

Working Small Stations on 10 and 24 GHz EME with the help of WSJT

Al Ward

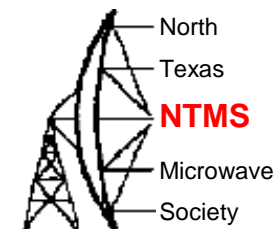
W5LUA

October 19, 2013

Morehead State University

Morehead, Kentucky

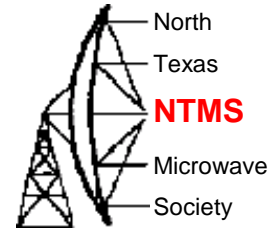
The Microwave Bands



Band	Frequency Range	Weak signal work in NA
33 cm	902 to 928 MHz	902 MHz (Region II only NA & SA)
23 cm	1240 to 1300 MHz	1296 MHz
13 cm	2300 to 2310 MHz	2304 MHz (2301 VK, 2320 some Europe and VE – cross band required)
	2390 to 2450 MHz	2424 JA
9 cm	3300 to 3500 MHz	3456 MHz (3400 MHz used for EME)
6 cm	5650 to 5925 MHz	5760 MHz
3 cm	10000 to 10500 MHz	10368 MHz (10450 MHz used by JA)
1.25cm	24000 to 24250 MHz	24192 MHz (24048 MHz used for EME)
.6 cm	47000 to 47200 MHz	47088 MHz
.35 cm	77000 to 81000 MHz	78192 MHz (77184 MHz used by RW3BP, W5LUA, & VE4MA)

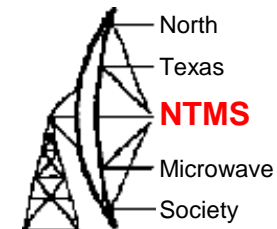
The problem...Not all countries have same allocation as us.....

How long have hams been doing EME on the upper bands?



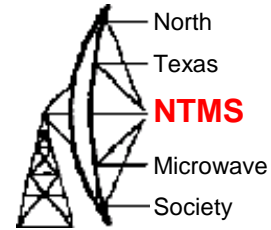
- First 902 MHz EME QSO on January 22, 1988 between K5JL and WA5ETV
- First 1296 MHz EME QSO in 1960 between W1BU and W6HB
- First 2304 MHz EME QSO in 1970 between W4HHK and W3GKP
- First 3456 MHz EME QSO on April 7, 1987 between W7CNK and KD5RO
- First 5760 MHz EME QSO on April 24, 1987 between W7CNK and WA5TNY
- First 10368 MHz EME QSO on August 27, 1988 between WA7CJO and WA5VJB
- First 24192 MHz EME QSO on August 18, 2000 between W5LUA and VE4MA
- First 47088 MHz EME QSO in January 2005 between RW3BP and AD6FP followed by W5LUA and RW3BP
- First 77184 MHz EME QSO TBD – RW3BP has heard echoes and was copied by W5LUA in June 2013, VE4MA also working towards EME.

JT-65 for EME



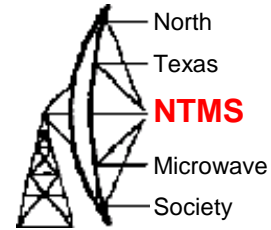
- Joe Taylor's (K1JT) WSJT digital modes have certainly revolutionized weak signal, meteor, and EME communications
- JT-65A used on 6M
- JT-65B used on 2M through 70 cm
- JT-65C used on 1296 MHz through 5760 MHz – Struggle at 5760 MHz due to excessive doppler shift during 1 minute transmission – Hand always on knob!
- Using JT-65C on 10 GHz and higher a struggle due to doppler shift being more than 200 Hz per minute!
- Additional challenge is that on 10 GHz and higher, the libration spreading can be as large as several hundred Hz which is much more than the 10.8 Hz tone spacing of JT65C – Signals sound aurora like

JT-4 Mode



- The JT-4 mode uses 4 tones and offers a range of tone spacings up to 315 Hz.
- JT-4F was found to be optimum for 10 and 24 GHz based on normal spreading of the signal.
- Only disadvantage of JT-4F is that there is no sync pulse as power is divided equally among the 4 tones.

Bandwidth Comparison between JT4 Modes and JT-65C



Mode	Expansion Factor N	Tone Spacing (Hz)	Bandwidth (Hz)
JT4A	1	4.375	17.5
JT4B	2	8.75	35
JT4C	4	17.5	70
JT4D	8	39.375	158
JT4E	18	78.75	315
JT4F	36	157.5	630
JT4G	72	315.0	1260

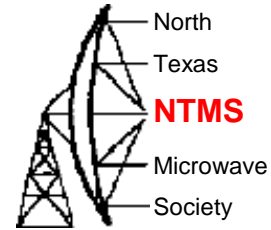
JT-65C

10.8 Hz

711 Hz

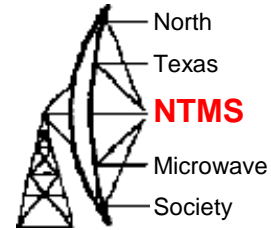
When libration spreading is low, contacts on 10 GHz are possible with JT-65C but our success rate went up with the JT-4 modes especially at 24 GHz where the spreading shows less peaking than seen at 10 GHz. Narrower antenna beamwidths also help to reduce the effective spreading of signals

Keeping on Frequency



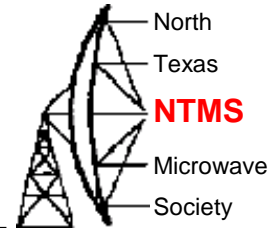
- The WSJT waterfall only has a several kHz wide passband.
- How do we keep our continuously doppler shifted signal within the pass band? Doppler can be as high as 25 kHz at moon rise on 10 GHz
- Answer...we must continuously correct our receive frequency to compensate for the mutual doppler between us and the station we are trying to work.
- Initially VK7MO was doing all the frequency correction at his end for both receive and transmit so all I had to do was set my Flex5000 to the sked frequency
- Recently K5GW wrote similar code for the Flex5000 to control both my receive and transmit frequencies so as to put my transmitted frequency precisely on the schedule frequency at any observer on earth by just knowing their 6 digit grid square.
- GPS frequency locking is a requirement for the microwave LO.

Picking the best times



- Perigee (when the moon is closest to earth) is always best
- Need to pick times when spreading is lowest so that the tones can fall into the narrow spaced frequency bins required for both JT-65C and JT-4
- I use an EME tracking program by K5GW that predicts times of lowest libration spreading – other programs by VK3UM and F1EHN

5M and 2.4M Dishes at W5LUA

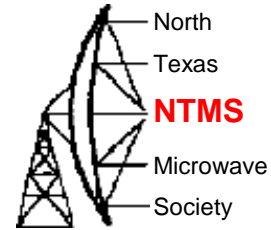


Used on 432 MHz through 10 GHz

Used on 24, 47 and 77 GHz



VK7MO .7M Prime Focus Dish used on 10 GHz EME

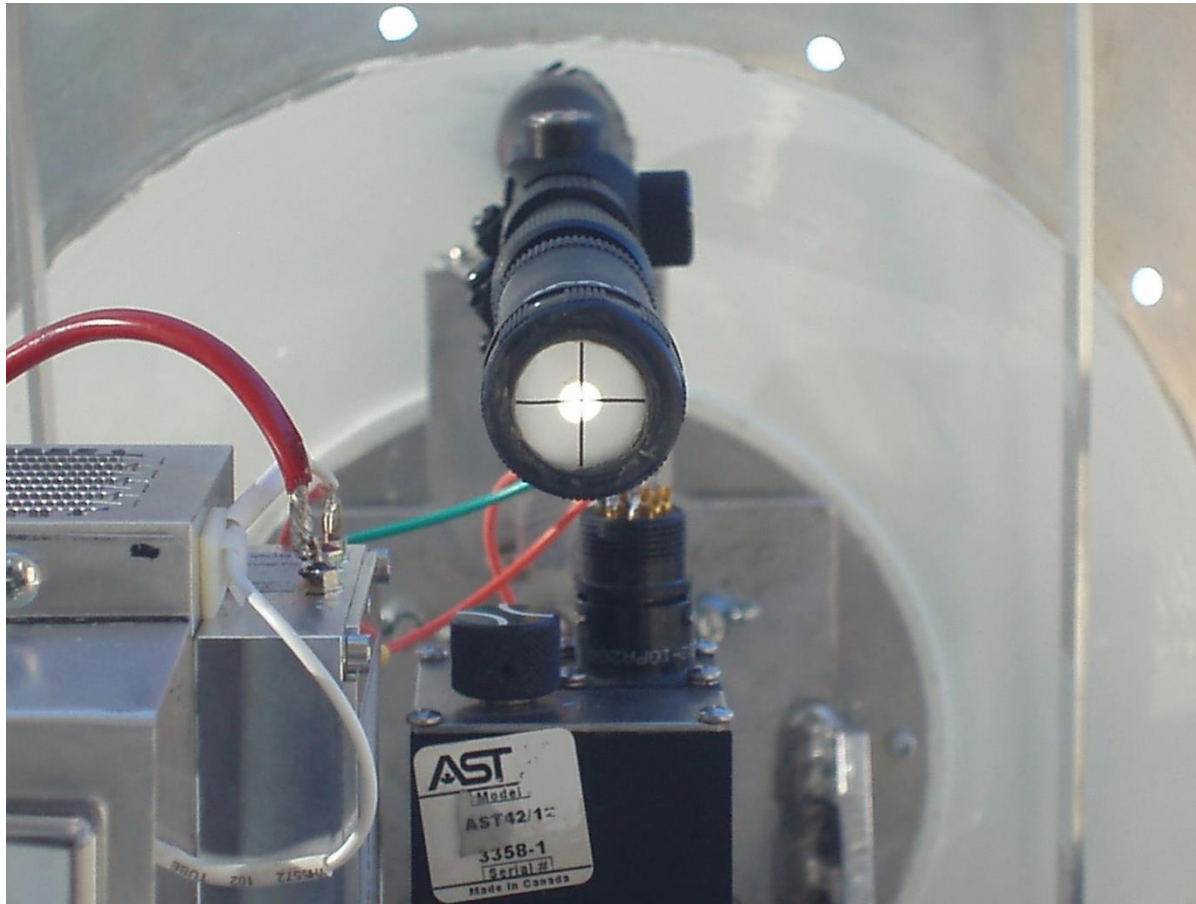
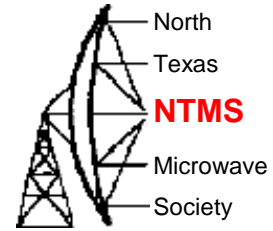


3dB Beamwidth
=2.5 degrees

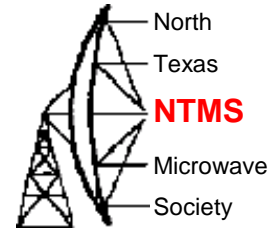
DB6NT Power
amplifier 45 watts
@ the feed

NF 1 dB

VK7MO uses rifle scope for tracking



VK7MO-W5LUA OCT 18 23:01Z



spectran

K5GW Tracking program for W5LUA

TIME	DATE	IGT	A/Z	BL	AZC	ELC	DEC	AZ ERROR	EL
23:01:39	10/18/12	MOON	OFF	206.32	30.52	1.5	0.4	-20.9	0.07

ANTENNA AZIM ELEV
 1296 197.23 30.66
 2304 207.24 27.30
 3400 205.59 27.05
 5760 210.85 29.48
 10368 206.25 30.60
 24048 120.05 45.94
 47088 118.95 46.05
 78192 118.95 45.68

Band: 10368MHZ
 Doppler: -12128.1
 Sky Ten: 2.7
 Loss dB: 0.52
 Tdeg dB: 0.52
 Pol: -66
 Lib: 163.2

OCT 18 2012 23:01:39

SUN	MON	TUE	WED	THU	FRI	SAT
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

WSJT6_DOC

WSJT 7 by K1JT

File Setup View Mode Decode Save Band Help

Moon
 Az: 206.32
 El: 30.50
 Dop: 3402
 Dgrd: -0.5

FileID Sync dB DT DF W DF (Hz) VK7MO_121018_230000

225300	0	-33	0.9	-307	46				
225400	3	-25	1.8	108	13	*	W5LUA	VK7MO	Q0E37
225600	4	-24	1.8	105	14	*	W5LUA	VK7MO	R-23
225800	2	-30		103	3	?			
225800	2	-30		103	3	?			
230000	5	-24	1.8	102	17	*	W5LUA	VK7MO	Q0E37

Log GSO Stop Monitor Save Decode Erase Clear Avg Include Exclude TxStgp

To radio: VK7MO Lookup
 Grid: Q0E37pc Add
 Az: 239 0972 mi

2012 Oct 18
 23:01:40

1.0000 1.0000 JT6SC Freeze DF: 0 Rx noise: 0 dB TR Period: 60 s Txing: 73

FlexRadio Systems PowerSDR v2.3.5 FLEX-5000: 1708-2183

STOP

VFO A: 10368.225 000
 10GHz General TX

VFO B: 3400.100 030
 TX: Out of Band

RX1 Meter: 0 W
 TX Meter: 0 W

AF: 14
 AGC-T: 106
 Drive: 75
 AGC Preamp: On

SQL: -115

RX1 ANT1 TX ANT1
 RX2: RX2 IN

SPLIT A > B NR ANF Panafal
 IF-V A < B NB NB2 AVG Peak
 SR BIN TNF +TNF

Mic 15 Transmit Profile: Default
 DX 3
 CPDR 1 Show TX Filter on Display
 VDX 100 RX EQ TX EQ
 DEXP -40

CPU %: 33.6

SpecJT by K1JT

Options Freq: 746 DF: -524 (Hz) BW: 200 Speed: 1 2 3 4 5 HI H2

5 Meter: 220
 Signal: 1 3 5 7 9 +20 +40 +60
 Edge: 1 1 1 1 1 1 1 1 1 1

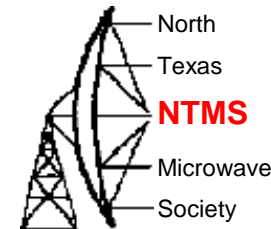
144.260 144.280 1
 144.260 144.280 1

9.4dBm 144.280 422 MHz
 Fixed 192 kHz Center

CPU %: 33.6
 AGC: Med

23:01:40

VK7MO portable in OF89ai



The screenshot displays the WSJT-X software interface with several windows open:

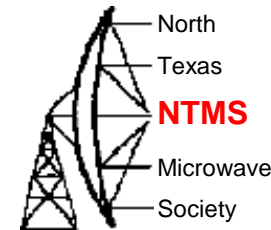
- WSJT 7 by K1JT:** Shows moon tracking data: Az: 282.30, El: 10.56, Dop: -8405, Dgrd: -2.3. A table of signal reports is visible below.
- FlexRadio Systems PowerSDR v2.4.4:** Shows the main signal processing window with a frequency of 10368.225 MHz and a 10GHz General TX mode.
- SpecJT by K1JT:** Shows a spectrogram of the signal.
- Astronomical data:** Displays moon and sun coordinates and Doppler shift data.
- K5GW Tracking program for WSJTUA:** Shows a tracking table for the moon and sun.

FileID	Sync	dB	DT	DF	W
101600	2	-30	2.4	13	8 *
101600	2	-30	2.4	13	8 *
101800	0	-33	2.5	11	29
101800	0	-33	2.5	11	29
102000	0	-33	5.9	-13	27
102200	0	-33	-1.8	19	58

TIME	DATE	IG	A/T	AZ	EL	AZC	ELC	DEC	AZ BRDN	EL BRDN
10:23:00	11/26/12	MOON	OFF	282.23	10.72	-1.7	0.2	16.4	-0.65	-0.60

Object	AZ	El	Doppler	df/dt
Moon	282.30	10.56	-8405	-42.20
Moon/DX	31.06	24.05		
Sun	94.44	-34.01		
Source	290.88	-28.67		

VK7MO Receiving W5LUA in Grid Square PF06 on 10 GHz



AZ E1

Moon: 73.33 20.95
 Moon/DX: 265.59 7.48
 Sun: 149.95 -27.52
 Source: 263.01 -10.39

Doppler df/dt

DX: 3326 -32.72
 Self: 28032 -48.96

RA DEC

Moon: 11:03 1.46
 Source: 00:00 0.00

Freq: 10368 Tsky: 3
 MNR: 0.1 Dgrd: -1.4
 DPol: -3 SD: 15.67

VK7MO Doppler IC910 control V 1.23.....

A FREQ: 144225110
 B FREQ: 144225110

OpFreq: 10368.00
 DX Doppler: 3326.70
 DXRate: -32.7
 Self Doppler: 28033.00
 Self Rate: -48.9
 COMPORT: COM1
 Applied: 144221783

SWAP: SWAP OFF
 B ON EVEN
 B ON ODD

Invert B

A FREQ: Use DX Use Self No Corr
 B FREQ: Use DX Use Self No Corr

DISC radio 7

Read azel.dat@9 46:11

WSJT 7 by K1JT

Moon
 Az: 73.33
 E1: 20.96
 Dop: 3326
 Dgrd: -1.4

FileID Sync dB DT DF W

171500	0	-33	-1.6	-528	3	
171600	0	-33	7.5	237	2	
171700	0	-33	3.0	514	11	
171800	0	-33	-0.1	495	32	
171900	0	-33	-1.4	565	18	
172000	0	-33	3.1	460	45	
172100	0	-33	9.6	-385	40	
172200	0	-33	1.8	519	32	
172300	0	-25	7.0	-24	15 #	
172500	0	-24	5.5	-27	6 *	
172700	5	-24	2.7	-27	11 *	VK7MO WSLUA EM13 0 10
172900	4	-23	2.7	-27	17 *	VK7MO WSLUA EM13 0 10
173100	3	-26	2.7	-27	17 *	VK7MO WSLUA EM13 0 10
173300	1	-27	2.5	-32	11 *	VK7MO WSLUA EM13 ? 0 1
173500	0	-31	2.7	-22	23 *	VK7MO WSLUA EM13 0 10
173700	0	-33	6.1	-153	26	
173900	2	-25	3.1	-30	11 *	VK7MO WSLUA R-29 0 10
174100	0	-25	1.8	404	16 #	
174300	0	-33	-1.7	-27	6	
174500	0	-33	-1.0	100	63	

Log QSO Stop Monitor Save Decode Erase Clear Avg Include Exclude TxStp

To radio: WSLUA Grid: EM13qc Az: 81 16830 km

2012 Dec 06 17:46:11

0.9992 0.9998 J765C Freeze DF: 0 Rx noise: 0 dB TR Period: 60 s 0 Receiving

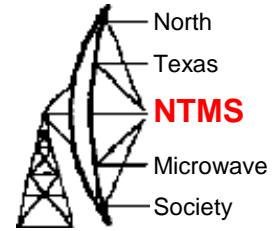
SpecJT by K1JT

Options Freq: 735 DF: -535 (Hz) BW

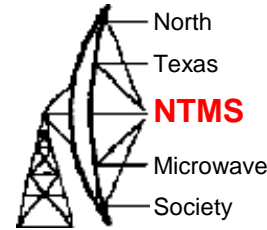
Speed: 1 2 3 4 5 H1 H2

17:46:11 0 dB

VK7MO working W5LUA from motel room on 10 GHz EME from Grid Square PF58kn



Using JT-4G on 10 GHz

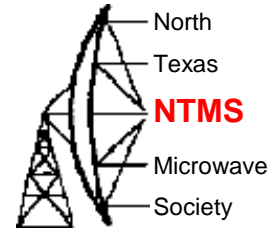


The screenshot displays a multi-window software environment for operating JT-4G on 10 GHz. The main window is FlexRadio Systems' PowerSDR v2.5.3, showing a spectrum plot centered on 10368.225 MHz. The interface includes various controls for tuning, AGC, and signal processing. A secondary window, SpecJT by K1JT, shows a waterfall plot. A third window, WSJT 9.4 by K1JT, displays a signal strength graph and a list of detected signals. The bottom right corner features a data table with columns for TIME, DATE, TGT, MOON, A/T, AZ, EL, AZC, ELC, DEC, and AZ ERROR. The table contains several rows of data, including antenna azimuth and elevation readings.

TIME	DATE	TGT	MOON	A/T	AZ	EL	AZC	ELC	DEC	AZ ERROR	EL
14:13:36	02/03/13	MOON	ON		212.77	32.30	-0.5	0.3	-16.9	0.61	0.61
ANTENNA AZIM ELEV 1296 208.27 32.23 Doppler: -9667.8 Sky Ten: 2.7 3400 211.93 28.89 5260 216.21 31.33 10368 212.81 32.30 24048 98.13 47.09 47688 96.06 47.22 78192 96.06 46.85											
Band: 10368MHZ Duplexer: -9667.8 Loss dB: 0.75 Tdeg dB: 0.75 Pol: -61 Lib: 165.8											
FEB 03 2013 14:13:36 SUN MON TUE WED THU FRI SAT 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28											

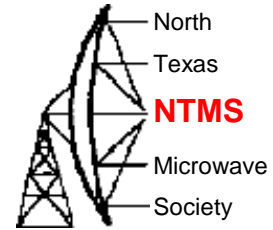
Working some issues with DT numbers that appear to be 1 to 2 seconds high compared to actual path delay prediction

QSO Procedure using JT-4F/G



- Both stations send 1270 Hz to help with alignment – usually for about 5 minutes
- Both calls are sent
- When both calls are received then send both calls and dB signal report as calculated by WSJT
- When both calls and report are received then send single tone @1500 Hz which designates R
- When R is received , then send single tone @1700 Hz which designates 73
- When signals are strong then text can be substituted for single tones

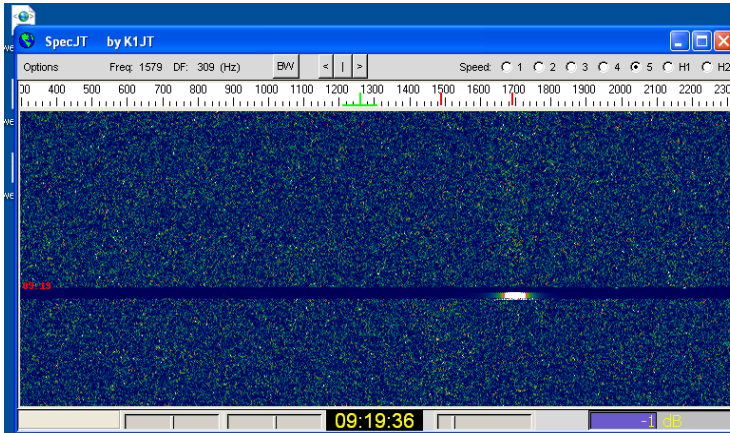
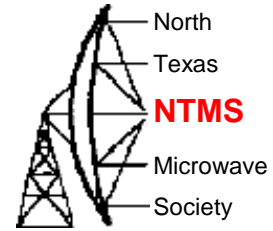
1.14M Prime Focus Dish used by VK7MO on 24 GHz EME



AZ-EL Mount Details



24 GHz QSO with VK7MO using JT-4F



WSJT 9.5 r3033 by K1JT interface showing moon phase information and a QSO log. The moon phase is "Moon" with Az: 234.94, El: 22.89, Dop: -2110, and Dgrd: -0.6. The QSO log shows a contact with WSLUA VK7MO at 24048.110 MHz.

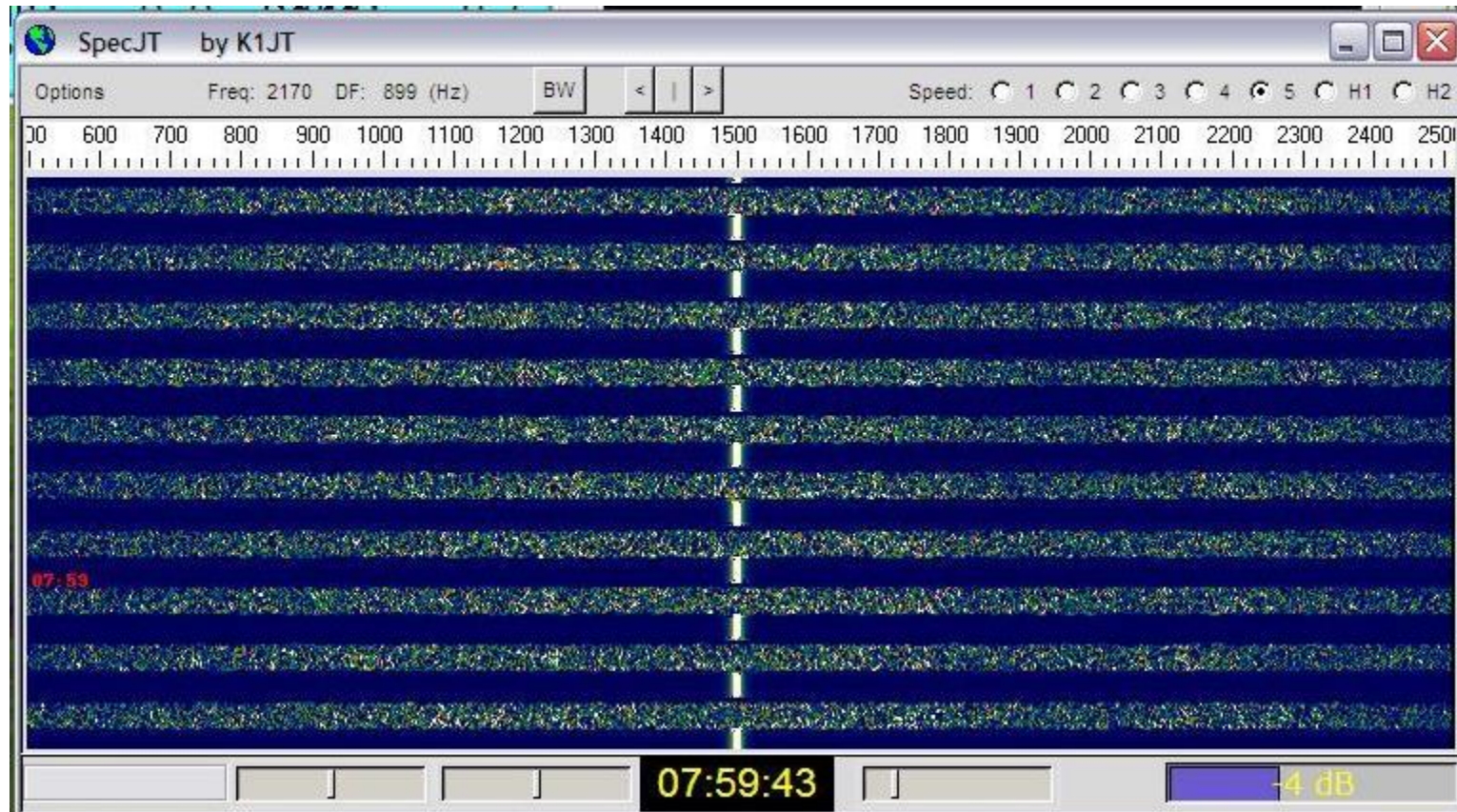
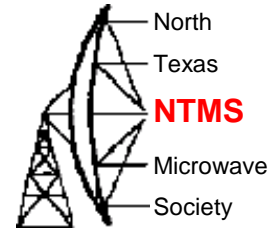
FileID	Sync	dB	DT	DF	VV	DF (Hz)	WSLUA_130425_091700
090900	0	-20	1.5	-300	4	#	
090900	0	-21	3.6	-13	7	#	
091100	0	-21	-0.8	9	4	*	
091300	2	-19	3.7	-22	20	#	WSLUA VK7MO -14 0 8 E
091500	0	-21	-0.4	-18	9	*	
091700	0	-21	-1.0	-26	4	#	

FlexRadio Systems PowerSDR v2.5.3 FLEX-5000: 1708-2183 interface showing frequency controls and station data. The main display shows 24048.107 688 MHz. The interface includes various control buttons and a station data window.

TIME	DATE	IGT	AZ	EL	AZC	ELC	DEC	AZ ERROR	EL
09:19:23	04/25/13	MOON	OFF	234.88	22.92131.9	0.1	-12.7	0.65	0.69

K5GW software controls Flex 5000 frequency

VK7MO Seeing his Echoes on 24 GHz

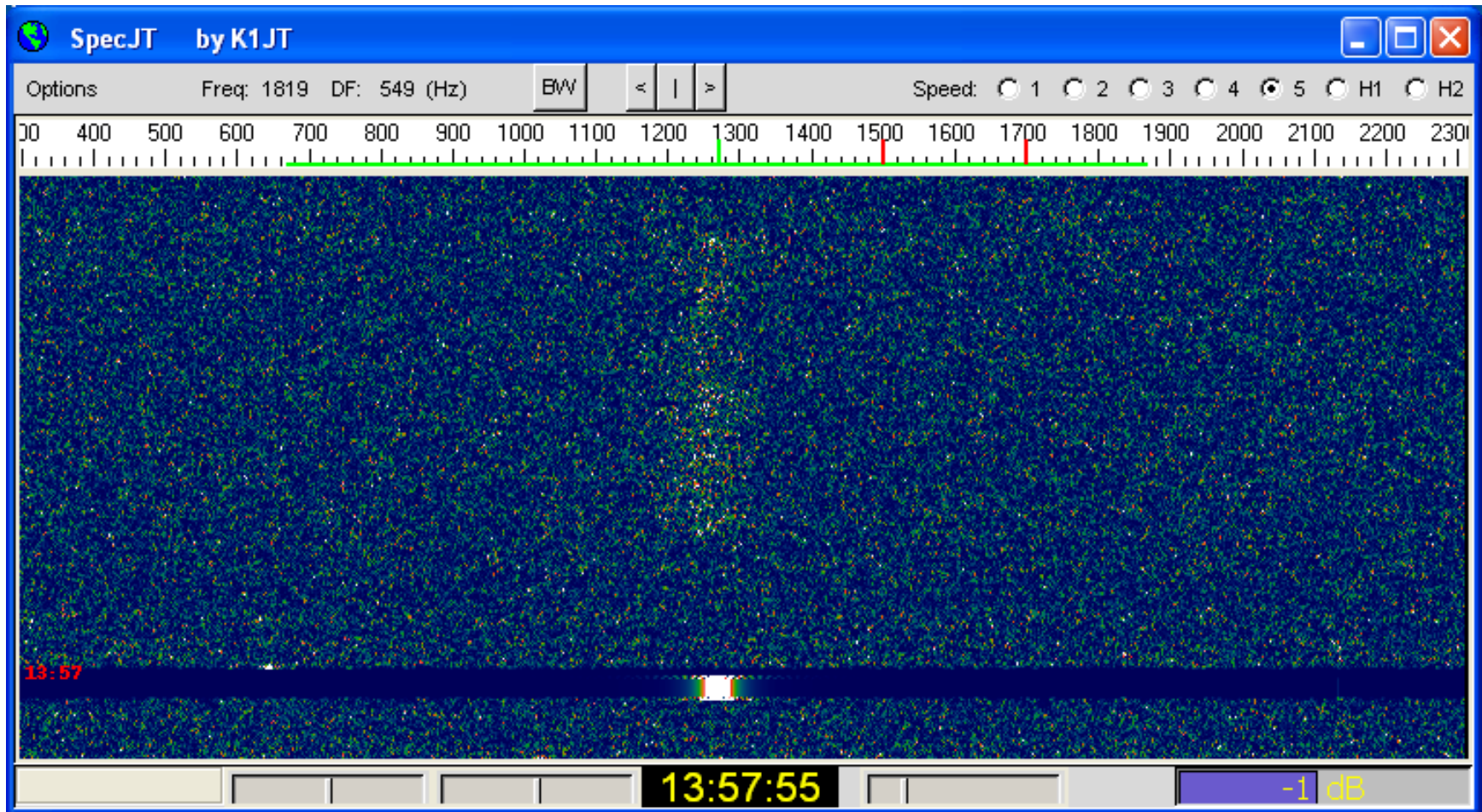
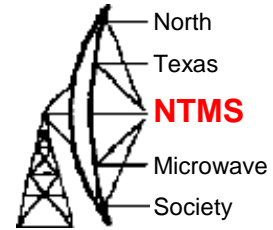


24 GHz EME QSO Between W5LUA and OZ1FF March 2013

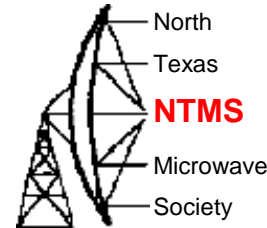


1.8M Offset Fed Dish
10W @ Feed

OZ1FF on 24 GHz – 1270 Hz



OZ1FF on 24 GHz – 1270 Hz



WSJT 9.5 r3033 by K1JT

File Setup View Mode Decode Save Band Help

4.0 Time (s) OZ1FF_130311_135700

Moon
 Az: 104.87
 El: 19.45
 Dop: 7958
 Dgrd: -1.3

FileID	Sync	dB	DT	DF	W
134700	1	-19	-0.5	571	4 *
134900	2	-19	-1.3	-599	4 #
135100	0	-20	-0.6	324	4
135300	0	-21	4.6	486	7
135500	0	-21	-0.8	470	4
135700	1	-19	-0.9	-545	9 *

135700	1	7/7
135700	2	5/5

Log QSO
Stop
Monitor
Decode
Erase
Clear Avg
Include
Exclude
TxStgp

To radio:

Grid:

Az: 35 4898 mi

2013 Mar 11
13:58:19

Dsec 0.0

Sync 1 Zap

Tol 400 AFC

MinW A Freeze

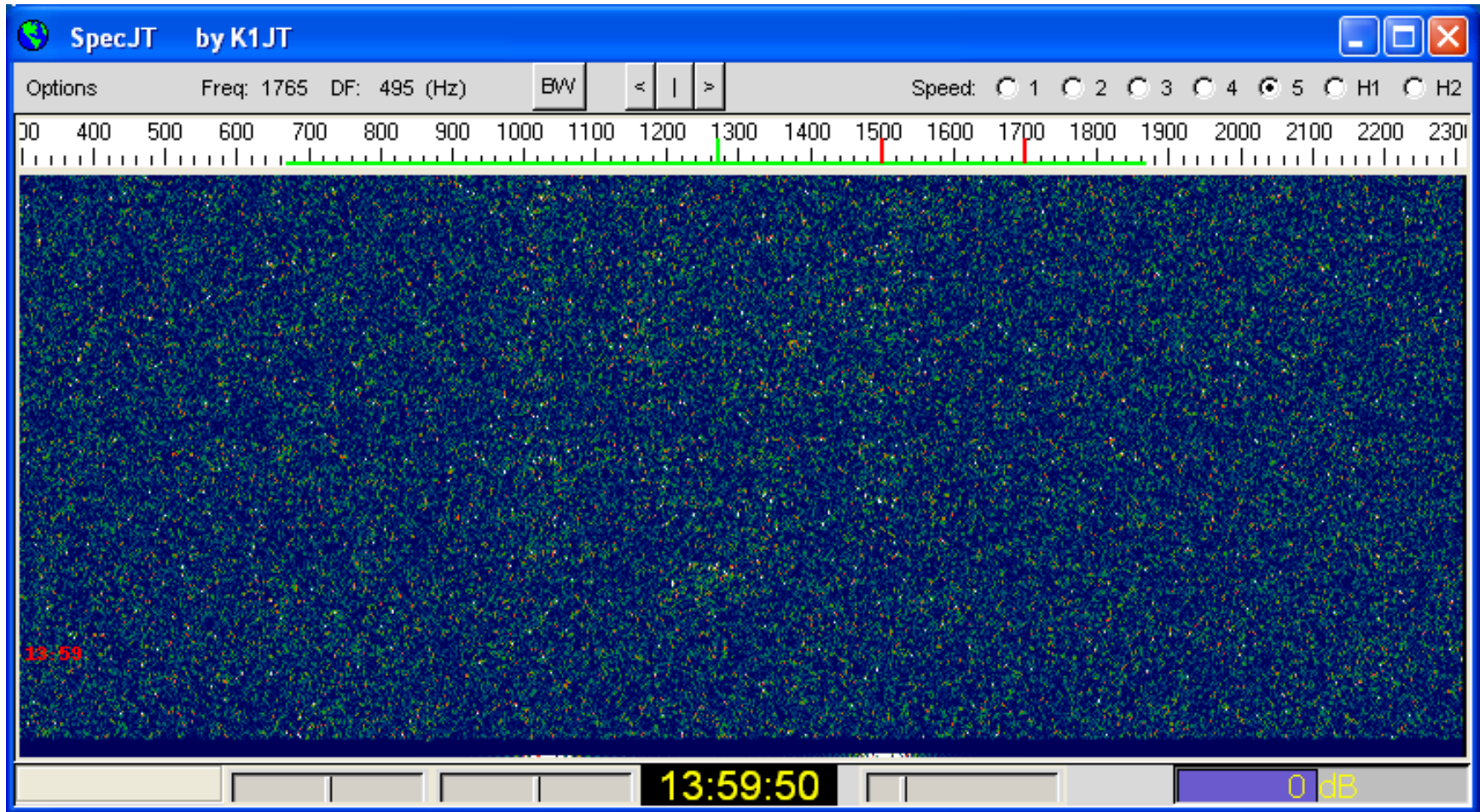
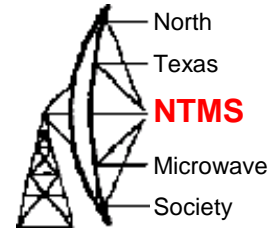
Tx First

Rpt:

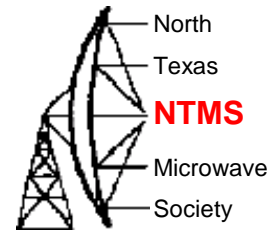
OZ1FF W5LUA EM13	<input checked="" type="radio"/>	Tx1
OZ1FF W5LUA -21	<input type="radio"/>	Tx2
OZ1FF W5LUA R-21	<input type="radio"/>	Tx3
@1500 (RRR)	<input type="radio"/>	Tx4
@1700 (73)	<input type="radio"/>	Tx5
@1270	<input type="radio"/>	Tx6

1.0000 0.9999
JT4F
Freeze DF: 0
Rx noise: 0 dB
T/R Period: 60 s
Txing: OZ1FF W5LUA EM13

OZ1FF on 24 GHz sending messages



Calls Received



WSJT 9.5 r3033 by K1JT

File Setup View Mode Decode Save Band Help

3.4 Time (s)

Moon
 Az: 105.49
 El: 20.28
 Dop: 7458
 Dgrd: -1.3

OZ1FF_130311_140100

FileID	Sync	dB	DT	DF	W	
135300	0	-21	4.6	486	7	
135500	0	-21	-0.8	470	4	
135700	1	-19	-0.9	-545	9 *	
135900	6	-15	4.9	-13	79 *	W5LUA OZ1FF 1 0 E
140100	2	-18	-0.8	-315	9 *	
140100	0	-21	-1.3	-155	4	

140100 1 7/7
140100 2 4/4

Log QSO
Stop
Monitor
Decode
Erase
Clear Avg
Include
Exclude
TxStgp

To radio:

Grid:

Az: 35 4898 mi

**2013 Mar 11
14:02:29**

Dsec 0.0

Sync 1 Zap

Tol 50 AFC

MinW A Freeze

Tx First

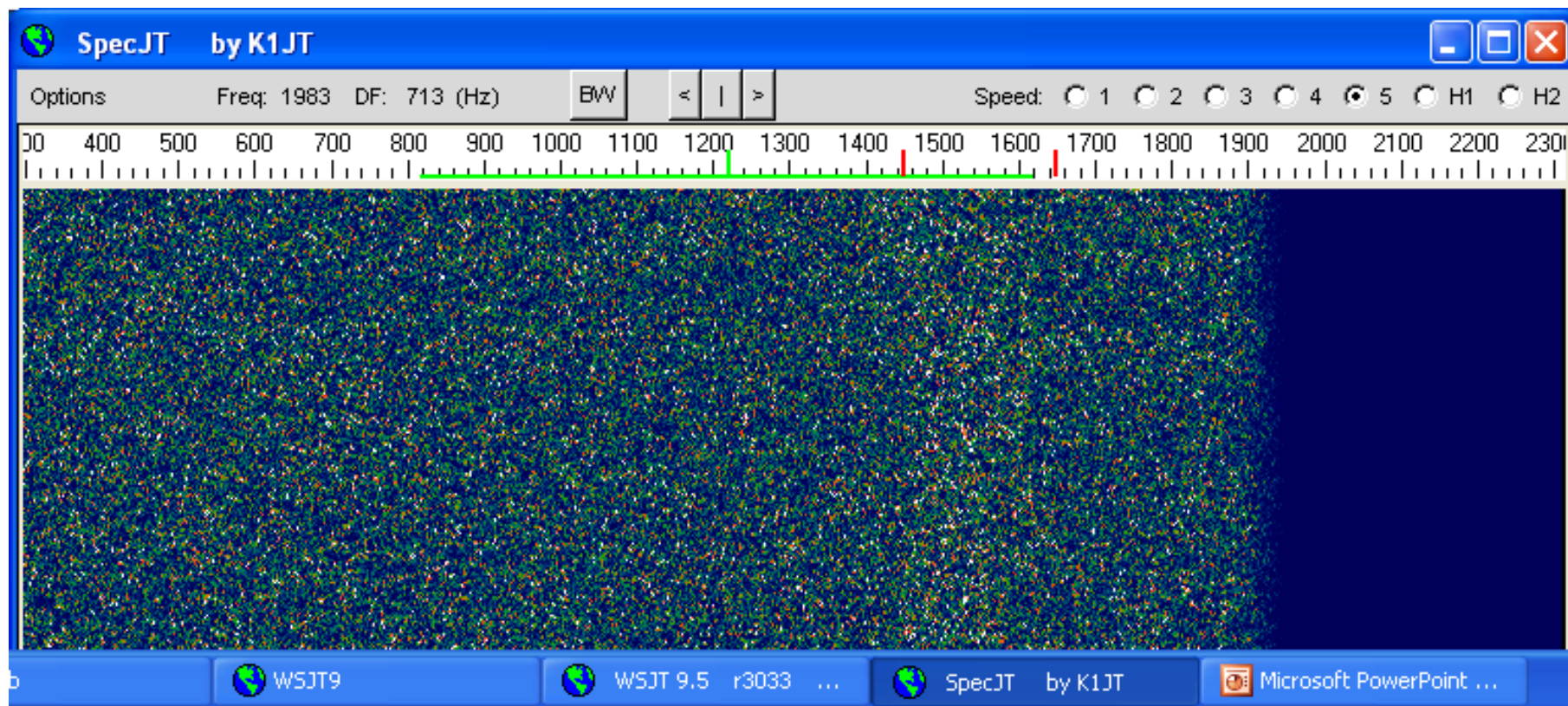
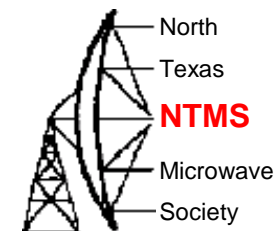
Rpt:

Gen Msgs

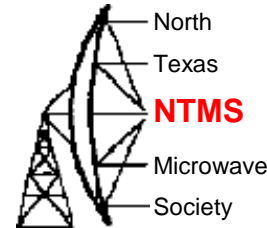
OZ1FF W5LUA EM13	<input type="radio"/>	Tx1
OZ1FF W5LUA -15	<input checked="" type="radio"/>	Tx2
OZ1FF W5LUA R-15	<input type="radio"/>	Tx3
@1500 (RRR)	<input type="radio"/>	Tx4
@1700 (73)	<input type="radio"/>	Tx5
CQ W5LUA EM13	<input type="radio"/>	Tx6

1.0000 1.0000
JT4F
Freeze DF: -104
Rx noise: 0 dB
T/R Period: 60 s
Txing: OZ1FF W5LUA -15

Receiving single tone R from OZ1FF



Receiving 73 from OZ1FF



WSJT 9.5 r3033 by K1JT

File Setup View Mode Decode Save Band Help

Moon

Az: 86.22
E1: 23.01
Dop: 10381
Dgrd: -2.0

4.1 Time (s) OZ1FF_130315_163900

FileID	Sync	dB	DT	DF	W	
163300	0	-21	2.3	-182	4	
163300	0	-21	2.3	-182	4	#
163300	0	-20	0.1	-24	4	#
163500	5	-16	4.3	-24	77	# W5LUA OZ1FF -11 1 20 F
163700	1	-19	4.4	-15	4	#
163900	1	-20	-1.3	20	4	#

163900	1	7/7				
163900	2	12/12				W5LUA OZ1FF 73 ? 0 2

Log QSO Stop Monitor Decode Erase Clear Avg Include Exclude TxStgp

To radio:

Grid:

Az: 35 4898 mi

2013 Mar 15
16:40:37

Dsec 0.0

Sync -2 Zap

Tol 400 AFC

MinW A Freeze

Tx First

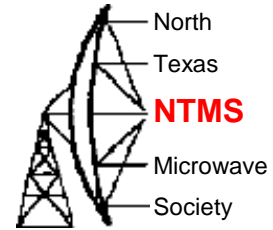
Rpt:

Gen Msgs

OZ1FF W5LUA EM13	<input type="radio"/>	Tx1
OZ1FF W5LUA -16	<input type="radio"/>	Tx2
OZ1FF W5LUA R-16	<input type="radio"/>	Tx3
@1500 (RRR)	<input type="radio"/>	Tx4
@1700 (73)	<input checked="" type="radio"/>	Tx5
CQ W5LUA EM13	<input type="radio"/>	Tx6

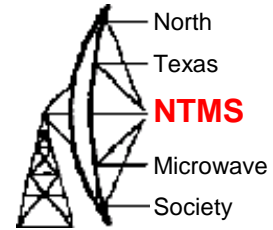
1.0000 1.0000 JT4F Freeze DF: -51 Rx noise: 0 dB T/R Period: 60 s

Txing: @1700 (73)



24 GHz EME QSO Between
W5LUA and JA1WQF
September 29, 2013
1930Z

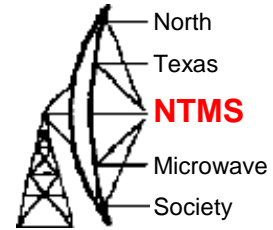
Mitsu JA1WQF



2.4M
Prime Focus

25 watts
@ Feed

W5LUA @ JA1WQF



The screenshot displays the WSJT-X software interface. The 'Astronomical data' window shows the following information:

	Az	E1
Moon:	104.05	40.53
Moon/DX:	273.61	19.38
Sun:	81.30	-16.32
Source:	262.90	9.69

	DX	Self
Dop:	10213	20425
df/dt:	-33.72	-67.45
Spread:	151.3	201.0
w50:	56.2	74.7

	RA	DEC
Moon:	08:29	13.38
Source:	00:00	0.00

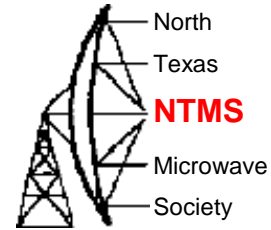
Other data shown in the interface:

- Freq: 10368 Hz, Tsky: 3
- MNR: 3.2, Dgrd: -2.2
- DPol: 66, SD: 14.96

The spectrogram window shows a dense field of signal activity across the frequency range from 600 to 2100 kHz, with a time axis at 19:17:02.

High mutual libration causing excessive spreading

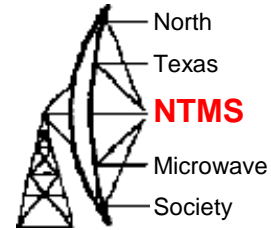
24 GHz Stations using JT-4



- VK7MO .7 M Prime focus dish and 9 watts
- W5LUA 2.4M Offset fed dish and 100 watts
- OK1KIR 4.5M Prime focus dish and 20 watts
- VK3XPD 3M Prime focus dish and 15 watts
- OZ1FF 1.8M Offset fed dish and 10 watts
- G3WDG 3M Prime Focus dish and 10 watts
- JA1WQF 2.4M Prime focus dish and 25 watts

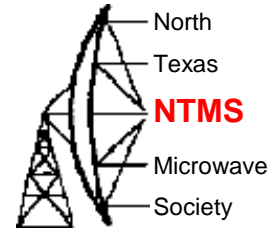
Other stations QRV on 24 GHz EME via CW include VE4MA, RW3BP, OK1UWA, LX1DB, G4NNS, DK7LJ, DF1OI, PA0EHG, DL7YC, IK2RTI, JA6CZD, F2CT, RK3WWF

Coordination



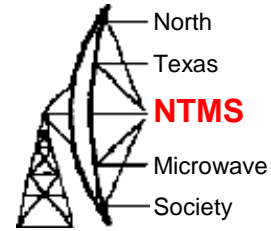
- HB9Q Logger for schedule coordination and chat on 432 MHz and higher <http://hb9q.ch/version2/index.php>
- 432 MHz and Above newsletter published every month for over 30 years
<http://www.nitehawk.com/rasmit/em70cm.html>
- Moon-Net Reflector <http://www.nlsa.com/nets/moon-net-help.html>
- Moon Reflector <http://lists.moonbounce.info/cgi-bin/mailman/listinfo/moon>
- Microwave Reflector <http://lists.valinet.com/cgi-bin/mailman/listinfo/microwave>

You might very well be close with your tropo setup but..



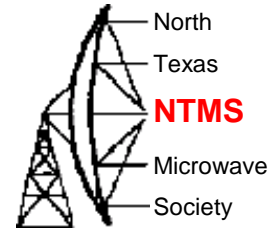
- Are you GPS locked?
- Do you have the proper software for predicting the moon location?
- Can you track the moon? Remember a 36 inch dish has a 3dB beam width of 2.3 degrees and a 1 dB beam width of 1.3 degrees at 10 GHz
- Elevation is easy – Remote a Sears inclinometer as written up by WA8RJF
- Azimuth – Use either a US Digital absolute encoder or an incremental encoder and a W2DRZ system or an HB9DRI system for both az and el. Other option for US Digital absolute encoders is the use of a Weeder RS-232 controlled relay control board and K5GW software
- Calibration – use the sun
- Let's run!

Thanks to K1JT & VK7MO



- Thanks to Joe Taylor K1JT for taking inputs and comments from VK7MO to help optimize the JT-4 modes for 10 and 24 GHz EME
- Check out Dubus 2/2013 for the article “Small Station EME at 10 & 24 GHz by Rex Moncur, VK7MO, and Joe Taylor, K1JT

Thanks for Listening!



- Any Questions?
- My presentation will be posted to www.ntms.org after the conference