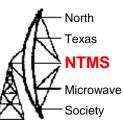


WSJT-X for Microwave August 10, 2024 KM5PO

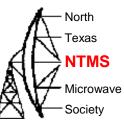
		View Mod	eriod Decodes										Average De	codes			
UTC	dB		q Messa	ge					UTC	dB	DT Freq	Message		couco			
								^									
Lo	og QSO		Stop		Monitor	Era		Clear Avg		Dec	ode	Enable Tx		Halt Tx	Tune		M
	og QSO		Sop 47,088.			🗌 Tx ev	ven/1st	Clear Avg			ode		nerate Skd M			lext	Now
						Tx ev	ven/1st	•	te B 🗘	5	ode	Ge	nerate Std M		N		
ю	-		47,088 . DX Call WSLUA	.100 00	0	Tx ev	ven/1st 1500 Hz Tol 50 🗘	•				Ge	nerate Std Ma		N	•	Now
0	H FT8		47,088 . Dx Call WSLUA Az: 42		DX Grid EM13QC	Tx ev	ven/1st 1500 Hz Tol 50 🗘	C Submoo	te B 🗘	2 2 2 2	SLUA KMSPO EM	Ge 112 5	nerate Std M		N	•	Now Tx 1
0	H FT8 FT4	Loc	47,088 . DX Call WSLUA	.100 00	O DX Grid	Tx ev Tx F Rx Re	ven/1st 1500 Hz Tol 50 C 1500 Hz eport -15	Submoo			SLUA KMSPO EM SLUA KMSPO -11	Ge 112 5 15	nerate Std M		N	• [• [•] •	Now Tx 1 Tx 2
	H FT8	Loc	47,088. DX Call WSLUA Az: 42 okup	.100 00	DX Grid EM13QC Add	Tx ev Tx F Rx Rt T/	ven/1st 1500 Hz Tol 50 🗘 1 1500 Hz eport -15 /R 30 s	Submot	٥		SLUA KMSPO EN SLUA KMSPO -1: SLUA KMSPO R-	Ge 112 5 15 R	nerate Std M		N		Now Tx 1 Tx 2 Tx 3

WSJT-X



- A computer program designed to facilitate basic amateur radio communication using very weak signals.
- WSJT-X is free software: you may redistribute and/or modify it under the terms of the GNU General Public License.
- The WSJT project was started by K1JT in 2001. Since 2005 it has been an Open Source project, and it has included the programs WSJT, MAP65, WSPR, WSJT-X, and WSPR-X. G4WJS (since 2013), K9AN (since 2015), IV3NWV (since 2016), KG4IYS (since 2021), and DG2YCB (since 2021) have made major contributions to WSJT-X.
- Except where otherwise noted, all algorithms, protocol designs, source code, and supporting files contained in the <u>WSJT-X</u> package are the intellectual property of the program's authors.

Use at microwave frequencies

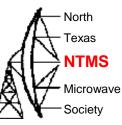


- Terrestrial contacts are being made on 10 GHz beyond 500 km
- WSJT-X contacts are being made at 24 and 47 GHz
- Lower microwave bands and VHF/UHF are also exhibiting long range DX contacts including 6 meter EME
- There is NTMS Microwave Rover adoption of *WSJT-X* in Oklahoma and Texas since 2023. At minimum there are 5 rovers with digital.
- A variety of operating modes exist for different propagation states
 - Terrestrial scatter
 - Rain scatter
 - EME path

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- Many others ie. TEP, ionospheric scatter
- For purposes of this presentation, we will be discussing mode Q65

How it works



- *A priori* or "AP" decodes messages using heuristics and available information, adding several dB to the SNR.
- Key elements that assist AP:

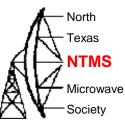
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- Expected audio offset frequency
- DX call sign and grid (and your call/grid via configuration)
- Multiple message averaging

	(Settings	<u>-</u>	?	
		General Radio Audio Tx Macros	Reporting Freque	encies Colors Advanced	
		Station Details My Call: KM5PO My Grid: EN	112IL 🗌 Aut	oGrid IARU Region: All	~
	Log QSO	Stop	Monitor	Erase	Clear Avg
6mm	× •	47,088.100 00	0	Tx even/1st Tx 1500 Hz	
[н	DX Call	DX Grid	▲ F Tol 50 🖨 🔻	Submode B
-80	FT8	W5LUA	EM13QC	Rx 1500 Hz 🗘 M	ax Drift 0
-60 -40	FT4	Az: 42 93 km Lookup	Add	Report -15	
-20 - 0 53 dB	Q65 JT65	2024 Aug 10 09:32:30		🗌 Sh 🗹 Auto Seq	CQ: None 🗸 🗌 Tx6

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Tone spacing



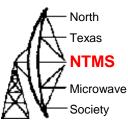
- Tone spacing varies with the T/R Period
 - Submodes A E have tone spacings 1, 2, 4, 8, and 16 times the symbol rate

T/R Period (s)	A Spacing Width (Hz)	B Spacing Width (Hz)	C Spacing Width (Hz)	D Spacing Width (Hz)	E Spacing Width (Hz)
15	6.67 4.33	13.33 867	26.67 1733	N/A	N/A
30	3.33 217	6.67 433	13.33 867	26.67 1733	N/A
60	1.67 108	3.33 217	6.67 433	13.33 867	26.67 1733
120	0.75 49	1.50 98	3.00 195	6.00 390	12.00 780
300	0.29 19	0.58 38	1.16 75	2.31 150	4.63 301

- 15 seconds, -22.2 dB SNR, with a priori (AP) decoding -23.7 dB SNR.
- 30 seconds, -24.8 dB SNR, with AP decoding -26.6 dB.
- 60 seconds, -27.6 dB SNR, with AP decoding -30.2 dB.
- 120 seconds, -30.8 dB SNR, with AP decoding -32.5 dB.
- 300 seconds, -33.8 dB SNR, with AP decoding -37.4 dB.

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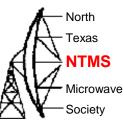
Bandwidth Q65A



Mode	FEC Type	(n,k)	Q	Modulation type	Keying rate (Baud)	Bandwidth (Hz)	Sync Energy	Tx Duration (s)	S/N Threshold (dB)
Q65-15A	QRA	(63,13)	64	65-FSK	6.667	433	0.26	12.8	-22.2
Q65-30A	QRA	(63,13)	64	65-FSK	3.333	217	0.26	25.5	-24.8
Q65-60A	QRA	(63,13)	64	65-FSK	1.667	108	0.26	51.0	-27.6
Q65-120A	QRA	(63,13)	64	65-FSK	0.750	49	0.26	113.3	-30.8
Q65-300A	QRA	(63,13)	64	65-FSK	0.289	19	0.26	293.8	-33.8

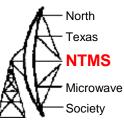
- QRA = Q-ary Repeat Accumulate
- n and k specify the sizes of the (equivalent) block codes
- Q is the alphabet size for the information-carrying channel symbols
- Sync Energy is the fraction of transmitted energy devoted to synchronizing symbols
- S/N Threshold is the signal-to-noise ratio (in a 2500 Hz reference bandwidth) above which the probability of decoding is 50% or higher
- Occupied bandwidths are 65 times the tone spacing, ranging from 19 Hz (Q65-300A) to a maximum of 1733 Hz (Q65-15C, Q65-30D, and Q65-60E)

How it works



- As an aid to the decoders, each protocol includes a "sync vector" of <u>known symbols</u> interspersed with the information-carrying symbols
- FEC:
 - Each Q65 payload contains 13 information symbols
 - A CRC is computed from the 13 information symbols which occupies 12 bits
 - The CRC is re-assembled on receive and provides a method of reducing false decodes to virtually zero.
- Additionally, a 22-symbol pseudorandom sequence spread throughout a transmission is sent as "tone 0" and used for synchronization
- Q65 is very intelligent and pretty much knows exactly what it is seeking in the received signal and noise.

Message averaging



- Piecing together multiple messages to achieve a decode
- Decodes are tagged with a "Q" followed by one or two numbers
 - The first number indicates the type of AP used
 - The second number indicates total number of receives used to produce decode
- Examples:

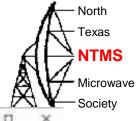
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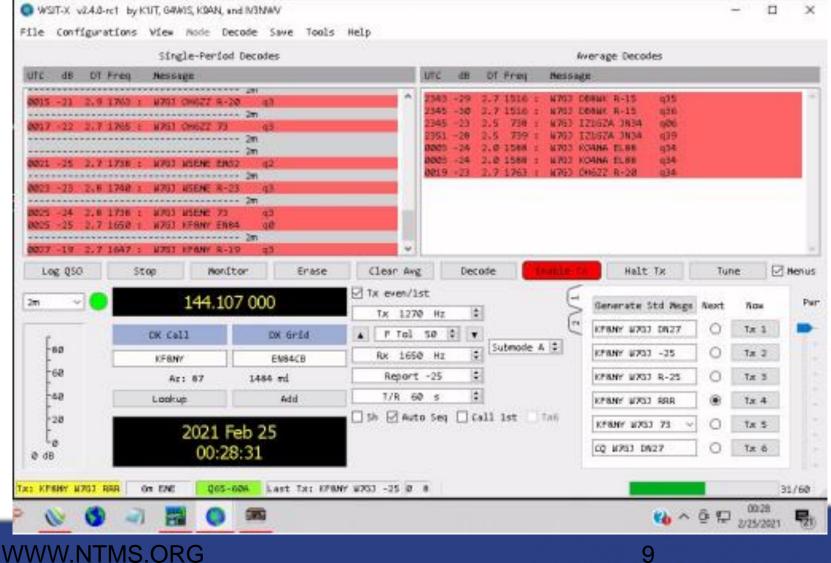
- Q0 This is a decode obtained without using any AP information.
- Q1 This usually means that AP has decoded the message as a CQ call, with the DX Call and Grid unknown to AP.
- Q2 This usually means that AP has used your call as AP knowledge but has assumed nothing about the DX Call or Grid.
- Q3 This usually means that AP has used AP knowledge of your Call and the DX Call in the decode. It then looks for a grid, a report, 73, etc.
- Q32 This means that a Q3 decode has been obtained after averaging 2 transmissions.

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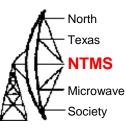
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Message averaging

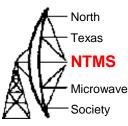




Setup



- Get audio from radio into your computer. Computer records what you are receiving.
- Get audio from your computer into your radio. Radio will transmit the WSJT-X messages from your computer.
- Tigertronics SignalLink
- NTMS members are experienced and can provide assistance
- Another source of help in setting up your station or configuring WSJT-X is the WSJTX Group (https://groups.io/g/WSJTX) at email address wsjtx@groups.io. The chances are good that someone with similar interests and equipment has already solved your problem and will be happy to help.



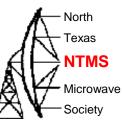


- Tigertronics SignaLink "Integrated USB Sound Card"
- Complete isolation between computer and radio
- No external power needed
- Built in low noise sound card
- External speaker support
- Works with virtually all computers and radios
- Cables available for all radios

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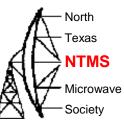
Setup with IC-705/905



- Single USB cable between radio and computer provides CAT control and audio connections
- Wireless WSJT-X is possible with the ICOM RS-BA1 software (costs \$) which permits the radio (in Access Point mode) to connect to a virtual COM port on the computer. (IC-705 WLAN with WSJT-X – KC8JC)
- Free wireless software is available for 705/905 also – WFVIEW from wfview.org



Setup with IC-705/905

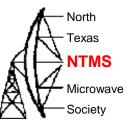


If using the USB cable then download and install the ICOM drivers. This will install two com ports.

📇 Device Manager	
File Action View Help	
V 📩 DESKTOP-QB4O65F	
> 🐗 Audio inputs and outputs	
> 🍃 Batteries	
> 📓 Biometric devices	
> 🚯 Bluetooth	
> 👰 Cameras	
> 💻 Computer	
> 👝 Disk drives	
> 🏣 Display adapters	
> 🎽 Firmware	
> 🛺 Human Interface Devices	
> 🦏 IDE ATA/ATAPI controllers	
> 🥅 Keyboards	
> III Mice and other pointing devices	
> 📃 Monitors	
> 💭 Network adapters	
V 🛱 Ports (COM & LPT)	
IC-705 Serial Port A (CI-V) (COM5)	
IC-705 Serial Port B (COM6)	
Intel(R) Active Management Technology - SOL (COM3)	
Silicon Labs CP210x USB to UART Bridge (COM7)	
> 🚍 Print queues	
> Processors	10
	13

Setup with IC-705/905

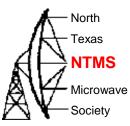
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 Time sync software from BktTimeSync by IZ2BKT will use the GPS in the rig to provide time sync and lat/long info

tTimeSync by IZ2BKT - Vers	ion 1.13.3		
Internet Configuration NTP server ntp1.inrim.it	List Time Server	ort: 123 Offset: Timeout:	+0.00 Enable NTP
GPS Configuration			
Serial Port : COM6 💌	BAUD : 9600 🗾 Bit :	8 Bit of Stop 1	Parity : N
RTS: ON 🚽 DTR: O	N 💌 Max Error :	0.3 s Offs	set: +0.00 s
Always connected to the GPS	Disconnect GPS	Protocol : NMEA	Enable GPS
Coordinates : 32° 29' 5" N -	- 97° 17' 23" W Al	titude : 243.0M	WW Locator : EM12IL
WSJT-X Auto Grid 🔽 Port :	2.237 IP : 12	7.0.0.1	Send WW Locator
General Options			
Start on windows startup	Start on syste	em tray 🔲 Syn	c on startup 🔽
Sync every 60 minute	es (0 to manual sync) to s	econd 0 If e	rror NTP try to use GPS
Max corr. 12 hours (0 no limits		Checks updates every	³⁰ days (0 to disable)
Display notifications	Enable BktClock	Diagnostic Log	Delete Diag. Log
Synchronization Log	C:\Users\Administrator\Do	ocuments\BktTimeSyncLog.	View Sync, Log
no update available Last Sync :Saturday, August (Time was successfully synchro	onized using GPS receiver 00 seconds		^
Local clock offset was 0.0460 Last Sync :Saturday, August	10, 2024 06:39:21		
ast Sync :Saturday, August Time was successfully synchro	onized using GPS receiver 👂		>
	onized using GPS receiver 👂	Forum	> > Donate

Testing/Learning



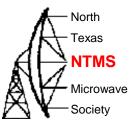
• KI5EMN test bench.

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- Two IF rigs IC-705 and FT-290
- Windows Surface USB cabled to IC-705 and Mac laptop using SignalLink and mic cable to FT-290



Q65 Review



- A new low-rate Q-ary Repeat Accumulate code for forward error correction
- User messages and sequencing identical to those in FST4, FT4, FT8, and MSK144
- A unique tone for time and frequency synchronization. As with JT65, this "sync tone" is readily visible on the waterfall spectral display. In addition, Q65 provides a sensitive "sync curve" near the bottom of the waterfall window. Unlike JT65, synchronization and decoding are effective even when meteor pings or other short signal enhancements are present.
- A new, highly reliable list-decoding technique for messages that contain previously copied message fragments. No use is made of a callsign database.
- Highly effective message averaging for situations where single transmissions are too weak or signal enhancements too sparse for a signal to be decoded.
- A "multi-decode" option that attempts to decode all Q65 signals in the received passband.

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Questions?

