

# Using WSJT-X for JT4 EME Operation

Updated to WSJT-X r5604

document revision 6

# G3WDG

Program Download from:

<https://drive.google.com/file/d/0B116lwQIUFNTV1NIRnpZeHY3a2s/view?usp=sharing>

# Features in WSJT-X JT4

- Enhanced sensitivity decoder (single period decodes and correlation averaging)
- Doppler control (“full” and “constant freq off moon” modes), compatible with a wide range of radios.
- Doppler calculations have changed, resulting in much improved accuracy.
- Averaging now done automatically, no need (or ability) to select frames to be excluded in the average.
- Simpler switching between single tone and long form messages
- Wider dynamic range for signal reports, no more limiting at -10/-11 for strong signals and with good accuracy of dB level differences, and reasonable agreement with link budget calculations.
- Echo mode with Doppler correction

# Differences to WSJT10 - 1

- There is no longer a DF parameter, instead a Freq term is used
- Freq is now defined as audio frequency of lowest tone
- **No longer any reference to 1270Hz**
- For all sub-modes (A-G), lowest tone is at 1000Hz. Subsequent tone spacing is same as for WSJT10. For example, for JT4F the tones are now at **1000, 1158, 1316 and 1474Hz**.
- Rate in and Rate out are gone. **Audio sampling has to be done at 48kHz!** (see Section 3.1 of [WSJT-X manual](#)).
- Other setups are done differently to WSJT10 – (refer to WSJT-X manual and later pages here).
- MinW setting can be set to A, with no need to adjust for different spreading

# Differences to WSJT10 - 2

- Single tone frequencies are now:

1000Hz: tuning in tone

1250Hz: please send messages

1500Hz: RRR

1750Hz: 73

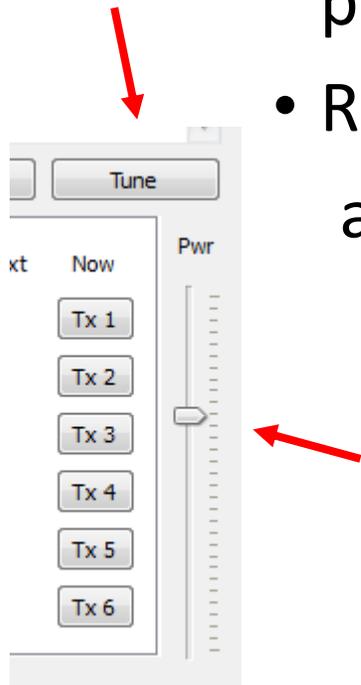
(Single tones are still “decoded” by eye.)

- Files such as all.txt, .ini file and the folder SAVE (for wav files) are in a different folder, example: C:\Users\\AppData\Local\WSJT-X .  
**Note on some PCs, AppData may be a “hidden” folder.** The path on your PC can be deduced by looking in File->Settings->Audio

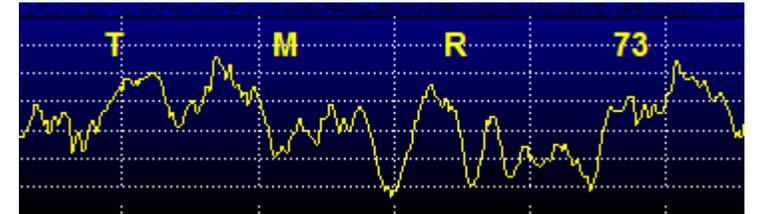
<user name> above is current user name

# Differences to WSJT10 - 3

- Waterfall and average spectrum combined in one window called Wide Graph
- Average spectrum has letters corresponding to meaning of the single tones for easier identification by eye, which move to correct positions based on clicking the 1000 tuning tone from other station.
- RF power control from the main window and Tune facility (1000Hz tone)



- Yellow average spectrum develops during the receive period, instead of appearing at the end



T= tuning in tone  
 M= send messages  
 R= RRR  
 73=73

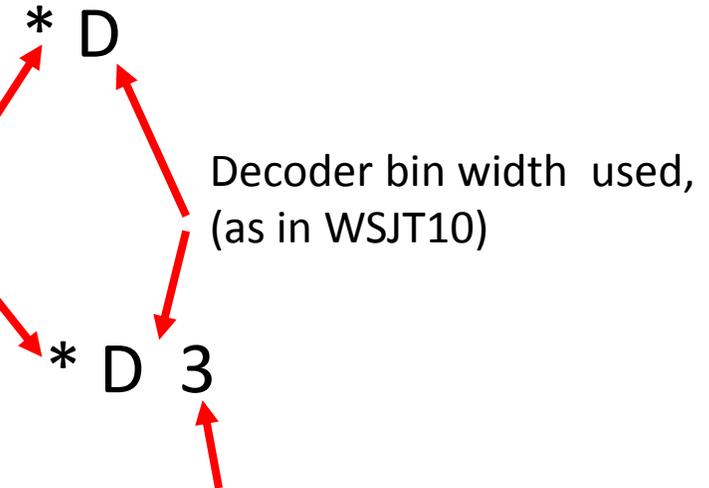
# Differences to WSJT10 – 4

Meaning of the characters after decodes:

1755 -13 2.62 1190# G3WDG OK1KIR -15

\* Indicates convolutional decode, or number here means correlation decode and number indicates confidence level

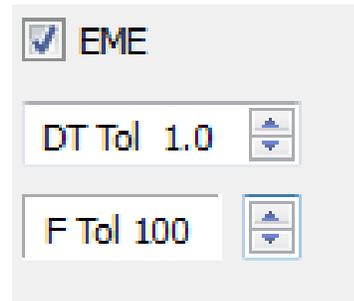
1809 -13 2.27 1238\* G3WDG OK1KIR JN79



A number here means decode was from averaging and number indicates the number of periods used in the average

# Differences to WSJT10 – 5

Nominal DT = 0 if unticked  
Nominal DT = 2.5 if ticked



EME

DT Tol 1.0

F Tol 100

DT Tolerance, +/-  
number selected

Replaces Tol box in WSJT10

Narrower tolerances seem to make little improvement, better to select on the wide side especially if signals are not marginal.

Note: If EME is not ticked, for terrestrial use, PC clock accuracy should be within +/- 0.35 sec

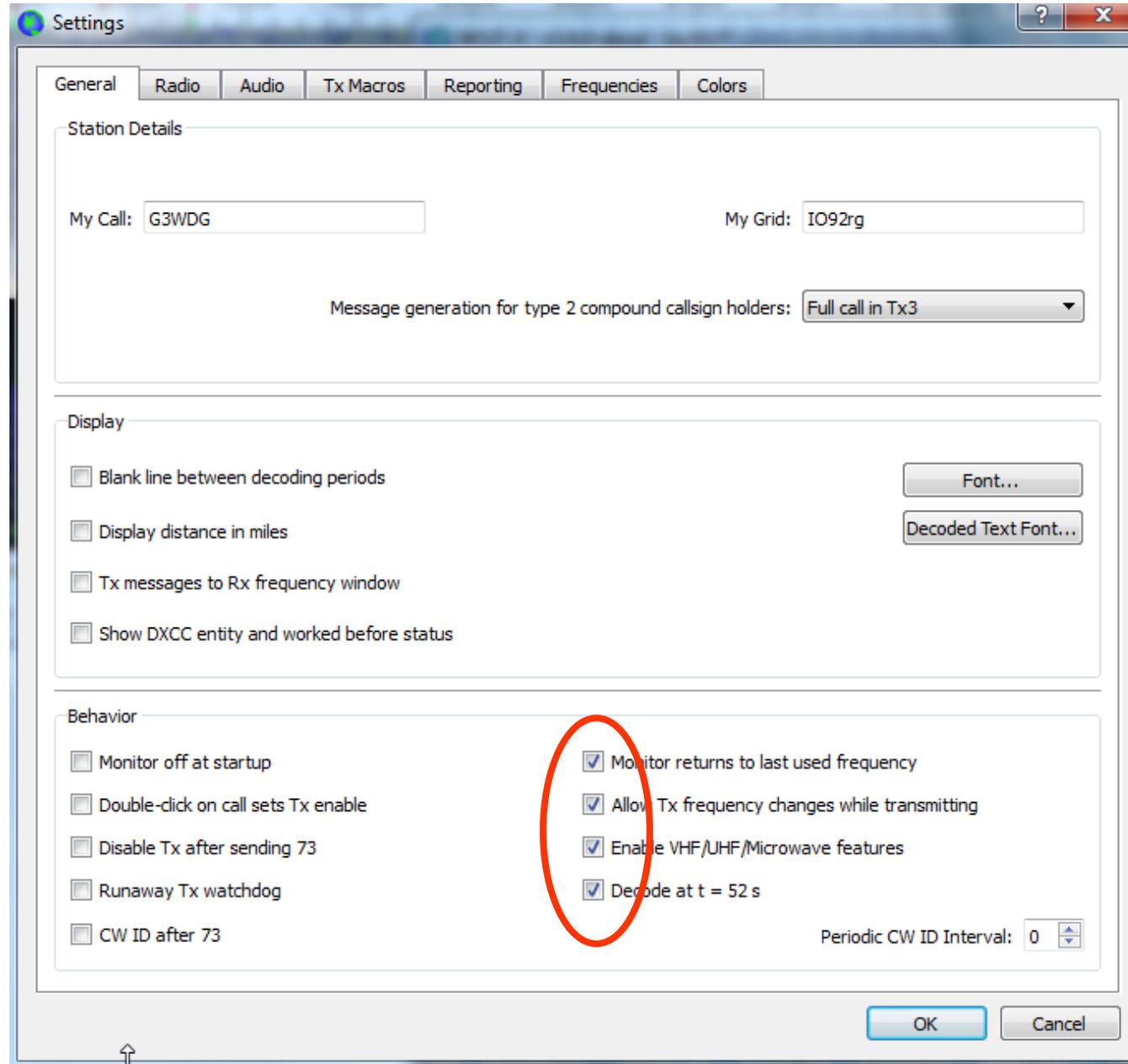
# What hardware do you need for WSJT-X?

- SSB transceiver and antenna
- Computer running Windows (XP or later), Linux, or OS X
- 1.5 GHz or faster CPU and 100 MB of available memory
- Monitor with at least 1024 x 780 resolution
- Computer-to-radio interface using a serial port for T/R switching, or CAT control, or VOX, as required for your radio-to-computer connections
- Audio input and output devices supported by the operating system **and capable of 48 kHz sample rate**
- Audio or equivalent USB connections between transceiver and computer
- A means for synchronizing the computer clock to UTC within  $\pm 1$  second (but see page 9 )
- Radios without CAT control can be used if other end does full Doppler correction.

## Setting up for Microwave EME and Doppler Control

- The following pages describe how to set up and use Doppler control
- It is recommended to follow the steps in the sequence shown in the following pages
- The examples shown are for the 10GHz band

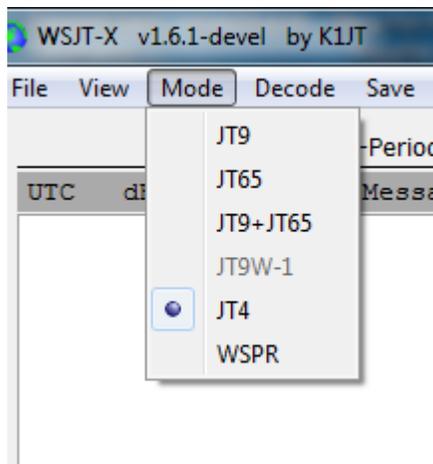
# Files->Setup->General



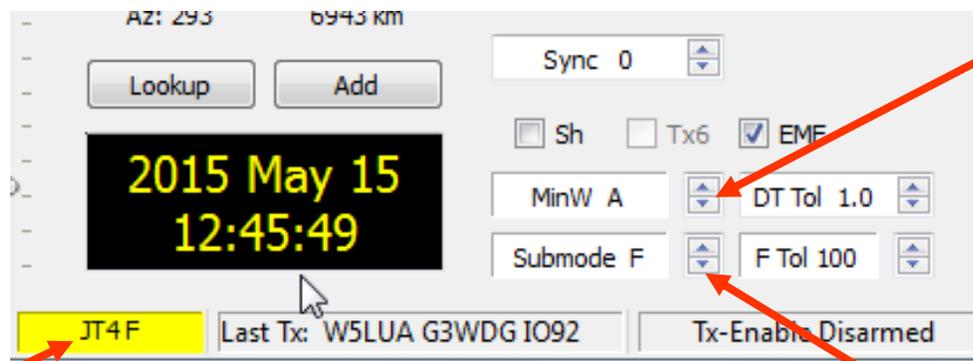
# Doppler control – pre setup

- If previous versions of WSJT-X (prior to r5260) have been installed, it is necessary to delete the WSJT-X.ini file before installing new version of WSJT-X (see page 4 for location of this file)
- For each band, it is necessary to enter an “offset”. Offset is defined as (desired radio’s frequency – operating frequency). For example, for 10368 and a 144MHz radio it is  $(144-10368) = -10224$ . If a 28MHz radio is used, with a 28/144 transverter prior to the 144/10368 transverter then the offset is -10340.
- Set to JT4 mode in main window

# Setting JT4 Modes



Changes decoder bin width. Can safely be set to A independent of signal spreading.



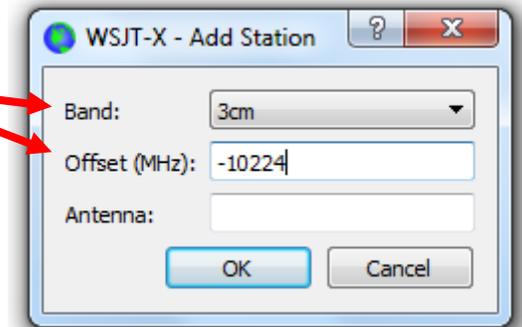
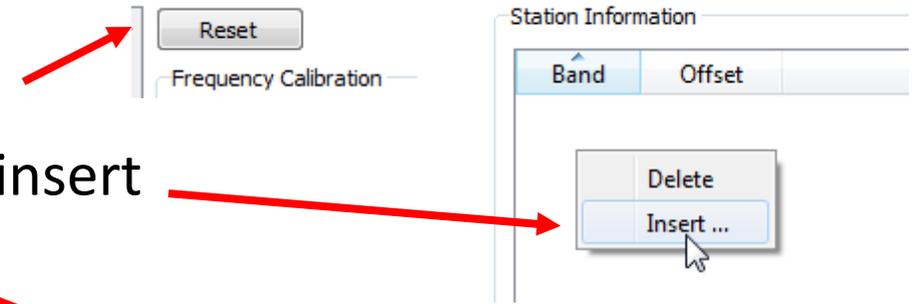
Shows selected mode

Changes sub-mode

# Setting the offset

From File->Settings->Frequencies follow these steps:

1. Press RESET and answer YES
2. Right click in Station Information area and select insert
3. Select band from pull down and type in offset
4. Press OK
5. Press OK to close Frequencies window



Go to main window

- Select 3cm (pulldown)
- Frequency display should now read 10,368.000 000

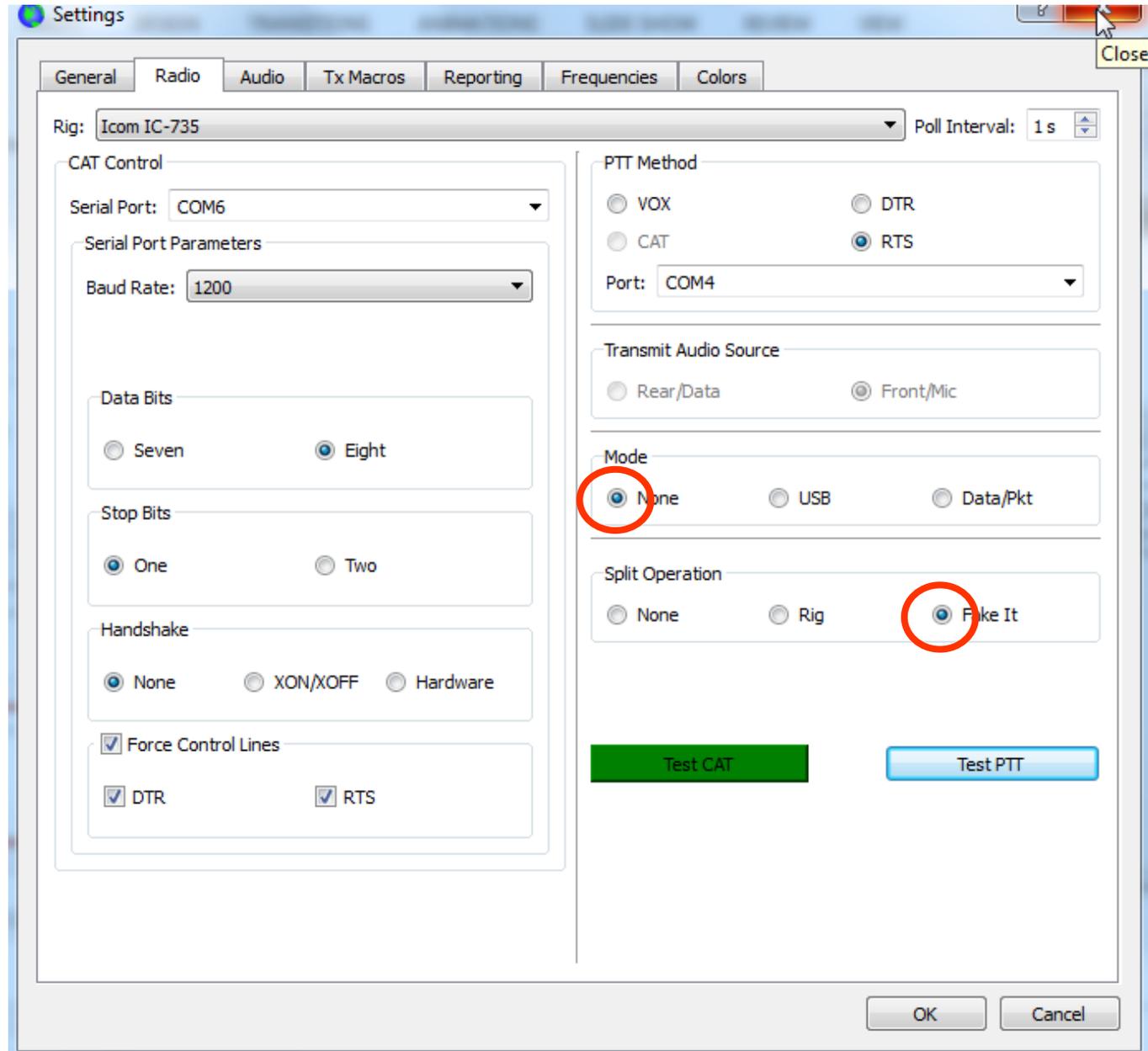


To edit an existing offset in the Station Information area, double left click the offset number and retype the **whole** new offset number, and press OK. It may sometimes be necessary to re-select the band eg 3cm on main window to make the change in offset take effect.

# Doppler setup – setting the radio

- Determine which methods will be used for CAT control and PTT, and which COM ports are used for each, eg use Windows device manager to identify which serial ports are which.
- Plug in the interfaces and connect to radio
- Fill out the other settings as appropriate for the radio and interfaces, referring to radio operating manual and/or the internet as needed
- Press Test CAT and Test PTT
- In case of Rig Control errors..... experiment. If the radio will support it, use of higher baud rate may be beneficial to reduce rig control errors.

# Setting the radio (IC735)

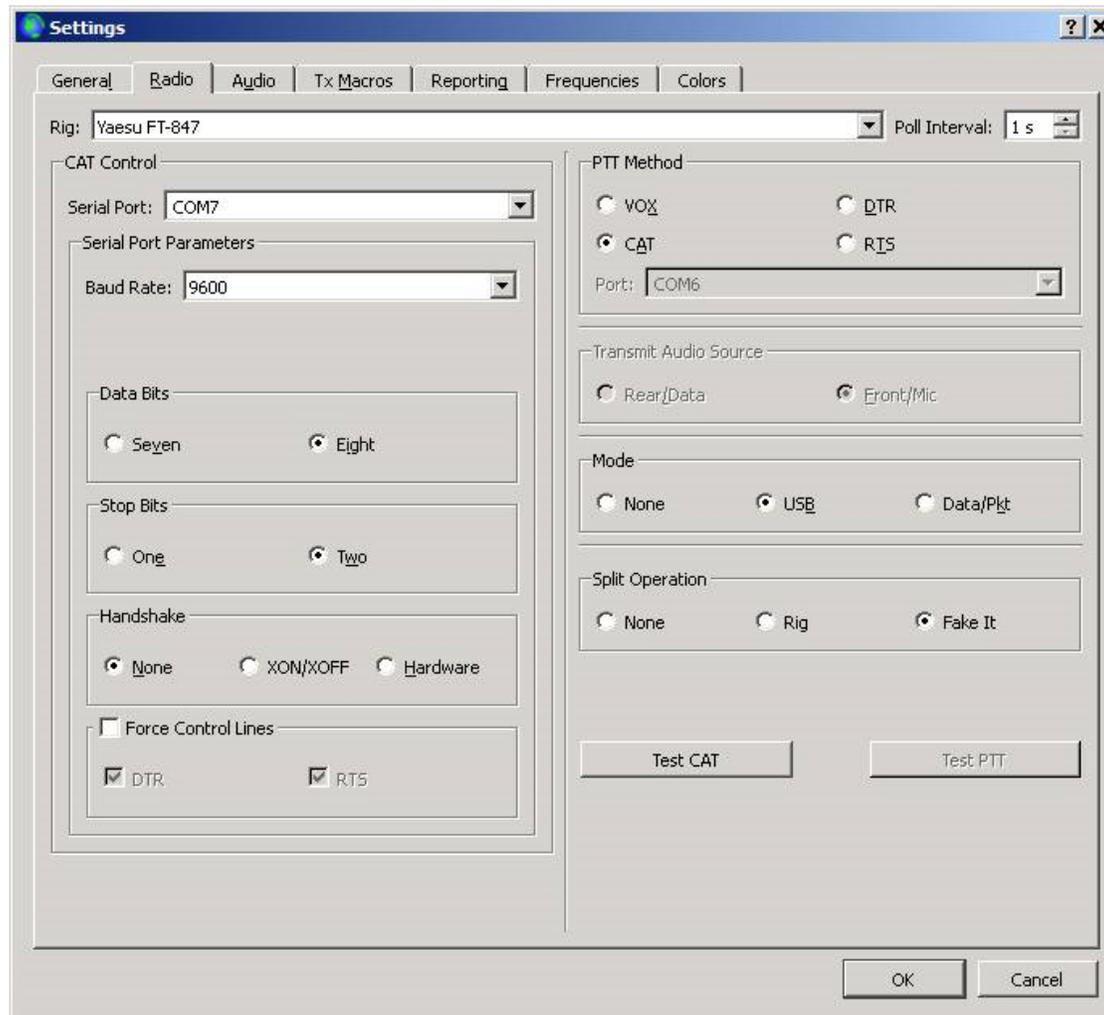


With this configuration, the IC735, which can have its frequency controlled when on TX, is **not** operated in its own Split mode, just uses VFO A.

Experience will be gained with use of more radios of different models enabling better recommendations to be made including whether to use Rig or fake it. Some experimentation may be needed here.

- Radios tested to date for Doppler control:
- IC735 (G3WDG)
- IC910H (VK7MO)
- TS2000 with upgrade (K1JT)
- FT817 – (G4FRE/OK2AQ) **does not work**
- K3 – (G4FRE)
- KX3 – (G4FRE)

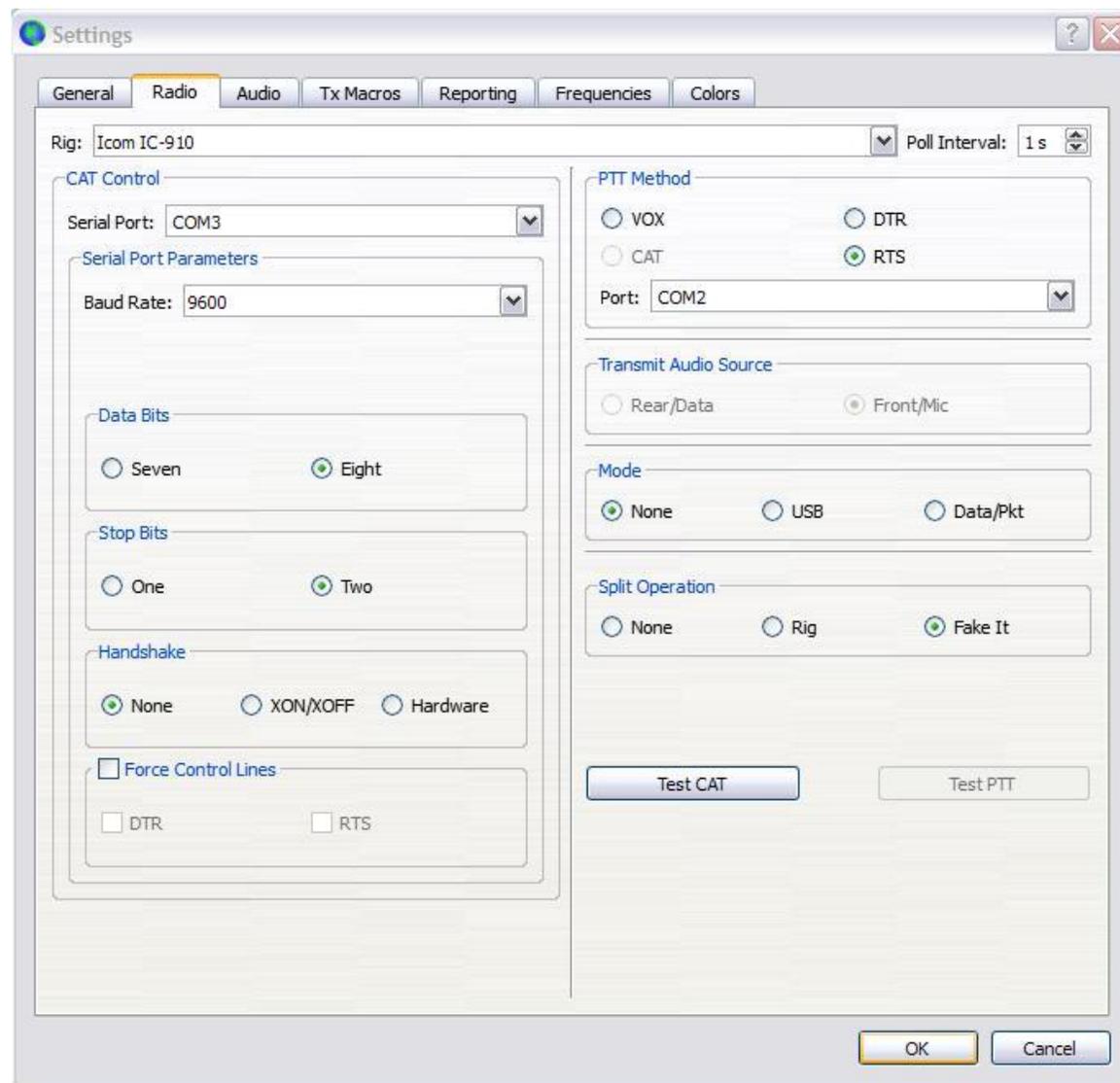
# Setting the radio (FT847)



FT847 radio is operated  
in split mode

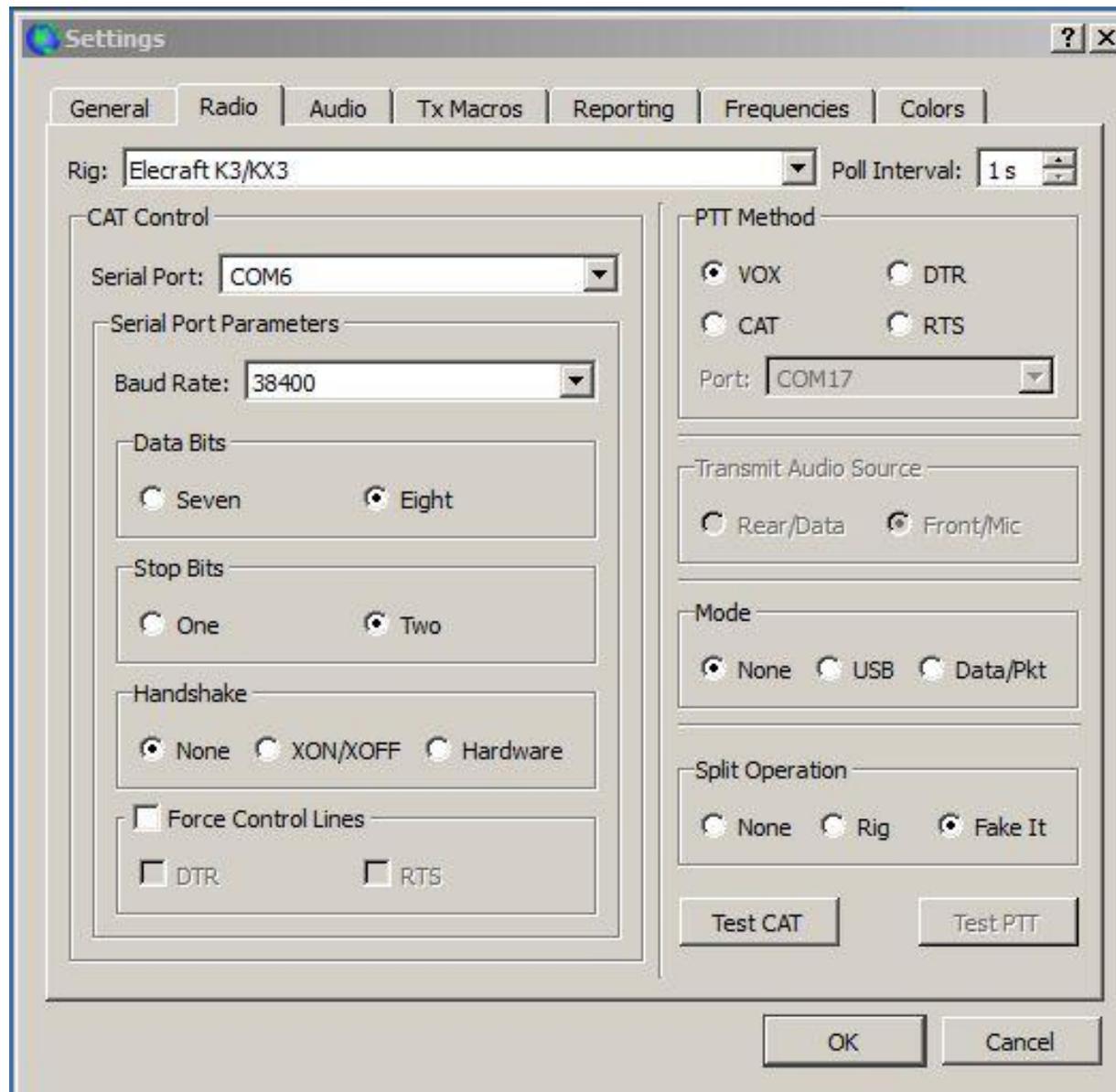
Tnx OK2AQ

# Setting the radio (IC910)



Tnx VK7MO

# Setting the radio (K3/KX3)



Tnx HB9Q

# Radio settings for one com port

The screenshot shows the 'Radio' tab of a software interface for an Icom IC-735. The 'Rig' is set to 'Icom IC-735' and the 'Poll Interval' is '1 s'. The 'CAT Control' section is expanded, showing the following settings:

- Serial Port: COM7
- Serial Port Parameters:
  - Baud Rate: 1200
  - Data Bits: Eight (selected)
  - Stop Bits: One (selected)
  - Handshake: None (selected)
  - Force Control Lines: DTR (checked), RTS (unchecked)

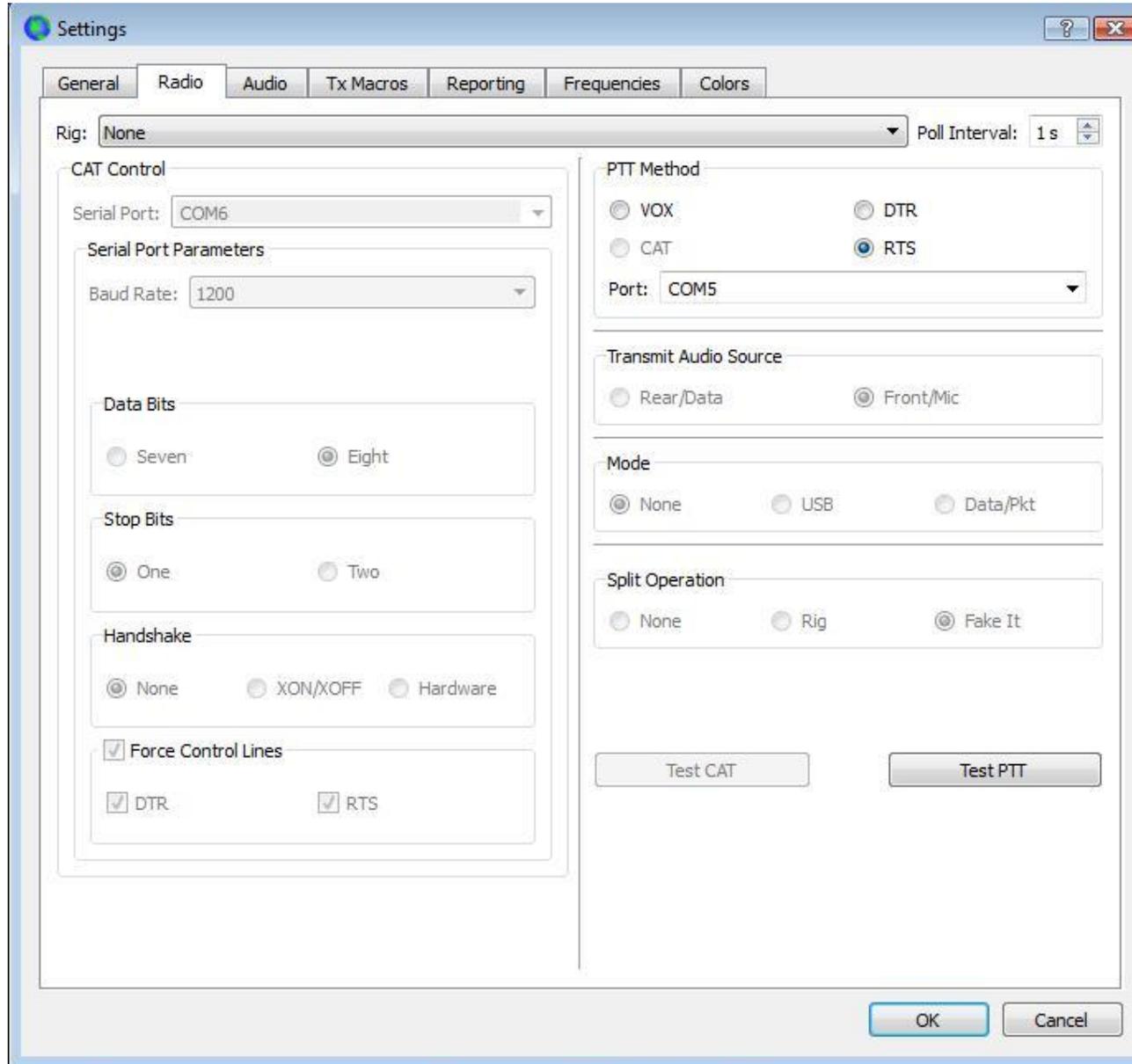
The 'PTT Method' section is also expanded, showing the following settings:

- PTT Method: RTS (selected)
- Port: COM7
- Transmit Audio Source: Front/Mic (selected)
- Mode: None (selected)
- Split Operation: Fake It (selected)

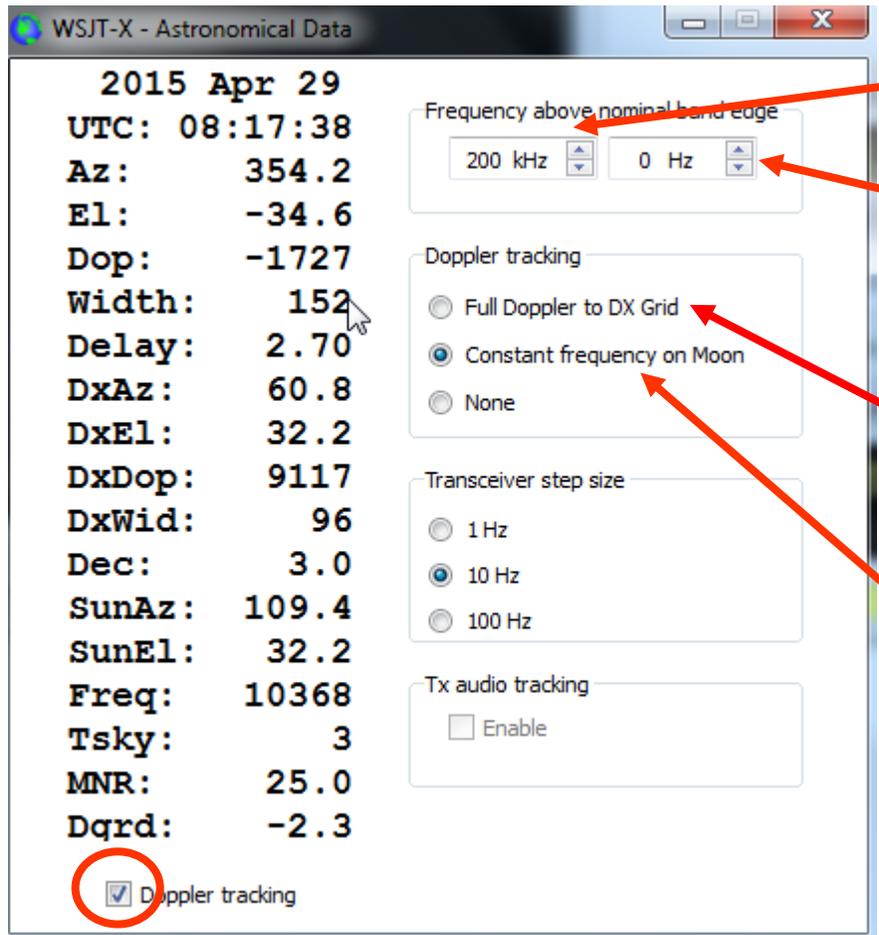
At the bottom of the PTT Method section, there are two buttons: 'Test CAT' and 'Test PTT'.

Only works with CAT interface that has external power

# Setting the radio – non CAT transceiver



# Doppler control modes (ASTRO window)



Set sked frequency, in this case 10368.200

Used to trim radio tuning, in 100Hz steps, to accommodate a station who is more than a few hundred Hz off frequency

Mode when one station is doing Doppler tracking for both stations. Other station receives and transmits on the sked frequency **with no Doppler corrections.**

Mode when both stations running WSJT-X or for self echo testing. Advantage of this is that other stations can monitor a QSO if they know the sked frequency as Doppler shifts are corrected by each station individually, giving a "constant frequency on the moon".

Note: It has been suggested that 'Constant frequency on Moon' operation is at 200kHz above band edge and 'Full Doppler to DX Grid' operation is at 225kHz.

# Doppler example

WSJT-X - Astronomical Data

2015 May 15  
UTC: 12:02:35  
Az: 225.4  
El: 34.9  
Dop: -11246  
Width: 81  
Delay: 2.44  
DxAz: 107.4  
DxEl: 32.6  
DxDop: 4431  
DxWid: 69  
Dec: 5.7  
SunAz: 181.7  
SunEl: 56.6  
Freq: 10368  
Tsky: 3  
MNR: 0.8  
Dqrd: -0.6

Frequency above nominal band edge  
225 kHz

Doppler tracking  
 Full Doppler to DX Grid  
 Constant frequency on Moon  
 None

Transceiver step size  
 1 Hz  
 10 Hz  
 100 Hz

Tx audio tracking  
 Enable

Doppler tracking

Total (two way) Doppler shift of your own echoes (Hz)

Total Doppler shift between you and DX station (Hz)

In Full Doppler to DX Grid mode, DX station operates on the sked frequency **with no correction on tx or rx**. Your rig is tuned + and - by the DXDop figure, so you hear the DX station on the corrected frequency and DX station also hears you on the corrected frequency. In this example, you would be transmitting on  $225 - 4.431 = 220.569$  kHz, and receiving on  $225 + 4.431 = 229.431$  kHz.

In Constant frequency on Moon mode, both stations offset their own one-way Doppler shift (in example shown this would be  $-11246/2$ , ie  $-5.623$  kHz), in one direction on tx and the other direction on rx. In this example, you would be transmitting on  $225 + 5.623 = 230.623$  and receiving on  $225 - 5.623 = 219.377$ . [In essence, this is similar to CW operating procedure, where one station nets their own echoes on the frequency that they are receiving the other station and both stations copy each other and their own echoes].

Another station can also monitor the QSO if they know only the sked frequency, if also operating in Constant Frequency on the Moon mode.

# VK7MO's Recommended settings for Wide Graph

More info at : <http://www.sucklingfamily.free-online.co.uk/Waterfalls%20on%20WSJT10%20and%20WSJT.docx>

Setting of Bins/Pixel affects span of displayed audio spectrum

Waterfall gain

Waterfall zero



Setting of N Avg affects waterfall speed

Spectrum gain

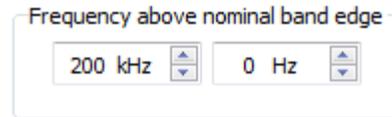
Spectrum zero

Spectrum smoothing

Some experimentation with palette, gain and zero settings is recommended to match operator preference. Some weak signal files to help optimize settings are available at:

<http://www.sucklingfamily.free-online.co.uk/REXFILES.zip>

# Using the frequency spinners in ASTRO window



- Two “spinner” controls are provided to allow radio frequency to be set above the band edge, in kHz (1kHz steps) and Hz (100Hz steps). The frequency above band edge is the sum of these two controls (ie kHz + Hz).
- It is recommended that skeds are arranged to be on exact multiples of 1kHz eg 200, 225 etc, so the Hz spinner should normally be set to 0 to avoid unwanted offsets. Any offset entered here will return to zero when the program is closed and restarted.
- The two controls can also be used to tune the radio in real time, for example to accommodate a station who is not exactly on frequency, or to find a station who has been detected on another frequency eg seen on a separate SDR. Doppler compensation is maintained while the radio is being tuned with the spinners.
- When using for fine tuning, decrease frequency to increase tone pitch.

# Audio levels

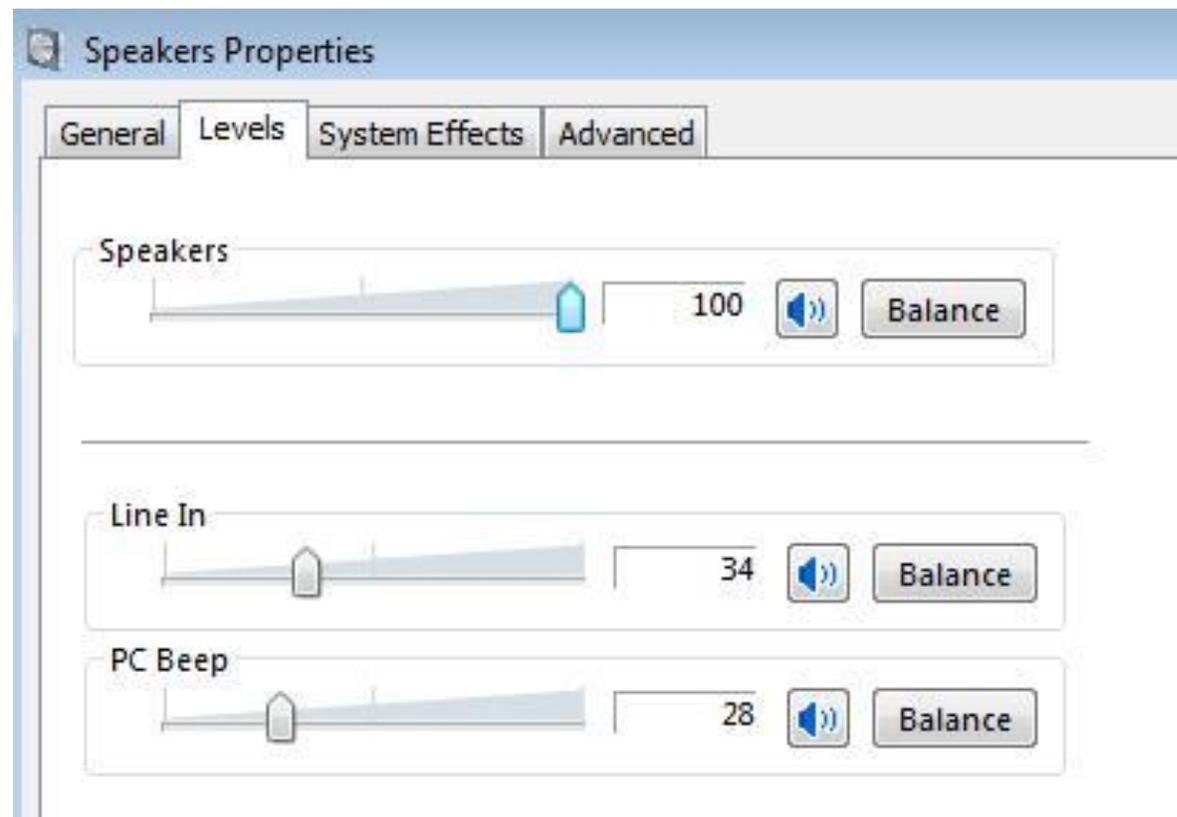
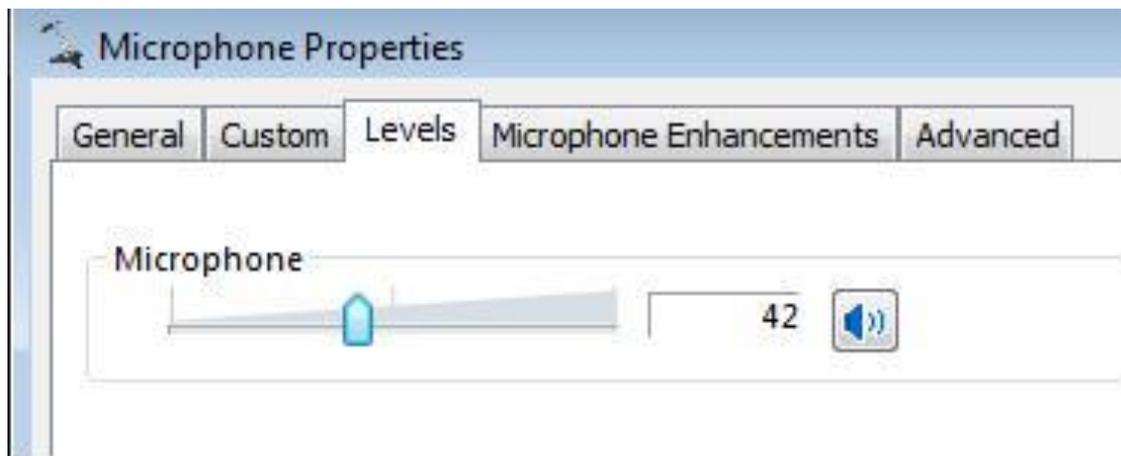
The only remaining thing would appear to be level settings. The orange level indicator on the left hand side of the WSJT-X main window is your friend here. I would recommend setting the gain slider next to it about half way for a start. Then adjust any Windows microphone level for the device you have connected to your receiver to maximum. It is worth checking at this stage that you have disabled any special effects on the microphone device such as echo cancellation or boost. Then you need to adjust the audio out level with either the output gain control of the rig or the interface. Aim to get the orange indicator falling just short of maximum for strong signals. If that doesn't get you a reasonable level and the indication is too high then try adjusting the Windows microphone level down. If that leaves you with too low or too high a level; adjust the gain slider in WSJT-X to compensate.

If you find that the gain slider in WSJT-X is near the top or bottom then you are probably under driving or over driving the sound card input which is not desirable and you need to investigate adjusting the audio level before it gets to the sound card.

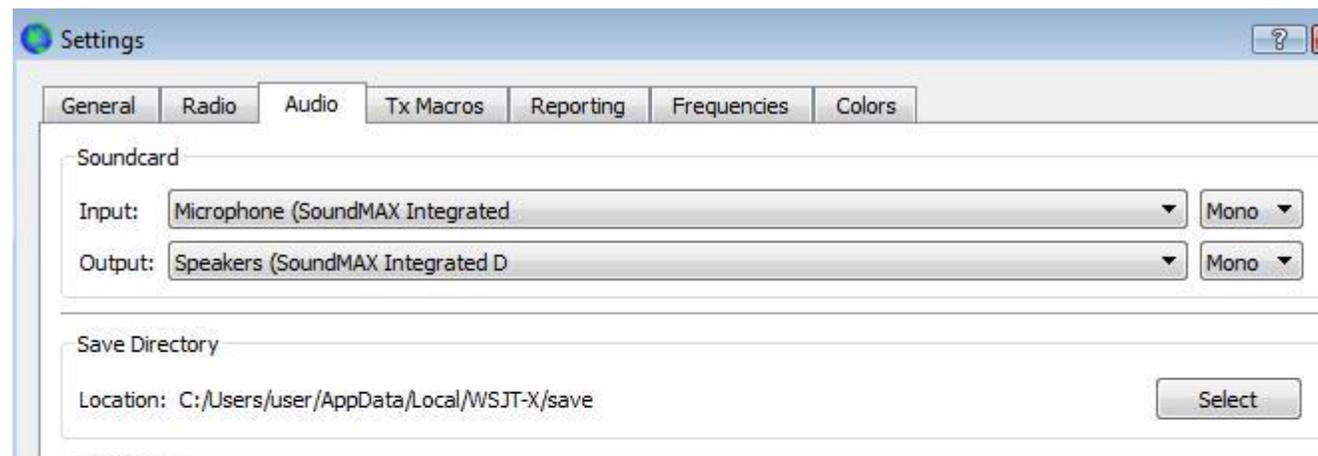
This material copied from WSJT User Group posting.

WDG note: I input the same audio level as gave 0dB on WSJT10, then adjust the slider to get noise at about 30.

# PC volume control settings (WDG Vista PC)

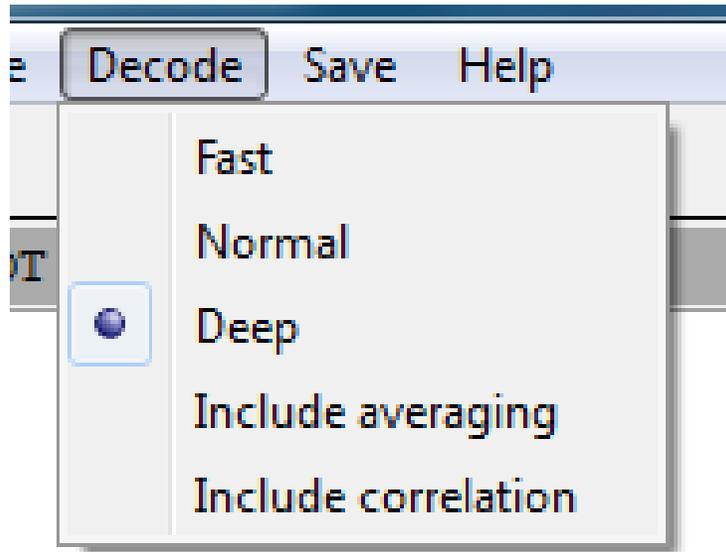


# Audio settings in -X (WDG specific)



These are for mic input jack and headphones jack

# Setting decoding type



Note: Averaging is also in operation with this setting at present

# Entering DX station info

1

10,368.218 480

DX Call	DX Grid
VK7MO	QE37pc
Az: 79	17409 km

Lookup Add

Lookup or add if station not in database

2

press

Generate Std Msgs

- VK7MO G3WDG IO92
- VK7MO G3WDG -15
- VK7MO G3WDG R-15
- VK7MO G3WDG RRR
- VK7MO G3WDG 73
- @1000 (TUNE)

If Generate Std Msgs is not pressed it is possible to have wrong callsign in messages!

# General settings for “long form” messages

The screenshot displays the software interface for message decoding. The top menu includes File, View, Mode, Decode, Save, and Help. The main area is divided into two tables: Single-Period Decodes and Average Decodes. The Single-Period Decodes table shows several entries, with the one containing the user's call (VK7MO) highlighted in red. The Average Decodes table also shows a single entry with the user's call highlighted in red. Below the tables are various control buttons and settings, including a frequency display (10,368.204 650), a date and time display (2015 Apr 28 10:10:52), and a list of standard messages for transmission. The 'Sh' checkbox is circled in red.

Single-Period Decodes					Average Decodes				
UTC	dB	DT	Freq	Message	UTC	dB	DT	Freq	Message
2304	-20	2.06	984		2322	-17	2.68	1081#	G3WDG VK7MO -19 3 A 2
2316	-17	2.69	1087*	G3WDG VK7MO PF88 2 E					
2318	-17	2.74	1072#						
2320	-18	2.74	938*						
2322	-17	2.68	1081#	G3WDG VK7MO -19 9 E					
2324	-20	2.74	969						

Log QSO Stop Monitor Erase Clear Avg Decode Enable Tx Halt Tx Tune

3cm 10,368.204 650

+2 kHz

VK7MO PF88aa

Az: 74 15866 km

Lookup Add

2015 Apr 28 10:10:52

Tx JT9 @ Tx even

Tx 1000 Hz Tx<Rx

Rx 1000 Hz Rx<Tx

Lock Tx=Rx Report -15

Sync 0

Sh  Tx6  EME

MinW A DT Tol 0.5

Submode F F Tol 100

Generate Std Msgs Next Now Pwr

VK7MO G3WDG IO92 Tx 1

VK7MO G3WDG -15 Tx 2

VK7MO G3WDG R-15 Tx 3

VK7MO G3WDG RRR Tx 4

VK7MO G3WDG 73 Tx 5

@1000 (TUNE) Tx 6

VK7MO\_140816\_232400.WAV JT4F Tx-Enable Disarmed

Note: decoded messages appear in red when they contain your call

# General settings for “single tone” messages

This screenshot shows the general settings for "single tone" messages. The interface is divided into two main sections. The left section contains various configuration options: "Tx JT9 @", "Tx even" (unchecked), "Tx 1000 Hz", "Tx<Rx", "Rx 1000 Hz", "Rx<Tx", "Lock Tx=Rx" (unchecked), "Report -15", "Sync 0", "Sh" (checked and circled in red), "Tx6" (unchecked), "EME" (checked), "MinW A", "DT Tol 0.5", "Submode F", and "F Tol 100". The right section, titled "Generate Std Msgs", lists several message templates with radio buttons: "VK7MO G3WDG IO92" (selected), "VK7MO G3WDG -15", "VK7MO G3WDG R-15", "@1500 (RRR)", "@1750 (73)", and "@1000 (TUNE)".

This screenshot shows the same software settings as the first image, but with additional changes. The "Sh" and "Tx6" checkboxes are both checked and circled in red. An orange arrow points from the "Tx6" checkbox to the "@1250 (SEND MSGS)" option in the message list. The message list now includes: "VK7MO G3WDG IO92" (selected), "VK7MO G3WDG -15", "VK7MO G3WDG R-15", "@1500 (RRR)", "@1750 (73)", and "@1250 (SEND MSGS)".

# Click decoded message to set report automatically

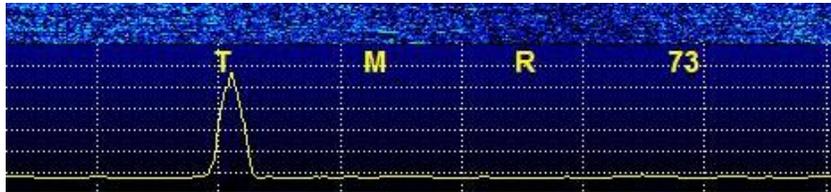
The screenshot shows the WSJT-X v1.6.0-devel interface. At the top, there are two tables for decoded messages:

Single-Period Decodes				
UTC	dB	DT	Freq	Message
2304	-20	2.06	984	
2316	-17	2.69	1087	* G3WDG VK7MO PF88 2 E

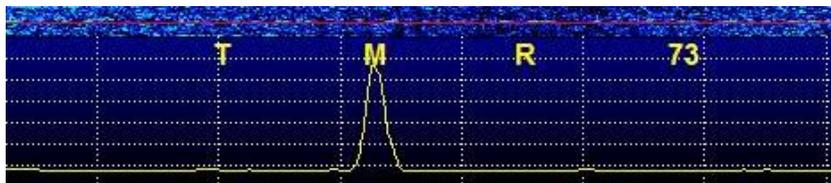
Average Decodes				
UTC	dB	DT	Freq	Message
2316	-17	2.69	1087	* G3WDG VK7MO PF88 2 E

Below the tables is a control bar with buttons: Log QSO, Stop, Monitor, Erase, Clear Avg, Decode, Enable Tx, Halt Tx, Tune. The main interface shows a frequency display at 10,368.200 000, a DX Call of VK7MO, and a DX Grid of PF88aa. A TX report box on the right lists messages for Tx 1 through Tx 6. The message 'VK7MO G3WDG -17' is selected for Tx 2. A text overlay with an arrow points to the message in the Single-Period Decodes table, stating: 'Double LEFT click message sends report to TX box 2 or 3 as appropriate'. Another arrow points from this text to the TX report box.

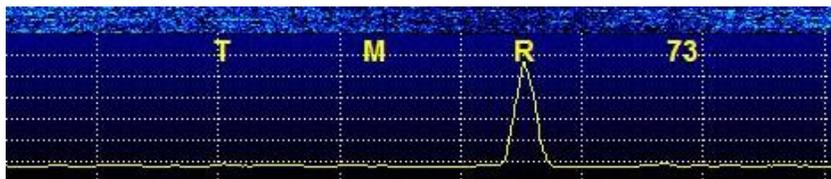
# Examples of single tone messages



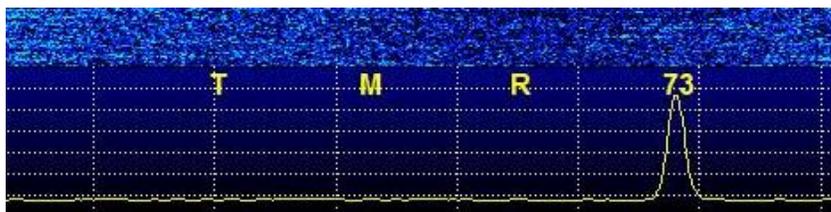
Tuning-in tone (1000Hz)



Please send messages (1250Hz)



RRR (1500Hz)

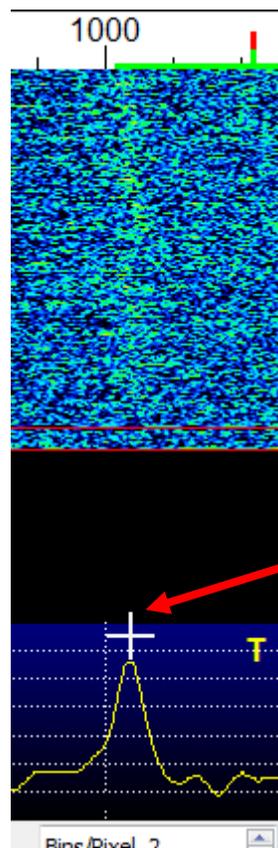


73 (1750Hz)

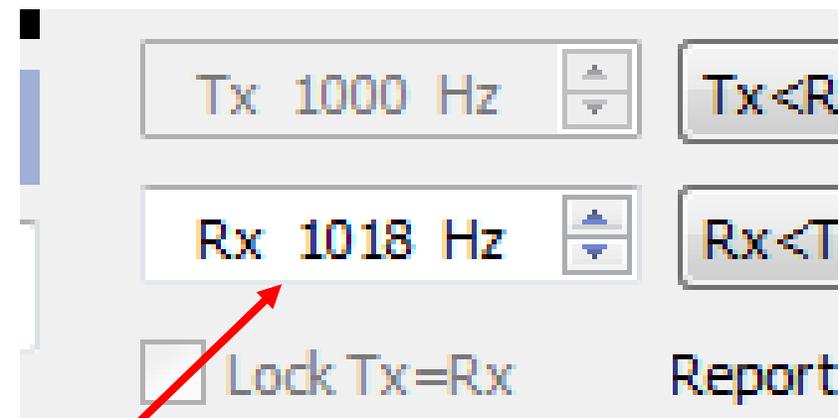
Note: Single tone messages are decoded by eye from the yellow average graph.

Do not use the red markers at the top of the waterfall (these mark the expected positions of the JT4 message tones),

# Determining tone frequency from wide graph



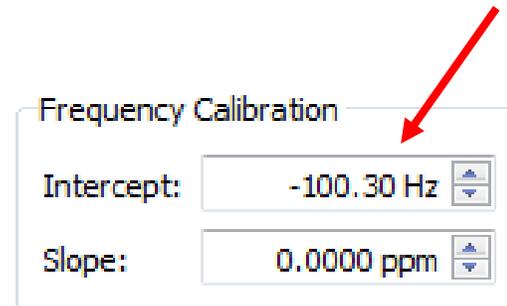
Place cursor on top of yellow peak and click



Read frequency from main window

# Calibrating a CAT non GPS locked radio

1. Inject a signal at IF eg 28 or 144MHz, 1000Hz above the set sked frequency. Ensuring Doppler compensation is set to “None”, measure the frequency of the tone as described on the previous page
2. Go to File->Settings->Frequencies and enter any difference from 1000Hz into the Intercept field in the Frequency Calibration. Slope stays at 0.

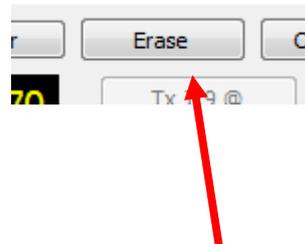


Example 1: If the tone is seen at 1125Hz, set intercept to  $(1125 - 1000) = 125$ .

Example 2: If the tone is seen at 975Hz, set intercept to  $(975 - 1000) = -25$

Calibration correction takes place after the Frequencies window is closed.

# Erasing message windows



Left click once to erase Average Decodes  
Double left click to erase Single-Period Decodes

# Power adjustment

The screenshot shows a software interface with a list of messages and a power slider. The messages are listed in a table with columns for 'Std Msgs', 'Next', and 'Now'. The 'Now' column contains buttons labeled 'Tx 1' through 'Tx 5'. To the right of the messages is a vertical slider labeled 'Pwr'. A mouse cursor is hovering over the slider knob, and a tooltip box displays the text 'Transmit digital gain -30.0dB'.

Std Msgs	Next	Now
IO92	<input checked="" type="radio"/>	Tx 1
-15	<input type="radio"/>	Tx 2
R-15	<input type="radio"/>	Tx 3
RRR	<input type="radio"/>	Tx 4
73	<input type="radio"/>	Tx 5
	<input type="radio"/>	Tx 6

Transmit digital gain -30.0dB

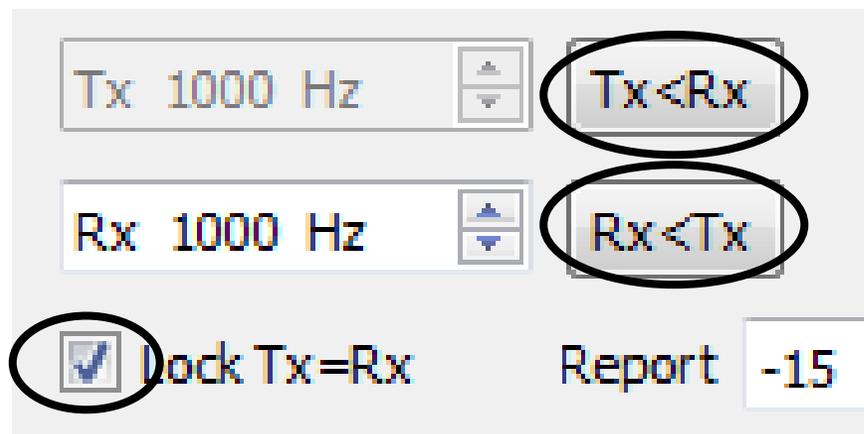
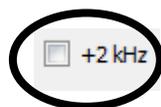
Power slider can be used to adjust TX power.

Provided that the system is linear, changing the digital gain by a given number of dB will change RF output power by the same number of dB.

Control range is 0 to -45dB

[Hover mouse over the slider knob to read the digital gain.]

Inactive buttons at 432MHz and up



Tx 1000 Hz

Rx 1000 Hz

Lock Tx=Rx Report -15

# Operating guide (WSJT-X to WSJT-X)

- Set sked frequency above band edge in Astro Window.
- If you are second station, left click on 1000Hz tuning signal from first station which transfers exact frequency to Rx box. Can click on waterfall trace or yellow spectrum peak. To start transmitting press Enable TX button.
- If you need to correct only your RX frequency later eg to accommodate a slightly drifting station, left click on their 1000Hz tuning-in tone or their lowest JT4 tone on the waterfall or yellow spectrum peak.
- Tick Sh to switch from long form messages to single tones, if desired. With 'Sh' ticked, 'Tx6' tick box switches TX6 message box from 1000Hz (Tune) to 1250Hz (Send Msgs).

Several EME tests using WSJT-X at both stations have been successful. Details are posted here:

<http://www.sucklingfamily.free-online.co.uk/WSJTXTwowaytest.pdf>

<http://www.sucklingfamily.free-online.co.uk/ok2aqq3wdg.pdf>

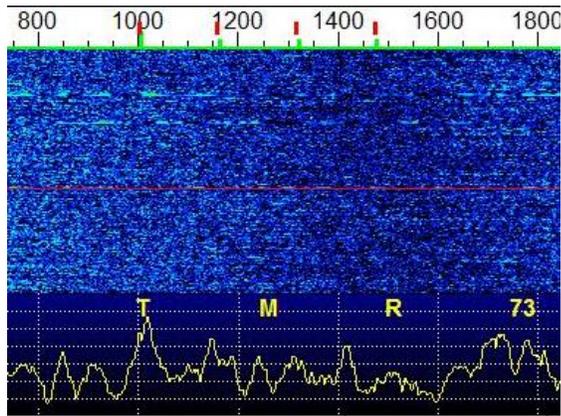
## JT4F Operating guide (WSJT-X to other station using WSJT10)

- Set sked frequency above band edge in Astro Window.
- Edit your tuning-in tone freq to 1270Hz by typing @1270 in TX6 message box
- Tick Sh to switch from long form messages to single tones if needed.
- Some single tone freqs now slightly different to WSJT10 - not an issue
- If you need to correct only your RX frequency eg to accommodate a slightly off-freq station, left click on the lowest JT4 tone from the other station, to change only your RX freq. Do not click on their 1270 tone, or it will offset your Rx Freq, as WSJT-X expects the tuning tone to be at 1000Hz.
- Tick Sh to switch from long form messages to single tones, if desired. The single tone messages transmitted by WSJT-X are in some cases slightly different to WSJT10 but not enough to cause any confusion.

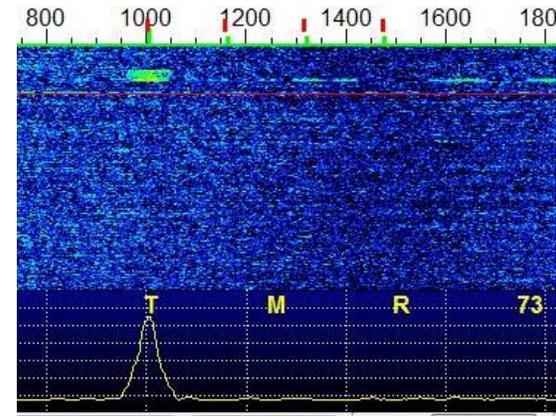
# Self echo testing

- Select 'Constant frequency on Moon' from Astro window
- Set sked frequency above band edge in Astro Window.
- Start a transmission of a single tone or other signal using "Tune" button, then press "Tune" again after about 3 seconds.
- Echo should appear on waterfall and yellow average graph at 1000Hz.
- Use PC's Print Screen facility quickly to save it if wanted, before traces disappear!

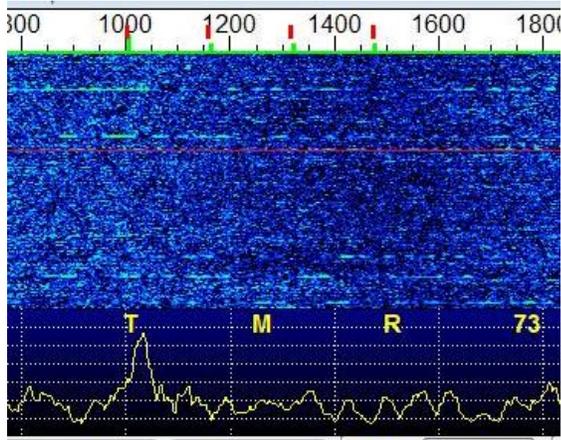
# Examples of single self echoes



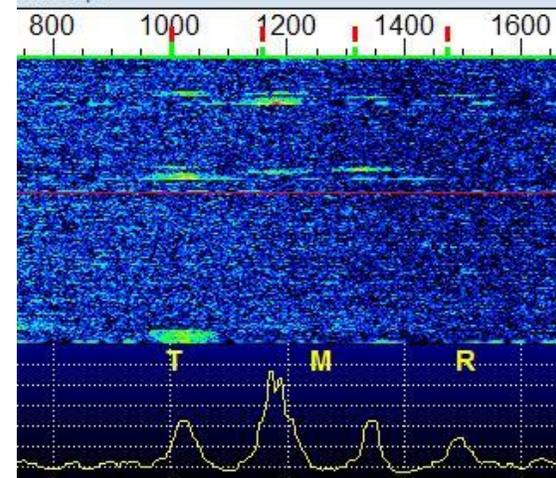
2W



100W



3W

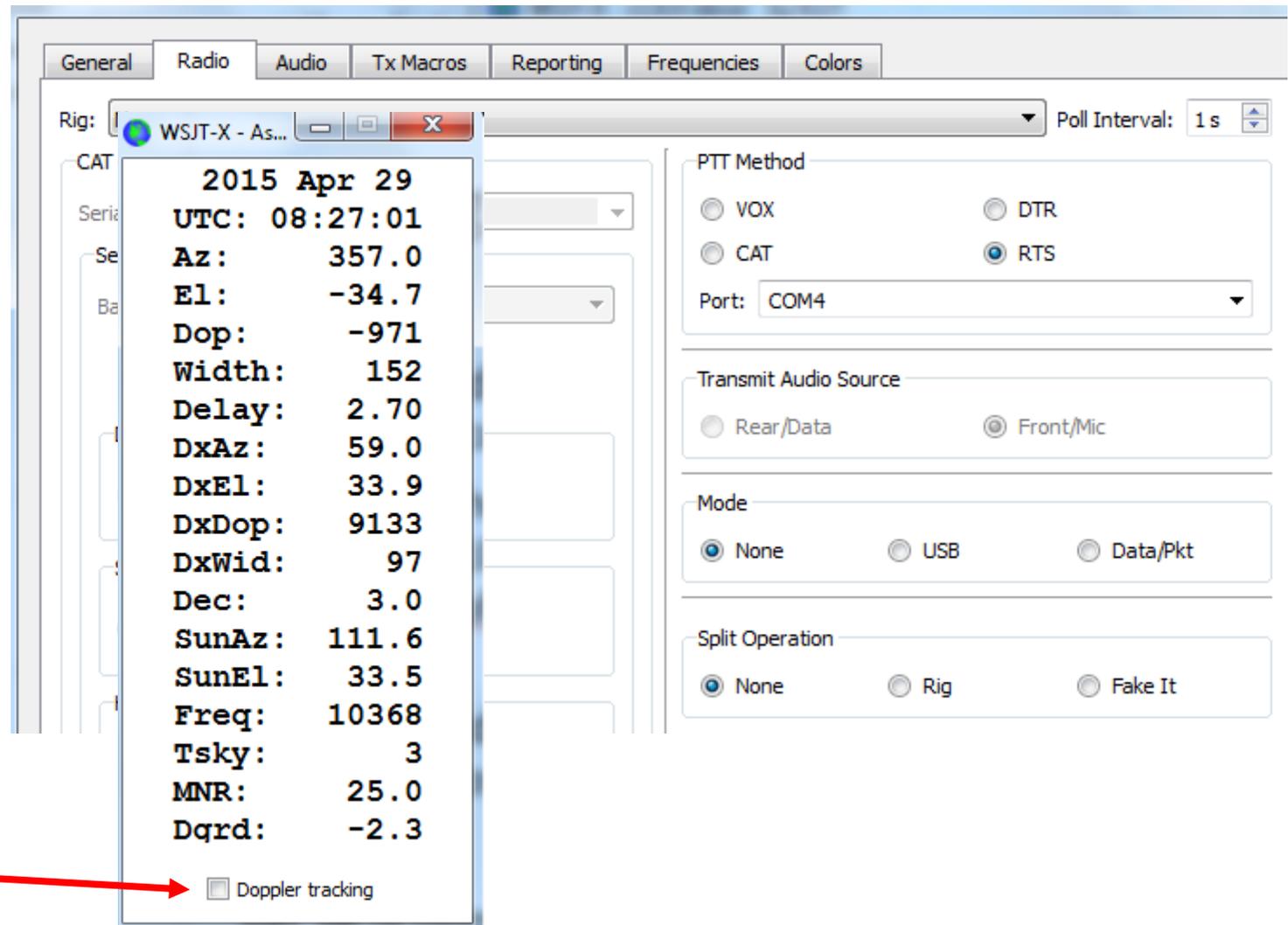


100W JT4F

10368MHz with 3m dish at different power levels – spread ~100Hz.  
1000Hz tones and JT4F

# Using a simple non CAT radio eg IC202

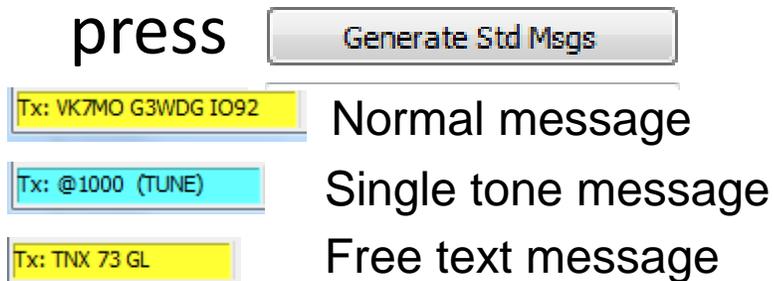
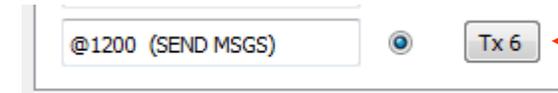
- Other station does full Doppler correction
- Tune in their 1000 tuning tone to 1000 on Widegraph as closely as poss
- RIT should be set to OFF or in zero position and not adjusted



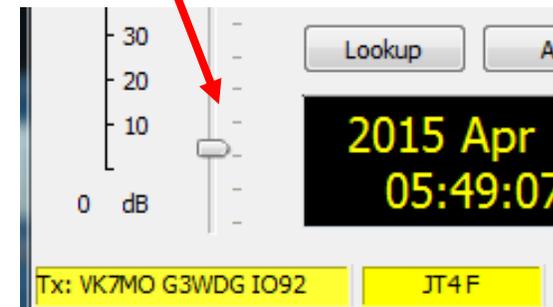
May get rig control error if this is ticked!

# Random notes - 1

- Audio level on TX may differ from WSJT10 and volume controls may need to be readjusted. For RX, use the same input audio level as previously used with WSJT10, and adjust slider to have audio at about 30 on the scale
- Remember to press button next to Tx Box to engage any changes to message in that box for immediate transmission.
- Observe that message box is sending is what you expect and if not press



Note: a Free Text message appears in colour in TX text box. Free text messages require stronger signals to decode compared to normal messages.



## Random Notes - 2

- As installed, WSJT-X does not come with a CALL3.TXT file, but will generate one automatically if Calls and grids are added with the “Add” button.
- Copying CALL3.TXT from a previous installation of WSJT10 can sometimes lead to degraded decoding of very weak signals and is not recommended.

# Sample files

Some sample files to play with are located at

<https://drive.google.com/file/d/0B116lwQIUfNTVkvTThGb0dVV1E/view?usp=sharing>

These files were received by G3WDG from VK7MO operating on 24GHz in PF88 with JT4F. The signals are marginal and not all periods will decode.

After downloading the files, unzip and copy them to the SAVE folder (see page 4 where to find this in WSJT-X).

Suggested initial settings for these recordings are MinW A, RX 1100, Ftol 100, Sync 0 and DT Tol 0.5.

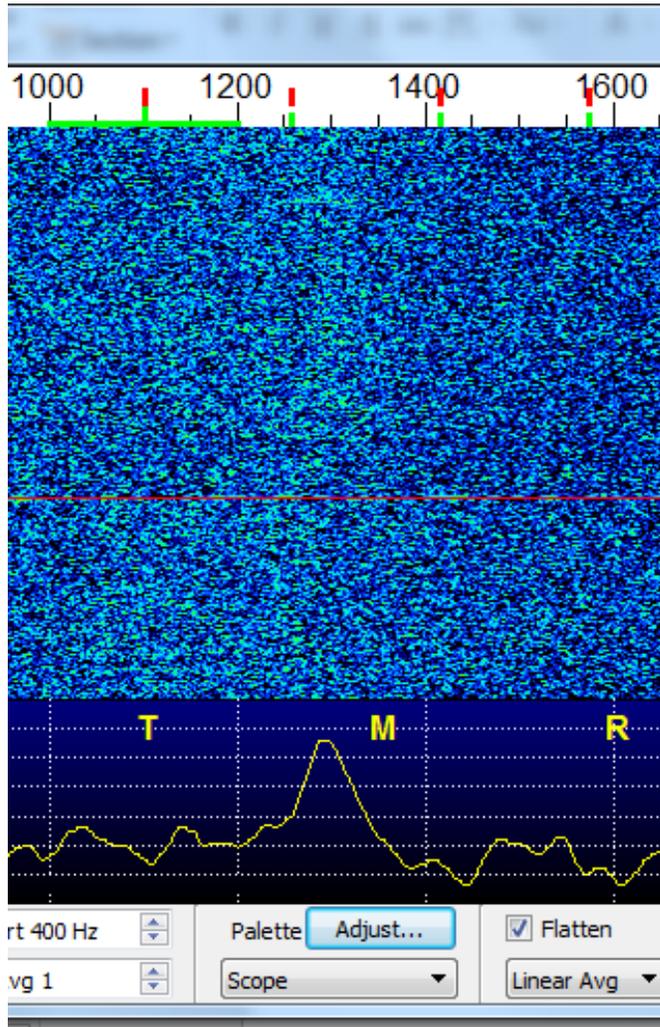
You will need (temporarily ) to set your call in Files->Settings->General to G3WDG (please remember to put it back to yours afterwards!). Enter VK7MO as DX Call and PF88 as DX Grid. Files are loaded using File->Open, clicking on the first one and then click Open. Files can then be replayed one at a time with F6 or all together using Shift F6.

Try the effects of varying the settings. Remember to Erase the message windows, and Clear Average after each run.

The .....2304 period was Rex's 1270Hz tone, which can be just seen on the waterfall, but clearly seen in the Average spectrum (with correct settings). All others are messages.



# Averaging example files decoded



2304 period showing  
VK7MO's tuning tone

The screenshot shows the WSJT-X v1.6.0-devel by K1JT interface. The main window is divided into two panes: 'Single-Period Decodes' and 'Average Decodes'. The 'Single-Period Decodes' pane shows a list of decoded messages with columns for UTC, dB, DT, Freq, and Message. The 'Average Decodes' pane shows a list of averaged messages with columns for UTC, dB, DT, Freq, and Message. Below the panes are various controls and buttons.

Single-Period Decodes					Average Decodes				
UTC	dB	DT	Freq	Message	UTC	dB	DT	Freq	Message
2304	-20	2.06	1006	#	2334	-16	2.74	1105	# G3WDG VK7MO -19 * D 8
2316	-17	2.69	1087	* G3WDG VK7MO PF88 2 E					
2318	-17	2.74	1072	#					
2320	-18	2.74	1133	#					
2322	-17	2.68	1081	# G3WDG VK7MO -19 9 E					
2324	-21	2.29	1113	*					
2326	-18	2.63	1107	#					
2328	-17	2.74	1105	#					
2330	-17	2.71	1094	# G3WDG VK7MO -19 6 E					
2332	-16	2.74	1089	#					
2334	-16	2.74	1105	# G3WDG VK7MO -19 8 E					

Buttons: Log QSO, Stop, Monitor, Erase, Clear Avg, Decode, Enable Tx, Halt Tx, Tune

Frequency: 3cm, 10,368.196 000

Call: VK7MO, PF88aa

Az: 74, 15866 km

2015 Jun 18 15:30:09

Buttons: Tx JT65 #, Tx even, Tx 1000 Hz, Tx<Rx, Rx 1100 Hz, Rx<Tx, Lock Tx=Rx, Report -15, Sync 0, Sh, Tx6, EME delay, MinW A, DT Tol 0.5, Submode F, F Tol 100

Buttons: Generate Std Msgs, Next, Now, Tx 1, Tx 2, Tx 3, Tx 4, Tx 5, Tx 6

Buttons: VK7MO G3WDG IO92, VK7MO G3WDG -15, VK7MO G3WDG R-15, @1500 (RRR), @1750 (73), @1000 (TUNE)

Status: VK7MO\_140816\_233400.WAV, JT4F, Last Tx: TUNE, Tx-Enable Disarmed, 0%

# Echo Mode overview

Echo mode transmits and receives repeated tones. The echo is displayed in the Echo Graph window, which builds up the echoes over time enabling weak echoes to be detected. Individual echo results also appear in a text window. N=number of echoes averaged, DF=freq offset from 1000Hz (only accurate for stronger signals).

Doppler correction mode '**Constant Frequency on Moon**' needs to be selected to use this mode.

Echo sequences are started by pressing 'Enable TX button' and terminated by pressing the same button again.

Echo Graph has similar gain, zero and smoothing controls to Widegraph. Bins/pixel is used to adjust the width of the displayed spectrum.

At any point, Echo Graph can be reset by pressing the 'Clear Average' button, which takes effect on the next receive period. The text window can be cleared by left click on 'Erase' button.

Windows should be sized and arranged so that Echo Graph is not behind any other window.

Attempts to detect marginal echoes are best done with low libration spreading ("Width" parameter in Astro window)

# Method of operation of Echo Mode

When you start Echo mode the program goes into a repeated 6-second cycle as follows:

- transmit a 1500 Hz tone for 2.3 s
- reset the dial frequency to account for EME Doppler shift
- receive the echo about 2.5 s later
- compute spectrum of received signal
- plot spectrum on expanded scale, centred at 1500 Hz

If a program crash occurs with Echo mode the first time it is used try editing `WSJT-X.ini` file, to change `EchoBPP=0` to `EchoBPP=1` This can be found in the settings for `[EchoGraph]`

# Echo Mode – 3m dish 10GHz 100W G3WDG

The screenshot displays the WSJT-X software interface. The main window shows a Wide Graph with a frequency range from 600 to 1800 kHz. A table of signal data is visible, listing UTC, N, Level, Sig, DF, Width, and Q. The current signal is identified as VK7MO G3WDG IO92. The Echo Graph shows a signal peak at approximately 10368 kHz. The Astronomical Data window provides details for the current date and time, including Azimuth, Elevation, and Doppler shift.

UTC	N	Level	Sig	DF	Width	Q
07:48:59	26	68.6	-20.7	15.4	25.6	10
07:49:05	27	68.2	-20.8	4.0	26.6	10
07:49:08	28	60.0	-20.8	4.0	26.6	10
07:49:11	29	57.4	-20.9	4.0	26.7	10
07:49:14	30	57.0	-20.9	4.0	26.7	10
07:49:17	31	57.0	-20.9	4.0	26.7	10
07:49:20	32	56.8	-20.9	4.0	26.7	10
07:49:23	33	56.7	-20.9	4.0	26.7	10
07:49:26	34	56.7	-20.9	4.0	26.7	10
07:49:29	35	57.1	-21.0	4.0	26.7	10

Frequency above nominal bar: 100 kHz, 0 Hz

2015 Jun 10  
 UTC: 07:49:32  
 Az: 201.6  
 El: 34.9  
 SelfDop: -5460  
 Width: 110  
 Delay: 2.44  
 DxAz: 206.9  
 DxEl: -49.8  
 DxDop: -6467  
 DxWid: 109  
 Dec: -0.8  
 SunAz: 96.4  
 SunEl: 34.4  
 Freq: 10368  
 Tsky: 3  
 MNR: 8.5

Frequency above nominal bar: 100 kHz, 0 Hz

Doppler tracking  
 Full Doppler to DX Grid  
 Constant frequency on I  
 None

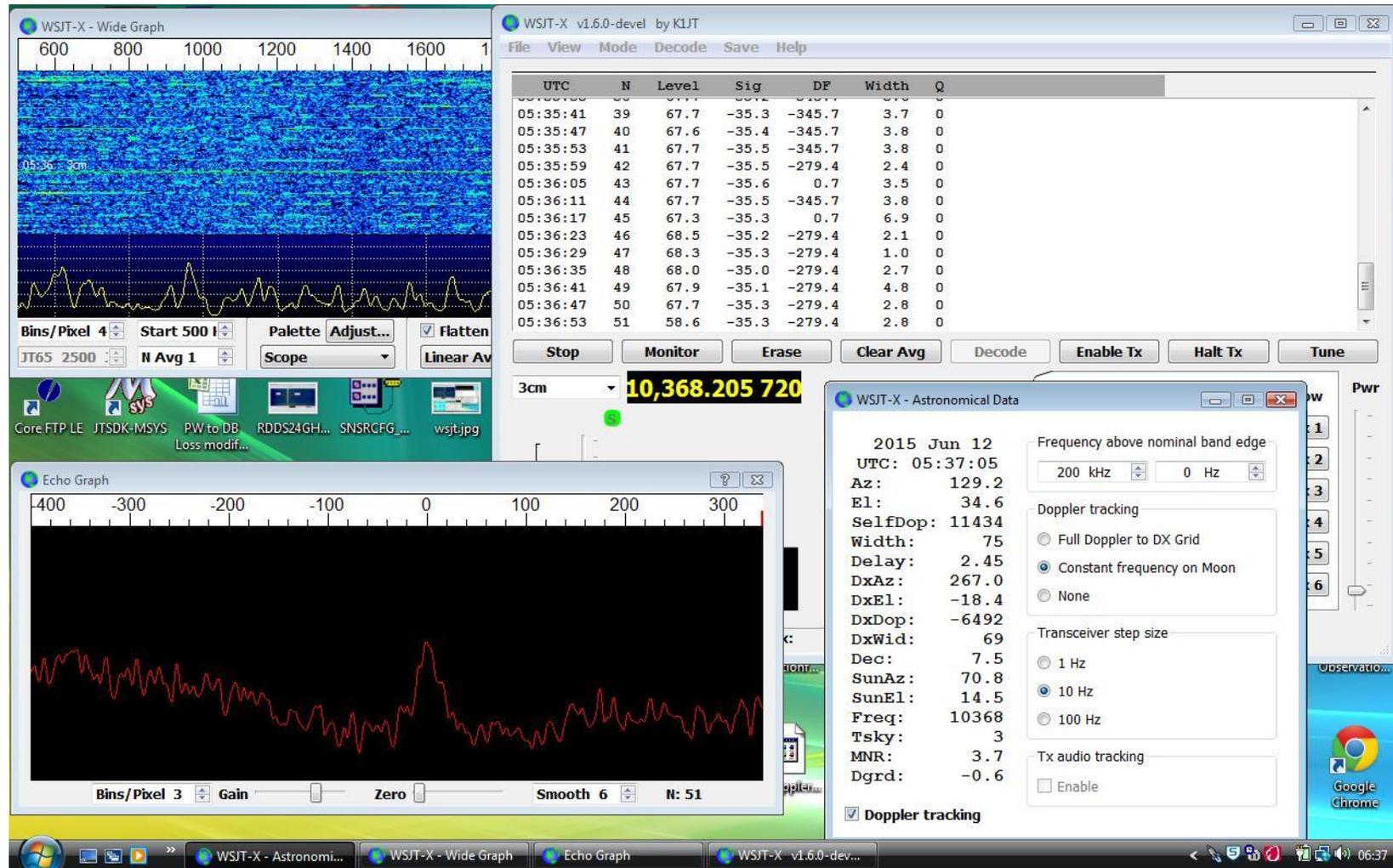
Transceiver step size  
 1 Hz  
 10 Hz  
 100 Hz

Tx audio tracking

Calculated S/N in 2500kHz bandwidth = -2dB

N=35 Spreading = 110Hz

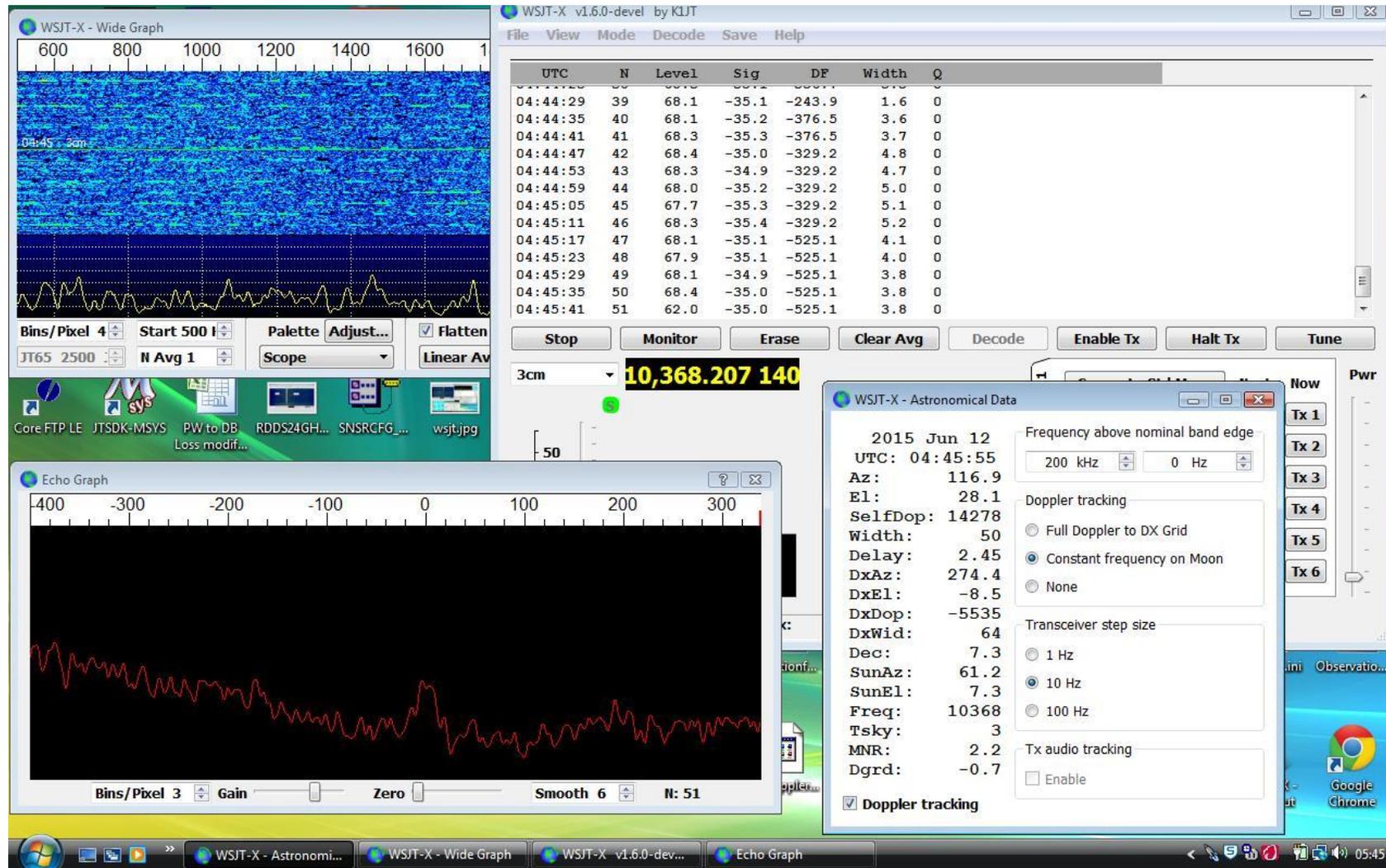
# Echo Mode – 3m dish 10GHz 1W G3WDG



Calculated S/N in 2500kHz bandwidth = -22dB

N=51 Spreading = 75Hz

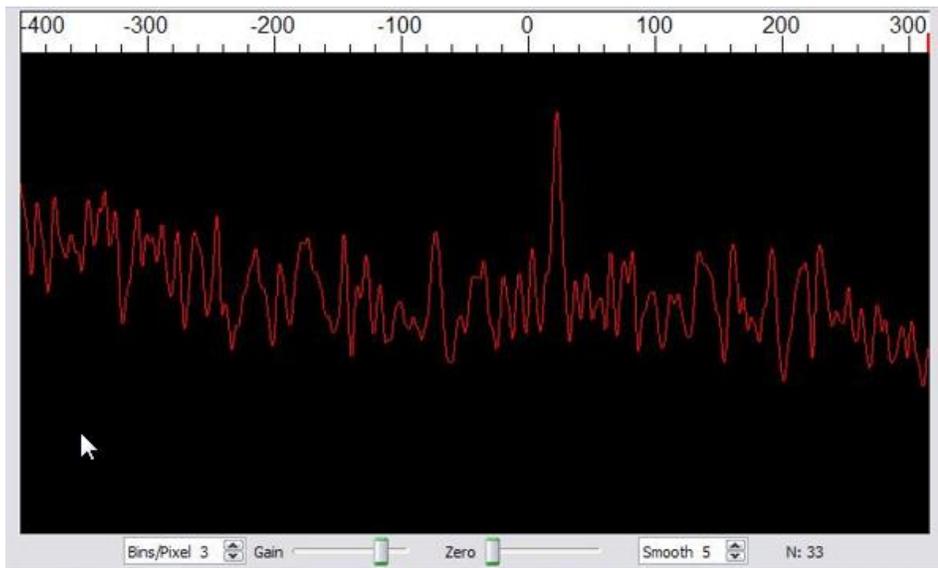
# Echo Mode – 3m dish 10GHz 400mW G3WDG



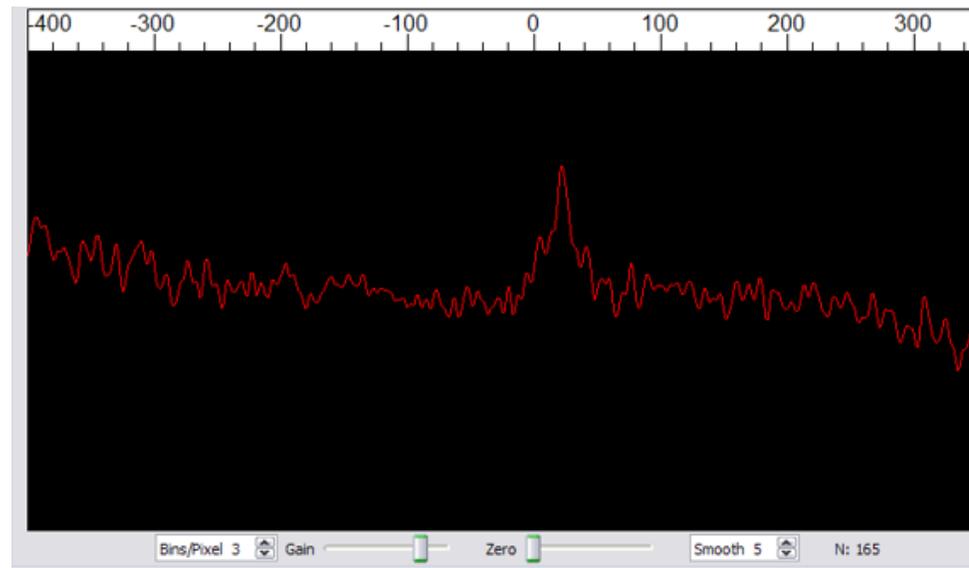
Calculated S/N in 2500kHz bandwidth = -26dB

N=51 Spreading = 50Hz

# Echo Mode – 76cm dish 10GHz 50W VK7MO



N=33 Spreading = 9Hz



N=165 Spreading = 35Hz

Calculated S/N in 2500kHz bandwidth = -27dB



# Decode success and false decodes – F Tol

- % decoding success range with Ftol of 500 to 10Hz of 23.4% and 33.3% represents only about 0.05 dB so Ftol is not all that critical
- If only periods with confidence of  $>2$  are used there are no false decodes, but 25% of good decodes would be missed.
- False decodes that could be misinterpreted were with calls and reports of -16, -16, -21 and -18. The others were either junk text or otherwise easily identified as false.

## Conclusions:

- 1. There is little penalty using Ftol of 100Hz , or even wider, in decoding success or likelihood of false decodes and offers greater tolerance to frequency offsets.**
- 2. Care needs to be taken in interpreting decodes from marginal signals with confidence of 2 or less, such as waiting for another decode to confirm.**

# Decode success and false decodes – DT Tol

The same signal files have been used to study the effect of the DT Tol setting, using Ftol=100Hz with the following results:

		DT Tol (Seconds)		0.3	0.8	3
		Correct Decode		30.3%	29.9%	29.5%
		Nil Decode		67.6%	68.0%	68.6%
		False Decode		2.1%	2.1%	1.9%
X=	2	False Decode Quality >X		0.0%	0.0%	0.0%
		Correct Decode Quality <=X		6.9%	6.9%	6.7%
		"" as % of Correct decodes		22.6%	22.9%	22.6%
		Good # Sync		86.5%	85.9%	85.9%
Y=	0.2	Good DT with +/-Y	Sec	97.1%	93.3%	89.0%
		Good DT & Sync	Sec	85.5%	84.6%	82.7%
		Av reported S/N	dB	-17.9	-17.9	-17.9
		Simulated S/N	dB	-22.5	-22.5	-22.5

The loss in decoding sensitivity going from 0.3 to 3 sec amounts to only 0.01dB, so **use of wide DT Tol is considered OK**

# Effect of MinW

DT Tol = 1 sec, Sync=0, F Tol 100 Hz Test Signal -22.5 dB with 200 Hz spreading

	Min W		A	B	C	D	E	F
	Correct Decode		30.3%	30.3%	30.3%	30.1%	29.0%	20.8%
	Nil Decode		67.6%	67.6%	67.6%	68.2%	69.9%	78.7%
	False Decode		2.1%	2.1%	2.1%	1.7%	1.1%	0.6%
X=	2	False Decode Quality >X	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Correct Decode Quality <=X	6.9%	6.9%	6.9%	7.0%	7.2%	6.3%
		''' as % of Correct decodes	22.6%	22.6%	22.6%	23.4%	25.0%	30.3%
		Good # Sync	86.5%	86.5%	86.5%	86.5%	86.5%	86.5%
Y=	0.2	Good DT with +/-Y	Sec	93.0%	93.0%	93.0%	93.0%	93.0%
		Good DT & Sync	Sec	84.6%	84.6%	84.6%	84.6%	84.6%
		Av reported S/N	dB	-17.9	-17.9	-17.9	-17.9	-17.9
		Simulated S/N	dB	-22.5	-22.5	-22.5	-22.5	-22.5

Conclusion: **No penalty in using MinW=A.** Time to decode increases for wider signals, as expected.

# Effect of Sync Setting

DT Tol = 1 sec, minW=A, F Tol 100 Hz Test Signal -22.5 dB with 200 Hz spreading

	Sync		0	1	2	3	4
	Correct Decode		30.3%	23.2%	15.0%	7.0%	1.9%
	Nil Decode		67.6%	75.0%	83.8%	92.4%	98.1%
	False Decode		2.1%	1.7%	1.1%	0.6%	0.0%
	False decodes as % of Correct		6.9%	7.4%	7.6%	8.1%	0.0%
X=	2	False Decode Quality >X	0.0%	0.0%	0.0%	0.0%	0.0%
		Correct Decode Quality <=X	6.9%	5.3%	3.8%	1.9%	0.6%
		"" as % of Correct decodes	22.6%	23.0%	25.3%	27.0%	30.0%
		Good # Sync	86.5%	64.0%	37.7%	16.2%	4.2%
Y=	0.2	Good DT with +/-Y	Sec	93.0%	93.0%	93.0%	93.0%
		Good DT & Sync	Sec	84.6%	63.2%	37.7%	16.2%
		Av reported S/N	dB	-17.9	-17.9	-17.9	-17.9
		Simulated S/N	dB	-22.5	-22.5	-22.5	-22.5

Conclusions: Number of correct decodes reduces with increasing Sync setting. While % of false decodes decreases with increasing Sync setting, the % of false decodes relative to number of decodes is essentially constant. Thus increasing sync setting uses more sked time to get a correct decode and is of no benefit. **Recommend therefore to use Sync=0.**

# Receiving DLOSHF 10GHz JT4G EME beacon

The screenshot displays the WSJT-X v1.6.1-devel interface. On the left, a waterfall plot shows a signal at 10.368 MHz. Below it, a spectrum plot shows peaks labeled 'T', 'M', 'R', and '73'. The top right panel, 'Single-Period Decodes', contains a table of received messages:

UTC	dB	DT	Freq	Message	UTC	dB
1728	-5	3.25	1037*	DLOSHF 28NEZ	*	A
1729	-14	3.43	1039*			
1730	-5	3.25	1024*	DLOSHF 30NEJ	*	A
1731	-13	3.43	1028*			
1732	-5	3.25	1026*	DLOSHF 32WAP	*	A
1733	-15	3.31	1048*			
1734	-5	3.25	1033*	DLOSHF 34JAW	*	A
1735	-16	2.40	1035*			
1736	-6	3.25	1026*	DLOSHF 36PEC	*	A
1737	-14	3.43	1030*			
1738	-4	3.25	1022*	DLOSHF 38GAG	*	A
1739	-13	2.97	930*			
1740	-6	3.37	934*	DLOSHF 40WUF	*	A
1741	-12	2.74	938*			
1742	-6	3.25	928*	DLOSHF 42ZAW	*	C
1743	-14	2.06	936*			
1744	-5	3.14	919*	DLOSHF 44BYD	*	C
1745	-13	2.29	934*			
1746	-6	3.14	921*	DLOSHF 46HUM	*	D
1747	-19	3.31	1028#			
1748	-6	3.25	1028*	DLOSHF 48BEB	*	A
1749	-16	2.06	1017*			
1750	-5	3.25	1017*	DLOSHF 50KAT	*	A

The bottom right panel shows the 'JT4G' mode selected, with a frequency of 10,368.036 200 MHz and a time of 2015 Apr 29 17:50:58. A red arrow points from the text 'JT4G (for DLOSHF)' to the 'JT4G' mode button.

Note the DT at about 3.25s – this is normal for DLOSHF

JT4G (for DLOSHF)

When finished listening to the beacon and moving on to other tests, suggest to reset to JT4F!

# Compiling WSJT-X in Windows (to get the latest version) - 1

Download and install in this order:

[http://sourceforge.net/projects/jt sdk/files/win32/2.0.0/base/contrib/vcredist\\_x86.exe/download](http://sourceforge.net/projects/jt sdk/files/win32/2.0.0/base/contrib/vcredist_x86.exe/download)

<http://sourceforge.net/projects/jt sdk/files/win32/2.0.0/base/contrib/OmniRig.zip/download>

Go to: <http://sourceforge.net/projects/jt sdk/files/win32/2.0.0/>

and download the two files: JTSDK-2.0.0-win32.exe and JTSDK-2.0.0-u1-win32.exe

Then install the first one (this will likely need to be done using "Run as Administrator"). Once this is installed, install the second one (which is an update). The files should install themselves into C:\JTSDK.

Then update the JTSDK as follows:

Windows Start Button --> All Programs → JTSDK --> Update JTSDK

Type **update** then when that is finished **upgrade**.

**Note: Some of these operations can take a long time and one of the files is a large download!**

# Compiling WSJT-X in Windows (to get the latest version) - 2

To do the build, open up JTSDK-QT which should have a desktop icon. The first time that you attempt to build WSJT-X, you will be asked to "Checkout". Just follow the instruction in the JTSDK window. This only needs to be done the first time, and not for subsequent builds.

## Build commands:

```
Either build-wsjtx rinstall
```

This creates `wsjtx\install\Release`. You can copy the files in that directory to another location or machine. Normally you only need the `wsjtx.exe` executable (need to try this).

```
Or build-wsjtx package
```

This creates an installable for you, which is overkill if you're constantly updating. The output location is displayed on the screen after building.

Each build updates or overwrites any previous one automatically. If you answer "Y" to updating from SVN it will update the source directory to whatever was the latest commit by the team. If you say 'N', it will build whatever is already in `C:\JTSDK\src\wsjtx`.

If you have used "package", install the .exe file as you would if downloaded from Joe's site. If you have used "rinstall" the `wsjtx` that runs will be in this directory:



# Compiling – more information

From time to time:

Start a Maintenance Terminal: Start > Programs > JTSDK > Tools > JTSDK Maintenance then type: update upgrade

To build WSJT10, use..



build-wsjt package

# Document revisions and references

Please check here for any updated version of this document:

<http://www.sucklingfamily.free-online.co.uk/WSJT10toX.pdf>

References:

<http://www.sucklingfamily.free-online.co.uk/Doppler%20Tests%202%20June%202015.pdf>

<http://www.sucklingfamily.free-online.co.uk/Doppler%20Tests%2023%20May%202015.pdf>