# TBARC Programs
# FT8: New WSJT-X Mode

Original Presenter: Israel K7HI

BAARC Presenters: Guy Shipley WB5MXO, Kent Powell K5WTS

&

Dan Woods W5BM

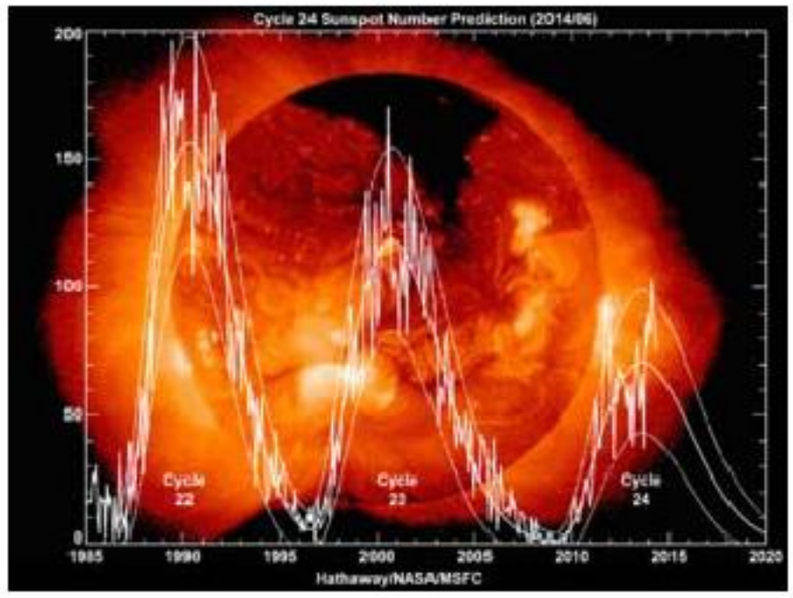
# Overview

1. Introduction to WSJT Modes
2. Downloading & Installing WSJT-X Software
3. Dimensions-D – Time Synchronization
4. Setup, Audio and CAT Configurations
5. Frequencies
6. FT8 Basic Operation
7. Power Level & ALC
8. Monitoring FT8
9. Answering FT8 Calls
10. Calling CQ
11. Logging QSOs

# Reasons to Operate Digital Modes

- **Reasons to use digital modes include:**

1. **More punch than (analog) voice**
2. **Better signal to noise ratio (S/N)**
3. **Forward Error Correction (FEC)**
4. **Bandwidth efficiency (better usage of spectrum)**
5. **Better performance relative to analog SSB/AM**
6. **QSOs can be recorded (and played back)**
7. **Solar Cycle Minimum**



# WSJT-X Version 1.8.0 Has FT8

- **WSJT-X Version 1.8.0 includes a new digital mode named FT8**
- **FT8 was developed by Steven Franke, K9AN and Joe Taylor, K1JT.**
- **FT8 stands for "Franke and Taylor, 8-FSK modulation".**
- **FT8 provides 50% or better decoding probability down to -20 dB on an AWGN (*) channel.**
- **FT8 maintains good performance on Doppler-spread fading channels.**
- ***"It 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..."[Joe Taylor] .***

***(*) Note: AWGN = Additive White Gaussian Noise***

# FT8 Designers

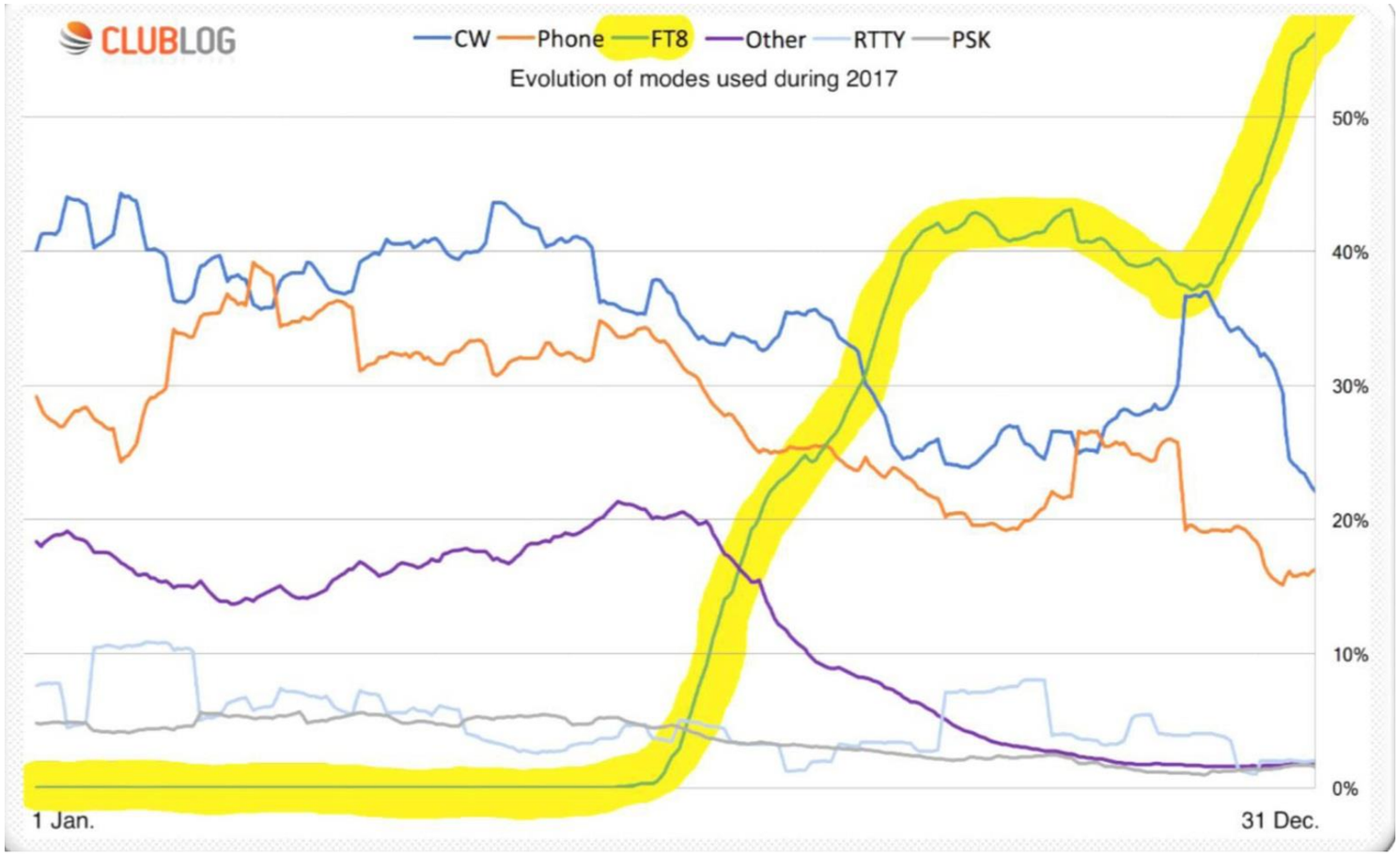

**Steven J. Franke, K9AN**
**Professor, Associate Head for Graduate Affairs**
**Dep. of Electrical and Computer Engineering**
**University of Illinois at Urbana-Champaign**

- **Illinois Radar Interferometer System (IRIS) (2012-)**
- **Urbana Meteor Radar (2008-2009)**
- **Maui Meteor Radar (2002-2007)**
- **Ionospheric Tomography**

**Joe Taylor, K1JT**
**Princeton University**
**University of Massachusetts Amherst**

- **Albert Einstein Medal (1991)**
- **Wolf Prize in Physics (1992)**
- **Nobel Prize in Physics (1993)**
- **Karl Schwarzschild Medal (1997)**

# GROWTH OF FT8




| Mode 05/05/2018 | Count last 2 hours 4:43 pm CST |
|---|---|
| FT8 | 1010266 |
| CW | 14105 |
| PSK63 | 3804 |
| RTTY | 2145 |
| PSK31 | 1635 |
| JT65 | 1547 |

# FT8 Characteristics

- **Some important characteristics of FT8:**
  - **T/R sequence length: 15 s (4 times faster than JT65/JT9)**
  - **Message length: 75 bits + 12-bit CRC**
  - **FEC code: LDPC**
  - **Modulation: 8-FSK, tone spacing 6.25 Hz**
  - **Constant-envelope waveform**
  - **Occupied bandwidth: 50 Hz**
  - **Transmission duration: 12.64 s**
  - **Decoding threshold: -20 dB (several dB lower w/ AP decoding)**
  - **Multi-decoder finds and decodes all FT8 signals in passband**
  - **Optional Auto-Sequencing/Auto-Reply to a CQ response**
  - **Operational behavior similar to JT65 and JT9**

***Source: Joe, K1JT, for the WSJT Development Team***
***http://physics.princeton.edu/pulsar/K1JT/Release_Notes_1.8.0.txt***

# WSJT-X Modes Decoding Threshold

***Relative Sensitivity in a 2500 Hz Bandwidth (*)***

| Mode | SNR Threshold | T/R Period |
|---|---|---|
| WSPR | -30 dB | 2 min |
| JT9 | -27 dB | 2 min |
| JT65 | -24 dB | 2 min |
| **FT8** | **-20 dB (**)** | **30 sec** |

***(*) Values are approximate***

***(**) – 23 dB when AP becomes available***

# What is Needed to Get Started?

- **At a minimum:**
  1. **PC running Windows XP/7/8/10 or Linux.**
  2. **SSB HF or VHF transceiver**
  3. **PC to Radio Interface (e.g. Signalink, Rigblaster)**
  4. **Connecting Cables**
  5. **WSJT-X Software version 1.8.0 or better**




# Digital Modes Typical Setup


PC +
Sound Card
+ Sw App

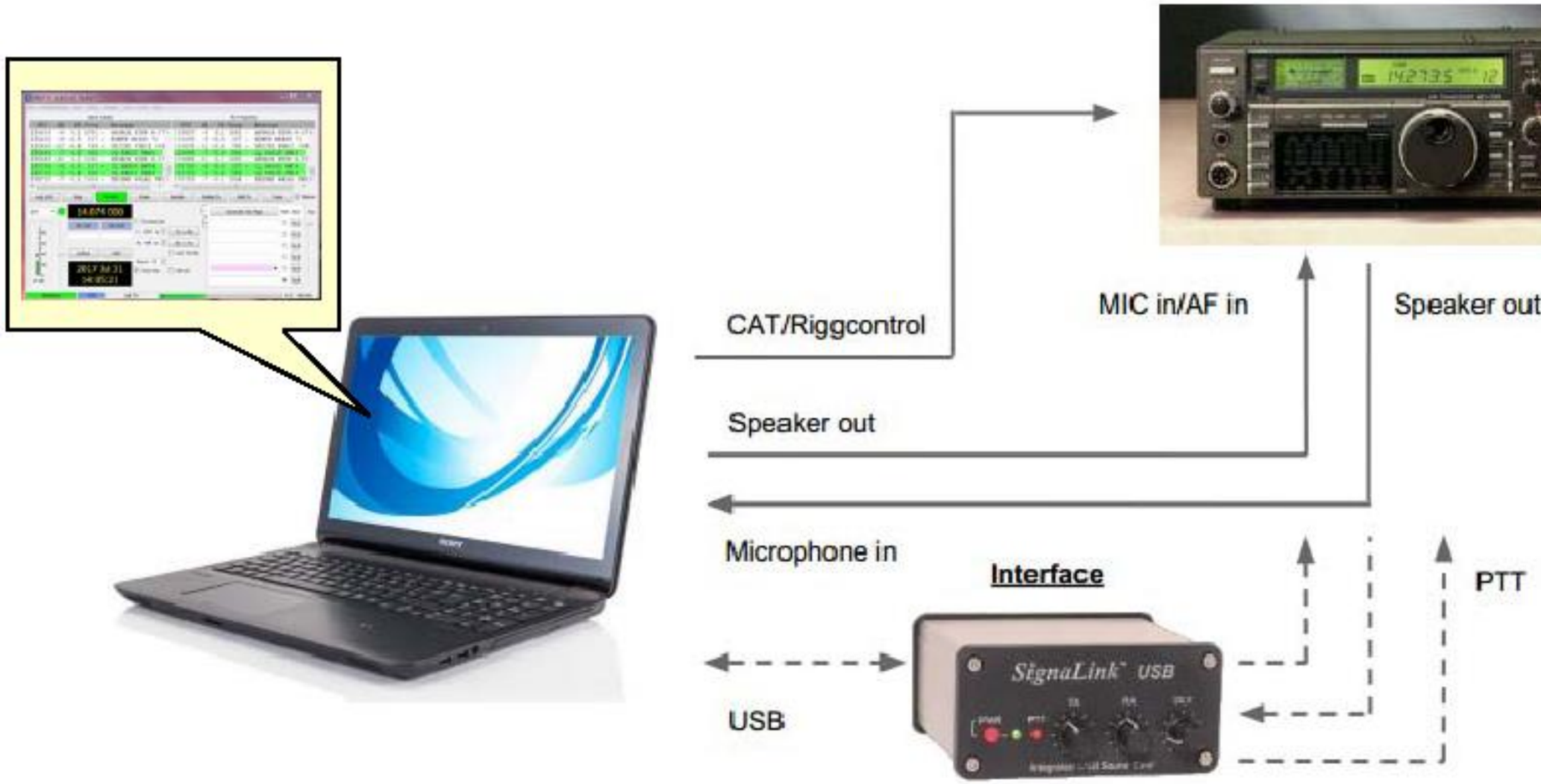
Audio/Control
Interface

Radio
Transceiver

- WSJT-X modes have 100% duty cycle
- Operating rig at full power may result in overheating and damage to the rig
- Choose appropriate power level for the capabilities of your rig.

Audio modulation level and ALC adjustment are very import as transmitter must maintain linear operation to avoid distortion of the digital signal.

# WSJT-X Basic Setup




**This is the same setup for most digital modes**

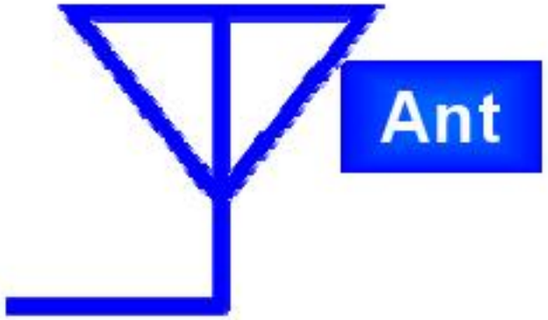
***Credit: SM7VRZ page https://sm7vrz.wordpress.com/jt9-english/***

# WSJT-X Basic Setup


Interface


Transceiver


Ant



**This setup works for most digital modes**


**Radios like TS-590 and IC-7300 do not require an interface**


# FT8 Basic Installation Steps

1. Download WSJT-X and Dimensions-4
2. Install WSJT-X and Dimensions-4
3. Connect PC, Interface and Radio
4. Configure Audio & CAT
5. Setup Your Station Information
6. Turn Off any speech processor or compression
7. Adjust Signal Levels, ALC, Power, etc.
8. Check signal reception and decoding
9. Transmit into a dummy load for testing
10. Ask another ham to monitor and report your first transmissions

# WSJT-X Download & Installation

- **Download WSJT-X software and Docs from here:**
  - http://physics.princeton.edu/pulsar/k1jt/wsjtx.html

**Candidate Release for *WSJT-X* Version 1.8.0-rc1**

**Release Notes:**
http://physics.princeton.edu/pulsar/k1jt/Release_Notes_1.8.0.txt

**Installation packages:**

**Windows:**

- Version 1.8.0-rc1: wsjtx-1.8.0-win32.exe. (runs on Win XP, Vista, Win 7, Win 8, Win10, both 32- and 64-bit).

*download this one*

- **Install WSJT-X into its own directory, for example C:\WSJTX or C:\WSJT\WSJTX, rather than the conventional location C:\Program Files\WSJTX**

# Download Dimension4 & JTAlert

- **Dimension-4**
  - http://www.thinkman.com/dimension4/
  - **Dimension4 synchronizes your computer's clock if you're running a Windows-based operating system.**

- **JTAlert (Optional)**
  - http://hamapps.com/
  - **WSJT-X FT8 requires JTAlert version to 2.10.1 or later.**

# JT ALERT

**Audio and visual alerts for several alert conditions**

- **CQ & QRZ**
- **Wanted Call sign**
- **Wanted Prefix (by Ban/Mode)**
- **Wanted Grid (by Band/Mode)**
- **Wanted US State (by Band/Mode)**
- **Wanted DXCC (by Band/Mode)**
- **Wanted CQ Zone (by Band/Mode)**
- **Wanted Continent (by Band/Mode)**
- **Wanted CQ Marathon (by Band/Mode)**

**Automatic logging to these log types when QSO is logged in JT65-HF or WSJT-X**

- **DXLab DXKeeper**
- **ACLog**
- **Log4OM**
- **HRD Log V5**
- **Standard ADIF 2.2 file**
- **MixW CSV file**

# Connecting PC-Interface-Radio

- **There are many types of interfaces, the link below provides step-by-step instructions to connect a Tigertronics SignaLink™ USB, which is a popular interface used by many hams operating digital modes:**

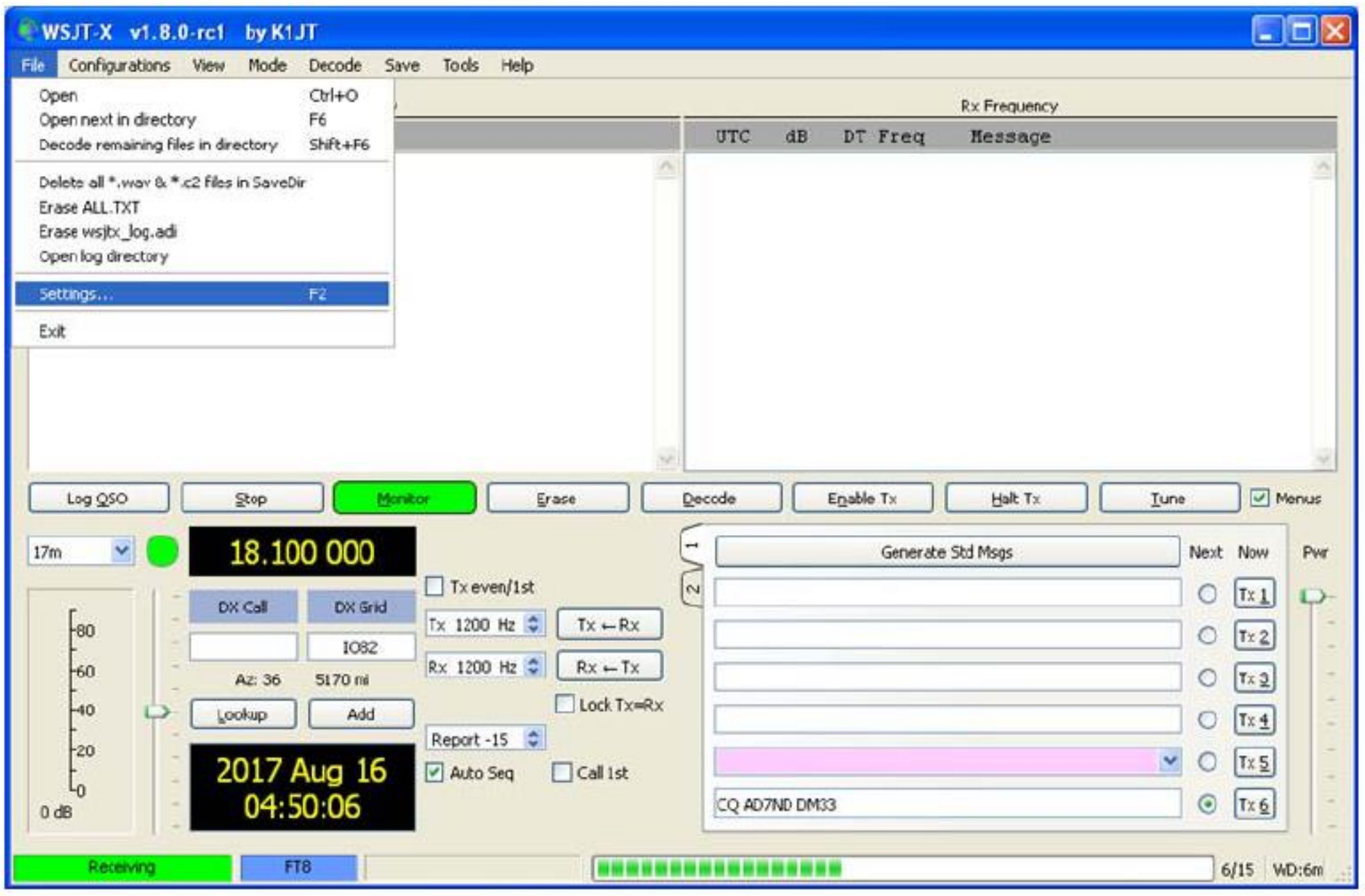
**http://www.tigertronics.com/sl_suprt.htm**

- **Rigblaster, Unified Microsystems, kits available in the internet and even homebrew can be used**

***Remember… some modern rigs don't need an external interface. Check before you buy hardware that you may not need.***

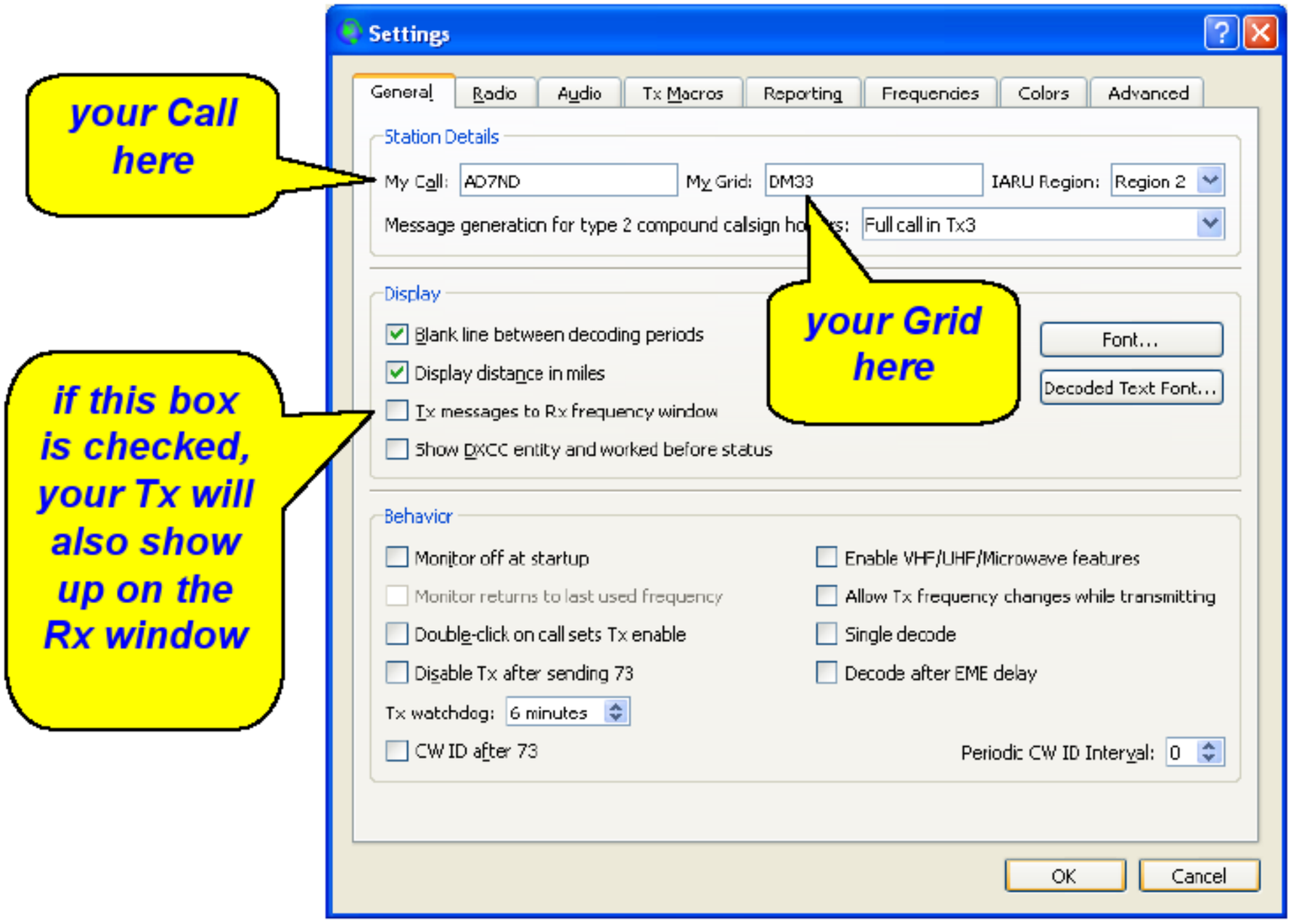
# WSJT-X Settings

## Click on File → Settings

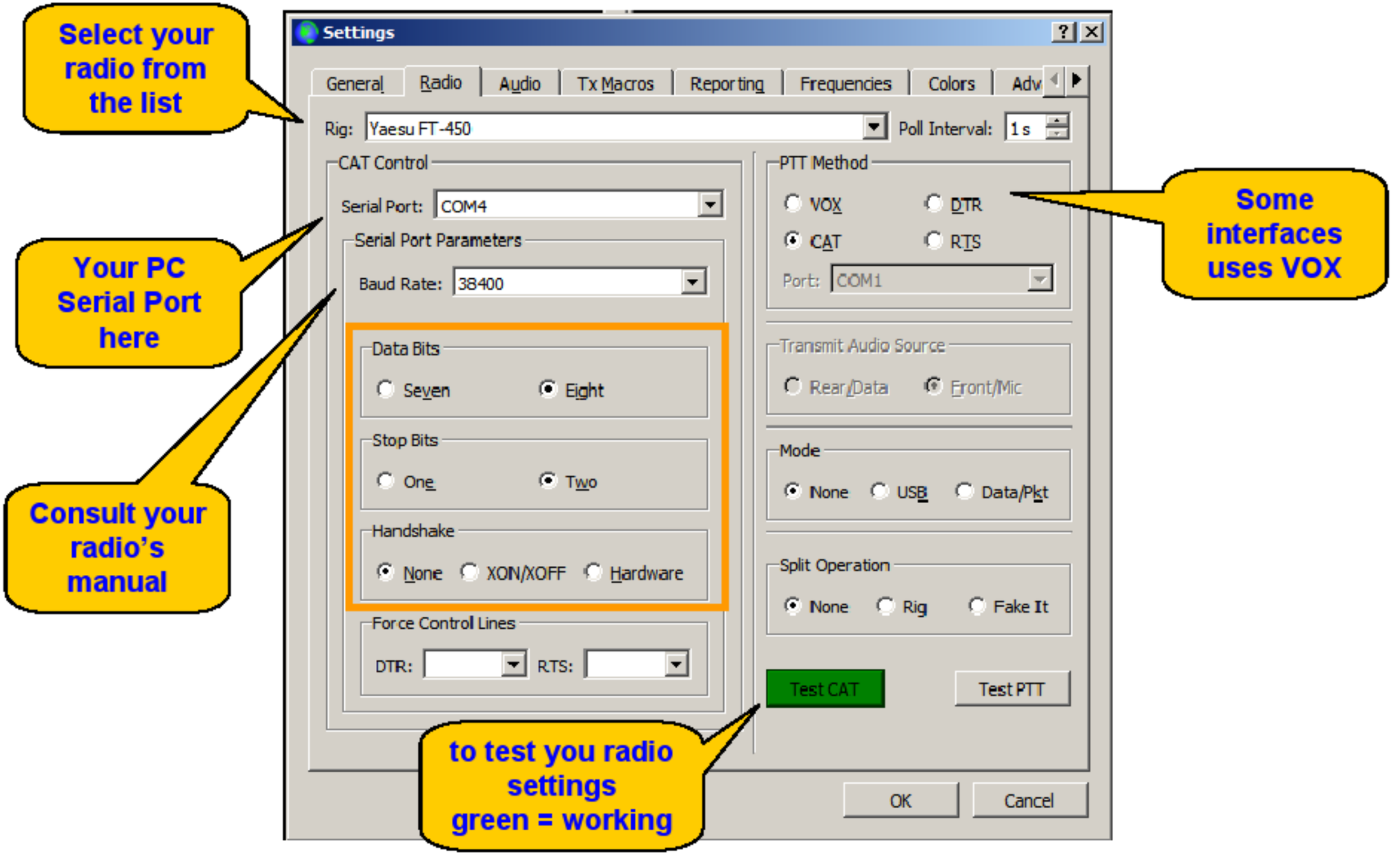


# WSJT-X Settings

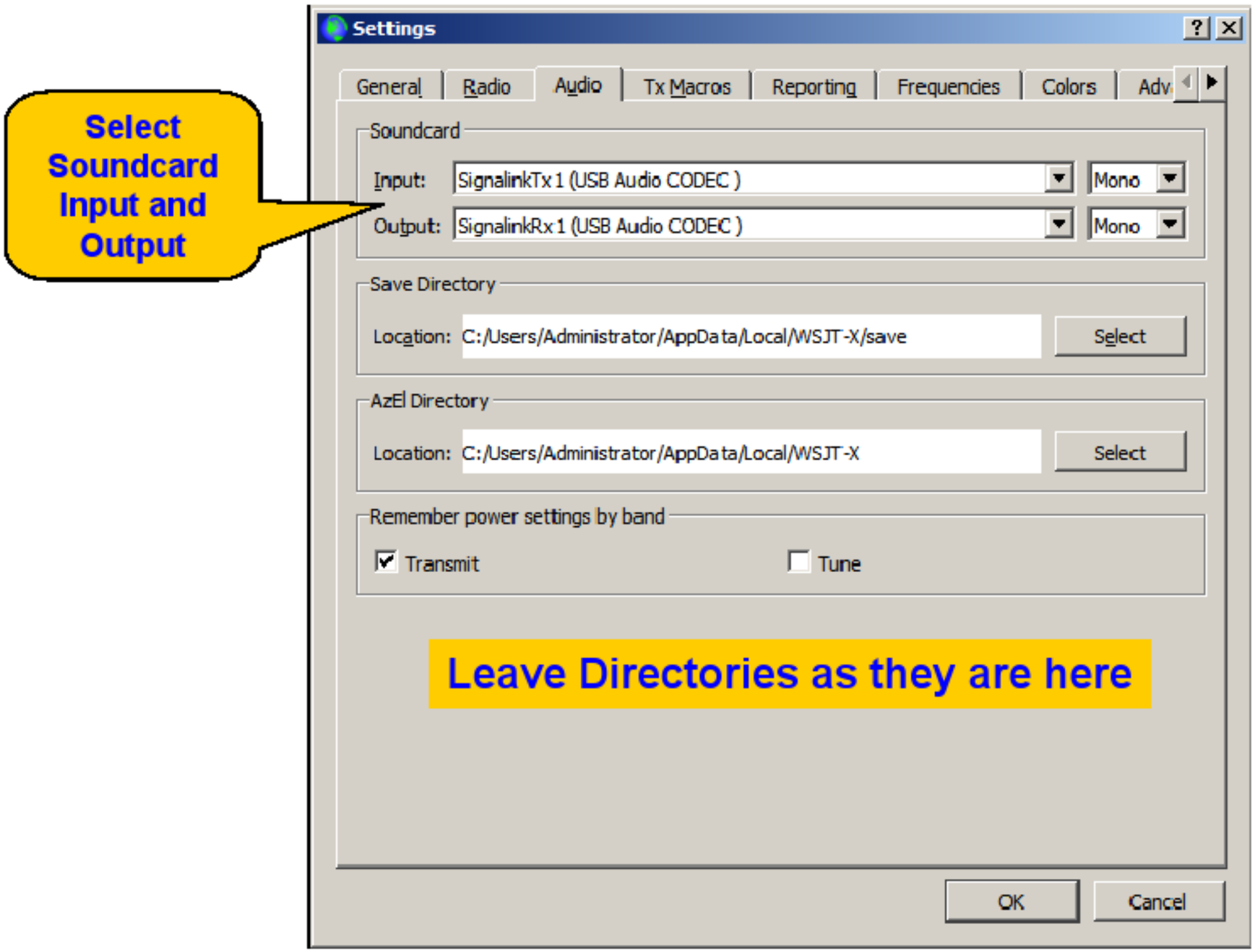
## Call, Grid and Blank Line should suffice to start



# WSJT-X Settings – Radio Tab



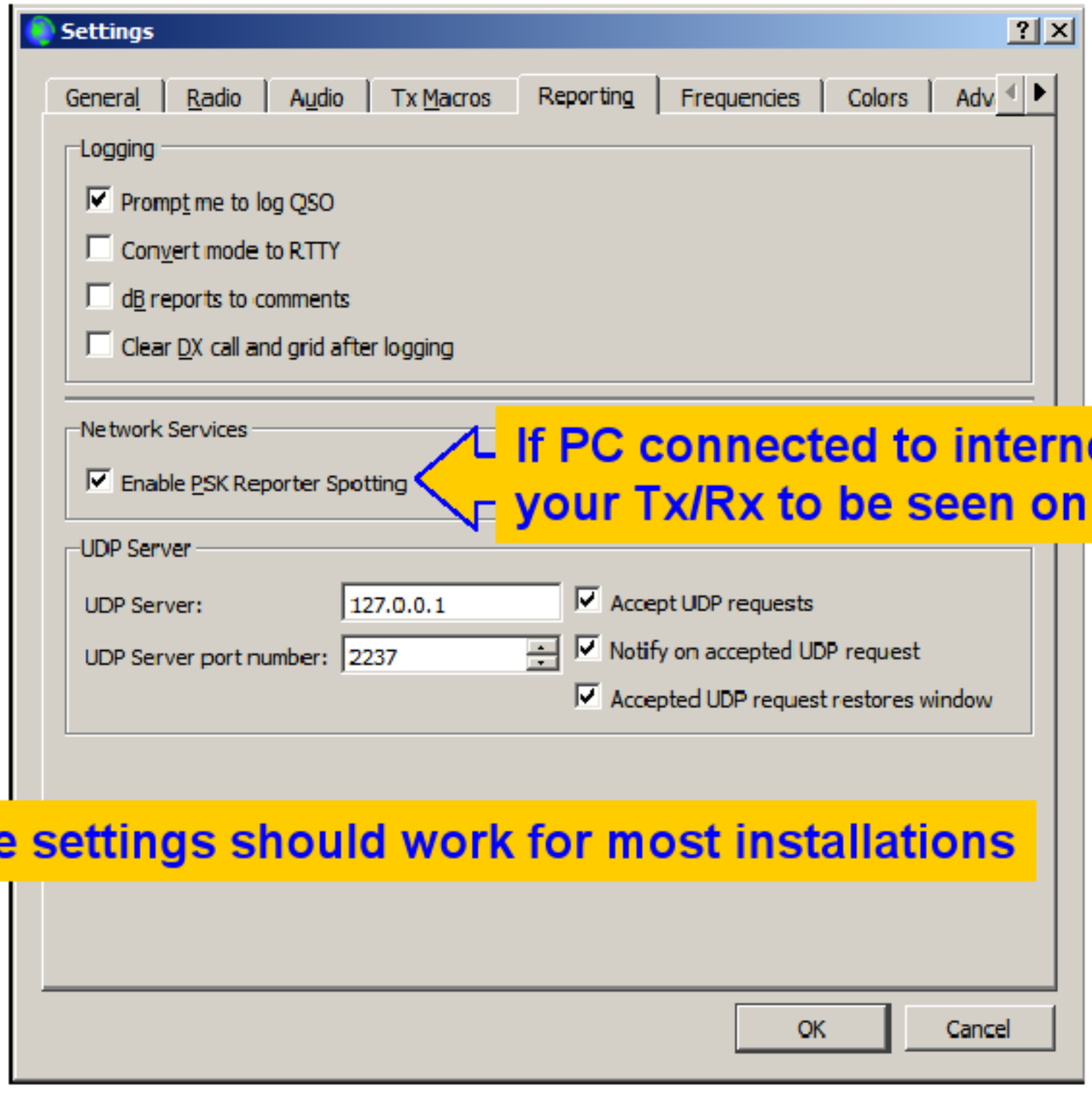
# WSJT-X Settings – Audio Tab




**Select Soundcard Input and Output**

**Leave Directories as they are here**

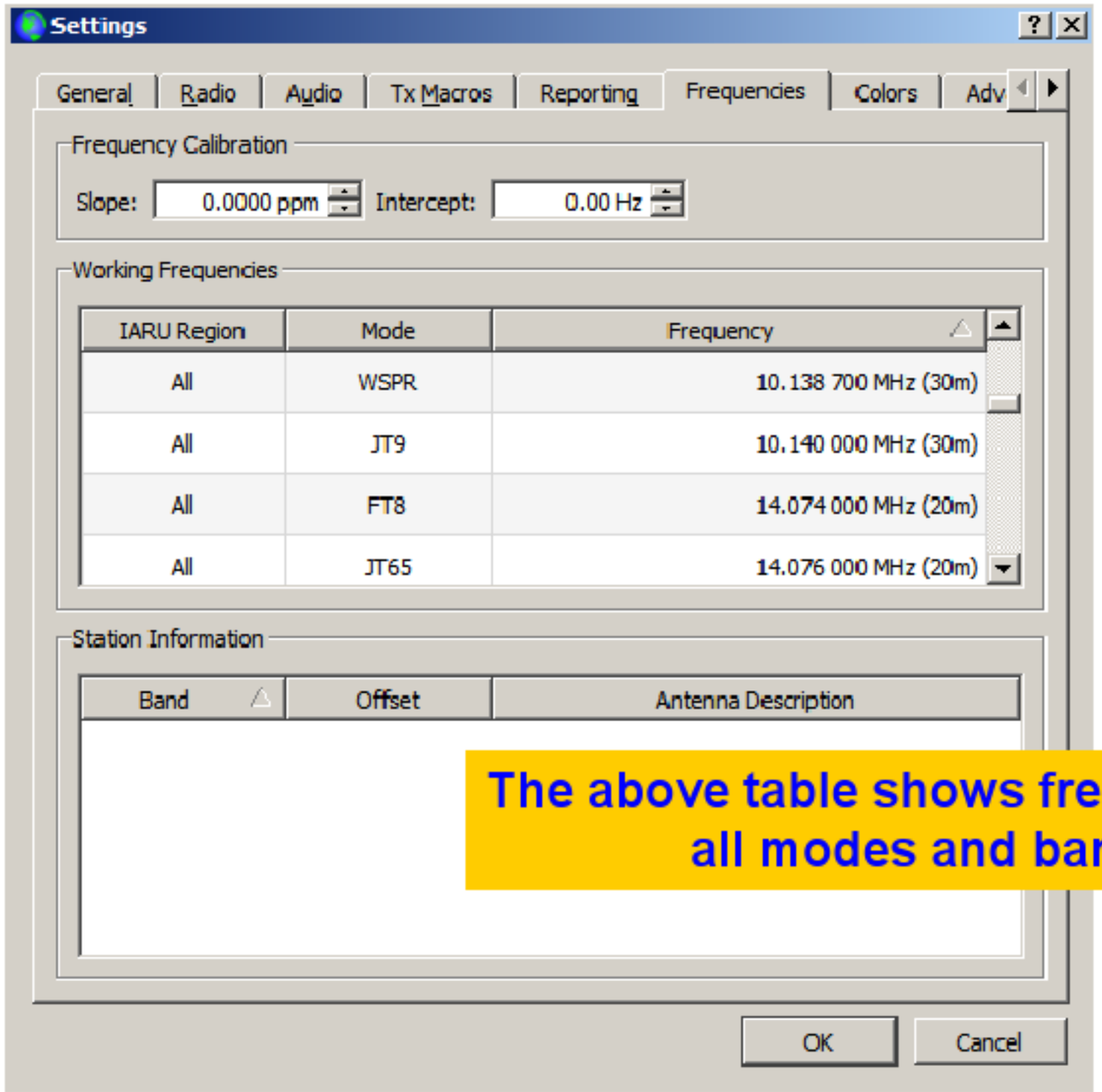
# WSJT-X Settings – Reporting Tab




**If PC connected to internet, this enables your Tx/Rx to be seen on PSKReporter**

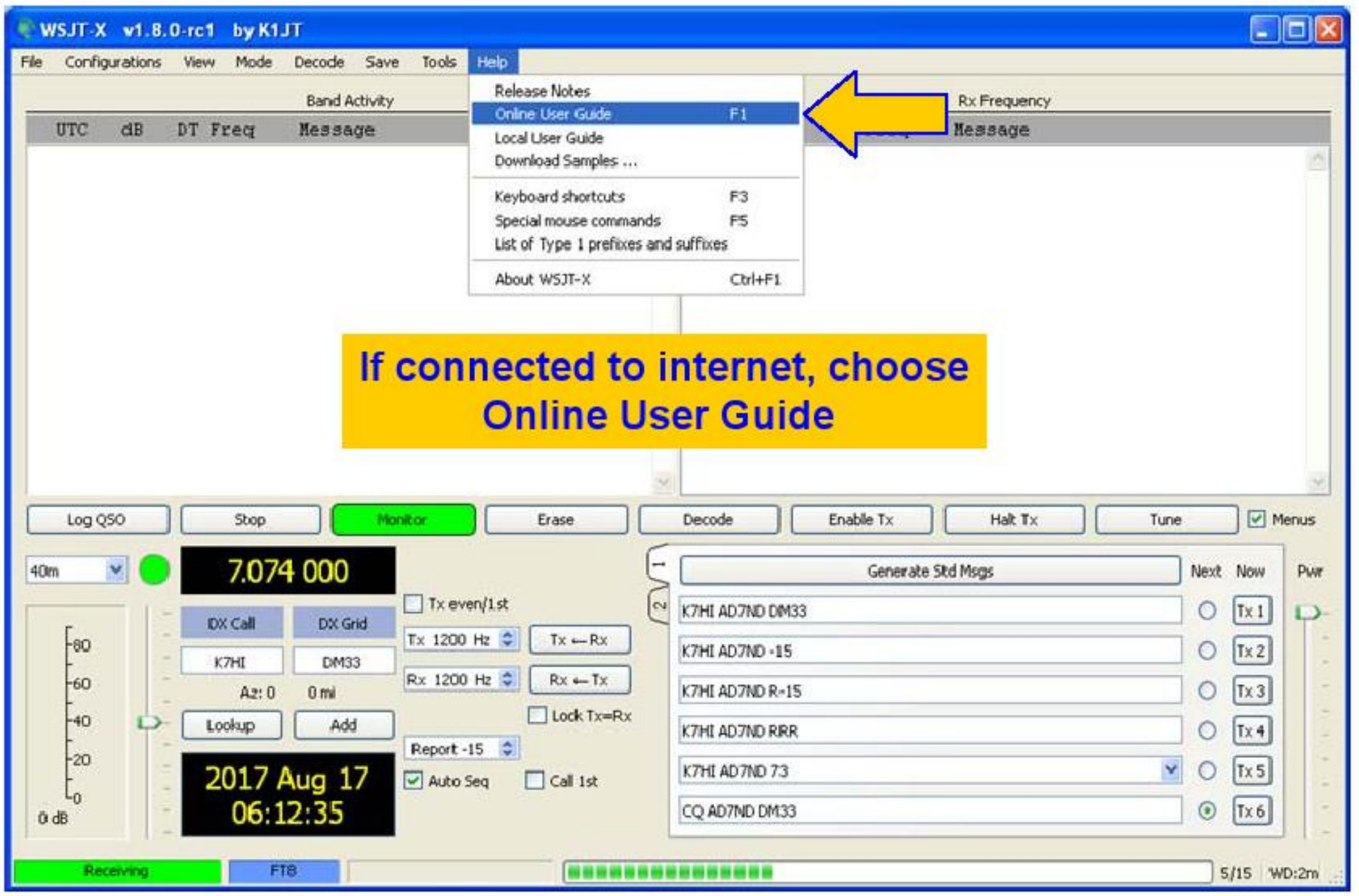
**The above settings should work for most installations**

# WSJT-X Settings – Frequencies Tab

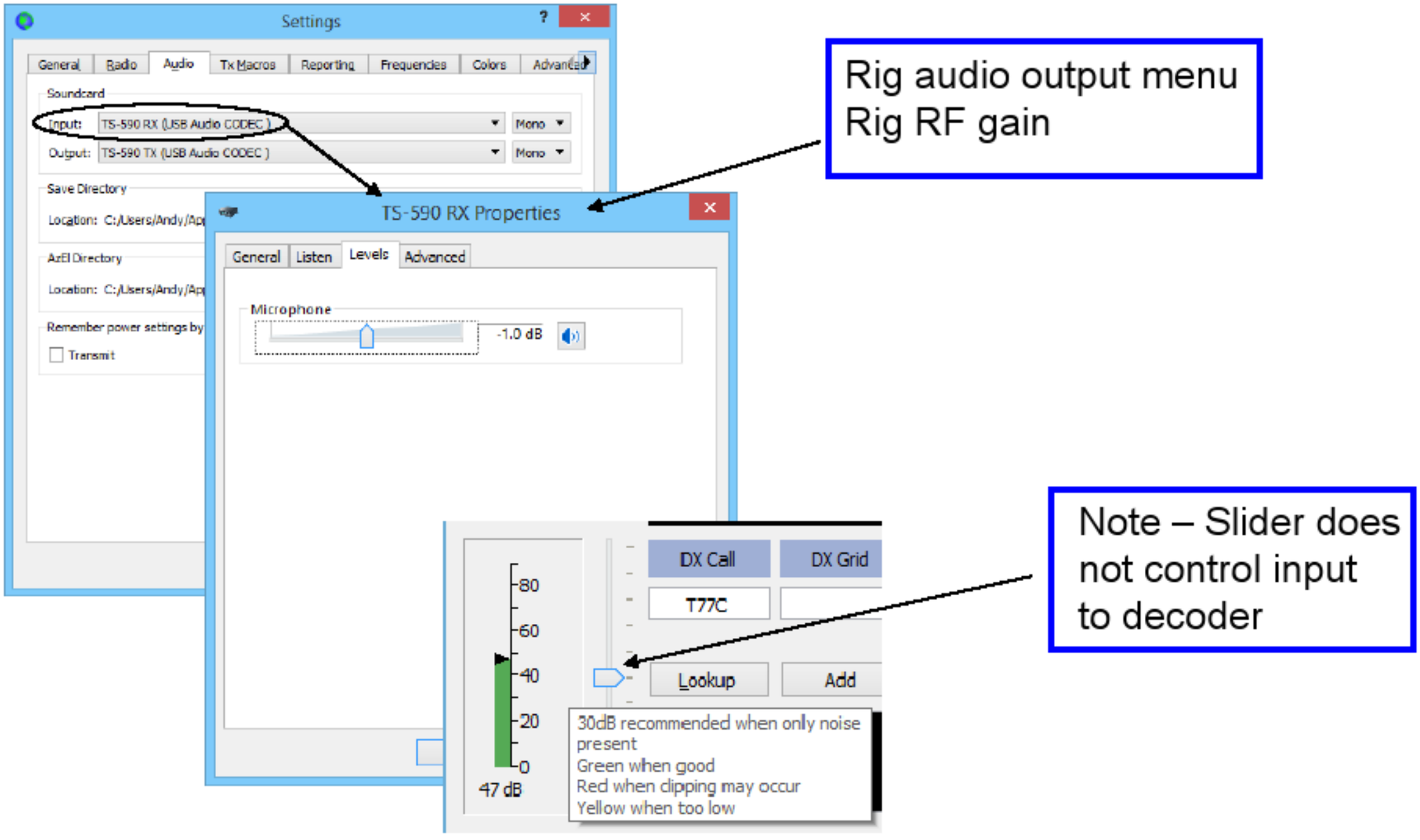



**The above table shows frequencies for all modes and bands**

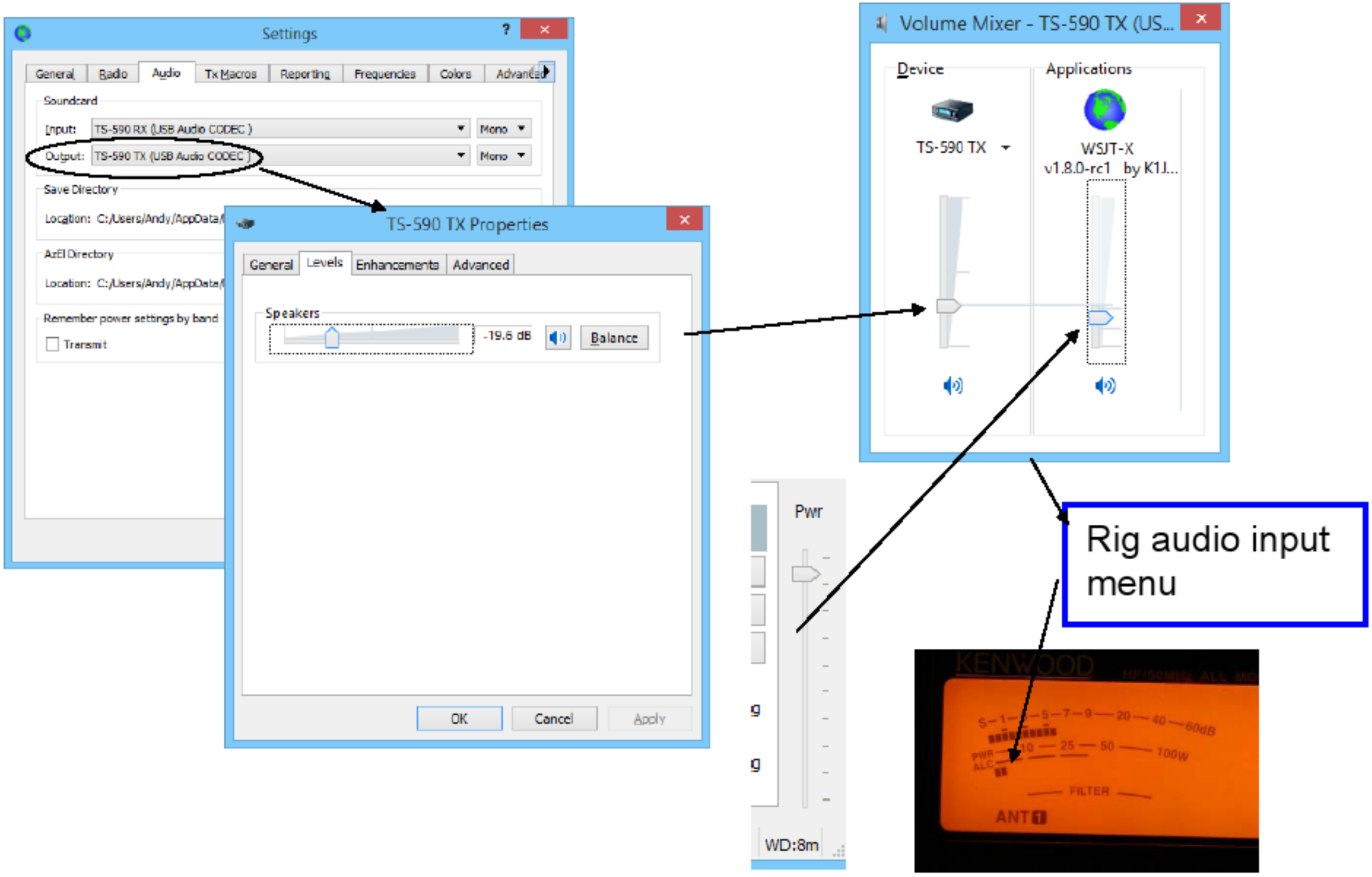
# WSJT-X Link to User Guide



# Configuring RX Audio

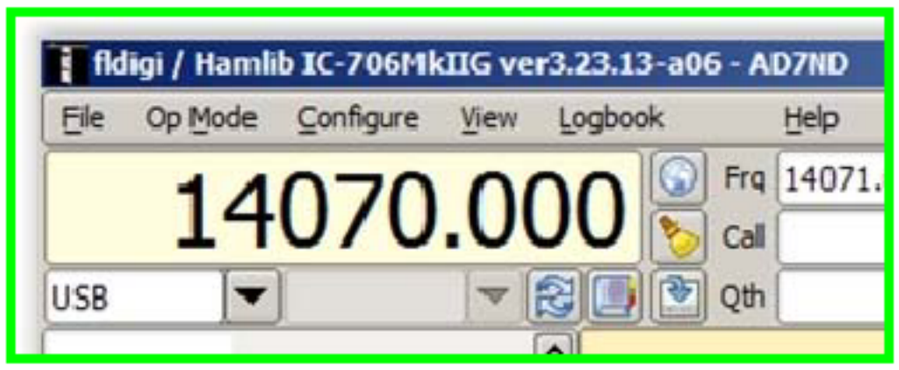


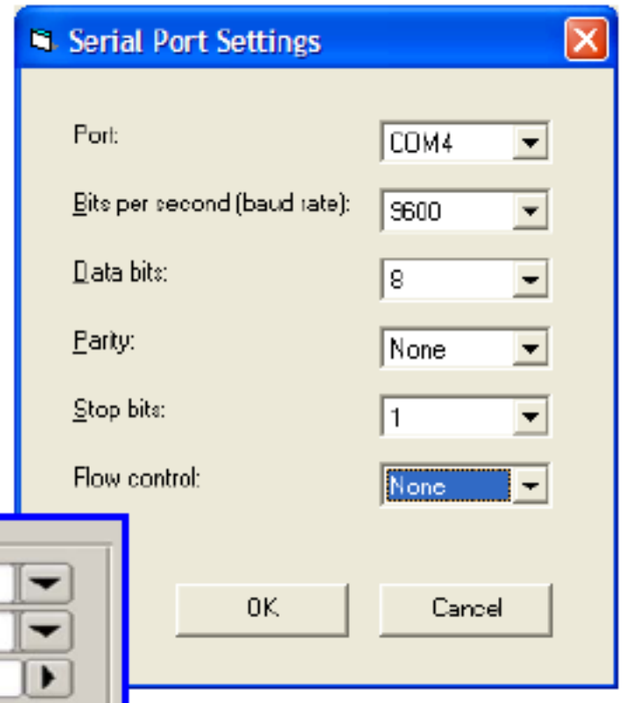
# Configuring TX Audio

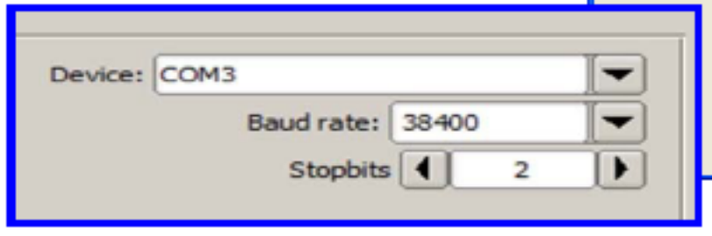


# Configuring CAT

- Most Radios require a Serial/USB cable interface to connect to the computer
- Serial/USB cable adapter usually requires a driver installation
- Port, Baud Rate, Stop Bits, Data Bits, Parity and Handshake information is usually required
- Radio's baud rate must match the serial port information



# Adjusting ALC

**ALC = Automatic Level Control**

- ALC is a transmitter closed loop control function that is intended to keep the transmitter operating in the linear region, and at set power, when the input signal (drive) varies in amplitude.

- ALC will only work correctly within the design range of audio signal drive levels

- Below the design operating range ALC will not maintain power

- Above the design operating range ALC may introduce significant distortion in the transmitted signal

- Know how ALC operates in your transmitter and understand how the acceptable ALC operating region is displayed

# Adjusting Power

## Two approaches to adjusting power:

1. **Set required power level on rig and then adjust audio input for correct ALC indication**

2. **Set rig power setting to maximum and control power by adjusting audio input level (for low power settings ALC will be outside the design range and there will be no ALC meter reading)**

# Adjusting Power

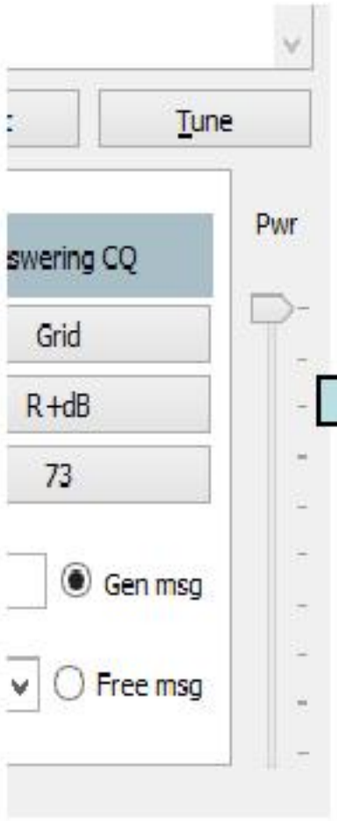
There are typically several places that the audio drive level can be adjusted:

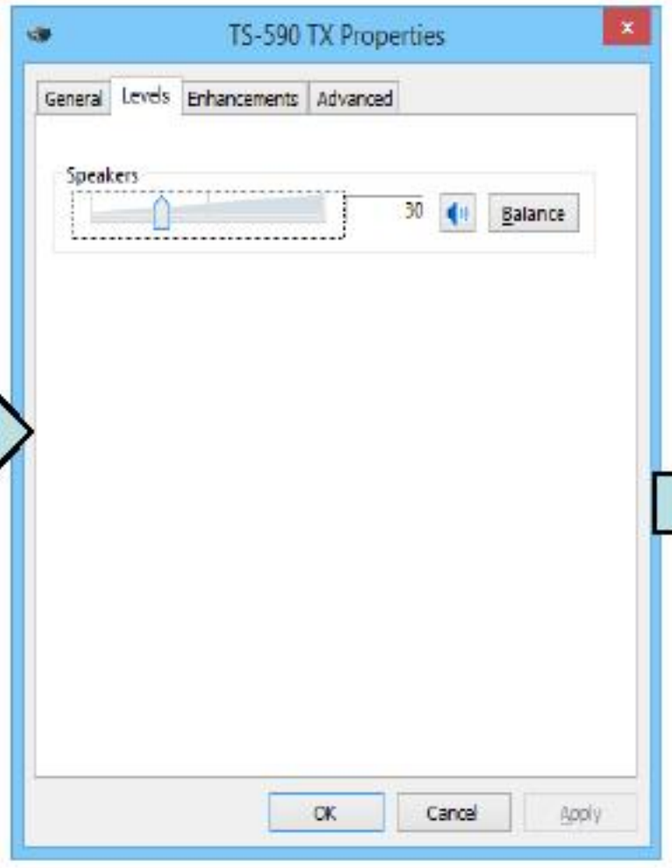
- In the digital mode application
- Using the Windows “Playback Device” level slider
- Using a control on the digital mode interface
- Level control internal to the transmitter

Sometimes the digital app controls the Windows slider, sometimes it’s an independent adjustment.

Balance the gain distribution so a high output of one stage does not drive next stage non-linear.

# Adjusting Power




# Monitoring FT8 Transmissions

- It is very easy to transmit a bad signal with most, if not all, modes (not just digital)

- The Choices

  - Don't monitor because you know your signal is perfect
    Congratulations…

  - Ask someone else to check your signal quality
    Can be a good choice for those new to a mode

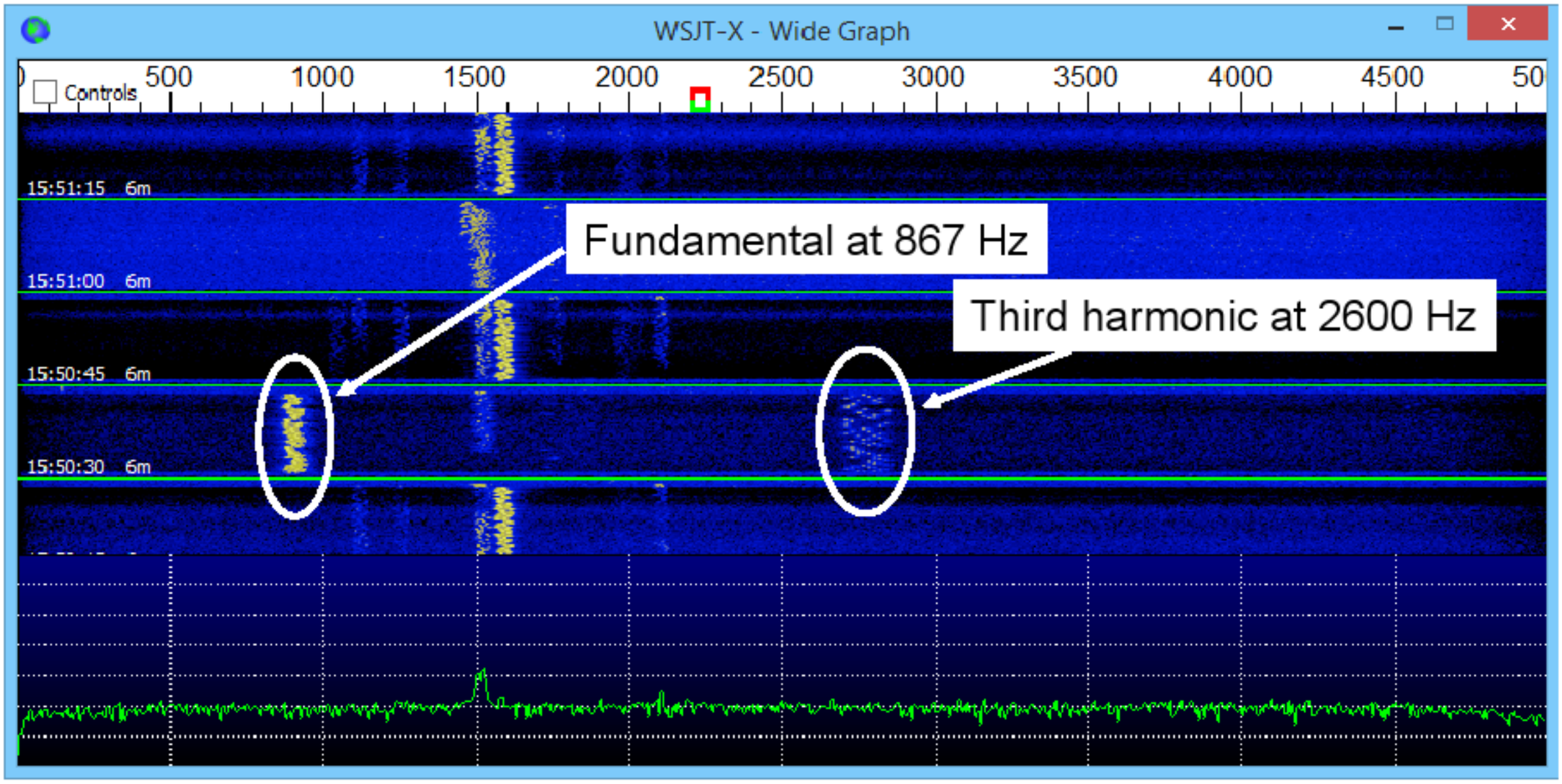
  - Check your signal yourself

# Typical Problems

- Over modulation
- Audio harmonics
- Spurious modulation by 60 Hz and its harmonics
- Spurious modulation by unintended PC audio
- Spurious modulation from microphone pickup

# Examples

- FT8 third harmonic




Note that third harmonic is 3 times width of fundamental

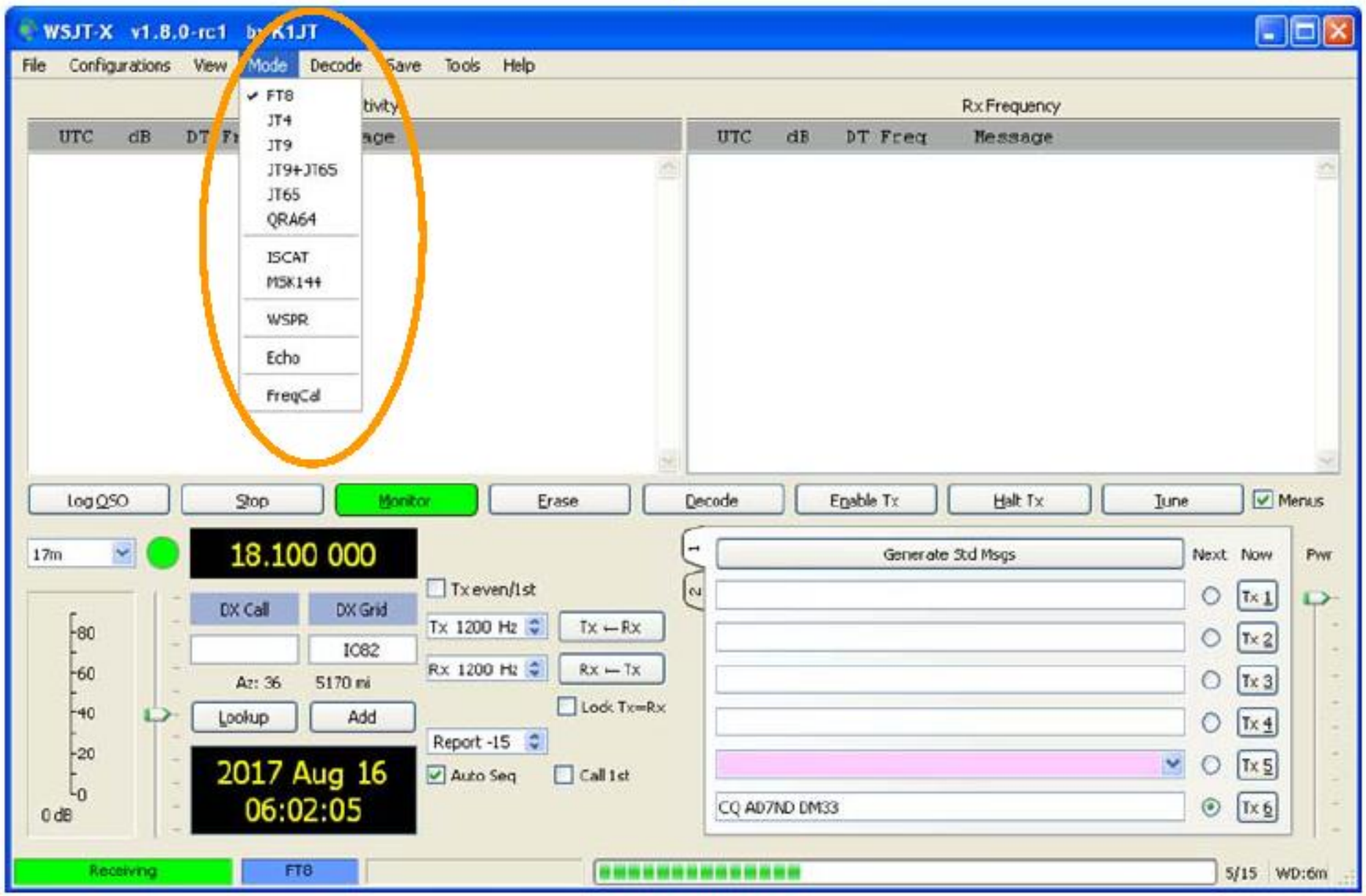
# Avoiding Transmitting Audio Harmonics

- Avoid over driving any part of the audio signal path
- Avoid driving rig finals into non linear operation
- Use Audio frequencies for which the third harmonic is outside the transmitter pass band (typical max frequency for SSB rig is 2.7 kHz so don't select TX audio frequency less than 2.7/3 = 900 Hz)

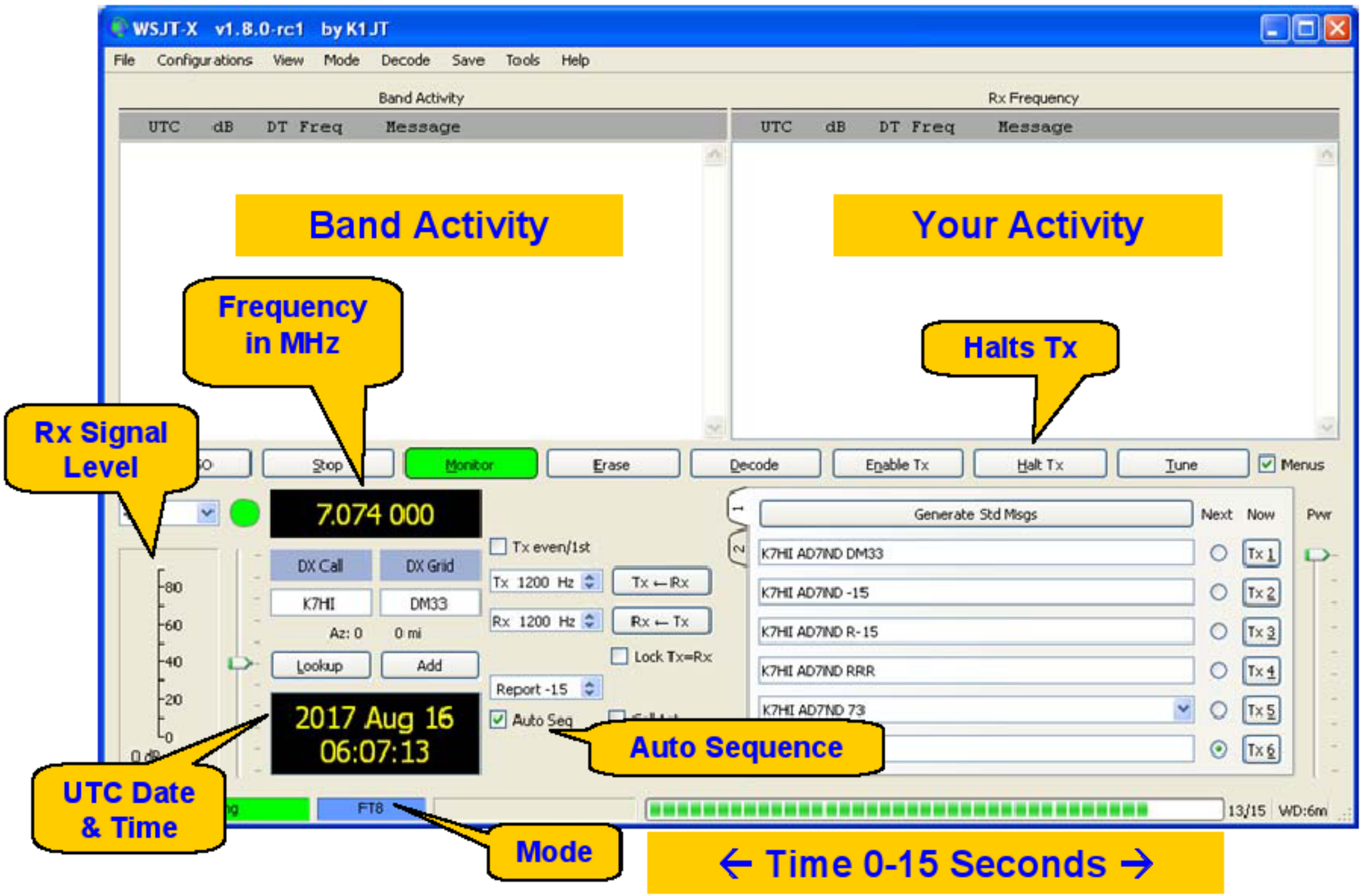
- WSJT-X supports a special "split" mode
- TX audio always in the range 1500 – 2000 Hz
- Audio harmonics are outside rig TX passband for most rigs
- Allows use of full TX frequency window by shifting the rig TX VFO frequency

# Selecting FT8 Mode in WSJT-X

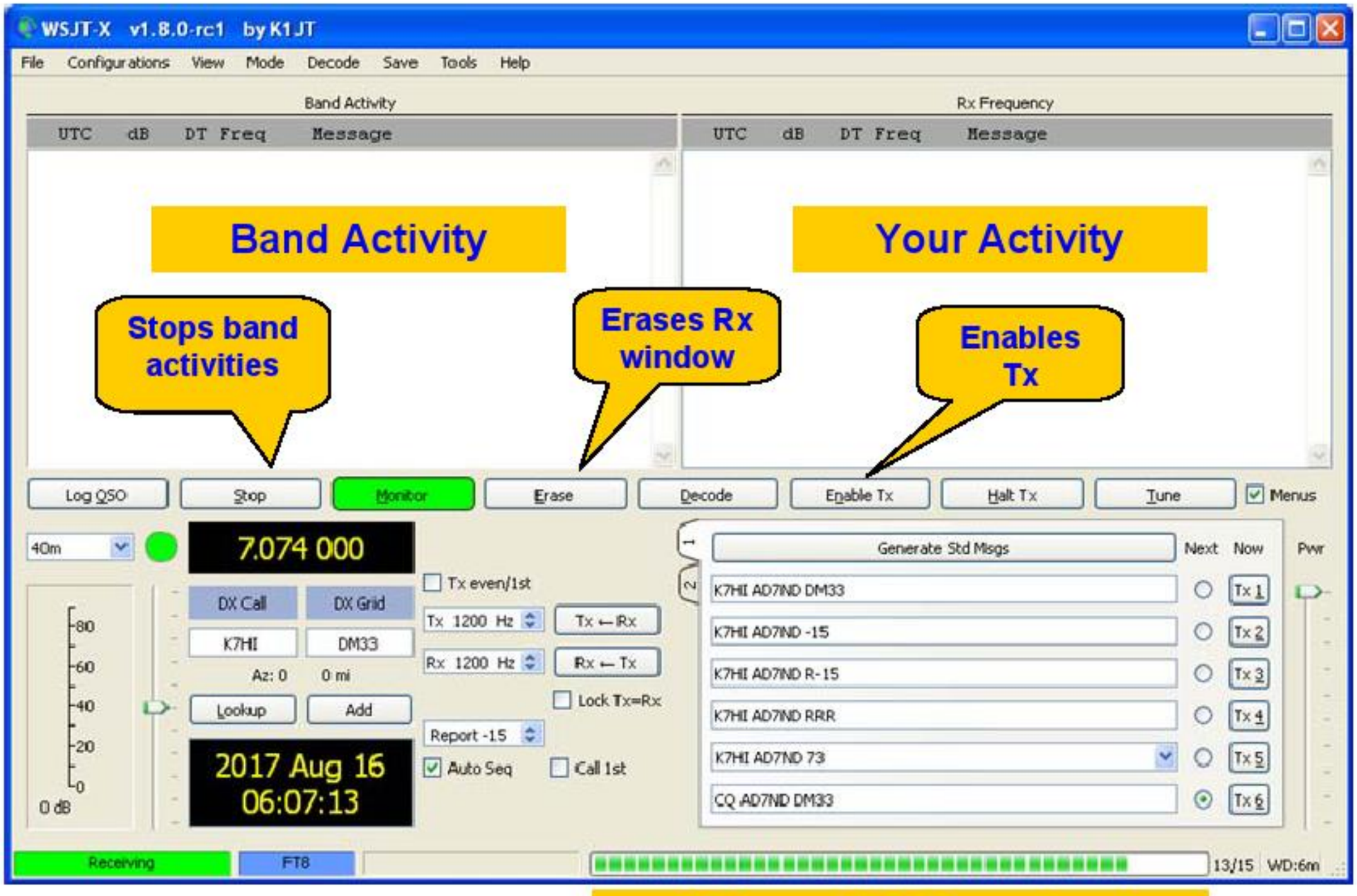
**Click on Mode → Select FT8**



# WSJT-X Main Window



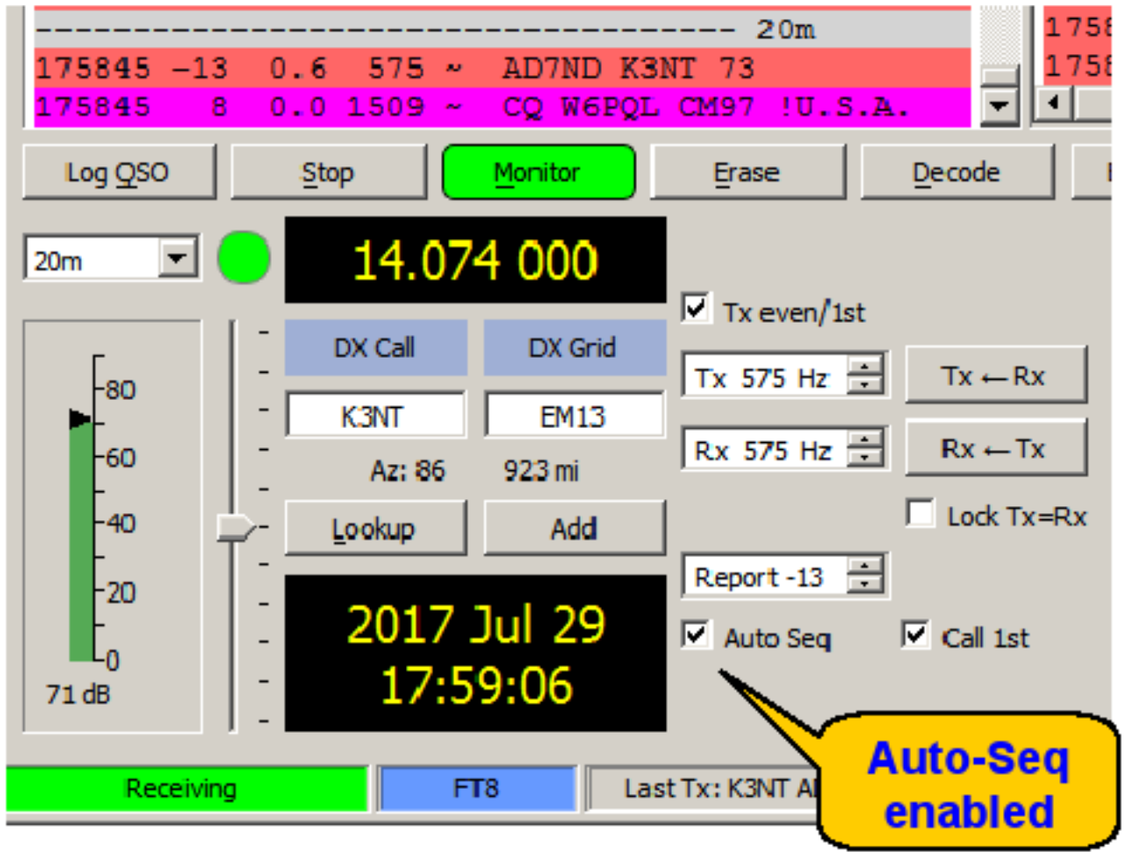
# WSJT-X Main Window




← Time 0-15 Seconds →

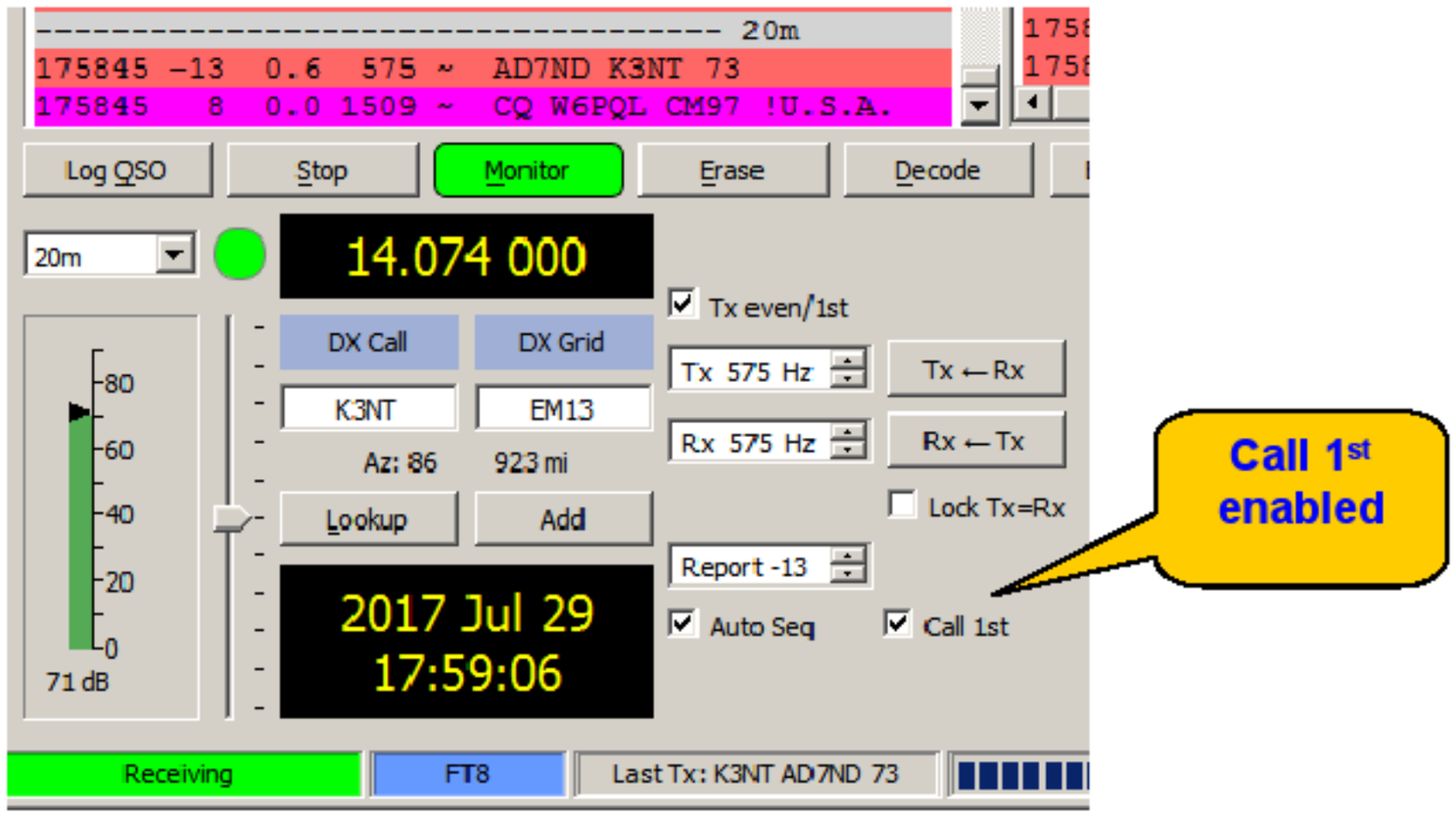
# FT8 Auto-Sequencing Feature

- **FT8 15-sec T/R cycles allow only ~ 2 secs for you to inspect decoded messages and decide how to reply, which is not enough time for most operators**
- **"Auto-Seq" will automatically complete the QSO for you**
- **You still need to pick the calling station one time**

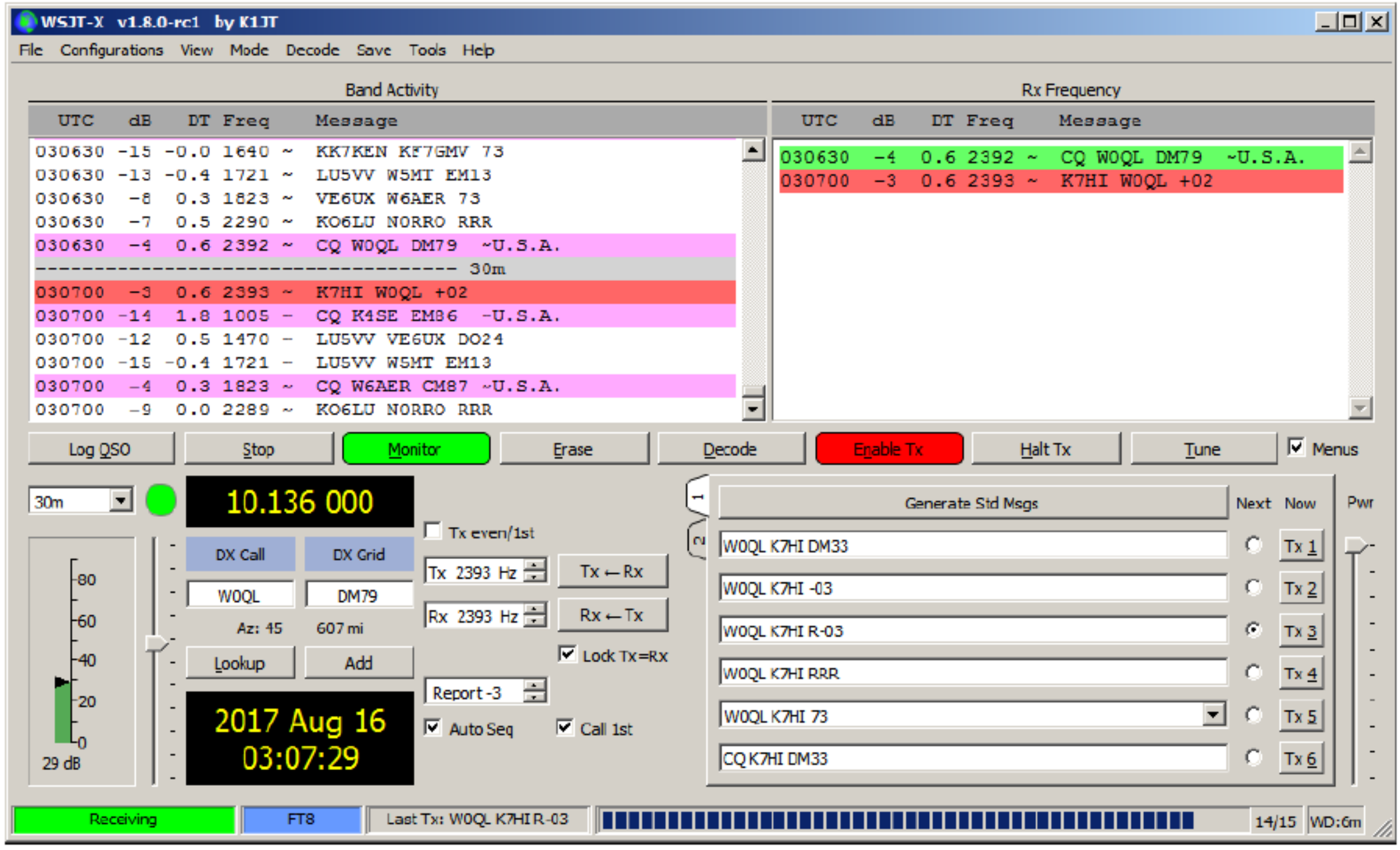


# FT8 Call 1st Feature

- **When calling CQ you can also choose to check the box "Call 1st" so WSJT-X can respond automatically to the first decoded responder to your CQ**

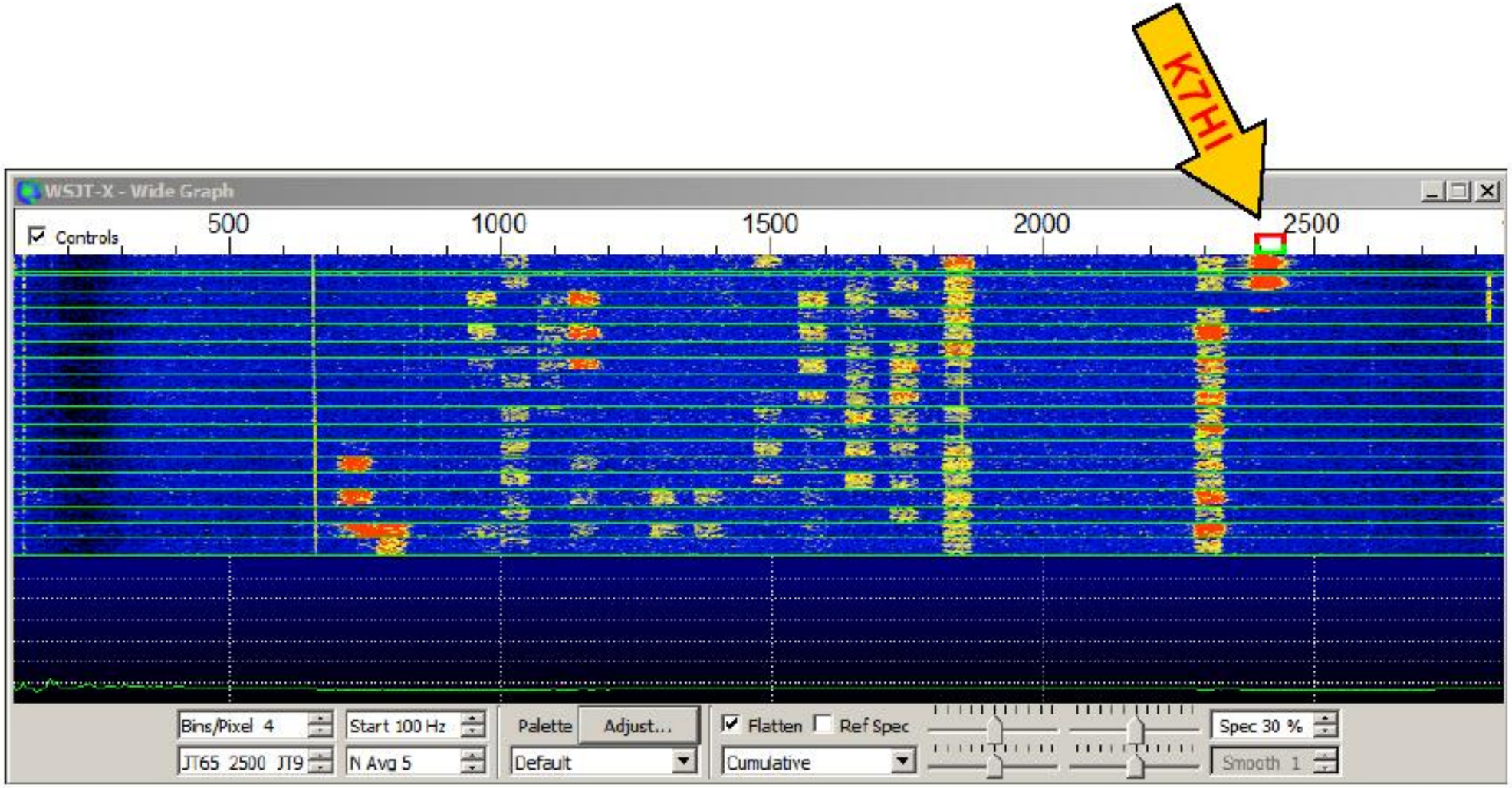


# WSJT-X FT8 QSO



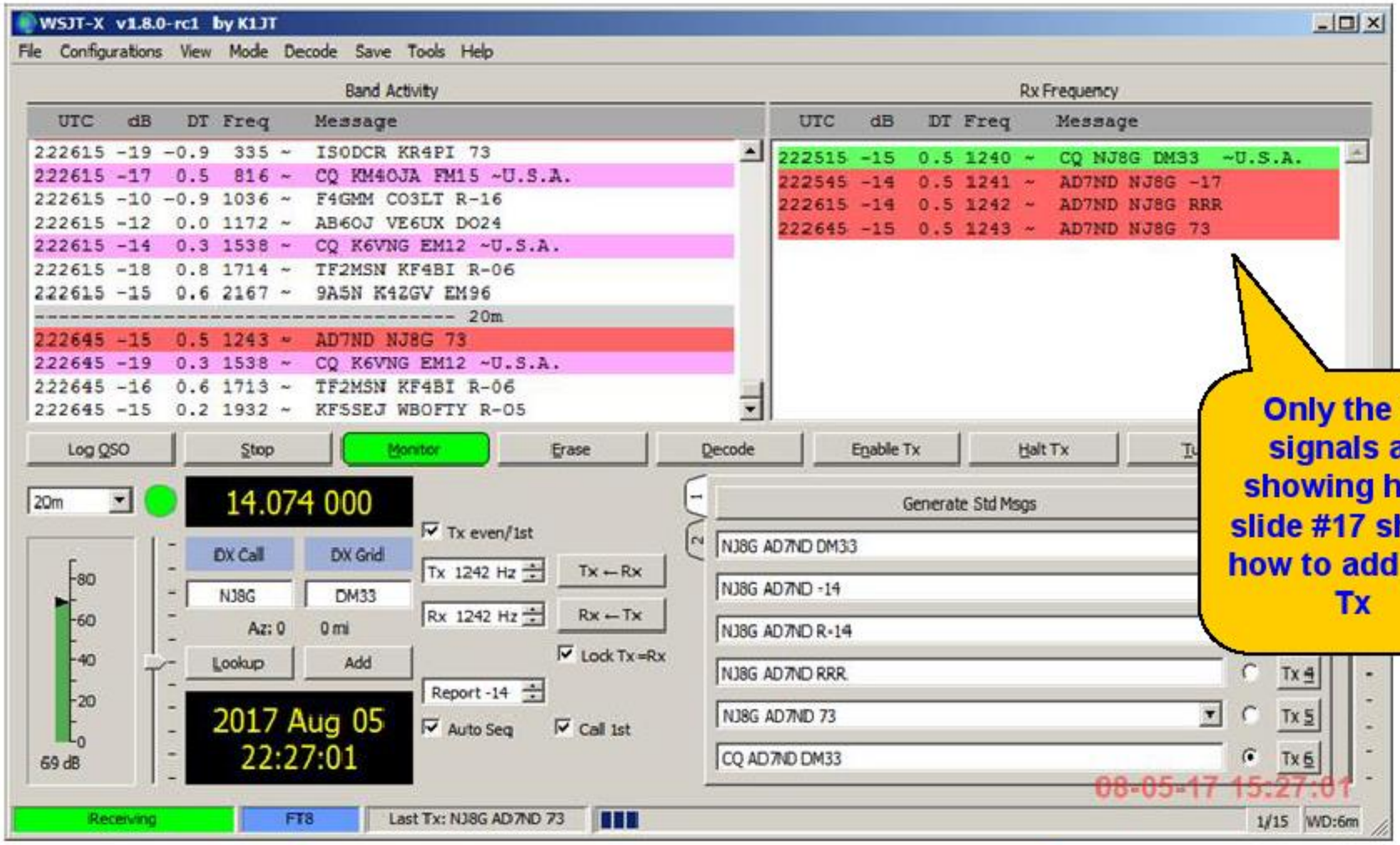

**K7HI Working W0QL in FT8 Mode 30m Band**

# WSJT-X FT8 Mode Waterfall



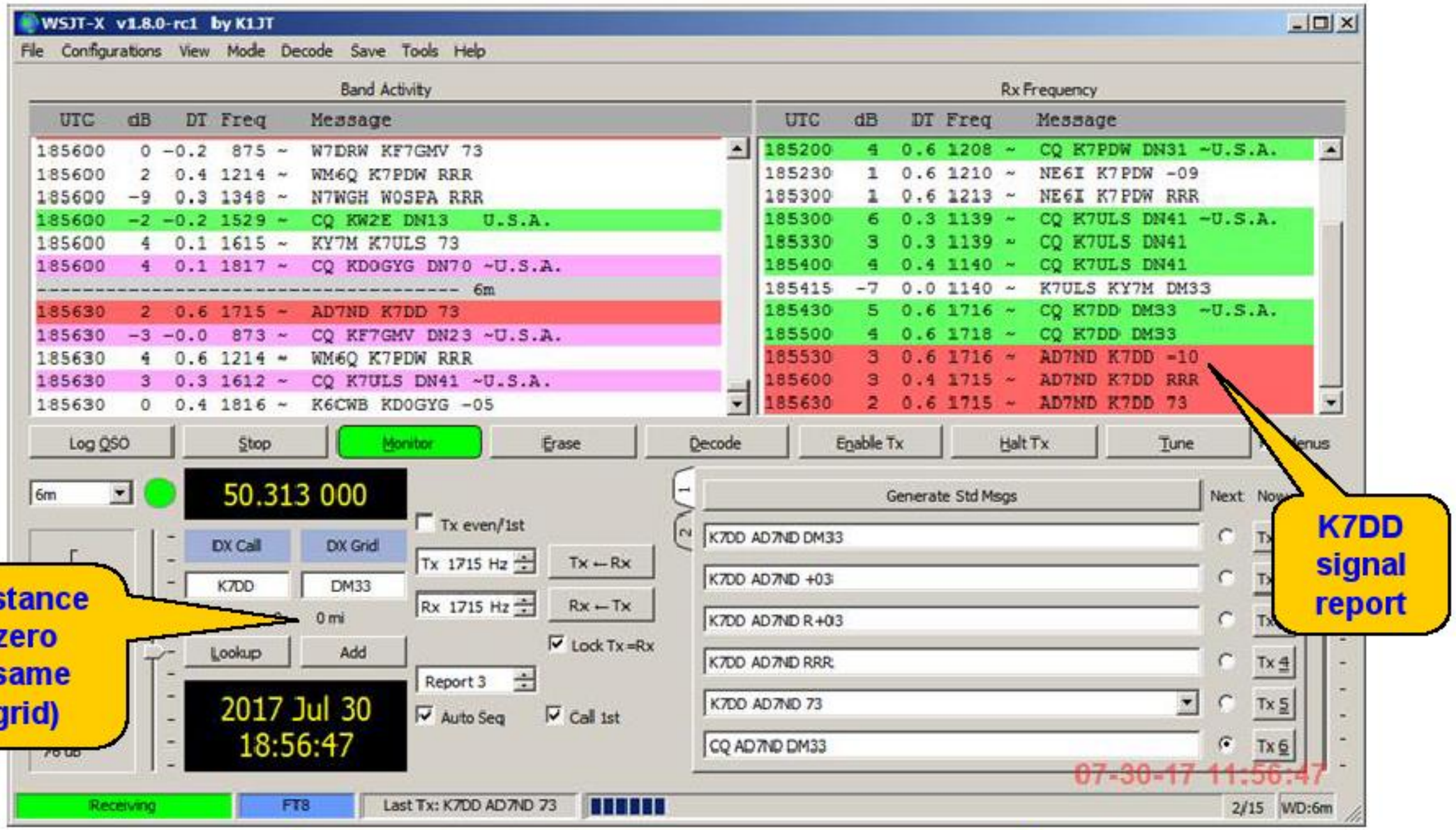

**K7HI Working W0QL Using FT8 in 30m**

# WSJT-X FT8 QSO




**AD7ND Working NJ8G (Walt) in 20m**

# WSJT-X FT8 QSO




**AD7ND Working K7DD (Mike) in 6m**

# WSJT-X FT8 QSO


WSJT-X v1.8.0-rc1 by K1JT

File Configurations View Mode Decode Save Tools Help

Band Activity

| UTC | dB | DT | Freq | Message |
|---|---|---|---|---|
| 030630 | -8 | 0.3 | 1823 | ~ VE6UX W6AER 73 |
| 030630 | -7 | 0.5 | 2290 | ~ KO6LU N0RRO RRR |
| 030630 | -4 | 0.6 | 2392 | ~ CQ W0QL DM79 ~U.S.A. |
| ---------- 30m | | | | |
| 030700 | -3 | 0.6 | 2393 | ~ K7HI W0QL +02 |
| 030700 | -14 | 1.8 | 1005 | ~ CQ K4SE EM86 ~U.S.A. |
| 030700 | -12 | 0.5 | 1470 | ~ LU5VV VE6UX DO24 |
| 030700 | -15 | -0.4 | 1721 | ~ LU5VV W5MT EM13 |
| 030700 | -4 | 0.3 | 1823 | ~ CQ W6AER CM87 ~U.S.A. |
| 030700 | -9 | 0.0 | 2289 | ~ KO6LU N0RRO RRR |
| ---------- 30m | | | | |
| 030730 | -12 | 0.3 | 2394 | ~ K7HI W0QL RRR |

Rx Frequency

| UTC | dB | DT | Freq | Message |
|---|---|---|---|---|
| 030630 | -4 | 0.6 | 2392 | ~ CQ W0QL DM79 ~U.S.A. |
| 030700 | -3 | 0.6 | 2393 | ~ K7HI W0QL +02 |
| 030730 | -12 | 0.3 | 2394 | ~ K7HI W0QL RRR |

Log QSO | Stop | Monitor | Erase | Decode | Enable Tx | Halt Tx | Tune | Menus

30m | 10.136 000 | Tx even/1st | Tx 2394 Hz | Rx 2394 Hz | Tx ← Rx | Rx ← Tx | Lock Tx=Rx

DX Call: W0QL | DX Grid: DM79 | Az: 45 | 607 mi | Lookup | Add

Report -12 | Auto Seq | Call 1st

2017 Aug 16
03:08:06

69 dB

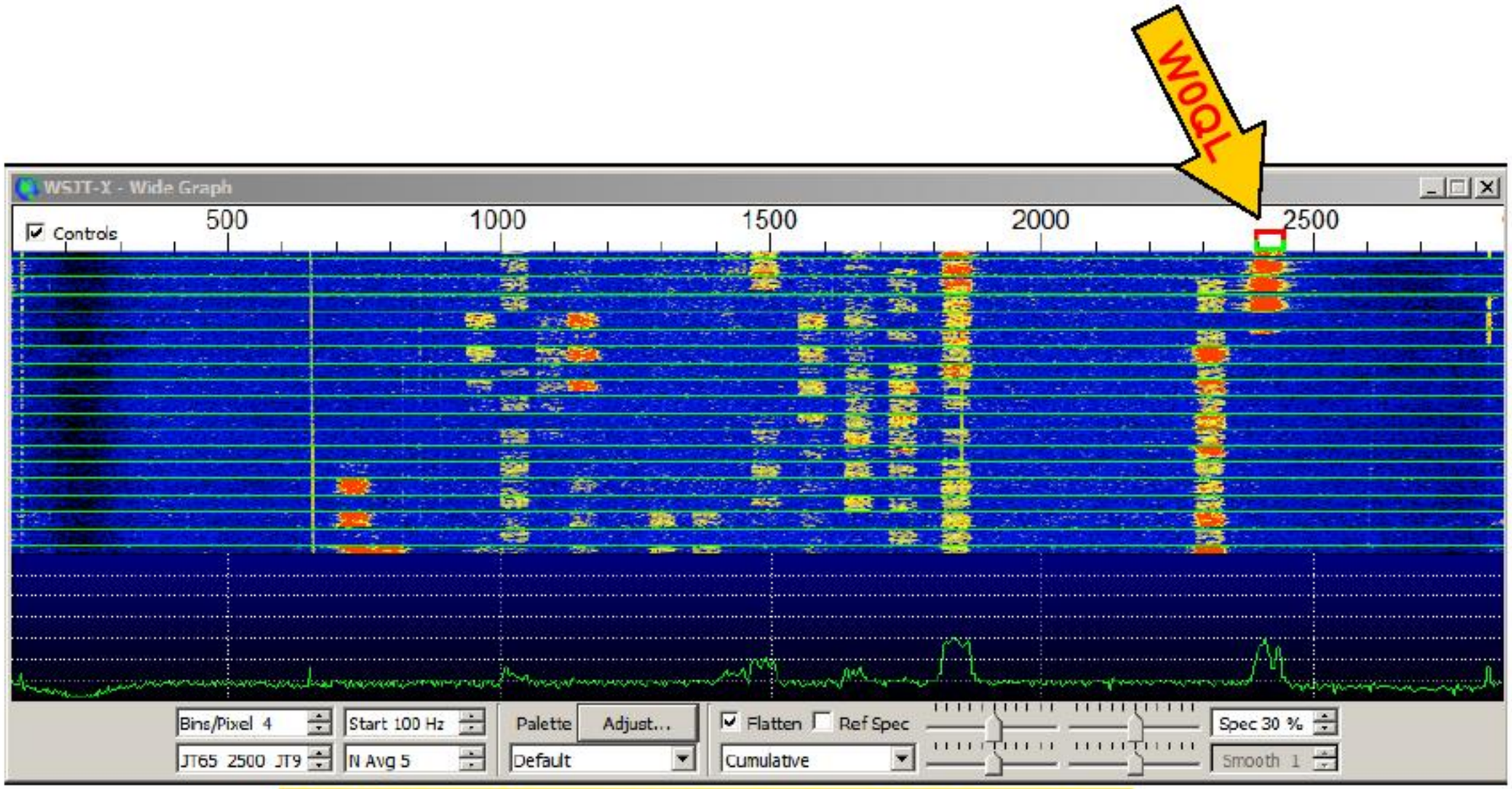
Generate Std Msgs | Next | Now | Pwr

| | | |
|---|---|---|
| W0QL K7HI DM33 | | Tx 1 |
| W0QL K7HI -12 | | Tx 2 |
| W0QL K7HI R-12 | | Tx 3 |
| W0QL K7HI RRR | | Tx 4 |
| W0QL K7HI 73 | | Tx 5 |
| CQ K7HI DM33 | ● | Tx 6 |

Receiving | FT8 | Last Tx: W0QL K7HI 73 | 6/15 | WD:5m

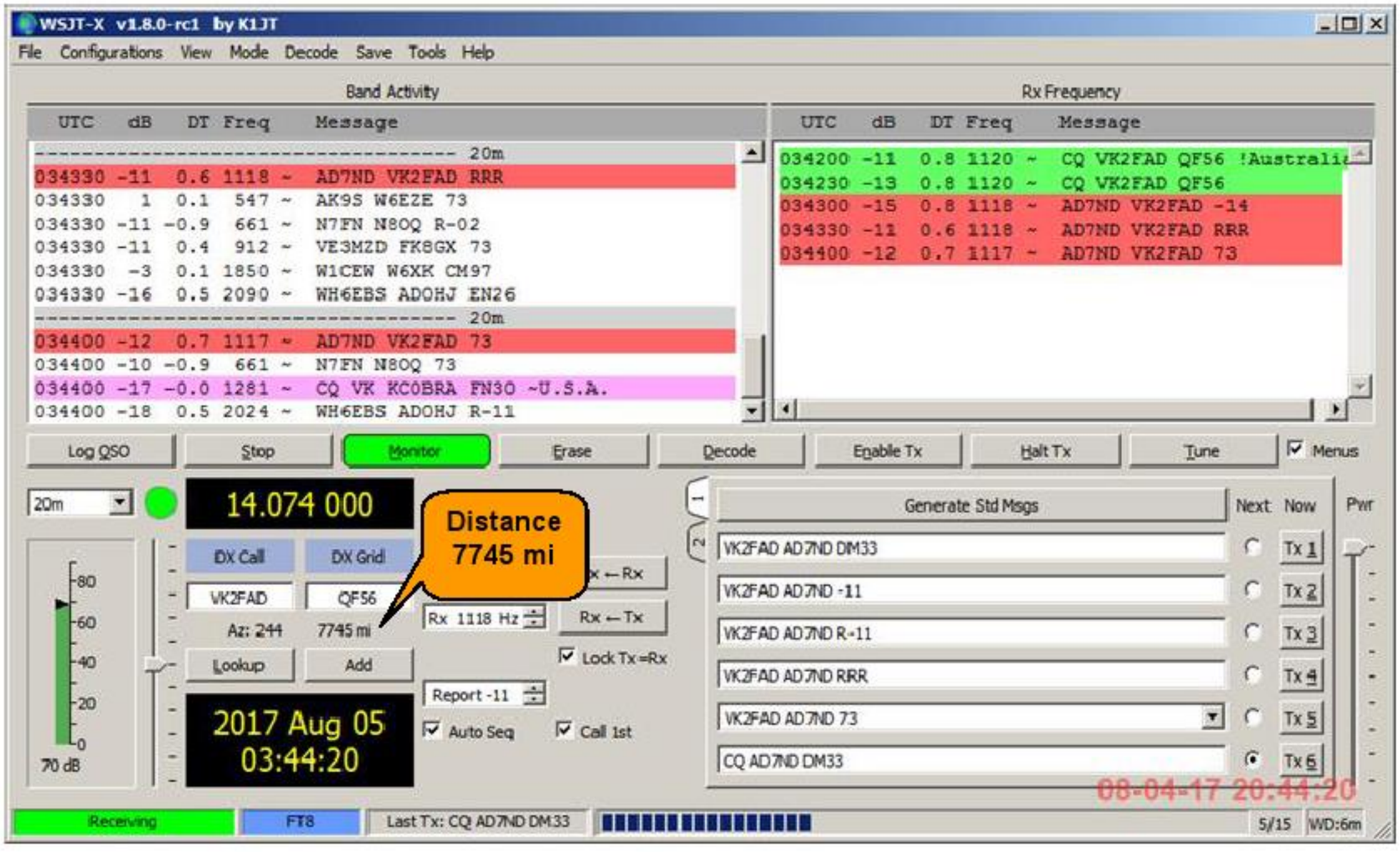
**K7HI Working W0QL in FT8 Mode 30m Band**

# WSJT-X FT8 Waterfall



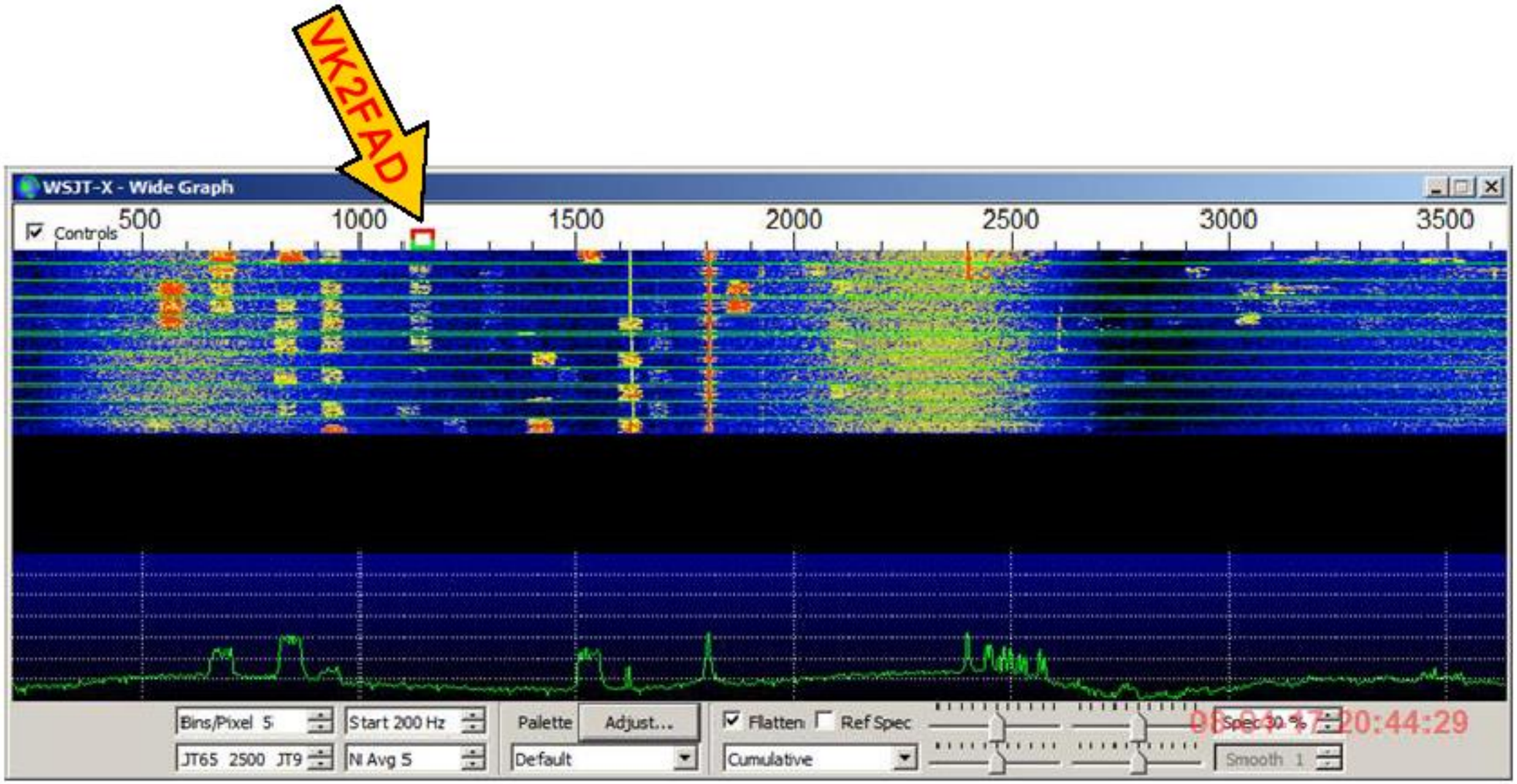

**K7HI Working W0QL Using FT8 in 30m**

# WSJT-X FT8 QSO



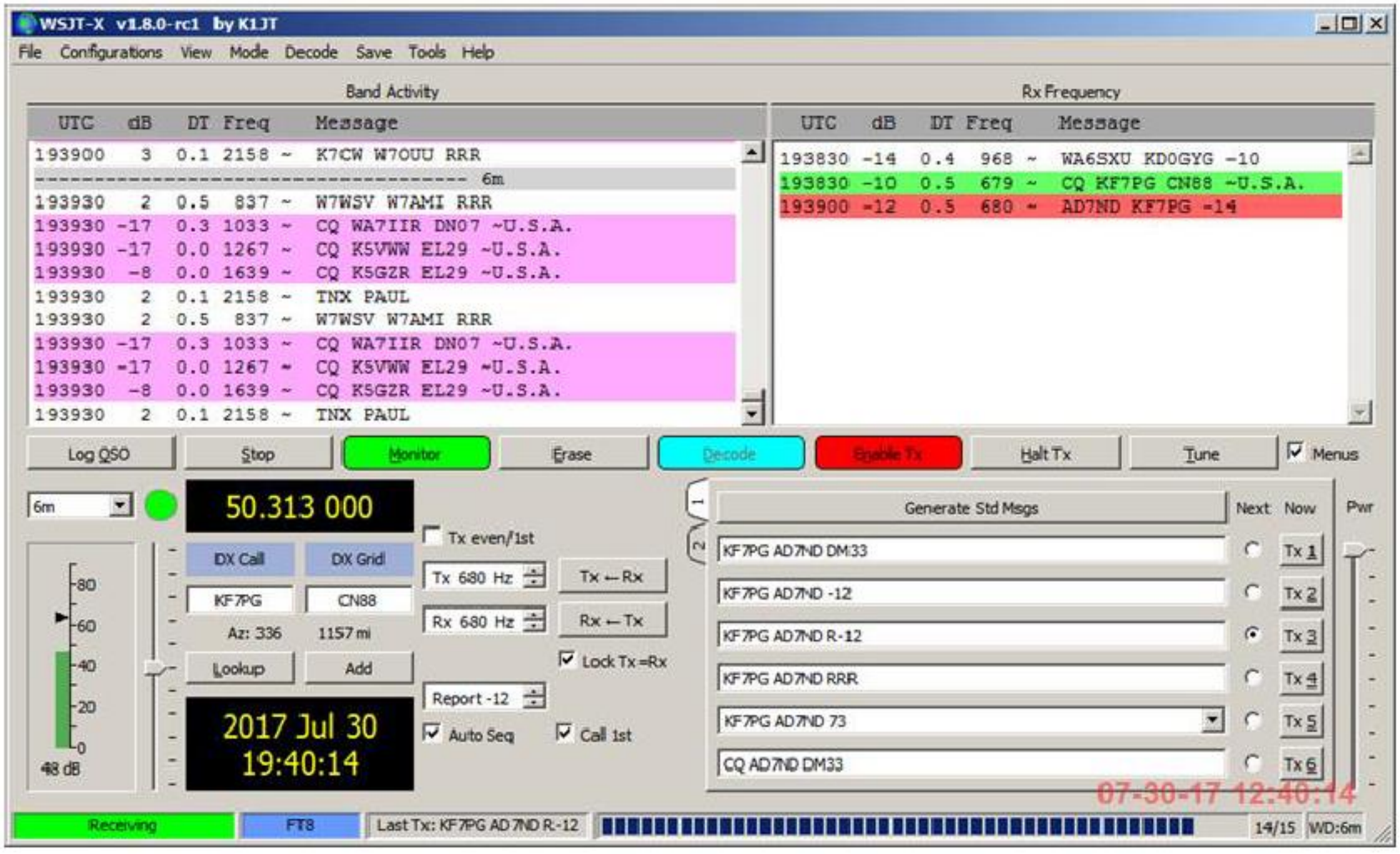

**AD7ND Working VK2FAD (Australia) in 20m**

# WSJT-X FT8 Waterfall



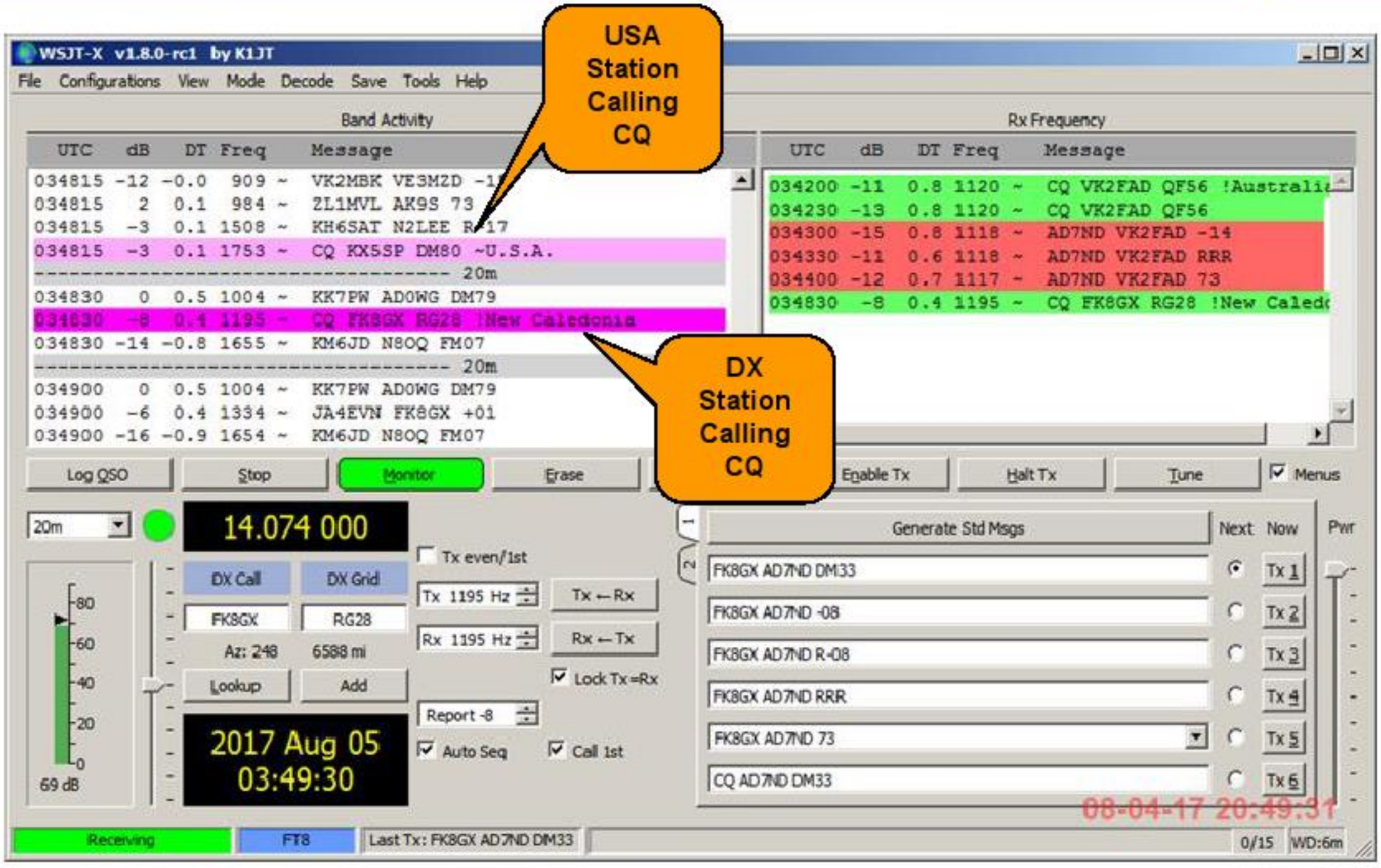

**AD7ND Working VK2FAD in 20m**

# WSJT-X FT8 QSO



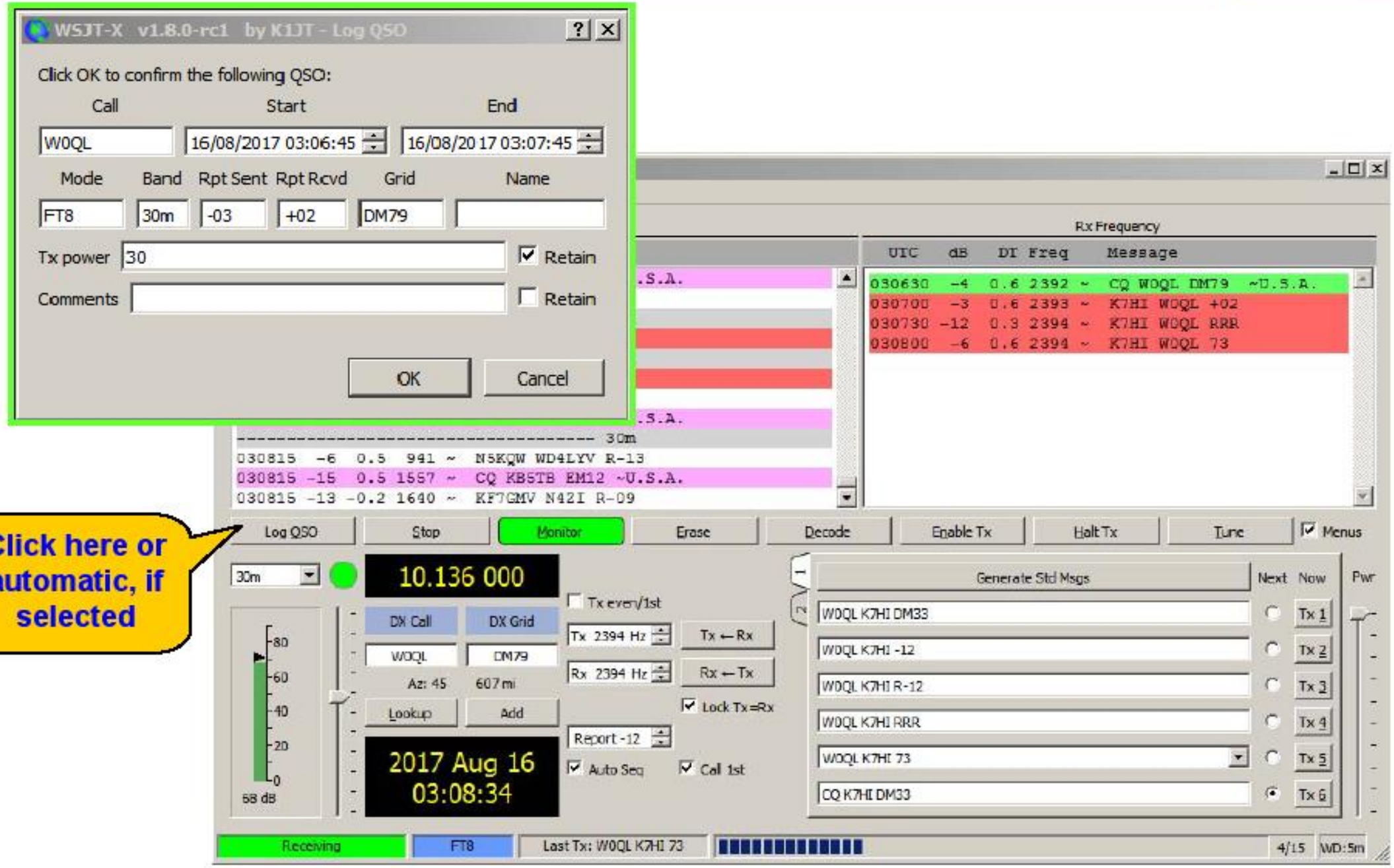

**AD7ND Working KF7PG (WA) in 6m**

# WSJT-X FT8 Calling CQ



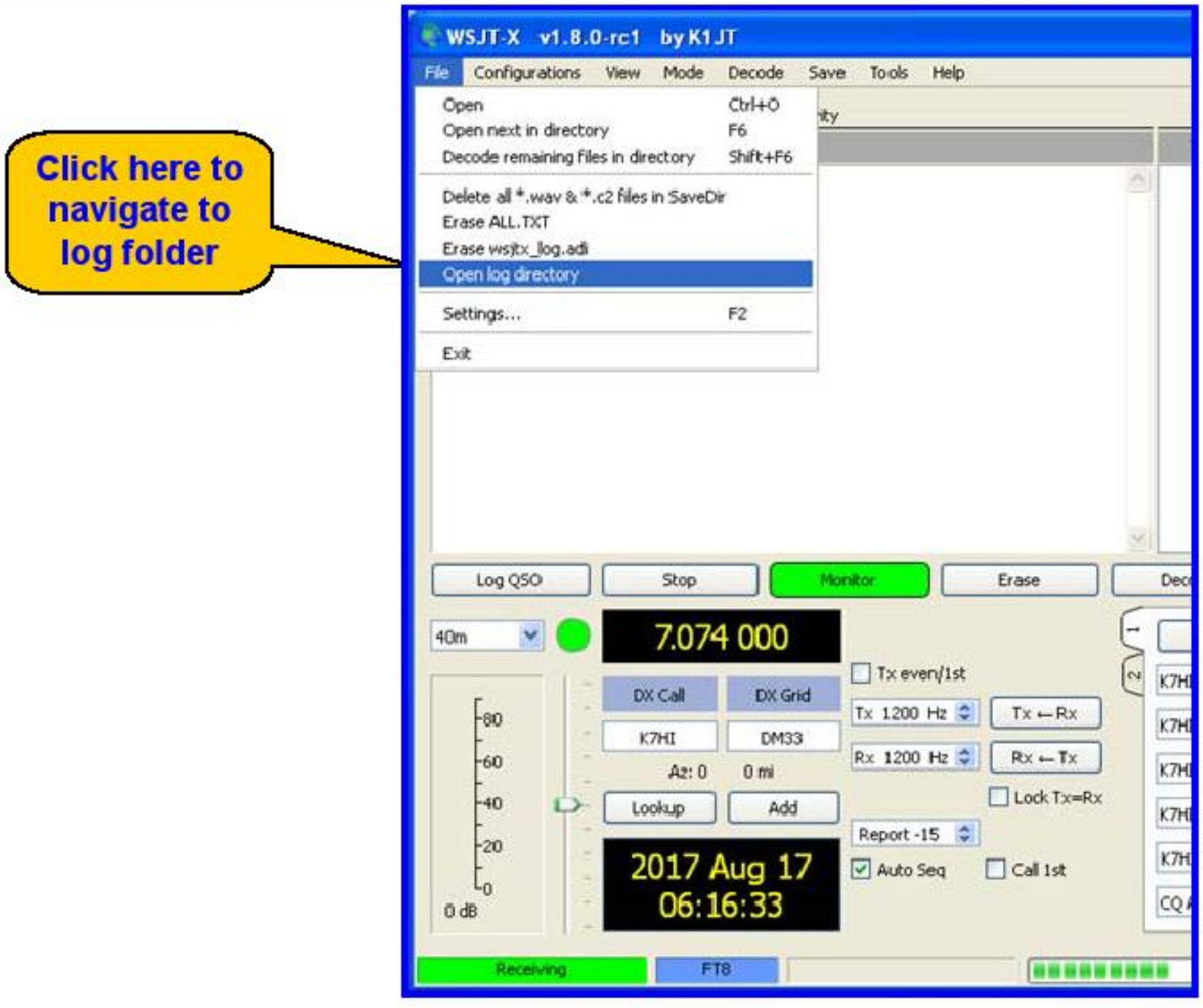

**FK8GX (New Caledonia) and KX5SP Calling CQ in 20m**

# Logging a QSO

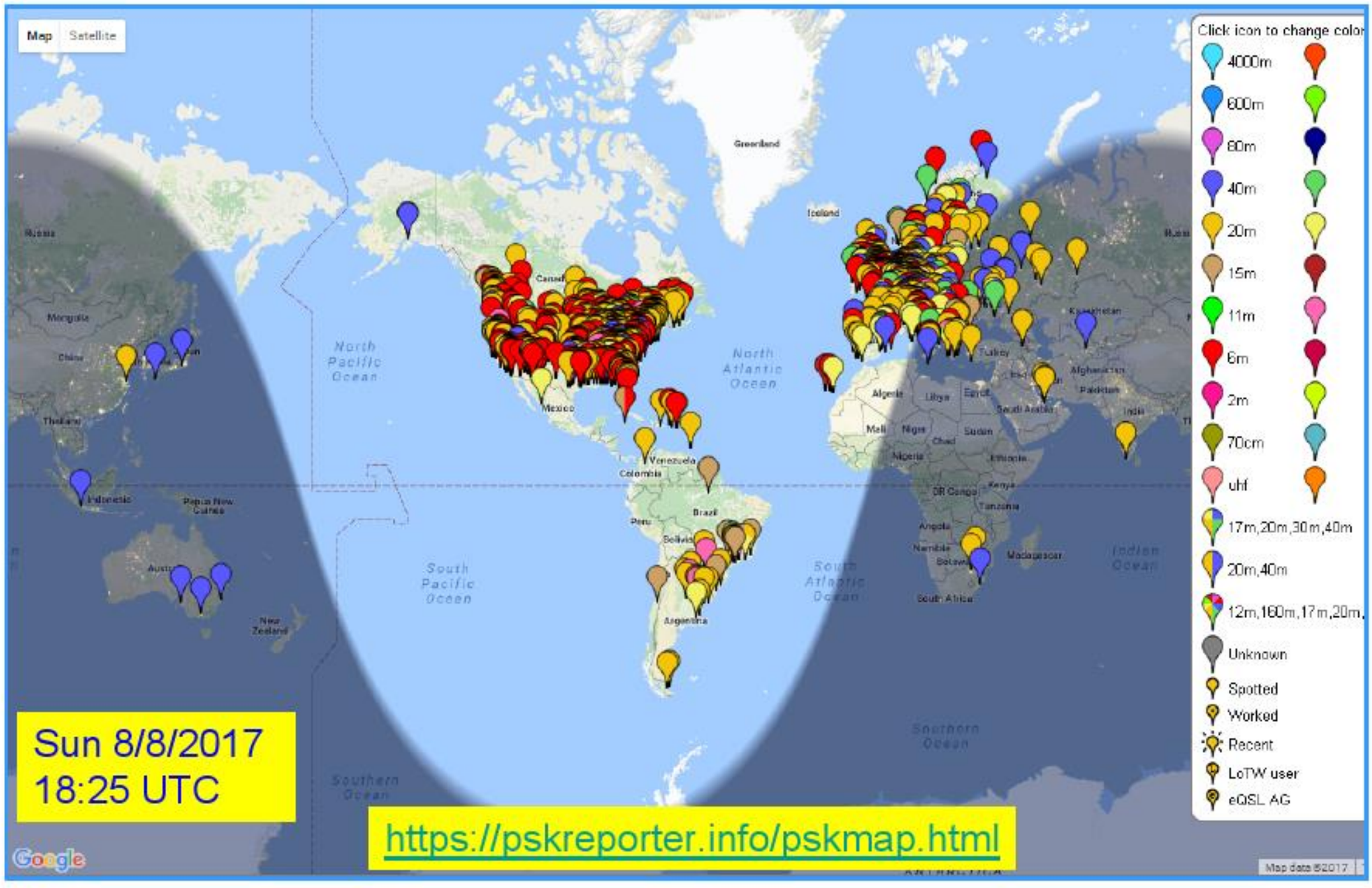



**Click here or automatic, if selected**

# Log Folder



# FT8 on PSK-Reporter



# Link References

- **WSJT-X Download:**
  http://physics.princeton.edu/pulsar/k1jt/wsjtx.html

- **Dimensions-4:**
  http://www.thinkman.com/dimension4/

- **JTAlert:**
  http://hamapps.com/

- **ARRL Digital Mode Page:**
http://www.arrl.org/digital-modes

- **WM2U Soundcard Interfacing:**
http://www.qsl.net/wm2u/interface.html

# THANK YOU!

# Q&A