South Florida DX ASSOCIATION

WORKING DX WITH JOE TAYLOR

By Pete Rimmel N8PR

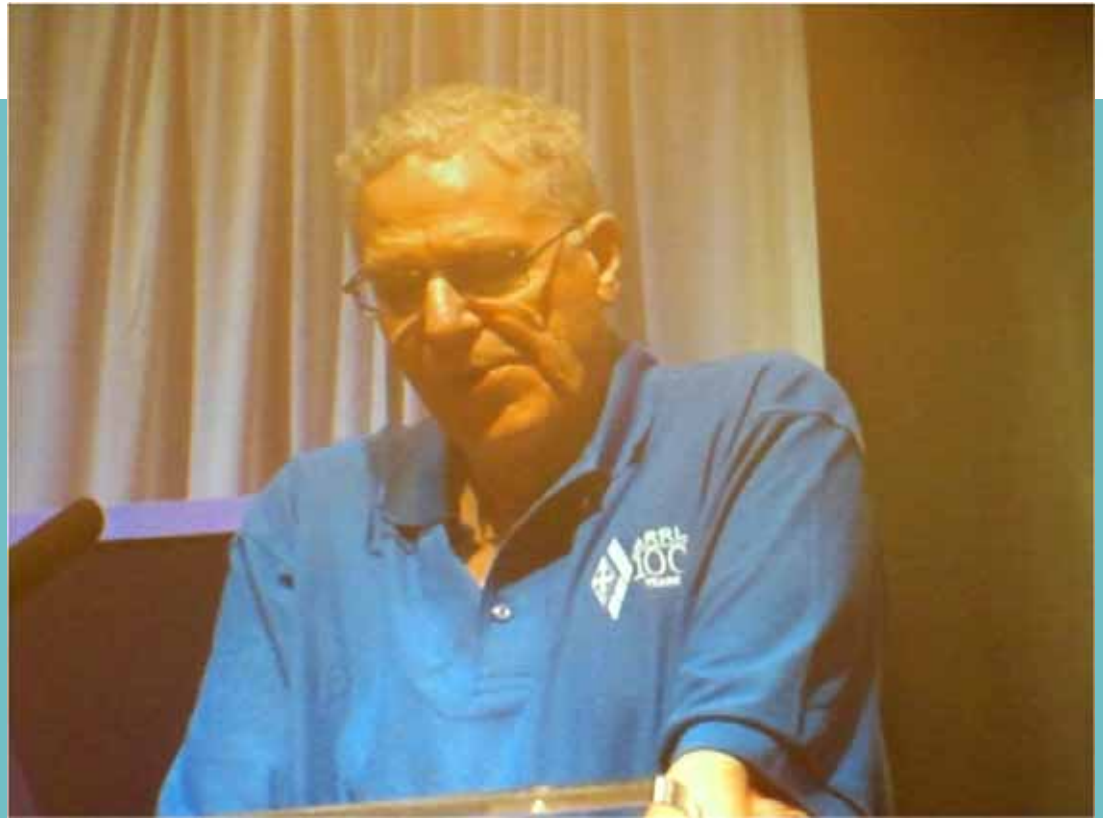
Presented at the Miami Hamfest

DX Forum

January 31, 2015

Joe Taylor, K1JT, 1993 Nobel Prize Winner

Taylor became interested in radio astronomy after obtaining his Amateur Radio license as a teenager. Today Taylor is well known for his 1974 joint discovery with Russell Hulse, of the first pulsar star in a binary system. Taylor used the Arecibo Radio Telescope to conduct moonbounce contacts with amateurs around the world using voice, Morse code, and digital communications. He is also known for his weak signal communication.



http://physics.princeton.edu/pulsar/k1jt/index.html

WSJT Home Page

by K1JT

Weak Signal Communication Software

WSJT, MAP65, WSPR, and *WSJT-X* are open-source programs designed for weak-signal digital communication by amateur radio. Normal usage requires a standard SSB transceiver and a personal computer with soundcard. SDR-style hardware including the SDR-IQ, Perseus, SoftRock, and FUNcube Dongle is supported by *MAP65* and *WSPR*. *SimJT* is a utility program that generates simulated signals for test purposes. Ready-to-run Windows versions of all programs are available for free download, and the programs (except *SimJT*) can also be compiled and used under Linux, OS X, and FreeBSD. For details about source code and operating systems other than Windows, see the Program Development page.

WSJT ("Weak Signal Communication, by K1JT") offers specific digital protocols optimized for EME (moonbounce), meteor scatter, and ionospheric scatter, at VHF/UHF, as well as for HF skywave propagation. The program can decode fraction-of-a-second signals reflected from ionized meteor trails and steady signals 10 dB below the audible threshold. Check the *WSJT* page and links therein for details about modes JTMS, FSK441, ISCAT, JT6M, JT65, and JT4.

WSJT-X implements JT9, a new mode optimized for weak-signal communication on the LF, MF, and HF bands. JT9 is about 2 dB more sensitive than JT65 and uses less than 10% of the bandwidth. A beta release of Version 1.4 of *WSJT-X* was released on October 1, 2014; further program enhancements are under active development . Plans call for the eventual inclusion of the other popular modes now supported in *WSJT*.

SOME OF JOE'S PROGRAMS

WSJT, MAP65, WSPR, and WSJT-X are all open-source programs designed for weak-signal digital communication by amateur radio.

Normal usage requires a standard SSB transceiver and a personal computer with soundcard. (More on this later)

SDR-style hardware including the SDR-IQ, Perseus, SoftRock, and FUNcube Dongle are supported by MAP65 (Wideband receive) and WSPR (Weak Signal Propagation Reporter).

SimJT is a utility program that generates simulated signals for test purposes.

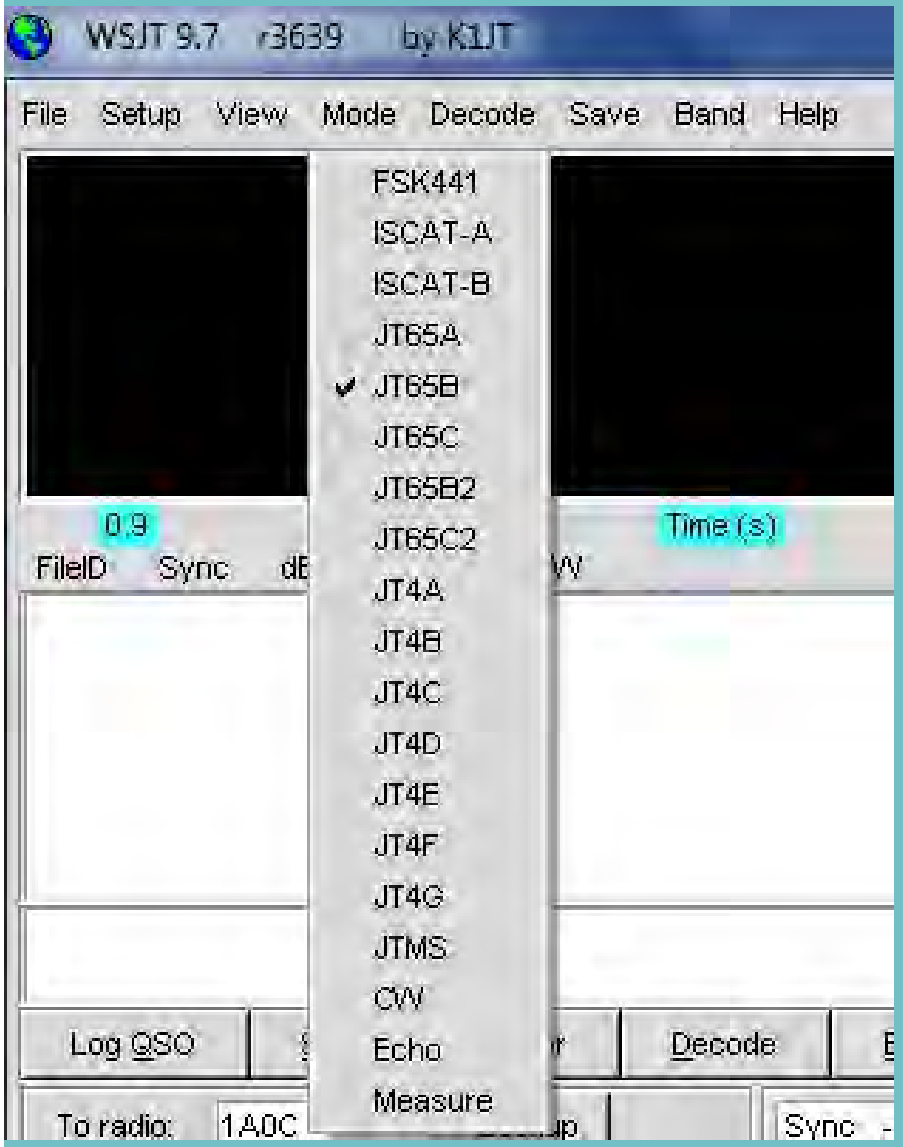
Ready-to-run Windows versions of all programs are available for free download, and the programs (except SimJT) can also be compiled and used under Linux, OS X, and FreeBSD.

WSJT ("Weak Signal Communication, by K1JT") offers specific digital protocols optimized for:

VHF/UHF	HF
EME (moonbounce) Meteor Scatter Ionospheric Scatter,	Skywave Propagation

The program can decode fraction-of-a-second signals reflected from ionized meteor trails and steady signals 10 dB below the audible threshold.

Check the WSJT pages and links at Joe's website for details about the many modes the program can produce:



WSJT for VHF can do many different modes. We will concentrate on JT65B for EME (Moonbounce) in this presentation.

Later we will talk about WSJT-X for HF communication.

WSJT

Description

WSJT facilitates basic digital communication using protocols explicitly optimized for a number of different propagation modes:

- **JTMS, FSK441** for meteor scatter
- **ISCAT, JT6M** for ionospheric scatter
- **JT65** for EME at VHF/UHF, and for QRP operation at MF/HF
- **JT4**: for EME on the microwave bands

See the online WSJT 10.0 User Guide for details.

Downloads

Important note: in Vista, Windows 7, and Windows 8 install *WSJT* to a directory such as C:\WSJT or C:\HamRadio\WSJT rather than the default C:\Program Files\WSJT.

(Otherwise, you might need to set some read/write permissions explicitly.)

- Windows WSJT 10.0 (beta release, v10.0 r4336)
- WSJT 10.0 User Guide

- Windows WSJT 9.7 (v9.7, r3639)
- Linux WSJT 9.0
- WSJT 9.0 Supplement to User's Guide
  - English
  - Italian
  - Portuguese
- Archival releases of WSJT7
  - Windows WSJT 7.07
  - Linux WSJT 7.06
- Archival Windows release WSJT 5.9.8
- Archival Windows release WSJT 4.9.8

WSJT-X FOR HF and LF QSOs

Description

WSJT-X implements JT9, a new mode designed especially for the LF, MF, and HF bands, as well as the popular mode JT65. Both modes were designed for making reliable, confirmed QSOs under extreme weak-signal conditions. They use nearly identical message structure and source encoding. JT65 was designed for EME ("moonbounce") on the VHF/UHF bands and has also proved very effective for worldwide QRP communication at HF; in contrast, JT9 is optimized for HF and lower frequencies. JT9 is about 2 dB more sensitive than JT65A while using less than 10% of the bandwidth. With either mode, world-wide QSOs are possible with power levels of a few watts and compromise antennas. A 2 kHz slice of spectrum is essentially full when occupied by ten JT65 signals. As many as 100 JT9 signals can fit into the same space, without overlap.

WSJT-X offers a "bi-lingual" operating mode in which you can transmit and receive JT65 and JT9 signals, switching between modes automatically as needed. Displayed bandwidth can be as large as 5 kHz. If your receiver has as upper-sideband filter at least 4 kHz wide, you can have all the typical JT65 and JT9 activity on screen at once, available for making QSOs with a click of the mouse. Even with standard SSB-width IF filters, switching between JT65 and JT9 modes is quick and convenient.

A beta release of WSJT-X Version 1.4 is now available, offering many new features.

Future plans

Plans call for future versions of *WSJT-X* to include the other popular modes from *WSJT*.

Downloads

Be sure to refer to the online **WSJT-X User's Guide** for the relevant program version: either Version 1.3 or the beta release, Version 1.4.

Windows

- Beta release, Version 1.4: wsjtx-1.4.0-rc2-win32.exe
- Latest full release: v1.3, r3673

Linux

Installation instructions for version 1.4 can be found here in the User Guide. Download the package file appropriate for your system:

- Debian, Ubuntu, ... (32-bit): wsjtx_1.4.0-rc2_i386.deb
- Debian, Ubuntu, ... (64-bit): wsjtx_1.4.0-rc2_amd64.deb

WEAK SIGNAL S/N LIMITS

MODE	B/W=2500 Hz	
SSB	~ +3 dB	#
FSK 441	-1	#
CW (ear and brain)	-15	#
ISCAT	-17	*
JT4	-22	*
JT65A	-24	*
JT9	-26	*
WSPR	-28	*

These signals are just detectable –
NOT armchair copy !

* These signal levels are NOT detectable by ear, only by a computer !

What is JT65-A, B or C?

- **A form of digital communications originally developed by Joe Taylor, K1JT, for Moonbounce applications where signals are extremely weak.**
- **Uses sophisticated digital signal processing**
- **Also relies on a 5:1 redundancy – it sends the encoded information with the powerful Reed Solomon code.**
- **The same sequence of tones never repeat, but the data is sent many times to allow for various types of QSB**

Many Different Tones

- **A synchronizing tone is sent a fixed spacing above the carrier frequency of your transmitter on JT65 A-B-C (or varies on WSJT-X).**
- **You may see it anywhere in your receiver passband due to doppler shift.**
- **Those varied tones carry the information**
- **On the air it sounds like someone playing music** 

Timing is Everything

- **Each JT65 transmission lasts precisely 46.8 seconds.**
- **During transmission only a small amount of information is sent – about 13 characters**
- **Station clocks must agree within about 2 seconds**
- **As much as 80% of the transmission can be lost and still be decoded**

Taking Turns

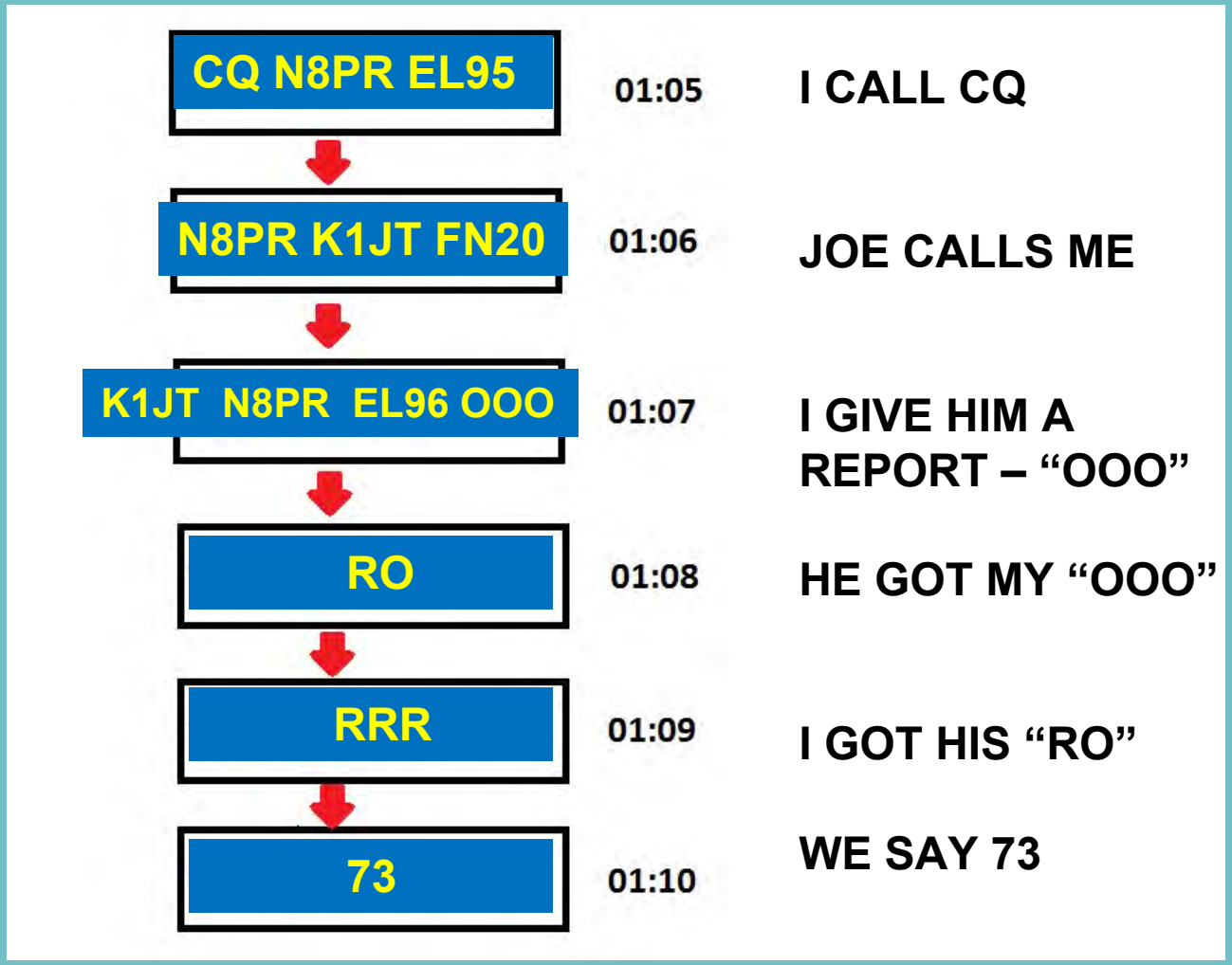
- **Stations take turns transmitting**
- **Stations transmit on even or odd minutes, and then listen on the following minutes**
- **First Period = Even Minutes**
- **Second Period = Odd Minutes**

Just the Facts!

- **A JT65 contact is designed to exchange the bare minimum information needed to qualify as a "QSO"**

- **Call signs**
- **Signal Reports**
- **Grid Squares**

Transmitting and Receiving Sequence (VHF/EME):

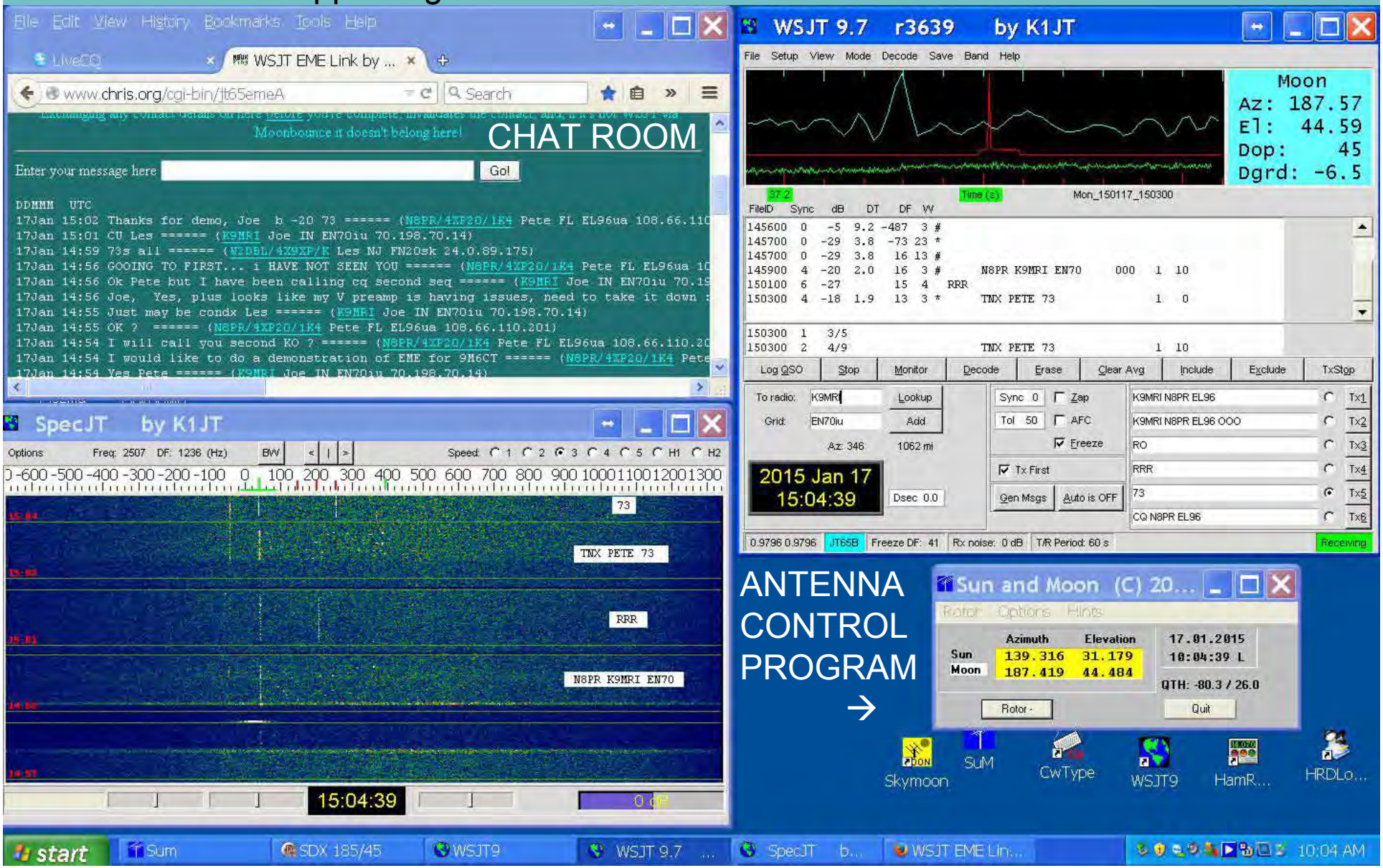


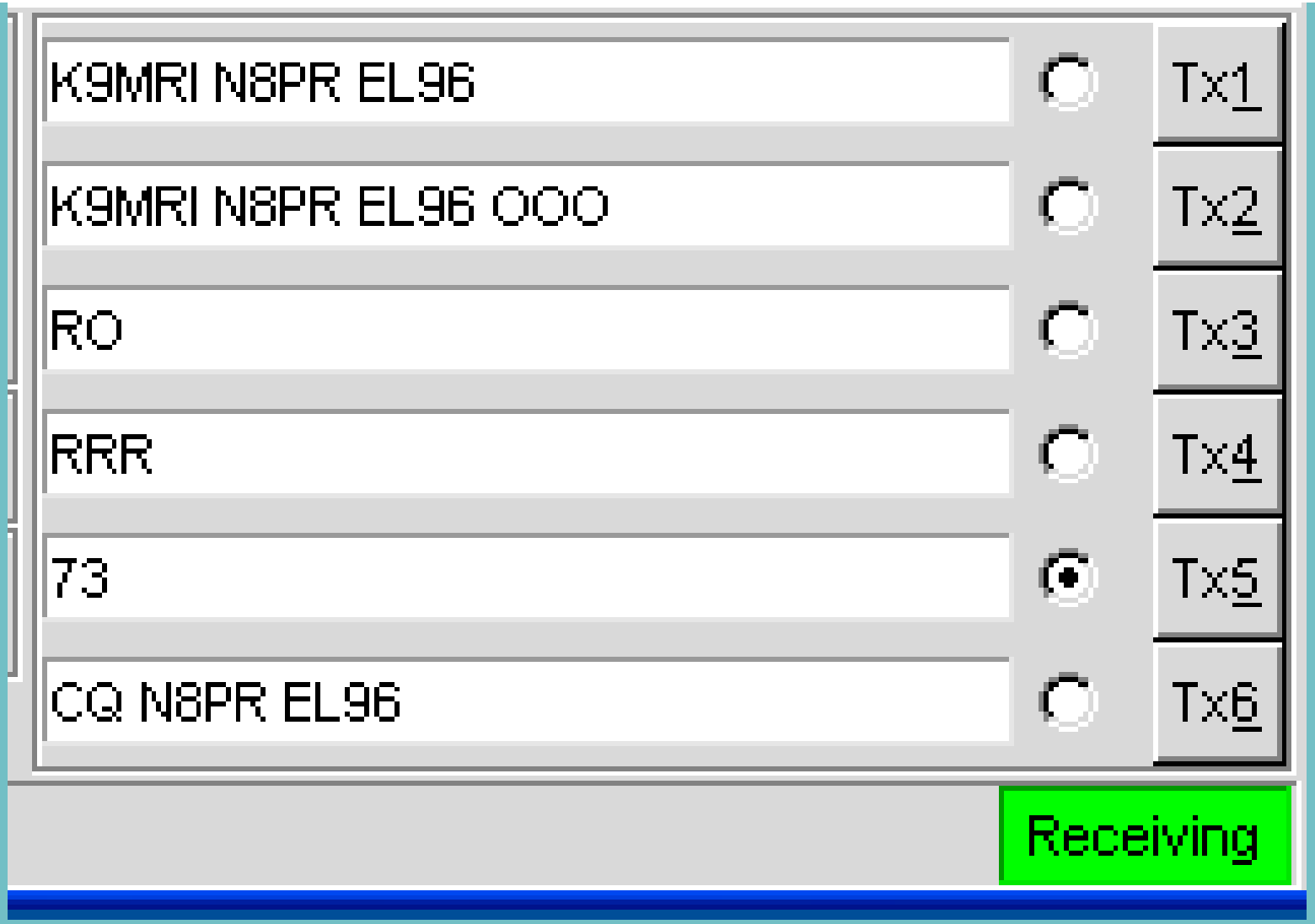
Typical JT65B EME screen setup

Upper Left is a chat room window to talk to others on EME

Below it is the waterfall showing a QSO.

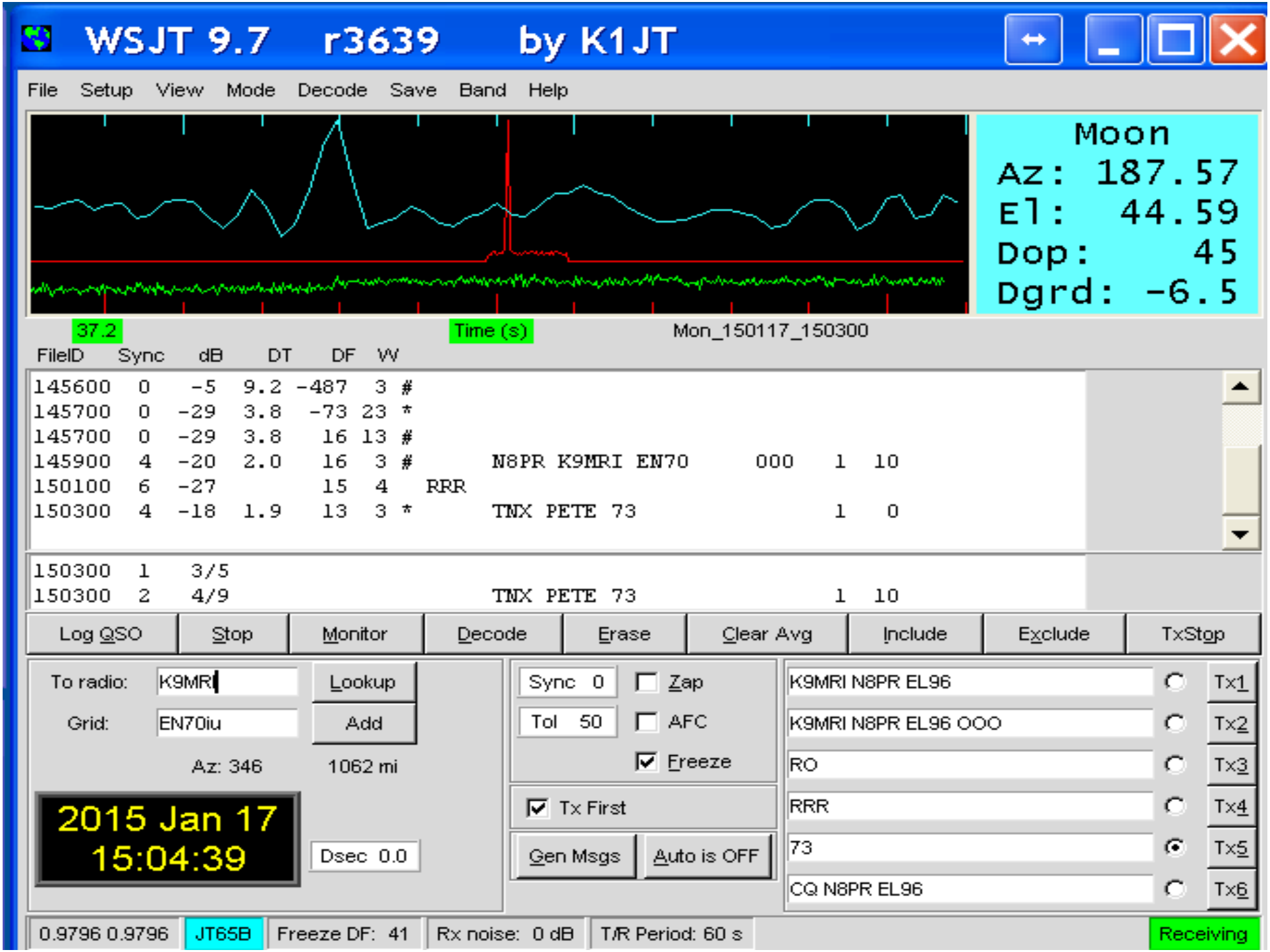
Upper Right is the data and QSO window

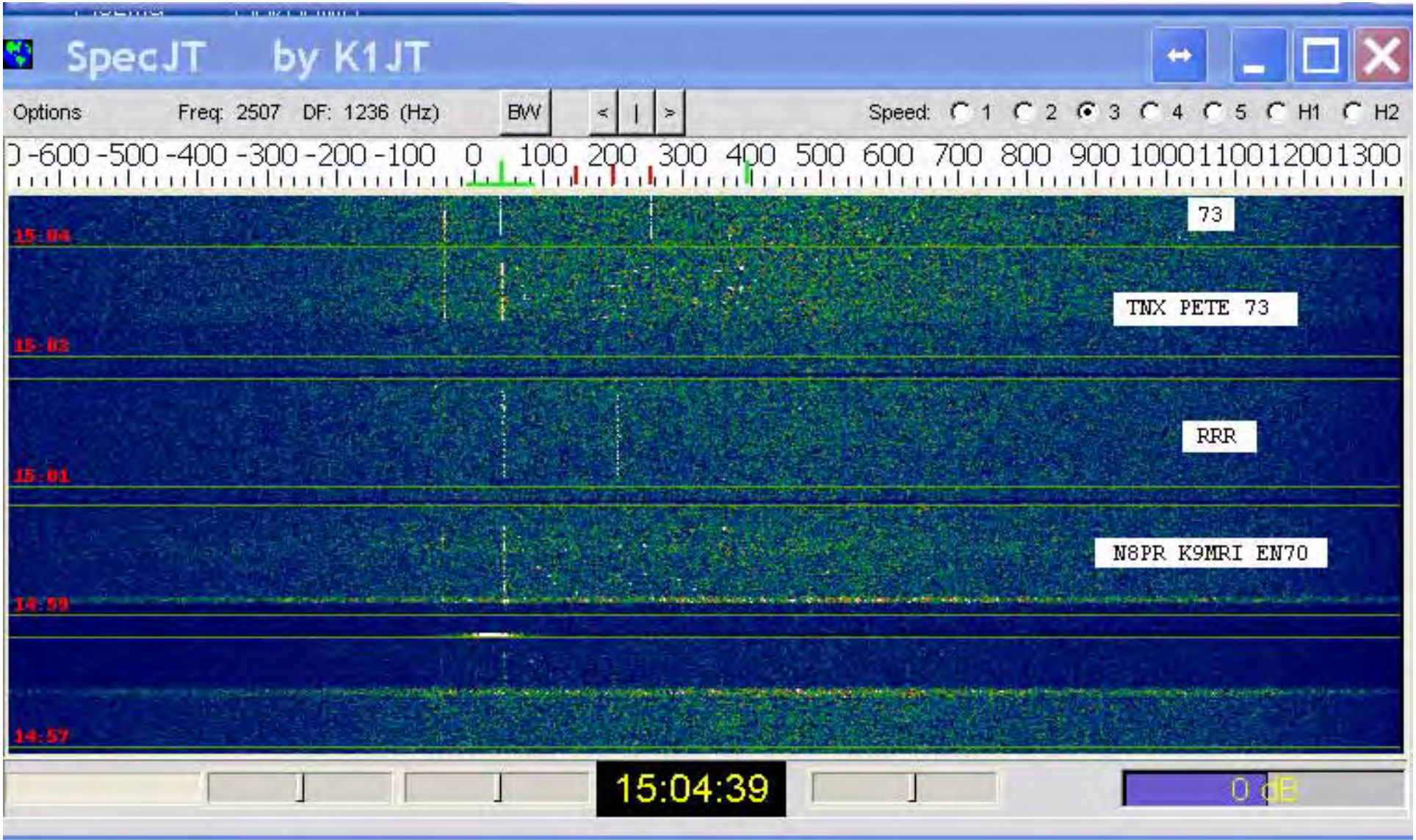




These are the standard messages that are sent on JT65B for EME

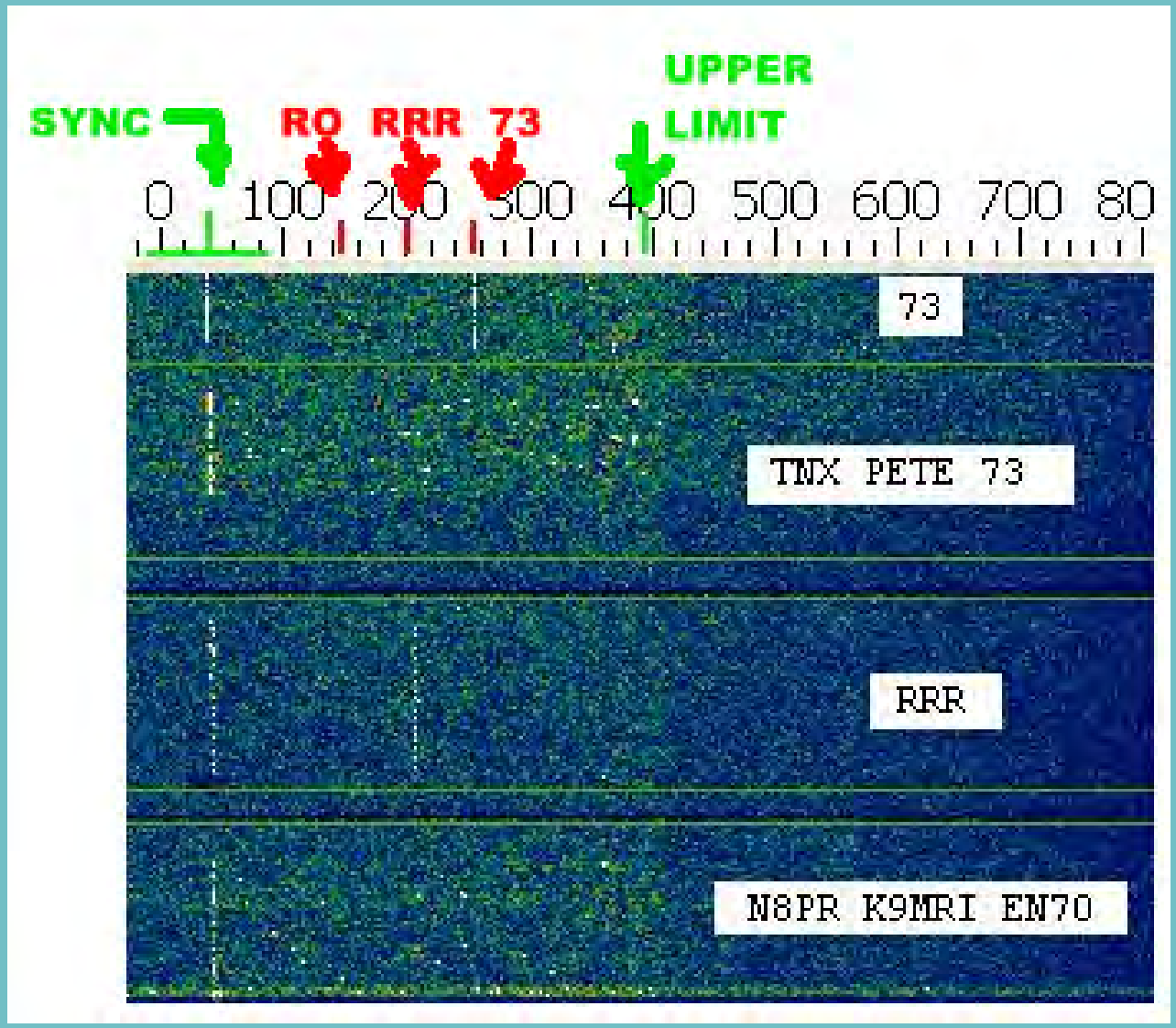
Simple but containing all the data needed for a valid QSO

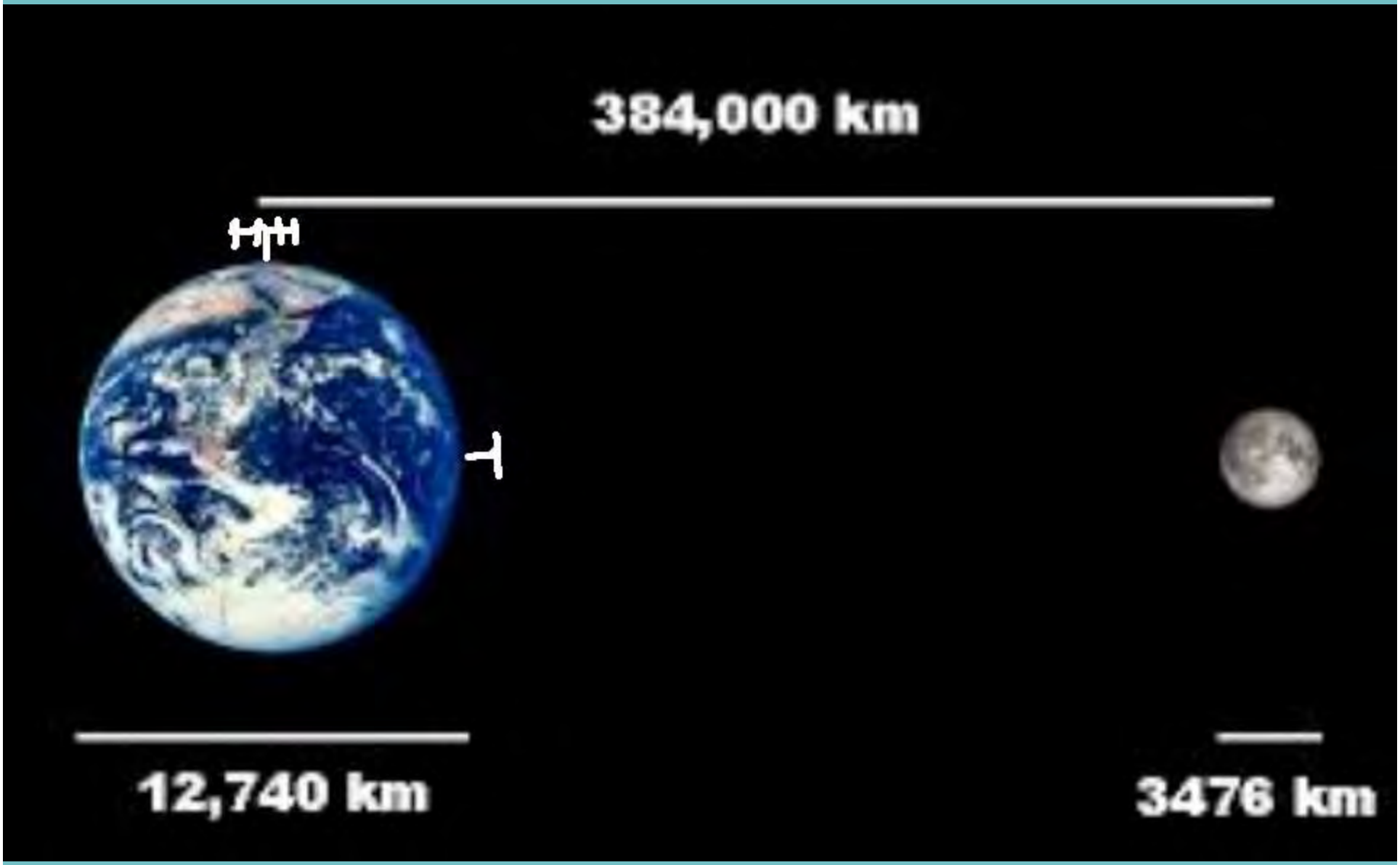

WSJT 9.7 r3639 by K1JT
File Setup View Mode Decode Save Band Help
Moon
Az: 187.57
El: 44.59
Dop: 45
Dgrd: -6.5
37.2
Time (s)
Mon_150117_150300
FileID Sync dB DT DF W
145600 0 -5 9.2 -487 3 #
145700 0 -29 3.8 -73 23 *
145700 0 -29 3.8 16 13 #
145900 4 -20 2.0 16 3 # N8PR K9MRI EN70 000 1 10
150100 6 -27 15 4 RRR
150300 4 -18 1.9 13 3 * TNX PETE 73 1 0
150300 1 3/5
150300 2 4/9 TNX PETE 73 1 10
Log QSO
Stop
Monitor
Decode
Erase
Clear Avg
Include
Exclude
TxStop
To radio: K9MR
Lookup
Grid: EN70iu
Add
Az: 346
1062 mi
2015 Jan 17
15:04:39
Dsec 0.0
Sync 0
Zap
Tol 50
AFC
Freeze
Tx First
Gen Msgs
Auto is OFF
K9MRI N8PR EL96
Tx1
K9MRI N8PR EL96 OOO
Tx2
RO
Tx3
RRR
Tx4
73
Tx5
CQ N8PR EL96
Tx6
0.9796 0.9796
JT65B
Freeze DF: 41
Rx noise: 0 dB
T/R Period: 60 s
Receiving



This is what I see on the waterfall during an EME QSO

With JT65 A,B,C Modes you can visually a message because of the simple tone spacing for reports.





Not considering Faraday shifts and other signal effects, a horizontally polarized signal leaving Europe looks like a vertically polarized signal in the USA.

So, can I work DX on the VHF Bands With JT65 modes ?

Yes.

Many stations have DXCC on 2 Meters using JT65B on Moonbounce !

But, you do need a good antenna.

4x20 XP at N8PR

24 Yagi Array at KB8RQ

Original 2x9 array at N8PR

JT65 on HF

- **The JT65 “revolution” on the HF bands is primarily due to Joe Large, W6CQZ.**
- **Joe wrote a piece of software called *JT65-HF* that makes it much easier to operate JT65 and make successful contacts.**
- **Since Oct, 2014, a newer program - WSJT-X has been used.**
- ***WSJT-X* is currently available for *Windows, Mac and Linux.***
- **Excellent mode for low power or antenna restricted stations.**

WSJT-X implements JT9, a new mode optimized for weak-signal communication on the LF, MF, and HF bands, as well as the popular mode JT65.

JT9 is about 2 dB more sensitive than JT65 and uses less than 10% of the bandwidth. As many as 100 JT9 signals can fit into the space of 10 JT65 signals, without overlap !

Both modes were designed for making reliable, confirmed QSOs under extreme weak-signal conditions.

They use nearly identical message structure and source encoding.

With either mode, world-wide QSOs are possible with power levels of a few watts and compromise antennas.

NOTE: That does not mean you MUST use QRP or small antennas on this mode, it only means that it is effective at low signal levels.

You still have to put out a signal that will be heard somewhere… AND hear the other guy.

WSJT-X offers a "bi-lingual" operating mode in which you can transmit and receive JT65 and JT9 signals, switching between modes automatically as needed.

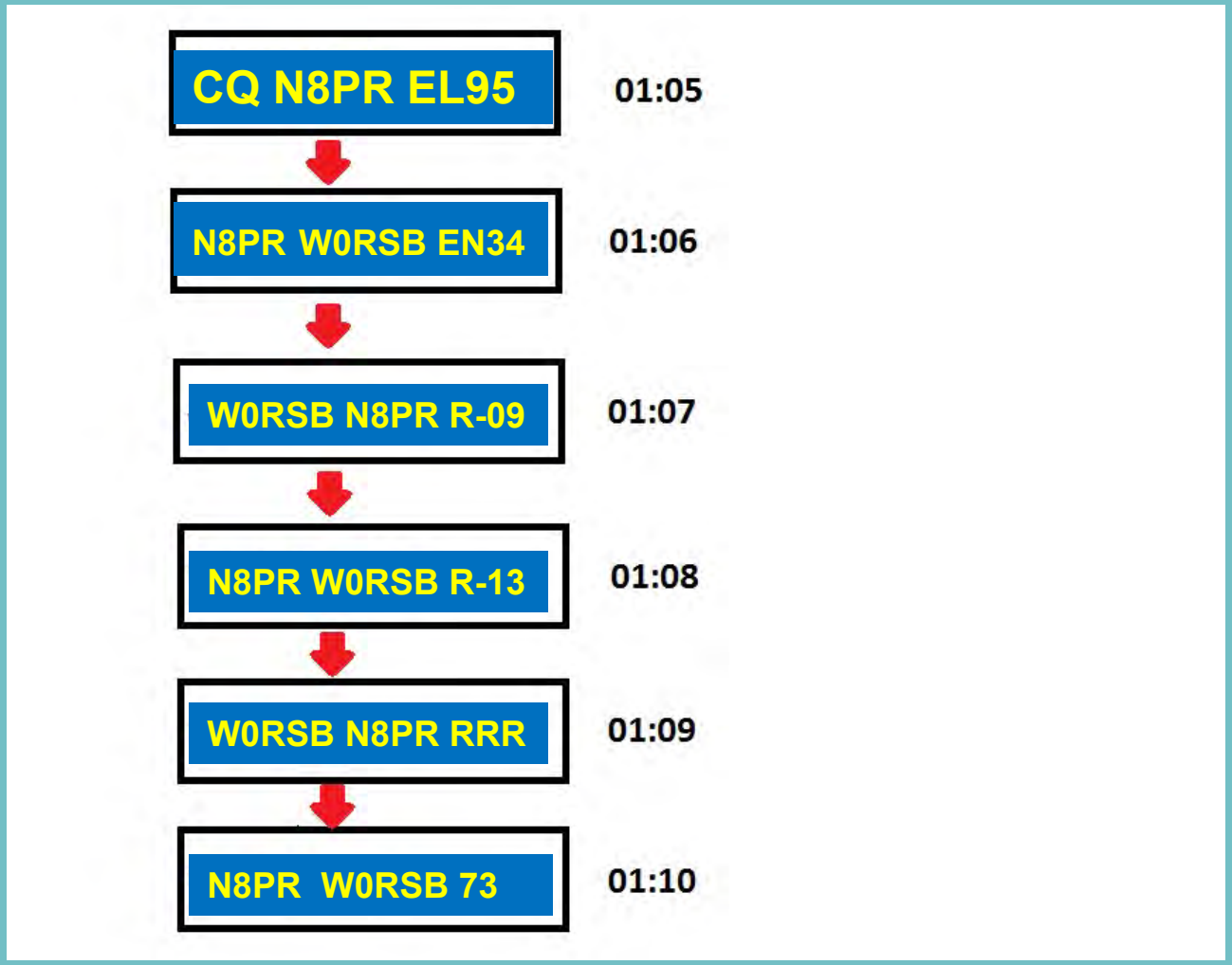
If your receiver has as upper-sideband filter at least 4 kHz wide, you can have all the typical JT65 and JT9 activity on screen at once, available for making QSOs with a click of the mouse.

Contacts by the “Colors”

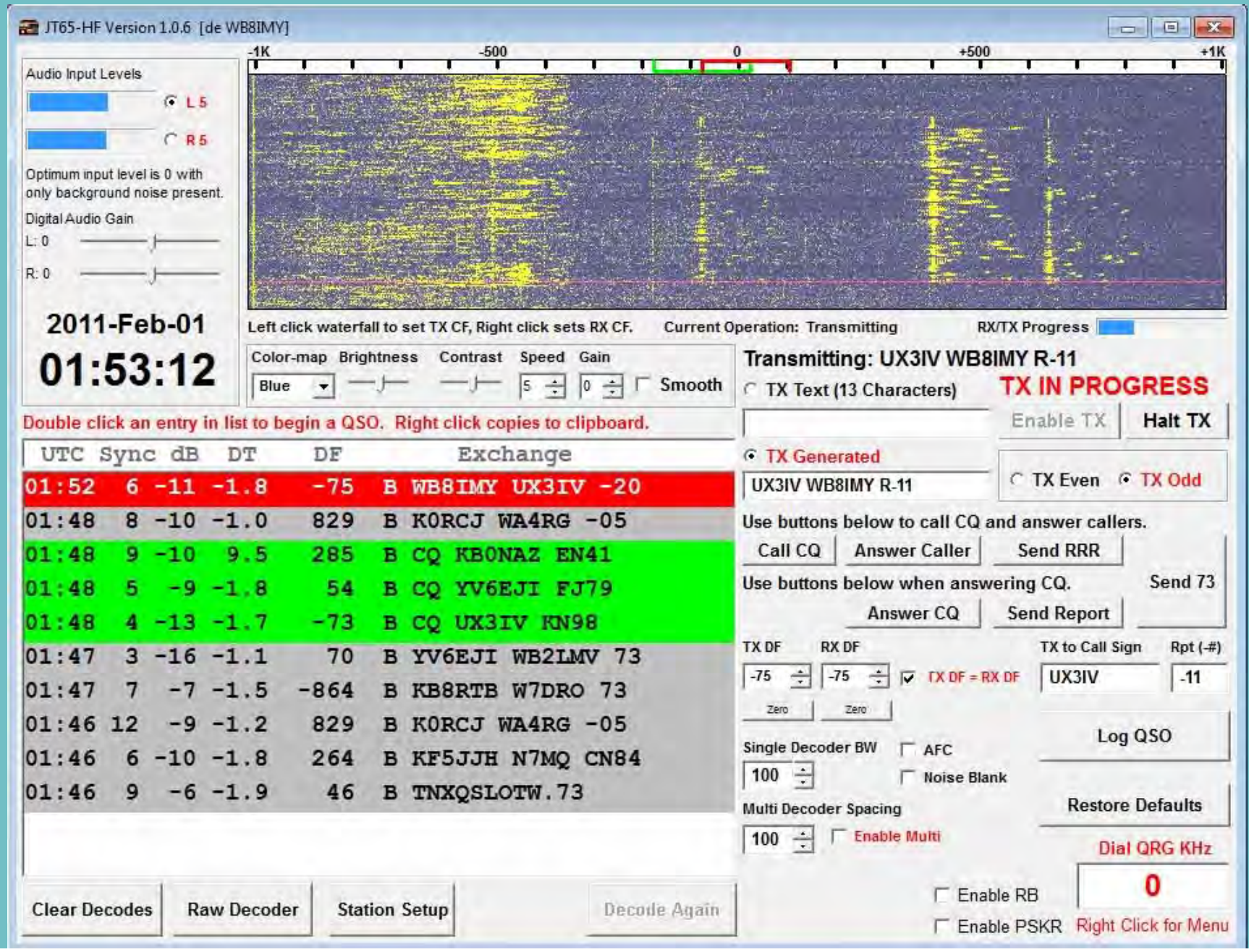
- *WSJT-X* (and JT65-HF) uses color highlighting to indicate which stations are calling CQ, which stations are in contact with each other, and which stations are transmitting to you.

- The program also has preformatted responses that you can send by simply double clicking on the appropriate line.

Transmitting and Receiving Sequence (HF):



This is an earlier version of JT65-HF – It will still work, but the latest Version, WSJT-X is easier to use.

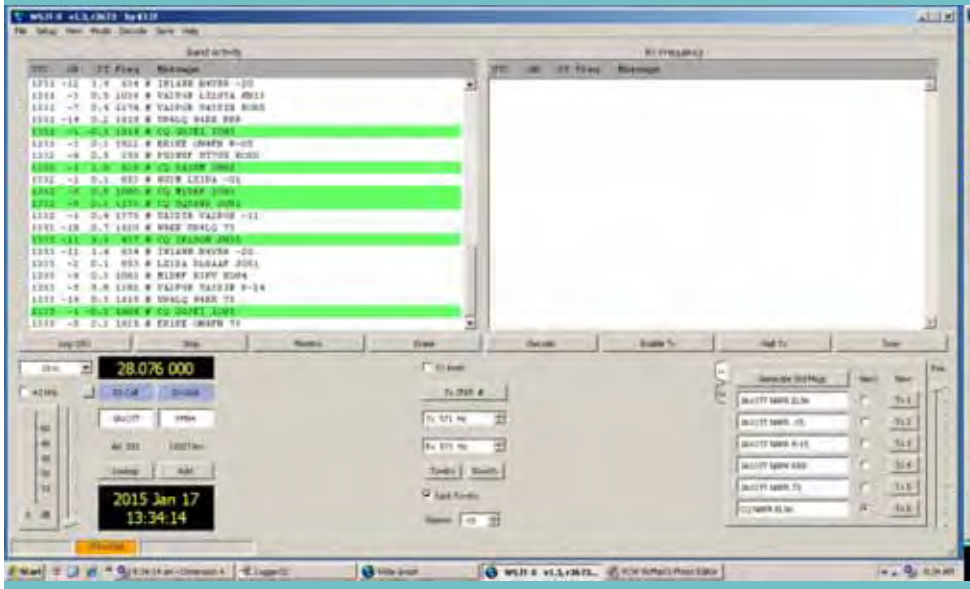


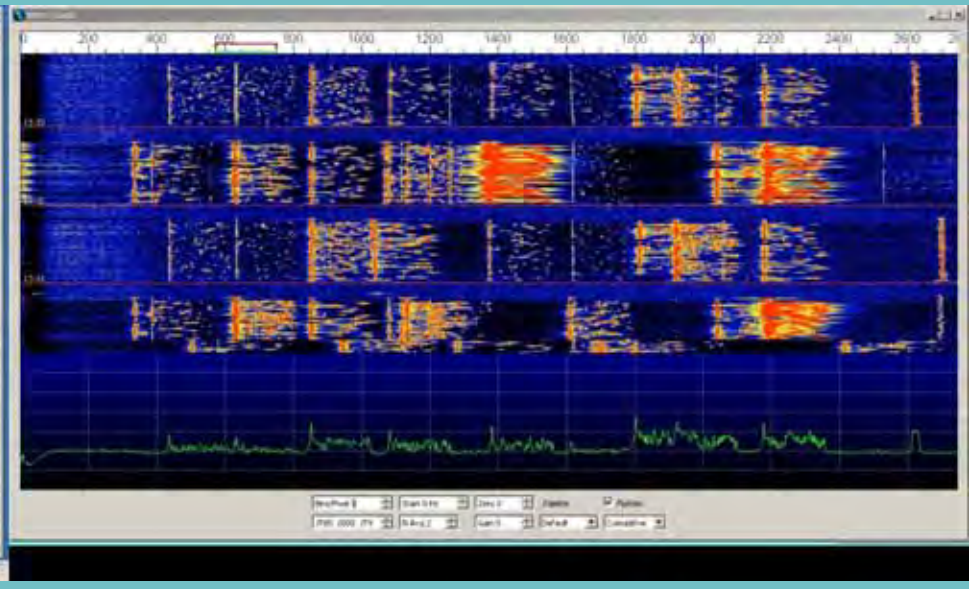
WHEN WSJT-X IS RUNNING YOU WILL SEE TWO WINDOWS:

THE DATA WINDOW WHICH HAS ALL THE QSO INFORMATION

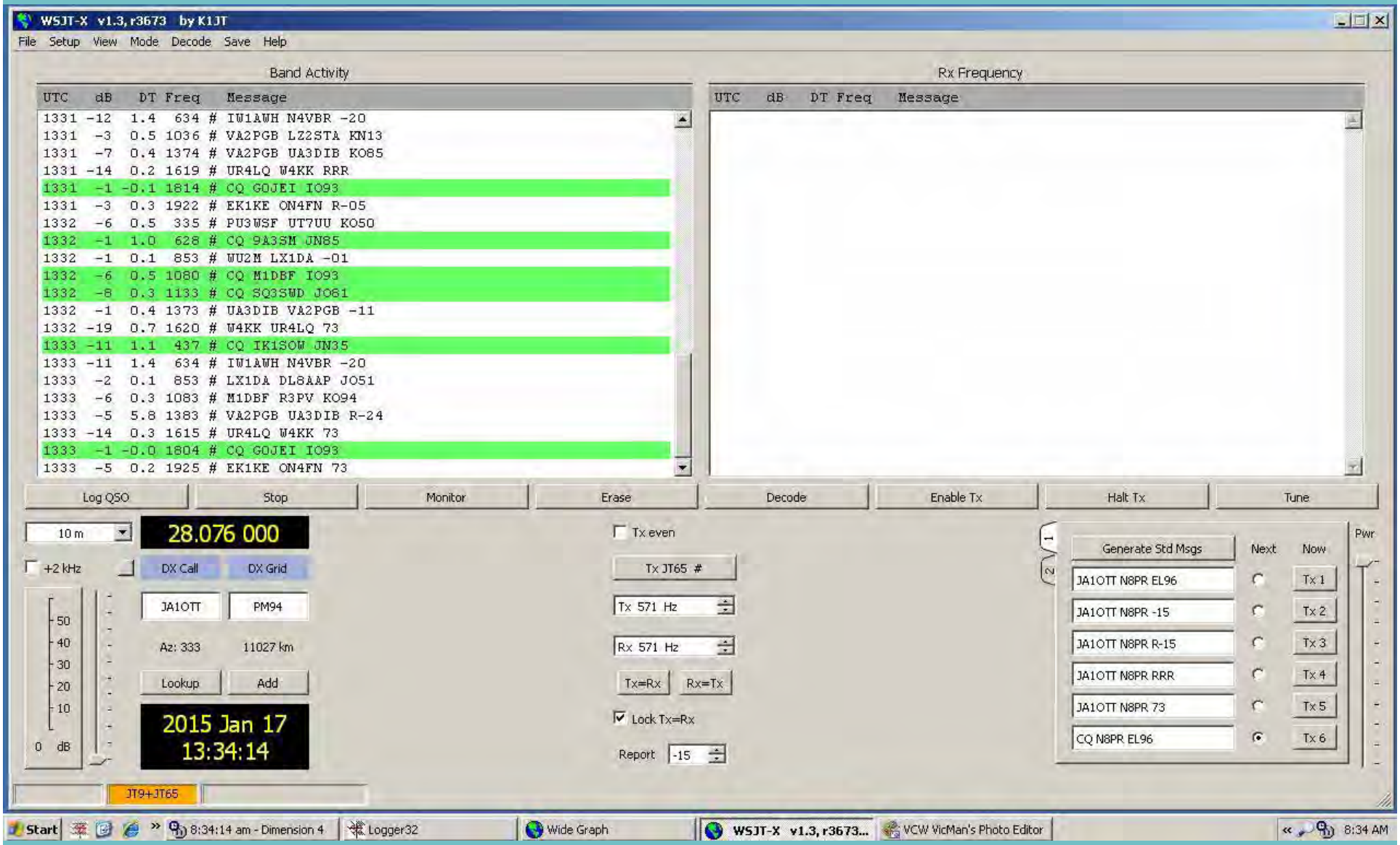
AND THE WATERFALL WHICH SHOWS ALL THE STATIONS IN YOUR RECEIVER PASSBAND.

WSJT-X WILL DECODE BOTH JT65 AND JT9 SIMULTANEOUSLY.

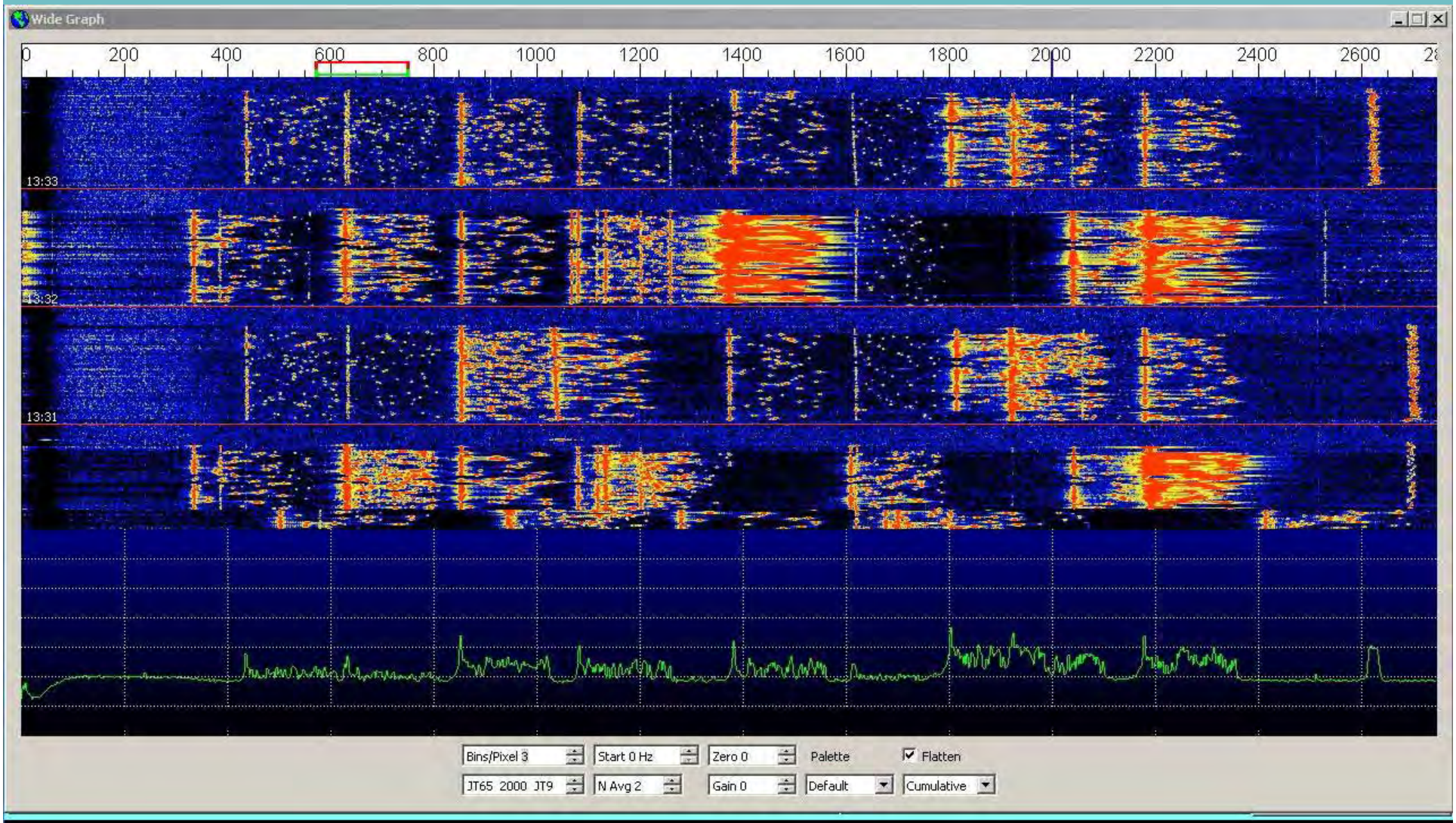




DATA AND QSO WINDOW



WATERFALL WINDOW



Understanding the WSJT-X and *JT65-HF* Decoding Screen

- **UTC** – When the signal was received.
- **Sync** – A measure of how well the synchronizing tone is being received. Higher is better.
- **dB** – The signal to noise ratio of the received signal in dB. Higher is better. 0 is the upper limit.
- **DT** – The calculated offset of the received signal from your local clock. Values of .3 to 1.9 are typical.
- **DF** – Offset in Hz from the center point (0).

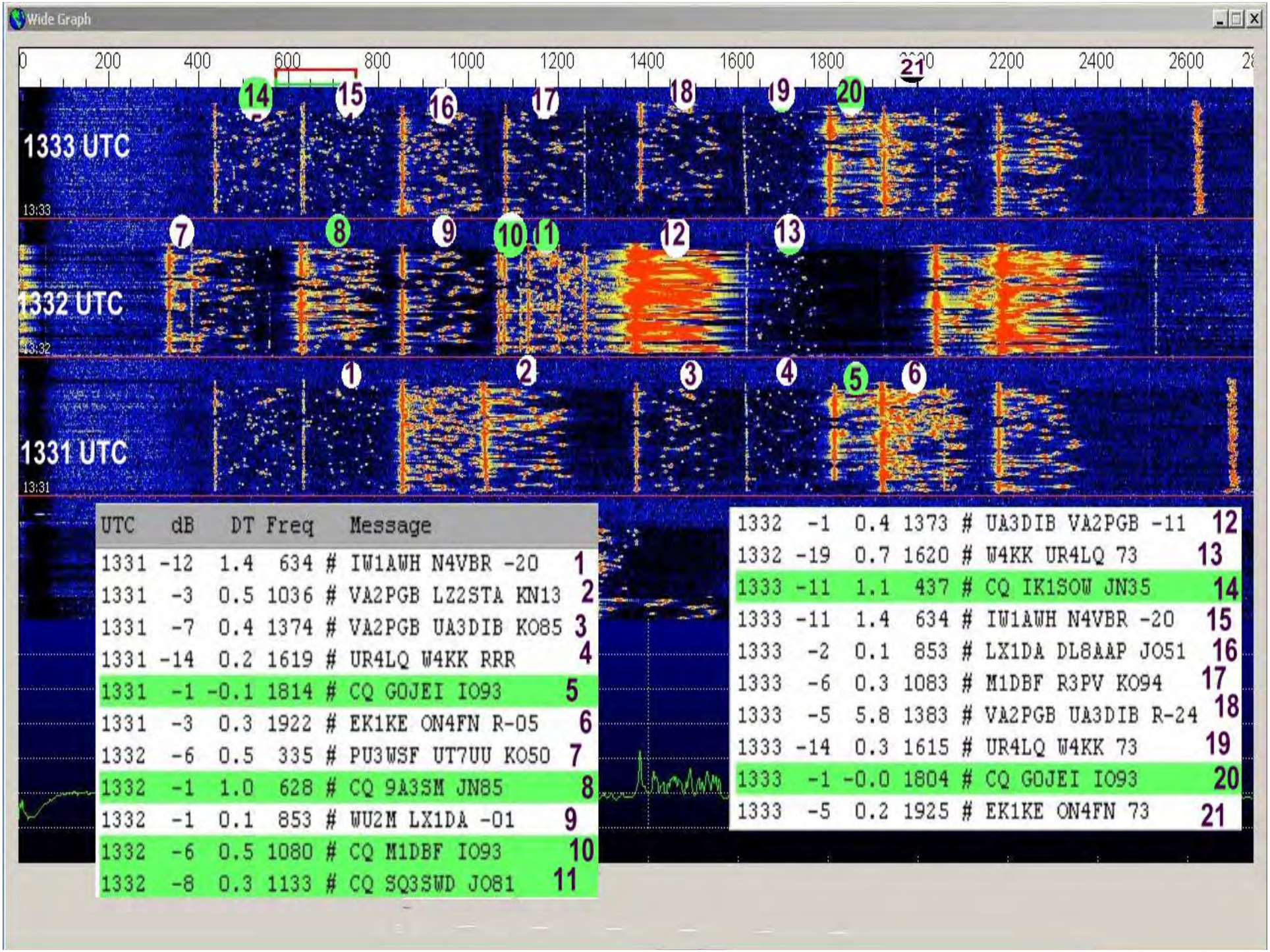
Here is a 3 minute recording on the WSJT-X waterfall.

Notice how many signals there are.

Some are very strong and others weak.

If you are TOO STRONG you may distort and not decode

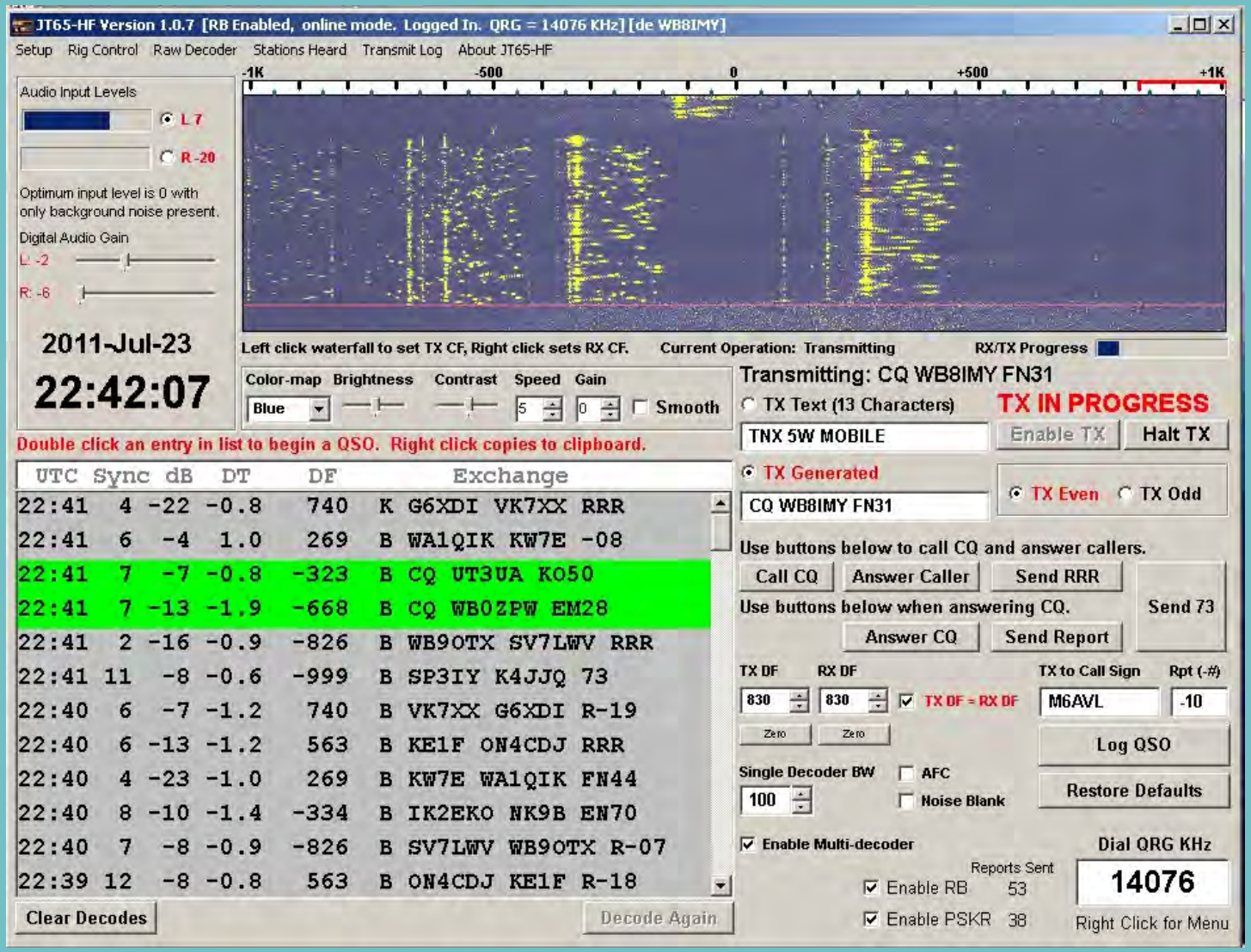
The following was taken at 8:30 AM on a Saturday Morning on 10 meters using a 3 element tri-bander 40 feet high pointed at 045 degrees (at Europe).


Wide Graph
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
1333 UTC
13:33
1332 UTC
13:32
1331 UTC
13:31
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
UTC dB DT Freq Message
1331 -12 1.4 634 # IW1AWH N4VBR -20 1
1331 -3 0.5 1036 # VA2PGB LZ2STA KN13 2
1331 -7 0.4 1374 # VA2PGB UA3DIB KO85 3
1331 -14 0.2 1619 # UR4LQ W4KK RRR 4
1331 -1 -0.1 1814 # CQ GOJEI IO93 5
1331 -3 0.3 1922 # EK1KE ON4FN R-05 6
1332 -6 0.5 335 # PU3WSF UT7UU KO50 7
1332 -1 1.0 628 # CQ 9A3SM JN85 8
1332 -1 0.1 853 # WU2M LX1DA -01 9
1332 -6 0.5 1080 # CQ M1DBF IO93 10
1332 -8 0.3 1133 # CQ SQ3SWD JO81 11
1332 -1 0.4 1373 # UA3DIB VA2PGB -11 12
1332 -19 0.7 1620 # W4KK UR4LQ 73 13
1333 -11 1.1 437 # CQ IK1SOW JN35 14
1333 -11 1.4 634 # IW1AWH N4VBR -20 15
1333 -2 0.1 853 # LX1DA DL8AAP JO51 16
1333 -6 0.3 1083 # M1DBF R3PV KO94 17
1333 -5 5.8 1383 # VA2PGB UA3DIB R-24 18
1333 -14 0.3 1615 # UR4LQ W4KK 73 19
1333 -1 -0.0 1804 # CQ GOJEI IO93 20
1333 -5 0.2 1925 # EK1KE ON4FN 73 21

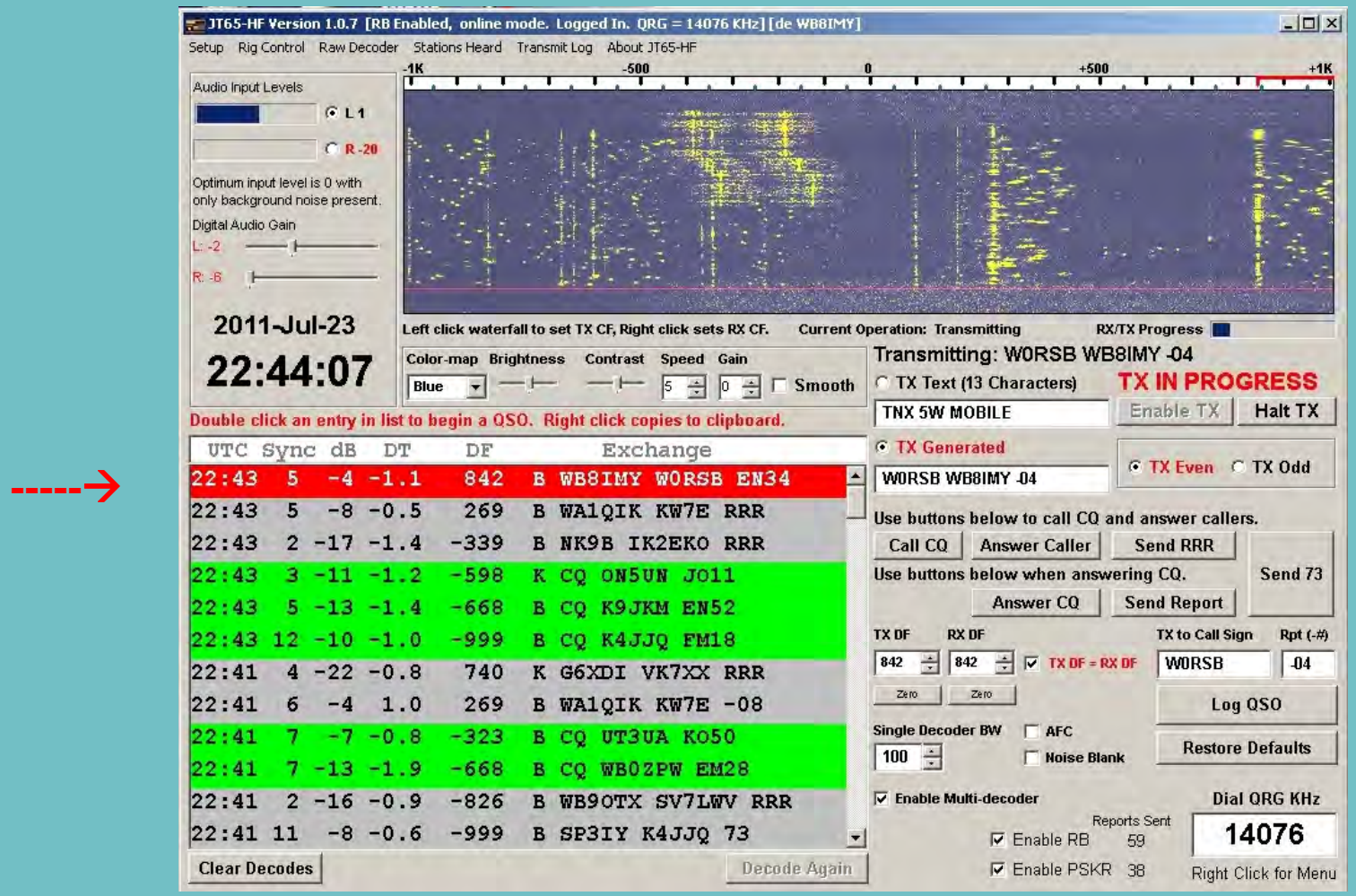
Let's Follow an Actual Contact, Step by Step

This contact was made from WB8IMY while running just 5W on 20 meters using two Hamstick mobile antennas connected together as a dipole.

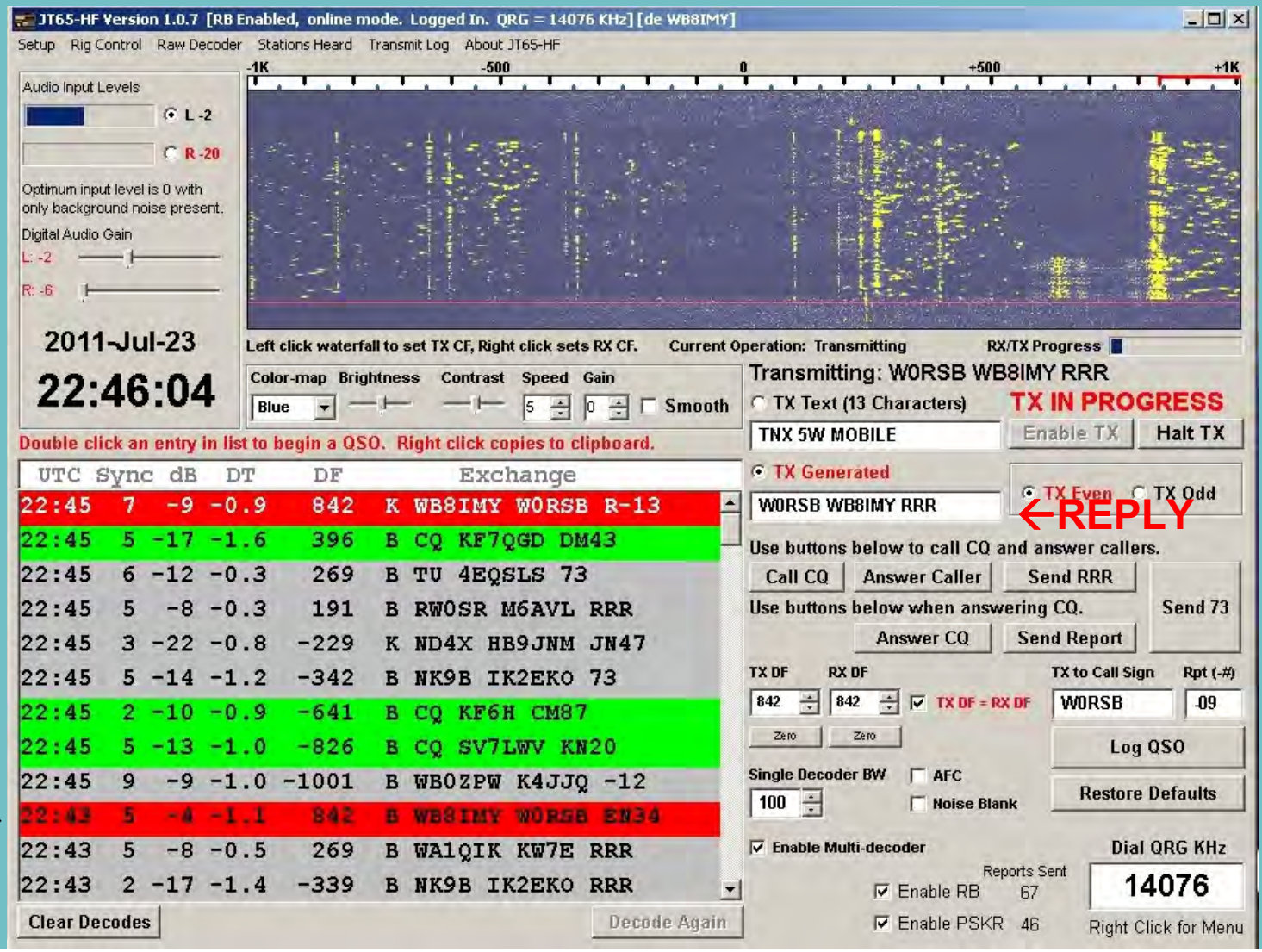
WB8IMY is Calling CQ…



W0RSB Has Answered.
WB8IMY Is Replying with a Signal Report
Note the top line with the RED background



W0RSB Confirms My Report and Gives a Report of -13 dB. WB8IMY Replies "RRR"

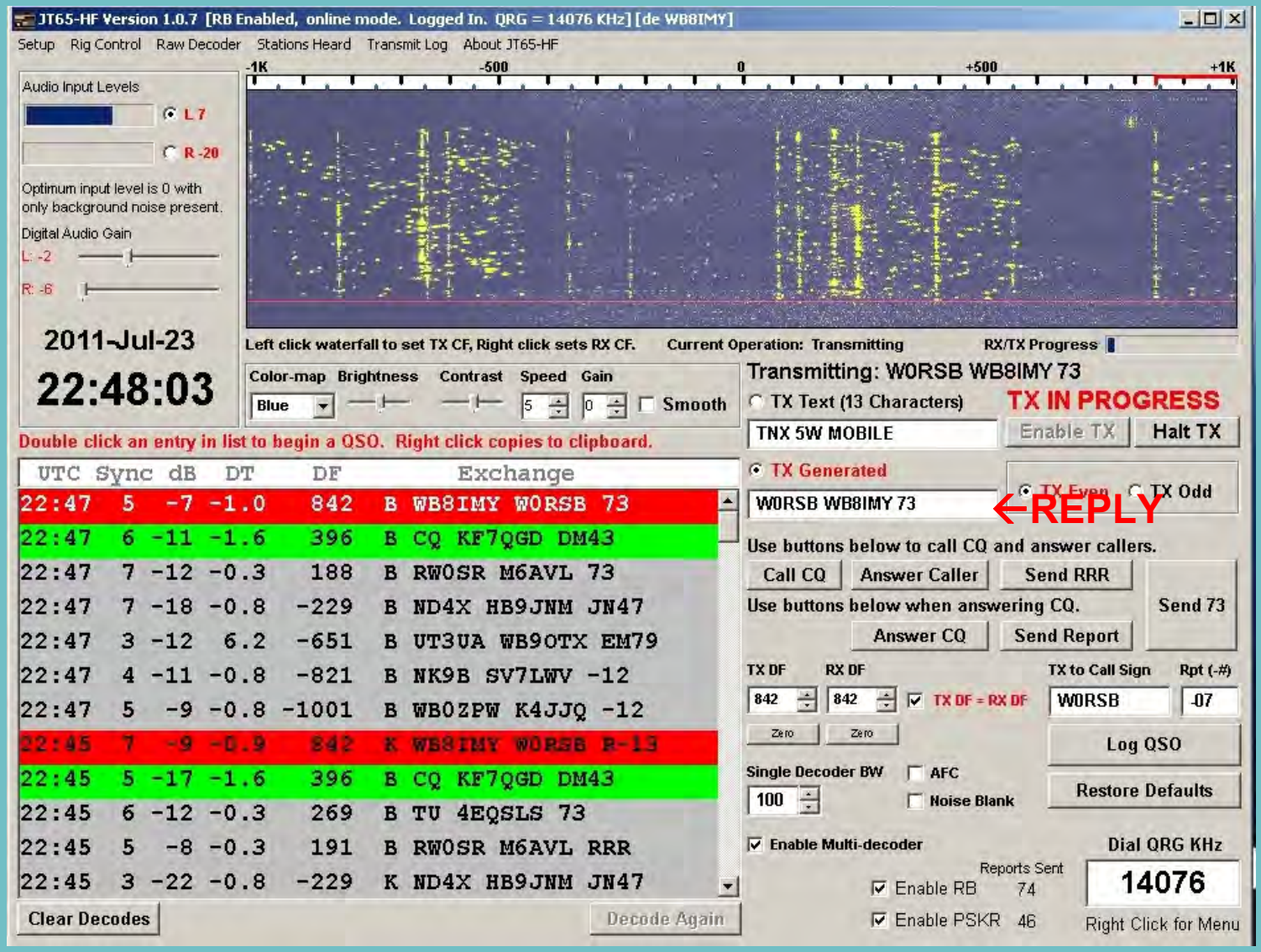


Signal report -------->

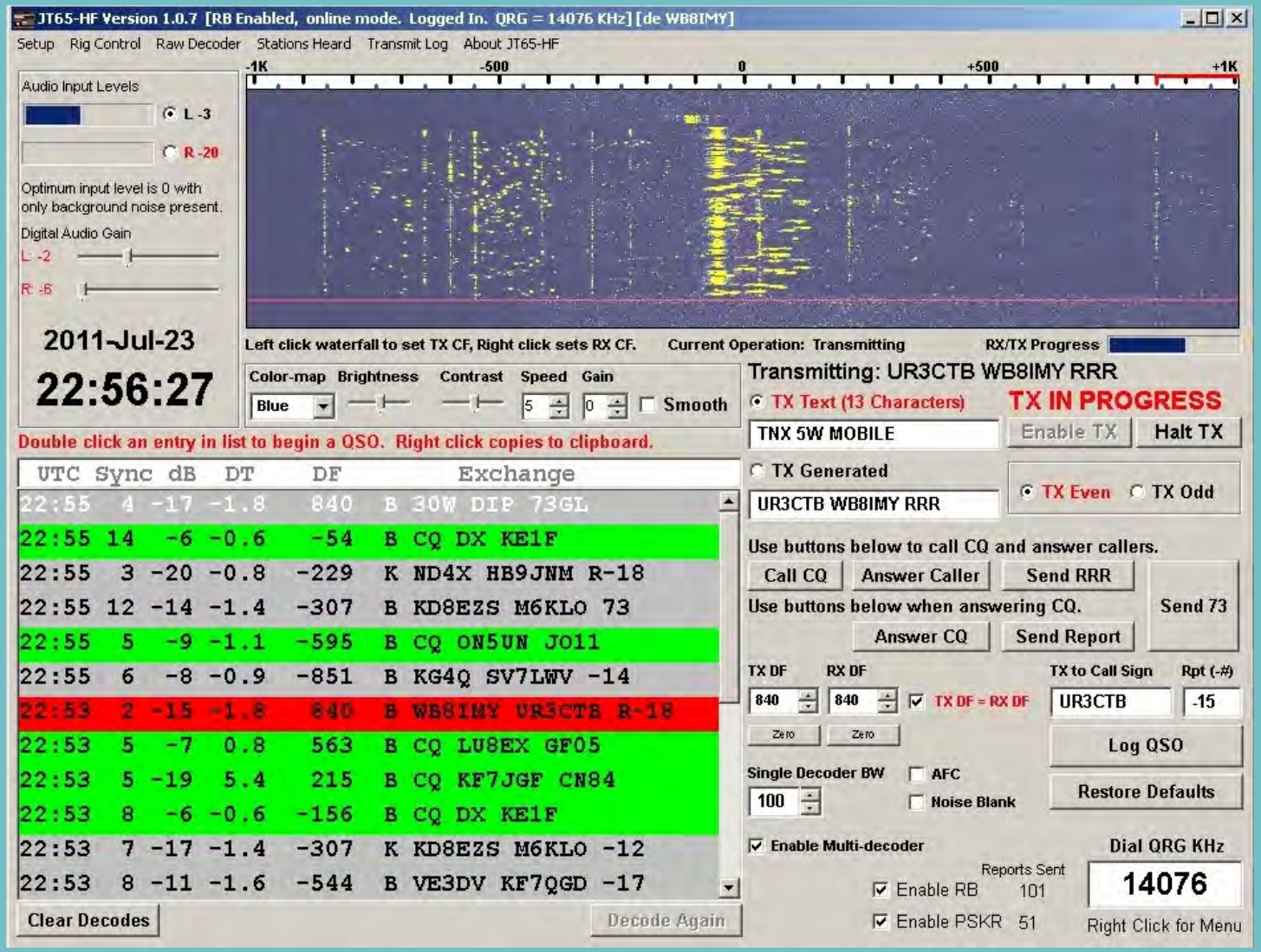
Previously Received Transmission →

←REPLY

W0RSB sends 73 and WB8IMY does the same



You Can Also Send Short Text Messages. The White Text is UR3CTB Telling that he is Running 30W to a Dipole Antenna (top gray line)



JT65 Contacts Are Valid For Most Awards

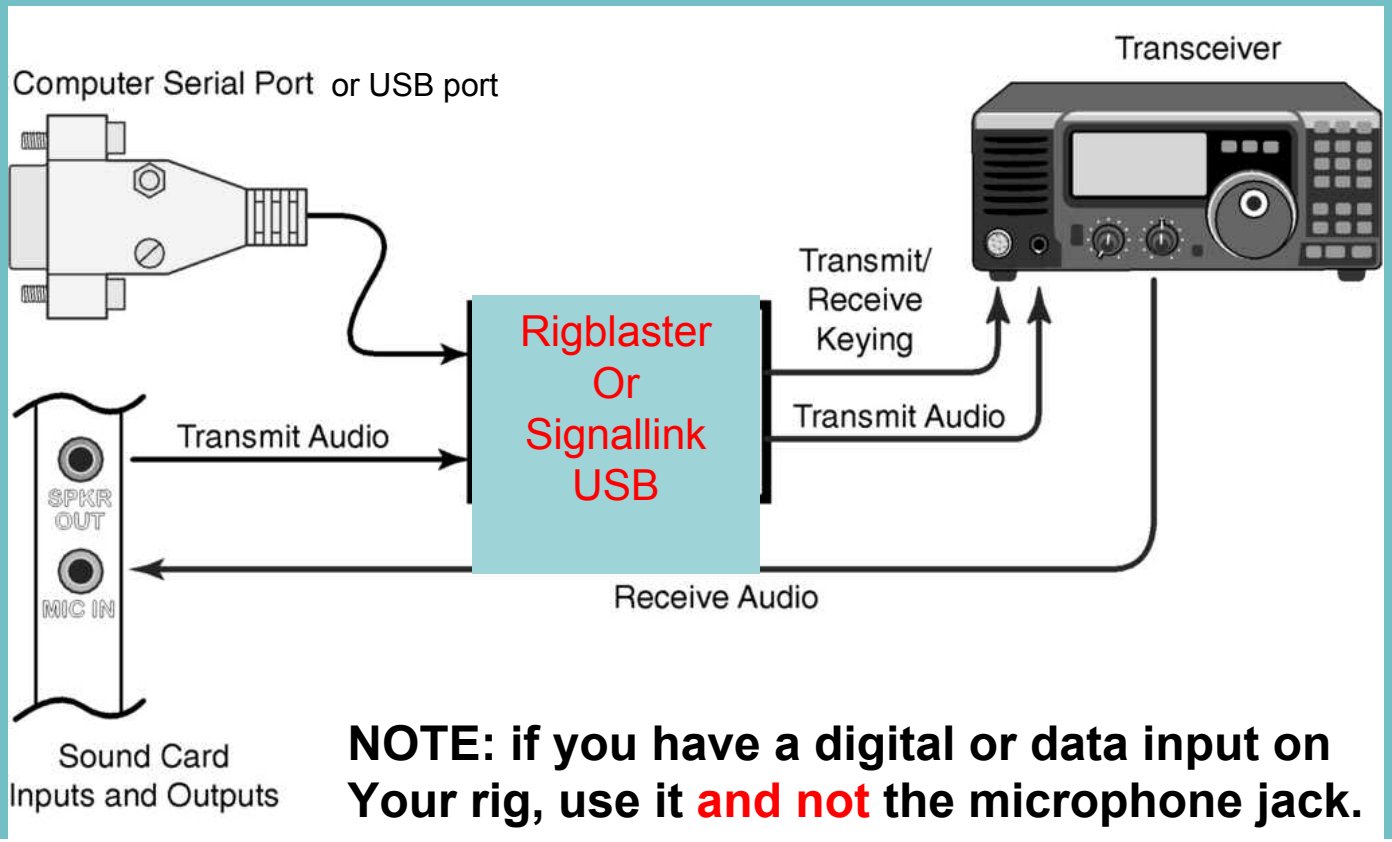
- DXCC (Digital or Mixed mode)
- Worked All States (Digital, Mixed or JT65)
- Worked All Continents (Digital or Mixed)
- CQ WPX and other awards
- Also supported by ARRL's Logbook of The World

What Do You Need to Try JT65 on HF?

- SSB Transceiver and antenna
- Computer with sound card (in and out)
- Sound Card Interface between the two

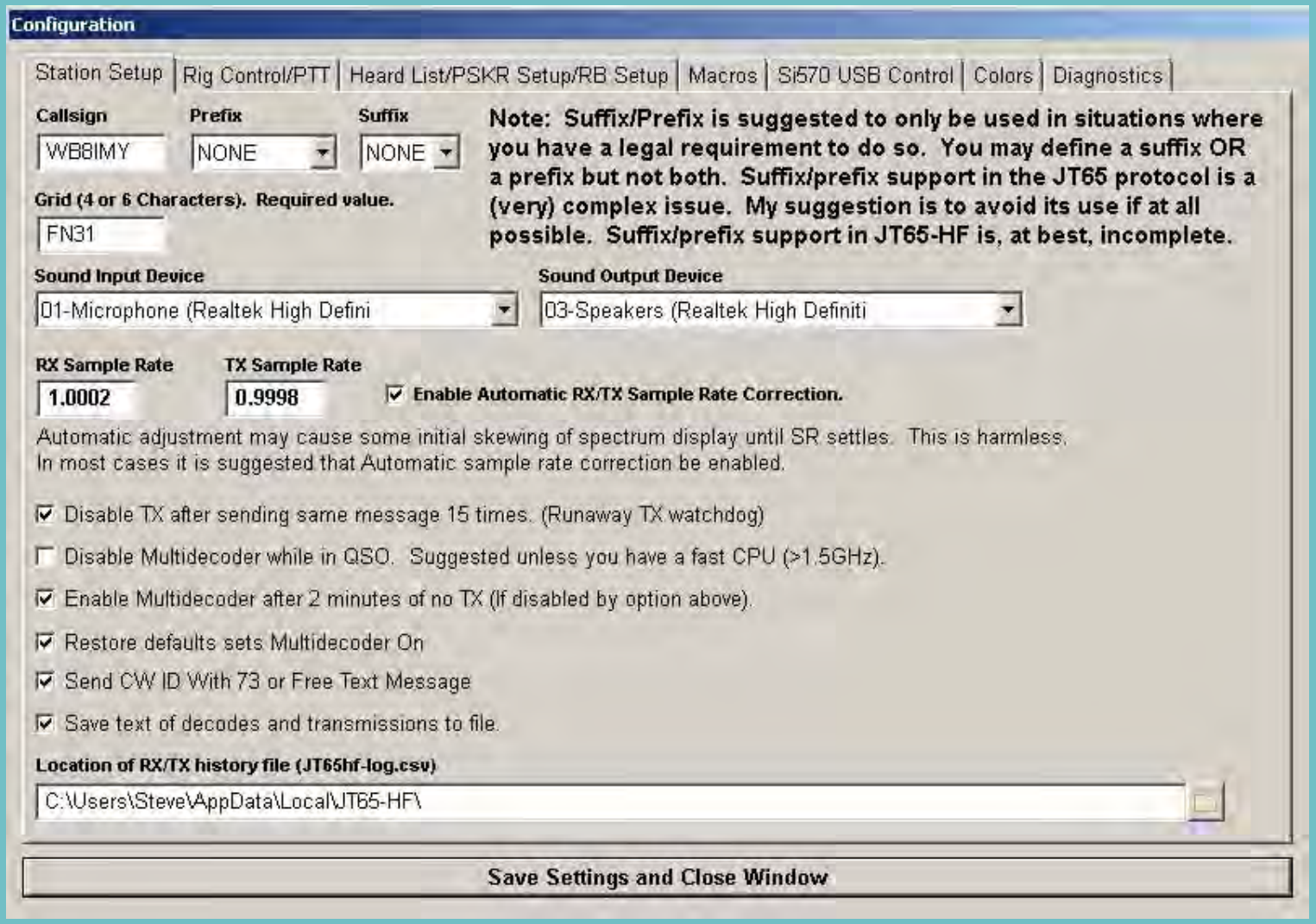
Typical Installation

- This installation will work the same as for other sound-card based digital modes like AFSK or PSK31 (MMTTY)
- Your interface can key the rig through a COM/USB port or you can use VOX to key the rig.

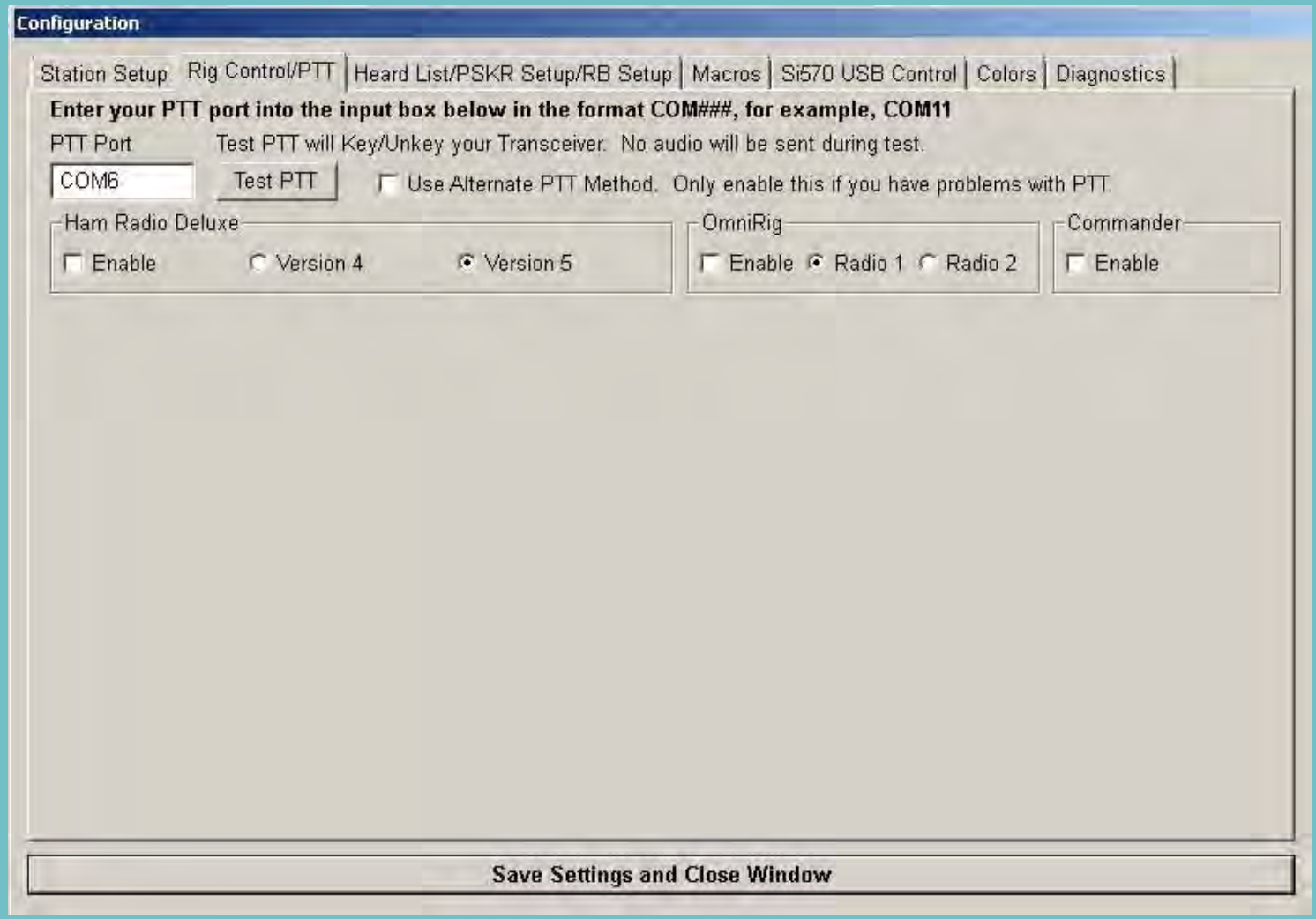


NOTE: if you have a digital or data input on Your rig, use it and not the microphone jack.

Configure the Software First



“Tell” *JT65-HF* Which COM Port is Used for T/R Switching



Accurate Time is Important

- If you have an Internet connection, update your time in *Windows* Control Panel before you start operating. Some say the *Windows* time synchronization isn't adequate for *JT65-HF*, but that hasn't been my experience.

- If you are running *Windows XP*, try *Dimension4*. This program will sync your clock automatically.

- http://www.thinkman.com/dimension4/

What's Your Grid Square?

- Use K2DSL's Web page to determine your grid square from your street address.

- http://www.levinecentral.com/ham/grid_square.php

JT65 HF Frequencies (All USB)

- 1838 kHz
- 3576 kHz
- 7076 kHz (European stations often use 7039 kHz)
- 14076 kHz
- 10139 kHz
- 18102 kHz
- 21076 kHz
- 24920 kHz
- 28076 kHz
- These are shown and can be selected on the JT65-X screen

But I am only a Tech Class Licensee -- Can I work DX with JT65-X?

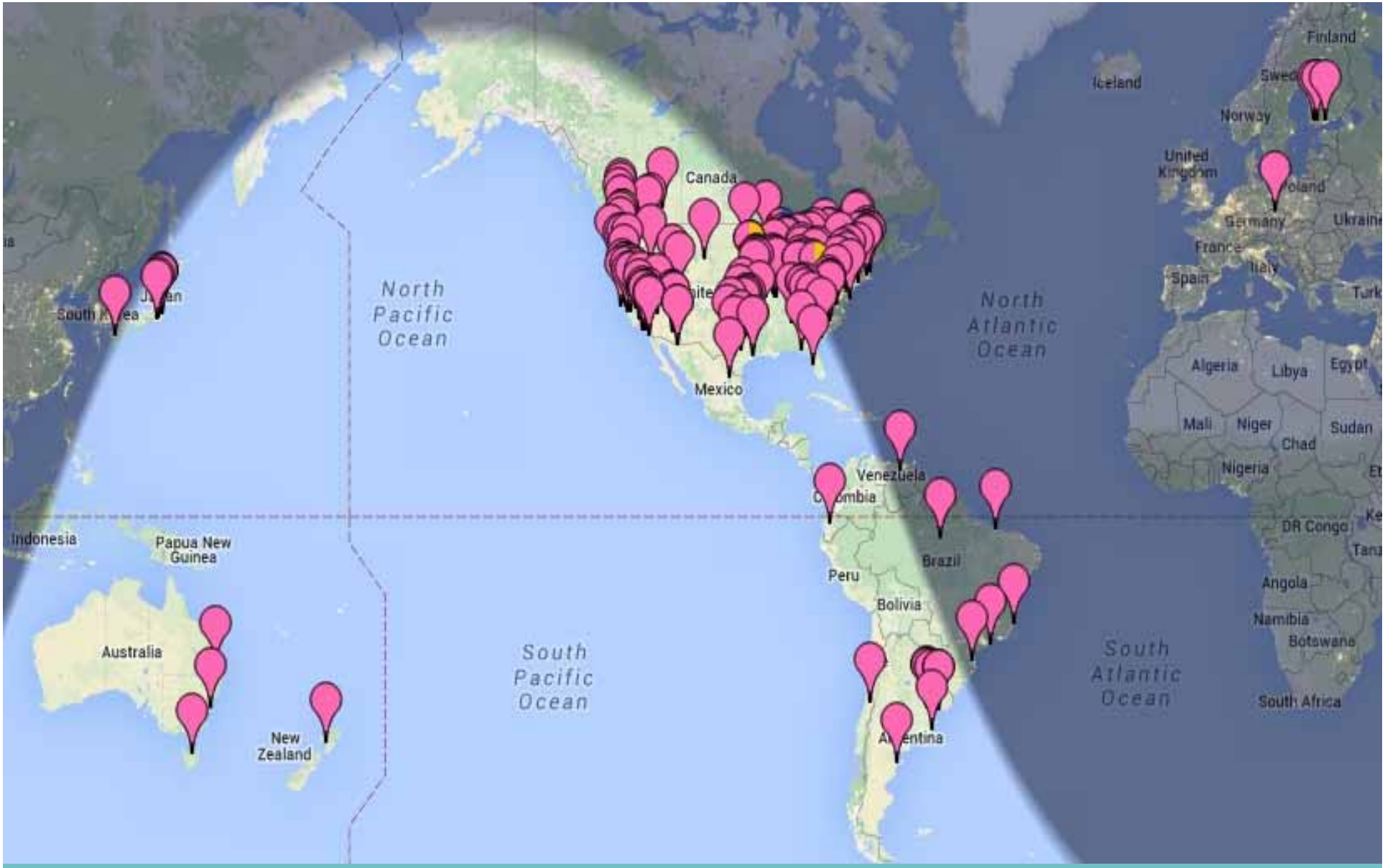
YES!

You can get DXCC on
2, 6 or 10 Meters !

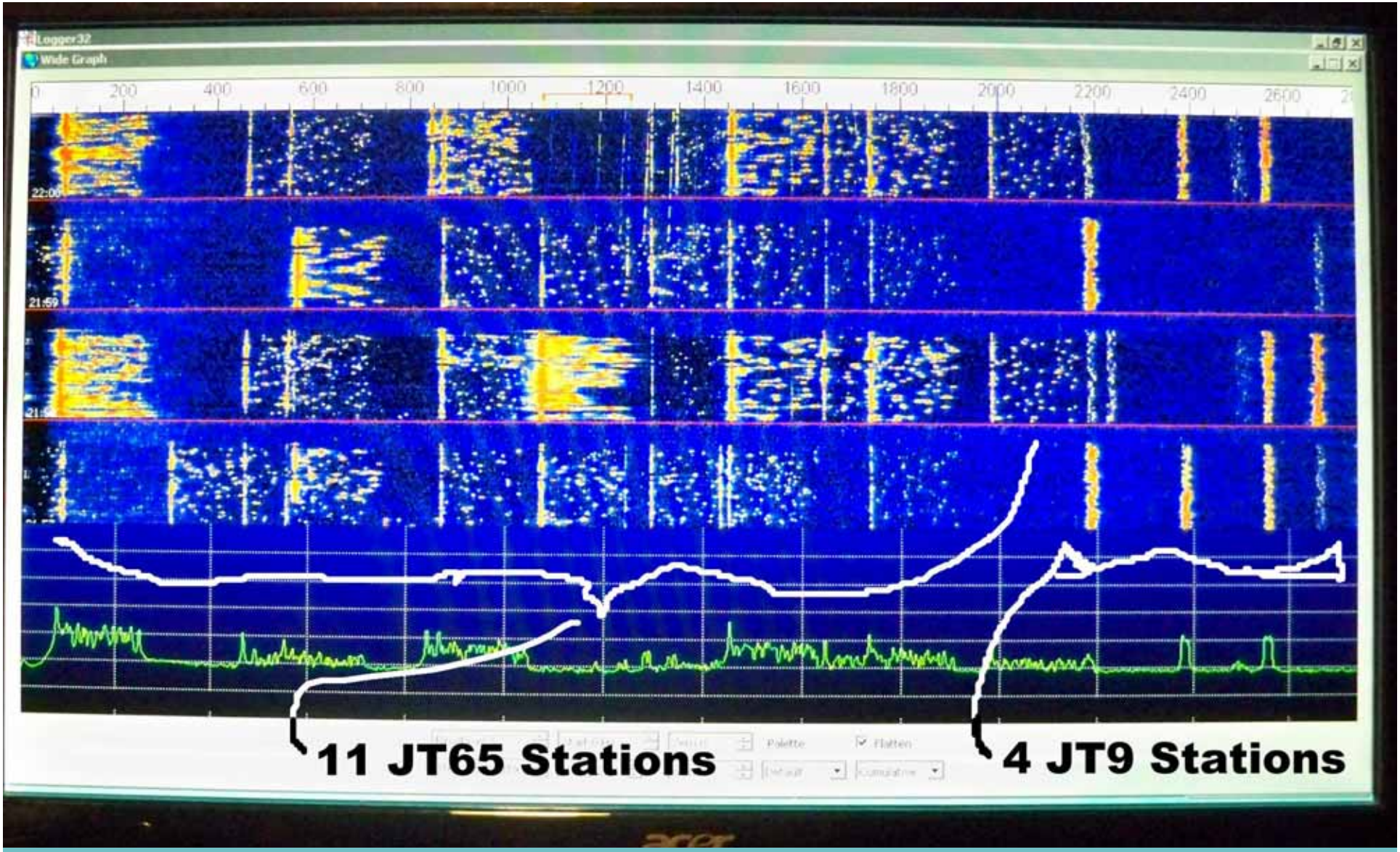
Joe Taylor's programs will allow you to get on the digital modes on all of these:

6 & 2 Meters and above…
Tropo
Meteor Scatter
Moonbounce (EME)
Aurora
Satellite

Novice and Technician classes:
28.000-28.300 MHz: CW, RTTY/Data--
Maximum power 200 watts PEP



JT-65 Operators Spotted at 5 PM on Dec. 4, 2014 on 10 meters



A typical afternoon on 10 meter Digital modes –
JT65 and JT9
Saturday - December 20. 2014

Here are a few of the stations
I have in my log at N8PR

Notice VK6 on 80 Meters,
Japan on 40 Meters.

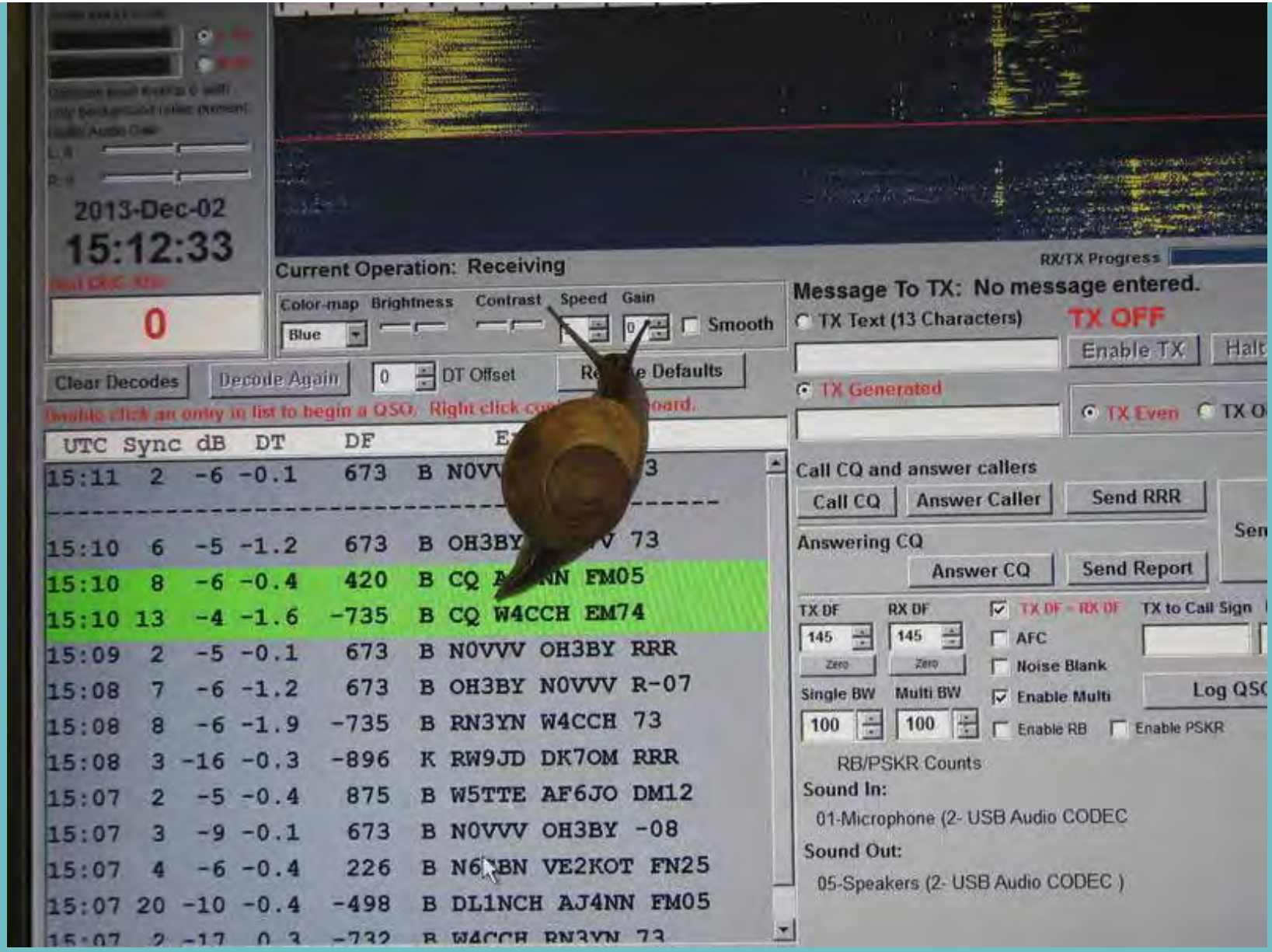
I was heard in Namibia on 160,
But I did not hear him. I was
Running 1000 watts on JT65-X !

Logbook page (C:\LOGGER32\N8PR)

DATE	TIME ON	BAND	MODE	CALL	CQZ	FREQ	NAME	QSL VIA	Route	QSL se
17 Oct 13	07:26:00	2M	JT65	YJ0HP	32	144144.00	Hermann	DL2NUD		13 Jan
21 Oct 13	12:05:00	2M	JT65	JH8CMZ	25	144128.00	Take			
22 Oct 13	13:09:00	2M	JT65	JM1GSH	25	144108.00	Kony			
26 Oct 13	06:54:00	2M	JT65	SV9ANJ	20	144114.00	Xteam		DF2ZC	30 Oct
05 Nov 13	17:37:41	15M	JT65	DL8ZBA	14	21076.00				25 Jul 1
09 Dec 13	23:54:26	160M	JT65	C6ARU	08	1838.00		Bahamas - 80 M JT65		
10 Dec 13	00:07:04	160M	JT65	W7JW	03	1838.00				
10 Dec 13	00:16:47	160M	JT65	KG4Q	05	1838.00	Larry			
02 Jan 14	01:10:52	40M	JT65	VE3FMC	04	7076.00				
09 Jan 14	23:19:00	2M	JT65	W1AW/4	05	144113.00	Ric			
02 Feb 14	19:13:00	2M	JT65	W1AW/5	04	144135.00	George			
03 Feb 14	16:38:00	2M	JT65	ER5WU	16	144132.00	Anatol			
05 Feb 14	20:37:00	2M	JT65	W1AW/4	05	144107.00	Rav			
17 Jul 14	10:38:00	2M	JT65	KH8/ZL1RS	32	144138.00	Bob			24 Aug
02 Aug 14	04:41:27	160M	JT65	W5XZ	04	1838.50				
02 Aug 14	04:55:58	30M	JT65	OE2DMA	15	10138.00				
03 Aug 14	00:04:07	20M	JT65	IZ2MZL	15	14076.00				
03 Aug 14	18:46:17	12M	JT65	N6ORB	03	24917.00				
08 Aug 14	18:10:08	20M	JT65	KB1TJC	05	14076.00				
22 Aug 14	04:01:22	160M	JT65	W0PTI	04	1838.00				25 Sep
22 Aug 14	04:06:02	160M	JT65	KJ3N	05	1838.00				
23 Aug 14	04:28:41	160M	JT65	W5UN	04	1838.00	Dave			
23 Aug 14	04:37:33	160M	JT65	WA2GSX	05	1838.00				
23 Aug 14	05:03:26	160M	JT65	AB1OC	05	1838.00				
23 Aug 14	05:10:04	160M	JT65	N8DEA	04	1838.00				
30 Nov 14	20:41:05	2M	JT65	W1AW/3	05	144119.00	Jim	N1SZ		
04 Dec 14	08:40:00	2M	JT65	W1AW/1	05	144121.00	Dave			
11 Dec 14	04:01:39	2M	JT65	W1AW/9	04	144149.00				
20 Dec 14	21:40:06	12M	JT65	W1AW/KH6	31	24917.00		Hawaii 12 M JT65		
29 Dec 14	21:36:00	2M	JT65	1A0C	15	144143.00	Frank			11 Jan
06 Jan 15	11:57:00	80M	JT65	VK6IR	29	3574.00		Western Australia 80 M JT65		
06 Jan 15	12:20:00	40M	JT65	JA1OTT	25	7076.00		Japan 40 M JT-65		
14 Oct 14	17:06:47	10M	JT9	EA3NE	14	28076.00		Spain - 10 M JT-9		
19 Dec 14	20:54:18	12M	JT9	W1AW/KH6	31	24917.54				
21 Dec 14	21:46:21	10M	JT9	W1AW/KH6	31	28078.00				

N8PR Pete ***K1JT Joe Taylor*** ***W4AS Sebastian***

We met Joe at the ARRL Centennial Convention in Hartford, CT this past summer (2014)



In case you think that this is a “Fast” operating mode, it is not !
Tim – N4UM – took this photo while operating as C6ARU in the Bahamas.

See You on JT65!

Thank you for your attention.

This presentation will be posted on the SFDXA web pages at:

http://www.qsl.net/k4fk/presentations.htm
OR- look for “Presentatons” on the SFDXA Home Page
at www.qsl.net/k4fk

Any Questions?