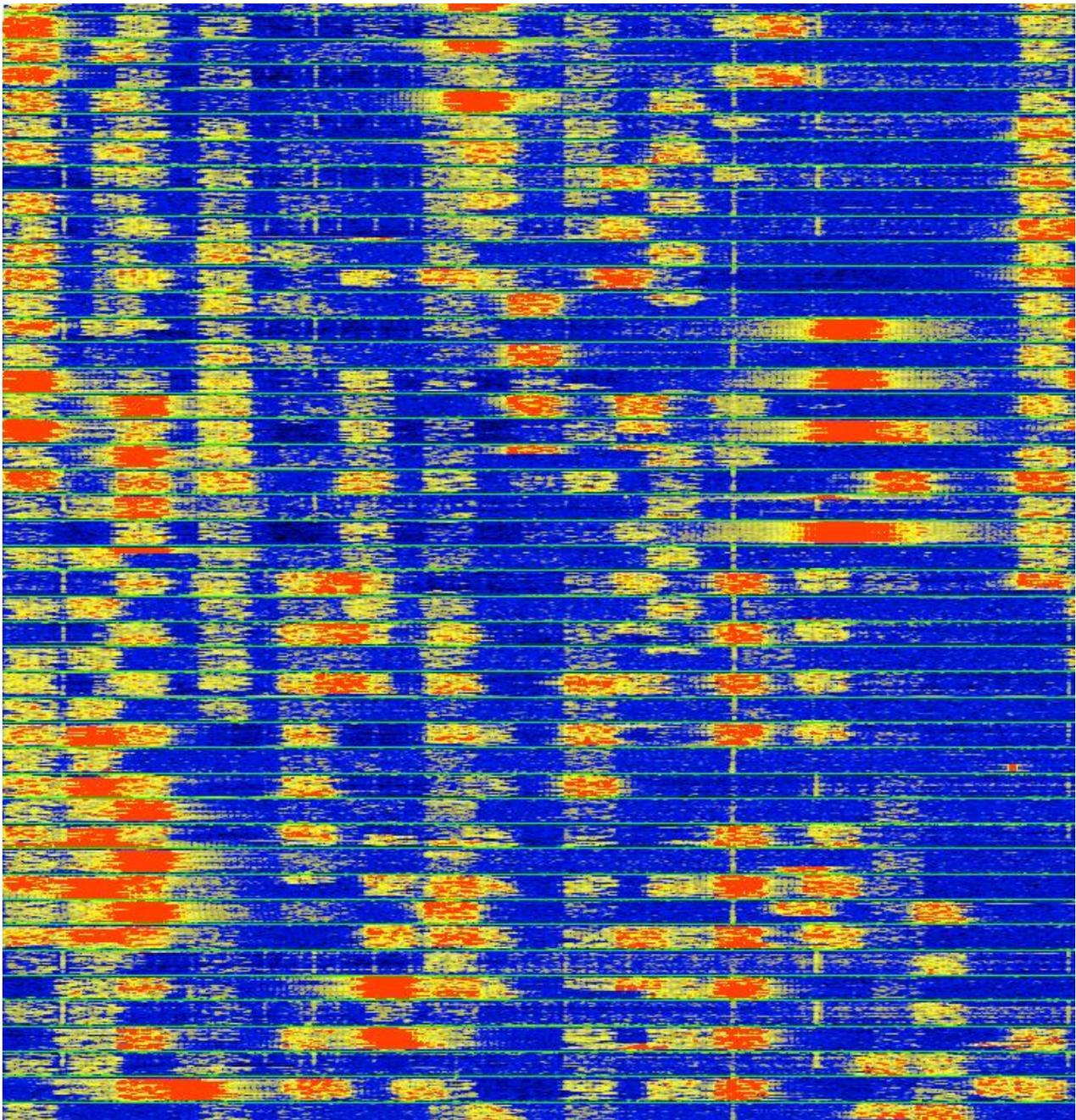


FT8 Operating Guide

Work the world on HF using the new digital mode

by Gary Hinson ZL2IFB Version 1.5 January 2018

Note: this document is still evolving.
The latest version is available from
www.g4ifb.com/FT8_Hinson_tips_for_HF_DXers.pdf



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By [Gary Hinson ZL2iFB](#) Version 1.5 January 2018

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Document history

Version	Date	Changes
1.5	19 Jan 2018	Added a Fake-it gotcha (possible bug?). Suggested hiding the controls and menu lines once set. Added use cases Appendix E .
1.4	18 Jan 2018	Assorted corrections and clarifications throughout (tnx Joe K1JT). Simplified sound card setting (tnx Shawn KU0D). Updated the DXpeditions section – more to come as we prepare for 3Y0Z . Added this change record. Adjusted page layouts, again: chapters each start on a new page now.
1.3	17 Jan 2018	Added a subjective SWOT analysis on the pros and cons of FT8 .
1.2	16 Jan 2018	A splatter of minor corrections (tnx all!). Added appendices A to C with supplementary/tech info.
1.1	15 Jan 2018	Added notes about compound and special event calls (tnx Romeo YR100R).
1.0	14 Jan 2018	Developed from the Hinson Tips accumulated at G4iFB dotcom .

1 Introduction

- 1.1 I have been steadily compiling the following “Hinson tips” over the past few months, in the course of making over 2,000 FT8 QSOs on the HF bands and teaching myself how to drive the software.

Some tips were inspired by suggestions from other FT8 users and by the WSJT-X developers. Many address **Frequently Asked Questions** on the [WSJT-X reflector](#) which I recommend joining.

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.

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. 😊

- 1.2 In particular, I must point out that I am a keen HF DXer with *zero* experience on meteor scatter, EME, rain scatter, topband and VLF, 6m and up *etc.* I have only used FT8 on 80 through 10 metres. Different techniques may well be appropriate and necessary elsewhere, in which case I urge you to [contact me](#). Maybe together we can add further appendices for other applications of FT8?

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 the tips don’t apply on *your* system.

Use the FT8 software installation instructions and help to set up the software with your computer and rig. *This* guide is intended to help you get the best out of FT8 from an operational perspective, not to set up your system up from scratch – sorry but there are too many situations for me to cover the initial software installation and configuration.

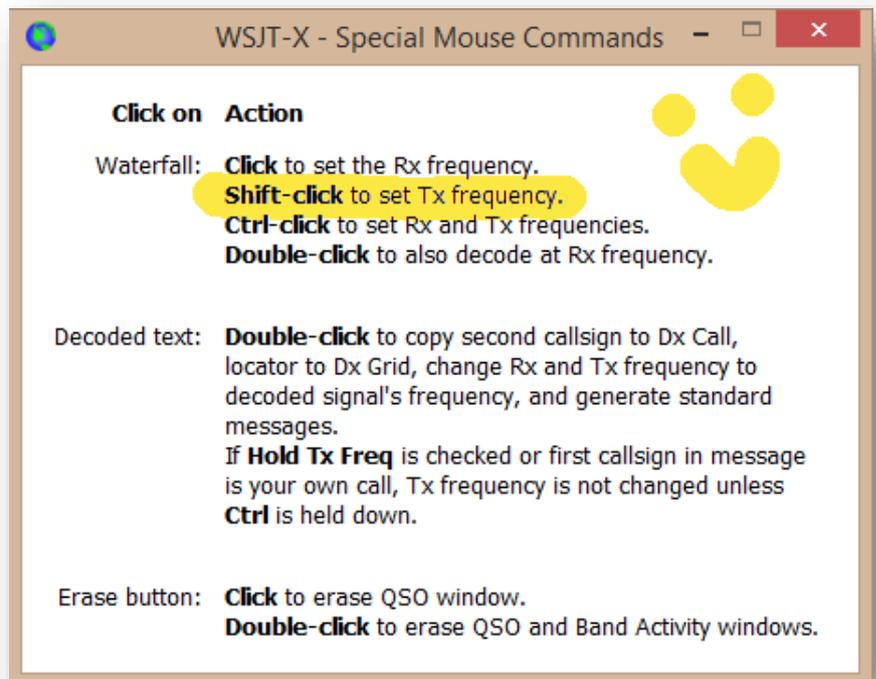
2 Start here

- 2.1 Use the **latest available release** of the FT8 software. You have a few choices, starting with [WSJT-X](#) written by the team that *invented* the mode (the original and best, you could say!).

In the best tradition of amateur radio, WSJT-X is open-source, hence others are developing variants of the program, changing the user interface and in some cases meddling with the decoding and encoding under the covers. Software updates are frequent with the more actively developed variants, as bugs and flaws are discovered and fixed, and new functions are released for alpha or beta testing.

If you are uncomfortable using buggy, often badly broken software with frequent updates (some of which make matters worse!), stick with WSJT-X v1.8.0 at least for now: it isn't perfect ... but it *is* usable and stable.

- 2.2 With WSJT-X running, press F1 and read the help file/manual. It's quite well written, if I say so myself¹. You'll discover, for instance, that the confusing combinations of shift/alt/control keys and clicks are handily explained on the screen by pressing **F5** to "Display special mouse commands"². By far the most useful combination is to **shift-click** on the waterfall to put your Tx signal there (think of it as '**shift my Tx**'). If nothing else sticks from these Hinson tips, at least remember to **shift-click**.



- 2.3 From time to time, check for updates to the FT8 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. 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.

¹ I am a technical author by day, a reformed IT auditor by training. This is high praise, coming from me!

² Commands for *special* mice?

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, you will probably experience problems** e.g. few responses to your CQs, or seemingly being ignored whenever you call others.

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:



If you see plenty of FT8 signals on the waterfall but few decodes, or a distinct bias in the dT values on the decode (e.g. mostly negative values), those are strong clues that your computer's clock may need resetting.

- 3.2 Resetting the computer clock manually soon becomes annoying, trust me. There are better ways. For starters, pop the lid and check/replace the battery for the real time clock.
- 3.3 Provided you have Internet access, the [free Meinberg NTP software](#) maintains millisecond accuracy continually initially by synchronising your PC time to atomic clocks on the Internet using the **Network Time Protocol**, designed for that purpose, and then micro-adjusting the clock speed (rather than just periodically resetting it, which is the more common but crude approach). Install, configure, check, forget: it's that easy with Meinberg FTP.

If Meinberg is beyond you, there are simpler programs such as [BktTimeSynch by IZ2BKT](#), [Dimension 4](#) or [TimeSynchTool](#).

The computer clock Internet time synchroniser built-in to Windows is a crude option *provided* you get it to update more often than weekly, which means meddling in the registry. Using regedit, find **HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\W32Time\TimeProviders\NtpClient** and reduce the **SpecialPollInterval** from 604800 (decimal) to something more sensible.

If you are offline (perhaps clinging precariously to a mountain peak on a SOTA expedition), 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.

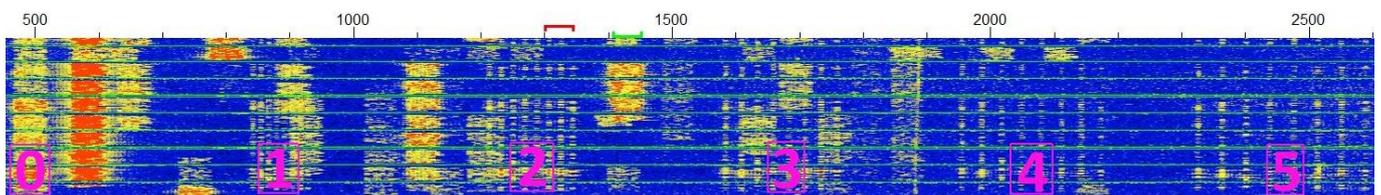
Hint: **SpecialPollInterval** is the number of seconds between time corrections. 86400 means daily updates, 3600 means hourly.

4 Important: transmit levels

4.1 Although FT8 is a constant-carrier FSK mode (unlike PSK, CW and SSB), it is very important to avoid overdriving that distorts and widens your signal and generates spurious signals. **Set the transmit levels so the entire chain from AF generation through to RF transmission is operating linearly.**

Check out your transceiver, sound system and software on-air on a quiet frequency with a competent ham giving you honest feedback, or while monitoring your own transmissions on a Web SDR as you systematically adjust the settings and make notes.

4.2 If you get your transmit levels badly wrong (such as the FT8 station labelled 0 in pink below), you may unknowingly be generating ‘ghostly barcodes’ (1-5): 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: *[Thanks for the 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 upstream audio circuits are overloaded.

Take care adjusting the level of audio output from the PC sound card:

- On the Elecraft K3 radio, set the PC sound card output (using the sound card headphone level slider and/or the “Pwr” slider on the WSJT-X main window) and the K3’s line input level (confusingly, using the front panel “MIC” control) to indicate 4 or 5 blobs on the ALC meter. The fifth blob indicates the start of ALC action.
- 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. Consult the radio manual to find out how to set the audio drive level.

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!).



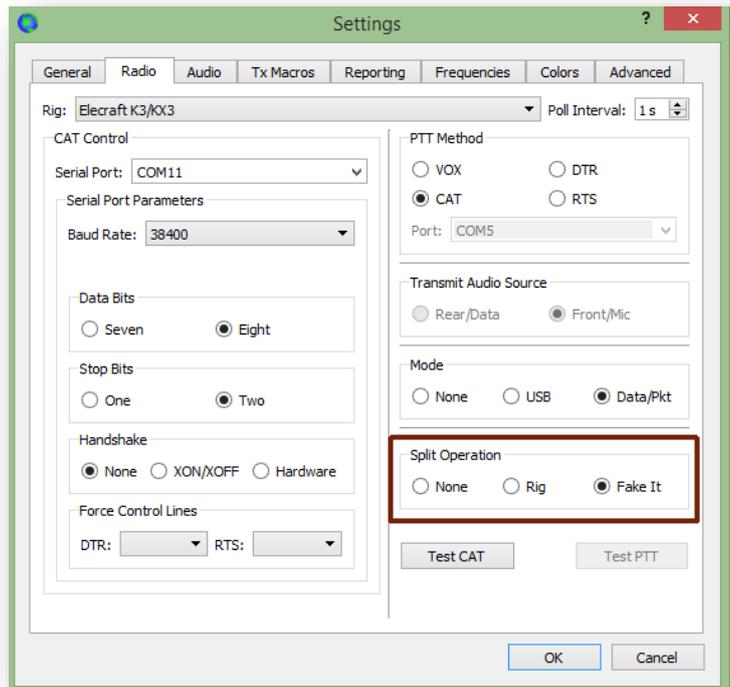
On some rigs, the ALC meter is, in effect, a distortion meter. Any indication above the bottom is bad news.

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

With many FT8 stations using QRP, someone running, say, 100 watts or more stands out from the crowd ... but not in a good way. Similarly, those running 50 watts to large beams: that’s a lot more ERP than most.

- 4.4 If you are using CAT control to read and set the rig's frequency, mode etc. from the PC, use the **Split Operation** function in WSJT-X under **F2 Settings** → **Radio** →

Depending on where your red goalposts sit above the waterfall, this function automatically adjusts both the radio VFO frequency and the audio frequencies so that the generated FT8 audio tones are towards the high end of the normal frequency range of SSB speech. Any audio harmonics, then, are more likely to be attenuated by the rig's transmit shaping/filters, resulting in a cleaner non-spooky (ghost-free) transmitted signal.



- 4.5 The “Fake It” setting automatically adjusts VFO A to compensate for different audio frequencies, sending the QSY commands at the start and end of every over. The “Rig” setting attempts to use the split function built-in to modern radios by receiving on VFO A and transmitting on VFO B ... but unfortunately WSJT-X v1.8.0 does not check the radio nor re-send the split and mode commands with every over. With the “Rig” setting, if for some reason split gets disabled on the rig itself (e.g. for a simplex QSO on another mode or band), be sure to turn split back on, on the rig, when you resume using FT8. Aside from any indication on the rig, you should normally see a bold S meaning *Split* in the green blob between band and frequency in WSJT-X.

According to one report, both “Fake-it” and “Rig” are disabled if you have “Enable VHF/UHF/Microwave Features” set. Go to **F2 Settings** → **General** and *unset* it.



- 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]

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 normally 'need' 100 watts or more, that is a strong hint that your feeder and antenna system are inefficient. Check for corrosion and loose connectors. Try making a simple halfwave dipole as a comparison antenna.

There *are* situations where QRO is both appropriate and necessary, for instance CQing on a closed band, hoping to catch DX as the band opens. 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. We can't DX if we can't receive weak signals.

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. 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 and you're not using SSB, something may be seriously amiss!

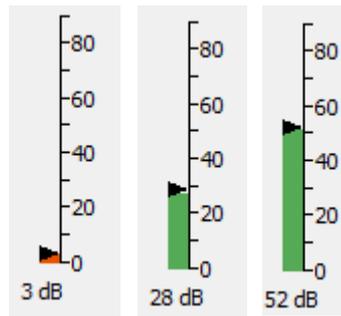
001615	-12	0.2	1665	~	AL2V AE5JH EL07	
001615	-12	0.2	1804	~	CQ DX KW4JY FM05	~U.S.A.
001615	-10	0.3	2169	~	K5AGC K4HVF 73	
001615	58	0.8	1448	~	CQ N2NL EL97	~U.S.A.
001630	-11	0.2	240	~	W5TCB K7AHF RRR	
001630	0	0.7	375	~	CQ NE N2DPF EM12	~U.S.A.
001630	-11	0.4	803	~	N8TL AC9E -08	
001630	-13	0.4	832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

4.8 Near the low end of the range, Signal-to-Noise Ratios become dubious for comparison purposes due to the way they are calculated →

"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." [Bill, G4WJS]

5 Important: receive levels

5.1 The bar graph audio level meter in WSJT-X should normally read *about 20-to-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.

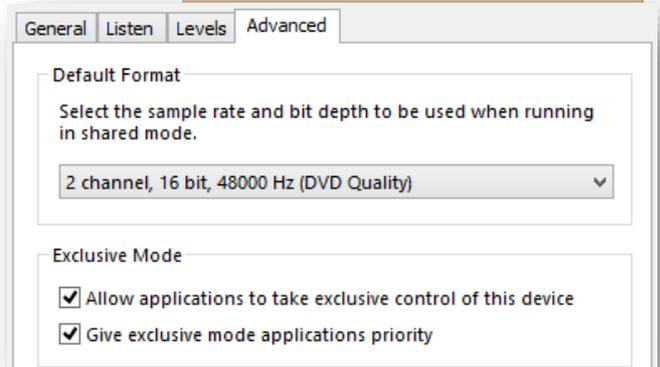
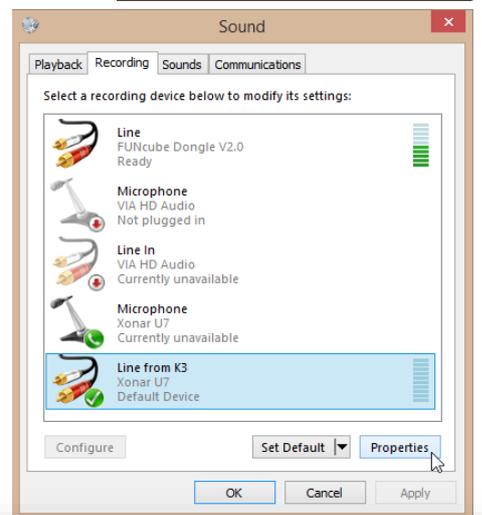


I suspect the WSJT-X bar graph was modelled on Star Trek’s medical bay 😊

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

5.2 Here’s how to set the audio input level to WSJT-X 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.
- If there is a balance control, check that both audio channels are set to the same level. On a radio with dual-receivers feeding the left and right channels on a stereo output, you may want to monitor each channel separately with two instances of WSJT-X, for example if a DXpedition is operating FT8 with a wide split.
- Click OK to close the levels tab, then open the **Advanced** tab →. Check that the default format is 48000 Hz (DVD Quality), the correct sampling rate for WSJT-X. The *default* default rate is often 44100 Hz (CD Quality) which creates sampling errors that degrade decoding a little - best avoided.
- Click **OK** and **OK** again to exit the Windows sound settings.



- Launch WSJT-X if it is not already running³. 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 20-to-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 20-to-30 dB*.
- If your radio has a *fixed* (non-adjustable) line level output or one that cannot be reduced to *about 20-to-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 20-to-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 dB⁴, 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 to WSJT-X! Ooops.

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 is more important than sensitivity. On my K3, with the Xonar U7 sound card, setting the line out level to 004 with the recording level set near 50% gives me a quiescent value on the WSJT-X level meter of 22 dB on 50 MHz, receiving band noise on an 80m loop. That works nicely for me. YMMV.

If there is so much band activity that the bar graph is above 70 dB and going red, you’ll need to 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’.

³ 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 for the tip Andrew VE3AND]

⁴ 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. The yellow fuzz either side of solid red blobs may simply be low-level skirts on the digital filter that generates the waterfall display: the signals are generally clean in fact.

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

“FT8 – 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.

6 Other WSJT-X settings

6.1 Select (tick, check) the **Hold Tx Freq** option and leave it permanently selected to avoid your transmit frequency being continually pulled around by successive callers. Even with **Hold Tx Freq** on, you can still put your Tx where you want by **shift-clicking** the 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** your Tx to their frequency, or click the Tx ← Rx button next to the Tx frequency box⁵.

If you can't find the **Hold Tx Freq** option, are you perchance running an early Release Candidate beta version of WSJT-X? Get with the program. It's time to update!

6.2 If you idly select **NA VHF Contest** on the WSJT-X main window, you will be perplexed to discover that your auto-generated messages no longer include signal reports. Shock! Horror! That's because reports are not needed for (some) **North American Very High Frequency** contests. If you are not in fact participating in an NA VHF contest, de-select (un-tick, un-check) the option to put things back to normal and regain your composure.

Stop fiddling randomly with the settings or you'll be sent to the naughty step!

6.3 Select **Auto Seq**. Auto-sequencing works well, reduces 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 couple of seconds of your transmission: this may be needed to recover from a sequence error. Alternatively, there's still the 100% manual option →

"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." [Bill, G4WJS]

⁵ The tiny left-facing arrow reflects the conceptual meaning of the A ► B button on many radios, copying the frequency currently in VFO A into VFO B. However, it faces the wrong way if you think in terms of 'moving the goalposts' on the waterfall.

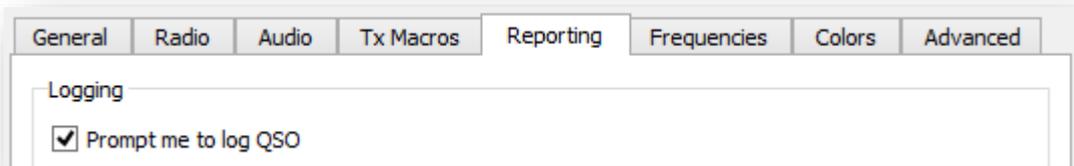
7 How to call CQ

7.1 First get ready:

- Set up WSJT-X to talk to your 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** to set your Tx frequency there;
- Set the **Hold Tx Freq**, **Auto Seq** and **Call 1st** options on the WSJT-X main window;
- Click the Tx 6 message box or button, or hit **F4**, to select your CQ message.

7.2 When you are all ready 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.

7.3 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 are using the **F2 Settings** → **Reporting** option "Prompt me to log QSO" ...



At the same time, **Enable Tx** is automatically *unset*⁶, 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 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.

7.4 If someone else has called you already (a tail-ender), you can double-click their decode to respond directly to them without sending another CQ, but you *must* wait until the previous QSO is complete: if you double-click too soon while your 73 message is still being sent, the 73 message will be aborted and you'll start calling the tail-ender instead, probably corrupting the transmission and causing chaos and confusion.

Some grumpy FT8 users feel snubbed if they don't receive a 73, and refuse to log the QSO on principle.

⁶ This only happens if you also have **Call 1st** selected though. Personally, I think that's a bug in WSJT-X v1.8.0. I find it inconsistent and disconcerting to discover that the **Call 1st** option affects the *end* of QSO behavior.

7.5 **Call 1st** automatically responds to your first decoded caller – literally, the first one whose message is decoded. If you would rather have responded to someone else, too bad if you had **Call 1st** selected ... unless you are quick: within the first second or so of your transmission, you can hit **F4** to clear the callsign of the first decoded caller, then double-click the decode that you want to respond to which picks up his callsign and puts it into the generated messages. 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 by WSJT-X v1.8.0.

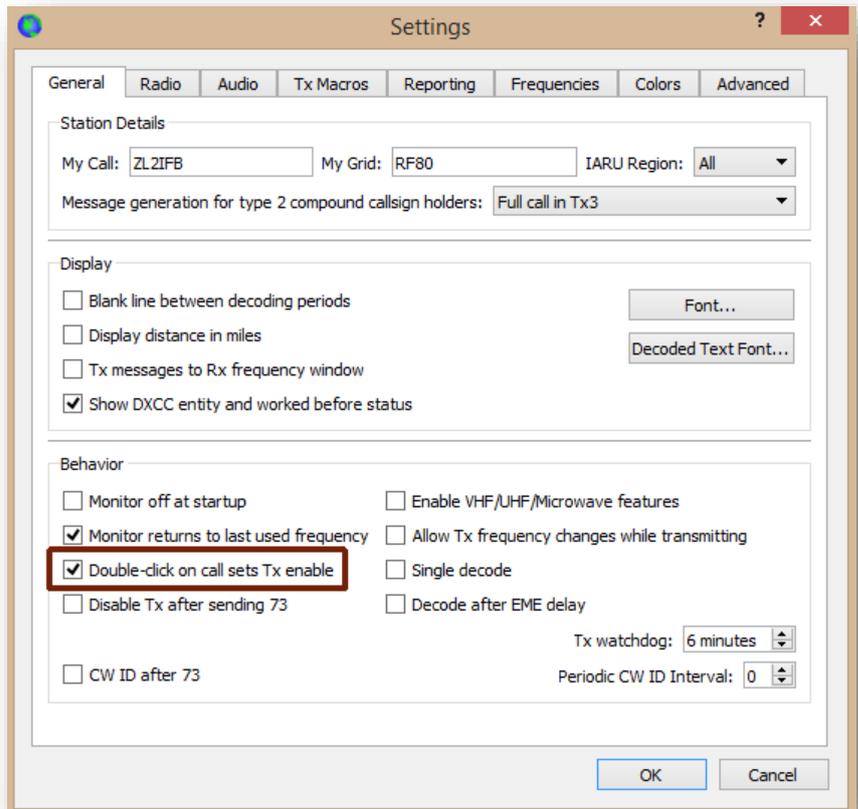
“Call weakest” would be a neat alternative. Weaker stations are generally DX, for starters, and if we all preferentially responded to weaker callers first, it would encourage everyone to keep their power down.

“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”,
K1JT, K9AN and G4WJS, QST October 2017.*

8 How to respond to a CQ

8.1 First set things up as you did for calling CQ (particularly the audio and power levels, and enable/select **Auto Seq** and **Hold Tx Freq**), and 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 CQ message decode, 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 at the start of the next period.

8.2 First, though, before you double-click to respond to someone's CQ, select a suitable transmit frequency. **Shift-click** on a clear space on the waterfall to put the red goalpost there.

8.3 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!

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.

- 8.4 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 PAC MONKR"), it isn't transmitted and interpreted as a standard predefined message type.

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 message, and click **Enable Tx** to start calling him. It's awkward, and a reminder not to get too fancy with your CQ calls.

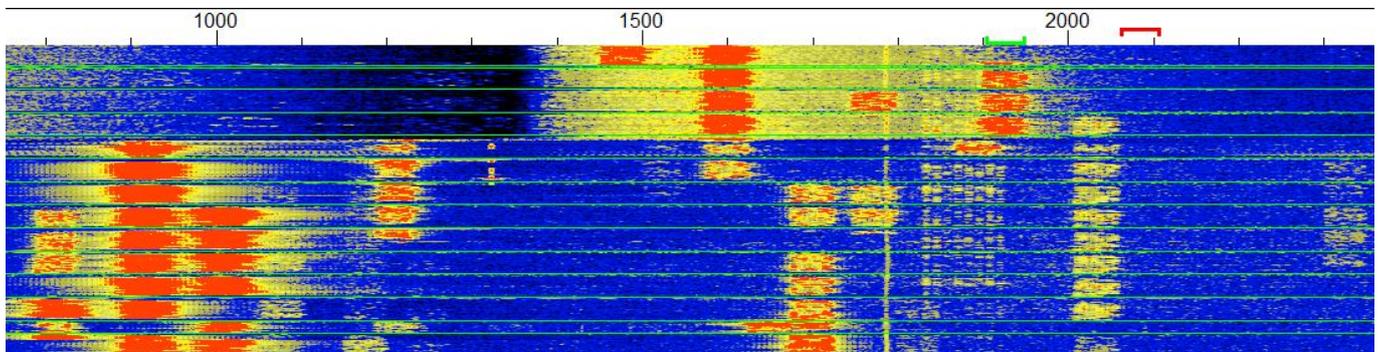


9 General FT8 operating tips

9.1 Generally speaking, it's best to turn off the rig's noise blanker, narrow filtering and fancy DSP 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. 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 and the most decodes.

“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 a real example, captured on the 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 easily.

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 When the band is humming and the DX is busy, spread out! Any decoded message containing your callsign will be highlighted for you, *wherever it is being transmitted on the waterfall*, so there is no need to work simplex. Calling or working simplex is not a good idea, especially with any popular station, since others will generally be doing the same, QRMing each other. As Hasan NOAN put it:

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

Split operating is not a hard-and-fast rule. It's not the law, just a tip that some experienced FT8 users (plus me!) find works well in practice.

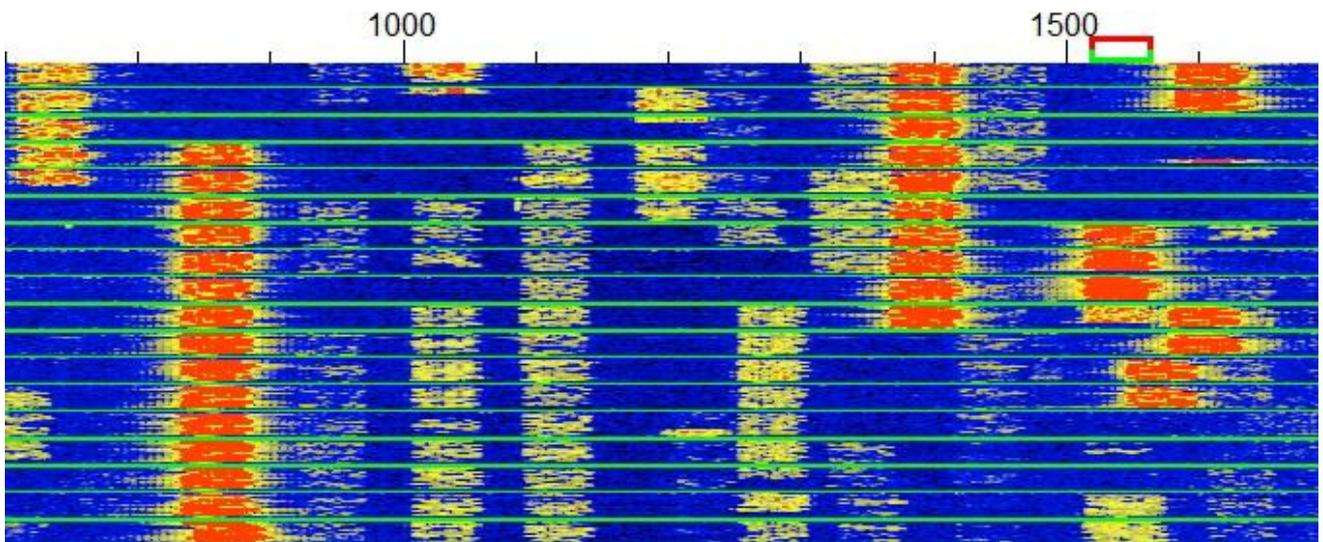
Rather than zero-beat to call someone on their working frequency, take a moment to **shift-click** your Tx signal (the red goalpost above the waterfall) elsewhere on the waterfall, somewhere quiet.

Unlike conventional analog (legacy) modes, split operation is preferred on FT8. The idea that split operation on FT8 "ties up two frequencies for one QSO" and is therefore an inefficient use of spectrum is a common but naïve misunderstanding →

Don't forget that each party to a QSO transmits in a different period. **Even and odd periods are orthogonal or independent, 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, their transmit frequency is then released for anyone else to use. See [Appendix E](#) for a more elaborate explanation.

However, something that 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 and abandoned QSOs. 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 operating is inherently bad and patently it does work, rather that split works *even better* on FT8.

- 9.3 Especially when the band is busy, monitor for a couple of minutes before selecting your transmit frequency. Look for a continuous blank column on the waterfall, ideally, and **shift-click** 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, or hold back in the hope of seeing other free columns open up. Another possibility is 760, but I prefer to avoid getting too close to strong signals such as the one at 830.

9.4 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 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 pane⁷. However, don't go too far to the right of the waterfall →

Be kind to other digihams. Stay within the FT8 sub-band: weak signal DXers using Olivia, JT65, JT9 and other digimodes, mostly above 2000 Hz or so on the waterfall, will not appreciate you stomping all over them. You may not even see their signals on the waterfall: that's why it's called weak-signal DXing!

9.5 If you CQ, transmit in the same period as any strong signals on your waterfall to minimize mutual interference. Transmit when they transmit, receive when they receive.

9.6 Keep an eye on what's going on, especially when you are new to the game. It's tempting to set the **Auto Seq** and **Call 1st** 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. Two ears, one mouth, remember.

9.7 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. The easy way is *not* to re-**Enable Tx** immediately after you log a completed QSO - skip a 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 someone else is sharing 'your' period.

FT8 is *extremely* good at unpicking interwoven and overlapping signals, but having a reasonably clear frequency makes it easier to copy, especially with weak signals.

9.8 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 the Rx Frequency pane scrolls at a far more sedate pace (try stretching the main WSJT-X window to full screen height).

9.9 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 tends to mess up the waterfall and decoding. AGC is the easy option, preferably on a fast setting.

9.10 *Please* don't continuously call someone who is calling or working someone else, even if you are calling them off-frequency. 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, you will simply waste watts, create QRM, cause delay, and you may even be blacklisted by the DX.

⁷ It helps to stretch the WSJT-X window towards the full screen height. I can see about 40 decode lines that way.

9.11 Use the waiting time wisely. Look at who else is QRV and where they are on the waterfall. Maybe **shift-click** 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!

Recent versions of WSJT-X automatically stop you calling someone simplex if they respond to someone else, but you should be keeping an eye on things anyway, and simplex is not recommended anyway.

9.12 ... 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 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.

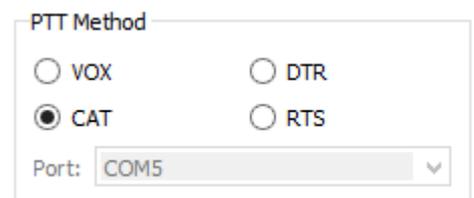
9.13 Tail-ending with FT8 is a bit awkward: first type the DX callsign into the **DX Call** box and click **Generate Std Msgs** to set up the appropriate messages (or double-click the DX station's CQ message and quickly hit **Halt Tx** to abort your transmission if now is not the perfect time to call). Remain on your carefully chosen clear Tx frequency to complete 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, check that **Hold Tx Freq** is selected.

9.14 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...'.

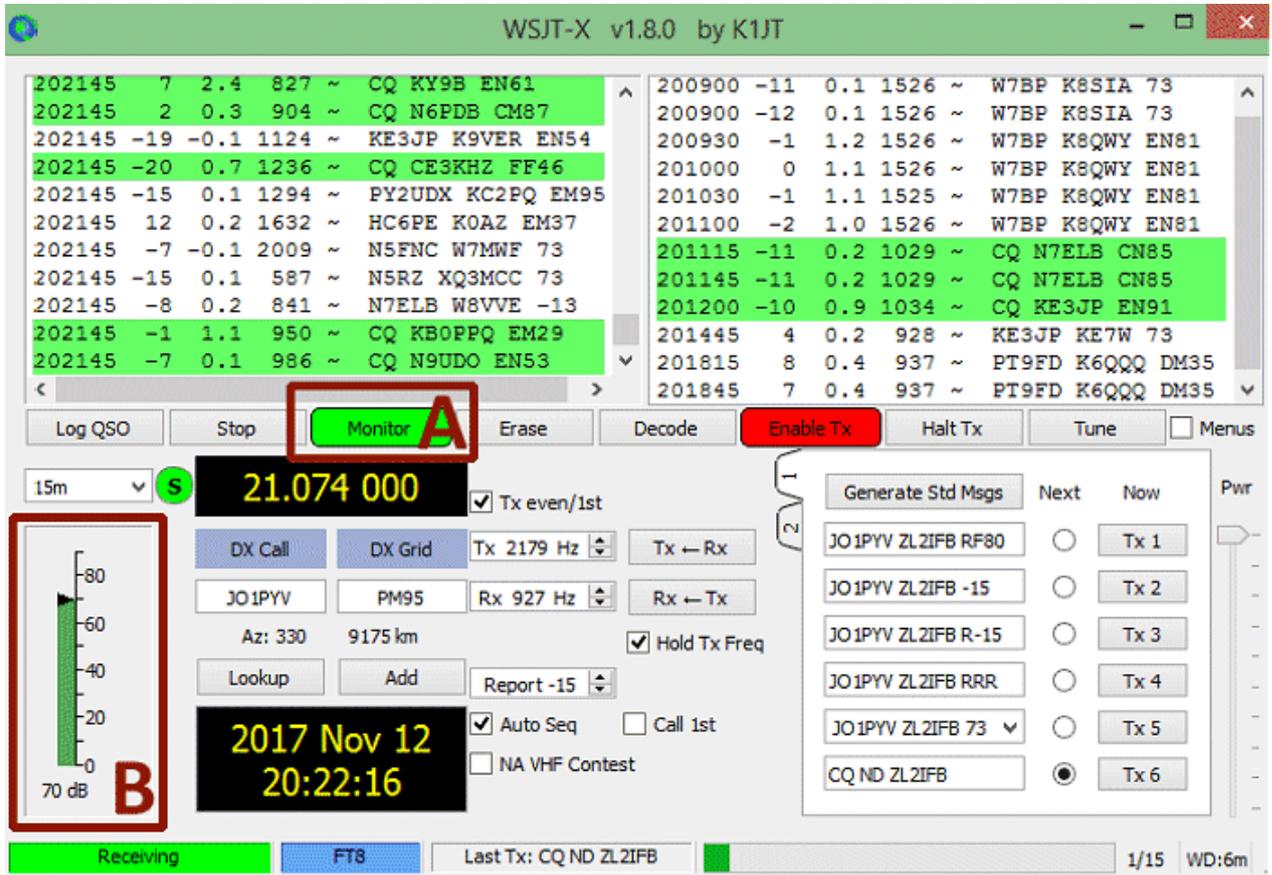
9.15 Broken something? **No transmissions?** There are several possible reasons, so check things systematically:

- Is the radio going into transmit? 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 tones? Check the rig's meters *e.g.* power out. 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 plugged in, to the right places?



9.16 Broken something else? **No decodes?** You'll probably find that WSJT-X is not dead, just resting. Check:

- (A) that the **Monitor** button is still enabled (bright green); and
- (B) there is sufficient audio reaching WSJT-X (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):



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

9.17 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 as you turn your beam towards directions where there is better propagation. Magic!

9.18 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.

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

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K1JT, K9AN and G4WJS, QST October 2017.

9.19 If a stalker is hounding you for a QSO, constantly calling you regardless of what you send but never sending you a report if you respond to them, or perhaps having started a QSO he is now 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 and WSJT-X! 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 tips ... well, we live in hope!
- Be patient. It is possible he is persistently sending the same message simply because your acknowledgements are not getting through to him for some reason (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 I have received a report indicating that my signal is very weak.
- Try sending a free-text message such as "NEXT MSG PLS" or "CHK AUTO SEQ".
- While you wait, visit [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.
- 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.

- Try **shift-clicking** to move 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 more savvy 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. Hug a stranger. Tidy the cave. [Email Gary with even more tips.](#)

9.20 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 normally only have 13 places to fill in each free-text message from a very limited character set (just numerals, capitals, spaces and a few punctuation characters)⁸. In particular, you will soon discover that most users are reliant on **Auto Seq**, which is easily confused by anything out of the ordinary. If you happen to be in contact with someone still using the first "RC1" beta release of WSJT-X, sending the RR73 message triggers **Auto Seq** at the far end to send you a report without the R - a bizarre response that takes the sequence backwards, the very opposite of what you probably intended.⁹

Custom final messages are less of an issue though. Free-text (Tx 5) messages containing "73" normally trigger

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

Auto Seq to realize the QSO is over - 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 ending.

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 you are not an accurate typist under pressure *e.g.*

- NO DECODE SRI
- QRZ CALL AGN
- SRI TOO WEAK
- CALL LATER
- BAD FREQ QSY
- 5W G5RV 73
- C QRZ.COM 73
- FB DX QSO 73
- CHECK UR CLK
- CHK TX AF LVL
- SPREAD OUT
- WAIT UR TURN
- UPD8 WSJTX 73
- SRI FINGR TRBL
- and perhaps TNX TIPS GARY

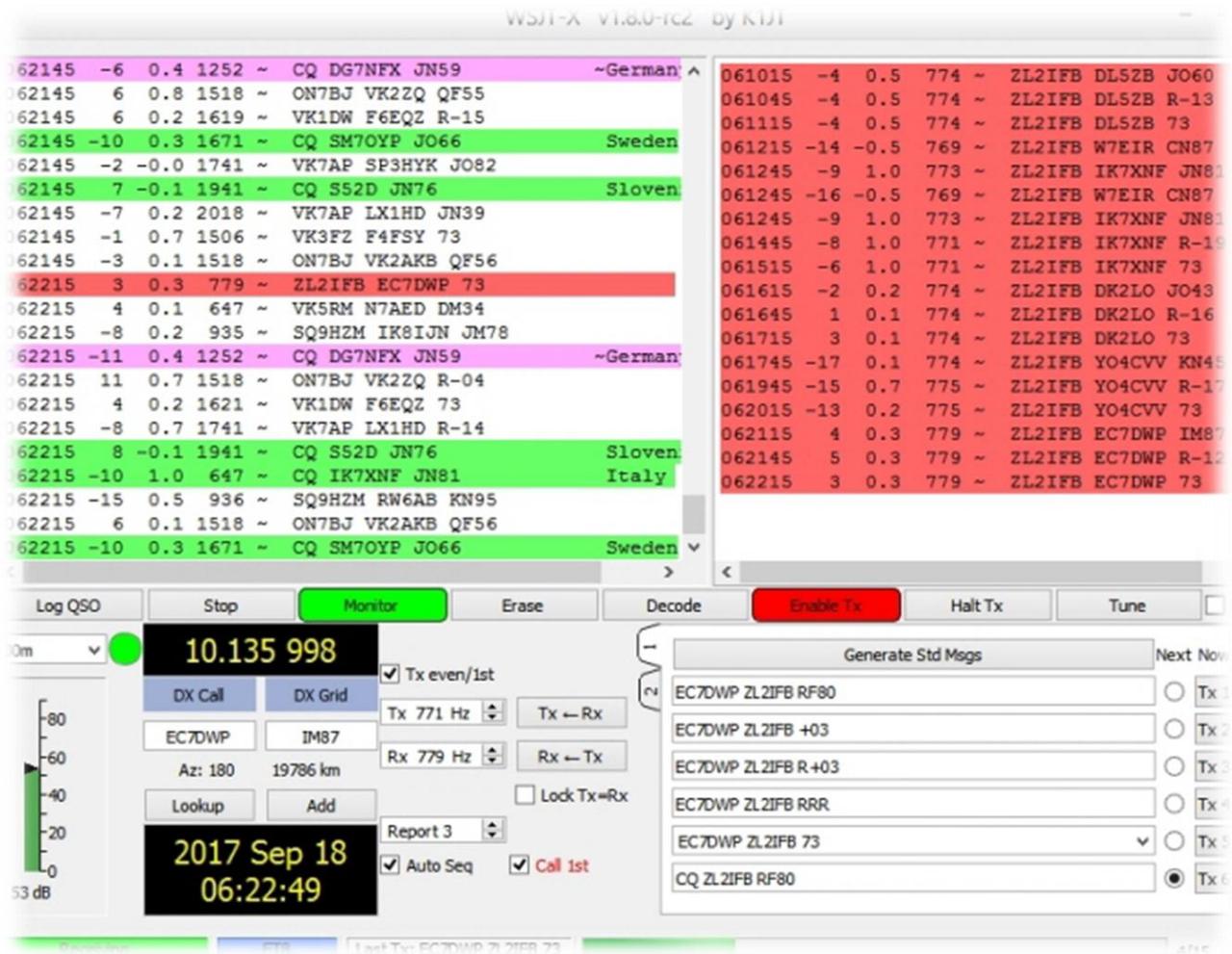
9.21 Once you have things set up, maximise use of your screen and minimise the temptation to fiddle with the settings by hiding the waterfall controls and WSJT-X menus. Simply clear the boxes.



⁸ 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. The full-stop (period) is handy to send short URLs.

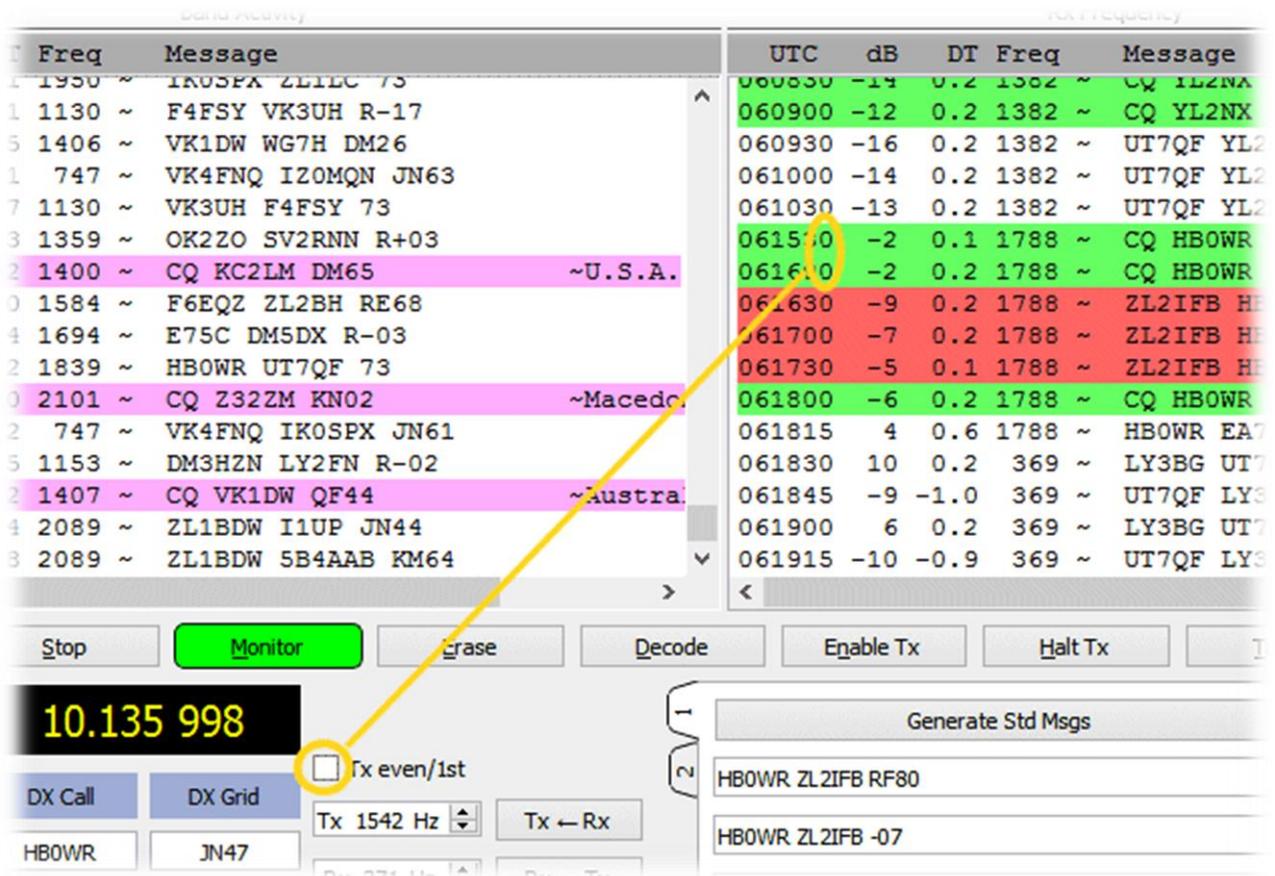
⁹ RC1 seems to interpret RR73 as a grid square. According to John, KA5BJC, RR73 would in fact be valid ... for an ice breaker in the Arctic Sea off the North-East coast of Siberia! Later versions of WSJT-X handle it just fine. Keep the software updated!

9.22 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:



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.

9.23 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:



9.24 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 to 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:

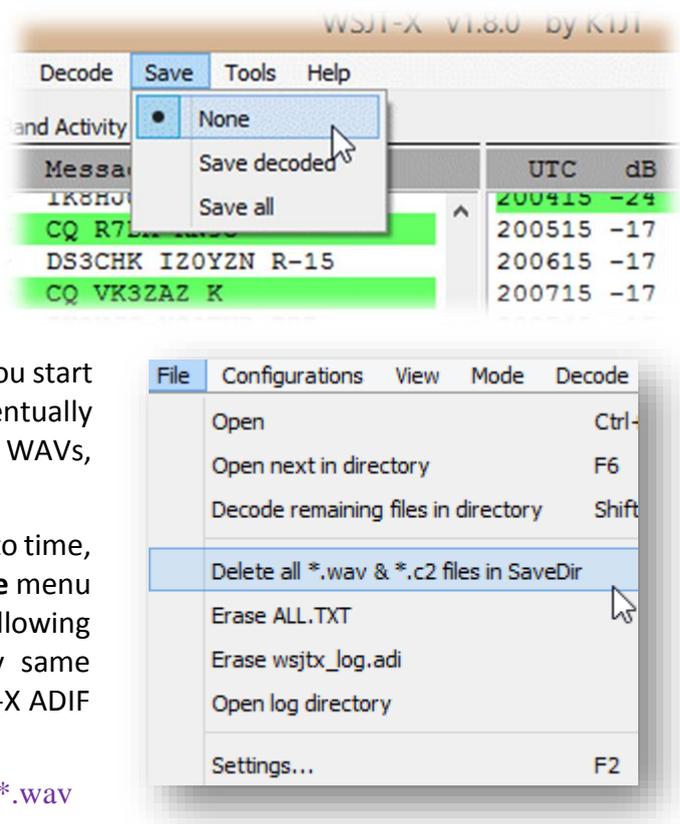
```
tail -n 3 -f ~/.local/share/WSJT-X/wsjtx.log
```



9.25 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 after the processing is completed. 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.

It’s worth clearing out the orphans from time to time, either manually (using the 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
```



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. However, some **special event and commemorative calls** are so “special” that the FT8 protocol simply cannot accommodate them within the 28 bits reserved to carry callsigns in most of its messages (e.g. CQ calls, reports and RRR or RR73 messages). WSJT-X accepts YR100R, for example, as the operator’s callsign in **F2 Settings → General**, and *appears* to generate messages that contain YR100R ... but it cannot actually transmit them, apart from in the free-text message type.

“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.” [Extract from section 17 of the WSJT-X help file – well worth reading!]

10.2 Standard callsigns with **location modifiers** (e.g. ZL9/G4IFB) are handled in software by using just the home callsign in most messages. The complete location-modified callsign should be sent in the particular message types specified under **F2 Settings → General → Message generation for type to compound callsign holders**. I am not entirely sure this is working as designed though: having set my callsign to, say, ZL9/G4IFB, with **Full call in Tx3** selected, my full callsign is only included in messages Tx 1 and Tx 6 →

	Next	Now
LU7DD ZL9/G4IFB	<input type="radio"/>	Tx 1
LU7DD G4IFB -13	<input type="radio"/>	Tx 2
LU7DD G4IFB R-13	<input type="radio"/>	Tx 3
LU7DD G4IFB RRR	<input type="radio"/>	Tx 4
LU7DD G4IFB 73	<input type="radio"/>	Tx 5
CQ ZL9/G4IFB	<input checked="" type="radio"/>	Tx 6

10.3 Non-standard special-event and other callsigns up to 13 characters long can be transmitted in free-text messages ... but they are *not* interpreted as callsigns. On the receiving end, if someone double-clicks one of those decoded free-text messages in the hope of calling the DX, they would be out of luck. 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.

There’s little point complaining about this issue to the software developers, just because you cannot use your non-standard special event call on FT8. It’s not their fault! They would love to help you out. A limitation inherent in the FT8 protocol is the root cause (see [Appendix B](#)). Not even the professors can change the laws of mathematics and physics!

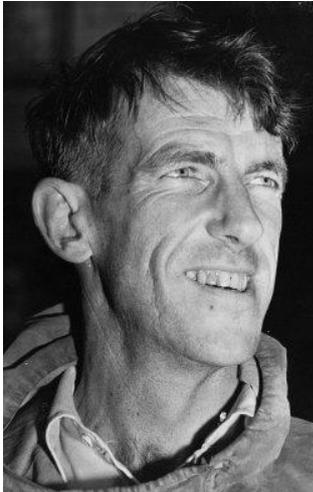
11 DXpeditioning with FT8

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

- On the upside, it is clearly a very popular HF mode, good for weak signal DXing even for stations limited to low power and basic or stealth antennas. It can make even short openings and marginal paths productive.
- On the downside, the maximum QSO rate with WSJT-X is about 60 QSOs per hour per transmission.

In practice, experienced digimode DXers (such as Roly P29RR) can sustain 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. In comparison, 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.

With clever programming, it is feasible to generate and transmit multiple FT8 signals simultaneously on a single transmitter, allowing for multiple QSOs in parallel on one rig and band. As to whether that would be a sensible approach, I will simply say that the challenge of working very rare DX is a large part of the allure of DXCC: making DX much less rare and DXCC much easier is not necessarily a worthwhile objective.



Having said that, FT8 *can* be fully automated, replacing operator effort with CPU cycles. I envisage futuristic DXpeditioners taking robotic FT8 stations with them, to sit silently in the corner making QSOs for the duration of the trip and perhaps beyond →

Would Sir Edmund Hillary have agreed to carving-off the top few thousand toughest feet of Everest with dynamite, or installing a walkway to the summit, complete with safety handrail, oxygen bottles and warning signs?

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 leave, perhaps with weather station or scientific/environmental monitoring capabilities to justify their presence.

“We are definitely not planning to make a QSO robot. Enhancements for DXpedition use are already in place, although not yet in a released version.”

Tnx Joe, K1JT

12 Flaws, bugs and improvement suggestions

12.1 Although WSJT-X has been around for more than 5 years, FT8 was released just 6 months ago as I write this, hence the amateur community¹⁰ is still coming to terms with it. In particular, FT8 has tempted a large number of *HF* amateurs onto the digital modes for the first time. For those reasons, there are bound to be teething troubles in practice as the situation unfolds before us ... and at the same time there are opportunities to help move things along in a positive direction.

12.2 Flaws in the design of FT8 and WSJT-X, software bugs and problems with our on-air operating conventions are coming to light. Most are trivial and can be easily overcome or simply ignored (*e.g.* inbound 73 messages to us are not always shown in the righthand pane, but they are highlighted in red as usual on the left). Some are potentially more significant blockers, such as:

Much of this is subjective: some of the things I call “flaws” and “bugs” and “issues” others call “as designed” and “not a problem”. Fair enough.

- The handling of “special” calls noted earlier;
- Inconsistencies, limited data-entry validation and other usability issues in the software;
- Limited consensus 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.

These and other concerns, plus test findings (such as ways to reproduce bugs), suggested workarounds and improvement suggestions in general are actively discussed on the [WSJT-X! reflector! on! Yahoo! groups!](#) By all means participate in the dialog. Be part of the solution.



¹⁰ Me included! My first FT8 QSO was made on July 21st 2017 and, although I had used JT65, JT9, RTTY and PSK before, and “packet radio” way back in the 1980s, and I work with computers, I am primarily a CW DXer not a digimoder. I’m definitely still learning, still making mistakes ... for which I humbly apologise.

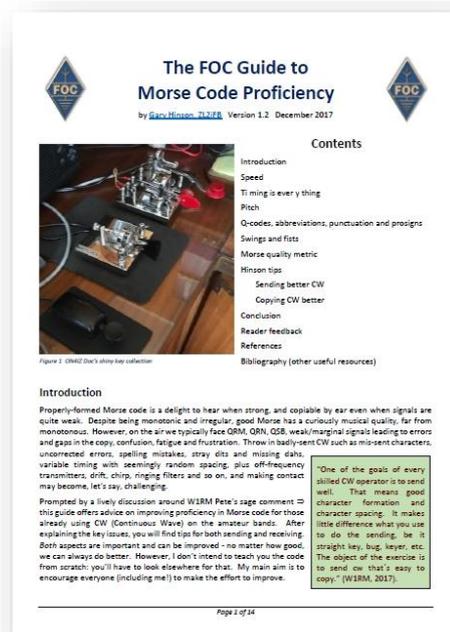
13 Close and acknowledgements

- 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 new 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 WSJT-X developers and long-suffering support crew on the reflector. I have collated, interpreted and expanded upon their inputs, drawing heavily on their inspiration. All the mistakes are mine!
- 13.3 Your feedback, corrections, improvement suggestions and further tips are very welcome. Please email me: Gary@isect.com I will *try* to maintain the online 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 I enjoy using my radio even more than the computer.

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



I am part of the team that developed and promotes the [DX Code of Conduct](#)



Find out more about me on G4iFB.com and QRZ.com

Appendix A: About FT8

FT8 is so new that a limited amount of technical information about the mode has been published on the web so far, other than 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: $79 \cdot 1920 / 12000 = 12.64$ 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.

One more source is the source itself, in other words the program source code for WSJT-X, 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>

Appendix B: FT8 - lifting 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 work in a fixed, predefined, mechanistic (=algorithmic!) way, squeezing as much useful information as possible into the few data bits exchanged in each over. In order to do that, they make some simplifications which, in turn, create the constraints that we live with.

Take a look at **section 17 of the WSJT-X help** for more details about the protocol. It mentions, for instance, that:

“Each message consists of two 28-bit fields normally used for callsigns and a 15-bit field for a grid locator, report, acknowledgment, or 73.”

So **there are just 28 digital bits to communicate a callsign**. 28 digital bits has 2 to the power of 28 possible values, which in decimal is a little under 270 million. 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 HF DXer will surely have come across some of them on air, on the legacy modes. ZL4RUGBY is one I remember fondly – that call is actually quite conventional in structure, but with 2 additional characters in the suffix beyond the 3 allowed for in the FT8 protocol. Oh-oh. 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 and other curious variants, some made up on the spot, 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, squeezed into just 15 digital bits** using compression. 15 bits is not enough to code all possible combinations of 4 Latin letters and Arabic numerals, which would require at least 36x36x36x36 values or 1,679,616 in decimal, more than 2 to the power of 20 ... in other words FT8 would be 5 bits short. No amount of pleading or complaining by those who want to re-purpose the grid square field to carry other information instead can squeeze more information into the 15 digital bits available under the current specification – the extra information simply won’t fit. The only realistic options are (1) to revise or replace the FT8 protocol, which is another kettle of fish entirely, or (2) use look-up tables to convert the 2 to the power of 15 possible “grid square” values into other things such as IOTA, SOTA or WWFF references, and somehow deal with the confusion this will create for those of us who stubbornly interpret them as grids.

Appendix C: 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 (depending on whether the ADIF import function skips the dupes).

Real-time log updating is a better approach, where capable logging programs receive and merge digimode QSO details broadcast by WSJT-X as TCP or UDP network datagrams whenever we complete and log a QSO in WSJT-X. It's only a one-way connection – QSO information flowing *FROM* WSJT-X *TO* the logging software in a matter of seconds – but it is automated and keeps the log current.

An even better approach would be closer integration of the digimode and logging functions: two-way connections between the digimode engine and logging program would make it easier, for example, to see any previous 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 would enable any "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 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 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 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. Some WSJT-X derivatives may extend the logging and awards tracking aspects.

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.

Appendix E: Simplex versus split FT8 use-cases

Use case A – simple Shared Working Frequency SWF QSO (“simplex”¹¹)

1000 Hz	Time slot	1500 Hz
Station A transmits	1	Vacant
Station B transmits	2	Vacant
Station A transmits	3	Vacant
Station B transmits	4	Vacant
Station A transmits	5	Vacant
Station B transmits	6	Vacant

Slots used = 6

Slots vacant = 6

Total slots = 12

Slot utilization = 50%

QSOs made = at least 1 (anyone else can use 1500 Hz to make QSOs)

Use case B – simple Different Working Frequencies DWF QSO

1000 Hz	Time slot	1500 Hz
Station A transmits	1	Vacant
Vacant	2	Station B transmits
Station A transmits	3	Vacant
Vacant	4	Station B transmits
Station A transmits	5	Vacant
Vacant	6	Station B transmits

Slots used = 6

Slots vacant = 6

Total slots = 12

Slot utilization = 50%

QSOs made = at least 1 (other stations can use the vacant slots, ideally DWF/split)

¹¹ Simplex is not the correct term, but it’s commonly used by hams to describe two or more stations alternately using the same working frequency. The correct term is half-duplex: see [Wikipedia](#).

Use case C – SWF QSO with SWF QRM (DX simplex pileup)

1000 Hz	Time slot	1500 Hz
Station A transmits	1	Vacant
Several stations transmit, QRM	2	Vacant
Station A transmits	3	Vacant
Several stations transmit, QRM	4	Vacant
Station A transmits	5	Vacant
Station B gives up!	6	Vacant

Slots used productively = 3 (or less)

Slots blocked by QRM = 3

Slots vacant = 6

Total slots = 12

Slot utilization = up to 25%

QSOs made = 0, possibly 1 if they are patient enough

Use case D – DWF QSO with SWF QRM (DX split pileup)

1000 Hz	Time slot	1500 Hz
Station A transmits	1	Vacant
Several stations transmit, QRM	2	Station B transmits
Station A transmits	3	Vacant
Several stations transmit, QRM	4	Station B transmits
Station A transmits	5	Vacant
Several stations transmit, QRM	6	Station B transmits

Slots used productively = 6 (or less)

Slots blocked by QRM = 3 (or more)

Slots vacant = 3

Total slots = 12

Slot utilization = up to 50%

QSOs made = at least 1

Use case E – SWF QSO with DWF ‘QRM’

1000 Hz	Time slot	1500 Hz
Station A transmits	1	Some other station transmits
Station B transmits	2	Some other station transmits
Station A transmits	3	Some other station transmits
Station B transmits	4	Some other station transmits
Station A transmits	5	Some other station transmits
Station B transmits	6	Some other station transmits

Slots used productively = 12 (or less)

Slots blocked by QRM = 0 (no effect aside from dirty signals and ALC pumping, perhaps)

Slots vacant = 0 (or more, if the other frequency is usable elsewhere)

Total slots = 12

Slot utilization = up to 100%

QSOs made = at least 1

Use case F – DWF QSOs interleaved

1000 Hz	Time slot	1500 Hz
Station A transmits	1	Station C transmits
Station D transmits	2	Station B transmits
Station A transmits	3	Station C transmits
Station D transmits	4	Station B transmits
Station A transmits	5	Station C transmits
Station D transmits	6	Station B transmits

Slots used productively = 12

Slots blocked by QRM = 0

Slots vacant = 0

Total slots = 12

Slot utilization = 100%

QSOs made = 2 (an idealized case)

Use case G – DWF QSO with SWF QSO QRM

1000 Hz	Time slot	1500 Hz
Station A transmits	1	Station C transmits
Vacant	2	Station B transmits
Station A transmits	3	Station C transmits
Vacant	4	Stations B and D transmit, QRM
Station A transmits	5	Station C transmits
Vacant	6	Station B and D transmit, QRM

Slots used productively = 7

Slots blocked by QRM = 2

Slots vacant = 3

Total slots = 12

Slot utilization = 58%

QSOs made = less than 1

Use case H – DWF call, SWF QSO (DWF caller immediately reverts to SWF)

1000 Hz	Time slot	1500 Hz
Station A transmits	1	Vacant
Several stations transmit, QRM	2	Station B transmits
Station A transmits	3	Vacant
Several stations transmit, QRM	4	Vacant
Station A transmits again	5	Vacant
Several stations transmit, QRM	6	Vacant

Slots used productively = 2

Slots blocked by QRM = 3

Slots vacant = 5

Total slots = 12

Slot utilization = 17%

QSOs made = 0, maybe 1 eventually

Use case I – DWF QSO, DWF QRM

1000 Hz	Time slot	1500 Hz
Station A transmits	1	Vacant
Several stations transmit, QRM	2	Station B transmits
Station A transmits	3	Vacant
Several stations transmit, QRM	4	Other stations transmit, QRM
Station A transmits again	5	Vacant
Several stations transmit, QRM	6	Other stations transmit, QRM

Slots used productively = 3

Slots blocked by QRM = 5

Slots vacant = 3

Total slots = 12

Slot utilization = 25%

QSOs made = 0, maybe 1 eventually

Use case J – DWF QSO, SWF+DWF QRM with QSY to clear frequency

1000 Hz	Time slot	1500 Hz	1800 Hz
Station A transmits	1	Vacant	Vacant
Several stations transmit, QRM	2	Station B transmits	Vacant
Station A transmits	3	Vacant	Vacant
Several stations transmit, QRM	4	Other stations transmit, QRM	Vacant
Vacant	5	Other stations transmit, QRM	Station A repeats response to B
Several stations transmit, QRM	6	Other stations transmit, QRM	Station B transmits
Several stations transmit, QRM	7	Other stations transmit, QRM	Station A transmits

Slots used productively = 6

Slots blocked by QRM = 8

Slots vacant = 7

Total slots = 21

Slot utilization = 29%

QSOs made = 1, eventually