

# WSJT Digital Modes

Bill Turner, W4WNT

June 19, 2020

# Connections

- Need at least one connection between radio and computer
- Icom uses audio and CIV connection in older models
- IC-7300 and IC-7610 uses only one USB cable
- Kenwoods use an audio connection (Signalink) and a Serial-USB cable (FTDI)
- Kenwood TS590 uses single USB cable

# Connections

- Facebook groups are very helpful in solving connection questions
- Software specific groups
- Hardware specific groups
- K0PIR YouTube videos

# WSJT

- WSJT: Weak Signal Joe Taylor
- Created by Dr. Joe Taylor, K1JT
  - 1993 Nobel Prize in Physics
  - Discovered Dual Pulsars

# Operating systems

- WSJT and WSJT-X will run on:
- Windows
- Mac OS
- Several flavors of Linux

# WSJT

- Originally created for EME (Moon Bounce)
- Previously needed very high power and large antenna arrays.
- You needed to hear your CW signal return from the moon.
- 239,000 miles one way path on 2m!

# WSJT

- With computer algorithms, WSJT decodes the signal and prints out the exchange on the computer screen.
- Signal reports are given in dBs relative to the noise level. -07 is a typical report for WSJT modes.
- Weak Signal mode but normally also low power compared to other ham radio modes.
- Average power 50-60 watts.

# WSJT-X

- Created as an experimental mode to introduce other modes into WSJT.
- JT4, JT9, JT65, QRA64, ISCAT, MSK144, FT8, and WSPR
- The WSJT-X exchanges are very structured, not a conversational mode.
- WSJT-X 2.2.1 GA is the current release.



# WSJTX

- JT65 and QRA64 are designed for EME
- JT9 is optimized for LF, MF and HF use and is 2 dB more sensitive than JT65.
- JT4 and QRA64 are designed for microwave EME work.
- WSPR is a low power mode used to test propagation. (Where is my 5w signal being heard?)

# WSJT-X

- FT8 (Franke-Taylor 8) is designed for contest use on HF and VHF.
- Created by Steven Franke K9AN and K1JT.
- This mode was introduced in July 2017.
- Currently the most popular WSJT mode.
- FT4 is designed for contest use and is twice as fast as FT8.

# FT8

- Runs in 15 second intervals, RX and TX
- Formatted exchange
- Has an Auto Sequence feature
- Operating frequencies are in a table
- Timing is critical, use Dimension4 from Thinkman.com or Meinberg NTP to sync your clock for Windows OS

# FT8

- dB measured Signal to noise ratio (S/N)
- dT time offset relative to your computer clock
- Signals visible at -26 dB
- Signals audible at -15 dB
- 50 Hz bandwidth, 12.6 sec Tx duration
- 15 sec TX, 15 sec Rx

# WSJT-X screen

WSJT-X v2.2.1 by K1JT, G4WJS, and K9AN

File Configurations View Mode Decode Save Tools Help

Band Activity

UTC	dB	DT	Freq	Message
161000	-18	-0.2	1210	AA4CB N5VH1 EL99
----- 10m -----				
161030	2	0.1	867	KC5CZC KM4SJM EL96
161030	18	0.2	1530	N7WEJ AI4FR EL88
161030	26	0.1	1920	WS9V WD4CNO 73
161030	-12	0.2	2146	K4KSW K5NWZ RR73
161030	0	0.0	1863	CQ NZ0T EM36 U.S.A.
161030	-4	0.1	903	K4LG KC5KE +02

Rx Frequency

UTC	dB	DT	Freq	Message
161052	Tx		1667	CQ W4WNT EM94

CQ only                            Menus

10m S 28.074 000    Tx even/1st  
Tx 1667 Hz    Hold Tx Freq  
▲ ▼  
Rx 1667 Hz  
Report -15  
     
       Auto Seq    Call 1st

Generate Std Msgs   Next   Now   Pwr

	<input type="radio"/>	<input type="button" value="Tx 1"/>	
	<input type="radio"/>	<input type="button" value="Tx 2"/>	
	<input type="radio"/>	<input type="button" value="Tx 3"/>	
	<input type="radio"/>	<input type="button" value="Tx 4"/>	
	<input type="radio"/>	<input type="button" value="Tx 5"/>	
CQ W4WNT EM94	<input checked="" type="radio"/>	<input type="button" value="Tx 6"/>	

64 dB

2020 Jun 19  
16:11:00

Receiving   IC-7300 xmits 7-30-19   FT8   Last Tx: CQ W4WNT EM94   6   0/15

# Settings-General

Settings

General Radio Audio Tx Macros Reporting Frequencies Colors Advanced

Station Details

My Call:  My Grid:   AutoGrid IARU Region:

Message generation for type 2 compound callsign holders:

Display

Start new period decodes at top

Blank line between decoding periods

Display distance in miles

Tx messages to Rx frequency window

Show DXCC, grid, and worked-before status  Show principal prefix instead of country name

Behavior

Monitor off at startup  Enable VHF/UHF/Microwave features

Monitor returns to last used frequency  Allow Tx frequency changes while transmitting

Double-click on call sets Tx enable  Single decode

Disable Tx after sending 73  Decode after EME delay

Calling CQ forces Call 1st

Alternate F1-F6 bindings Tx watchdog:

CW ID after 73 Periodic CW ID Interval:

# Settings - Radio

Settings

General Radio Audio Tx Macros Reporting Frequencies Colors Advanced

Rig: Icom IC-7300 Poll Interval: 10 s

CAT Control

Serial Port: COM4

Serial Port Parameters

Baud Rate: 9600

Data Bits

Default  Seven  Eight

Stop Bits

Default  One  Two

Handshake

Default  None  
 XON/XOFF  Hardware

Force Control Lines

DTR:  RTS:

PTT Method

VOX  DTR  
 CAT  RTS

Port: COM4

Transmit Audio Source

Rear/Data  Front/Mic

Mode

None  USB  Data/Pkt

Split Operation

None  Rig  Fake It

Test CAT Test PTT

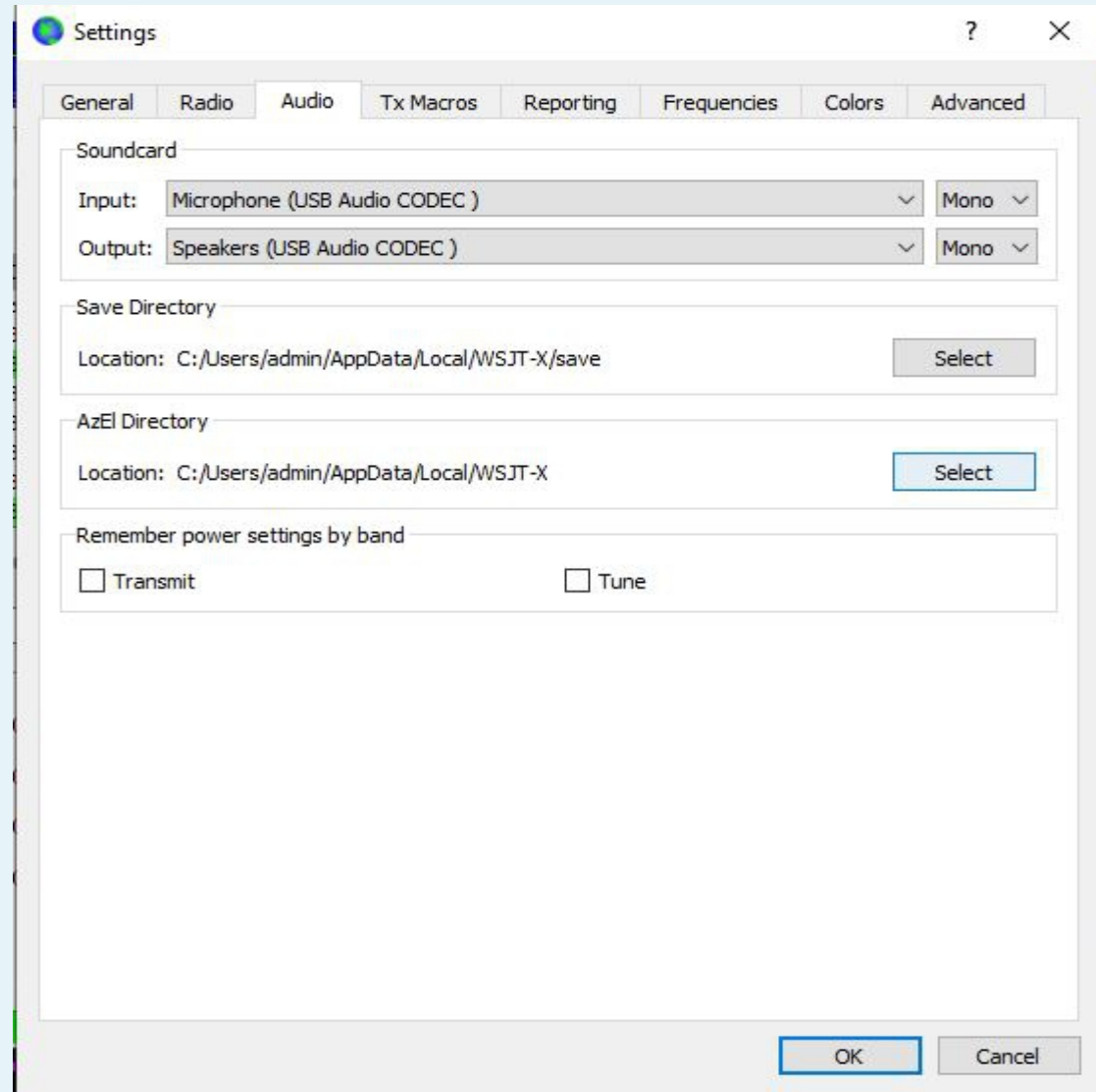
OK Cancel

# Audio settings in Device Manager

- Ports (COM & LPT)
  - Communications Port (COM1)
  - Silicon Labs CP210x USB to UART Bridge (COM4)



# WSJT-X Audio Screen



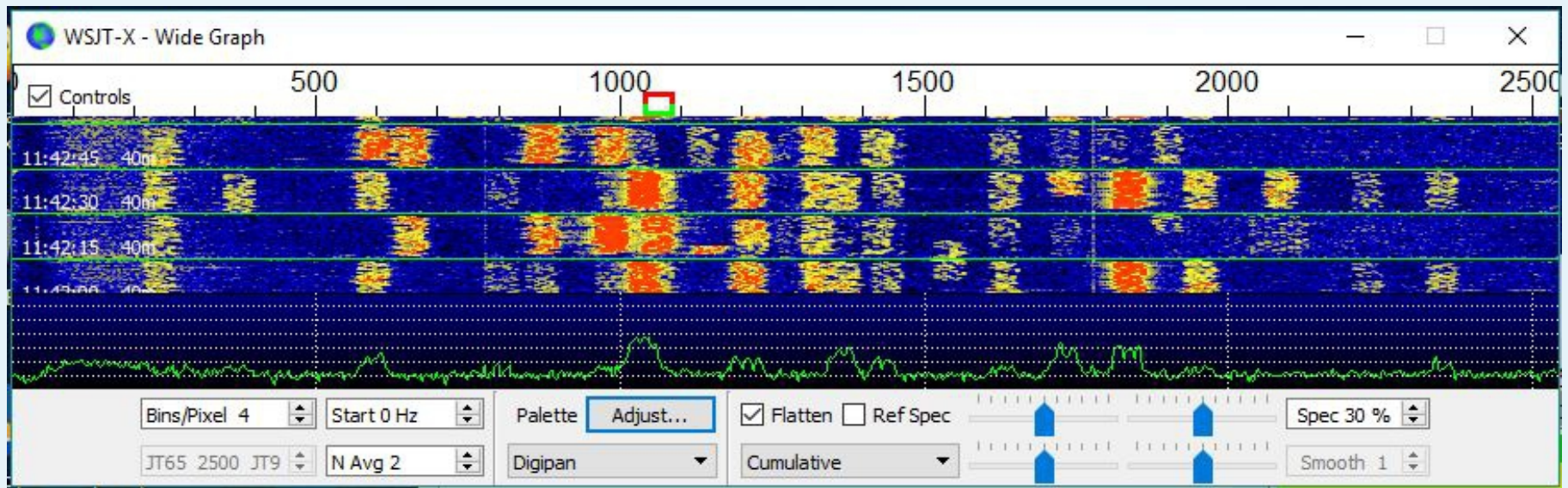
# Other “Rigs”

- The Radio Screen also has
  - Ham Radio Deluxe
  - Omnirig
- See the Instruction Manual (F1) under Section 4.2 for more info.
- Test CAT and Test PTT buttons on Radio Screen

# Windows Snipping Tool

- Used to save screen prints.
- Created the screen slides here.
- When you have the software running, use this tool to save the parameters that work.
- Windows updates mess with audio settings and com ports. Save parameters.
- If a screw up occurs, restart the computer to ensure that the update has completed.
- Only then look at your parameters for changes.

# Wide Graph (Waterfall)



# Wide Graph

- Use the widest filter setting on rig
- No DSP, Noise Reduction or Noise Blanking
- Control the image with sound card/RF gain
- Wide Graph also has controls to optimize the data presentation
- Strongest TX output between 1500 and 2000 Hz

# Main screen

WSJT-X v1.7.1-devel by K1JT

File Configurations View Mode Decode Save Tools Help

Band Activity					
UTC	dB	DT	Freq	Message	
114345	11	0.1	572	~	VK3TZU N5GDM EM42
114345	-4	0.1	634	~	VK3TZU K1JT FN20
114345	7	1.3	851	~	CQ CO8LY FL20 ~Cuba
114345	4	0.1	964	~	KOPT N9KO R-07
114345	-15	0.3	1114	~	CQ DX WA0LIF ~U.S.A
114345	-21	0.1	1257	~	JR3IIR KB7Q 73
114345	-8	0.1	1402	~	CQ WT9WT EM59 ~U.S.A
114345	8	0.0	1617	~	VE9RAC KC3RN EN90
114345	-19	-0.1	1714	~	WD5ENH KM4WAA RRR
114345	-19	-0.1	1787	~	CQ NZ2X EM83 ~U.S.A
114345	-14	1.0	1879	~	W5ZP KB4C +01
114345	1	0.7	1931	~	CQ KF7TLL DM34 ~U.S.A
114345	1	0.1	2208	~	K8DOC W4GH 73

Rx Frequency					
UTC	dB	DT	Freq	Message	
113745	7	0.4	1040	~	CQ CO2II EL83
113803	Tx		1040	~	CO2II W4WNT EM95
113815	6	0.9	1040	~	CQ CO2II EL83
113830	Tx		1040	~	CO2II W4WNT EM95
113845	6	0.9	1040	~	W4WNT CO2II -08
113900	Tx		1040	~	CO2II W4WNT R+06
113915	8	0.9	1040	~	W4WNT CO2II RRR
113930	Tx		1040	~	CO2II W4WNT 73
113945	11	0.9	1040	~	W4WNT CO2II 73
114045	12	0.9	1040	~	CQ CO2II EL83
114115	13	0.4	1040	~	CQ CO2II EL83
114130	-8	-0.1	1040	~	CO2II W2HTS FN20
114215	6	0.9	1040	~	CQ CO2II EL83

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

40m ● 7.074 000  Tx even/1st

DX Call DX Grid Tx 1040 Hz Rx 1040 Hz Tx ← Rx Rx ← Tx

Lookup Add Report 8  Lock Tx=Rx

2017 Sep 23 11:44:14  Auto Seq  Call 1st  NA VHF Contest

Generate Std Msgs Next Now Pwr

	<input type="radio"/>	Tx 1
	<input type="radio"/>	Tx 2
	<input type="radio"/>	Tx 3
	<input type="radio"/>	Tx 4
CO2II W4WNT 73	<input type="radio"/>	Tx 5
CQ W4WNT EM95	<input checked="" type="radio"/>	Tx 6

1  
2

}

Receiving IC-7300 transmits FT8 Last Tx: CO2II W4WNT 73 14/15 WD:44m

# Main Screen

- dB column: received signal relative to noise level
- dT column: time difference between you and the station you are decoding
- Time sync software keeps dT to a minimum
- Windows OS needs time sync software

# FT8 Frequencies

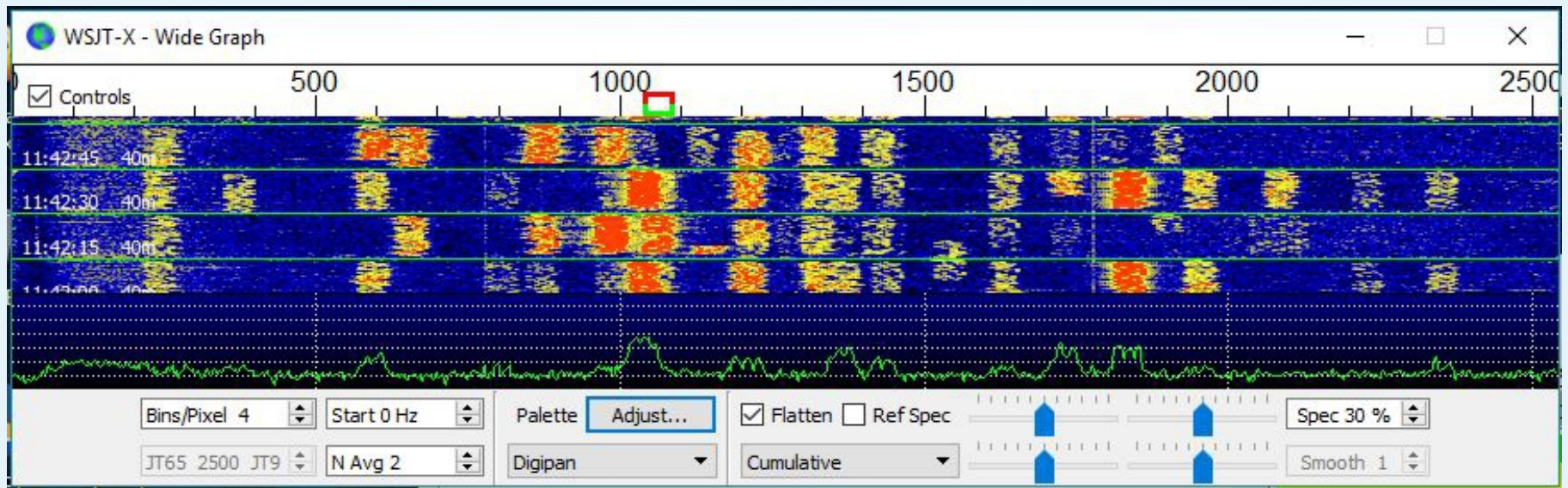
- 3.573, 7.074, 10.136, 14.074, 21074, 28.074, 50.313
- USB or USB-Data mode
- Power: normally low power 5-30 watts, but can use higher power (under 100watts)
- 2 kHz band at listed frequencies
- Eg: 7.074-7.076 Wide Graph 0-2000Hz
- JT65 7.076-7.078, JT9 7.078-7.080



# Power or not?

- According to Jim Shaver, N2ADV, adding power without a well tuned amplifier can make you unpopular on FT8. Remember the FT8 section is only 2kHz wide.
- Doubling your power is a 3dB increase and since the increase is logarithmic, even going to 1500 watts does not do a great deal to your signal.
- An amplifier will not turn a -24 signal into a +24 signal!

# Wide Graph (Waterfall)



# Weak Signal Mode

Solar-Terrestrial Data - <http://www.n0nbh.com>

10 Feb 2018 1634 GMT		VHF Conditions		HF Conditions		
		Item	Status	Band	Day	Night
SFI	77 SN 23	Aurora	Band Closed	80n-40n	Poor	Fair
A	5 K 3 / PIntry	6n EsEU	Band Closed	30n-20n	Fair	Fair
X-Ray	A8.7	4n EsEU	Band Closed	17n-15n	Poor	Poor
304A	99.2 @ SEM	2n EsEU	Band Closed	12n-10n	Poor	Poor
Ptn Flx	0.31	2n EsNA	Band Closed	Geonag Field UNSETTLD		
Elc Flx	0.13	EME Deg	Very Poor	Sig Noise Lvl S2-S3		
Aurora	3/n=1.99	MUF	ES - SEASON BREAK	MUF US Boulder 7.80		
Aur Lat	65.6°	MS		Solar Flare Prb 37%		
Bz	-1.6 SW 354.4	(C) Paul L Herriman 2013				

# Antenna

- When I moved to my present home in a new HOA, I decided to stay low key and operate with an indoor antenna. The antenna is an EARCHI End Fed strung around the walls of the radio room. Following are some examples of stations worked with that set up.

# Weak Signal Mode

## 40w 17m 30 ft End Fed Indoor Antenna

Rx Frequency				
UTC	dB	DT	Freq	Message
164100	2	0.1	1445 ~	CQ MI0LLG IO65
164118	Tx		1445 ~	MI0LLG W4WNT EM94
164130	5	0.1	1444 ~	W4WNT MI0LLG -15
164145	Tx		1445 ~	MI0LLG W4WNT R+05
164200	1	0.1	1444 ~	W4WNT MI0LLG -15
164215	Tx		1445 ~	MI0LLG W4WNT R+01
164230	-1	0.1	1444 ~	W4WNT MI0LLG RRR
164245	Tx		1445 ~	MI0LLG W4WNT 73
164300	-2	0.1	1443 ~	W4WNT MI0LLG 73

# Weak Signal

## 40w 17m Indoor End Fed

Rx Frequency				
UTC	dB	DT	Freq	Message
170615	14	0.1	431 ~	CQ KP4EJ FK67
170630	Tx		431 ~	KP4EJ W4WNT EM94
170645	15	0.1	431 ~	W4WNT KP4EJ +11
170700	Tx		431 ~	KP4EJ W4WNT R+15
170715	13	0.1	431 ~	W4WNT KP4EJ RRR
170730	Tx		431 ~	KP4EJ W4WNT 73
170745	15	0.1	432 ~	W4WNT KP4EJ 73

No one needs an amp!



One more example: 519 miles  
60m 5w Indoor End Fed Antenna  
Danville, IL

001345	Tx		1600	~	CQ W4WNT EM94
001400	7	-0.0	1600	~	W4WNT WA9EIC EN60
001415	Tx		1600	~	CQ W4WNT EM94
001445	Tx		1600	~	CQ W4WNT EM94
001515	Tx		1600	~	CQ W4WNT EM94
001545	Tx		1600	~	WA9EIC W4WNT +07
001600	8	-0.1	1001	~	W4WNT WA9EIC EN60
001615	Tx		1600	~	WA9EIC W4WNT +08
001630	3	-0.0	1001	~	W4WNT WA9EIC R-15
001645	Tx		1600	~	WA9EIC W4WNT RRR
001715	Tx		1600	~	WA9EIC W4WNT 73



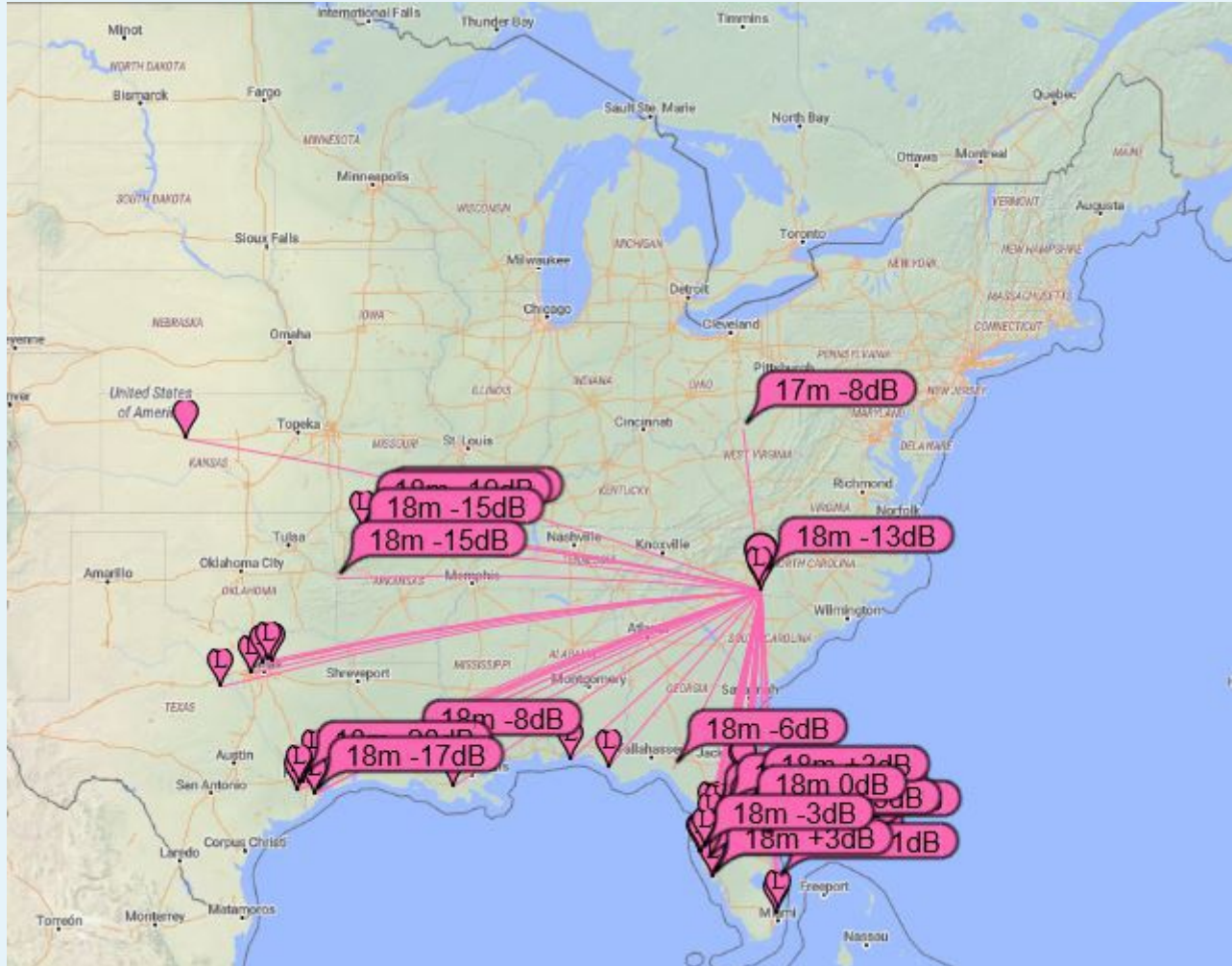
# Power as needed 60w 20m 9492 miles

				Rx Frequency
UTC	dB	DT	Freq	Message
211746	Tx		1909 ~	VK2DDS W4WNT EM94
211800	-18	0.2	1909 ~	W4WNT VK2DDS -15
211815	Tx		1909 ~	VK2DDS W4WNT R-18
211845	Tx		1909 ~	VK2DDS W4WNT R-18
211900	-14	0.2	1909 ~	W4WNT VK2DDS -15
211915	Tx		1909 ~	VK2DDS W4WNT R-14
211945	Tx		1909 ~	VK2DDS W4WNT R-14
212000	-18	0.2	1908 ~	K1BZ VK2DDS +05
212015	Tx		1909 ~	VK2DDS W4WNT R-14
212045	Tx		1909 ~	VK2DDS W4WNT R-14
212100	-13	0.2	1909 ~	W4RJC VK2DDS -07
212115	Tx		1909 ~	VK2DDS W4WNT R-14
212218	Tx		1909 ~	VK2DDS W4WNT R-14
212245	Tx		1909 ~	VK2DDS W4WNT R-14
212315	Tx		1909 ~	VK2DDS W4WNT R-14
212330	-13	0.2	1908 ~	W4WNT VK2DDS RR73
212345	Tx		1909 ~	VK2DDS W4WNT 73

# Auto Sequence

Rx Frequency				
UTC	dB	DT	Freq	Message
002845	Tx		1600 ~	K9NP W4WNT +08
002900	0	1.0	884 ~	W4WNT K9NP R-09
002900	17	0.0	1602 ~	W4WNT WB8ART EM79
002915	Tx		1600 ~	K9NP W4WNT RRR
002930	7	1.0	885 ~	W4WNT K9NP 73
002945	Tx		1600 ~	K9NP W4WNT 73
002900	17	0.0	1602 ~	W4WNT WB8ART EM79
003045	Tx		1600 ~	WB8ART W4WNT +17
003115	Tx		1600 ~	WB8ART W4WNT +17
003130	17	0.0	1687 ~	W4WNT WB8ART R-19
003145	Tx		1600 ~	WB8ART W4WNT RRR
003200	15	0.1	1687 ~	W4WNT WB8ART 73
003215	Tx		1600 ~	WB8ART W4WNT 73

# PSK Reporter



# DXPedition version

- Released in Beta February 2018
- Fox and Hound operation
- DXPedition = Fox, DXer = Hound
- Released on Joe's Princeton website
- Used by the Baker Island DXPedition in June 2018 and several others since.

# References

WSJT Home Page:

<http://physics.princeton.edu/pulsar/K1JT/index.html>

The current accepted version is wsjt-x 2.2.1 GA

October and November 2017 QST articles by Joe Taylor, K1JT, Steven Franke, K9AN, and Bill Somerville, G4WJS

Time Sync software: (for Windows machines)

Dimension4: Thinkman.com

Meinberg:

[www.meinbergglobal.com/english/sw/ntp.htm](http://www.meinbergglobal.com/english/sw/ntp.htm)

# Additional Resources

- IGC Grid Map:
- <http://www.n1kdo.com/lotw-gridmapper/GridMapper.html>
- Antenna: [http://www.earchi.org/proj\\_homebrew.html](http://www.earchi.org/proj_homebrew.html)
- PSK Reporter:
- <https://www.pskreporter.info/pskmap.html>

# References

- Facebook:
- FT8/FT4/JT9: WSJT 2-Way Narrow Band Modes for Amateur Radio
- Yahoo: WSJT Group
- Ian Wade: [G3NRW.net/IC-7300](http://G3NRW.net/IC-7300)  
also has a TS590 family website
- Gary Hinson, ZL2IFB
- [www.g4ifb.com/FT8\\_Hinson\\_tips\\_for\\_HF\\_DXers.pdf](http://www.g4ifb.com/FT8_Hinson_tips_for_HF_DXers.pdf)

- Thanks to Jim Shaver, N2ADV and Neil Zampella, KN3ILZ for their comments on this presentation.