by an individual message. In 77-bit FT8, callsigns can be compressed down to hash values which are transmitted, then expanded back to callsigns on receipt²⁶. However since the compression routine is lossy, at the receiving end there are several possible expansions of a given hash ... so which is the correct callsign? The answer is found by checking back through recent decodes to find the callsign that was transmitted in full at some prior point, and which gives a matching hash value. You may notice this process happening from time to time

as the **hashed callsigns may be shown in angle brackets** ►

Notice that, in that particular example, DL7ACA – a perfectly ordinary and conventional

German callsign – has been hashed to reduce the number of bits required because the other callsign in that message, SX60RAAG, is special and needed more bits. Either callsign may be hashed.

1/16000 -20 0.1 1221 ~	TF1A 1U8FRF JN/0
171615 -13 0.2 389 ~	<DL7ACA> SX60RAAG RR73
171615 -11 0.2 700 ~	503MM 5EFX 11

Hash collisions (where *different* callsigns compress to the *same* hash values) are a possibility, along with CRC and AP failures. If you see a truly *bizarre* callsign (not merely *special*), it is probably a bust.

10.5 Here's an example of the hashing process at work ► Having just launched [JTDX](#) and tuned to a DXcluster spot for 9LY1JM on 17m, the first seven decodes all displayed the <...> placeholder in place of the DXpedition callsign, indicating that the callsign was being passed as an as-yet-unrecognised hash code.

Subsequent decodes showed 9LY1JM's callsign after *someone*²⁷ had sent the DX callsign in full, hence [JTDX](#) was able to hash it and match up its hash value with the hash value sent by other callers, displaying the corresponding DX callsign for me rather than <...>

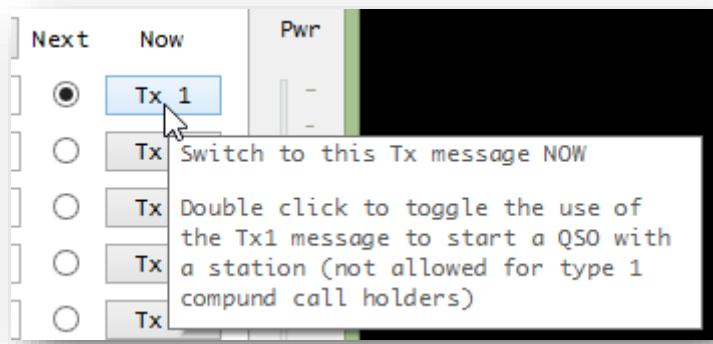
195345 -1 -0.6 2202 ~ <...>	K7PI
195345 -4 0.1 1529 ~ <...>	PY2FUL -16
195345 -8 0.3 1865 ~ <...>	PY2RJ GG66
195345 -14 0.2 2577 ~ <...>	WA6SCW
195345 -17 -0.0 1094 ~ <...>	N6ED
195345 -16 0.2 1585 ~ <...>	KD5M EM60
195345 -16 1.1 1674 ~ <...>	K5LJ EL29
195415 -8 0.1 1528 ~ 9LY1JM PY2FUL RR73	
195415 -2 -0.6 2150 ~ 9LY1JM K7PI	
195415 -9 0.2 1195 ~ 9LY1JM PY2APK	
195415 -9 0.3 1865 ~ 9LY1JM PY2RJ GG66	

10.6 Hashing isn't a precise method to pass callsigns. Hash values are ambiguous. If, coincidentally, two or more callsigns with the same hash values are both active, the software may choose and display the wrong one. The software *should* always send the sender's full callsign un-hashed at least once in a QSO in order to be crystal clear, although it may need to hash the other callsign in the message to save bits.

²⁶ Hash codes for special callsigns are calculated and cached as they are received, ready to match against any subsequently transmitted. When WSJT-X is closed, the cache is cleared and it takes a while to rebuild the cache after it restarts.

²⁷ Not 9LY1JM themselves, unfortunately, since I could not copy them! The software can hash *either* callsign in the two-callsign messages, so by chance someone must have sent a message containing a hash of their own callsign with the DX callsign in full.

10.7 Hovering the mouse over the Tx 1 button in WSJT-X pops-up an ambiguous message ► stating that toggling Tx 1 is 'not allowed for type 1 compound call holders' but the user *can* press ahead and skip Tx 1 anyway. The pop-up message is in fact an instruction, not a statement of fact. 'Not allowed' actually means '**Do not do this**'. Don't do it!



10.8 If the operator foolishly ignores the instruction, skips Tx 1 and calls a station with a compound callsign using Tx 2, the called station's **Auto Seq** responds with Tx 3 which *omits the call of the station to whom they are responding*. This is a recipe for confusion when there are several callers, often the case since compound calls tend to be DX travellers. Regardless of whether our callers send Tx 1 or Tx 2 at us, and regardless of what kind of callsign we are using, we should **always** respond with the caller's callsign in our first message to be clear who we are working²⁸.

*"A caution to those of us who often bypass the Tx 1 message (calls and grid) and start with Tx 2 (calls and report). If you are calling a DX station with a special callsign, when the DX station responds, none of the messages in his transmitted sequences will have *your* callsign in them. There is no way to know for sure that the DX station is responding to you or another station. The fix, when calling stations with special callsigns, is always to start with Tx 1."*

[Rick K1HTV]

10.9 The same issue affects both parties to a QSO involving a special callsign. Stations with special callsigns who skip Tx 1 when calling other stations may be frustrated to discover that their Tx 2 messages are mostly ignored. The reason is that their special callsign gets transmitted as a hash code that is displayed as <...> on the receiving end *unless* by chance the recipient's system happens to have previously received a message containing the full callsign, enabling it to match up the hash codes. Recipients see *someone* repeatedly sending cryptic messages of the form "<...> +10" at them. **They are unable to respond properly because their systems do not know who to respond to.** The auto-sequencer robot is quite clever <...> but not bloody clairvoyant!

10.10 Likewise stations with special callsigns²⁹ are unable to make contest QSOs on FT8 because the contest exchange does not leave sufficient bits to send their special callsigns in full. There simply aren't enough bits available. FT8 falls a bit short sometimes.

WARNING

Repeat after me:
do not skip Tx 1
Do not skip Tx 1.

Do not skip Tx 1!

²⁸ I believe this is a design requirement for the software. Not doing this qualifies as a design flaw.

²⁹ Special callsign holders can still contest using legacy modes with character-wise encoding such as CW, RTTY and PSK. Don't shoot the messenger, or the developers: it is one of the inevitable compromises of trying to squeeze quarts into pint pots. Rant at Mr Shannon or the bit tax. Or apply for an ordinary, common-or-garden, plain, simple and most of all *short* callsign! ☺

10.11 To explore the way various messages and callsigns are handled in FT8, check out “ft8code.exe” in the WSJT-X program directory. Run it from a command line with a message as a parameter in quotes to find out how the message would be encoded, sent and decoded. For example, if I wanted to send the message “CQ E5/ZL2IFB/P RA01” via FT8, ft8code tells me that’s a nonstandard call so my message would be transmitted as “CQ E5/ZL2IFB/P” omitting the grid ▼

```
C:\Users\Gary>c:\WSJT\wsjtx\bin\ft8code "cq e5/zl2ifb/p ra01"
Message                                Decoded
r i3.n3

1. CQ E5/ZL2IFB/P RA01
* 4. Nonstandard calls

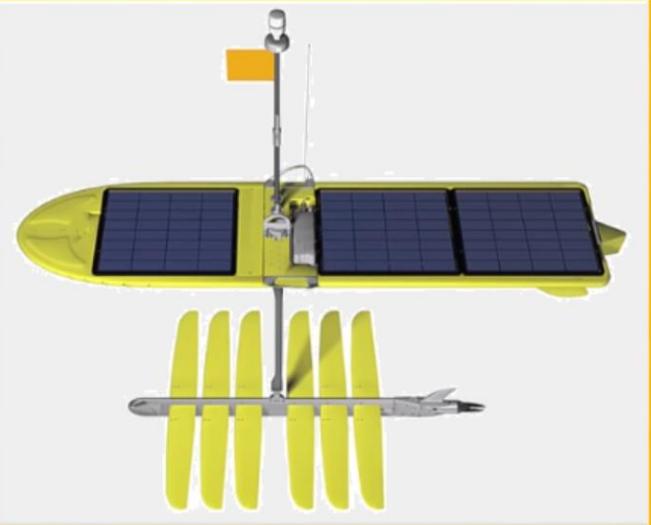
CQ E5/ZL2IFB/P

Message bits:
1111110000100101010010101011011001101100011111101010010000100110000001100

Channel symbols <tones>:
3140652770336136665441773551150213673140652042772532175041705234726703433140652
```



This is [HF Voyager](#), an experimental scientific buoy (a Wave Glider solar-powered drone) floating across the Pacific tracking whales ... and amusing itself by making FT8 QSOs *en route* under the callsign KH6JF/MM. Did you work the robot? Got your QSL card yet?



11 DXpeditioning with FT8

11.1 There are pros and cons to using FT8 on DXpeditions:

- On the upside, it is a popular HF mode, good for DXing even for those limited to low power and basic or stealth antennas. It can make short openings and marginal paths productive.
- On the downside, the maximum QSO rate is *normally* about 60 QSOs per hour using the standard protocol.

In practice, experienced digimode DXers (such as Roly P29RR) can sustain a rate of about 50 FT8 QSOs per hour, provided they have the ability to concentrate intently on the screen and cope with the occasional need for repeats and the sequence-out-ofs. QRM and contention for bandwidth would reduce the rate still further for very rare and popular DX.

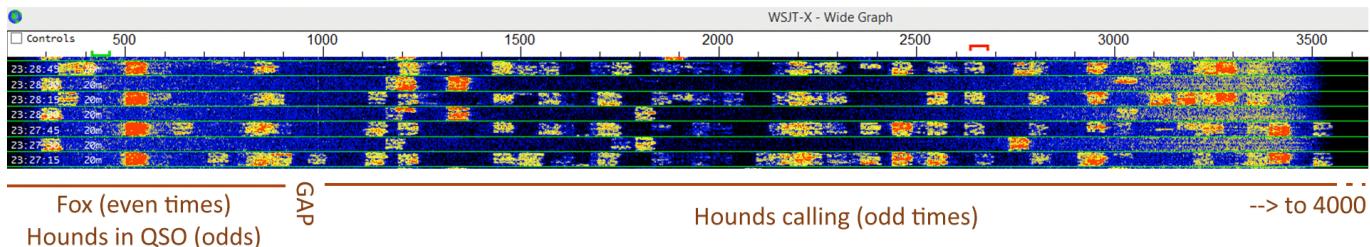
A competitive CW, SSB or RTTY op on a good station can sustain a rate of 200+ QSOs per hour, maybe 250 or more for a similar level of operator effort - so that's potentially 4 or 5 times as many DXpedition QSOs per hour using legacy modes.

11.2 The **DXpedition protocol** changes FT8 for both the DXpedition station (the fox) and their callers (the hounds). A single fox transmitter can generate multiple FT8 signals simultaneously, and in some cases send messages to two stations in the same transmission on a single frequency, making QSOs with several hounds in parallel on one rig and band.

11.3 To use DXpedition protocol as a hound (a DX chaser):

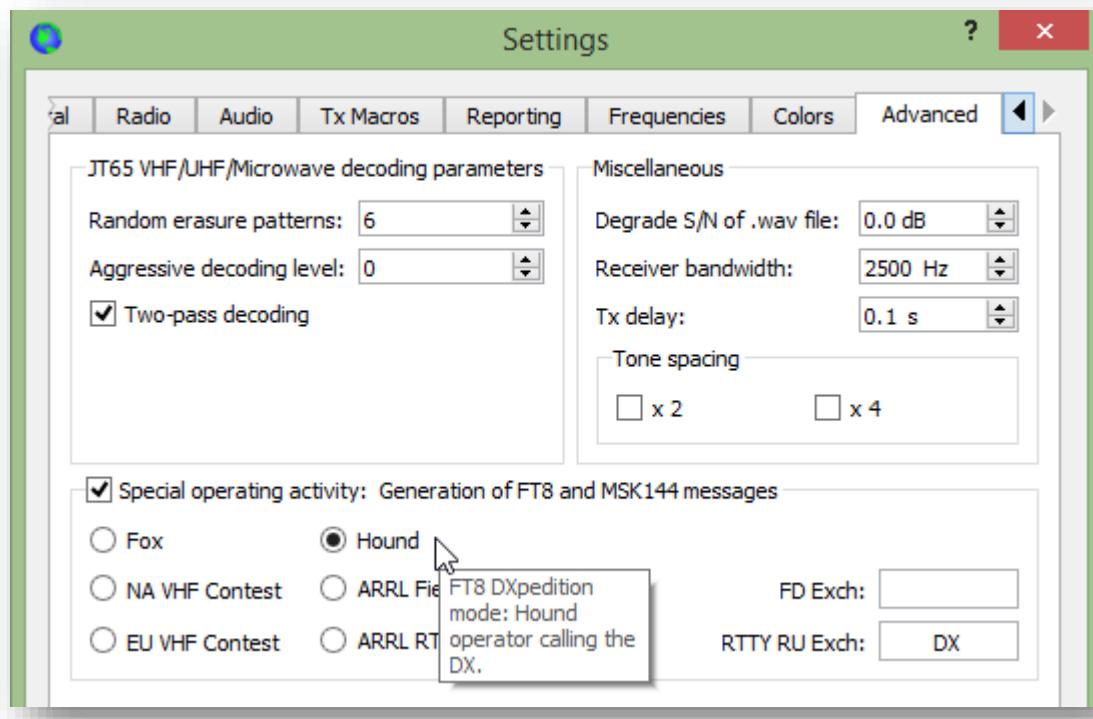
- Install, run and configure a recent version of WSJT-X or [JTDX](#). Get it running properly, ideally with CAT control of your radio using the Rig or Fake It settings. Spend some time making normal QSOs to familiarise yourself with FT8 operating.
- Add the nominated DXpedition FT8 frequencies to the frequency table *e.g.* 14.090 (*not* the usual FT8 frequencies!) under **F2 Settings → Frequencies**. Right-click the table, then insert the DXpedition FT8 frequencies. Leave the usual FT8 frequencies alone (it's OK to have multiple FT8 frequencies on each band - set up a separate configuration for DXpeditions if that helps).
- When the DXpedition is on the air, expand the band coverage of your waterfall ▼ to view from 200 to 4000 Hz *e.g.* using 3 Bins/Pixel and start at 200. Although your rig's bandwidth may not cover the entire range, with CAT control you can shift-click the waterfall to transmit anywhere above 1000: before transmitting, the rig will automatically QSY and generate the appropriate audio frequencies, QSYing back again afterwards. However, you may then be unknowingly QRMing other callers if your waterfall blanks out towards the right³⁰.

If you don't have CAT control, you will have to QSY your Tx somewhere below 1000 Hz manually after the fox responds to your calls. If you don't QSY, the fox can't complete the QSO with you.

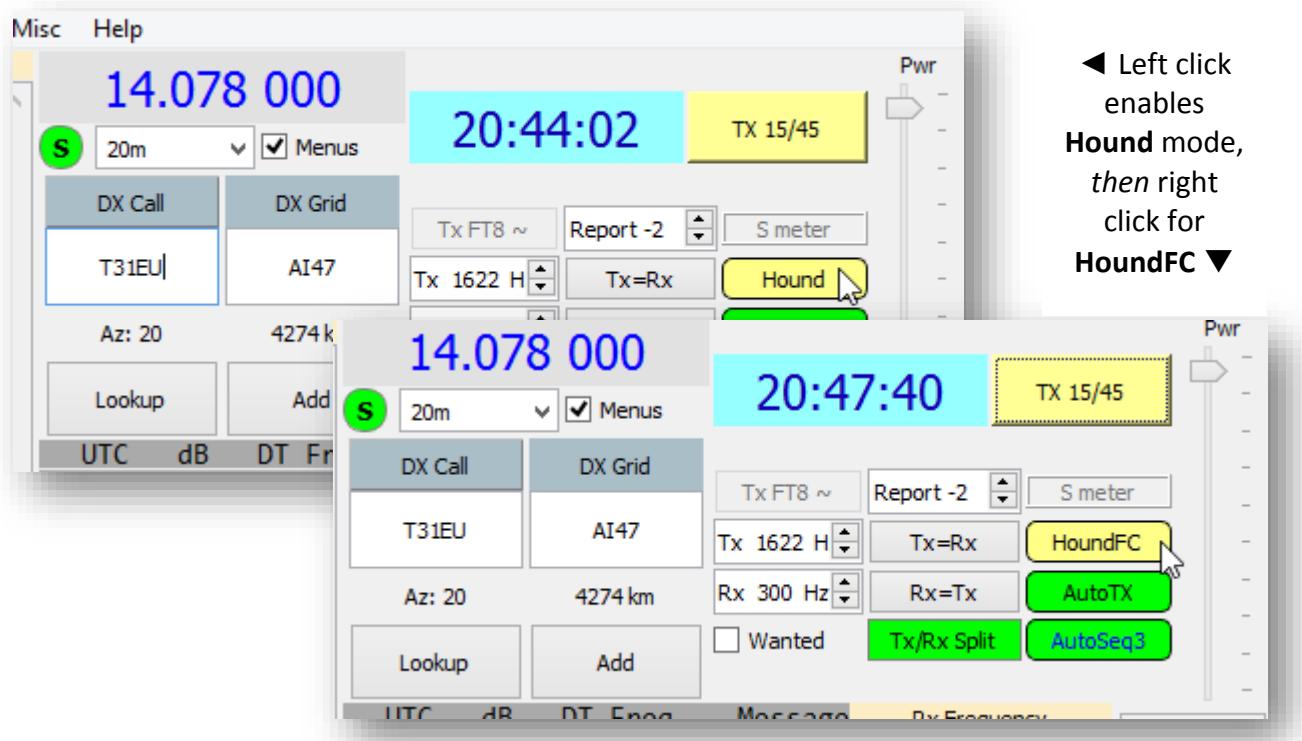


³⁰ With my K3, the waterfall blanks out just above 3500 Hz, even with the K3 data mode filter wide open at 4.0 kHz.

- In WSJT-X, select *Special operating activity* then *Hound* on the **F2 Settings → Advanced** tab (unless you are the fox *on* the DXpedition!) ▼



- It's easier still in [JTDX](#): click the **Hound** button on the main screen ▼ *then* right-click it to enable the auto-QSY Frequency Control function. It even auto-cancels when you revert to the normal FT8 frequencies. *Nice!*



11.4 In DXpedition mode, a hound's *Band Activity* left hand pane only shows decodes up to 1000 Hz, in other words the fox and the hounds he is working, unless you have selected **Rx All Freqs** on the main screen ►. The fox sees them all, of course, and selects them to add them to his queue.



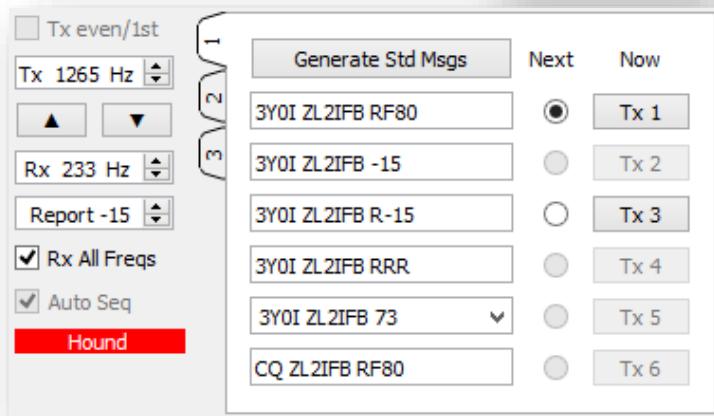
11.5 In DXpedition mode, most of the usual message selectors are greyed-out³¹, leaving just two ► You will call the fox with your Tx 1 message until he responds to you, then you'll send Tx 3 with your report until he acknowledges it. That's it. No RRR or 73 or custom messages are needed from you – keep your transmissions to the absolute minimum so other hounds have their chance to catch the wily fox.

11.6 Point your antenna towards the DXpedition and select an appropriate power level (typically in the region of 5 to 50 watts – neither so little that you won't be heard, nor so much that the fox pointedly ignores you).

11.7 **Shift-click** (WSJT-X) or **right-click** (JTDX) to set your transmit frequency (the red goalpost) on a reasonably clear column on the waterfall above 1000 Hz.

11.8 **Wait patiently until you see the fox transmitting**, generally on the even cycles. You may see his single CQ call, or several signals as he makes QSOs with up to 5 hounds in parallel. Fox decodes often include concatenated messages like this ► Here a very weak fox is completing a QSO with NA7TB and (at the same time on a second fox Tx frequency), sending a report to K5EK.

11.9 **Once you are copying the fox reliably**, double-click one of his decodes to set things up and start calling him in the normal fashion.

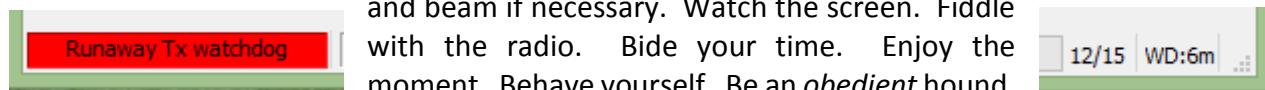


234900 -24 0.2 417 ~ NA7TB RR73; K5EK <K1JT> -21

If you cannot copy the fox, **DO NOT CALL HIM** as you will simply create QRM and aggravation. Even if by some miracle he responds to you, you won't see his response and someone else may miss out on a QSO as he tries to contact you in vain. Try turning your beam or using another antenna. Try another band maybe. Do the sunspot dance. Or simply wait patiently like a good DXer, watching the screen, poised to pounce like a hawk if and when you do see decodes from him.

³¹ The Tx even/1st option is also unavailable to the hounds: foxes ALWAYS transmit on the even/1st sequences. You will normally see lots of blobs on the odd/2nd sequences, but hopefully only the fox on the left of the waterfall on the evens.

11.10 In DXpedition mode, a special hard-coded timer automatically disables your transmissions after 2 minutes³² without a response ... however, in that time, the fox may have put you on the queue. If the fox responds to you later, after your DXpedition mode timer has timed out and before you restart transmissions, **your Tx will automatically be re-enabled to send him his report**, completing the QSO when he acknowledges it with his RR73 message back to you. Use the Tx breaks wisely. If necessary, QSY to a nice clear Tx frequency and hope it is clear at the fox end. Adjust your power and beam if necessary. Watch the screen. Fiddle with the radio. Bide your time. Enjoy the moment. Behave yourself. Be an *obedient hound*.



11.11 If the fox responds to your call with his Tx 2 message (your callsign and report), **your system will automatically QSY your Tx to a frequency below 1000 Hz**³³ to send him your Tx 3 message (both callsigns, R and his report). If you don't have CAT control, you should QSY manually below 1,000 Hz to make the QSO unless the DXpedition op is alert enough to complete it manually.

11.12 If for some reason a fox is transmitting on the odd/2nd periods, hounds can use **control-E** to force their transmissions to the Even/1st periods even though in WSJT-X the Tx even/1st option on the screen is greyed out in DXpedition mode ► As well as not being active to select the period, it doesn't show the current status. Use **shift-E** to return to the odd/2nd periods, the default.



11.13 Your system will continue sending Tx 3 below 1000 Hz several times until the fox acknowledges receipt with his Tx 4 message (your callsign and RR73, possibly as part of a multi-transmission message), concluding the QSO.

Having initially responded to your calls, if the fox is ignoring your Tx 3 messages, your Tx frequency may be busy with other callers causing QRM. Try manually shifting your Tx to a different, clear frequency on the waterfall. Stay *below* 1000 Hz though.

11.14 In *Hound* mode, information from decodes is not routinely sent out onto your shack network via UDP, although once you work and log the fox, the log QSO message *is* broadcast as normal. The usual stream of [UDP messages](#) resumes when you leave DXpedition mode ... so after you work and log the fox, don't forget to de-select *Hound* and tune back to the normal FT8 frequencies³⁴ ... unless you are hunting the fox on another band next. Take a moment to celebrate the wonders of weak-signal digimode DXing!

11.15 [MSHV](#) has a hybrid multi-transmit mode (called "Multi Answering Auto Seq Protocol FT8"), similar but not identical to the DXpedition fox-n-hounds mode. These are conventional FT8 QSOs except the DX station/fox makes several at once using separate transmit frequencies. Some DX stations have taken to running this way on the normal FT8 frequencies, causing confusion and hogging the subband: it would be more considerate of them to shift to a different frequency.

³² Due to a persistent WSJT-X "feature", the WD timer value remains static in the bottom right corner of the screen in DXpedition mode. The normal WD timer is *not* used. Instead a separate, secret, internal timer is hard-coded at 2 minutes (4 transmissions). When your 2 minutes baying at the fox are up, the receiving bar does not go red and display "Runaway Tx watchdog" as it normally does with the WD timer. The Enable TX button is automatically deselected, loses its red background and you stop transmitting. That's it.

³³ It does this intentionally to separate you from the other baying hounds. All that yapping would slow or prevent your QSO.

³⁴ I recommend checking that the **Hold Tx Freq** option remains selected after entering and leaving DXpedition mode. Due to an annoying little bug in WSJT-X, it is silently de-selected.

12 Flaws, bugs and improvements

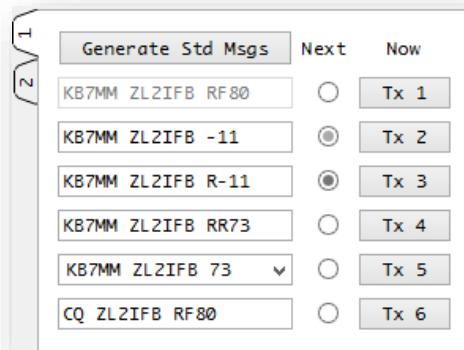
12.1 Flaws or limitations in the design of FT8 and the associated software, plus bugs and problems with our on-air operating conventions, are coming to light. Most are trivial and can be easily overcome or simply ignored. Some are potentially more significant blockers, such as:

- The handling of [special callsigns](#);
- Inconsistencies and awkwardness in the user interface, especially in WSJT-X (more below);
- Differences of opinion on what truly constitutes a completed, valid QSO, and on how to use FT8 for contesting;
- Inconsiderate operating such as calling over the top of ongoing QSOs, rudely ignoring directed CQ calls and messages, over-driven audio and excessive power for the path, and contention for finite band space.

12.2 There are inconsistencies, limited data-entry validation and other usability issues in WSJT-X³⁵ such as:

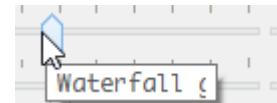
- The message selector buttons can be ambiguous ►
- There's no feedback to the user when entering or editing a free-text message that goes beyond 13 characters or includes invalid characters [solved in [JTDX](#)];
- Inability to toggle message settings (e.g. swapping message Tx 4 between RRR and RR73) without also selecting the toggled message to be sent immediately [solved in [JTDX](#)];
- Inability to change the Rx frequency while transmitting;
- Decodes are appended to the Band Activity and Rx Frequency window strictly according to when they were decoded (on the first pass then the second pass), with no ability to sort them by frequency, call, locator, strength *or* time received;
- New decodes reset the *Band Activity* window to the bottom, even if we were scrolling up looking for a specific decode (the only way to lock the list is to stop decoding);
- The Tx and Rx frequency-setting boxes *include* the static/boilerplate text "Tx", "Rx" and "Hz", which makes it a bit trickier to update the numeric values: we first need to select the numbers, being careful not to select the boilerplate text;
- Shift-clicking F11 or F12 moves the Tx down or up in 60 Hz steps but (on my system) this stops working after WSJT-X has been running for a while. Subsequently, those function keys move the RX frequency in 1 Hz steps, regardless of whether I also hold shift, control or alt;

Much of this is subjective: some of the things I call "flaws", "bugs" and "issues" others dismiss "as designed" and "not a problem".

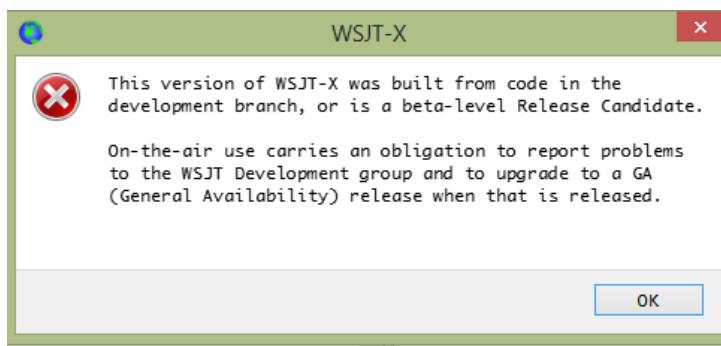


³⁵ JTDX is not immune to issues but, in my experience, they are fewer and less annoying than those in WSJT-X.

- Various auto-sequencing issues including the [bouncing ball thing noted earlier](#) and [QSO hijacking](#), plus possible inconsistencies in responding when someone answers our CQ with their Tx 2 skipping Tx 1;
- The log QSO pane evidently only appears if we send a free-text message containing the string “73” ... but what if I choose to end my QSOs with, say, “BIT.LY/FT8OP” (the short URL for this very document) or “MERRY XMAS” or whatever? If I’m not on-the-ball, there’s a good chance I will neglect to log the QSO;
- The “Disable Tx after sending 73” option is ignored if you are using **Call 1st**. After logging a QSO, remember to **Enable Tx** to start your next CQ;
- Any change to the current Tx 5 free-text message is lost if we open and close **F2 settings**: it reverts to the auto-generated plain [his call] [my call] 73 message;
- In DXpedition mode, fox decodes don’t stand out on the *Band Activity* pane *unless* it is a new DXCC country. It would be handy if decodes from the fox (*i.e.* sent by the callsign currently in the DX Call box) were highlighted in some way, even when he was not actually working us. This might be useful also in non-DXpedition mode;
- Various other minor issues (*e.g.* confusing colours, low-contrast sliders, truncated screen-tips ► *etc.*).



12.3 These and other concerns, plus test findings (ideally explaining how to reproduce bugs on demand), suggested workarounds and improvement suggestions in general *may be discussed on the [WSJT-X! reflector! on! Yahoo! groups!](#)* However, despite the splash screen warning message



If you are a UI programmer, please volunteer to work on WSJT-X: your expertise is sorely needed!

when rc/beta versions load ◀, if you are not a programmer willing to get involved in coding **User Interface** changes on a multiplatform system, be prepared for your UI-related feedback to be ignored or robustly rejected: essentially, UI matters are unwelcome distractions to the team.

12.4 Users should be able to disable the auto-QSY CQ function intended for VHF/UHF use as it can cause the transmitter to QSY unexpectedly, perhaps out of band. For example, imagine a station on 1850 kHz sending “CQ 1930 AB1CDE”: if we double-click that message to respond to them, our rigs will automatically QSY to 1930 kHz to make the QSO.

12.5 Technically, FT8 and other digimodes *can* be fully automated, replacing operator effort and manual input with CPU cycles, but that is a step too far for most amateurs, as well as the team behind the JT modes: this is, after all, a participative hobby. Watching our stations making QSOs ‘for us’ reduces us to passive observers. However, one potentially useful application involves setting up automated stations on extremely inhospitable DX locations such as Bouvet Island. I envisage futuristic DXpeditioners taking robotic FT8 stations with them, to sit silently in the corner racking-up rare DX QSOs for the duration of the trip ... and perhaps beyond ►

FT8 may also be useful for telematics (e.g. remotely monitoring/controlling repeaters and beacons, tracking vehicles) and store-and-forward email-like systems using long-distance amateur HF radio links, rather than VHF/UHF point-to-point, satellite or Internet links.

Provided the licensing and environmental authorities approved, self-contained ruggedized solar-powered FT8 robots with satellite links for logging and control could potentially be left behind when the DXpeditioners depart, perhaps with scientific research and monitoring capabilities (like weather stations) to justify their continued presence.

12.6 Various other enhancements to the FT8 protocol and software have been suggested e.g.:

- Using a bit as a flag denoting “Message continues”, allowing free-text messages to be chained together on transmit and reassembled on receipt ([JS8](#) uses the ~ tilde character ~ in the message text for a similar purpose);
- Combining the audio streams from separate antennas and receivers (diversity reception);
- A simple “go back” function to un-do a QSY, instantly returning to the previous tuned frequency;
- [Enhancing WSJT-X’s logging and lookup capabilities](#).

Aside from the substantial effort required to specify, code, test, debug and document such changes, there are other issues to consider:

- Complexity: the more complicated the system, the more likely it is to suffer performance and other limitations, including design flaws, bugs and operator errors;
- Backward and forward compatibility: step-changes are problematic, hence incremental changes are preferred ... but that’s not always possible (e.g. the change from 75 to 77-bit FT8 forced everyone to upgrade or be left for dust);
- Priorities: one amateur’s enhancement is another amateur’s drawback. It is hard to gain consensus on the few changes actually worth progressing from the *many* possible approaches, especially given the variety of applications for WSJT-X (e.g. EME and meteor scatter on VHF/UHF, plus HF DXing).

At the end of the day, the developers have the final say in what gets implemented and how, since they are the ones doing the hard graft. It’s their ball: we’re just kicking it about.

12.7 A bug in DXpedition mode caused severe problems for 9LY1JM in January 2019. Whereas the software *should* have been hashing the usual foxy messages due to their special callsign, in fact they were sending their callsign in full in free-text messages, truncated at 13 characters. Hounds who double-clicked the fox's free-text messages expecting to start calling them were perplexed to discover that nothing happened: they had to type 9LY1JM correctly into the DX Call field (already a challenge for us inept typists and dyslexics!), *then* generate the standard messages, *then* click **Enable Tx**. Coincidentally, an autosequence bug surfaced at the hound end where the R messages were sent even by hounds that had *not* received their reports from the fox. The fox's RR73 messages concluding the QSO were also truncated at 13 characters. As if that wasn't enough already, the multi-transmit function further confused the concatenated message displays, and hounds with lengthy callsigns had an even tougher time due to the 13-character free-text limits.

In practice due to the bugs, the digimode station at 9LY1JM was mostly confined to RTTY, meaning that DXers were unfortunately unable to take advantage of the weak signal capabilities of FT8. *C'est la vie*. Better luck next time.

12.7.1 Another DXpedition mode bug has been reported, that results in some completed QSOs not being logged. The messages are stored in the ALL.TXT file, however, allowing the full log to be reconstructed.

Take-home lessons for DXpeditioners intending to use FT8:

- 1) Request a standard, conventional, short DX callsign if possible; and
- 2) Try-out the software using your (likely) DX call and get familiar with DXpedition mode well *before* setting off.

13 Close and acknowledgements

- 13.1 Remember, it's only a hobby. Most of the issues with FT8 operating are not due to malice but ordinary hams like you and me, exploring the mode and picking up tricks as we go. We make mistakes. We get things wrong. We experiment. We try. We learn. We enjoy ourselves and help each other out. Slack needs to be cut. Stay cool. Chill bro'!
- 13.2 Although my name is on the front, this document is largely the product of the HF DX community. Please join me in thanking the numerous amateurs who have kindly contributed ideas, comments and tips, particularly of course the professors ([Steven Franke, K9AN](#) and [Joe Taylor, K1JT](#)) who gave us the mode, plus the other WSJT-X developers and long-suffering support crew on the WSJT reflectors (Bill Somerville, G4WJS in particular). I have collated, interpreted and expanded upon their inputs, drawing heavily on their inspiration and information. I take full responsibility for all my mistakes!
- 13.3 Your feedback on this document, such as corrections, responses/challenges, improvement suggestions and further tips, are very welcome. Please email me: Gary@isect.com I will try to maintain the [online living version of this document](#) on my website (www.G4iFB.com) as time and energy permits. No promises though: I have a job to do and given the choice I'd rather be flapping my trusty Bencher paddle than bashing the keyboard.



◀ I am part of the merry band that developed and promotes the [DX Code of Conduct](#). We know it is imperfect but the situation would be *even worse* without it! Something had to be done about declining operating standards, so we did ... something. So what have *you* done lately?



If you can stomach any more of my writing, you might enjoy the [FOC Guide to Morse Code Proficiency](#) ►

Find out more about me on G4iFB.com and QRZ.com or catch me on the air

The FOC Guide to Morse Code Proficiency
by [Gary@isect.com](#), Version 1.2 December 2017



Contents

- Introduction
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- References

Figure 1: CW1000 1920s style key collection

Introduction

Properly-formed Morse code is a delight to hear when strong and可靠, but even when signals are either weak or noisy, Morse can be a burden. Most of the time, Morse is monotonous. However, on the air we typically face QRM, ORN, QSB, weak/marginal signals leading to errors and gaps in the copy, confusion, fatigue and frustration. Throw in badly-sent CW such as mis-sent characters, uncorrected errors, spelling mistakes, stray dots and missing dots, variable pitch, and you have a recipe for disaster. The goal of this guide is to help you learn how to send better transmitters, drift, chirp, ringing filters and so on, and making contact may become, let's say, challenging.

Promoted by a lively discussion around W1RM's page comment, this guide offers advice on improving proficiency in Morse code for those already using CW (Continuous Wave) on the amateur bands. After explaining the key issues, you will find tips for both sending and receiving. Both aspects are important and can be improved - no matter how good we are at one, we do worse at the other. I don't expect you to learn CW from scratch: you'll have to look elsewhere for that. My main aim is to encourage everyone (including me!) to make the effort to improve.

One of the goals of every CW operator is to send CW well. That means good character formation and consistent spacing. It makes little difference what you do to the sending, be it straight key, bug, lever, etc. The most important goal is to send CW that's easy to copy. (W1RM, 2017)

Appendix A: About FT8

A limited amount of technical information about FT8 is available on the web, such as this brief outline when [FT8 was first announced](#) with the release of WSJT-X v1.8.0 Release Candidate 1 (I have added a few links for those who, like me, feel the urge to explore further):

WSJT-X Version 1.8.0 includes a new mode called FT8, developed by [K9AN](#) and [K1JT](#). The mode name "FT8" stands for "Franke and Taylor, 8-FSK modulation". FT8 uses 15-second T/R sequences and provides 50% or better decoding probability down to -20 dB on an [AWGN](#) channel. An auto-sequencing facility includes an option to respond automatically to the first decoded reply to your CQ. FT8 QSOs are 4 times faster than those made with [JT65](#) or [JT9](#). FT8 is an excellent mode for HF DXing and for situations like [multi-hop Es](#) on 6 meters, where deep QSB may make fast and reliable completion of QSOs desirable.

Some important characteristics of FT8:

- T/R sequence length: 15 s
- Message length: 75 bits + 12-bit [CRC](#)
- [FEC](#) code: [LDPC \(174,87\)](#)
- Modulation: 8-[FSK](#), tone spacing 6.25 Hz
- [Constant-envelope](#) waveform
- Occupied bandwidth: 50 Hz
- Synchronization: 7x7 [Costas arrays](#) at start, middle, and end
- Transmission duration: $79*1920/12000 = 12.64$ s
- Decoding threshold: -20 dB; several dB lower with [AP decoding](#)
- Multi-decoder finds and decodes all FT8 signals in passband
- Optional auto-sequencing and auto-reply to a CQ response
- Operational behavior similar to JT9, JT65

Two further definitive sources of information on FT8 are the WSJT-X help file (provided with the program) and a brace of articles in QST written by Joe Taylor, K1JT, Steve Franke, K9AN, and Bill Somerville, G4WJS:

["Work the World with WSJT-X, Part 1: Operating Capabilities"](#) – QST October 2017, pages 30-36 – a general introduction to the digital modes supported by WSJT-X.

["Work the World with WSJT-X, Part 2: Codes, Modes, and Cooperative Software Development"](#) – QST November 2017, pages 34-39 – dips further into the mathematics, Forward Error Correction etc.

An excellent [presentation by Joe Taylor](#) explains the history behind WSJT-X and FT8.

One further source is the source itself, in other words the program source code for WSJT-X and the associated documentation, generously made freely available through a Creative Commons license in order to encourage widespread uptake and continued development of the digital modes.

Finally, Joe maintains a set of references at <http://www.physics.princeton.edu/pulsar/K1JT/refs.html>

“The popularity of FT8 on HF is largely a happy accident in that it fulfilled a latent frustration of many potential users of WSJT-X with the slow rate of QSOs using 1 minute T/R periods. Clearly that frustrated group of users did not require the greater sensitivity of JT65 or JT9 and once the level activity grew greatly the opportunities for many QSOs, even with limited equipment, caused a near exponential growth since launch.”

[Bill Somerville, G4WJS]

Appendix B: JS8 for weak signal text chat

JS8 (Jordan Sherer-designed MSK-8) is an experimental digimode inspired by FT8 shortly after its release in 2017, designed and then implemented in software by developer Jordan Sherer (KN4CRD) during 2018.

JS8 is derived from FT8 and freely shared in accordance with the FT8 open source license, in the best traditions of amateur radio.

The JS8Call software supporting JS8 mode was originally known as FT8CALL.

It applies FT8-style message encoding and modulation to longer messages, in effect allowing senders to transmit across adjacent time slots instead of the usual 15 second alternating transmit-receive sequence. The tilde character denotes the end of a message sequence.

75-bit JS8 messages cannot be decoded by 77-bit FT8 software. They use different sub-bands (e.g. 7078 and 14078 kHz).

Re the message length, “longer” is relative. This is still a block-mode system compressing and sending an entire block of information (several characters) at a time, unlike say RTTY, PSK or CW where each individual character is encoded separately then sent, received and decoded.

As of JS8Call version 2.1, four speeds are available in JS8:

- **Slow:** 30 second frames, 25 Hz bandwidth, 3.125 baud (~3½ WPM) decoding down to -28dB;
- **Normal:** 15 second frames, 50 Hz bandwidth, 6.25 baud (~7½ WPM) decoding down to -24dB;
- **Fast:** 10 second frames, 80 Hz bandwidth, 10 baud (~12 WPM) decoding down to -20dB;
- **Turbo:** 6 second frames, 160Hz bandwidth, 20 baud (~24 WPM) decoding down to -18dB.

The FT8-style message integrity controls built-in to JS8 make it suitable for applications such as leisurely chats over weak signal paths, emergency comms using solar or wind powered QRP stations with temporary/inefficient antennas, and automated beacon-type stations broadcasting sensor data. It makes efficient use of even low-quality RF bandwidth.

For more information, see:

- The [JS8Call website](#)
- Jordan's [original design specification](#)
- The current (maintained, updated) [User Guide](#) for JS8Call
- The [IOgroups user and tech support forum for JS8Call](#)

“The idea with JS8Call is to take the robustness of FT8 mode and layer on a messaging and network protocol for weak signal communication on HF with a keyboard-to-keyboard interface. JS8Call is heavily inspired by WSJT-X, Fldigi, and FSQCall and would not exist without the hard work and dedication of the many developers in the amateur radio community.”

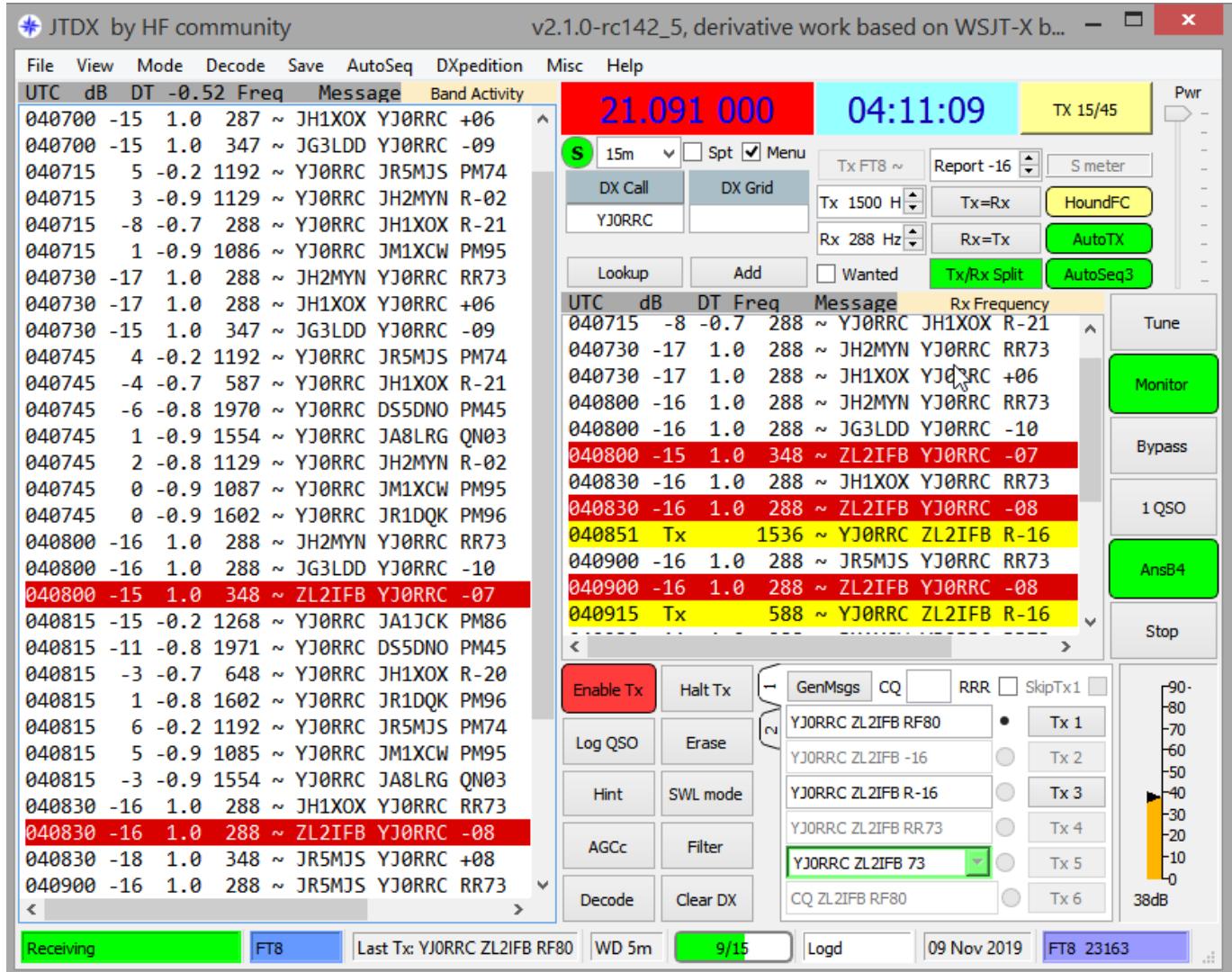
[JS8Call.com](#)

“JS8Call is a derivative of the WSJT-X application, restructured and redesigned for keyboard-to-keyboard message passing.”

[JS8Call IOgroups description](#)

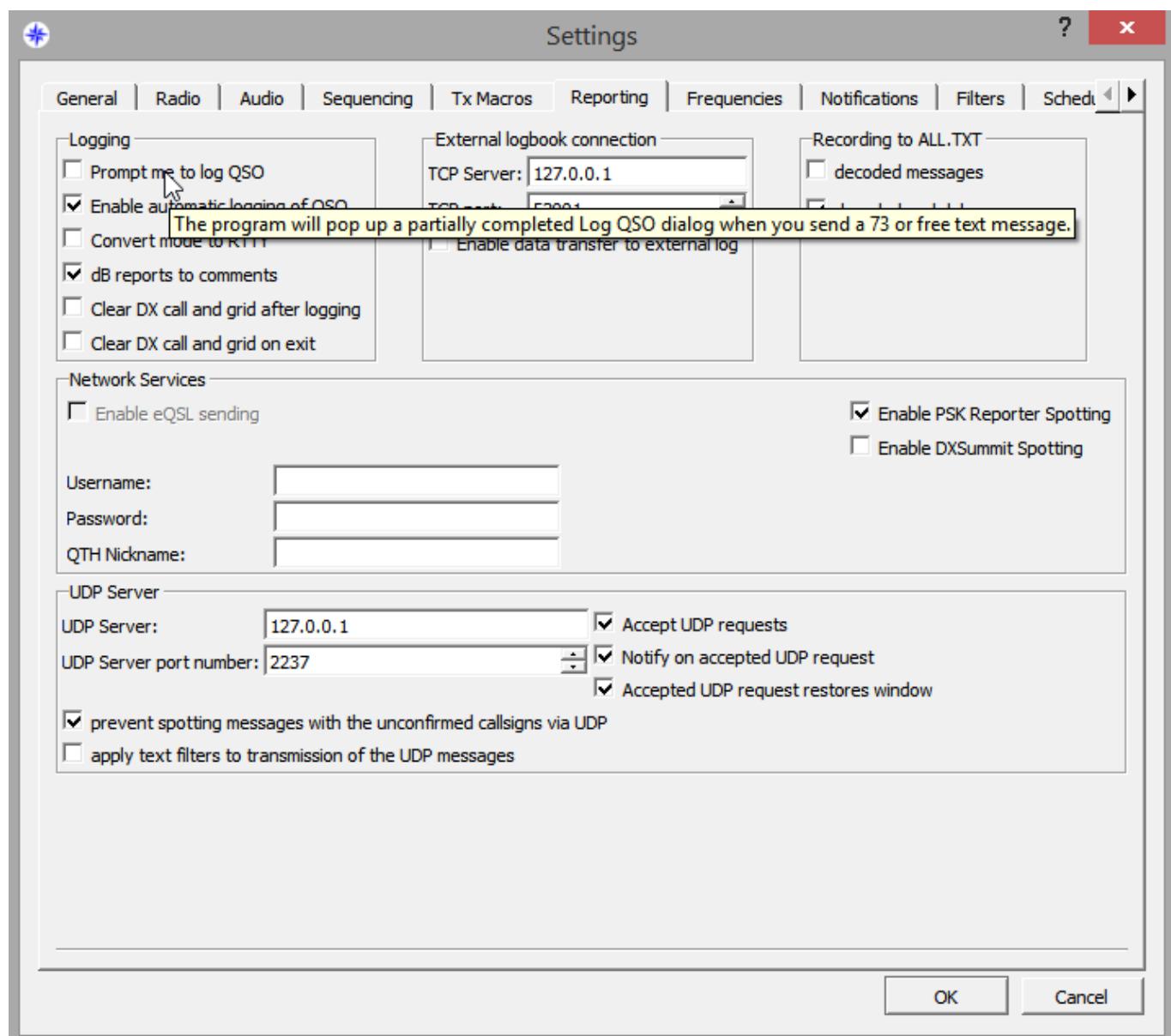
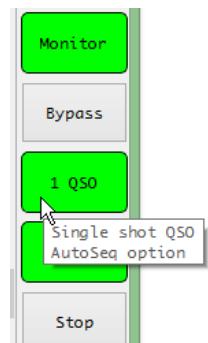
Appendix C: JTDX

Personally, I prefer JTDX over WSJT-X for FT8 HF DXing. The programs are similar enough that swapping between them is easy with a shallow learning-curve. I find the JTDX user interface more intuitive, less awkward and stressful, easier and more efficient in practice than WSJT-X. YMMV.

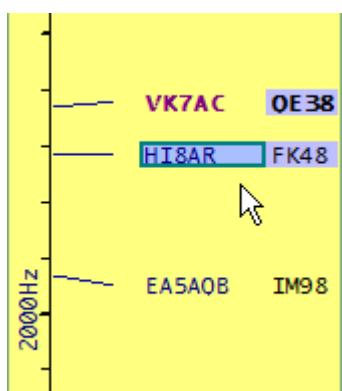


- The main screen layout ▲ moves the settings to the righthand side leaving more vertical space on the left for up to 50 'band activity' decodes, showing most if not all of the decodes from the last period even on a very busy HF band. There is less space for messages to/from me in the right 'Rx frequency' pane but still plenty enough in practice for the present and usually the previous QSO.
- **New** The DT value shown in the header of the left-hand Band Activity pane (-0.52 in the screenshot above) is the average time offset of recently received signals, relative to my PC clock. Normally it sits at about 0.2 on my system but shortly before the screenshot I deliberately 'nudged' my PC clock back a second or two in a vain attempt to work YJ0RRC given his dT of 2.1 (maybe there's no Internet and hence no NTP on Tongoa Island, and no handy GPS receiver).
- I can left click the waterfall to move the dead green Rx goalposts there, or right click to move the red Tx goalposts. That is intuitive and one-handed, with no need to press a keyboard key while clicking the mouse.

- **New** We have the option to shift the timestamps to the right of the waterfall or hide them – useful as they can obscure weak DX fox signals. Also the waterfall sliders have labels and values, making it easier to try out changes and if necessary return to known good settings. And FT4 mode is supported now. JTDX is getting better by the week!
- My even/odd Tx slot setting button is blue or yellow, respectively, and the adjacent clock uses the same colours depending on the time, making it easy to determine whether I would be transmitting or listening at any point: I transmit when the colours match.
- Having selected ‘Prompt me to log QSO’ under **F2 Settings → Reporting** tab, JTDX displays the logging pane at the end of a QSO, waiting patiently for me to check it and click “Log QSO”. That click also re-enables Tx and selects Tx 6, my CQ message, making it easier to continue CQing, unless I have selected “1 QSO” on the main menu ► That’s a single-shot option meaning ‘remain in receive after completing the present QSO’. It’s an easy way to conclude a session and slip away for a cup of tea.



- If I select 'Enable automatic logging of QSO' under **F2 Settings → Reporting** ▲ my QSOs are logged automatically on completion, giving me no chance to check and modify the log entry (e.g. noting the power I am using). Even with that option selected, JTDX deliberately does *not* recommend CQing after a QSO is completed and logged, as that would make the operator redundant.
- When I respond to someone else's CQ, there is an option to stop my transmissions automatically if he responds to someone else ... which reduces needless QRM, reduces my power bill and most importantly gives me the chance to check that my transmit frequency appears clear when I would otherwise have been transmitting. [WSJT-X only stops my *simplex* transmissions.] If for some reason I want to hound someone, calling them repeatedly, I simply click the **Hound** button ... but that setting also stops me sending a custom 73 message.
- The PC beeps when people call me, using the Windows default output sound card. A handy audio cue, that, if I am busy working on another screen.
- When I am CQing, the auto-sequencer can be configured to auto-respond to the most distant caller instead of simply the first caller decoded. I guess it uses grid squares to calculate the distance, otherwise the country identified by the prefix. There are other autosequence options too.
- Using a new control on the waterfall, I can shift the timestamp from the left to the right edge of the waterfall, or turn it off completely, making it easier to see faint traces of DX foxes on the left.
- I can easily generate directional CQs targeting a specific country or continent, and more importantly the autoresponder can be set to ignore callers not in my target area, if I choose to do so. [I'm not sure it handles custom CQs though: it only accepts 1 or 2 letters in the entry box].
- When someone responds to my CQ call but their response decodes late (after I have started my next CQ call), the autoresponder automatically flips to sending them their report and erases the partially-transmitted CQ message from my screen, making it easier to figure out what messages were sent.
- Logger32 communicates bidirectionally with JTDX³⁶ via UDP messages. I can display all the stations decoded in JTDX on Logger32's "UDP bandmap", with any new ones highlighted for me in the same colours as DXcluster and RBN spots on the conventional bandmaps ▲. If I click a decoded FT8 callsign on the UDP bandmap, JTDX will call him when appropriate (either when he next CQs or when he sends his 73 or RR73 message at the end of a QSO, according to the bandmap config settings). If he doesn't immediately respond to my call, I can simply wait patiently to call him again, try calling another wanted station in the same way, start CQing, or give up.



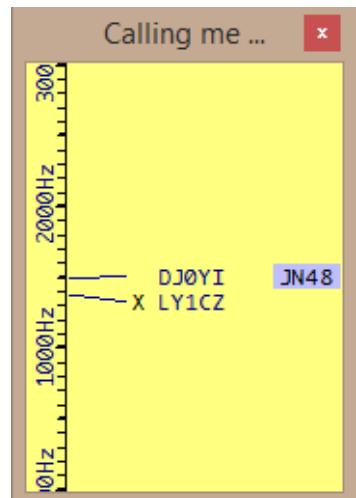
bandmaps ▲. If I click a decoded FT8 callsign on the UDP bandmap, JTDX will call him when appropriate (either when he next CQs or when he sends his 73 or RR73 message at the end of a QSO, according to the bandmap config settings). If he doesn't immediately respond to my call, I can simply wait patiently to call him again, try calling another wanted station in the same way, start CQing, or give up.

Better autosequencing is a distinct advantage of JTDX over WSJT-X for DXers like me ... but it is still not perfect e.g. it can loop on Tx3 messages.

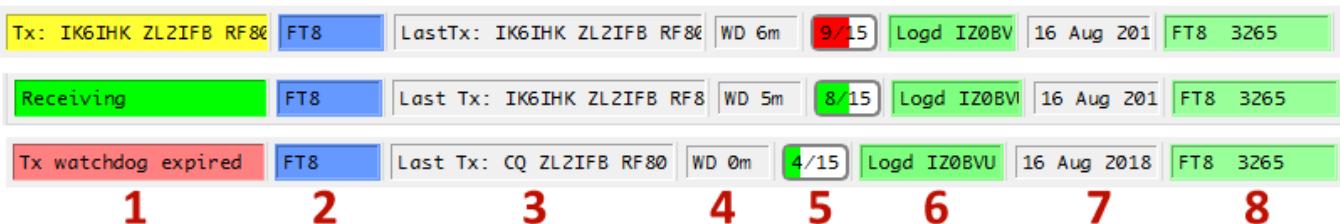
After clicking someone's callsign on the UDP bandmap, Logger32 waits politely until it has received a further message from him before telling JTDX to call him. With minimal user feedback (just a box around the call on the bandmap as it waits to call the selected station), the pregnant pause can be disconcerting but be patient. Trust me, it works ... eventually, usually.

³⁶ It also communicates with WSJT-X via UDP, with minor differences e.g. WSJT-X only lets Logger32 respond to CQs.

- Logger32 can optionally also display another bandmap-type thing showing only the stations currently **calling me**, with their entries highlighted in the normal manner – handy when I'm being called by several stations at the same time, trying to decide which one to respond to first. In the example ► I'm being called by LY1CZ who I have contacted before (hence the X) plus DJ0YI in grid JN48 that I haven't worked yet on this band (hence the blue highlighting). While it would be good to contact LY1CZ again, I would probably respond to the German first by double-clicking a decode from him in the Rx frequency pane on JTDX, letting the autosequencer take us through the conventional QSO sequence. Meanwhile, if anyone else calls me during our QSO, their call will also appear as if by magic on the **calling me** bandmap so I can get ready to respond to one of the callers in the same manner – going for the highlighted ones first, generally.



- The JTDX lower status line shows useful info. It pays to keep an eye on things. Here are three snapshots showing the 8 fields at different stages of a QSO ▼



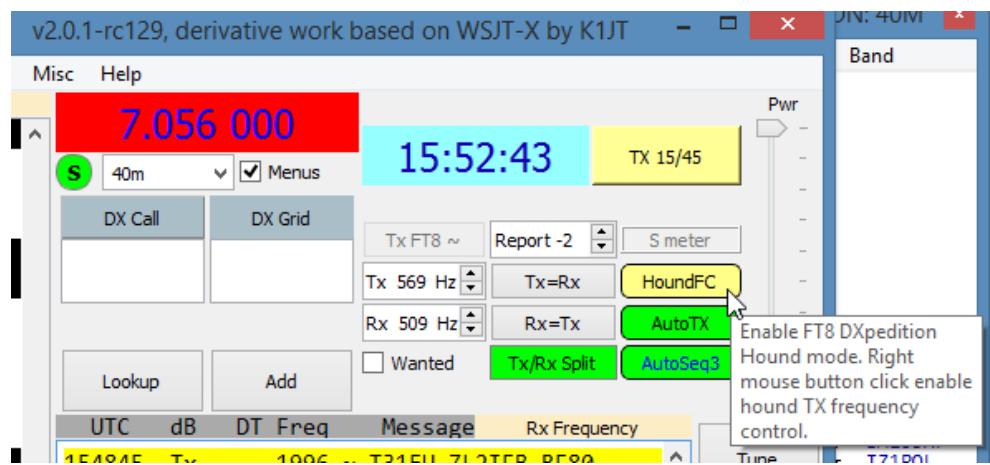
1 2 3 4 5 6 7 8

- This field normally shows the message you are transmitting (yellow) or 'Receiving' (green). The red warning message appears when the watchdog counts down to zero and your transmissions have ceased.
- The mode: JTDX supports FT8 and a few other HF JT-type digimodes (JT9 & JT65, T10 and WSPR-2).
- The message you transmitted last.
- Watchdog timer counting down the minutes remaining. Click anywhere in the program's main window, or log a QSO, to reset it to the starting value defined in **F2 Settings → General** tab.
- Shows each over ticking away the 15 seconds with a coloured progress bar. Red = transmitting. Green = receiving.
- The callsign of the station logged most recently. Handy if, like me, you sometimes get distracted and forget whether you have logged someone.
- The date in UTC (I presume).
- How many QSOs you have logged on this mode, in this program, under your current callsign, in the current ADIF log file.

If you are monitoring an active FT8 subband and see plenty of FT8 signal blobs on the waterfall but no decodes, check that you haven't accidentally selected a different mode. *Doh!*

JTDX supports contacting foxes with a simple click or right-click on the **Hound** button on the main screen

► Left-click the button to make brief split QSOs *without* QSYing below 1000 Hz (e.g. when working a DX station using MSHV's multi-transmit function), then right-click if you want your rig to QSY below 1000 automatically when the DX responds to you (the button then shows **HoundFC** meaning hound with Frequency Control). The auto-QSY function is disabled and cannot be selected on the normal FT8 frequencies since DX stations *should not* be using fox-n-hounds or indeed multi-transmit mode in the normal FT8 subbands.



Pileups clog-up the normal subband. Spare a thought for those who are *not* presently trying to work the DX. Please take your pileup elsewhere!

The Hound button also lets us hound (as in pester) DX stations, calling them persistently even as they call and contact other stations. There *are* situations where that may be justified, but please consider the effect continuous calling has both on the DX and on other band users. If your calls are going unheeded, it may be that your Tx frequency is busy at the DX end. If you are so selfish as to be calling the DX *simplex*, your calls may well cause QRM to the stations he is calling and working. Play nicely, please.

There are a few little bugs in JTDX. JTDX bugs spotted in the wild include:

- Sometimes after I've entered the 2-character code for a directional CW, the program transmits an empty message. I'm not sure of the exact sequence that causes this behaviour but it has happened several times.
- In an early version, the main screen's radio buttons used to be clickable during a transmission, allowing us to select the *next* message after the present one is gone, manually overriding the autosequencer. For some reason, that no longer works. I can still click the Tx buttons to send a given message now, but that changes the message currently being sent and can easily result in a corrupted, undecodable message unless I am careful/lucky with my timing.
- The autosequencer can be confused by sequence-out-of received messages, for example when I break off an incomplete QSO after the station has faded out in order to call someone else, then the original station returns. JTDX sometimes skips sending R and my report to someone who has sent me theirs, jumping directly to the RR73 message to spread konfusion and kaos.
- For some unknown reason, a fair number of people initially call me with their Tx 3 R+report message, despite me not having sent them a report. JTDX is as confused as me over what to do next: which message (if any) should I send back? I tend to ignore these confused callers, sending my Tx 6 message (CQ) instead.
- After the end of a QSO, JTDX often displays a spurious RR73 or 73 transmit message at the bottom of the righthand window that has *not* actually been sent. I guess it changed its mind, displaying what it *thought* it was going to send. Or it is just toying with me.

- JTDX quite often replaces my manually-typed 73 message with the auto-generated one when the autosequencer triggers Tx 5 to be sent, too late to re-type it. [Selected Tx macro messages are not overwritten in that way but they have to be stored first.]
- Unless my custom Tx 5 message includes “73”, the QSO is not automatically logged, nor am I prompted to log it, despite the QSO being technically complete at that point.
- If I fiddle with the settings using F2, when I exit the settings my current transmission is aborted and the callsign of whoever I’m working is cleared. Too bad, unless I remember their callsign they’re toast.
- Selecting or deselecting the RRR message *during* a QSO doesn’t simply change the contents of Tx 4 as expected: it also selects a different message to send next, for no apparent reason.
- With **Hound** selected in order to hound a selected DX station, double-clicking a decoded message from someone else has no effect. I think this may be intentional – it’s certainly a handy reminder to deselect **Hound**.

Appendix D: FT8 under the covers

FT8 does not simply encode and transmit our messages character-by-character (in the same way as, say, CW or RTTY or PSK). The entire message is encoded first, *as a block*, using a clever algorithm that compresses the message down to as few bits as possible which are then transmitted digitally along with error correction bits through our radios and the ether, taking 12.6 seconds. On the receiving end, the process happens in reverse: the digital bits are dragged kicking-and-screaming from the ether, error-corrected then expanded back into those human-readable and often actionable message that we read and double-click on – all within the remaining 2.4 seconds before the next transmission period begins.

The ‘compression down to as few bits as possible’ on transmit, and corresponding expansion on receive, introduces hard constraints on the amount and nature of information that can be passed using FT8. Under the covers, the software uses algorithms for compression and expansion, algorithms that are specified as an integral part of the FT8 protocol. They are designed to work in a fixed, predefined, mechanistic (=algorithmic!) way, squeezing as much useful information as possible into the few bits exchanged in each over. In order to do that, they make some simplifications which, in turn, create the constraints that we live with.

Each character in a 13-character free message is converted to a number, then those numbers are multiplied together forming a large integer of 71 binary bits. Standard messages consist of two 28-bit fields normally used for callsigns and a 15-bit field for a grid locator, report, acknowledgment, or “73” message, also totalling 71 bits. Six *message-type* bits are appended, giving 77 bits. These are the precious information payload. All the remaining bits in transmitted FT8 messages are required for error-correction purposes, enabling the payload to be reliably communicated over a noisy radio channel. The [Low Density Parity Check](#) is assembled thus:

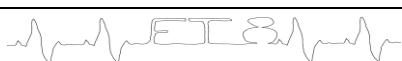
- A 14-bit [Cyclic Redundancy Check](#) is calculated on the 77 bits and appended, giving 91 bits.
- Next an 83-bit parity code is calculated and appended, giving 174 bits.
- The 174 bits are grouped into 58 chunks of three bits each, which are then [Gray coded](#).

Symbols are now assembled from a 7-chunk [Costas](#) array + the first 29 Gray-coded chunks + the 7 [Costas](#) + the remaining 29 Gray-coded chunks + the 7 [Costas](#), resulting in 79 symbols for transmission. Those Costas arrays (“sync vectors”) sent at the start, middle and end of each FT8 message are used to synchronize the receiver to the sender such that bits can be reliably timed within the transmissions.

Take a look at [section 17](#) of the [WSJT-X online user guide](#) for more details about the protocol, or look for articles by Joe and team in QEX.

Notice **there are just 28 bits available to communicate a standard callsign**. 28 bits gives [2²⁸ \(the 28th power of 2\)](#) possible values, which in decimal means a little under 270 million possible callsigns. Using the algorithm defined in the protocol, that is more than sufficient to code all the normal, conventional, old-style, everyday, standard callsigns currently in use across the world, each one coding to a unique digital value ... but 28 bits is *not* enough for all the weird and wonderful special event calls that are increasingly issued. The prefix parts of our calls are defined quite narrowly in the ITU regulations and by general convention, but the suffix parts are more flexible, giving too many possibilities to squeeze into the available 28 bits. Any

9LY1JM was a classic example – an unusual callsign allocated for a DXpedition. That “Y” in the prefix meant it would not fit into the 28 bits allowed for a conventional call without being hashed but bugs in the autosequencing in WSJT-X messed up the fox-and-hounds DXpedition protocol.



HF DXer will surely have come across some of them on air, on the legacy modes. Self-assigned suffixes are another example: when they were first used on-air, many of us wondered whether /LH indicated the lighthouse stations were all in Norway! I've worked and logged stations using /QRP, /MM, /M, /P, /A, /AM, /PP, /R and other curious variants, some made up on the spot, some probably not in conformance with the op's license, as well as the location-variant *suffixes* such as /VE2 and CEPT *prefixes* such as P4/.

The same consideration applies to the **4-character Maidenhead grid squares communicated with 15 digital bits**. 15 bits is more than adequate for grid square references comprised of two Latin letters and two decimal digits but is not enough to code all possible combinations of four letters or numerals, which would require *at least* $36 \times 36 \times 36 \times 36$ values or 1,679,616 in decimal, more than 2^{20} ... in other words FT8 falls 3 bits short. That said, the particular grid RR73 is exceptionally interpreted by the software as a message, not a grid. If an intrepid sailor ever activates that grid square on FT8, things could get interesting.

Six message-type bits cater for up to 64 different types of message. Currently, the following message types are in use:

Clearly, there's a lot of processing going on when FT8 signals are received and decoded hence a *reasonably* fast computer is needed. It's not just the raw CPU speed that matters though, as the captured audio is written to disk before processing: a slow disk, or contention caused by other software such as antivirus and backup programs, can cause delays that result in no decodes being displayed after some if not all overs. Network delays may also cause problems *e.g.* if you elect to send decodes to PSK Reporter.

- Tx1 initial call with 4-character grid locator *e.g.* K1JT ZL2IFB RF80
- Tx2 response to a caller with signed 2-digit signal report *e.g.* K1JT ZL2IFB -05
- Tx3 report received and return report *e.g.* K1JT ZL2IFB R-05
- Tx4 all received message *e.g.* K1JT ZL2IFB RRR
- Tx5 free text message, normally a 73 *e.g.* K1JT ZL2IFB 73
- Tx6 CQ message *e.g.* CQ ZL2IFB RF80
- Message contains a [hashed?] non-standard callsign
- NA VHF contest exchange
- EU VHF contest exchange
- ARRL RTTY Roundup exchange
- ARRL Field Day exchange
- DXpedition (fox-n-hounds) mode
- Telemetry – the 71-bit payload contains arbitrary data
- And perhaps others?

The FT8 modulation scheme is 8-FSK *i.e.* an 8-bit transmission using 8 different audio tones separated by just 6.25 Hz, giving an overall transmission bandwidth under optimal conditions of 50 Hz.

“FSK in general is chosen because it allows the use of constant amplitude and near continuous phase signals, as such linear RF stages are not necessary this making virtually any transmitter suitable. FSK signals are inherently narrow without having to apply complicated pre-modulation filtering. They are also relatively easy to analyse in the frequency domain within a decoder routine. Basic characteristics that have to be designed are bandwidth (increases with greater N in N-FSK) vs. higher symbol rates (increases with greater N in N-FSK). Given the typical frequency stability and propagation stability on the bands targeted, 8-FSK turns out to be a good choice for a modulation bandwidth around 50 Hz for 15s T/R periods and the alphabet, and symbol rate required for WSJT-X style QSO messages plus parity bits and checksum bits.” *[Bill Somerville, G4WJS]*

FT8 now uses Gaussian FSK (GFSK). Instead of sharp transitions between tones, Gaussian shaping is applied to smooth the transitions, reducing unwanted sidebands bringing the signal closer to the optimal bandwidth. The amount of smoothing trades-off narrower transmitted bandwidth against reduced decodability.

Plain FSK and even GFSK are straightforward and conventional: what makes FT8 special is the clever way the software makes additional passes through the captured audio, mathematically removing reconstructed signals a layer at a time to reveal weaker signals beneath ►.

“Given the decoded message we regenerate the transmitted waveform and use that as a reference to derive the time-varying, complex, gain function that describes the channel. We use this to reconstruct a (nearly) noiseless version of the received signal’s waveform that includes the channel-induced amplitude fading and phase-variation. The reconstructed signal is subtracted from the received data, enabling us to uncover weaker signals that occupy the same frequency slot as the subtracted strong signal. These weaker signals can often be decoded on a second decoding pass, after the stronger signals have been subtracted.” *[Steve Franke, K9AN]*

Appendix E: FT8 logging and lookups

WSJT-X and derivative programs log QSOs using the ADIF XML standard. Almost all logging software can import ADIF log files, hence it is possible to merge your digimode QSOs made and logged in WSJT-X *etc.* with your legacy mode QSOs logged in programs such as Logger32, Ham Radio Deluxe, AClog, Log4OM, DXlab, [N1MM+](#) and many others including online logs such as LoTW, QRZ.com and eQSL, by importing the ADIF. However, there are drawbacks to this approach:

- A few logging programs make a hash of importing ADIF files, for example misinterpreting some of the standard fields. Fortunately, this is a rare problem, and the basic QSO data (at least) generally makes it through unscathed. Issues tend to arise whenever new ADIF standards are implemented, as it takes time and effort to interpret the standard and update the software accordingly;
- Importing an ADIF log is generally a manual, asynchronous activity: we have to stop logging digimode QSOs for a while, open the logging program, run the ADIF import function to update our log, deal with any options and errors, and then resume our digimode activities;
- It is error-prone *e.g.* forgetting to do the import, importing into different logs by mistake, and importing the same ADIF file into the same log more than once, potentially creating duplicate log entries (unless the logging program ADIF import function automatically spots and skips dups).

Real-time log updating is a better approach, where capable logging programs receive and merge digimode QSO details broadcast by WSJT-X or [JTDX](#) as TCP or [UDP network datagrams](#) whenever we complete and log an FT8 QSO.

Tighter integration of the digimode and logging software extends the possibilities. Bidirectional UDP connections between the digimode engine and logging program make it possible, for example, to lookup any previously-logged QSOs with a station we are contacting on FT8, showing details such as the operator's name and QTH, perhaps displaying their QRZ.com page and email address for good measure. For DXers, it enables "new ones" to be highlighted as they appear on the decodes, according to how we define "new ones" *e.g.* new grids, DXCC countries, zones, prefixes, club members, LoTW users, states *etc.*, either all-time, just this year or month or contest, just on this band or mode, other criteria, or some combination of the above.

WSJT-X is unlikely ever to be developed into a fully-fledged logging and awards-tracking program: the team's prime focus is on the coding, communication and decoding of weak signals using various digimodes, not logging – and fair enough, they are doing a great job with that. More likely is that logging programs will be adapted to do the digimode stuff, perhaps calling on WSJT-X or the coding and decoding engines to do so in much the same way that some logging programs already call MMVARI or MMTTY, through their own internal program functions, or using shared library functions to implement an FT8 modem.

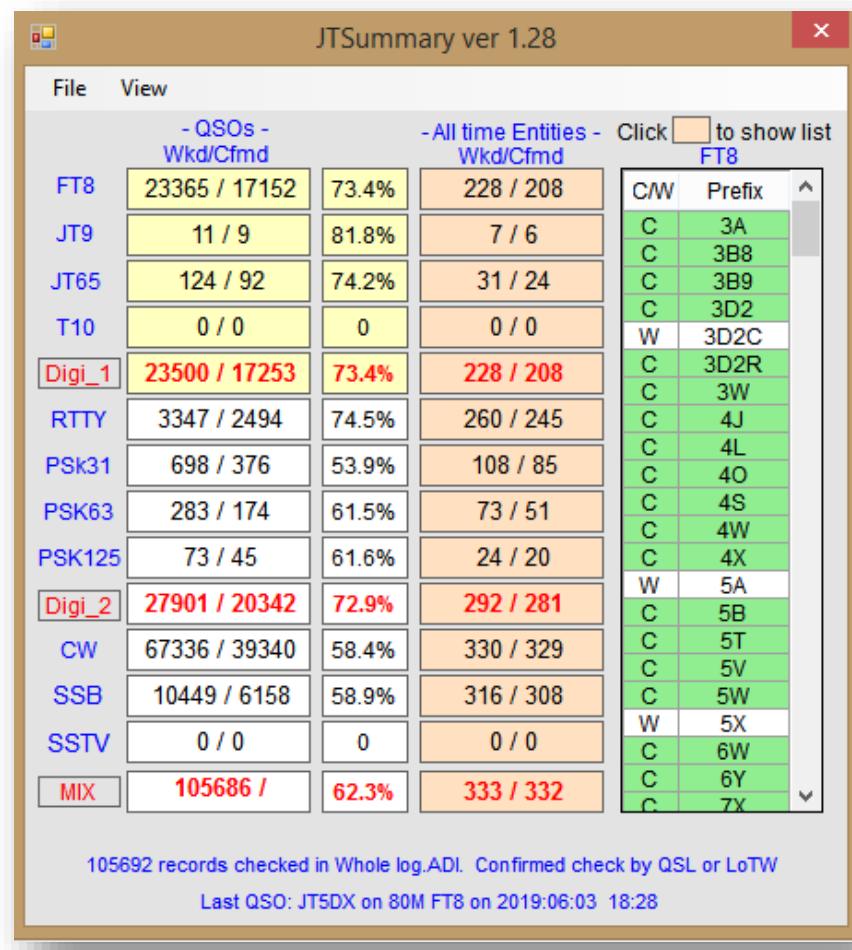
Meanwhile, enterprising programmers have developed utilities to plug some of the gaps, with [JTAlert](#) being top of the heap. JTAlert uses the decodes and logged QSOs from WSJT-X to highlight new ones (maintaining an internal HamApps database) and pass logged QSOs through to other logging programs. It acts as a middle-man with benefits.

I gather that JTAlert can pass each FT8 QSO as it is logged in WSJT or JTDX to DXkeeper which can, in turn, send on the info automatically to tQSL to update LoTW. Cool!

To upload your FT8 QSOs to LoTW you need the tQSL program along with a digital certificate, both from ARRL, confirming that you are duly licensed to use your callsign. If you don't already have those, [start here](#).

The minimalist approach is to use the logging facility built-in to WSJT-X (or [JTDX](#) or [MSHV](#) or whatever): when you complete and log an FT8 contact, it appends a QSO record to the `wsjtx_log.adi` (ADIF) file in the directory `%LocalAppData%\WSJT-X`. You can sign and upload that ADIF file to LoTW manually using tSQL as often as you like: as an active DXer I sign and upload the latest QSOs once or twice a day, others may do it weekly, monthly or ‘whenever’.

If you use one or more separate logging programs, it’s a good idea to pull *all* your QSOs (on FT8, JT9, CW, SSB or whatever, made by regular DXing or contesting) into *one consolidated log*, then generate, sign and upload an ADIF file from the logging program. Having one consolidated log makes it simpler to search for all previous QSOs with someone, and generate statistics such as the total number of DXCC countries you have worked. Most logging programs also let you download and save the confirmations from LoTW and input details of any QSL cards you receive, updating the relevant QSOs to show they have been confirmed. When you have enough confirmations, you can apply for awards such as DXCC.



The ADIF log file grows bigger with each new QSO but tSQL maintains its own internal list of QSOs previously signed and uploaded, and by default it automatically skips those QSOs, only signing and uploading any new ones since the last run. Therefore, there’s no need to worry about separating out the recent QSOs: simply pass the entire ADIF through tSQL each time. The whole process is painless and typically takes less than a minute. You’ll soon get the hang of it.

◀ [JTSummary](#) is a handy little utility by Aki JA1NLX that analyses an ADIF log to determine the number of QSOs made and confirmed on various modes.

Of the ~105k QSOs in my log, I’ve made ~23k FT8 QSOs in over 200 DXCC countries. Nearly three-quarters of the FT8 QSOs are confirmed, compared to about 58% of my CW and SSB QSOs. Digimode QSOs require a computer, hence it is more likely that digimode QSOs will be logged and confirmed on LoTW than legacy mode QSOs.

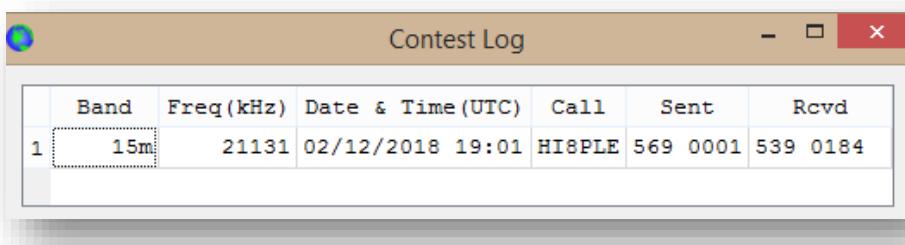
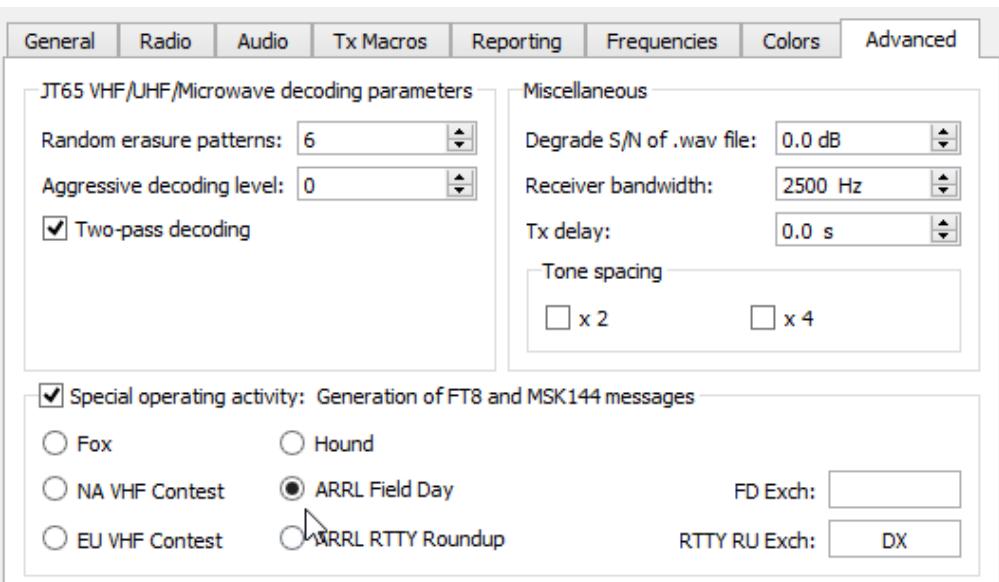
JTSummary also lets me graph the digimode statistics by bands, modes and continents. Neat! Thanks Aki!

Appendix F: Contesting with WSJT-X

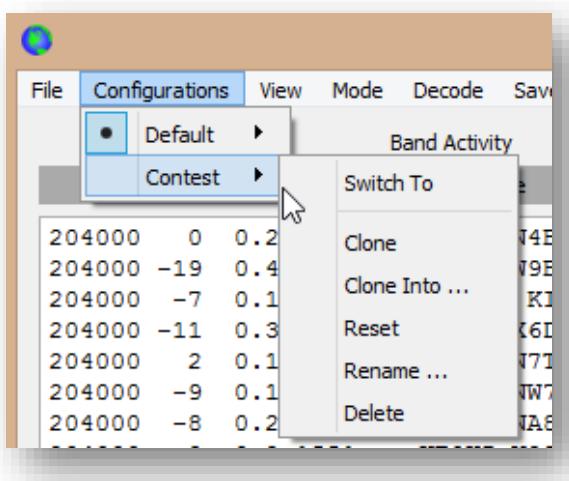
Both FT8 and [FT4](#) can be used to exchange (some) contest information such as sections and serial numbers using specific message types, in addition to the normal QSO information. Contest organizers may allow or disallow FT4 and FT8 in their events, possibly defining separate categories: check the rules!

JTDX does not
[yet] support
FT8 contesting

To enable contest mode in WSJT-X, go to **F2 Settings → Advanced**, select the *Special operating activity* then select the relevant (or closest available!) contest type ►. Enter the exchange you should be sending *e.g.* your field day section code or 'DX'. This text is automatically included in your outgoing exchange message, and is logged on receipt from other participants.



in turn enables contesting software such as [N1MM+](#) to support FT8 contests, with all the advantages of multiplier tracking and dupe-checking etc.

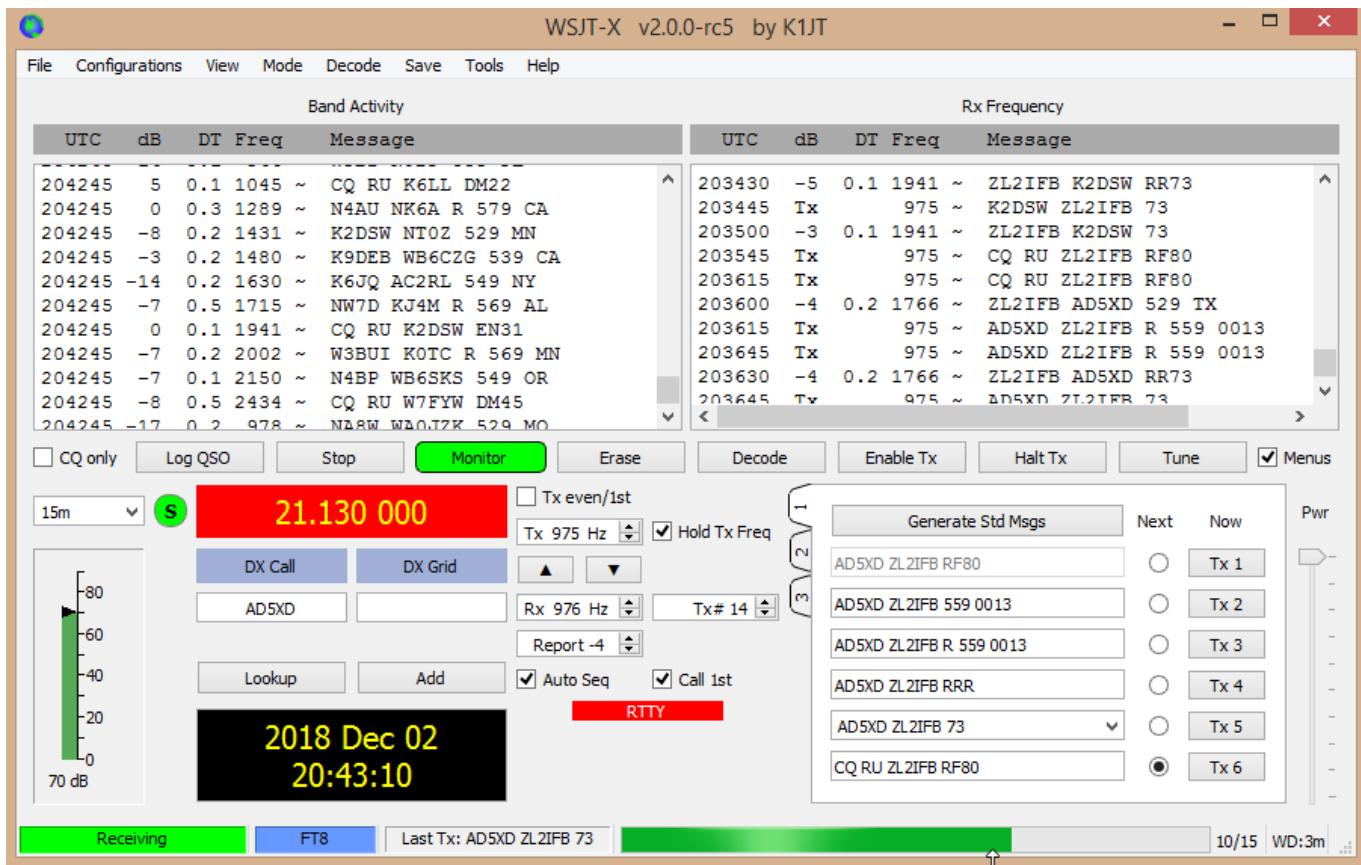


Talking of logging, in contest mode WSJT-X generates a plaintext column-aligned Cabrillo format contest log in addition to the usual ADIF log and [UDP](#) or TCP broadcasts onto your shack network ... which

Check the contest rules for suggested or permitted frequencies. It's a good idea to define them in WSJT-X's frequencies table so they appear on the band selector.

► If you set up a separate WSJT-X configuration for contesting, you'll avoid cluttering-up your normal everyday settings. You can preload a specific configuration when launching WSJT-X using the `-c` command line parameter (see the **F1** help for details), or simply select it from the menu which closes and relaunches the program for you.

In contest mode, the main WSJT-X window and operation is the same as always, with selector buttons for the next message and **Enable Tx** to start transmitting on the next applicable slot ▼



All the usual FT8 operating and avoidance tactics apply to contests:

- Watch and if necessary adjust your audio levels on receive and transmit to stay in the green zone, avoiding the red.
- Try not to transmit on a busy frequency.
- Keep your power down to avoid causing receiver overload and nasty red blobs on waterfalls at the other end.
- Chase down bonus points or multipliers according to the contest rules, avoiding disappointment.
- Study and comply with the contest rules to avoid disqualification.

Use the normal FT8 subbands, other modes or the WARC bands to avoid FT8 and FT4 contests.

Appendix G: Picking FT8 cherries with Logger32

Most of the time, there are plenty of stations active on FT8 on the bands I'm using. With my ZL prefix, I seldom need to CQ for long before someone responds ... and that suits me fine. Sometimes, though, when my CQs are going unheeded, it's time to change tactics by picking out and calling other stations.

So who shall I call? As an HF DXer, these are *my* priorities from the top down³⁷:

- An **All -Time New One** *i.e.* a DXCC country that I have *never* worked before, not ever on any band or mode. For me, these are the ripest, reddest, sweetest, most 'needed' cherries of all, and as such I'm willing to invest a lot of effort to pluck them;
- A DXCC country that I have worked before but don't yet have confirmed on any band or mode;
- A new DXCC country for me on this band;
- Someone I have just contacted and logged (are they calling back to correct something, tell me something or still trying to complete the QSO?);
- A new DXCC country on any digimode;
- A new DXCC country on FT8;
- A DXCC country that I have worked before but don't yet have confirmed on *this* band;
- A DXCC country that I have worked before but don't yet have confirmed on any digimode;
- A DXCC country that I have worked before but don't yet have confirmed on FT8;
- An old friend whose callsign I recognise, especially if we haven't caught up in a while;
- A DXpedition to some exotic part of the world, especially to a rare zone;
- An IOTA, SOTA, WFF or special event station that catches my eye *e.g.* a new IOTA for me;
- Anyone on the Far Side, or who I think might be coming in via the long path;
- Any other IOTA, SOTA or special event station;
- A QRPer or anyone with a weak trace on the waterfall and low signal-to-noise metric;
- Any novice or foundation-class newbie callsign that I recognise as such;
- Anyone with an unusual prefix or suffix;
- Those who call me off-frequency/split, avoiding the unsightly simplex red blob;
- Anyone else. Anyone at all, including people I have worked several times already (within reason!).

That's a lot to figure out, in a hurry, when I'm scanning through each batch of decoded message, but luckily help is at hand. For a start WSJT-X and [JTDX](#) can highlight new ones on FT8 as a result of reading their ADIF log files into memory as either program launches. The highlighting is basic and easily messed up by me carelessly renaming or deleting the ADIF files, or meddling with the colours.

I believe [JTAlert](#) improves the highlighting ... but I don't use it so that's all I have to say on that. Sorry.

Logging programs that interoperate with WSJT-X or [JTDX](#) increase the possibilities, for example Logger32 can distinguish ATNOs from countries we haven't worked yet (ever, or this year only) on FT8, and determine whether previously-logged QSOs have or have not been confirmed and verified for award

³⁷ Your priorities are probably different to mine. I'm listing mine simply to point out the complexity involved, not to claim that my priorities are any better than yours. We're all individual, a.k.a. 'special'.

purposes. [Logger32](#) by Bob K4CY, for example, can display a “UDP bandmap” conceptually and graphically similar to the bandmaps for DXcluster and RBN DX spots, showing callsigns decoded on FT8 ► The bold red stations are/were calling CQ, while the timid blue ones are/were responding to others’ CQ calls. Grid squares sent by some of the stations are highlighted (highlit?) with background colors according to whether they are new ones.

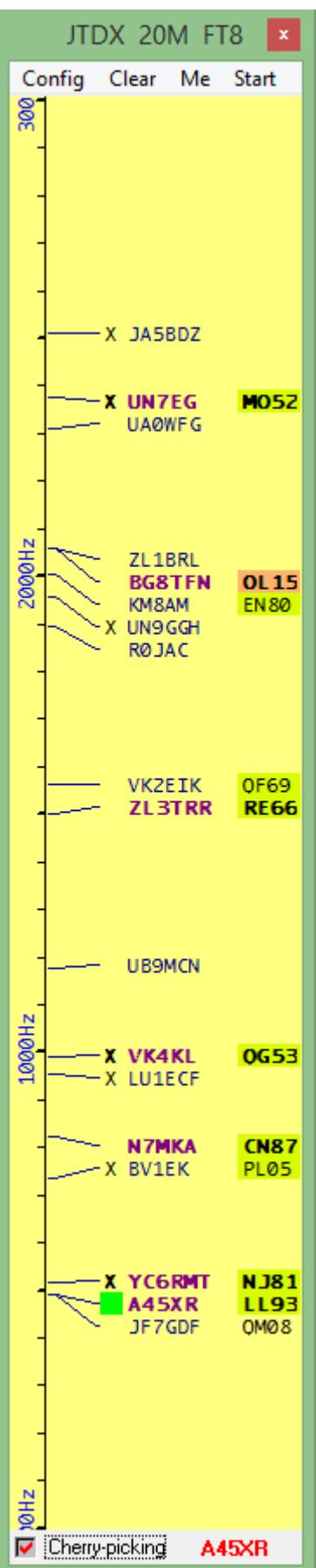


Logger32 supports semi-automatic DXing: we can select interesting stations on the UDP band map, then sit back and watch developments. If our chosen station completes a QSO or calls CQ, Logger32 sends a [UDP message](#) telling WSJT-X or [JTDX](#) to call him. If he starts another QSO with someone else, Logger32 quietly bides its time until it is appropriate to give him another

Logger32 gives us lots of options to customize the highlighting rules and colors, using *Config/Appearance /Highlight colors* on the UDP bandmap top line menu ◀.

Your system will of course look different to these example images unless you happen to choose the same options and colors as me.

call ... like this ◀ When I first noticed HL5FUA CQing, I was busy with a QSO and missed my chance to respond to him. Having finished my QSO, I clicked to select him on the UDP band map and watched as my system tail-ended him. He



worked someone else so my system waited then tail-ended him again. Bingo! It worked! We QSOd!

Logger32 also offers a full-auto “cherry-picking” function – an FT8 automaton or robot – that:

- Identifies “cherries” *i.e.* potentially interesting stations on the UDP bandmap, according to the program’s internal logic and priorities;
- Looks them up in our log and shows any previously-logged QSO information (*e.g.* date, time, band, mode, operator name, QTH, QSL status *etc.*), plus their country, beam heading *etc.* as if we had entered them manually into the logging pane;
- Looks them up in callsign databases such HamQTH.com or QRZ.com, showing the relevant records;
- At the right moment, sends a [UDP message](#) telling WSJT-X or [JTDX](#) to call them on FT8;
- Tracks the sequence of messages to determine whether the station responds to us and completes the QSO, or else gives up calling after a few goes to wait for the *next* cherry to ripen.

It’s up to us whether to use the full-auto cherry-picker function at all, and if so how to configure it. Completed QSOs *can* be logged automatically, although personally I would rather click the *Log QSO* button after each QSO because I’m an old-skool DXer (=old fart) who prefers to stay firmly in control of my station. If you are excited at the prospect of letting your PC do *all* the work, robotically driving up your digimode counts for you, knock yourself out (literally if you wish, subject to your licensing laws about being the control operator for your station).

If robot-style full-auto is not for you, or if the rather cryptic who-to-call-now rules built-in to Logger32 don’t reflect *your* DXing priorities, consider the semi-auto option. Choose your own cherries: turn off the robot then manually click callsigns on Logger32’s UDP bandmap, any of those highlit calls being prime candidates. Logger32 will then do its level best to prod [JTDX](#) into working the selected stations

Failing that, ignore Logger32’s suggestions entirely: simply double-click the WSJT-X or [JTDX](#) decodes from stations that catch your beady eye to have the programs call them in the old-fashioned manual form of digital DXing.

Or just CQ and wait for the cherries to fall into your lap – your lap, your choice.

Watching the robot make QSOs is vaguely interesting at first but soon becomes dull, compared to the thrill of DXing. Personally, I find I can work DX more efficiently and more effectively than the robot ... but the robot wins in terms of chair-time. It can do fairly well through sheer persistence. I find it useful, sometimes, to unleash but keep a close eye on the robot while I’m busy doing other things in the shack such as working ... or updating this guide on the adjacent monitor. YMMV.

In due course, I expect there will be (more) calls to outlaw fully-automated amateur stations except for specific, legitimate purposes such as beacons, Skimmers, propagation pingers and the like. That, in turn,

Trust me, it pays to keep an eye on things, even if the robot is running. In particular, make sure your receive and transmit audio levels remain in the green. It’s down to you to choose your band and transmit frequency, to select the best antennas and turn the beam to exploit useful propagation paths, and to know when to switch to DXpedition mode or chase some rare DX that may not be around for long. DXing takes skills that are hard to automate.

In addition to practical and technical constraints, there are design flaws and bugs in the software. Sometimes the sequencing fails so you need to step in and take charge to rescue or abandon failing QSOs. Contrary to some naysayers, you can’t simply wander away and come back later to collect your awards – and anyway, that’s no fun and no achievement for any self-respecting DXer. You might as well try DXing via SMS TXT messages or email!

may stimulate efforts to 'out' the robots among us, an interesting challenge in its own right, the radio amateurs' version of the famous [Turing test](#).

For now, full-auto lights-out robotic FT8 stations are fairly easy to spot thanks to obvious clues such as:

- Operating 24x7, or at least for extended periods whereas most *normal* people would need or choose to take breaks;
- Always using auto-sequencing with standard messages – no friendly greetings or off-the-cuff comments and responses during or at the end of their QSOs, easily confused by out-sequence-of and custom messages;
- Static audio frequency for all transmissions – no QSYing to avoid QRM;
- Absence from DXpedition fox-n-hounds pileups;
- Frank admissions by their operators, or at least evasive or dubious answers if challenged about this.

Stealthier, more sophisticated robots, though, could prove difficult to identify as such and might conceivably match competent DXers and contesters in capability.

Once the robots can work DX, solve catchpas and write user guides as quirky as this one, my days as a radio ham and tech author will be over. I can sit on the sidelines watching what remains of my life pass me by, quietly humming imaginary Morse QSOs with myself, rocking and dribbling.

Be especially wary of leaving the robot operating your station unattended for more than just the odd moment. Aside from the ethical considerations, practical constraints and bugs, **unattended operation may be prohibited by your license terms and conditions**. Furthermore, there are safety hazards. What if faulty equipment leads to overheating and fire? What if someone wanders into the shack and fiddles with the controls or touches exposed terminals? What if your system goes haywire, causing chaos and confusion on air, perhaps QRMING the emergency services? Your reputation will be shot to pieces and the authorities may come a-knocking at your door.

Fools rush in where angels fear to tread

[Alexander Pope]

Appendix H: FT4, a digimode for contesting

In April 2019, Joe Taylor announced FT4, a [new digimode specifically designed for “rapid-fire contest QSOs”](#). The software and protocol were refined, then WSJT-X v2.1 was released on July 15th with the following specifications:

- 4 FSK tones spaced ~20 Hz apart instead of 8 tones ~6 Hz apart, hence **FT4** vs. **FT8** – the clue is in the name;
- Small bandwidth (80 Hz) constant-envelope MFSK signals with Gaussian smoothing (“GFSK”) giving narrow sidebands (pencil skirts) hence room for more thirsty contesters around each FT4 watering-hole (see next page ►►);
- ~21 baud transmission rate and short overs (just 7½ seconds long including the couple of seconds needed for decoding) giving quick QSOs and a max contest run rate of about 100 QSOs per hour, even *without* the multi-transmit fox-n-hounds DXpedition approach;
- Structured messages the same as FT8 using the same encoding scheme with 77 payload bits and LDPC (174,91);
- Reasonable sensitivity, better than legacy modes but 3½ dB worse than FT8 ►
- Overs are synchronized needing system clocks accurate to within one second (between one second slow and one second fast);
- [UDP](#) and TCP links to contest logging software such as N1MM+.

Lowest copyable signal-to-noise ratios in 2.5 kHz bandwidth

SSB	+10ish dB
MSK144	-8 dB
CW	-15 dB
FT4	-17½ dB
FT8	-21 dB
JT4	-23 dB
JT65	-25 dB
JT9	-27 dB
QRA64	-27 dB
WSPR	-31 dB
??	-35 dB*

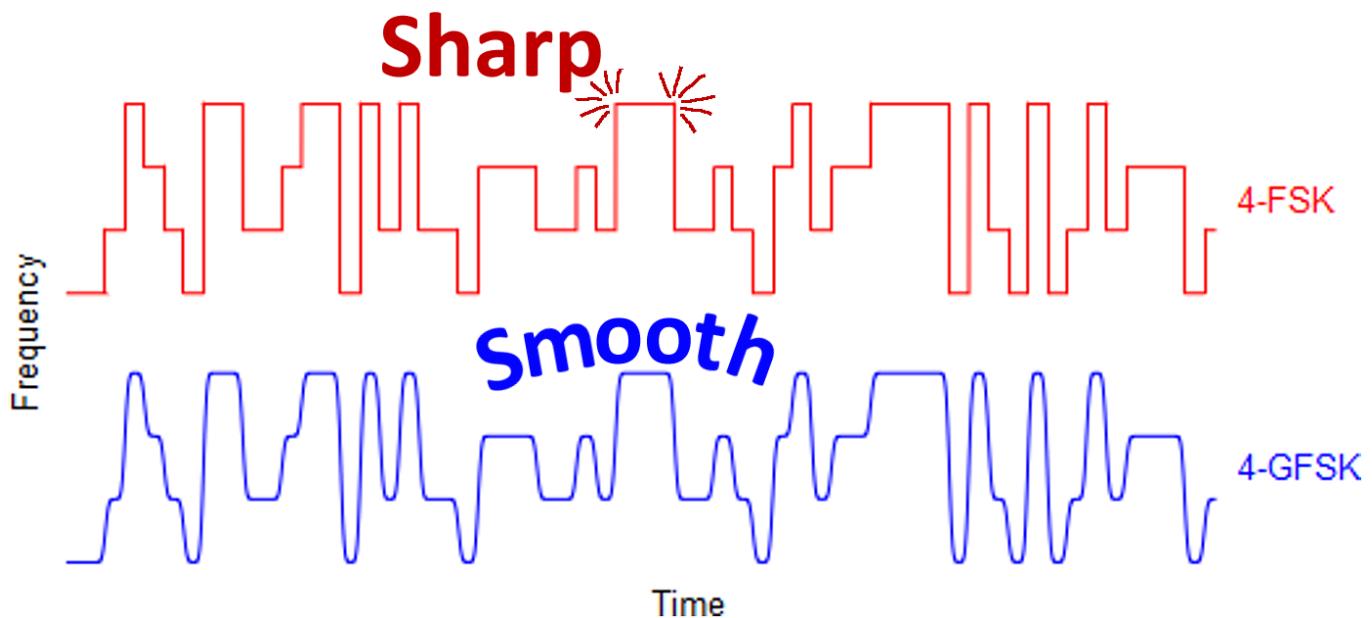
** Joe & team are developing a new ultra-sensitive but very slow mode for VLF experimenters*

For more on FT4, watch [these excellent presentations](#) by Joe³⁸.

“FT4 is a special-purpose mode designed for rapid-fire contest QSOs. It serves this purpose very effectively, but like FT8 the mode is not useful for more extensive conversations. FT4 uses much less bandwidth than RTTY and provides reliable decoding at much lower signal levels. It has no need for “Super Check Partial” or similar contesting aids, and skilled operators using FT4 will find less motivation to use a DX Cluster or other non-radio aids. All information necessary to score well in a contest can be obtained over the air, during the contest, through one’s own antennas and radios.”

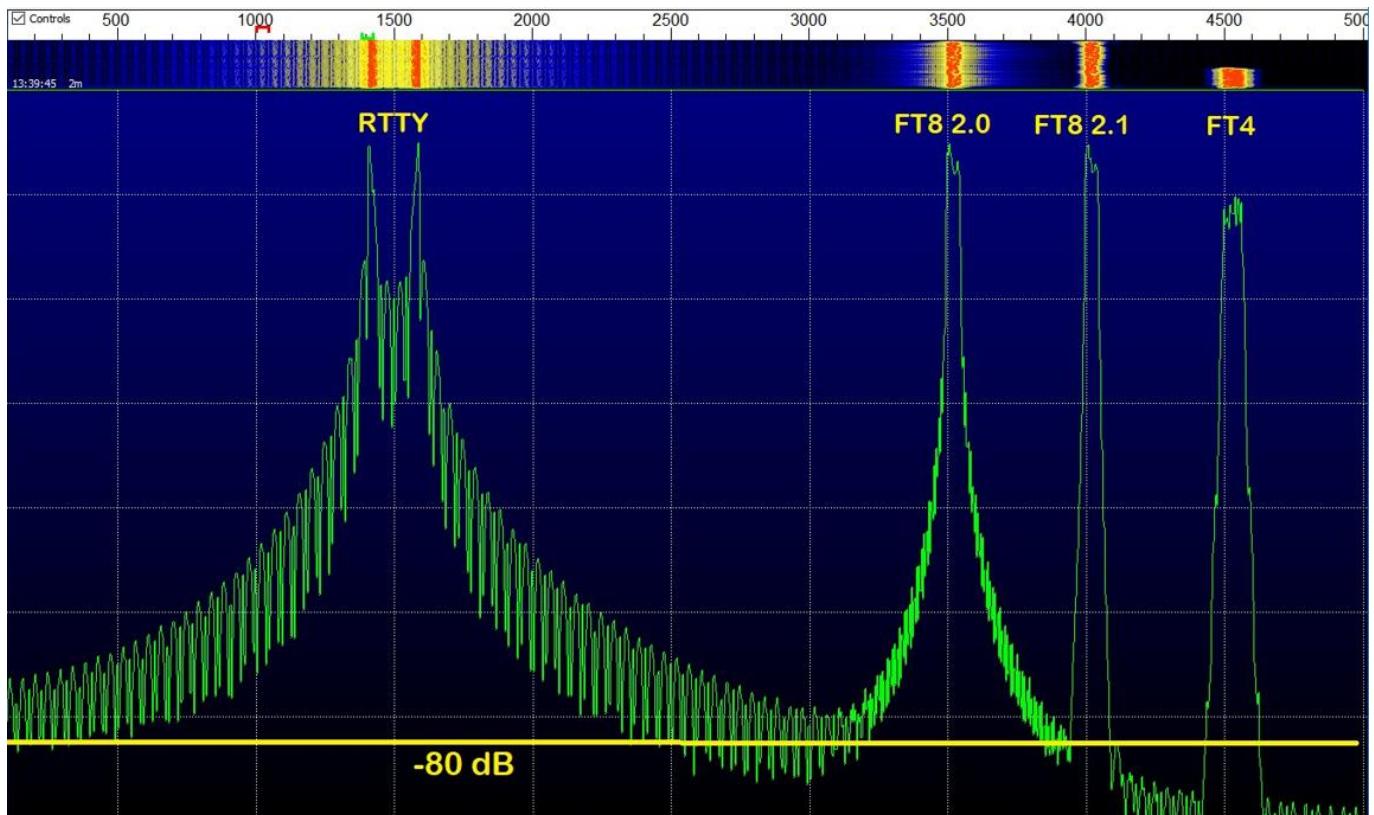
Joe Taylor, April 2019

³⁸ The asynchronous timing approach mentioned in an early seminar was abandoned.



By smoothing the frequency transitions ▲, GFSK significantly reduces the skirts (sidebands) on the two simulated signals shown on the right of this spectrum plot ▼ narrowing the FT8 bandwidth by a remarkable ~80% at the -80 dB level.

Even unsmoothed, FT4 and FT8 sigs are *much* narrower than RTTY.





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*That's it from me,
It's time for tea.
Go work DX,
I'm QRT!*