# FT8 Operating Guide

Work the world on HF using the new digital mode

by Gary Hinson ZL2iFB   Version 1.19 April 2018

Note: this document is actively maintained. The latest version is at
www.g4ifb.com/FT8_Hinson_tips_for_HF_DXers.pdf

The FT8 Operating Guide
is now also available in
German and Czech.

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By [Gary Hinson ZL2iFB](#)   Version 1.19   April 2018

Recent changes to this document – just the 🆕 stuff

Version	Date	Changes
1.19	7 Apr 2018	Tip on halting transmissions, and one on working split *(tnx Gary AG0N)*.
1.18	20 Mar 2018	Minor amendments including the release of WSJT-X v1.9.0-rc3
1.17	7 Mar 2018	Added notes from the on-air fox-n-hounds test. Mentioned an FT8 QSO with a buoy.
1.16	6 Mar 2018	Added a note re compound-call hounds. New tips on working fast/slow stations and suppressing RF in the shack. German and Czech translations available *(tnx Ekkehard DJ5EJ and Zdenek OK2PAD)*.
1.15	3 Mar 2018	Added an example of a QSO hijack. Expanded on flaws, bugs and enhancement suggestions. New tip on resetting the 73 message *(tnx Jim ZL1LC)*.
1.14	28 Feb 2018	WSJT-X v1.9.0-rc2 released: more on fox-n-hounds. Added more QSO examples. Fixed yet another blasted typo! New tips on setting Rx frequency and bagging someone directing CQs at someone else. Generate std msgs needs a DX callsign.

1 Introduction

1.1 I have been steadily compiling these "Hinson tips" over the past few months, in the course of making thousands of 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 **F**requently **A**sked **Q**uestions on the WSJT-X reflector which I recommend joining. All of them draw on my 30 years of HF DXing.

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. 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 I urge you to contact me. Maybe together we can add further advice 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 after you have it running, not to set up your system up from scratch – sorry but there are too many situations and my knowledge is too limited to do justice to the initial software installation and configuration activities.

Important disclaimer

We are all individually responsible for complying with our licenses plus applicable laws and regulations 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 WSJT-X lets us do something does not necessarily mean it is legal and appropriate where we are. *Neither the team behind WSJT-X, nor the author of this guide, is responsible for your compliance.*
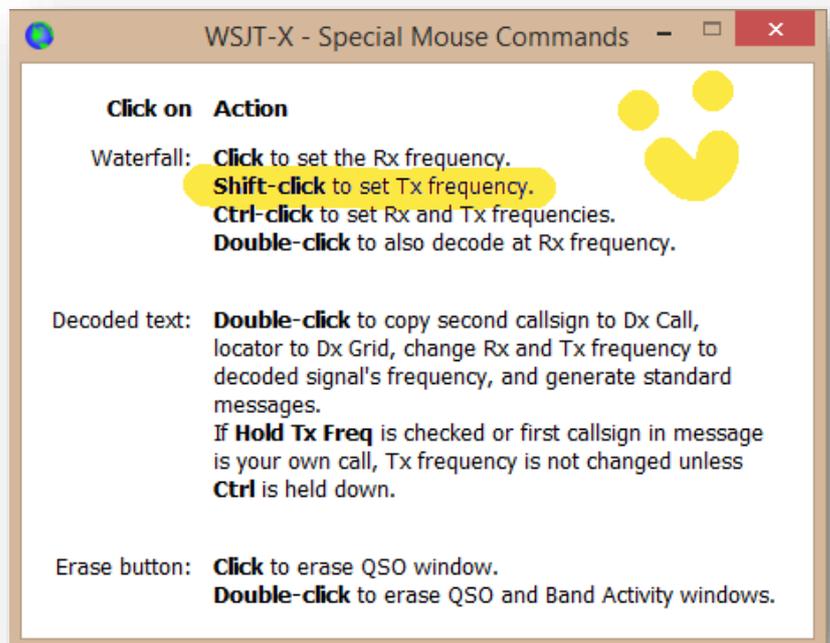
2 Start here

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 might say!). WSJT-X v 1.8.0 is the current production release, while v1.9.0 Release Candidate 3 is out now for beta testing.

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 beta 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 myself[1]. 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**.

Although not yet shown on the pop-up help, we can also **right-click** on the waterfall and then click the only option to set *both* Rx *and* Tx frequencies **right there[3].**

2.3 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.

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[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] Why we can't simply left-click to move the Rx and right-click to move the Tx in WSJT-X is beyond me. Seems much more intuitive. JTDX uses this scheme – try it out and see what you think.

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, 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.

Time.is

Your time is exact!
The difference from Time.is was -0.001 seconds (±0.014 seconds).

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 **N**etwork **T**ime **P**rotocol, 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 NTP.

> 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.
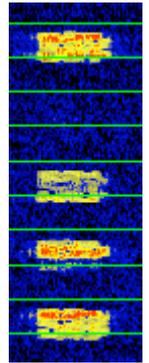
If Meinberg is beyond you, there are simpler programs such as BktTimeSynch by IZ2BKT, Dimension 4 or TimeSynchTool. You can even 'nudge' your clock forward or backward 50 milliseconds at a time using the Time Fudge utility by W9MDB.

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.

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

3.4   When trying to contact someone whose clock is wrong, it may help to advance or retard your system clock temporarily to reduce the discrepancy. You may notice their blobs don't line up with the horizontal timing lines on the waterfall. In this example → YD3BGM's CQ calls were decoded OK by WSJT-X v1.9.0-rc2 with a dT of -2.4 seconds (*i.e.* 2.4 seconds earlier than my system clock). On the headphones, I heard his tones starting well before others in the same timeslots.


```
012730    0 -2.3 1395 ~    CQ YD3BGM OI61
012745   Tx       1281 ~    YD3BGM ZL2IFB -01
012800    1 -2.3 1395 ~    CQ YD3BGM OI61
012815   Tx       1281 ~    YD3BGM ZL2IFB -01
012830   -1 -2.3 1394 ~    CQ YD3BGM OI61
012845   Tx       1281 ~    YD3BGM ZL2IFB -01
012900    4 -2.4 1393 ~    CQ YD3BGM OI61
```

First I called him several times without success, despite the path being open between us.

Guessing that he might be using an older version of WSJT-X 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, put the cursor


```
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
```

on 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, then clicked OK to set the clock. After

To move his blobs **up** the waterfall, I clicked the **up** arrow to adjust my clock the right way.

checking the decodes to see that his dT was now much less, I responded to his CQ call again and this time we completed a QSO easily. I closed with a free-text message "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.
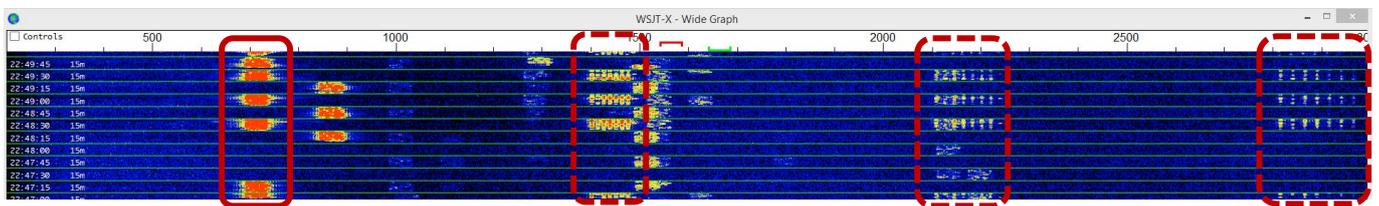
4   *Important:* transmit levels

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 spurii. **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 ringed in red to the left below), you may unknowingly be generating 'ghostly barcodes' (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 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.
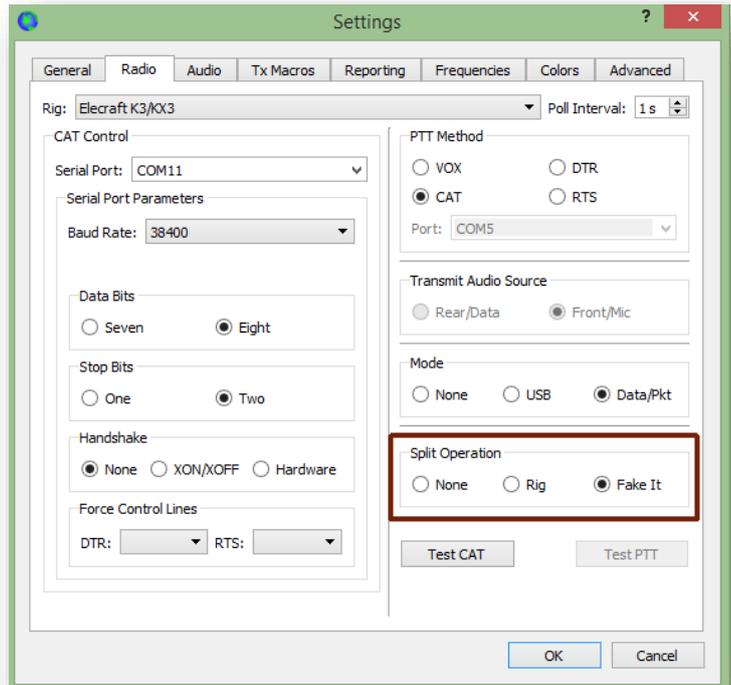
The Spinal Tap approach, also known as Mediterranean Syndrome ("All knobs to 11") will create more mayhem and complaints than FT8 QSOs.
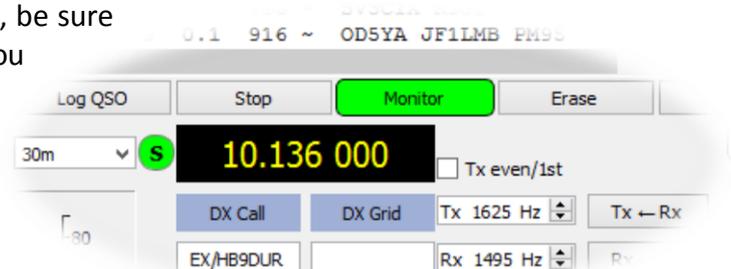
> With many FT8 stations using QRP, someone running, say, 100 watts or more stands out from the crowd … but not in a good way. Similarly, those running 50 watts to large beams: that's a lot more ERP than most.

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 green blob with **S** meaning *Split* between the band selector and frequency box in WSJT-X.

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*",
> *K1JT, K9AN and G4WJS, QST October 2017.*

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. 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 reception is kinda useful for DXin.

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!

> 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.

> Automatically report the callsigns you are decoding and their signal reports to PSK Reporter by selecting **F2 Settings → Reporting → Network Services → Enable PSK Reporter Spotting.** 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 G0HDB]*


```
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, **S**ignal-to-**N**oise **R**atios 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." *[Tnx Bill G4WJS]*

5 *Important:* receive levels

5.1 The bar graph audio level meter in WSJT-X 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 (**A**nalogue to **D**igital **C**onverter) that, in turn, reduce the ability to decode FT8 signals. You might even damage your sound card.

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!).
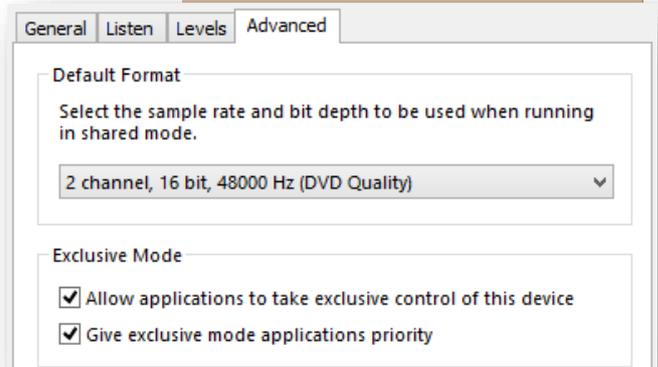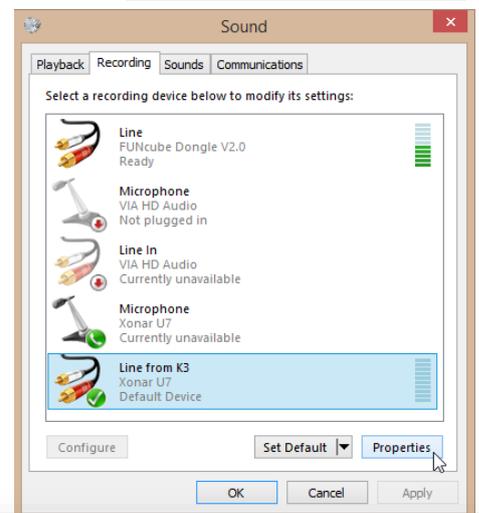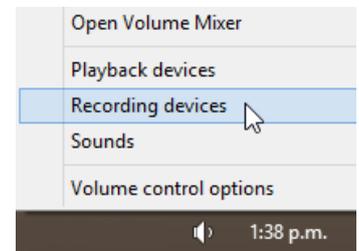
I suspect the WSJT-X bar graph was modelled on Star Trek's medical bay ☺

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 preferred sampling rate for WSJT-X. The *default* default rate is often 44100 Hz (CD Quality) which can create resampling errors and degrade decoding - best avoided if 48000 Hz works.

- Click **OK** and **OK** again to exit the Windows sound settings.

- Launch WSJT-X if it is not already running[4]. 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.

> 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.

- 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*.

> 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 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 dB[5], still in the green, and after a period or two you should see some decodes appear.

> If there is so much band activity that the bar graph is above 70 dB and going red, turn off the radio's preamp, turn on the attenuator and/or reduce the RF gain to bring the levels 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'.

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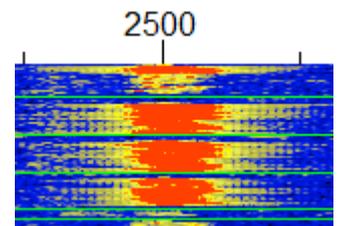
[4] If your radio has a built-in sound card and USB interface, you won't be able to use the sound card while the radio is switched off … but to simulate no audio input, maybe you can tune to a dead band and disconnect your antenna? [*Tnx for the tip Andrew VE3AND*]

[5] 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.
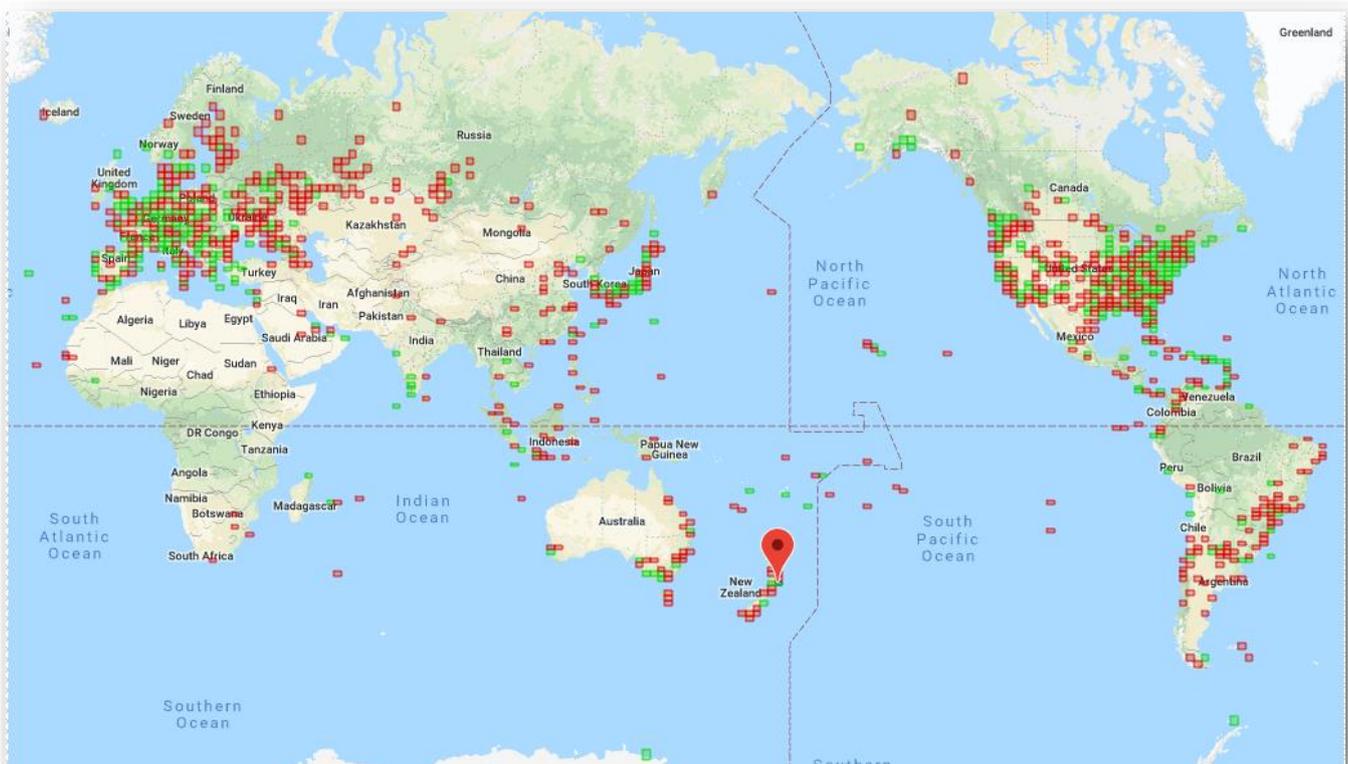
> When conditions are favourable, I've often seen genuine QRP DX signals showing plenty of red on my FT8 waterfall. Remember, FT8 is *designed* for weak signal DXing.

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

> There are more tips about using your filters and AGC below.

> "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 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 box[6].

> If you can't find the **Hold Tx Freq** option, are you perchance running a Release Candidate (beta test) 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) **N**orth **A**merican **V**ery **H**igh **F**requency 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 tinkering with random 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." *[tnx Bill, G4WJS]*

> "The new FT8 digital operating mode is ideal for the ARRL International Grid Chase. You can set up FT8 to call CQ and automatically respond, completing a contact in a little over a minute while you watch. When the contact is complete, simply click your mouse to trigger another CQ."
>
> *ARRL press release about the International Grid Chase*
> *December 2017*
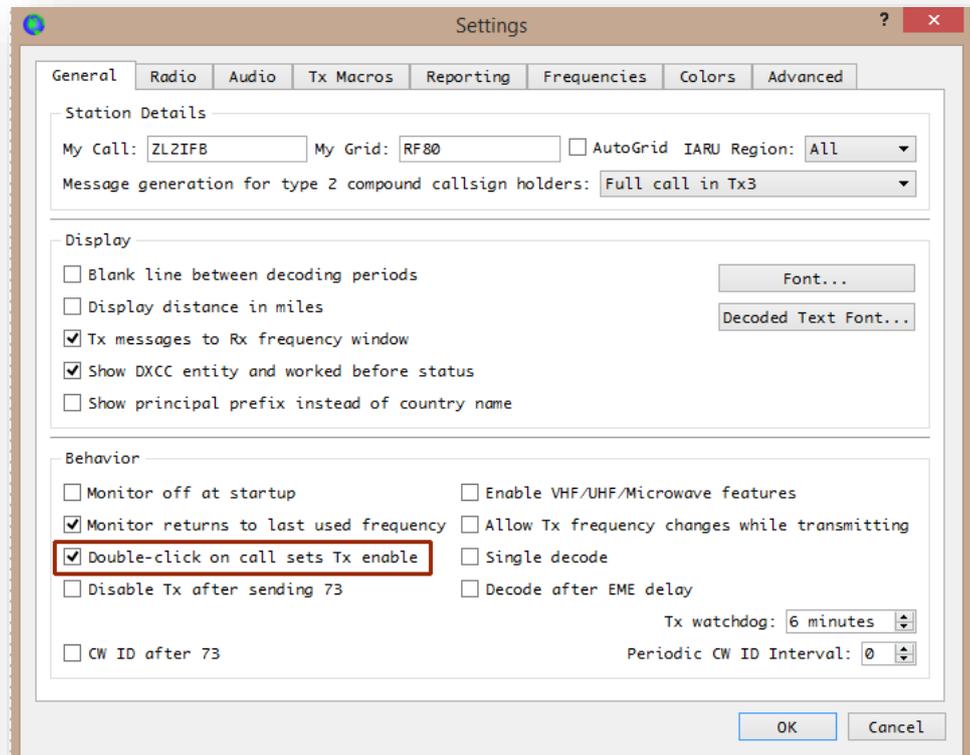
---

[6] 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 respond to a CQ

7.1 First set things up:

- 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;

- 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 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.

> 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 E used this option.

7.2   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.

> To encourage split callers, some people use "CQ UP". They don't mean it literally – up or down is fine, just don't call them simplex please.

> **NEW** "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."
>
> *Gary AG0N*

7.3   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 **R**eceived 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.

7.4   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 M0NKR"), 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[7], and click **Enable Tx** to start calling him. It's awkward, and a reminder not to get too fancy with your CQ calls.

7.5   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 (at present) there is no way to revert automatically to your previous Tx frequency if you **shift-click** yourself somewhere new.

---

[7] 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!
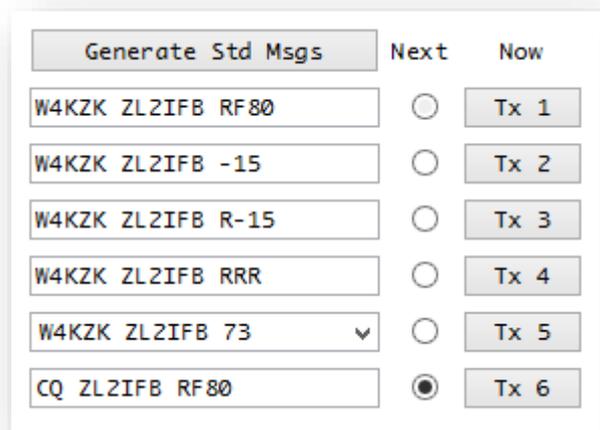
8   How to call CQ

8.1   Hopefully by now you have your system working on receive and transmit. Get ready to call CQ by:
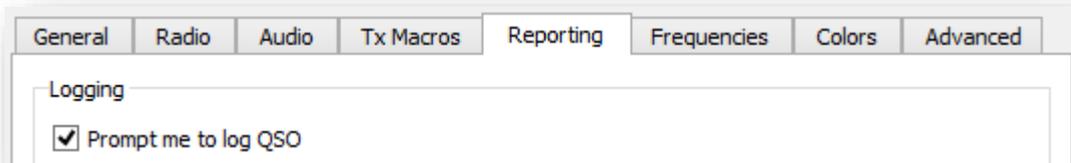
- Setting the **Hold Tx Freq**, **Auto Seq** and **Call 1st** options on the WSJT-X main window;

- Clicking the Tx 6 message box or button, or hitting **F4**, to select your CQ message if not already selected (look for the *Next* selector blob →).

8.2   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.

8.3   When someone responds to your CQ, **Auto Seq** takes you though the conventional QSO sequence, automatically.   It sets up the messages with both callsigns, and sends

> WSJT-X can only '**generate std msgs**' if you double-click a decoded message, or enter a callsign into the DX Call box: otherwise it can only generate Tx 6, the CQ message with your own call, assuming you have configured it under **F2 Settings → General** tab.

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 *un*set[8], 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.

---

[8] 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 v1.8.0. I find it inconsistent and disconcerting to discover that the **Call 1st** option affects the *end* of QSO behavior. Maybe it's just me.

8.4 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 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, 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.

8.5 **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.

8.6 Directed CQ calls can be made by editing the Tx 6 message in the format "CQ xx ZL2IFB RF80" where xx is an arbitrary two-character indication of the location you are calling *e.g.*:

- A continental indicator such as AF, AS, EU, NA, OC or SA

- A state indicator such as VA or RI

- A country prefix such as PY, JA, 5B or VK

- Some other widely used code such as DX[9], UK or US

You can only specify one location per message, and you only have two characters.

If recipients double-click a valid CQ message, their systems respond to the call *regardless* of their locations. A lot of hams evidently don't read or don't care about directed CQ calls, responding even if they are nowhere near the specified location. It is up to the CQer, then, to decide whether to complete the QSO with them or wait for a call from someone in the specified location.

> You can easily change Tx 6 to include some other string (*e.g.* CQ PAC, CQ VK ZL, CQ ND SD or CQ IOTA) but doing so changes it into 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.

> **Call 1st** will automatically initiate a QSO with anyone from anywhere who responds to your call: if you *only* want to QSO the specified location, turn off **Call 1st** and double-click the specific callers you want to work, ignoring the riff-raff.

8.7 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. If you do not receive a 73 from the other party, tough: perhaps it got lost en route, swallowed up by the ionosphere.

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[9] DX means whatever the sender thinks it means. There is no formal or universal definition. Oh HF, it *may* be 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!

8.8 **New** The **Halt Tx** button takes effect immediately – 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 right at the end of the transmission or wait until the receive period – click it whenever you like.

> When you want to take a break, de-select **Enable Tx** at any time during or following your final CQ call. If you can, keep an eye on the screen for a while longer for any late responses.
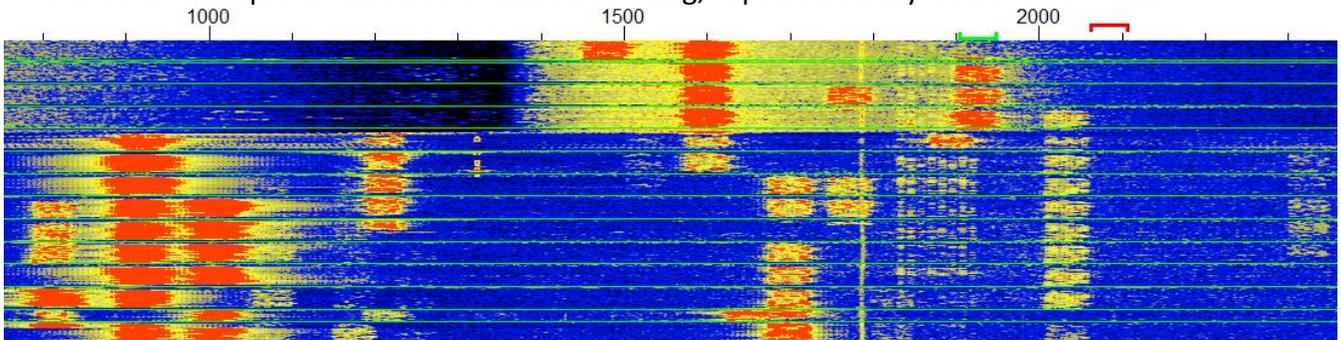
9 General/miscellaneous FT8 operating tips

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, NU0C).*

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, causig 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 Messages appear in the left and right hand windows in whatever 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.

9.3　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. 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. As Hasan N0AN 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 →

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.

> 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.*

> 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 an over or two simplex to let them know the frequency is in use. *[Tnx tip Olaf DK2LO]*

9.4　Higher transmit frequencies towards the right of the waterfall are *slightly* advantageous for two reasons:
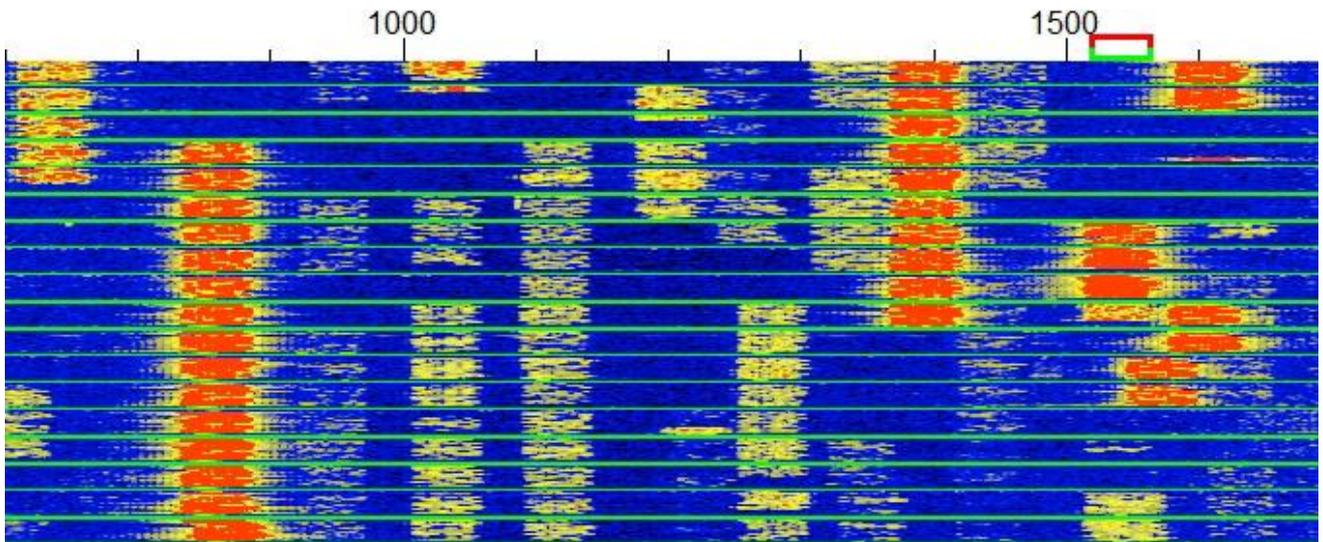
(1) harmonics caused by overdriving something in the audio chain are more likely to be blocked by your rig's filters [don't rely on this though! Keep your audio level down!]; and

(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 pane[10]. However, don't go too far to the right of the waterfall →

> Spare a thought for 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!

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

9.5 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 prefet to avoid getting too close to strong signals such as the one at 830.

> You may need to shift your TX every few minutes on a busy band if other stations encroach on you. Keep an eye on the waterfall.

9.6 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.

9.7 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.

9.8 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.

9.9 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 take a quick screenshot first, 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 AG0N]*

9.10 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.

9.11 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 fast setting. Consider using your rig's filters too.

9.12 *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.

> 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.

9.13 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!

9.14 ... 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.

9.15 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.
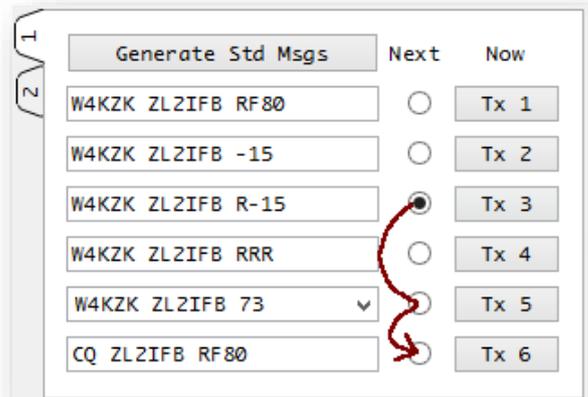
> If you find your Tx being "pulled" around, check that **Hold Tx Freq** is selected.

9.16 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...'.

> These toggles work on Tab 1. If you use Tab 2, switch to Tab 1 to toggle then return to Tab 2.

9.17 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 Tx4 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".
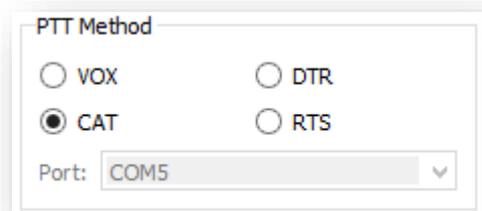
> Since many of us are using QRP, it might be nice to use RR72 to indicate that, in the same way as some QRPers sign-off 2-way QRP legacy mode QSOs by exchanging 72's. It might also remind others to keep their power down, where possible. That would however require a change to WSJT-X.

9.18 At the end of a QSO, have you noticed the bouncing ball? After someone sends us their RRR or RR73 message, the "Next" message selector blob sometimes jumps from Tx 3 to Tx 5 … but then in a blink of an eye bounces on to Tx 6. If you are not paying attention, you might think your 73 message has been skipped and WSJT-X is CQing for you, but no: check the status bar at the bottom of the WSJT-X main screen to confirm that your 73 message is being transmitted then appears in the "Last Tx" box.

9.19 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
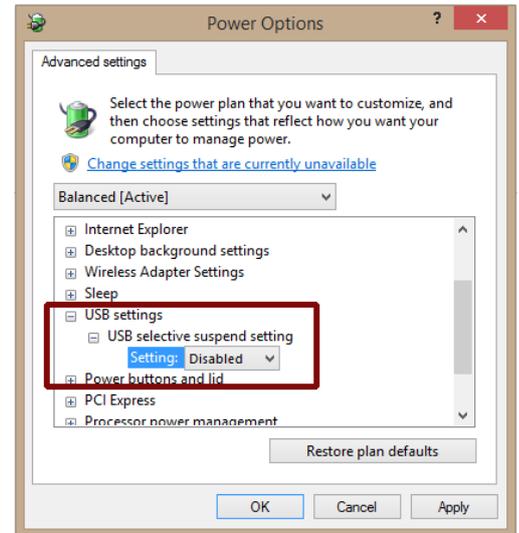
it is actually generating tones, then figure out why the audio isn't getting to the radio. Is the cable broken? Is it plugged in, to the right places?

- 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*, unselect "Allow the computer to turn off this device to save power" for each of your USB devices and hubs.
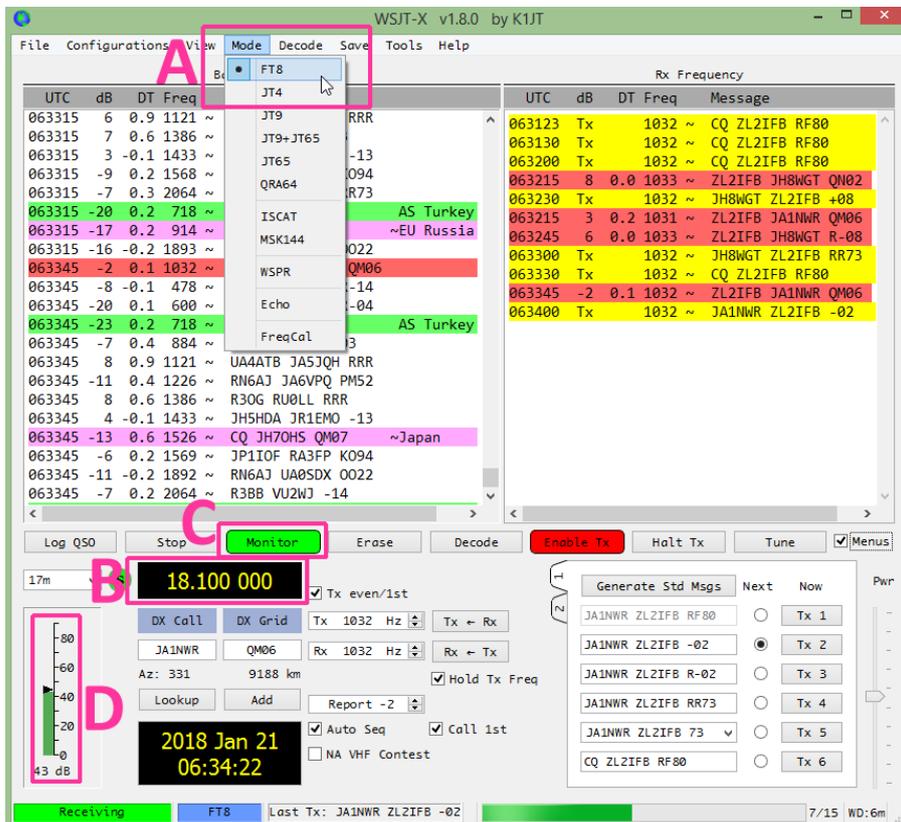
Also in *Power Options* under *Control Panel*, disable the *USB selective suspend* →

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

(A) WSJT-X is set to **FT8 mode** *[tnx tip Jacky ZL3CW]*;

(B) You are on a designated **FT8 frequency**, on a band that is open and active;

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

(D) 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 and red blobs on the waterfall? Is the rig on the right mode and antenna? Can you hear the *weeeeeee* of FT8 signals on your receiver? Is the rig on? FT8 is a *weak-signal*, not a *no-signal* mode!
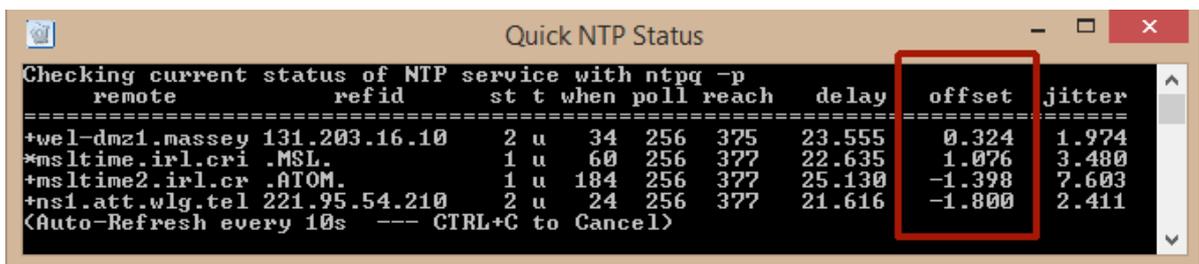
9.21 The stock DXing advice to LISTEN, LISTEN, **LISTEN** applies equally to FT8 and other digimodes, well almost: I normally have the Rx audio turned right down, the headphones sitting on the desk, so the

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.

9.22 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.

9.23 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:

- 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 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. Hug a stranger. Tidy the cave. Email Gary with even more tips.

9.24 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, capitals, spaces and a few punctuation characters)[11]. 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 v1.8.0, 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.[12]

> 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.*
>
> ```
> CHK TX AF LVL
> CHK UR CLOCK
> G4IFB.COM 73
> NO DECODE SRI
> OUCH LOUD 73
> PLS EMAIL ME
> QRM PLS QSY
> SRI FNGR TRBL
> TNX NEW 1 73
> TNX GRID 73
> TNX QRX 73
> TRY HOLDTX 73
> TU LOGGED 73
> UPD8 WSJTX 73
> ```
>
> and perhaps TNX TIPS GARY

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 - although clued-up

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

and patient ops can continue conversing using 13-character free-text messages indefinitely, holding back on the 73 until the conversation is ending.

---

[11] 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.

[12] WSJT-X v1.8.0 RC1 interprets RR73 as a grid square. According to John, KA5BJC, RR73 is in fact a valid grid … 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!

9.25 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.
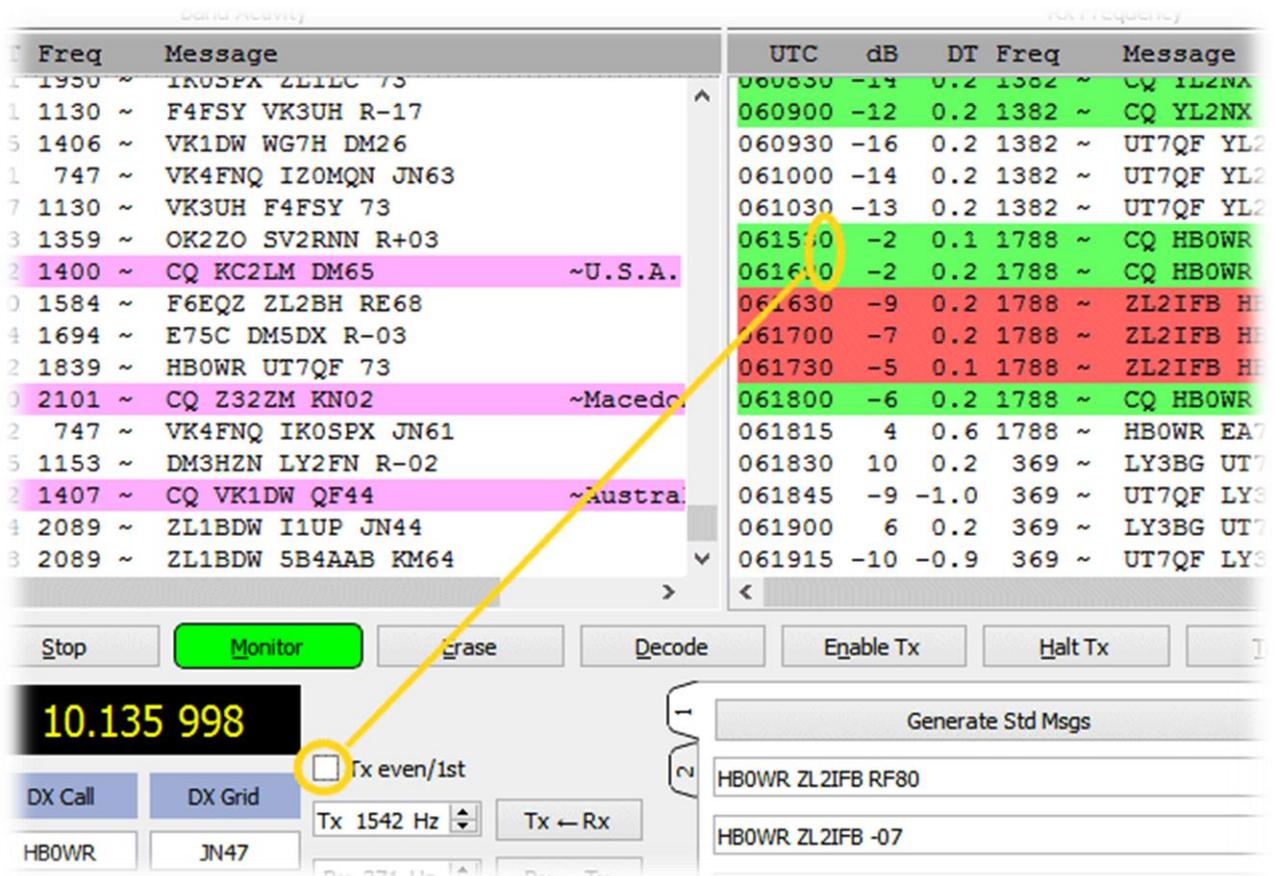
9.26 With so little information exchanged in each 15 second over, a sequence of even the most efficient and succinct QSOs in FT8 hardly qualifies as running - more of a jog. The pace is easy enough once you get the hang of it (it took me a few hundred FT8 QSOs). Here's a screenshot during a leisurely 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.

9.27 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:

9.28 **NEW** 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 getting radiated – ideally with a short run of low-loss feeder and an efficient well-matched antenna (ideally without the 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.

> 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, having fun learning and trying new tricks. It's not only about bagging the catch – enjoy the chase!

- Be patient and persistent yourself.

9.29   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. Another approach is to double-click his decodes, which sets up the messages and often starts calling him (unlss you hurriedly click **Halt Tx**). Yet another way is to type the audio frequency listed on his decodes into the Rx frequency box on the main WSJT-X screen[13] or if you are close already, 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*.

9.30   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, if they are feeling generous, they may well respond to you at a time that suits them;

- Patiently wait and watch. If they stop CQing, or drop the specified target, pounce: call them.

---

[13] 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.

9.31 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 →
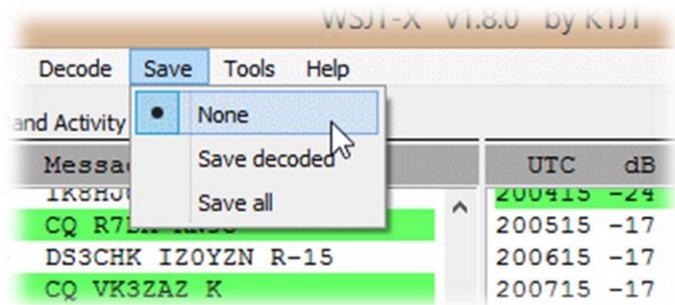
To do this for yourself, the Windows PowerShell command line is:

powershell.exe get-content %LOCALAPPDATA%\WSJT-X\wsjtx.log -tail 3 -wait
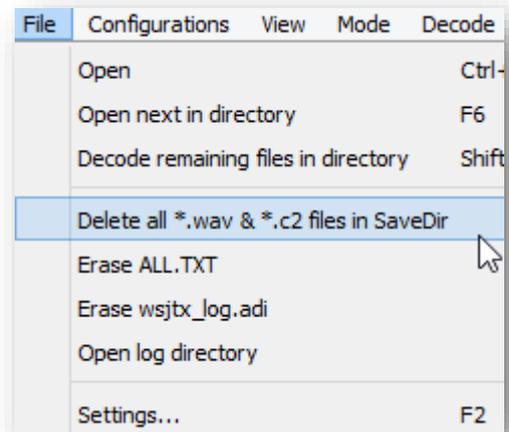
Courtesy of VE2EVN, the Linux equivalent is:

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

9.32 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.
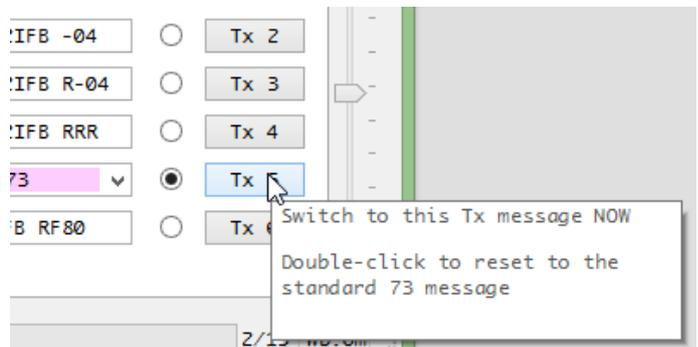
It's worth clearing out the orphans from time to time, either manually (using the housekeeping function on the **File** menu →) or using a simple batch file with the following Windows command line (perhaps the very same batch file that displays the end of your WSJT-X ADIF log):

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

9.33 If you change your mind or mess up your typing while 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 that message if you are transmitting a different message at the time, and offers to log the QSO.
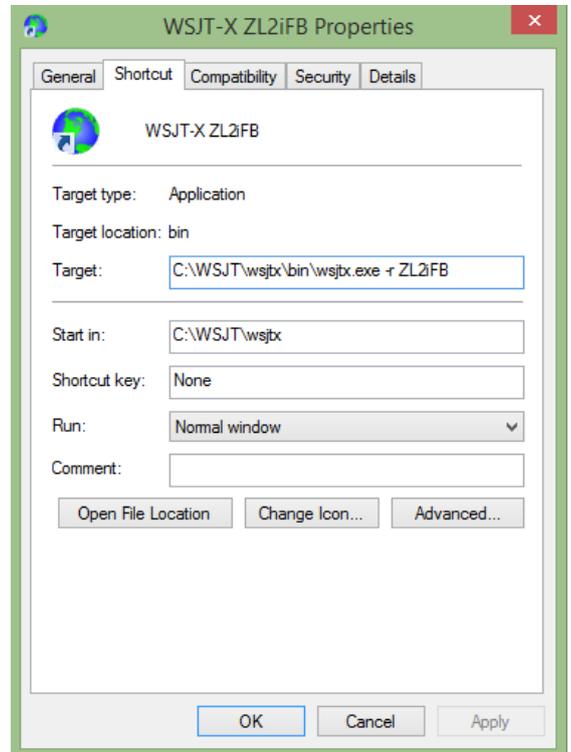
9.34 Different amateurs sharing the same station can set up personal WSJT-X profiles to suit themselves, using the **-r [name]** command line modifier originally intended for using alternative rigs with different settings. [Name] is just a handy label for the profile, such as the callsign.

For example, if I launch WSJT-X using **WSJT-X -r ZL2iFB** it sets up a 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 profle 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 →

9.35 **New** 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 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 chokes[14] on the PC cables. Split-core clamp-on chokes are easy to fit[15]. Physically routing the cables, and perhaps re-siting the whole computer, further away from your radio, amp and feeder may help too.

> While you mess around with earthing, baluns and clamp-on chokes, order some good quality 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..

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[14] Choose an HF-rated ferrite mix with an A_L value of at least 2,000 to add enough inductance per turn. VHF ones are cheaper (maybe free!) but make little difference at HF.

[15] The larger cores, including circular toroids, are better as you can pass the cable through them several times. The choking inductance increases according to the number of turns *squared e.g.* 2 turns have 4 times the inductance of 1 turn.

10 Special callsigns
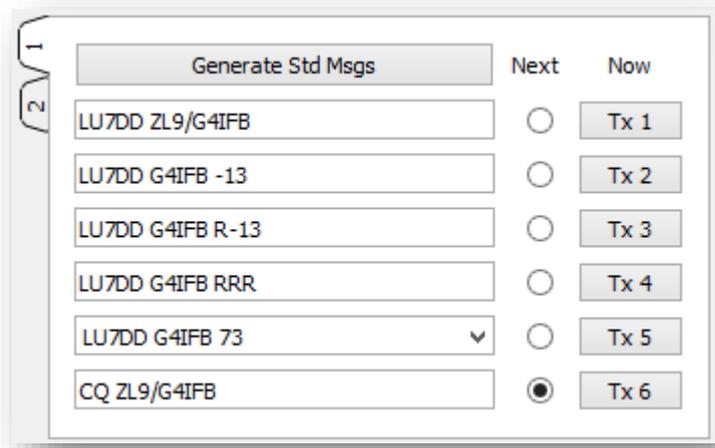
10.1 Deep within the technical specification of the FT8 protocol itself, the format of "standard callsigns" is defined quite specifically and narrowly. This reduces the variety of callsigns that the protocol needs to handle, hence limiting the number of digital bits required to code them. However, some **special event and commemorative calls** are so "special" that the FT8 protocol simply cannot accommodate them within the 28 bits reserved for 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 as standard messages, only as free-text 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." *[Extract from section 17 of the WSJT-X help file – well worth reading!]*

10.2 Non-standard special-event and other callsigns up to 13 characters long can be transmitted as character strings in free-text messages … but they are *not* interpreted by the software as callsigns. On the receiving end, 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. 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 fundamental 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!

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 the generated messages for a typical QSO would be like these →

The list of prefixes and suffixes that are treated in this way is available from the **Help** menu on the WSJT-X main screen (enable **Menus** to see it!):

```
Type 1 Prefixes and Suffixes:

1A    1S    3A    3B6   3B8   3B9   3C    3C0   3D2   3D2C  3D2R  3DA   3V    3W    3X
3Y    3YB   3YP   4J    4L    4S    4U1I  4U1U  4W    4X    5A    5B    5H    5N    5R
5T    5U    5V    5W    5X    5Z    6W    6Y    7O    7P    7Q    7X    8P    8Q    8R
9A    9G    9H    9J    9K    9L    9M2   9M6   9N    9Q    9U    9V    9X    9Y    A2
A3    A4    A5    A6    A7    A9    AP    BS7   BV    BV9   BY    C2    C3    C5    C6
C9    CE    CE0X  CE0Y  CE0Z  CE9   CM    CN    CP    CT    CT3   CU    CX    CY0   CY9
D2    D4    D6    DL    DU    E3    E4    EA    EA6   EA8   EA9   EI    EK    EL    EP
ER    ES    ET    EU    EX    EY    EZ    F     FG    FH    FJ    FK    FKC   FM    FO
FOA   FOC   FOM   FP    FR    FRG   FRJ   FRT   FT5W  FT5X  FT5Z  FW    FY    M     MD
MI    MJ    MM    MU    MW    H4    H40   HA    HB    HB0   HC    HC8   HH    HI    HK
HK0A  HK0M  HL    HM    HP    HR    HS    HV    HZ    I     IS    IS0   J2    J3    J5
J6    J7    J8    JA    JDM   JD0   JT    JW    JX    JY    K     KG4   KH0   KH1   KH2
KH3   KH4   KH5   KH5K  KH6   KH7   KH8   KH9   KL    KP1   KP2   KP4   KP5   LA    LU
LX    LY    LZ    OA    OD    OE    OH    OH0   OJ0   OK    OM    ON    OX    OY    OZ
P2    P4    PA    PJ2   PJ7   PY    PY0F  PT0S  PY0T  PZ    R1F   R1M   S0    S2    S5
S7    S9    SM    SP    ST    SU    SV    SVA   SV5   SV9   T2    T30   T31   T32   T33
T5    T7    T8    T9    TA    TF    TG    TI    TI9   TJ    TK    TL    TN    TR    TT
TU    TY    TZ    UA    UA2   UA9   UK    UN    UR    V2    V3    V4    V5    V6    V7
V8    VE    VK    VK0H  VK0M  VK9C  VK9L  VK9M  VK9N  VK9W  VK9X  VP2E  VP2M  VP2V  VP5
VP6   VP6D  VP8   VP8G  VP8H  VP8O  VP8S  VP9   VQ9   VR    VU    VU4   VU7   XE    XF4
XT    XU    XW    XX9   XZ    YA    YB    YI    YJ    YK    YL    YN    YO    YS    YU
YV    YV0   Z2    Z3    ZA    ZB    ZC4   ZD7   ZD8   ZD9   ZF    ZK1N  ZK1S  ZK2   ZK3
ZL    ZL7   ZL8   ZL9   ZP    ZS    ZS8   KC4   E5

Short-list of Add-on Suffixes:    /0 /1 /2 /3 /4 /5 /6 /7 /8 /9 /A /P
```

Those specific "type 1" prefixes and suffixes (about 350 of them) are presumably specially encoded and sent in as few bits as possible, allowing two callsigns to be included in the generated messages[16], whereas some unlisted "type 2" compound calls (such as /M, /MM and /W3) may be sent without the other callsign in some messages.
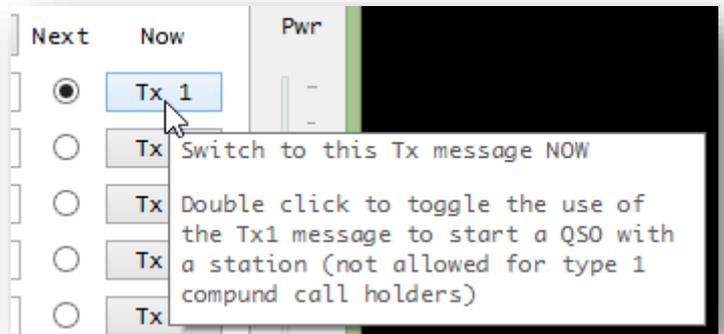
As I said a moment ago, strange special-event callsigns plus those with self-assigned made-up suffixes (such as /QRP) *cannot* be encoded as callsigns in FT8 (insufficient bits!) and hence can only be sent as uninterpretable character strings in free text messages. I call these "type 0" callsigns ☺

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 see what happens – and please let me know!

---

[16] WSJT-X v1.8.0 doesn't *always* get this quite right. See my FT8 QSO with YV5IAL/7 at the end of Appendix E.

10.4 Early 'release candidate' rc (beta) versions of WSJT-X reportedly had problems with their handling of compound calls … hence this is another good reason to check that you are using the released production version of WSJT-X, or a recent rc ("arsey") version. However, even the production version has problems, for example allowing us to skip message Tx 1 when calling a compound call user.

The pop-up message on Tx 1 states, ambiguously, that deselecting Tx 1 is 'not allowed' → … whereas the software allows it in fact. Evidently the pop-up actually means 'do not do this', an instruction to the operator, not a description of its behaviour.

If some krazy fool skips Tx 1 and calls a station with a compound callsign using Tx 2, their **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.

Do not skip Tx 1 when calling someone using a compound callsign.

Anyway, regardless of the message a caller sent, I believe WSJT-X should *always* state the callsign of the particular station being worked in the first message when initially responding to a caller, otherwise callers do not know if they are in QSO or not.

"A caution to those of us who often bypass the Tx 1 message (calls and grid) and start with Tx 2 (calls and report). When calling a DX station with a complex 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 complex callsigns, is to start with the Tx 1 message." *[tnx Rick K1HTV]*

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 with WSJT-X is about 60 QSOs per hour.

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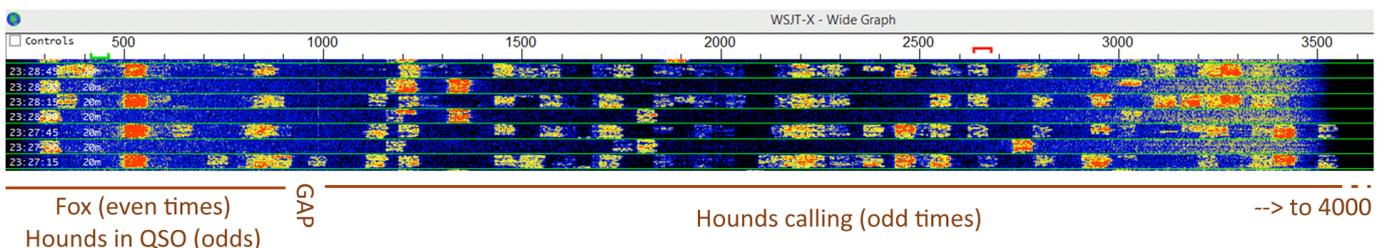
> A competitive CW, SSB or RTTY op on a good station can sustain a rate of 200+ QSOs per hour, maybe 250 or more for a similar level of operator effort - so that's potentially 4 or 5 times as many DXpedition QSOs per hour using legacy modes.

11.2 It is feasible for a single transmitter to generate multiple FT8 signals simultaneously, allowing for multiple QSOs in parallel on one rig and band, using new features introduced with WSJT-X v1.9.0-rc2 – a Release Candidate version made available at the end of February 2018 for beta testing. WSJT-X v1.9.0-rc2 incorporates a special **DXpedition mode** with changes for both the DXpedition station (the fox) and their callers (the hounds).

> We will see how it works out for real with the KH1 Baker Island DXpedition in mid-2018!
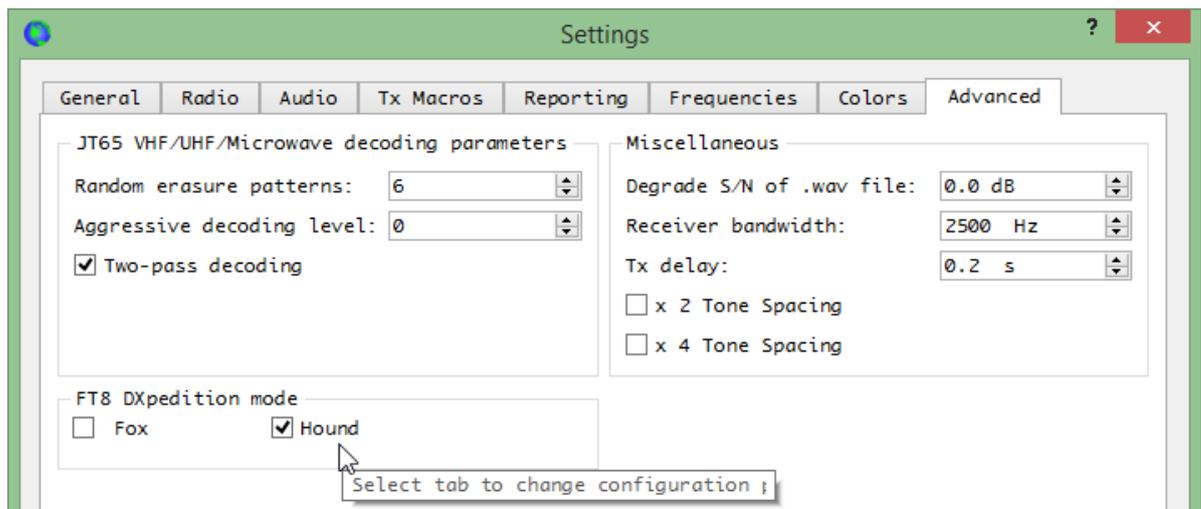
11.3 To use DXpedition mode:

- Install, run and configure a recent version of WSJT-X (v.1.9.0-rc2 or later). Get it running properly, 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.* 14.080 (*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 separate configurations if that helps).

- When the DXpedition is on the air, expand the band coverage of your waterfall to view from 300 to 4000 Hz *e.g.* using 3 Bins/Pixel and start at 200 or 300. Although your rig's bandwidth may not cover the entire range, 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 right[17].

Fox (even times)
Hounds in QSO (odds)
GAP
Hounds calling (odd times)
--> to 4000

---
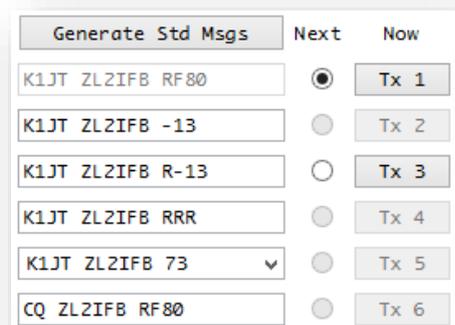
[17] With my K3, the waterfall blanks out just above 3500, even with the K3 data mode filter bandwidth set to 4.0 kHz.

- Select *Hound* on the **F2 Settings → Advanced** tab (unless you are the fox *on* the DXpedition!).

- In DXpedition mode, the *Band Activity* left hand pane only shows decodes up to 1000 Hz, in other words the fox and the hounds he is working. Hounds still calling him can be seen on your waterfall above 1000 but you don't see their decodes. The fox does, of course.

- In DXpedition mode, most of the usual message selectors are greyed-out, 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.

- 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 may ignore you).

- Shift-click to set your transmit frequency (the red goalpost) on a reasonably clear column on the waterfall between 1000 and 4000 Hz.

NEW "Currently compound callsigns are not supported for hound callers in FT8 DXpedition mode" *[tnx Bill G4WJS]*

- Wait and watch patiently until you see the fox transmitting. You may see his single CQ call, or several signals as he makes QSOs with up to 5 hounds in parallel. Fox decodes may include concatenated messages like this →   Here the fox is completing a QSO with NA7TB and, at the same time, sending a report to K5EK.

- Once you are copying the fox on most if not all his overs, double-click one of his decodes to set things up and start calling him. *If you cannot copy the fox (i.e. no fox decodes), too bad. DO NOT CALL HIM as you will simply create QRM.* Even if by some miracle he responds to you, you won't see his response so you will keep on calling. Try turning your beam or using another

antenna. Try another band. Do the sunspot dance. Make a cup of tea. Or simply wait patiently like a good DXer, watching the screen like a hawk (a feathered hound!).

- In DXpedition mode, the watchdog timer will automatically disable your transmissions after 4 minutes (8 calls) without a response … however, if the fox responds to you later on, transmission is automatically re-enabled to send him his report, completing the QSO when he acknowledges it with his RR73 message back to you. Use the breaks wisely. Check that your chosen Tx frequency remains clear, or QSY to another. Adjust your power if necessary.

- If the fox responds to your call with his Tx 2 message (your callsign and report), your system will QSY to a randomized frequency below 1000 Hz to send him your Tx 3 message (both callsigns, R and his report). It will continue sending Tx 3 until the fox acknowledges receipt with his Tx 4 message (your callsign and RR73). If he doesn't seem to be receiving you, is your Tx frequency busy with other callers? Try shift-clicking your Tx to a different, clear frequency below 1000 Hz.

- In DXpedition mode, it seems info from decodes is not sent out onto the network via UDP. The UDP output resumes as normal when you leave DXpedition mode …

- After you work and log the fox, don't forget to de-select *Hound* under **F2 Settings → Advanced** and resume using the normal FT8 frequencies[18] … unless you are hunting the fox on another band next. Take a moment to celebrate the wonders of weak-signal digimode DXing!

---

[18] Re-select the **Hold Tx Freq** option after entering and leaving DXpedition mode. Due to a minor bug in WSJT-X v1.9.0 RC2, it is de-selected.

12 Flaws, bugs and improvement suggestions

12.1 Although WSJT-X has been around for more than 5 years, FT8 is less than a year old, hence the amateur community[19] 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.
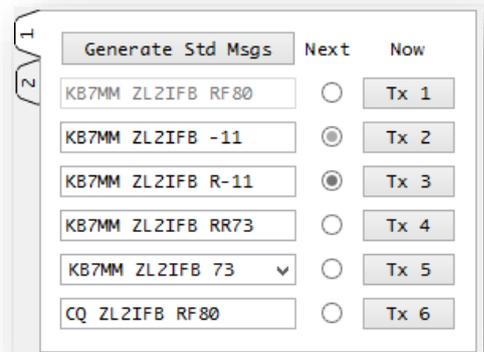
12.2 Flaws in the design of FT8 and WSJT-X, software/programming bugs and problems with our on-air operating conventions are coming to light. Most are trivial and can be easily overcome or simply ignored (*e.g.* in v1.8.0, inbound 73 messages to us were not always shown in the righthand pane, but they were always highlighted in red on the left). Some are potentially more significant blockers, such as:

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

- The handling of "special" calls noted earlier;

- Inconsistencies and awkwardness in the User Interface (more below);

- 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.

12.3 Inconsistencies, limited data-entry validation and other usability issues in the software include:

- Sometimes auto-responding to callers even when **Call 1st** is *not* selected;

- Sometimes ignoring double-clicks on decodes rather than setting up the messages and responding to someone as expected;

- This rare but not unique sighting of ambiguous radio/selector buttons (spotted originally in v1.8.0 and again in v1.9.0-rc2) →

- No feedback to the user when entering or editing a free text message that goes beyond 13 characters;

- 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;

- 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, with no ability to sort by frequency, call 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);

---

[19] Me included! My first FT8 QSO was made in July 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.

- The rig QSYs to the band last used in WSJT-X when the program starts, rather than simply reading the current frequency and mode from the rig;

- 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;

- 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 rather than Tx 1;

- 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 highlit in some way, even when he was not actually working us. This might be useful also in non-DXpedition mode;

- Various other issues (*e.g.* confusing colours, low-contrast sliders, missing screen-tips *etc.*).

12.4 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 **U**ser **I**nterface changes on a multiplatform system, be prepared for your UI-related feedback to be ignored or robustly rejected: essentially, UI matters are unwelcome distractions.

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 WSJT-X: 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 could also be used for telematics (*e.g.* remotely monitoring and 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 leave, 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 WSJT-X software have been suggested from time to time *e.g.*:

- Using the 2 'spare' bits to increase the amount of useful information carried in each message *e.g.* allowing a greater variety of callsigns, or codes such as IOTA and SOTA references and context exchanges, or Q-codes such as QRM, QRZ, QSX, QRX and QRT;

- Using one of the 'spare' bits as a flag denoting "Message continues", allowing free-text message to be chained together on transmit and reassembled on receipt;

- Combining the audio streams from separate antennas and receivers (diversity reception);

- A simple "go back" function to un-do a QSY, returning to the previous frequency;

- Enhancing WSJT-X's logging and lookup capabilities.
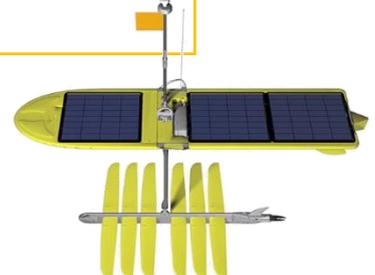
Aside from the substantial effort required to specify, code, test, debug and document such changes, there are other issues to consider:

- 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: users who fail to upgrade promptly when new software releases are available may find their software does not decode and respond as expected to FT8 messages generated by newer releases, and *vice versa*;

- 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 baby.

> Here's an ordinary-looking 20m FT8 QSO extracted from my ALL.TXT:
>
> 035400 -5 1.6 656 ~ CQ KH6JF/MM CK19
>
> 180220_035415 Transmitting 14.074 MHz FT8: KH6JF ZL2IFB RF80
>
> 035430 -6 1.6 656 ~ ZL2IFB KH6JF -06
>
> 180220_035445 Transmitting 14.074 MHz FT8: KH6JF ZL2IFB R-06
>
> 035500 -4 1.6 656 ~ ZL2IFB KH6JF RRR
>
> 180220_035515 Transmitting 14.074 MHz FT8: KH6JF/MM 73
>
> 035530 -6 1.6 656 ~ DE KH6JF/MM 73
>
> Unremarkable … until you realise that KH6JF/MM is HF Voyager, an autonomous robotic station on a scientific/experimental buoy floating East across the Pacific from Hawaii, tracking whales.
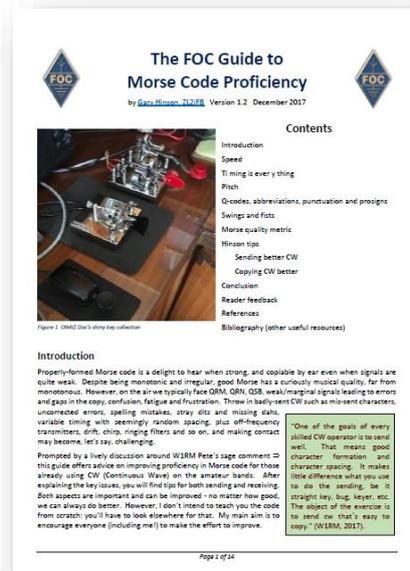
13 Close and acknowledgements

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 other WSJT-X developers and long-suffering support crew on the WSJT reflectors. 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 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

Find out more about me on G4IFB.com and QRZ.com

I am part of the team that developed and promotes the DX Code of Conduct. We know it is imperfect but the situation would be *even worse* without it!

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*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 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

"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 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 to 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 gives 2^{28} (the 28th power of 2) 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 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 and numerals, which would require at least 36x36x36x36 values or 1,679,616 in decimal, more than 2^{20} … in other words FT8 is 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 – it simply won't fit. The only realistic options are (1) to revise or replace the FT8 protocol, which opens another kettle of fish entirely, or (2) use look-up tables to convert the 32,768 (2^{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 (unless the logging program ADIF import function automatically spots and skips 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 D: The pros and cons of FT8

With a bit of thought, we can probably all place ourselves on this subjective scoring scale:

How I feel about FT8

0%	33%	67%	100%

I absolutely detest it!   *I can tolerate it*   *I quite like it*   *I absolutely love it!*

The reasons *why* we feel the way we do are personal – we're all different. The factors relevant to using FT8 on HF are both objective and subjective. Here are my impressions, so far:

Strengths	Weaknesses
• Good for weak signals *e.g.* marginal paths, QRP, stealth antennas, poor conditions • Efficient use of bandwidth: signals are just 50 Hz wide, and can often be decoded if they overlap more or less entirely with others • Minimal QSO information is passed reliably • Popular, with *lots* of HF activity at present	• Mechanized, without the personal touch that comes from legacy-mode human-to-human contacts and conversation • Slow communication speed equivalent to about 5 wpm • Complex and confusing for beginners • Problems with non-standard calls including CEPT travellers and special event calls
Opportunities	**Threats**
• User interface improvements, addressing software design flaws and programming bugs • Enhanced functionality *e.g.* better logging and statistics • Further innovation *e.g.* multi-transmit capability for DXpeditions	• Fragmentation of digital modes if too many variants develop • Automating ourselves out of the game • Marginalization of legacy modes and low-tech hobbyists • Increasing dependence on technology

> "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*

Appendix E: Simplex *versus* split FT8 use-cases

I developed this set of 'use-cases' to demonstrate and compare typical FT8 QSO sequences under various scenarios that we commonly experience on HF *e.g.* QRM.

Use case A – simple **S**hared **W**orking **F**requency **SWF** QSO ("**simplex**"[20])

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 **D**ifferent **W**orking **F**requencies **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)

---

[20] 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, fully interleaved)

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%
SOs 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

Here are some screen grabs from WSJT-X v1.8.0 of actual FT8 QSOs on HF, further illustrating the sequences. Having selected "Tx messages to Rx frequency window" under **F2 settings → General** tab, the yellow lines are my outbound transmissions, while the reds, whites and greens are inbound messages received and decoded on my system.

1. 9Z4Y called me (nice!). Our QSO took just a minute (4 overs plus my CQ call). No need for us to exchange 73s as well. Very efficient. Uber cool.

```
051245  Tx         1237  ~   CQ ZL2IFB RF80
051300   0  0.3 1235  ~   ZL2IFB 9Z4Y FK90
051315  Tx         1237  ~   9Z4Y ZL2IFB +00
051330   2  0.8 1236  ~   ZL2IFB 9Z4Y R-12
051345  Tx         1237  ~   9Z4Y ZL2IFB RR73
```

2. JQ2QHQ's final 73 was a courtesy that tells me he knows we completed … but I had already logged it anyway[21].

```
045700   3  0.4 1333  ~   ZL2IFB JQ2QHQ PM94
045715  Tx         1334  ~   JQ2QHQ ZL2IFB -06
045730   4  0.4 1333  ~   ZL2IFB JQ2QHQ R-02
045745  Tx         1334  ~   JQ2QHQ ZL2IFB RR73
045800   5  0.4 1333  ~   ZL2IFB JQ2QHQ 73
```

3. N8CWU was presumably using WSJT-X v1.8.0-rc1, the first public beta test release to offer FT8, so he responded to my RR73 not with the expected 73 but with his Tx 2 message! I manually selected and sent my RR73 again, and he must have manually selected his 73 message this time. I ended the QSO by suggesting that maybe he should update his software!

```
050345  Tx         1237  ~   CQ ZL2IFB RF80
050400  -7  0.2 1334  ~   ZL2IFB N8CWU EM89
050415  Tx         1237  ~   N8CWU ZL2IFB -07
050430  -9  0.2 1237  ~   ZL2IFB N8CWU R-11
050445  Tx         1237  ~   N8CWU ZL2IFB RR73
050500  -8  0.2 1237  ~   ZL2IFB N8CWU -11
050520  Tx         1237  ~   N8CWU ZL2IFB RR73
050530  -9  0.2 1237  ~   ZL2IFB N8CWU 73
050545  Tx         1237  ~   UPD8 WSJTX 73
```

4. Two callers both called me at once: VK2UCT was split and RX6APY simplex. **Call 1st** auto-responded to the first decoded signal (RX6APY), then as soon as my RR73 was sent to him to complete the first QSO, I double-clicked to respond to VK2UCT who had carried on calling me during my 1st QSO. Annoyingly, he then didn't respond until my third transmission, giving me a fairly weak R-15 report off the back of my beam. We completed and I resumed CQing.

```
055245  Tx          1133  ~   CQ ZL2IFB RF80
055300  -8 -0.2 1133  ~   ZL2IFB RX6APY KN95
055300   6  0.2  476  ~   ZL2IFB VK2UCT QF56
055315  Tx          1133  ~   RX6APY ZL2IFB -08
055330 -11 -0.2 1133  ~   ZL2IFB RX6APY R-20
055330   3  0.2  476  ~   ZL2IFB VK2UCT QF56
055345  Tx          1133  ~   RX6APY ZL2IFB RR73
055400   4  0.2  476  ~   ZL2IFB VK2UCT QF56
055415  Tx          1133  ~   VK2UCT ZL2IFB +03
055445  Tx          1133  ~   VK2UCT ZL2IFB +03
055515  Tx          1133  ~   VK2UCT ZL2IFB +03
055530   4  0.2  476  ~   ZL2IFB VK2UCT R-15
055545  Tx          1133  ~   VK2UCT ZL2IFB RR73
055615  Tx          1133  ~   CQ ZL2IFB RF80
```

---

[21] Due to a known bug in WSJT-X 1.8.0, show the final inbound 73 message at the end of a QSO *does not always appear as expected* in the right-hand pane below the other messages in that QSO (*e.g.* see QSO #6 on the next page). All decoded messages, including the 73s, do however appear on the left-hand pane. On this occasion, the 73 message from JQ2QHQ correctly appeared on the right.

5. I noticed another signal on "my" frequency on the waterfall so I shifted a few Hz before CQing on the odd periods. Sure enough, IK0OEF was CQing on "my" frequency on the even periods (his CQ message was highlit in green not red or yellow since it did not include my callsign) … and I was called by TA7P, split. Despite patiently responding to him seven times (!), he evidently wasn't copying my responses and eventually gave up, so I resumed CQing. Rats! I haven't worked Turkey yet this year. Maybe we will try again later if the path improves.

060115	Tx		1138	~	CQ ZL2IFB RF80
060130	-16	-0.5	1143	~	CQ IK0OEF JN61
060130	-9	1.5	735	~	ZL2IFB TA7P KN90
060145	Tx		1138	~	TA7P ZL2IFB -09
060200	-8	1.5	737	~	ZL2IFB TA7P KN90
060215	Tx		1138	~	TA7P ZL2IFB -09
060230	-5	1.5	738	~	ZL2IFB TA7P KN90
060245	Tx		1168	~	TA7P ZL2IFB -09
060300	-8	1.5	739	~	ZL2IFB TA7P KN90
060315	Tx		1168	~	TA7P ZL2IFB -09
060330	-9	1.5	740	~	ZL2IFB TA7P KN90
060345	Tx		1195	~	TA7P ZL2IFB -09
060400	-13	1.5	741	~	ZL2IFB TA7P KN90
060415	Tx		1195	~	TA7P ZL2IFB -09
060430	-11	1.5	741	~	ZL2IFB TA7P KN90
060445	Tx		1195	~	TA7P ZL2IFB -09
060515	Tx		1195	~	CQ ZL2IFB RF80

6. JG1LHB had a strong signal with me but I was beaming due East over the Caribbean, and evidently I was weak with him. He missed my first two responses then caught the third, and then he missed my RR73, re-sending his report to me after I had logged the QSO and started CQing. I sent my RR73 again, and finally received his 73 message (not shown on this pane, only on the left pane).

064245	Tx		2082	~	CQ ZL2IFB RF80
064230	6	0.3	2080	~	ZL2IFB JG1LHB PM95
064245	Tx		2082	~	JG1LHB ZL2IFB +06
064315	Tx		2082	~	JG1LHB ZL2IFB +06
064300	4	0.2	2080	~	ZL2IFB JG1LHB PM95
064345	Tx		2082	~	JG1LHB ZL2IFB +06
064330	5	0.2	2080	~	ZL2IFB JG1LHB R-17
064345	Tx		2082	~	JG1LHB ZL2IFB RR73
064415	Tx		2082	~	CQ ZL2IFB RF80
064400	2	0.3	2080	~	ZL2IFB JG1LHB R-17
064415	Tx		2082	~	JG1LHB ZL2IFB RR73

7. YO7DBR didn't hear my 20 watts via the long path, despite him having a strong signal with me. I saw his signal disappear from the waterfall so I guessed he had given up after just 2 calls, and I soon resumed CQing, bumping up my power to 50 watts due to a series of these failed QSOs.[22]

064745	Tx		2082	~	CQ ZL2IFB RF80
064730	4	0.2	2081	~	ZL2IFB YO7DBR KN24
064745	Tx		2082	~	YO7DBR ZL2IFB +04
064815	Tx		2082	~	YO7DBR ZL2IFB +04
064800	4	0.2	2082	~	ZL2IFB YO7DBR KN24
064800	-16	0.0	1191	~	UA0J RA3UAG LO06
064845	Tx		2082	~	YO7DBR ZL2IFB +04
064915	Tx		2082	~	CQ ZL2IFB RF80

---

[22] The white decode line from RA3UAG is displayed here due to a flaw/bug in WSJT-X v1.8.0. The 'dead green goalposts' above the waterfall did not jump automatically to the frequency of my caller as they should have done, but remained stubbornly on the frequency I had been monitoring previously … and RA3UAG happened to come up on that frequency, calling UA0J. That decode is irrelevant to me and need not have appeared on the right hand pane. Previous versions of WSJT-X would not have shown it, but I guess this was broken in the course of finalizing and releasing v1.8.0.

8. SN6P called me and we had a QSO, except he missed my RR73, paused, then re-sent his report to me another 4 times … while meanwhile, in that pause, I had been called by JA1AZR so I started a QSO with him. Once that QSO was done, I sent SN6P my RR73 message again. Luckily he had waited patiently for me to complete the other QSO, and this time we both sent our 73s just to be sure we agreed it was a good QSO.
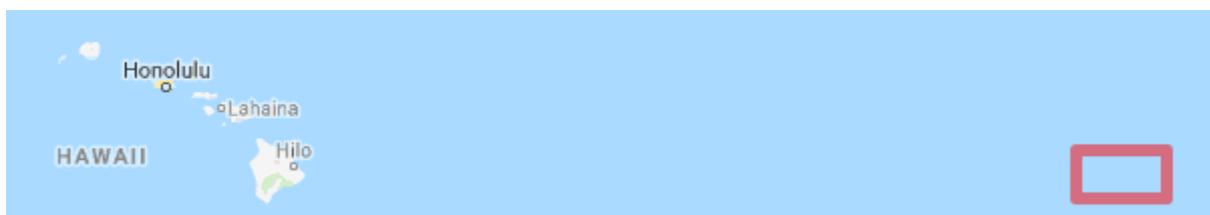
    I had in fact already logged the QSO as I was sending my RR73 message but I guess he missed it or just wanted to be absolutely sure.

073545	Tx		2479	~	CQ ZL2IFB RF80
073600	1	-0.0	2481	~	ZL2IFB SN6P JO80
073615	Tx		2479	~	SN6P ZL2IFB +01
073630	0	-0.1	2481	~	ZL2IFB SN6P R-20
073645	Tx		2479	~	SN6P ZL2IFB RR73
073630	-6	-0.3	2477	~	ZL2IFB JA1AZR QM06
073715	Tx		2479	~	JA1AZR ZL2IFB -06
073730	-1	-0.1	2481	~	ZL2IFB SN6P R-20
073745	Tx		2479	~	JA1AZR ZL2IFB -06
073800	1	-0.1	2481	~	ZL2IFB SN6P R-20
073815	Tx		2479	~	JA1AZR ZL2IFB -06
073830	0	-0.0	2481	~	ZL2IFB SN6P R-20
073845	Tx		2479	~	JA1AZR ZL2IFB -06
073830	-7	-0.3	2478	~	ZL2IFB JA1AZR R-15
073845	Tx		2479	~	JA1AZR ZL2IFB RR73
073830	0	-0.0	2481	~	ZL2IFB SN6P R-20
073900	-7	-0.3	2478	~	ZL2IFB JA1AZR 73
073915	Tx		2479	~	SN6P ZL2IFB RR73
073930	-1	-0.0	2482	~	ZL2IFB SN6P 73
073945	Tx		2479	~	SN6P ZL2IFB 73
074000	1	-0.0	2482	~	ZL2IFB SN6P 73
074015	Tx		2479	~	CQ ZL2IFB RF80

9. Having just completed a QSO with UA5D, I was called by DJ0QO, split, sending my report (Tx 2) rather than his grid (Tx 1). Despite the other callers, both split, we completed the QSO easily in 1 minute with just the 4 messages. However, due to a bug, **Auto Seq** would have responded to *his* Tx 2 message with *my* Tx 2 message: I had to select Tx 3 manually to send the R as well as my report to him.

110430	Tx		982	~	UA5D ZL2IFB RR73
110445	-9	0.3	912	~	ZL2IFB DJ0QO -12
110445	11	0.3	677	~	ZL2IFB UA5D 73
110500	Tx		982	~	DJ0QO ZL2IFB R-09
110445	-9	0.4	1031	~	ZL2IFB IZ1MKE JN44
110515	-8	0.3	912	~	ZL2IFB DJ0QO RRR
110515	-7	0.2	445	~	ZL2IFB F8NHF -16
110515	-8	0.4	1031	~	ZL2IFB IZ1MKE JN44
110530	Tx		982	~	DJ0QO ZL2IFB 73

10. KH6JF was maritime mobile in grid CK19, a 'wet square' East of Hawaii, a third of the way to Mexico.

Notice that the only messages which contain his full type 2 callsign with the /MM are his Tx 6 (CQ) and both our Tx 5s (73s).

Notice also that his final message to me in this QSO was not highlighted in red because it didn't contain my callsign.

Finally, his clock was 1.6 seconds adrift of mine, perhaps a consequence of being all at sea.

035400	-5	1.6	656	~	CQ KH6JF/MM CK19
035419	Tx		1200	~	KH6JF ZL2IFB RF80
035430	-6	1.6	656	~	ZL2IFB KH6JF -06
035445	Tx		1200	~	KH6JF ZL2IFB R-06
035500	-4	1.6	656	~	ZL2IFB KH6JF RRR
035515	Tx		1200	~	KH6JF/MM 73
035530	-6	1.6	656	~	DE KH6JF/MM 73

11. Here's another /MM example QSO, this one a bit more involved.

    I noticed YU2AX/MM working someone and decided to give him a call. The easiest way to set it up was to double-click one of his decode lines, then quickly abort my Tx 2 transmission (the first yellow line) since he was still in QSO. Then I waited until his QSO was almost over *i.e.* he sent an RRR to someone else (I should really have waited until he sent his 73, but I was calling split on a quiet frequency so I doubt my premature call caused any issue).

    He responded by calling me with his Tx 1 message and [grid FL93 in the Bermuda triangle](#) (the first red line). **Auto Seq** re-sent my Tx 2 to him, which he then acknowledged with his Tx 3. Notice I got a -24 report *i.e.* very weak, so it was no surprise that it took several repeats before my Tx 4 RRR message got through, with another station close to his frequency.

    Eventually he copied my report and sent me his Tx 4 RRR message, and I ended the QSO with a final Tx 5 73 message containing his full callsign.

```
210845    1  0.7 1789 ~    DE YU2AX/MM R+05
211100   Tx       654 ~    YU2AX ZL2IFB +01
211045   -2  0.7 1790 ~    K7EMI YU2AX -24
211115   -1  0.7 1790 ~    K7EMI YU2AX RRR
211130   Tx       654 ~    YU2AX ZL2IFB +01
211145   -4  0.7 1789 ~    K7EMI YU2AX RRR
211200   Tx       654 ~    YU2AX ZL2IFB +01
211215   -2  0.7 1790 ~    DE YU2AX/MM 73
211230   Tx       654 ~    YU2AX ZL2IFB +01
211245   -1  0.7 1790 ~    ZL2IFB YU2AX FL93
211300   Tx       654 ~    YU2AX ZL2IFB -01
211315   -5  0.7 1790 ~    DE YU2AX/MM R-24
211330   Tx       654 ~    YU2AX ZL2IFB RRR
211400   Tx       654 ~    YU2AX ZL2IFB RRR
211430   Tx       654 ~    YU2AX ZL2IFB RRR
211415    2  0.7 1790 ~    ZL2IFB YU2AX -24
211430   Tx       654 ~    YU2AX ZL2IFB R+02
211445    6  0.8 1782 ~    YV5JBI KG4JOK R-05
211500   Tx       654 ~    YU2AX ZL2IFB R+02
211445    0  0.6 1789 ~    ZL2IFB YU2AX -24
211500   Tx       654 ~    YU2AX ZL2IFB R+00
211515    3  0.8 1783 ~    YV5JBI KG4JOK R-05
211530   Tx       654 ~    YU2AX ZL2IFB R+00
211515   -2  0.7 1790 ~    ZL2IFB YU2AX RRR
211530   Tx       654 ~    YU2AX/MM 73
```

12. W0ZD/W3 initially called me without the /W3 suffix. While **Auto Seq** was busy responding to W0ZD, I selected a custom 73 message to send him at the end of our QSO, but then sent me the /W3 part in his Tx 3 message (and again in his Tx 5 73 message). My custom 73 message

```
215715    8  0.2 1232 ~    ZL2IFB W0ZD FN11
215730   Tx      1231 ~    W0ZD ZL2IFB +08
215745   10  0.2 1232 ~    DE W0ZD/W3 R-05
215800   Tx      1231 ~    W0ZD ZL2IFB RRR
215815   11  0.2 1232 ~    DE W0ZD/W3 73
215830   Tx      1231 ~    W0ZD/W3 73
```

    was automatically replaced with a generated message confirming my receipt (and logging) of his full callsign. Cool! Notice that the decodes where he sent his full callsign were not highlighted in red – another trivial user interface bug.

13. In my QSO with YV5IAL/7 (a legitimate type 1 callsign), his full callsign complete with the /7 suffix was correctly logged by WSJT-X. However, **Auto Seq** never actually sent the /7 part back to him in either of my messages

```
054945   Tx      1133 ~    CQ ZL2IFB RF80
055000    3  0.3 1132 ~    ZL2IFB YV5IAL/7
055015   Tx      1133 ~    YV5IAL ZL2IFB +03
055030    4  0.3 1132 ~    ZL2IFB YV5IAL R-09
055045   Tx      1133 ~    YV5IAL ZL2IFB RR73
```

    (highlighted in yellow), possibly because I was using RR73 instead of RRR followed by a 73 message. Unless he checks LoTW (or reads this!), he doesn't know for sure whether I copied and logged his full call correctly.

    Auto Seq might have sent an RRR message then a 73 message such as "YV5IAL/7 73" instead of the RR73 I had selected, or WSJT-X could at least have informed me during the QSO that I should have composed a free-text message containing his full callsign.

14. A conventional 20m FT8 QSO with KB5GP fell off-the-rails when he sent me a custom 73 message including the string "B4" … which WSJT-X mistakenly interpreted as his callsign. It changed my generated messages accordingly and even invited me to log a QSO with "B4" which, due to a caffeine deficiency at 8am, I didn't notice Doh!

I'm not sure why KB5GP felt I should know we had had a prior QSO: he's not in my log so as far as I'm concerned, this was our only QSO.

```
185115  Tx        1835 ~  CQ ZL2IFB RF80
185100  -3  0.2 1725 ~  ZL2IFB KB5GP CN72
185115  Tx        1835 ~  KB5GP ZL2IFB -03
185130  -8  0.1 1776 ~  CQ K2ANT DM33
185145  Tx        1835 ~  KB5GP ZL2IFB -03
185200  -7  0.1 1776 ~  KE5TD K2ANT -06
185215  Tx        1835 ~  KB5GP ZL2IFB -03
185200   3  0.2 1725 ~  ZL2IFB KB5GP R-03
185215  Tx        1835 ~  KB5GP ZL2IFB RRR
185230  -9  0.1 1776 ~  QSO B4 TU 73
185245  Tx        1835 ~  B4 ZL2IFB 73
```

Of more concern, it is conceivable that somone sending a 73 message containing their callsign (at the right time?) might hijack a QSO in progress and be logged. If true, this is a flaw in the **Auto Seq** logic. Luckily, on this occasion, Logger32 was awake enough to spot the error and refused to accept the "B4" QSO:

Appendix F: Auto-QSY function

Within the FT8 protocol and WSJT-X software, it is possible to designate a separate frequency on the same band within a CQ message, specifying just the kHz part. For example, assuming I am on 17m on the usual FT8 VFO frequency 18100 kHz, I could send CQ **101** ZL2IFB RF80 to indicate that people should call me (roughly) 1 kHz higher at 18**101** kHz. If my Tx audio frequency is at 500 Hz on the left of the waterfall, I would expect callers around 1500 Hz in the middle of my waterfall, depending on their audio frequency

settings. My callers wouldn't need to do anything special, though, simply double-clicking my CQ call as normal. Their CAT-controlled radios will QSY automatically to 18101 kHz. *I am controlling their radios! <Cue evil laugh>*

There are some drawbacks to this approach in practice, however:

- The facility is not well explained in the Help and is vanishingly rare on HF, hence most users will not understand the CQ message. If they double-click it they may get a nasty surprise when their radios unexpectedly QSY;

- Callers' Tx *and* Rx frequencies *both* change: this is a QSY function not a split function;

- Having edited the CQ message in Tx 6 to include the receive frequency, it gets reset to the standard message *without* the frequency after each QSO. It is good practice for DXpeditioners operating split to include the "UP" message with every CQ, reducing the number of simplex callers;

- We can potentially send callers out of band, on top of other users or beacons, into other mode segments, with an inappropriate choice of QSY frequency;

- Callers using high audio frequencies will probably be off the righthand side of my waterfall when their VFO shift 1 kHz higher, hence I won't see their signals and they won't be decoded.

> I gather the auto-QSY function is used by those calling Japanese hams on 160m, since the JA allocation is up above 1.9 MHz whereas the rest of the world mostly uses 1.8something.

> Testing this out on-air, some stations called me a little up the band as I wanted but then disappeared when I responded to them: perhaps they were *so* surprised at the unexpected QSY that they went QRT to check for faults!

> Even with the **Call 1st** function *un*selected, WSJT-X sometimes responds automatically and unexpectedly to the first decoded caller. Curiously, this intermittent bug materialized more often when I was testing the auto-QSY function. I wonder why?

Bottom line: **be careful using this auto-QSY facility**.