

500

Controis

15:54:30

15:54:15

15:53:30

15:53:15

Deep space communications — on earth?

1000

1500

2000

2020-01-08 Presentation at SK7DX by Björn Ekelund SM7IUN

2500

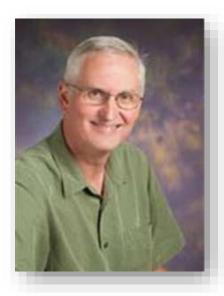
The back story

- When Joe Taylor was approaching 60 in the late 90's, he got an urge to return to the hobby of his teens: ham radio.
- A childhood dream was to communicate using moon-bounce but he was also fascinated by intermittent propagations, such as meteor scatter.
- Having extensive experience from weak signal detection (radio astronomy) and deep space communications he wanted to try this also for himself.
- In 2001 the DOS-based software WSJT was released.
- He later joined forces with remote sensing Professor Steve Franke and brilliant British software designer Bill Somerville.

Two professors and a software guru



Prof. Joe Taylor, K1JT Former Dean of the Physics Department, Princeton. Nobel Laureate

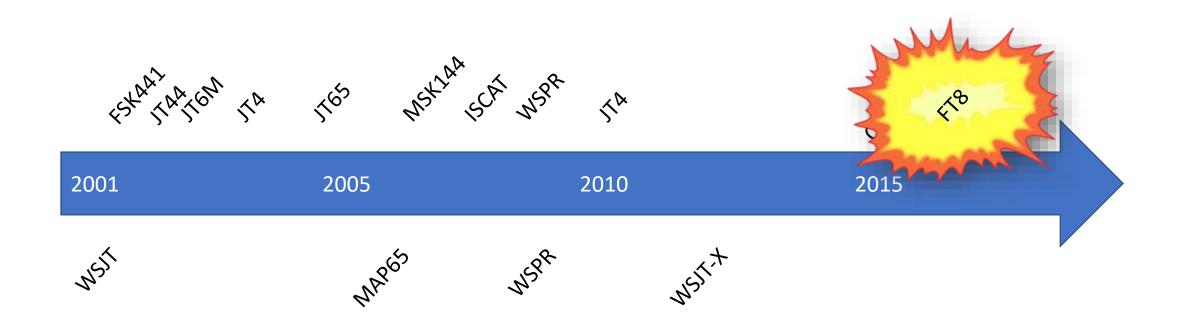


Prof. Steven J. Franke, K3AN Electrical and Computer Engineering University of Illinois at Urbana

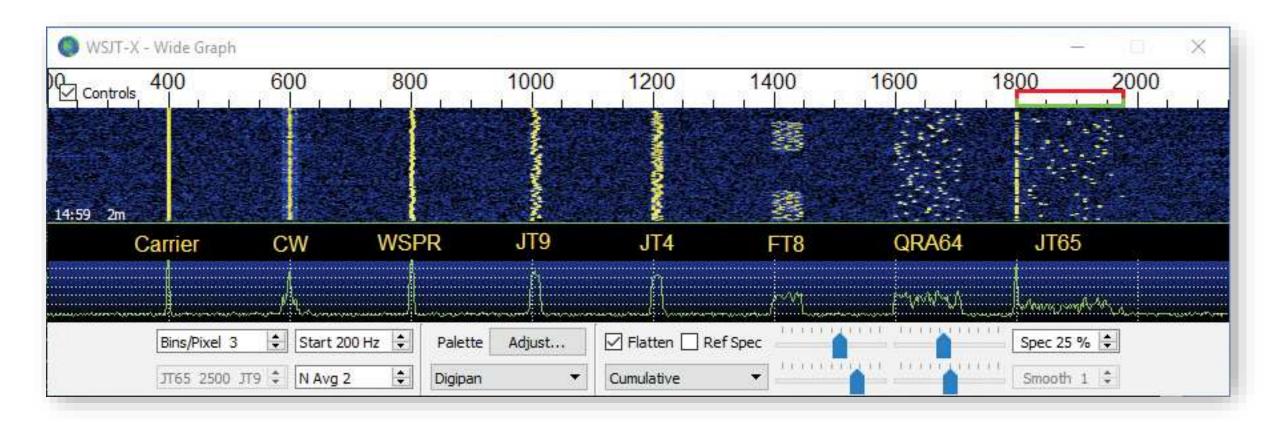


Bill Somerville, G4WJS Freelance software engineer Stokenchurch, UK

Evolution



Modulation characteristics

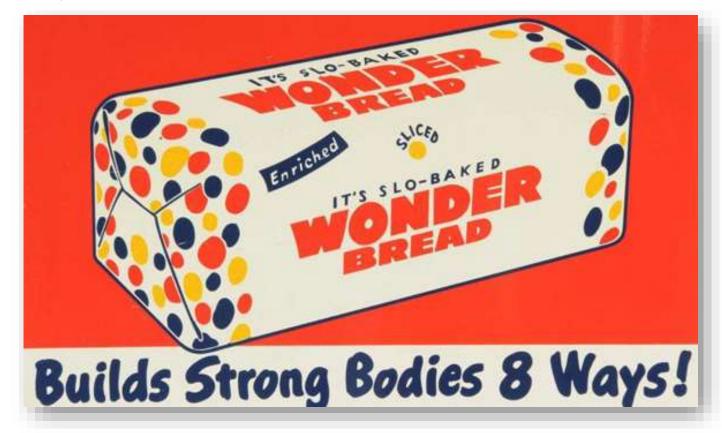


Better than CW? Only a little...

Modulation + protocol	SNR @ 2.5kHz
SSB (telephony)	~10dB
MSK441	-8dB
FT4	-16dB
Human Morse code	~-18dB
FT8	-20dB
JT65	-25dB
QRA64	-27dB
WSPR	-31dB

FT8: DXing on Dead Bands

Some Say: The Greatest Thing Since...

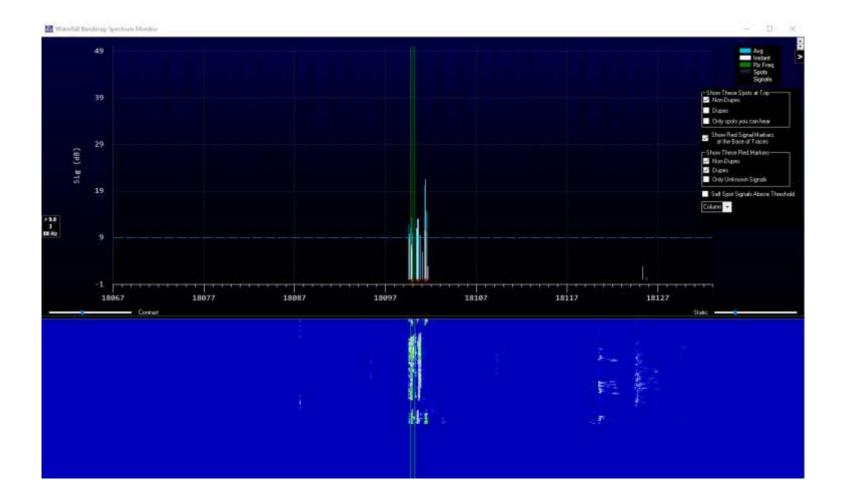


FT8: DXing on Dead Bands

Others Say: The End of Ham Radio as We Know It



FT8: 17 Meters, Monday 8am



FT8: 17 Meters, Monday 8am

125845 -13 0.3 1626 ~ 9Z4A KA1J R-24

125845 -4 -0.6 1796 ~ CQ RZ3DZ KO85

125845 -3 0.2 1951 ~ CQ E73DN JN93

125845 -1 0.2 1990 ~ CO8LY I1YTO JN44

6 -0.0 1715 ~ TA11FV SM6CKU -01

-9 0.1 1891 ~ R6LC VE3PJ -07

125845

125845

🔇 WSJT-X - Wide Graph	- 🗆 X
☑ Controls 1000 1500	2000 2500 3000
12538 445 17m	
12:58:90 17m 12:58:35 17m	
12958:00 2 120 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	
12457:45 17m	
12657:15 17m 10 10 10 10 10 10 10 10 10 10 10 10 10	
12 30:43 1/m 24 24 24 24 24 24 24 24 24 24 24 24 24	
M	
	per per
med why an off the M	
an walk the second seco	Apr M HUM MAN You Man Man Man Man
Bins/Pixel 4 🖨 Start 300 Hz 🖨 Palette Adjust.	Flatten 🗌 Ref Spec 🦳 🧴 👘 Spec 30 % 🕏
]T65 2500 JT9 ‡ N Avg 3 ‡ Default	Cumulative
🔘 WSJT-X v1.8.0 by К1JT	- D X
File Configurations View Mode Decode Save Tools Help	
File configurations view node becode save foots neit	p
Band Activity	Rx Frequency
UTC dB DT Freq Message	UTC dB DT Freq Message
125845 -6 U.I IIIS ~ G6GA K5EK /3 125845 -7 U.2 1191 ~ WB2REM CT1GYD IN51	125545 -10 0.2 1477 ~ CQ E01FQ K033 125608 Tx 1477 ~ E01FQ K80T EN82
125845 -3 0.2 1322 ~ COBLY ON5SA JN29	125615 -7 0.2 1476 ~ CQ EU1FQ KO33
125845 9 0.1 1382 ~ R7FC S52D JN76	125630 Tx 1477 ~ EU1FQ K8UT EN82

125645

125700 Tx

125730 Tx

125715 -5 0.2

125745 -6 0.2 1476 ~

✓ 125830 -14 0.2 1475 ~

-9 0.4 1476 ~

1477 ~

1476

1477

KSUT EU1FQ -15

EU1FQ K8UT R-09

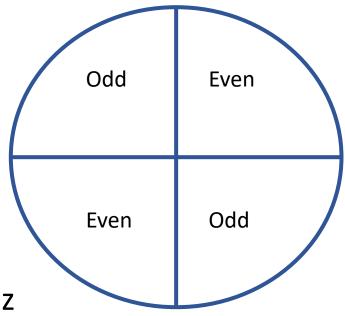
KSUT EU1FQ 73

CO EU1FO KO33

REIT

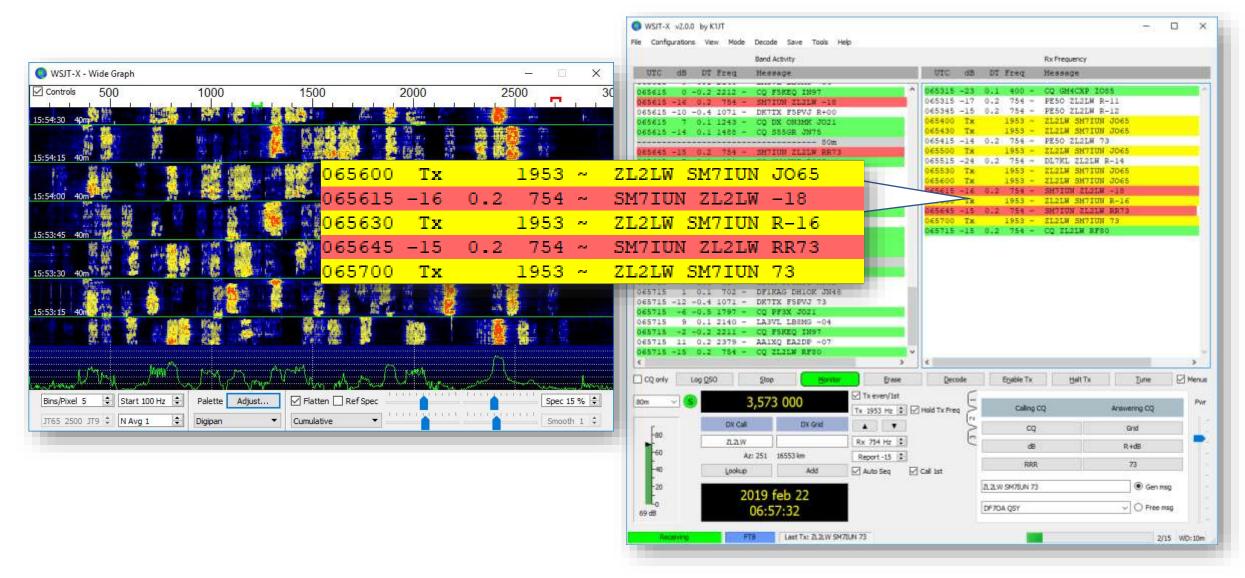
FT8 – Franke-Taylor-8FSK

- T/R sequence period: 15s
- Message length: 75 bits + 12-bit CRC
- FEC code: (174,87) LDPC
- Modulation: 8-FSK, keying rate = tone spacing = 6.25Hz
- Waveform: Continuous phase, constant envelope
- Occupied bandwidth: 50Hz
- Synchronization: Three 7 x 7 Costas arrays (start, middle, end of transmission)
- Transmission duration: 79 x 1920/12000 = 12.64s
- Decoding threshold: -20dB SNR (down to -24dB with a priori decoding)
- Multi-decoding: Finds and decodes all FT8 signals in passband





Using the software



				General	<u>R</u> adio A	Audio	Tx <u>M</u> acros	Reporting	Frequencies	Colors	Advance
WSJT-X v2.1.2 by K1JT				Station D	etails						
le Configurations View Mode [Decode Save Tools Help										
1	Band Activity		Rx Frequency	My Call:	SM7IUN	Mv	Grid: JO65	SMR [AutoGrid IA	RU Region:	Region 1
UTC dB DT Freq	Message	UTC dB DT F	reg Message	,							
-				Message	generation f	for type 2	compound c	allsign holders:	Full call in Tx3		
200245 -17 0.1 1327 ~ 200245 1 0.2 1570 ~	HASLN EI9KF -08		374 ~ CQ OY5ET IP62		-			-			
	DL9HD UA2FF -13	195936 Tx 13 195945 -7 0.0 13	374 ~ OY5ET SM7IUN JO65 374 ~ G3UEG OY5ET R-10								
	E75JD ON7DE JO20		693 ~ OY5ET SM7IUN JO65								
200245 -14 0.1 2244 ~		200015 -7 0.0 13		Display							
200245 -7 0.6 2345 ~			693 ~ OY5ET SM7IUN J065								
200245 -10 0.1 2558 ~		200045 -6 0.1 13		Start	new period d	decodes af	t top			F	ont
00245 -9 0.2 2855 ~			693 ~ OY5ET SM7IUN JO65								
200245 -1 0.3 2920 ~	YB6HAI R6KX -21	200115 -6 0.1 13		✓ Blank	line between	n decoding	periods				
	EC5CFV SV3AQT -07	200145 -4 0.0 13					<u> </u>			Decoded	Text Font.
200245 0 0.9 645 ~	YO3GD GD3YUM -16	200200 Tx 11	100 ~ OY5ET SM7IUN JO65	Displa	ay distance in	n miles					
	PA3FRZ F6BHK JN24	200215 -3 0.0 13	374 ~ SM7IUN OY5ET -08								
200245 -18 0.3 1095 ~	MW0CSO TA7LZB KN90	200230 Tx 11	100 ~ OY5ET SM7IUN R-03	🗸 Tx me	essages to Ra	x frequen	cv window				
	ZS6GTK EA1AGP IN73	200245 -6 0.0 13	375 ~ SM7IUN OY5ET RRR								
	TF3PPN M7RKK I093	200300 Tx 11	100 ~ OY5ET SM7IUN 73	Show	DXCC. grid.	and work	ed-before st	tatus 🗌 Sho	w principal prefix	c instead of c	ountry nam
200245 -21 0.3 2204 ~		200315 -6 0.0 13			<u>B</u> /ree/ gild/	and north	to before or		in principal preni		counter y main
	F4ERS RV6HEG R-10	200330 2 -0.5 13									
200245 -10 0.1 662 ~			375 ~ G5LP OY5ET -08								
	40m	200400 -1 -0.5 13		Behavior							
200315 -6 0.0 1375 ~ 200315 -10 0.4 201 ~	EC5CFV SV3AQT RR73	200415 -23 0.1 24 200436 Tx 11		_				_			
	CQ RW6AIC KN96		100 ~ <5Z4/G3AB> SM7IUN J0 100 ~ <5Z4/G3AB> SM7IUN J0	Monit	or off at star	rtup		Enable VH	IF/UHF/Microway	ve features	
	9K2OD EW4C -05		100 ~ <524/G3AB> SM/10N 30 100 ~ <524/G3AB> SM7IUN J0								
	CQ AF LA3WJA JP32	200330 1X 1		Monit	or returns to	last used	frequency	Allow Tx f	requency chang	es while tran	smitting
	BI6KAE IZOXYX JN62		401 ~ <5Z4/G3AB> SV1LIQ KM				<u> </u>				-
(> <		🗸 🗸 Doub	le-click on call	ll sets Tx e	enable	Single dec	ode		
					_						
CQ only Log QSO	Stop Monitor	Erase Decode En	able Tx Halt Tx T	✓ Disab	le Tx after se	ending 73		Decode at	fter EME delay		
		even/1st									
0m 🗸 🔵 🕇 7	/ 0 /4 000		Calling CQ Answerin	Callin	g CQ forces (Call 1st					
		832 Hz 😫 🗹 Hold Tx Freq >	County CQ Answerin		-					_	
DX Call	DX Grid		CQ Grid	Alterr	nate F1-F6 bii	indings			Tx v	vatchdog: 1	.4 minutes 🗄
-80		001 Us 📩 🕅									
- 5Z4/G3AB	Rx 2	901 Hz 🗧	dB R+d	CW II	D a <u>f</u> ter 73				Period	lic CW ID Inte	erval: 0
-60	Rep	ort -19 韋									<u> </u>
-40 Lookup	Add Aut	to Seg 🗸 Call 1st	RRR 73								
- <u>_</u>	Aut										
-20	20 : 07	<524	/G3AB> SM7IUN JO65								
L ₀ 20)20 jan 07									OK	Can
	20:16:07		ii vy orm 🗸 🗸								

Basic set-up of WSJT-X

WSJT-X v2.1.2 by K1JT File Configurations View Mode Decode Save Tools Help Band Activity Rx Frequency UTC dB DT Freq Message UTC dB DT Freq Message 200245 -17 0.1 1327 ~ CQ SV1TN KM18 195915 -3 0.0 1374 ~ CQ OY5ET IP62 200245 1 0.2 1570 ~ HA8LN EI9KF -08 195936 Tx 1374 ~ OY5ET SM7IUN JO 200245 -8 0.1 1894 ~ DL9HD UA2FF -13 195945 -7 0.0 1374 ~ G3UEG OY5ET R-10 200245 0 0.1 1952 ~ E75JD ON7DE JO20 200000 Tx 1693 ~ OY5ET SM7IUN JO 200245 -14 0.1 2244 ~ CQ RA3WII K071 200015 -7 0.0 1374 ~ G3UEG OY5ET 73 200245 -7 0.6 2345 ~ EC5CFV G4DBW -15 200030 Tx 1693 ~ OY5ET SM7IUN JO 200245 -10 0.1 2558 ~ OY5ET US1IK KN88 200045 -6 0.1 1374 ~ SM1HOW OY5ET -12 200245 -9 0.2 2855 ~ CQ MORCM IO94 200100 Tx 1693 ~ OY5ET SM7IUN JO 200245 -1 0.3 2920 ~ YB6HAI R6KX -21 200115 -6 0.1 1375 ~ SM1HOW OY5ET RRR 200245 -8 0.3 201 ~ EC5CFV SV3AQT -07 200145 -4 0.0 1375 ~ SM1HOW OY5ET 73 200245 0 0.9 645 ~ YO3GD GD3YUM -16 200200 Tx 1100 ~ OY5ET SM7IUN JO 200245 -16 1.0 729 ~ PA3FRZ F6BHK JN24 200215 -3 0.0 1374 ~ SM7IUN OY5ET -0 200245 -18 0.3 1095 ~ MW0CSO TA7LZB KN90 200230 Tx 1100 ~ OY5ET SM7IUN R-200245 -14 1.8 1414 ~ ZS6GTK EA1AGP IN73 200245 -6 0.0 1375 ~ SM7IUN OY5ET RR 200245 -9 0.5 1563 ~ TF3PPN M7RKK I093 200300 Tx 1100 ~ OY5ET SM7IUN 73 200245 -21 0.3 2204 ~ ZS6GTK G0CQZ I091 200315 -6 0.0 1375 ~ SM7IUN OY5ET 73 200245 -19 2.1 2601 ~ F4ERS RV6HEG R-10 200330 2 -0.5 1374 ~ OY5ET G5LP IO92 200245 -10 0.1 662 ~ UR3EO HA8RC RR73 200345 -7 0.0 1375 ~ G5LP OY5ET -08 ----- 40m 200400 -1 -0.5 1374 ~ OY5ET G5LP IO92 200315 -6 0.0 1375 ~ SM7IUN OY5ET 73 200415 -23 0.1 2401 ~ CQ 5Z4/G3AB 200315 -10 0.4 201 ~ EC5CFV SV3AQT RR73 200436 Tx 1100 ~ <5Z4/G3AB> SM7IU 200315 2 0.6 325 ~ CQ RW6AIC KN96 200500 Tx 1100 ~ <5Z4/G3AB> SM7IU 200315 1 0.1 377 ~ 9K20D EW4C -05 200530 Tx 1100 ~ <5Z4/G3AB> SM7I 200315 3 0.8 800 ~ CQ AF LA3WJA JP32 200700 -4 0.2 2403 ~ <5Z4/G3AB> IZ8JF 200315 -19 2.4 916 ~ BI6KAE IZ0XYX JN62 200730 -9 0.1 2401 ~ <5Z4/G3AB> SV1LI < < > CQ only Log QSO Stop Monitor Erase Decode Enable Tx Halt Tx Tx even/1st 7.074 000 40m \sim Calling CQ Tx 2832 Hz 😫 🗹 Hold Tx Freq DX Call DX Grid ▲ ▼ CQ -80 5Z4/G3AB Rx 2901 Hz ≑ dB -60 Report -19 ≑ RRR -40 Lookup Add Auto Seq Call 1st -20 <5Z4/G3AB> SM7IUN JO65 2020 ian 07 L

20:16:07

FT8 Last Tx: <5Z4/G3AB> SM7IUN JO65

0 dB

ZB2GI VY QRM

: Icom IC-7610	∨ Poll Interval: 1s
Serial Port: COM8 ~	PTT Method O VOX O DTR O CAT O RTS
Baud Rate: 115200 ✓ Data Bits ○ Default ○ Seven ● Eight	Port: COM7 Transmit Audio Source Rear_Data
Stop Bits O Default O On <u>e</u> O T <u>w</u> o	Mode O None O US <u>B</u>
Handshake O Default None XON/XOFF Hardware	Split Operation None Rig Fake It
Force Control Lines DTR: V RTS: V	Test CAT Test PTT

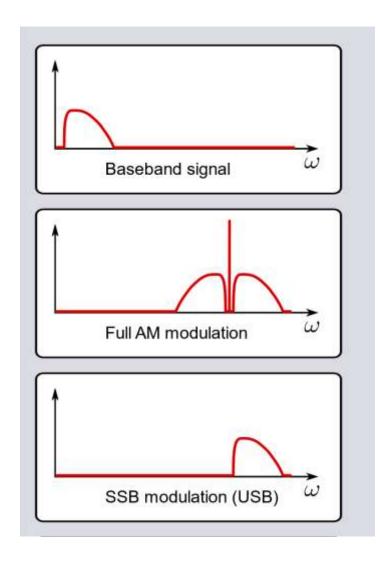
"Split operation"

This setting has nothing to do with transmitting and receiving on different frequencies.

To secure a <u>clean transmission</u> WSJT-X only generates transmit audio signals between 1500kHz and 2000kHz and then modifies the base frequency down or up to achieve the wanted radio frequency.

Example: You want to transmit on 3573.5kHz.
1. Radio on 3573kHz + audio 500Hz → RF on 3573.5kHz (bad)
2. Radio on 3572kHz + audio 1500Hz → RF on 3573.5kHz (good).

"Rig" puts the modified base frequency for transmission in VFO B and sets "Split operation" on the radio.
"Fake it" instead uses CAT commands. (Recommended!)
"None" should never be used unless you restrict transmission to above 1500Hz!



Basic set-up of WSJT-X

				Band Ad	tivity						Rx Frequency		
UTC	dB	DT	Freq	Messa	ige		UTC	dB	DT	Freq	Message		Outpu
200245	-17		1327 ~	-	/1TN KM18	^	195915	-3	0.0	1374 ~			
200245	1		1570 ~		1 EI9KF -08		195936	Тx		1374 ~			Save
200245	-8		1894 ~) UA2FF -13			-7	0.0		G3UEG OY5		
200245	0		1952 ~		ON7DE JO20		200000	Τx		1693 ~			
200245			2244 ~	-	A3WII KO71		200015	-7	0.0	1374 ~	G3UEG OY5		Loc <u>a</u> ti
200245	-7		2345 ~		V G4DBW -15		200030	Тx		1693 ~			
200245					USIIK KN88		200045	-6	0.1	1374 ~	SM1HOW OY		
200245				_	RCM IO94		200100	Тx			OY5ET SM7		AzEl D
200245	-1		2920 ~		AI R6KX -21		200115	-6		1375 ~	SM1HOW OY		
200245	-8	0.3	201 ~		V SV3AQT -07		200145	-4	0.0	1375 ~	SM1HOW OY		
200245	0	0.9	645 ~) GD3YUM -16		200200	Тx		1100 ~	OY5ET SM7	IUN JO65	Locati
200245			729 ~		RZ F6BHK JN24		200215	-3	0.0	1374 ~	SM7IUN OY	5ET -08	
200245			1095 ~		SO TA7LZB KN90		200230	Тx		1100 ~			
200245			1414 ~		TK EALAGP IN73		200245	-6	0.0	1375 ~	SM7IUN OY	5ET RRR	Remer
200245	-9		1563 ~		N M7RKK 1093		200300	Тx		1100 ~	OY5ET SM7	IUN 73	
200245	-21	0.3	2204 ~	ZS6G	TK GOCQZ IO91		200315	-6	0.0	1375 ~	SM7IUN OY	5ET 73	
200245	-19	2.1	2601 ~	F4ER	S RV6HEG R-10		200330	2	-0.5	1374 ~	OY5ET G5L	P IO92	
200245	-10	0.1	662 ~	UR3E	HASRC RR73		200345	-7	0.0	1375 ~	G5LP OY5E	т -08	
					40m		200400	-1	-0.5	1374 ~	OY5ET G5L	P 1092	
200315			1375 ^		JN OY5ET 73		200415	-23	0.1	2401 ~	CQ 5Z4/G3	AB	
200315	-10	0.4			V SV3AQT RR73		200436	Тx		1100 ~	<5Z4/G3AB	> SM7IUN 🗸	
200315	2	0.6	325 ~	-	V6AIC KN96		200500	Тx		1100 ~	<5Z4/G3AB	> SM7IUN 🗸	
200315	1	0.1	377 ~		D EW4C -05		200530	Тx		1100 ~	<5Z4/G3AB	> SM7IUN (
200315	3	0.8	800 ~		F LA3WJA JP32		200700	-4	0.2	2403 ~	<5Z4/G3AB	> IZ8JFA ·	
200315	-19	2.4	916 ~	BI6K	AE IZOXYX JN62	~	200730	-9	0.1	2401 ~	<5Z4/G3AB	> SV1LIQ I	
<						>	<						1
CQ only	I	.og <u>Q</u> SC	C	<u>S</u> top	Monitor	Erase	Deco	de		E <u>n</u> able Tx	<u>H</u> alt T:	x	
40m				7 07/	000	Tx even/1st			_				
40m	× (7,074	1000	Tx 2832 Hz 🖨	Hold Tx	Freq	\geq	Callir	ng CQ	Answei	
г			DX Ca	al	DX Grid		1		5	(0	G	
-80			5Z4/G3	AB		Rx 2901 Hz 🖨	_		[m				
-60			32-103	~~	L		-		_	(dB	R-	
						Report -19 韋							
-40			<u>L</u> ooku	р	Add	Auto Seq	🗹 Call 1st			R	RR	/	
-20									L	574/C3AP> 9	SM7IUN JO65		
-20				2020	an 07					.52 T/GUND > 3	34171014 30003		
Lo				2020]									1

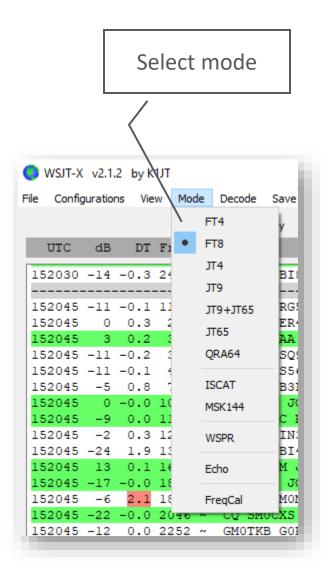
Settings	? ×
General Radio Audio Tx Macros Reporting Frequencies Colors Soundcard Soundcard	Advanced
Input: IC-7610 Rx (3- USB Audio CODEC) Output: IC-7610 Tx (3- USB Audio CODEC)	✓ Left ✓✓ Both ✓
Save Directory Location: C:/Users/SM7IUN/AppData/Local/WSJT-X/save	S <u>e</u> lect
AzEl Directory Location: C:/Users/SM7IUN/AppData/Local/WSJT-X	Select
Remember power settings by band	
ОК	Cancel
0/15 WD:14m	

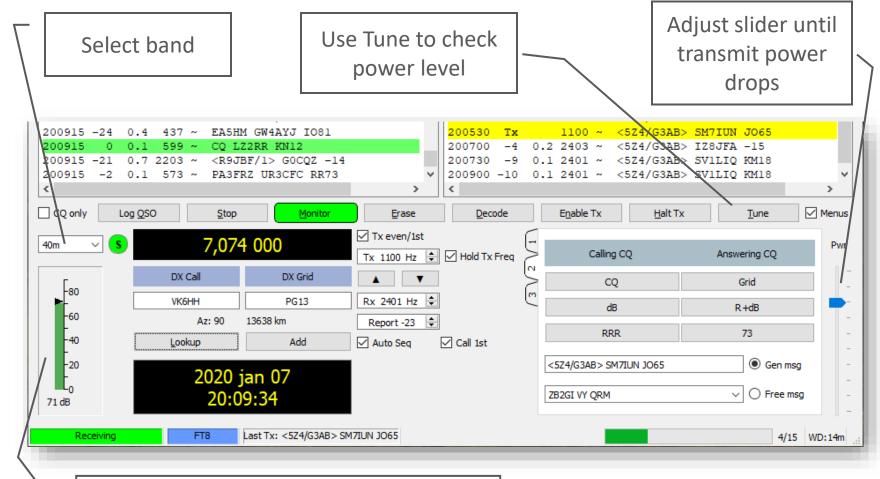
Accurate time is essential

- Timing needs to be within 1 second.
- <u>www.time.is</u> checks your clock.
- The built-in Windows facility for time synchronization is usually not adequate.
- *Meinberg NTP* and *Dimension 4* are popular time synchronization clients.

	Sen	rer						01
	Se	erver	1	ocatio	n	Protocol	-	OK
		e-b.timefred e-c.timefred			NIST Boulder Laboratori	SNTP		Cancel
		e-c.timetreo e-d.timetreo			NIST Boulder Laboratori	SNTP	-	Help
		s2.usno.nav k.usno.nav			U.S. Naval Observatory U.S. Naval Observatory	SNTP	~	About
	100	erver tick	even inte	41.10.00		Ad	1	Esit
	lo	ation	DEUSIN	lawaf (Diservatory, Washington, DC	Ed		
				100071.0		Bemo		[
	1.1.1	otocol SNI						Advanced
		Notes Acc					0	
00245	-8	0.3	201	~	EC5CFV SV3AQ			
00245	0	0.9	645	~	YO3GD GD3YUM	-16		
00245	-16	1.0	729	~	PA3FRZ F6BHK	JN24		zed
00245	-18	0.3	1095	~	MW0CSO TA7LZ	B KN90)	minimized
00245	-14	1.8	1414	~	ZS6GTK EA1AG	P IN73	3	n in <u>t</u> ray
00245	-9	0.5	1563	~	TF3PPN M7RKK	1093		
00245	-21	0.3	2204	~	ZS6GTK G0CQZ	1091		History
00245	-19	2.1	2601	~	F4ERS RV6HEG	R-10		
00245	-10	0.1	662	~	UR3EO HA8RC	RR73		
						40m		
00315	-6	0.0	1375	~	SM7IUN OY5ET	73		
00315	-10	0.4	201	~	EC5CFV SV3AQ	T RR73	3	
00315	2	0.6	325	~	CQ RW6AIC KN	96		
00315	1	0.1	377	~	9K2OD EW4C -	05		
00315	3	0.8	800	~	CQ AF LA3WJA	JP32		
00315	-19	2.4	916	~	BI6KAE IZOXY	X JN62	2	
				_				_
CQ only		Log <u>Q</u> SC)		Stop	<u>M</u> onitor		
								THE
Dm	\sim				7 074 000		\sim	TX

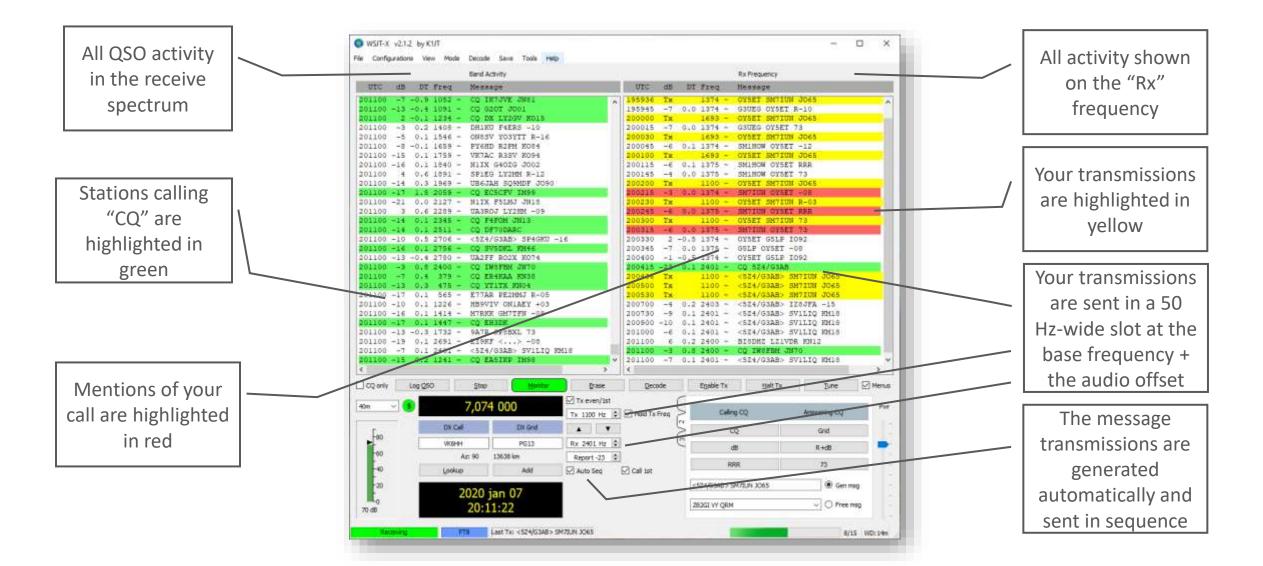
Getting Started



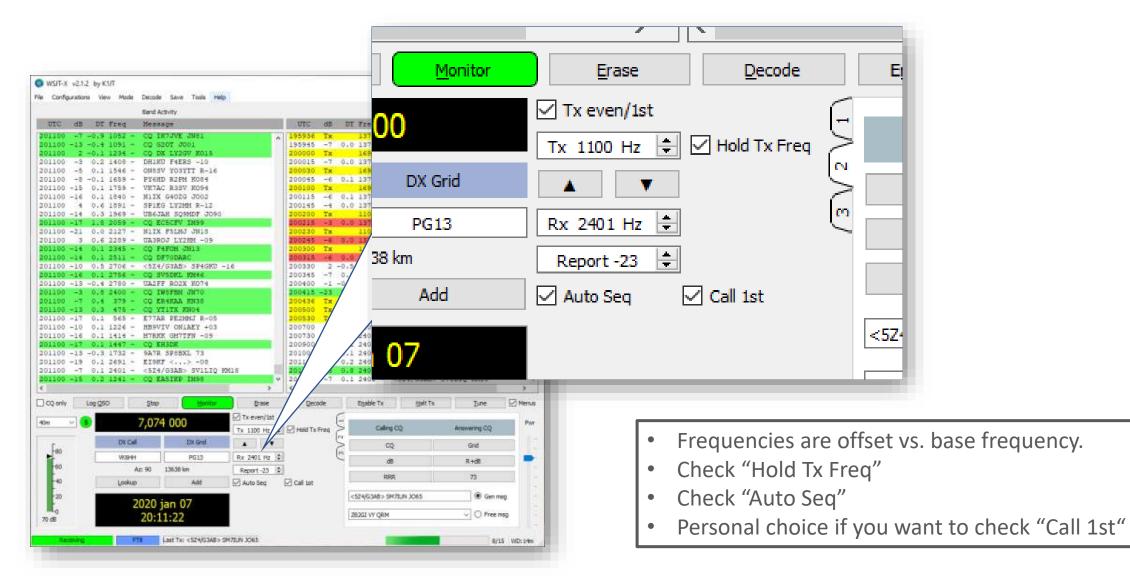


Adjust AF level as high as possible without ever turning red.

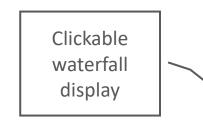
WSJT-X Main Screen



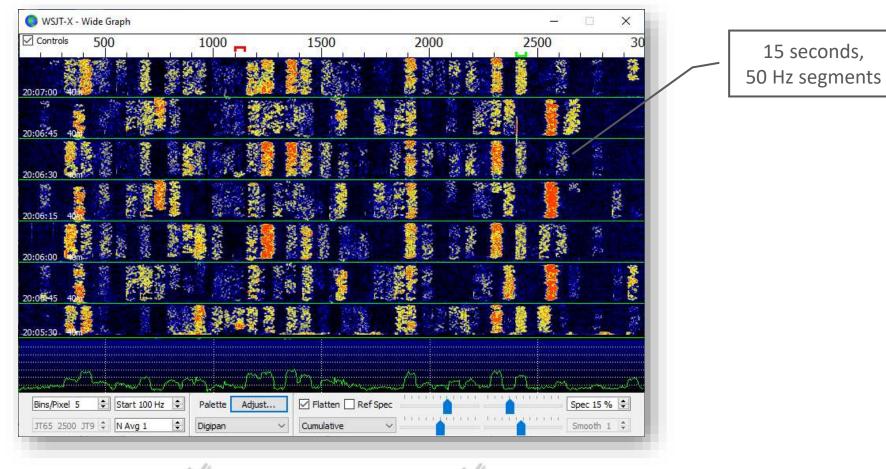
Where to send and receive



The Looks and Sounds of FT8



- Click = Rx
- Shift-Click = Tx
- Ctrl-Click = Both



Single FT8 signal





An entire FT8 sub-band

Audio courtesy of Dave le Vasseur, NODL

Typical QSO sequence

- Select a clear transmit slot with Shift-Click.
- Avoid transmitting on the same offset as the station you call.
- Double-Click to call a station calling CQ.

📀 WSJT-X - Wide Graph	- 🗆 X		
Controls 500 1000 1500 2000 Controls 500	2500 30	WS/T-X v2.1.2 by K1//T File Configurations View Mode	e Decode Save Tools Help Band Activity
20:07:00 40		UTC dB DT Freq	Message
20:06:45 40		201100 -7 -0.9 1052 201100 -13 -0.5 1091 - 201100 2 -0.1 1236 - 201100 -3 0.2 1408 201100 -5 0.1 1546	- CQ G2OT JOO1 - CQ DX LY2GV KOIS - DHIKO F4ERS -10
20:06:30			- FYGHD B2FM K084 - VETAC R3SV K094 - WIIX G402G J002
20:06:15 4		201100 -14 0.3 1963 - 201100 -17 1.8 2055 - 201100 -21 0.0 2127 - 201100 3 0.6 2289 -	- UB6JAH SQBMDF JO90 - CQ ECECEV IM99 - NIIX FSLMJ JN18
20:06:00 and a local and a loc		201100 -14 0.1 2385 - 201100 -14 0.1 2511 -	- CQ F4FOH JH13 - CQ DF70DARC - <524/G3A8> SP4GKD -16
20:0545 40		201100 -13 -0.4 2780 - 201100 -3 0.8 2400 - 201100 -7 0.4 379 -	- UA2FF RC2X H074 - CQ INSFEM JH70 - CQ ER4HAA HM30
20:05:30		201100 -17 0.1 565 201100 -10 0.1 1226 201100 -16 0.1 1414 201100 -17 0.1 1447	- E77AR PE2MMJ R-05 - HBSVIV ONIAEY +03 - MTREK GM7IFH -09 - CQ EH3DE
	TILLING TILLIGHT TILLIG	201100 -13 -0.3 1732 201100 -19 0.1 2491 201100 -7 0.1 2401 201100 -15 0.2 1241	- KI9KF <> -00 - <524/63AB> SV1LIQ RM18
Bins/Pixel 5 Start 100 Hz Palette Adjust Flatten Ref Spec	Spec 15 % 🖨	CQ only Log QSD	Stop Manuar
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		WK5H	H PG13 Rx

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201100 -13 -0,	4 1091 -	CQ 620T				195955	-7	0.0 2374 +	GBUEG OYSE:		
	1 1236 +		Y2GV KO15			200000	Tx	1693 -	OYSEI SM711		
	2 1408 -		4ERS -10			200015		0.0 1374 ~	GSUEG OYSE:		
	1 1546 -		OSYTT R-16			200030	TX	1693 ~	OYSET SHTI		
201100 -8 -0.			2FM KO84			200045		0.1 1374 -	SMIHOW OYSS		_
	1 1759 -		3SV K094 0ZG J002			200100	Tx -6	1693 -	SMINON OYS		
	6 1891 -		Y2MM R-12			200115		0.1 1375 ~	SMINOW CYS	and a second sec	
	3 1969 -		SQSMDF JOSO			200200	TR	1100 -			
	8 2059 -	CO ECSC			_	200215		0.0 1974 -	SHTINI OVS		-
	0 2127 -		LMJ JN18		_	200230	Tx	1100 -	OYSET SHTIT	and the second se	- 8
	6 2289 -		LYZHM -09			200245	-0	0.0 1375 -	SMTINE OVER	and the second se	
	1 2345 -	CO E4FO				200300	TX	1100 -	OVSET SM7I		-
201100 -14 0.	1 2511 -	CO DETO	DARC			200315	-6-1	0.0 1975 -	SHTEINI OYSI	MT 73	
	5 2706 -	<524/63	AB> SP4GKD -	16	_	200330	2 -	0.5 1374 ~	OYSET GSLP	1092	_
201100 -16 0.	1 2756 -	CQ. SVSD	KL KNEE			200345	-7	0.0 1975 -	GELP OYSET	-08	
201100 -13 -0.	4 2780 -	UA2FF R	02X H074			200400	+1 =	0.5 1374 -	OYSET GSLP	1092	
201100 -3 0,	8 2400 -	CO INSE	886 33970			200415	-25	0.1 2401 ~	CQ 524/G3A	and an increase of	
201100 -7 0.	5 379 -	CO ER4K	AA BIF30			200436	TH	1100 -	<524/G3AB>	SM7IUN JO65	
201100 -13 0.	3 475 -	CQ YTIT	X 2090 E		_	200500	Tx	1100 -	<524/63AB>	SM7IUN JO65	
201100 -17 0.			E2MMJ R405			200530	Tx	1100 -		SM7IUM JO65	
	1 1226 -		ONTWEA +03			200700		0.2 2403 ~		IZOJFA -15	
and the second se	1 1414 -		H7IFN -09			200730		0.1 2401 -		SVILIQ HH18	
	1 1447 -	CQ EH3D	and the second se					0.1 2401 ~		SVILIQ KM18	
	3 1732 -	SATH SP				201000		0.1 2401 -		SVILIQ MH18	
	1 2691 -		> -00	002.25	100	201100			SISDME LEL		1
	1 2401 -	CQ EASI	AB> SVILIQ H	M10		201100		0.1 2401 -	CO INSFER	SVILIO RM18	
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70 dB		20:11						282GI VY QR	4	- O Free #	192
10.000			Card and a second s								

Typical contact – message exchange

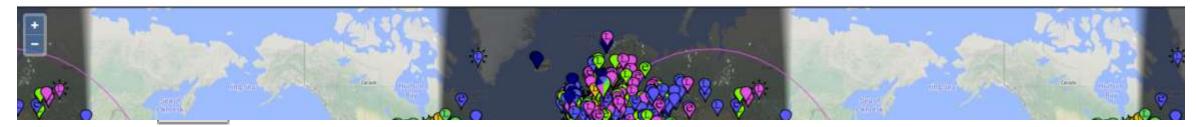
Party station	You
CQ ZL2LW RF80	
	ZL2LW SM7IUN JO65
SM7IUN ZL2LW -18	
	ZL2LW SM7IUN R-16
SM7IUN ZL2LW RR73	
	ZL2LW SM7IUN 73

Sometimes magic happens

061000	Тx	1357	~	CQ SM7IUN JO65		l.
061015	-3	0.1 1358	~	SM7IUN IU8CEE JN71		
061015	-6	0.3 1357	~	SM7IUN RW6AB KN95	a2	
061015	-13	0.7 1357	~	SM7IUN VK2EHQ QF56		

Spotting: PSK Reporter

On all bands V, show signals V rovd by V the callsign V sm7iun using all modes V over the last 24 hours V Go! Display options Permalink Automatic refresh in 3 minutes. Small markers are the 1621 transmitters (show logbook) heard (distance chart) at SM7IUN (22426 reports, 135 countries last 24 hours; 158269 reports, 150 countries last week). There are 3357 active monitors: 1031 on 40m, 918 on 20m, 474 on 30m, 284 on 80m, 131 on 17m, 128 on 160m, 109 on 60m, 87 on 15m, 60 on 2m, 56 on 6m, 33 on unknown, 4 on 10m, 4 on 600m, 3 on 23cm, 3 on 4m, 2 on 2200m, 1 on uhf. Legend



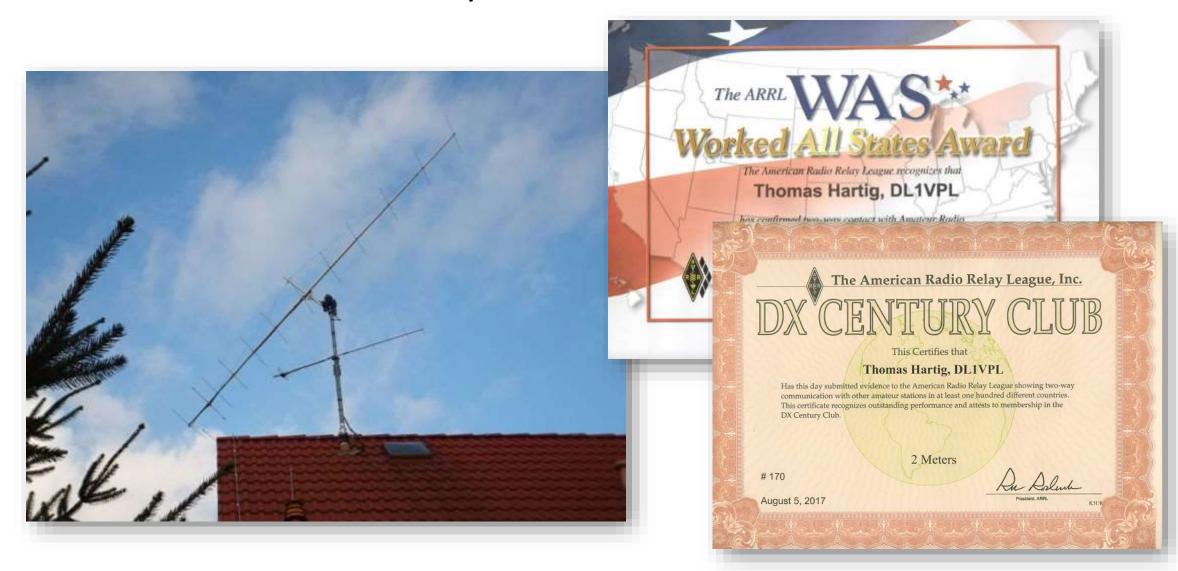
(distance chart) at SM7IUN (24775 reports, 143 countries last 24 hours; 160391 reports, 149 countries last week).



Statistics - Comments to Philip Gladstone - Online discussions - Reception records: 6,529,442,773 (150/sec) - Hosting by Fast Serv Networks, LLC

PSKREPORTER.INFO

There is also **real** space communication



Resources

- Lecture on weak signal communications by Joe Taylor <u>https://youtu.be/233HQs_8JGQ</u>
- Lecture on the evolution of FT8 and FT4 by Joe Taylor <u>https://youtu.be/2Pd7zB40xdY</u>
- Joe Taylor's web page at Princeton University https://physics.princeton.edu/pulsar/k1jt
- Ham radio science organization <u>http://www.hamsci.org/</u>

Table 1: Parameters of the Slow WSJT-X Protocols

Bandwidths (BW) are for the narrowest submodes. S/N threshold is referenced to a 2,500 Hz bandwidth at a 50% probability for decoding of an unfading signal.

Mode	FEC type (n,k)	q m	Modulation	Keying rate, baud	BW, Hz	Sync energy	TX duration, s	S/N threshold, dB
FT8	LDPC(174,87)	1 3	8-FSK	6.250	50.0	0.27	12.6	-20
JT4	C(206,72)	1 2	4-FSK	4.375	17.5	0.50	47.1	-23
JT9	C(206,72)	1 3#	9-FSK	1.736	15.6	0.19	49.0	-27
JT65	RS(63,12)	6 6#	65-FSK	2.692	177.6	0.50	46.8	25
QRA64	QRA(63,12)	6 6	64-FSK	1.736	111.1	0.25	48.4	26
WSPR	C(162,50)	1 2	4-FSK	1.465	5.9	0.50	110.6	28

#Modulation includes one additional tone used for synchronization.

Table2: Parameters of the Fast WSJT-X ProtocolsMSK144-Sh is the optional short-message format in the MSK144 protocol.

Mode	FEC type (n,k)	q m	Mod	Keying rate, baud	BW, Hz	Sync energy	Message duration, s
ISCAT-A			42-FSK	21.5	905	0.17	1.176
ISCAT-B	<u> </u>	—	42-FSK	43.1	1809	0.17	0.588
JT9E	C(206,72)	1 3#	9-FSK	25	225	0.19	3.400
JT9F	C(206,72)	1 3#	9-FSK	50	450	0.19	1.700
JT9G	C(206,72)	1 3#	9-FSK	100	900	0.19	0.850
JT9H	C(206,72)	1 3#	9-FSK	200	1800	0.19	0.425
MSK144	LDPC(128,80)	11	OQPSK	2,000	2400	0.11	0.072
MSK144-Sh	LDPC(32,16)	11	OQPSK	2,000	2400	0.20	0.020

#Modulation includes one additional tone used for synchronization.