VE3JW
JT65-HF Operator's Guide

An introduction to JT65: A weak-signal high frequency digital mode.

By: VE3BUX

WSJT Modes

Mode	Typical Bands	Intended Propagation Mode	Minimum Transmission Duration (sec)	Notes
FSK411	2m & 70cm	Meteor Scatter	~1	Optimized for decoding “pings” of information less than 150ms in duration.
JT6M	4m & 6m	Meteor Scatter	~1	Also optimized for decoding transmission “pings” of very short duration.
JT65A	HF	Earth-Moon-Earth, Weak Signal	47	Computers must be synchronized. Transmissions occur on the minute.

WSJT modes of digital communication were originally developed by Joe Taylor (K1JT) in 2001 as a method of communicating via radio in conditions where other modes would not be intelligible.

These so called WSPR (weak signal propagation) modes use sophisticated DSP (digital signal processing) methods to decode signals which are not audible as they exist below the noise floor.

JT65: Overview

- Developed in 2003 for EME and Tropospheric propagation modes
- Intended to be a QRP mode in HF
  - QRO operation wreaks havoc around the world!
- Able to decode signals many dB below noise floor
- Intelligence sent using MFSK with 65 tones
- Each transaction takes 1 minute
  - Transmit duration is 47 seconds
- Forward error correction done via RS (Reed-Solomon)

JT65: Requirements

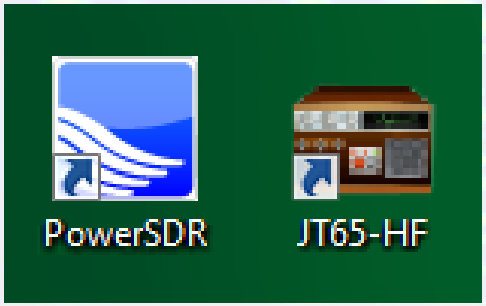
- Computer clocks must be synchronized
  - The use of an NTP (network) time server such as time.nrc.ca is highly recommended
  - Any operating system can be set to synchronize with a central time server
  - When using JT65, ensure your time is correct as a difference of 10s may prevent operation
- Transmit on either even or odd minutes
  - Traditionally, Region 2 transmits on even minutes
  - In HF bands, the convention is generally followed but if conditions require, it is common to switch to odd frames

Station Setup: FLEX-3000 Radio

- PowerSDR is the front-end control software for the FLEX-3000 SDR radio
- The controls mimic the front-panel of a traditional radio set
- There are many advantages of an SDR platform, one of which is the spectrum view of the tuned band
- Ensure the antenna switch is set to the FLEX-3000 radio
- You must manually turn the radio on using the power switch on the left of the unit. Power the radio on now.

Station Setup: Software Used

- Using the FLEX-3000 at VE3JW, two software packages are required for JT65 operation:
  - PowerSDR
  - JT65-HF



- Launch both applications now, starting with PowerSDR

PowerSDR: Basic Layout

1. On/Off
2. Drive (output power)
3. Band Selection / VFO Frequency
4. Spectrum display (set to “Panafall”)

PowerSDR: Basic Layout

One major difference with an SDR platform is the ability to **see** the activity on the band which you have selected. This is visualized in the spectrum display window.

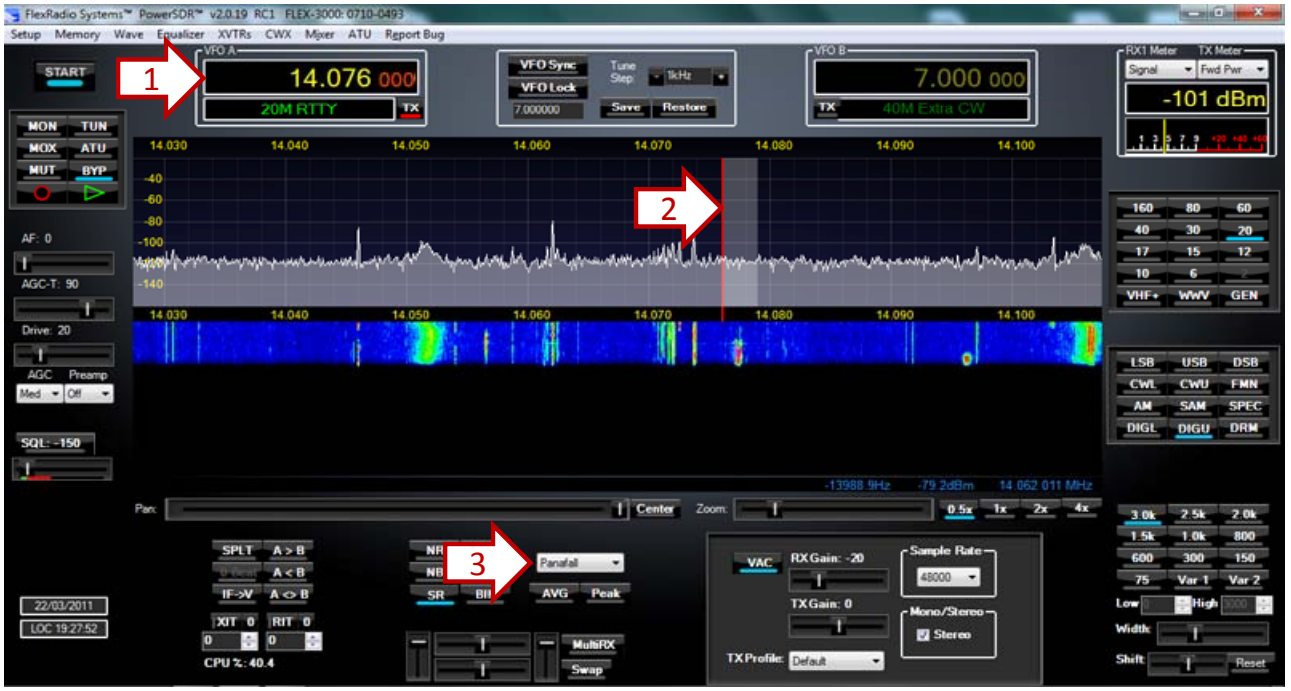
Using the FLEX-3000 via the PowerSDR software is very similar to using a traditional analog radio. Though the controls are displayed on a computer monitor, the functions are effectively the same.

To start, you must power on the unit (Start) and then select the band on which you wish to operate. Radio control is done by clicking on the associated icons in the software. If you wish to operate using SSB or CW, you may plug headphones into the FLEX-3000 and adjust the AF to a comfortable listening volume.

PowerSDR: Tuning

There are two ways to tune the FLEX-3000 transceiver. The first is by direct entry of the frequency in the box labelled VFO A.

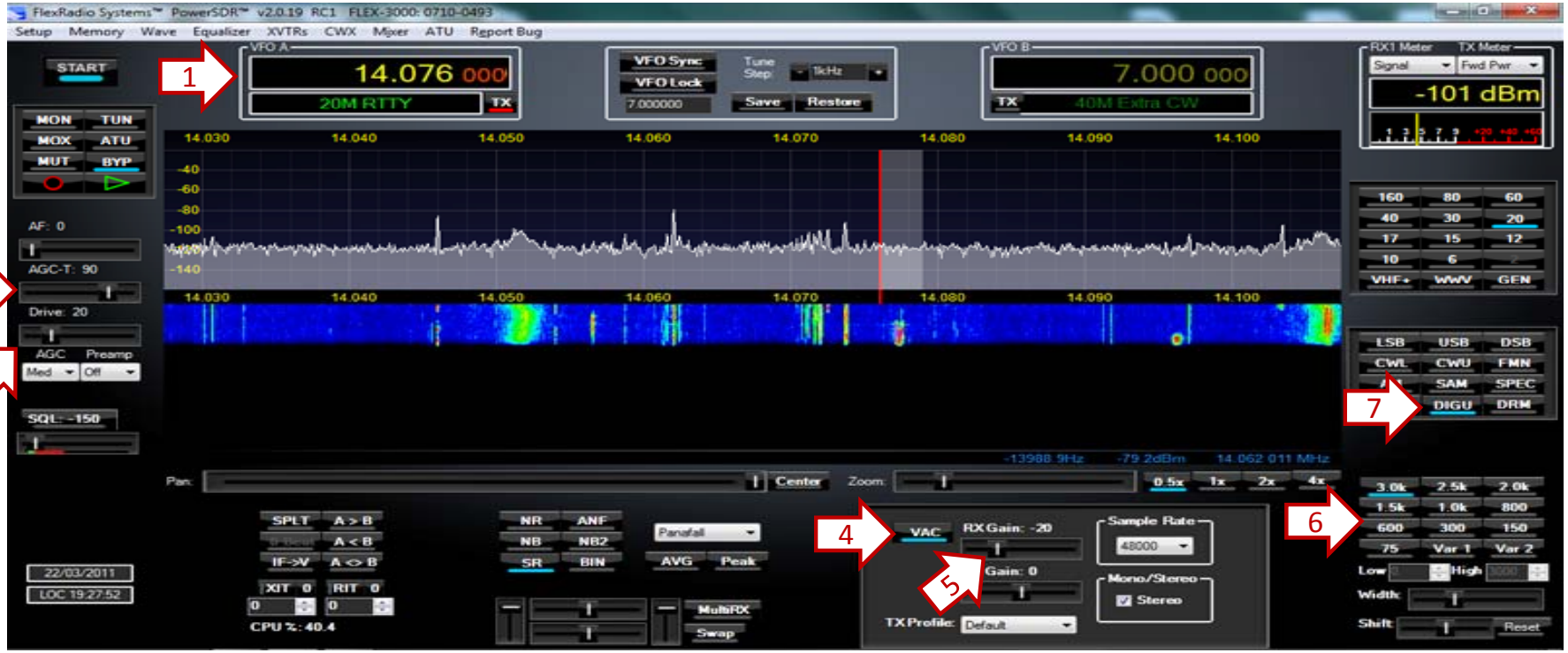
Simply click in the VFO-A box and enter the desired frequency.



The second method of tuning involves using the spectrum display. With the display type set to “Panafall” (3) you will see an image similar to the one above. If/when you see a peak of interest, you are able to click on the peak and drag it into the pass-band area defined as the gray bar indicated above.

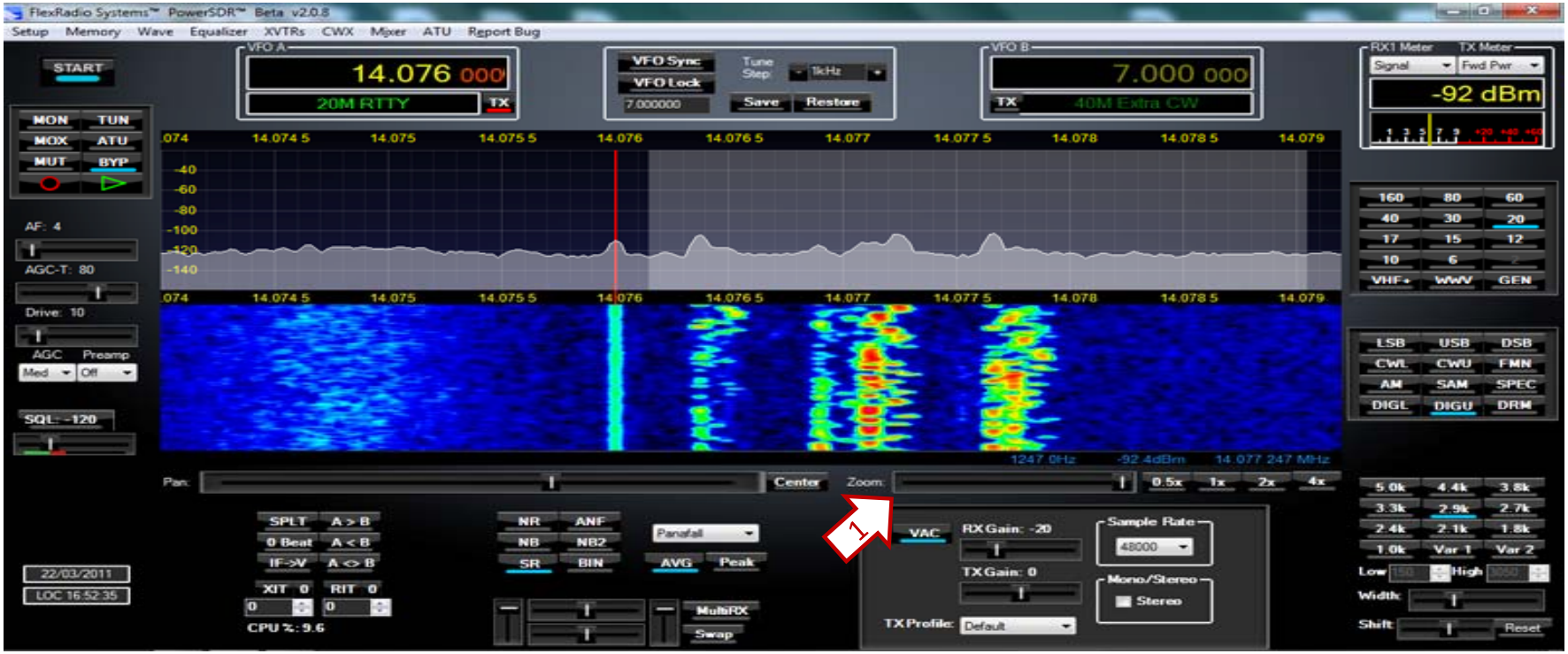
As you use the waterfall display, you will become familiar with various fingerprints which will give some indication as to the mode being received.

PowerSDR: Default Setup for JT65



#	Function	Setting	Notes
1	Frequency	XX.076	In most bands, the JT65 traffic is found at: XX.076 MHz near PSK-31 and RTTY traffic
2	AGC-T	80	AGC-T is similar to the traditional RF gain – this setting will effect the RX Gain
3	Drive	>30	This value is approximated to Watts. Recall that this is intended to be a QRP mode!
4	VAC	Enabled	Must be enabled to pass audio to external applications (i.e. JT65) – Virtual Audio Cable
5	RX Gain	-20	Use this setting to achieve an approximately “0” audio level in the JT65-HF software
6	Filter	2.7kHz	The software decodes ± 1.2kHz from the “center frequency”
7	Mode	DIGU	Must be set to digital upper sideband for digital modes to function properly

PowerSDR: Spectrum Example

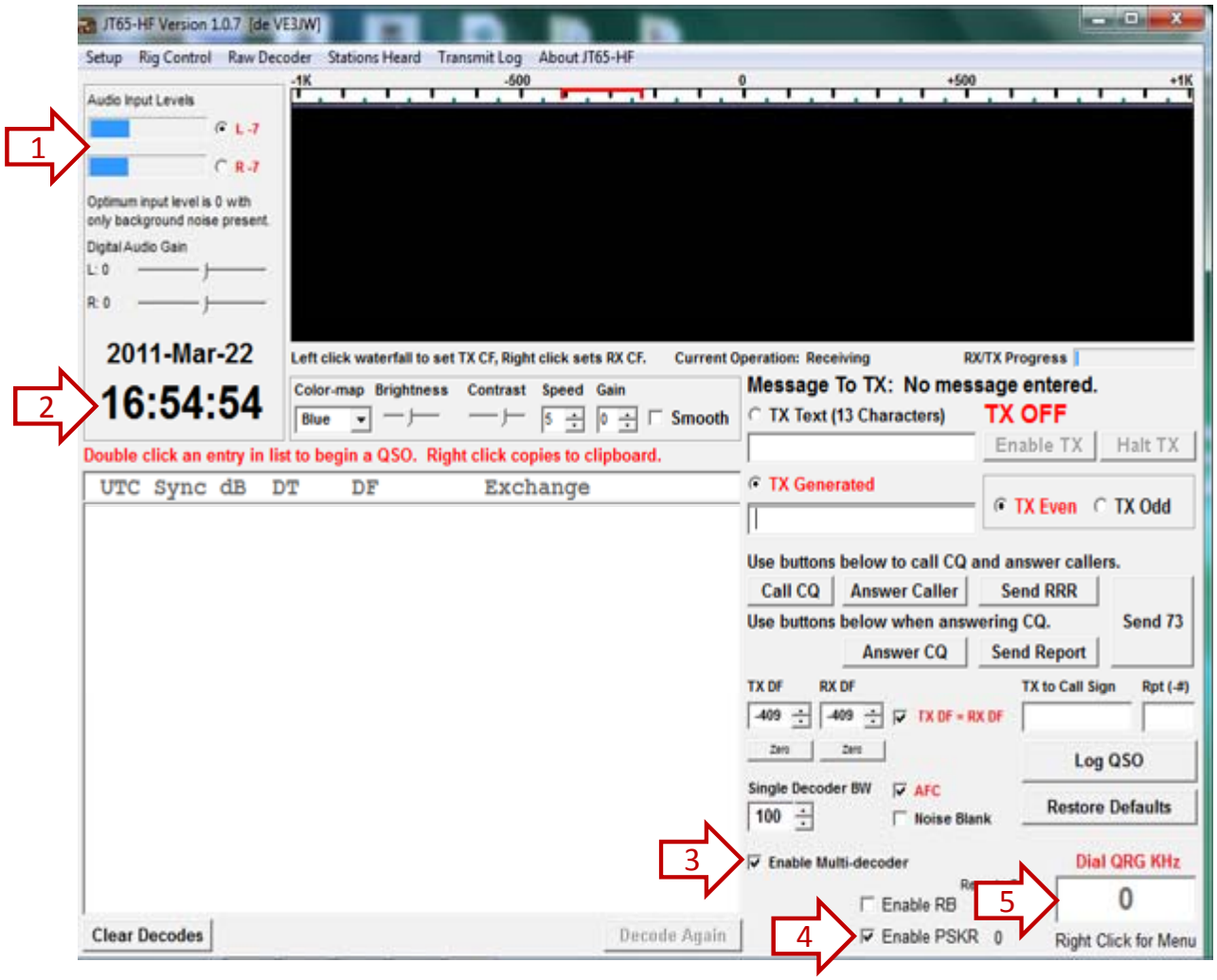


You are able to zoom into the pass-band to which your radio is tuned by simply selecting the appropriate zoom level (1) using the slider-bar. This example shows the spectrum and waterfall (Panafall setting) fully zoomed in (to the right).

At this zoom level, we are able to see JT65 traffic.

JT65: Initial Setup

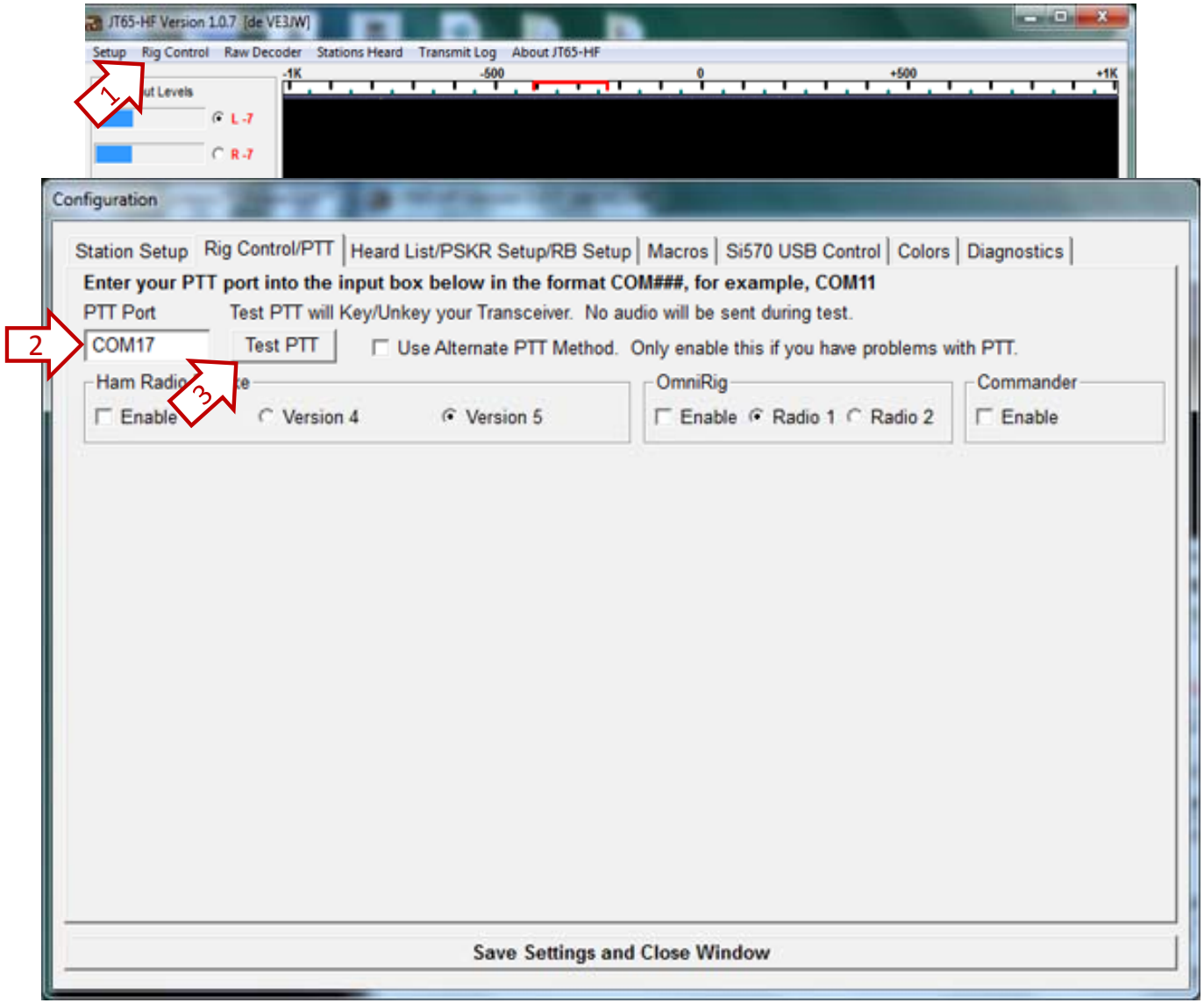
When the JT65 software first loads up, you will see the standard display. You are almost ready to operate! As with all modes, the best way to learn is to listen first.



To set up the software properly:

1. Verify the audio input levels (this is tied to RX Gain in PowerSDR)
2. Check that the time displayed is properly synchronized
3. Confirm that “Multi Decoder” is enabled
4. Ensure that the PSKR reporter is enabled.
5. Right-click in the “QRG” box and select the frequency you are tuned to in PowerSDR

JT65: PTT Function



To transmit, JT65-HF must be able to engage the PowerSDR via a PTT (push to talk) serial connection.

To check that the PTT function will work:

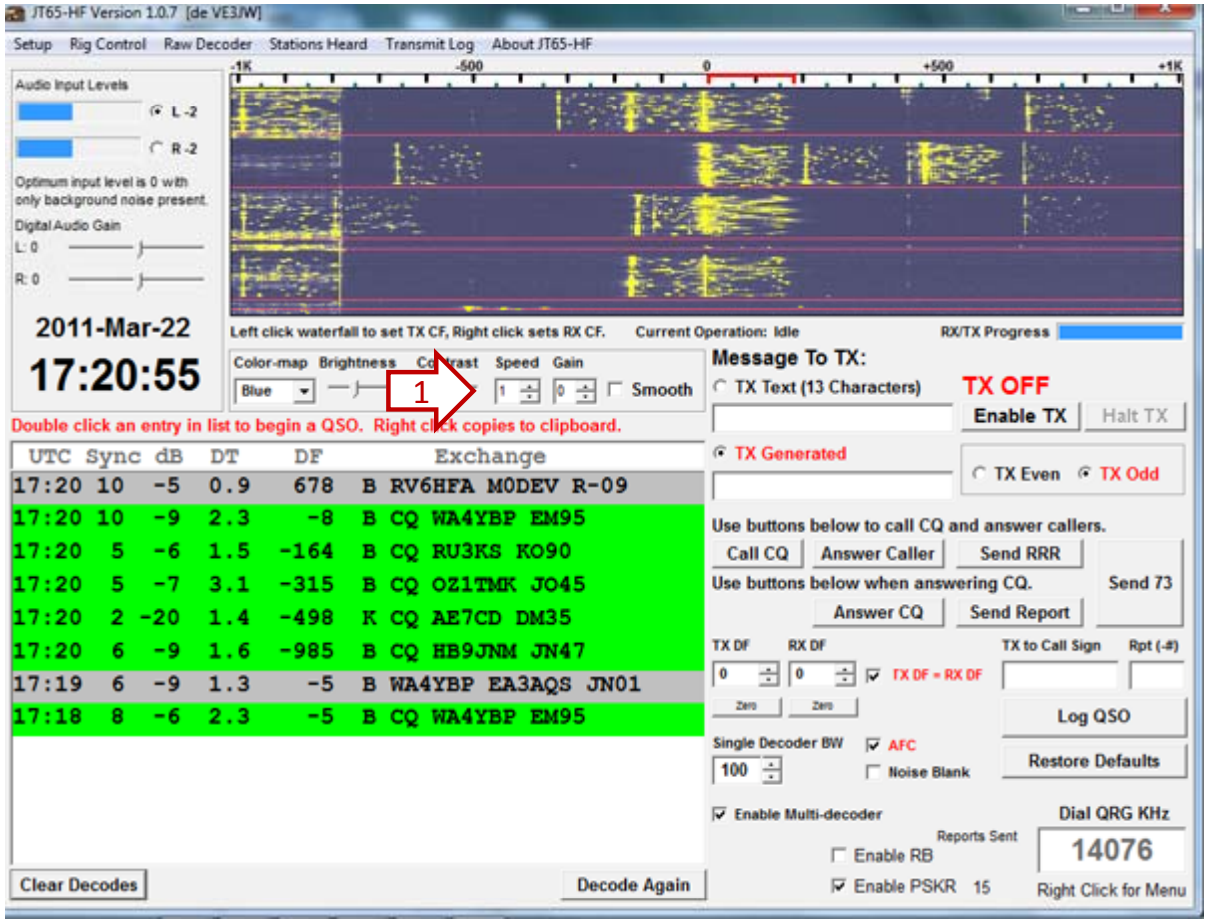
1. Click on “Rig Control”
2. Ensure the PTT Port reads: “COM17”
3. Confirm PTT functionality by clicking on “Test PTT”

JT65: Receiving

The image displayed shows all signals decoded from the last few minutes.

The display speed (1) was set to “1” in an effort to better show the multiple exchanges in the spectrum display (top right).

The red horizontal bars in the spectrum view indicate the beginning of the next frame (minute). Notice the regions which seem squashed? Those show when a transmission was being made.



The data in the bottom left shows seven people calling CQ (green) and two QSOs in progress (gray). This region provides much information and warrants further discussion.

JT65: The QSO Window

UTC	Sync	dB	DT	DF		Exchange
17:22	6	-5	1.3	-161	B	VE3JW RU3KS -12
17:20	10	-5	0.9	678	B	RV6HFA M0DEV R-09
17:20	10	-9	2.3	-8	B	CQ WA4YBP EM95
17:20	5	-6	1.5	-164	B	CQ RU3KS KO90
17:20	5	-7	3.1	-315	B	CQ OZ1TMK JO45
17:20	2	-20	1.4	-498	K	CQ AE7CD DM35
17:20	6	-9	1.6	-985	B	CQ HB9JNM JN47
17:19	6	-9	1.3	-5	B	WA4YBP EA3AQS JN01
17:18	8	-6	2.3	-5	B	CQ WA4YBP EM95

Colour Codes:

Gray = QSO in progress

Green = Someone Calling CQ

Red = Someone replying to YOU

Header	What It Means
UTC	The time of the exchange (most recent at the top)
Sync	The number of synchronizing tones received as part of the transport layer protocol design. The more sync tones, the better. This is usually related to the received strength.
dB	Received strength (after decoding). The closer to 0, the stronger. Theoretically, the software is able to decode down to -26dB. Those are the fun signals!
DT	Time differential. Ideally, this value would be 0.3 to 0.1 – the fact everyone was showing +1 sec (average) suggests we are ahead by 1 second. Better re-sync that computer clock.
DF	Decoding frequency. This corresponds to where in the pass-band the signal was heard.
Exchange	The actual data payload – i.e.. The pre-defined “conversation”.

JT65: A Standardized QSO

The nature of the optimized JT65 decoding algorithms requires each exchange to be very short in length. You are limited to a message of no more than 13 characters. The software uses some special tricks to squeeze more out of the protocol by using prosigns.

A standard QSO only consists of the following exchange:

CQ <my call> <my grid>	- ME	(on even minutes)
<my call> <your call> <your grid>	- YOU	(on odd minutes)
<your call> <my call> <your RSQ in dB>	- ME	...etc
<my call> <your call> R <my RSQ in dB>	- YOU	...etc
<your call> <my call> RRR	- ME	
<my call> <your call> 73	- YOU	

People will sometimes exchange one last bit of information and the last transmission often looks like:

3EL 5W TU73 Which tells us they used a 3 element beam at 5W

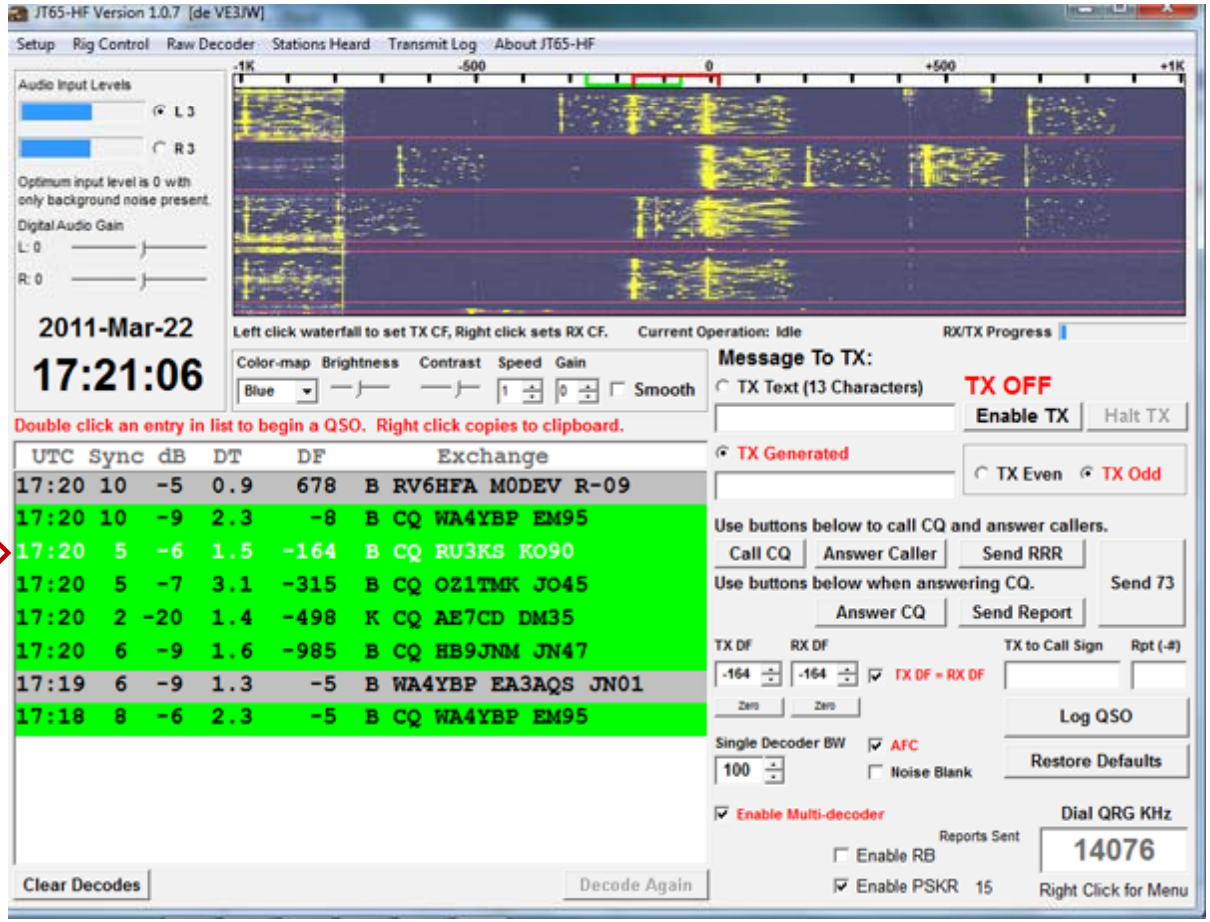
Notice that the entire (proper) QSO takes at least 6 minutes from start to finish!

JT65: Answering CQ

To answer someone's CQ call, the preferred method is to simply double click on the contact of interest in the QSO window.

Here I have only clicked once on the contact of interest to illustrate that the software highlights it by changing the text to white.

When you double click a CQ, the software will automatically generate the appropriate response text.



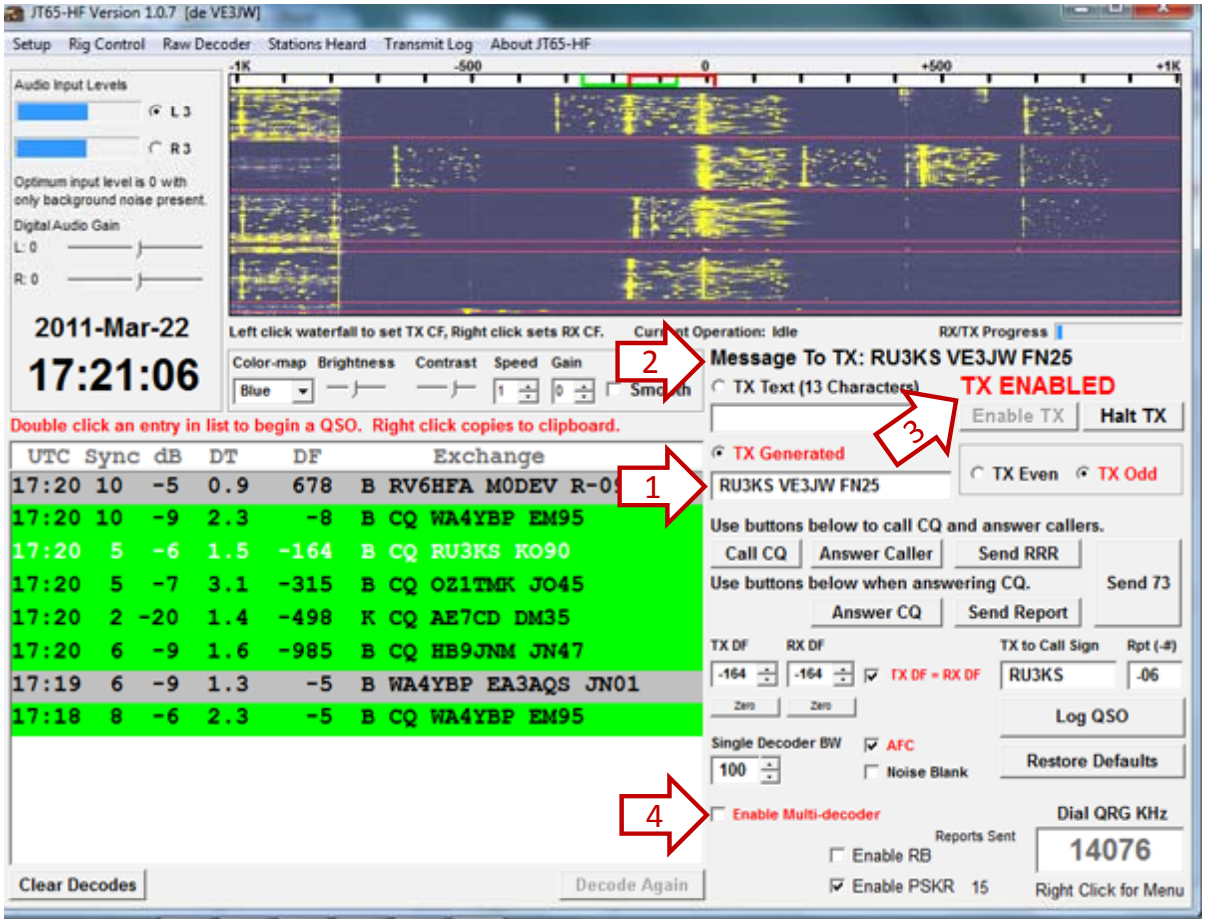
When answering a CQ, the convention is: <their callsign> <your callsign> <your grid>

JT65: Answering CQ continued

When you double click on a CQ call, the software does four things automatically:

1. Generates the appropriate response to the CQ
2. Displays the out-bound message to be transmitted
3. Enables the transmit mode
4. Disables multi-decoder

The software knows we are responding to a CQ call made during an “even frame” so it sets itself to transmit on an “odd frame” as appropriate.



The software disables multi-decoder to avoid spending too much time decoding signals not relating to your QSO. You should re-enable this when you are ready to listen again. After 2 frames of no decodes, the software re-enables multi-decoder by default.

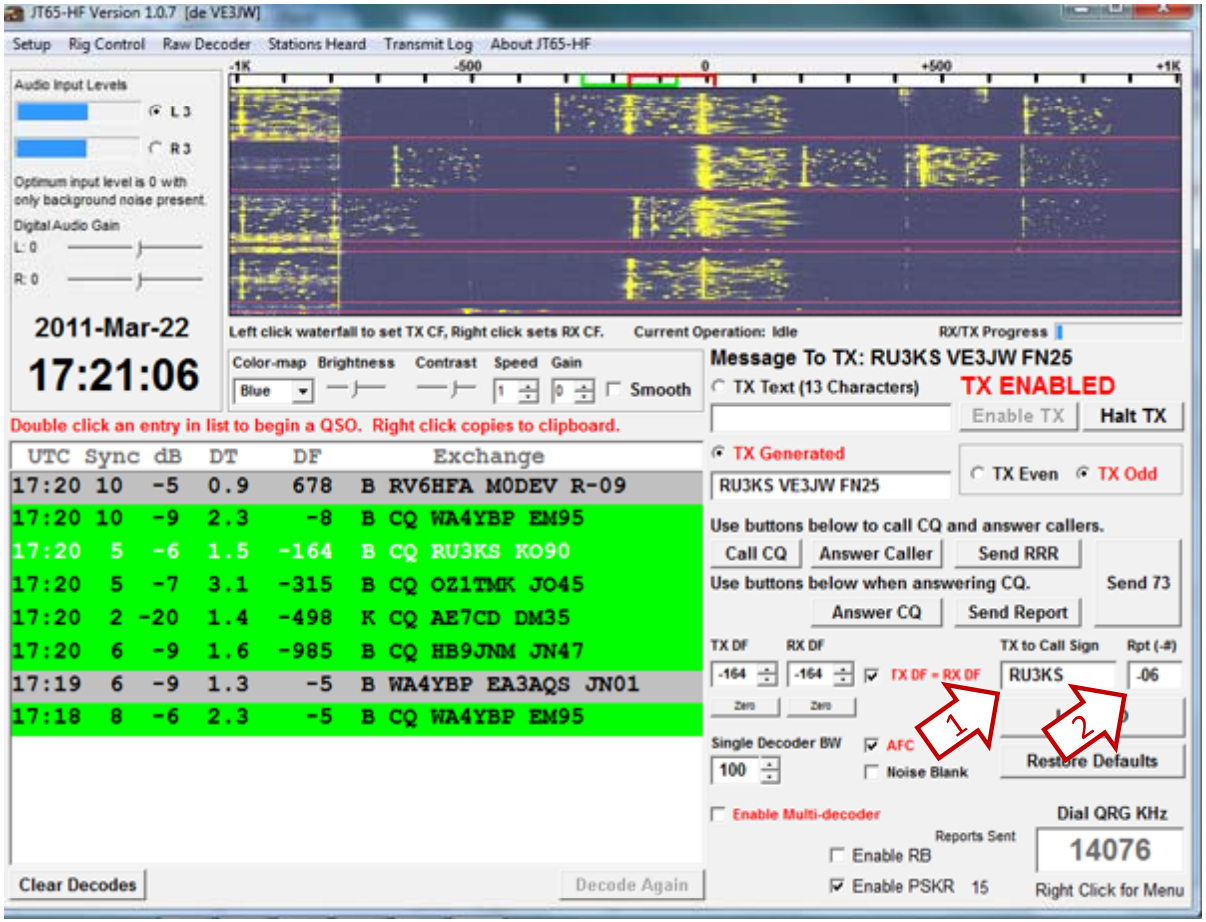
JT65: Answering CQ continued

The other method of replying is to manually enter the information as follows:

1. call sign in the:
   "TX to Call Sign" box
2. the report in the
   "Rpt (-#)" box

When ready, simply click on the "Answer CQ" button.

It is advised that you stick to the double-click method as it is faster, and less prone to input error.



You have a very narrow window (less than 10 seconds) between the decoding phase and the start of the next transmission "frame". Thus, to answer a CQ you need to be quick and decisive.

JT65: QSO Established

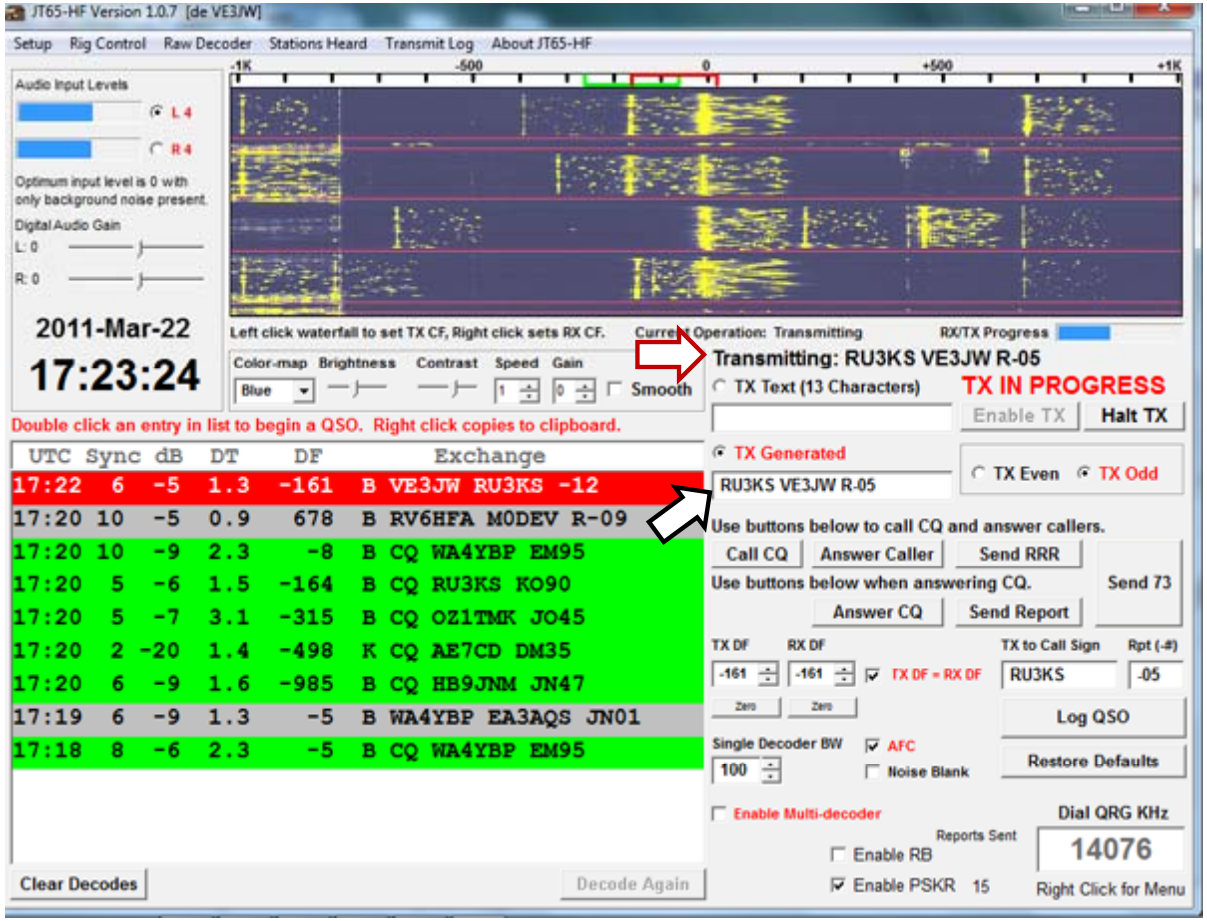
The station who we replied to has now sent our signal report (-12dB) and so we reply with their signal report (-5dB in this case) but we add R as a prefix.

RU3KS VE3JW R-05

This indicates to the recipient that we have received their signal report.

To have the software generate this automatically, simply double click on the QSO line. As usual, this should be done as quickly as possible to avoid missing the reply frame.

JT65: Sending a signal report

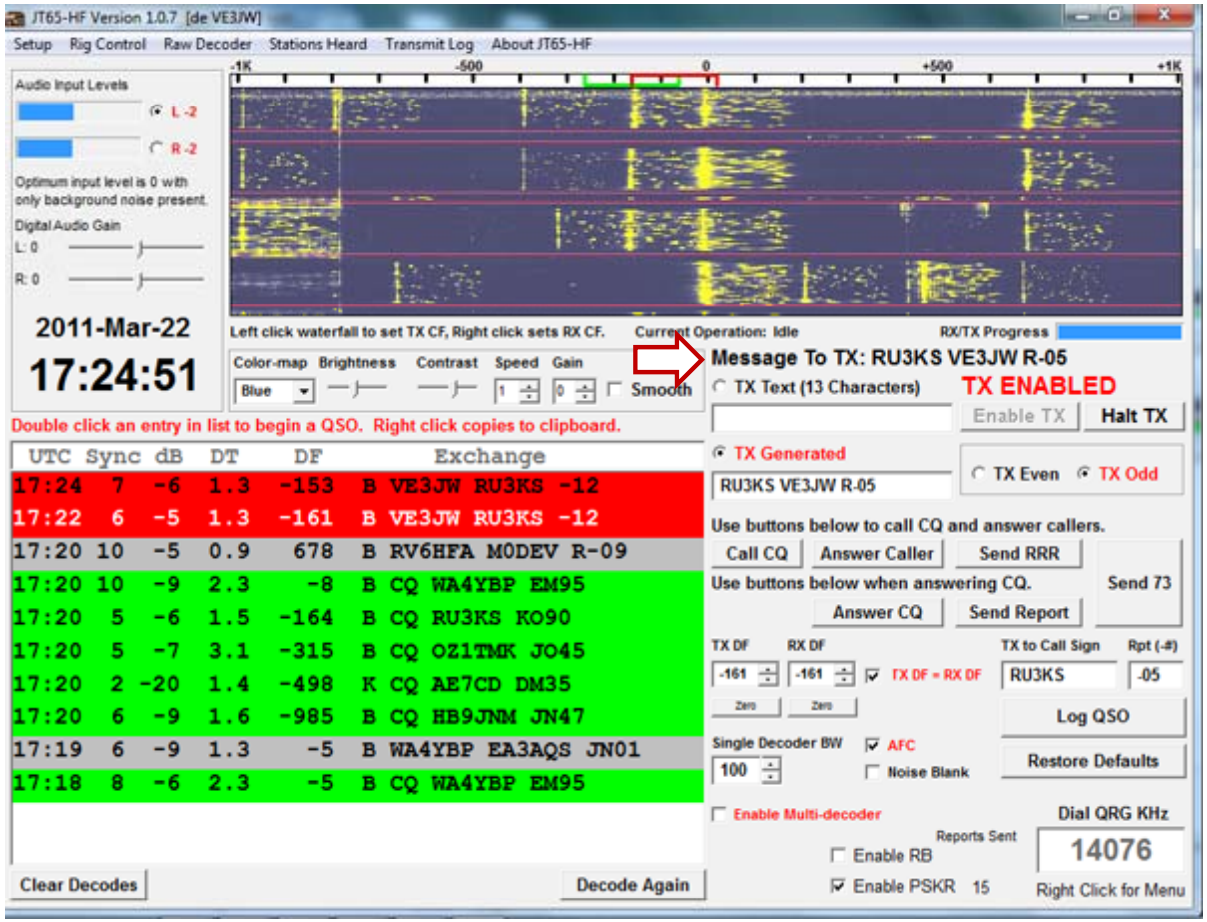


By double-clicking on the QSO line, the software will automatically generate the reply:

RU3KS VE3JW R-05

This message will of course be transmitted on the next odd-minute cycle (as is shown).

JT65: Missed frame



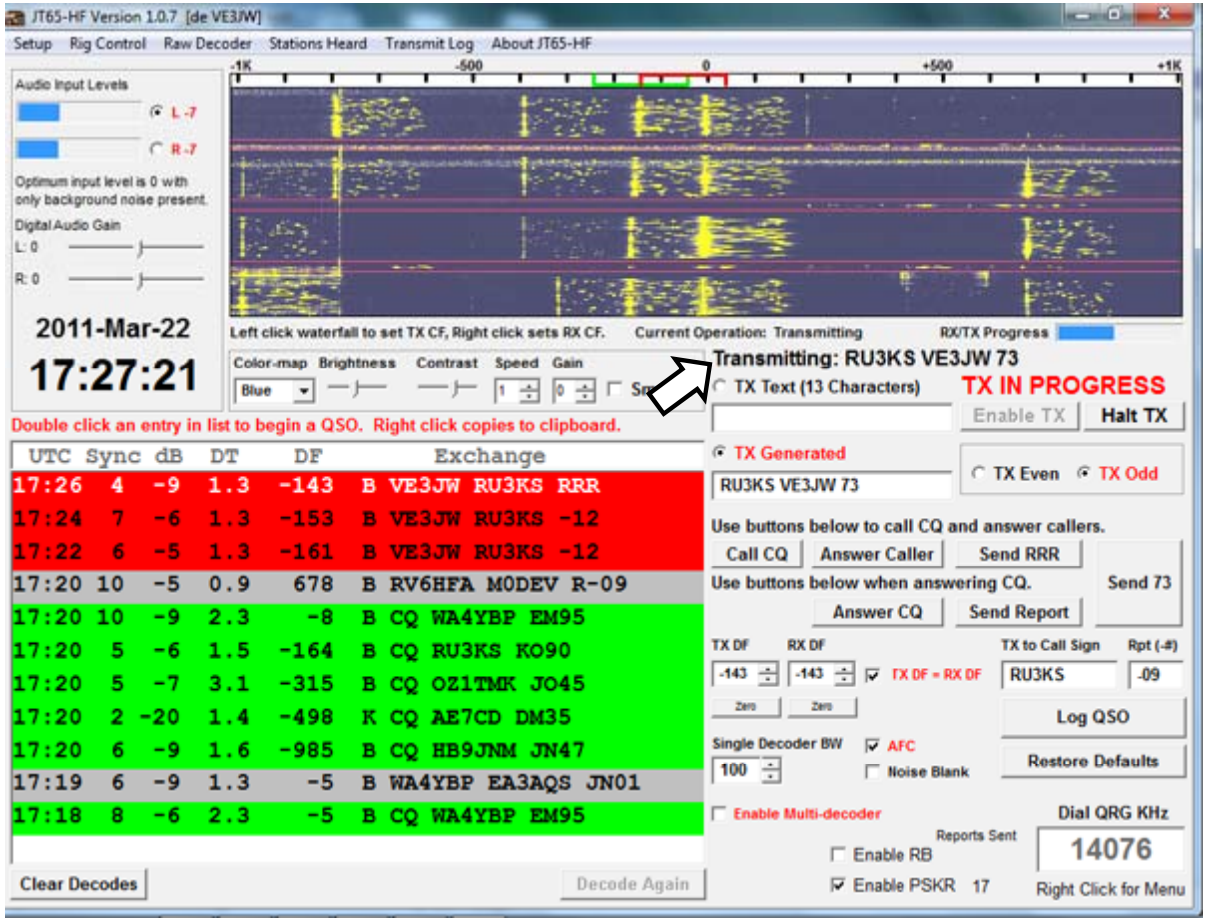
You may notice that the same exchange was transmitted by the distant station a second time.

There are many reasons for a repetitive exchange, one of which may be that they did not receive our reply.

On occasion, it is a result of the operator failing to generate the appropriate response in time and so the previous message was retransmitted.

By default, the JT65-HF software will only transmit a message 15 times before automatically disabling the TX function. This is to prevent run-away transmissions.

JT65: End of QSO



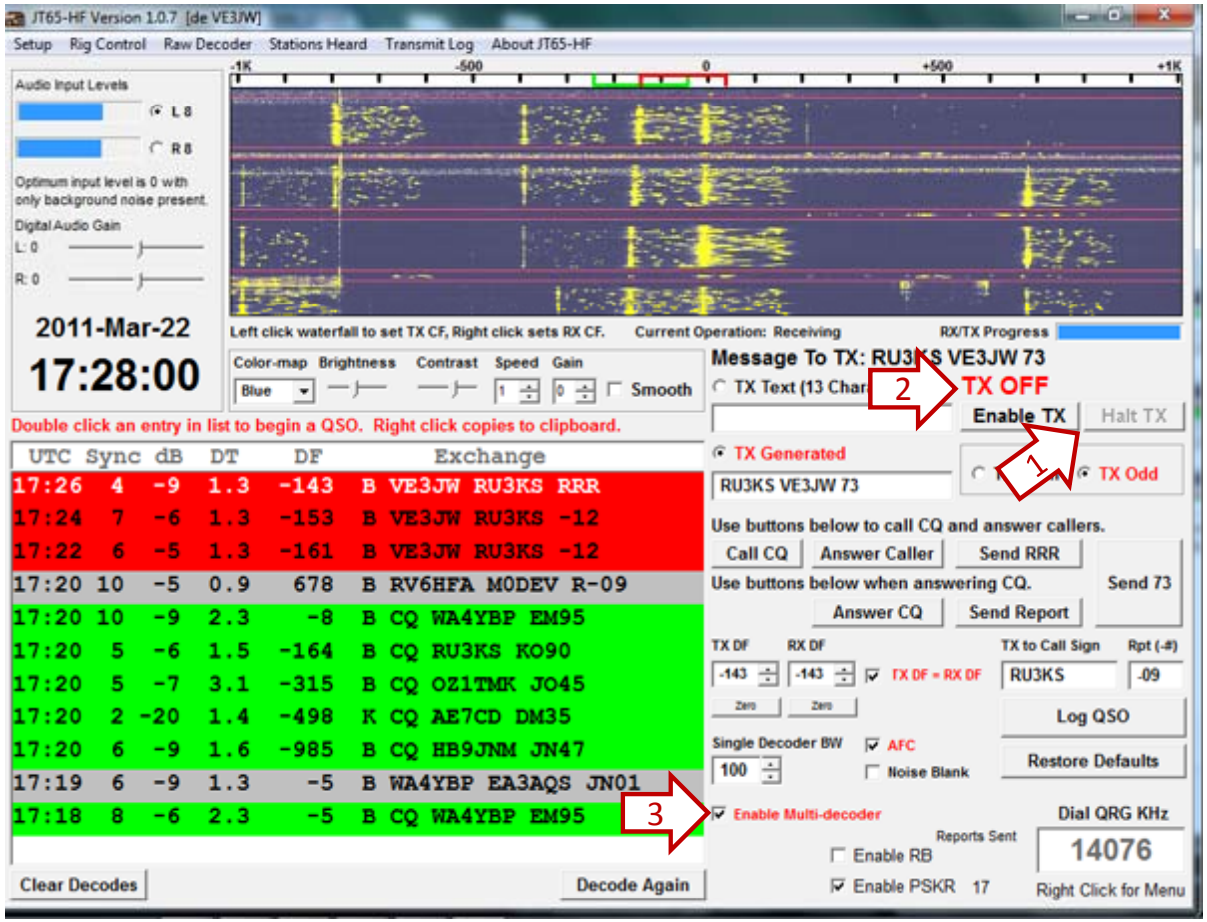
The second last step of a JT65 QSO is the exchange of RRR and 73 prosigns.

Whomever calls CQ is the one who is supposed to send RRR as their final exchange.

It is common courtesy to respond to the RRR with a 73.

As usual, double clicking on a QSO line with RRR will generate the 73 response automatically.

JT65: QRT - End of transmission



Once you are done transmitting your regards, be sure to halt any further transmissions.

1. Simply click on “Halt TX”
2. Ensure TX OFF is seen
3. Re-enable multi-decodes

If you forget to halt your transmission, the software will continue transmitting your last message 15 times before being halted automatically.

To log your QSO, a suggested convention is as follows: (note the time)

Date	Time (UTC)	Freq. (MHz)	Mode	RXQ	TXQ	Details	Operator
22 Mar	1727	14.076	JT65	-6	-12	Andrey from Russia – sent using 20W	VE3BUX

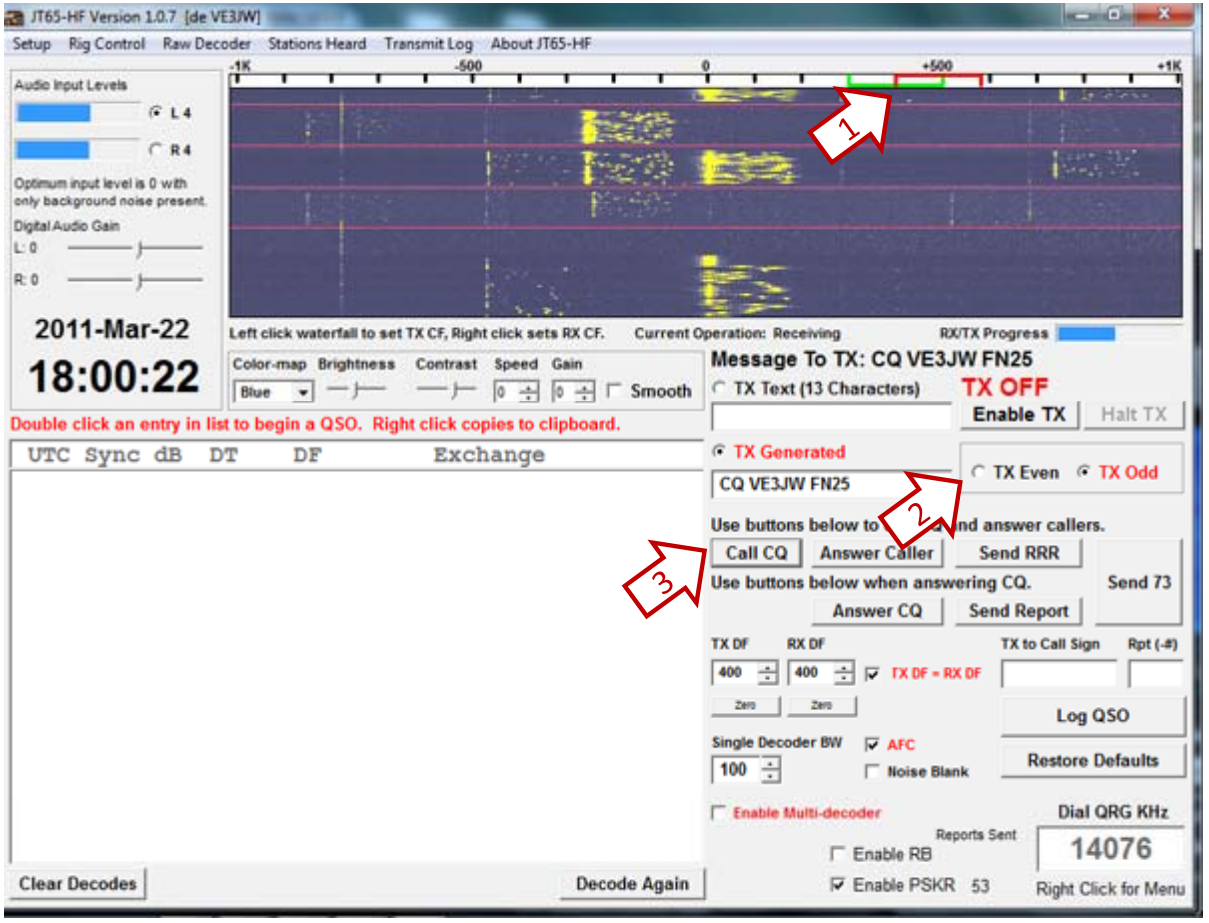
JT65: Calling CQ

Calling CQ is simple.

Unlike in answering a CQ, you must click on a button to initiate the call.

The procedure is as follows:

1. Tune to a vacant region of the spectrum by left-clicking in the black space.
2. Decide whether to call CQ on an even or an odd frame and select the appropriate choice.
3. Click on Call CQ

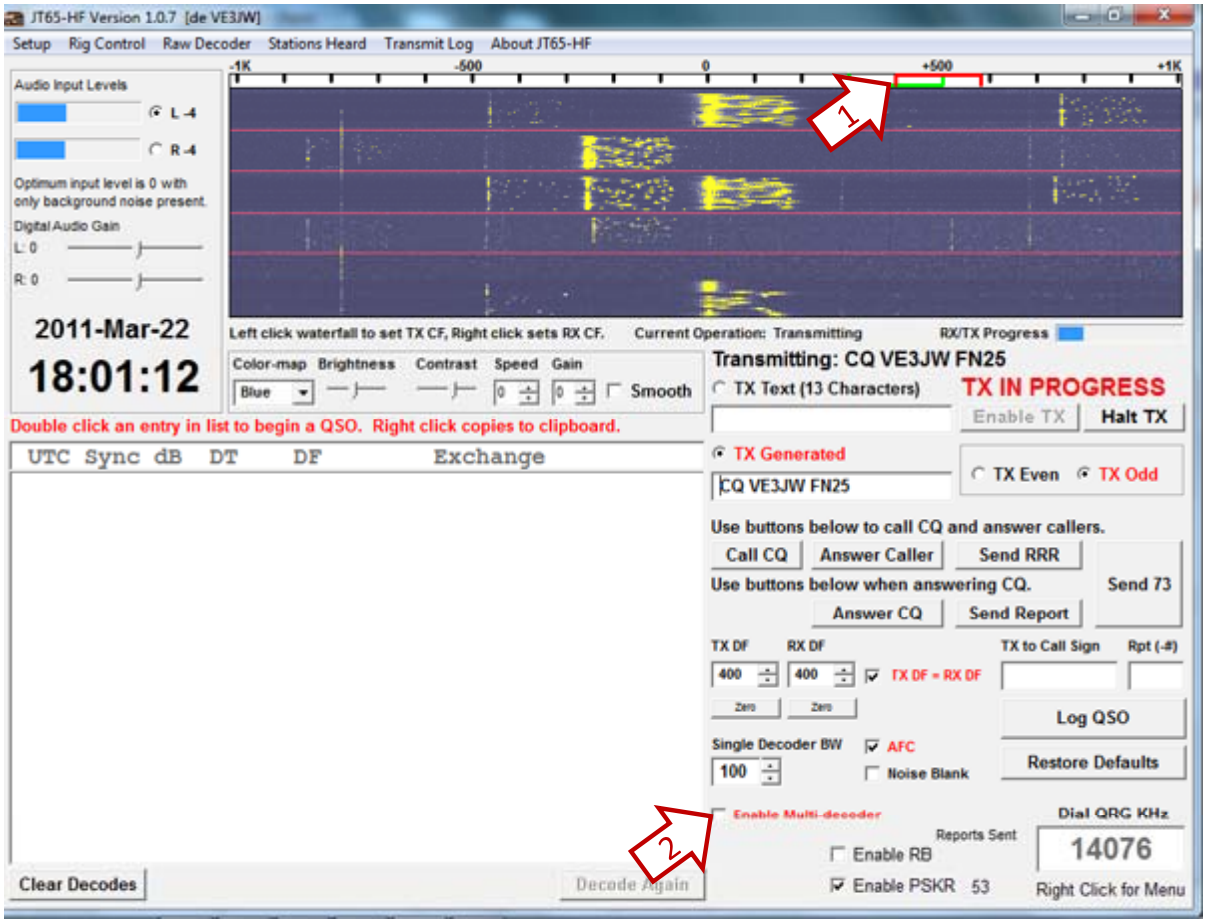


JT65: Calling CQ

When you “tune” in before transmitting, you will notice a red bar appear (1).

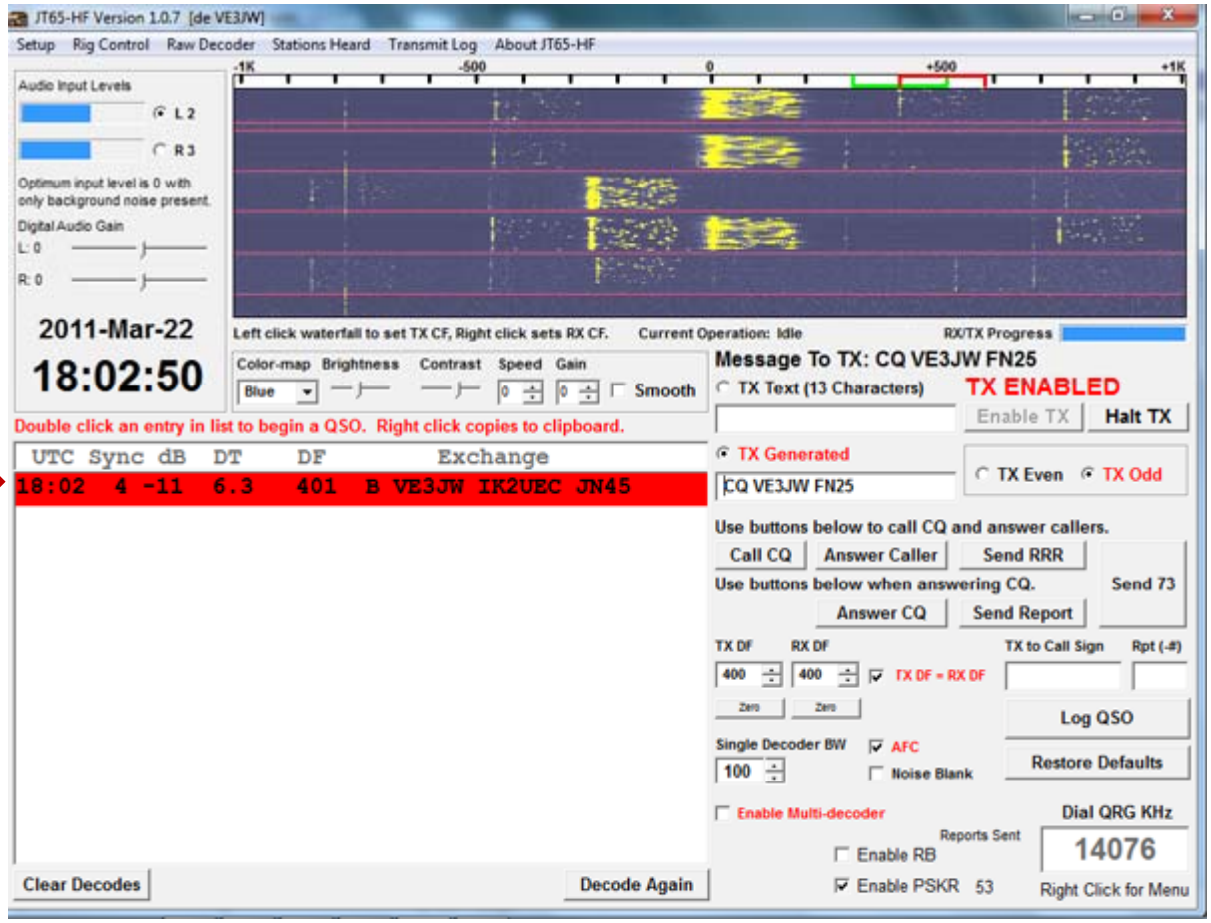
The left edge of this region (250Hz wide) will be placed where you click.

The hard-copy of this guide may not show the bar very well, so be sure to try it for yourself and observe the results of clicking on various locations in the spectrum.



When you call CQ, the “enable multi-decoder” function should automatically be disabled (2). If you see otherwise, be sure to disable the multi-decoder.

JT65: Answering a station

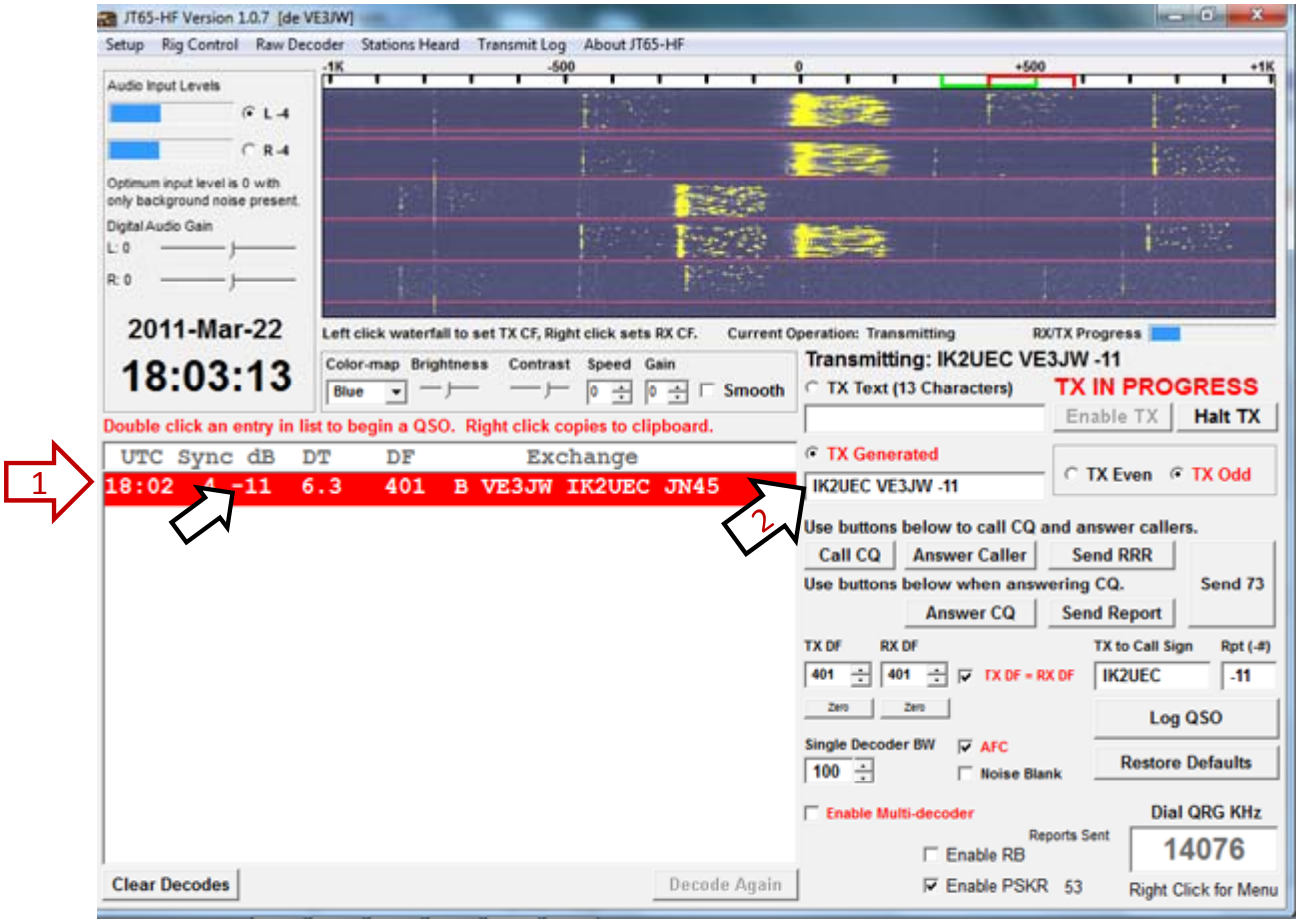


When you receive an answer to your CQ, the resulting QSO will be colour coded as red.

Be sure to decide whether to answer or not quickly!

This was a quick decode, giving a full 10 seconds before it was my turn to either continue calling CQ or to answer the caller.

JT65: Answering a station

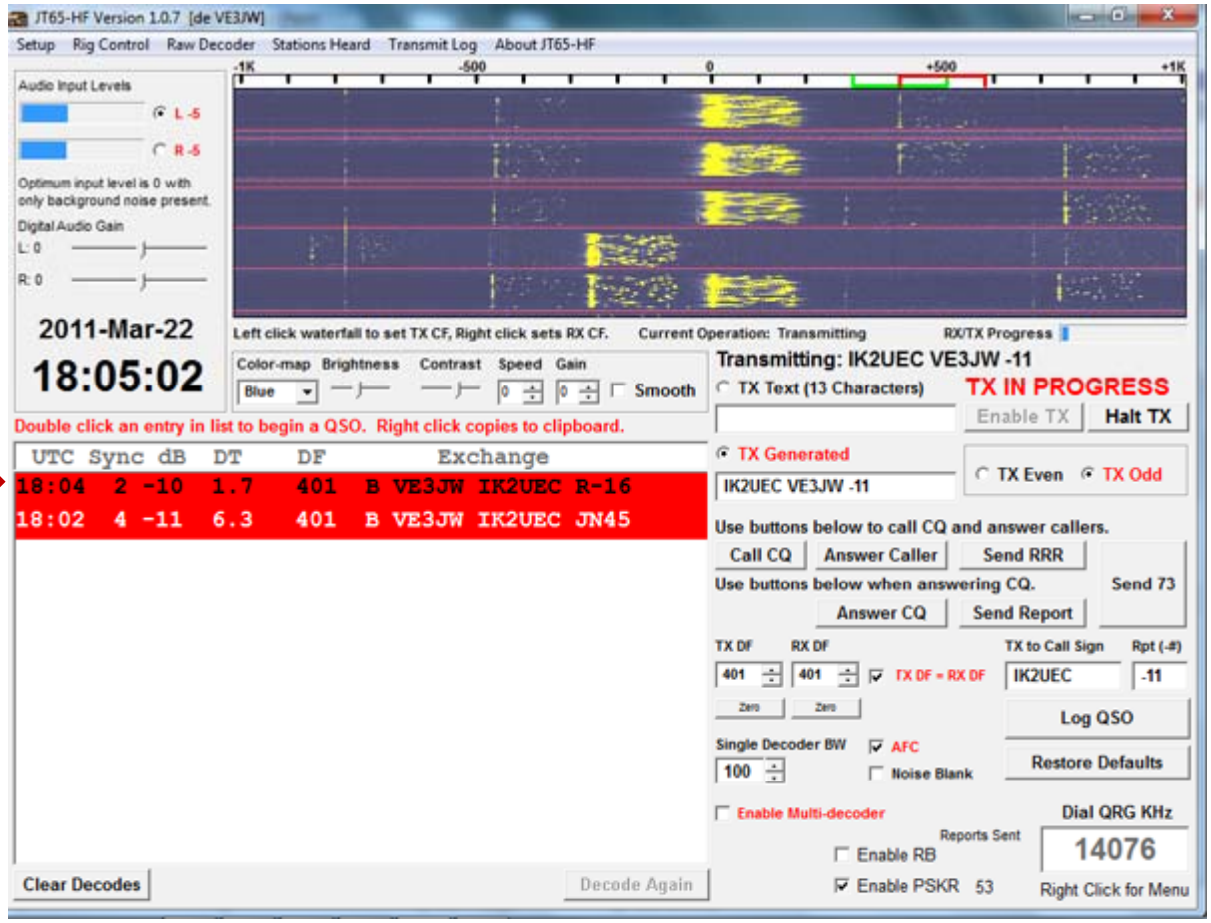


1. By simply double clicking on the QSO, the software will respond by giving a signal report.
2. In this case, the response is:

VE3JW IK2UEC -11

Keep in mind that if the station you are attempting to communicate with is coming in weak, it may take 2 or more cycles to receive a response.

JT65: Answering a station



1

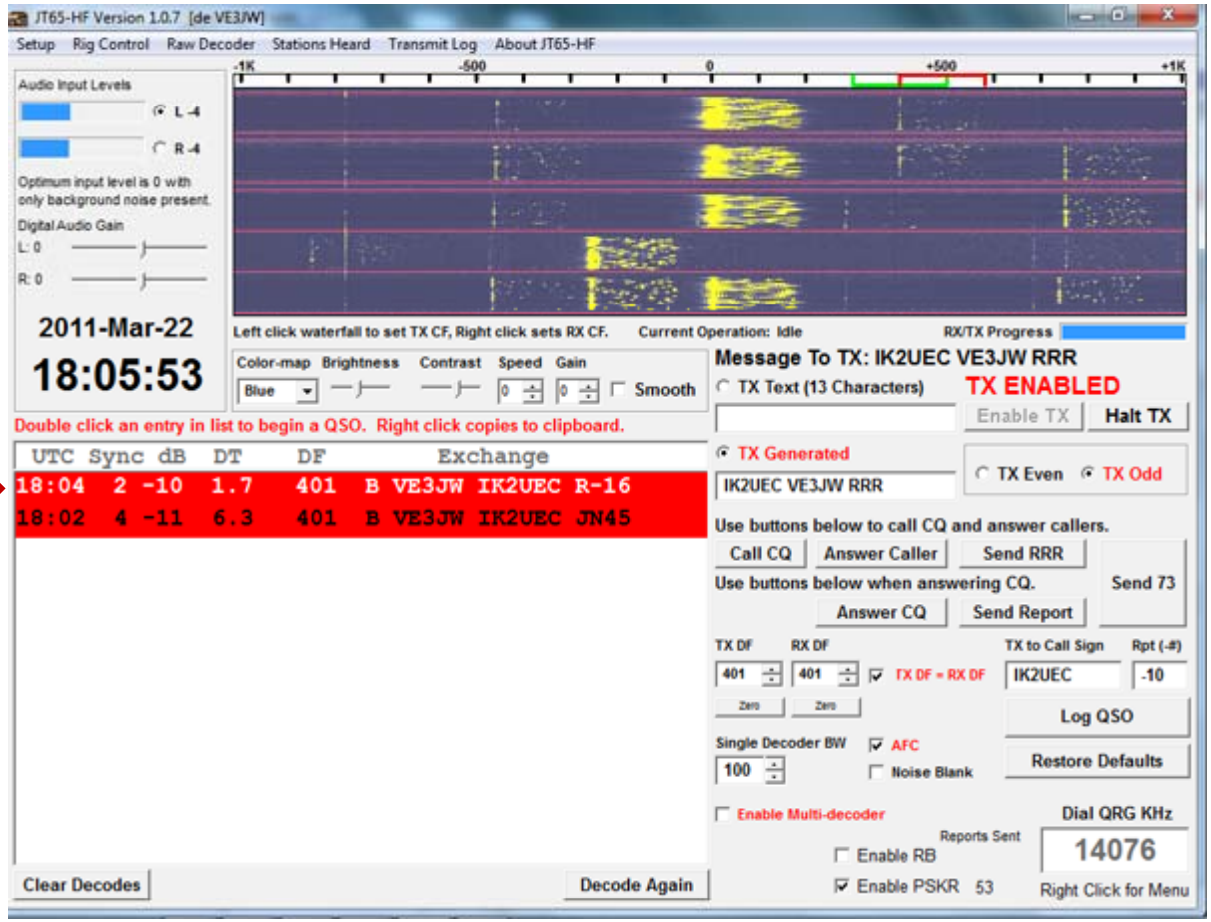
Success!

The operator at the far-end acknowledges their signal report by responding with ours preceded by an R as follows:

VE3JW IK2UEC R-16

This means we are coming in fairly weak (recall -26dB is the lower limit) and so we may have to transmit the same message more than once to complete the QSO.

JT65: Finishing QSO with RRR



As always, double clicking the most recent QSO line will auto-generate the response dictated by the protocol which is:

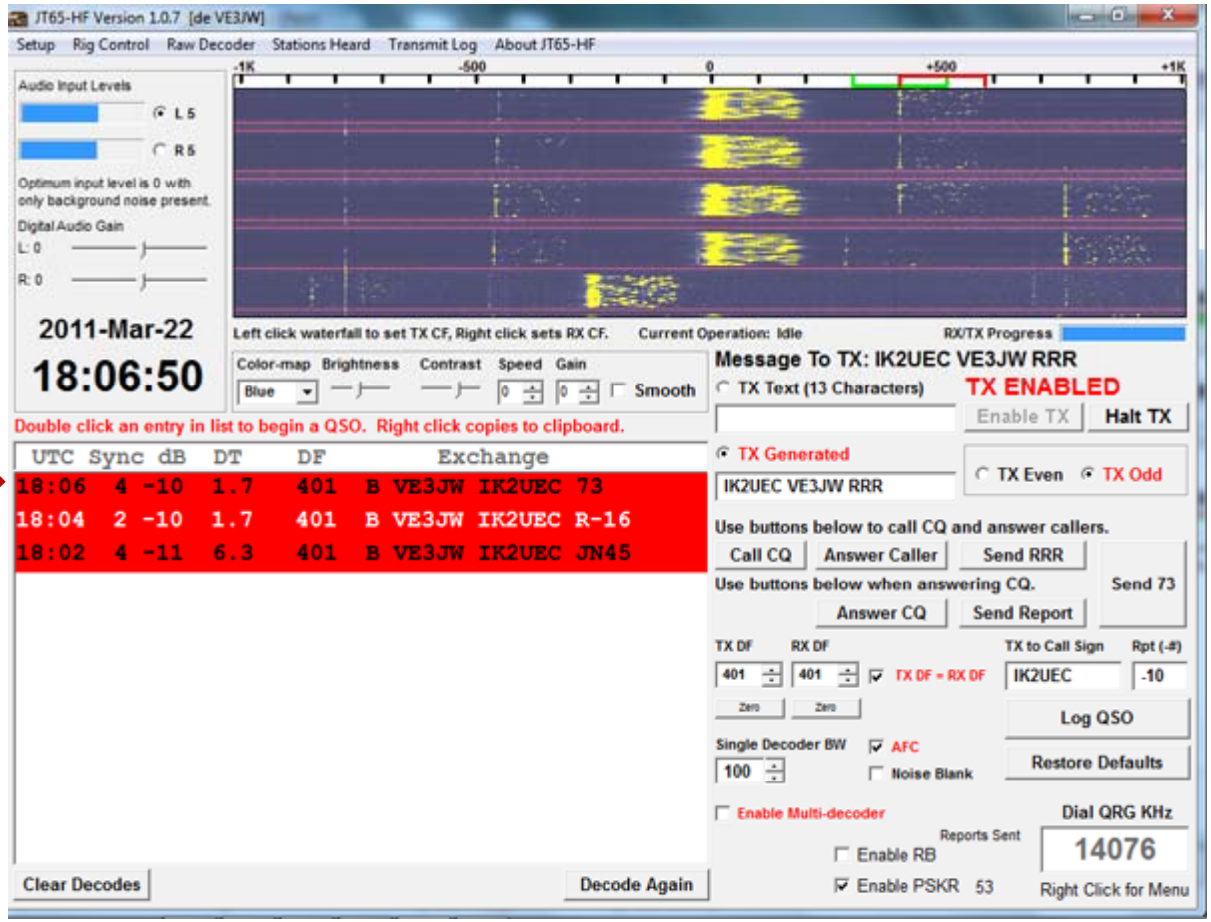
IK2UEC VE3JW RRR

Because we initially called the CQ, we are the one who terminates the QSO by sending the prosign RRR.

To log your QSO, a suggested convention is as follows: (again, note the time)

Date	Time (UTC)	Freq. (MHz)	Mode	RXQ	TXQ	Details	Operator
22 Mar	1806	14.076	JT65	-10	-16	Bruno from Italy – sent using 10W	VE3BUX

JT65: Final transaction



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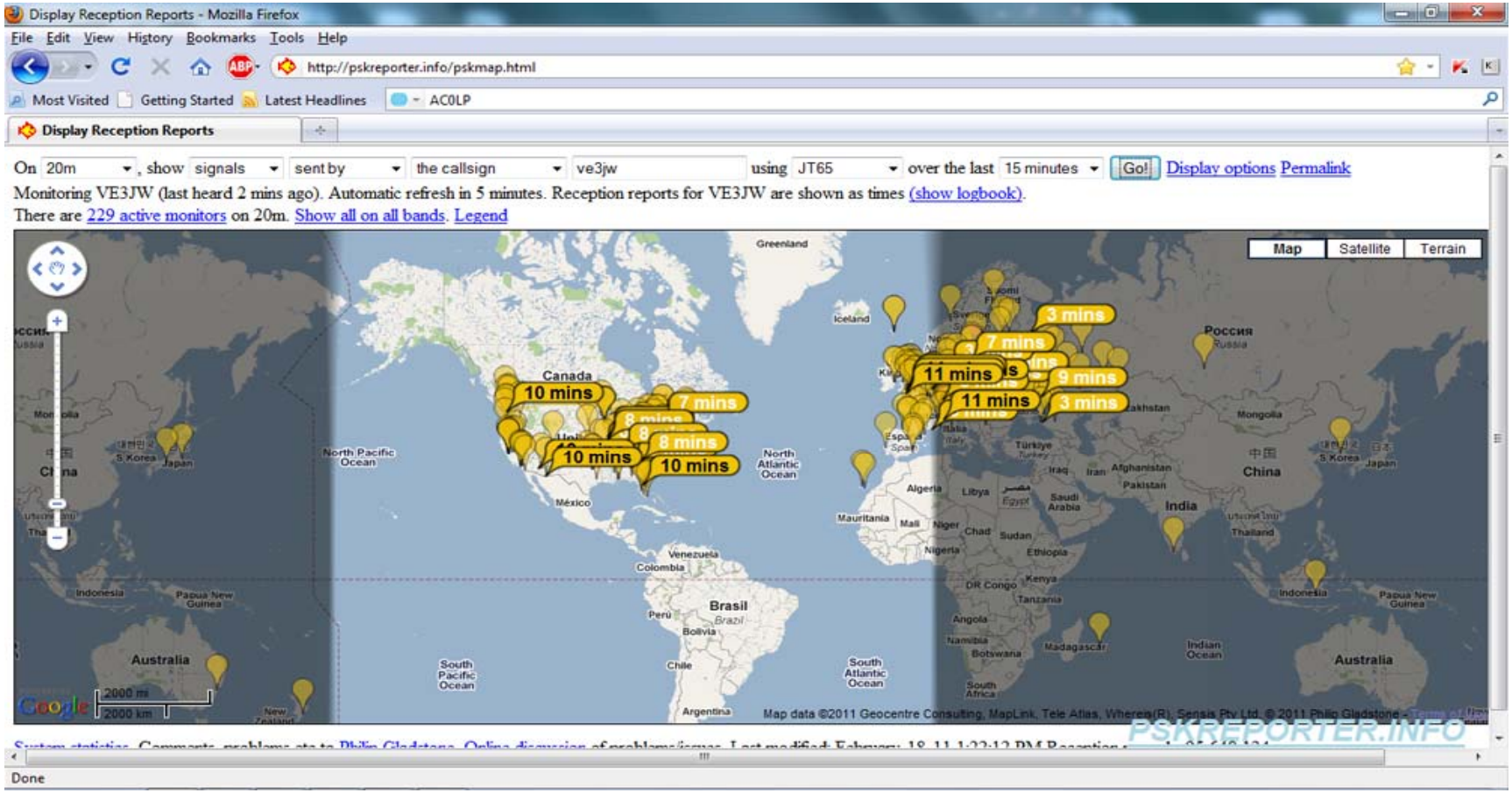
The final transaction is the courtesy 73 from the other operator.

I usually log this as the QSO time since it was the last transaction between the two of us.

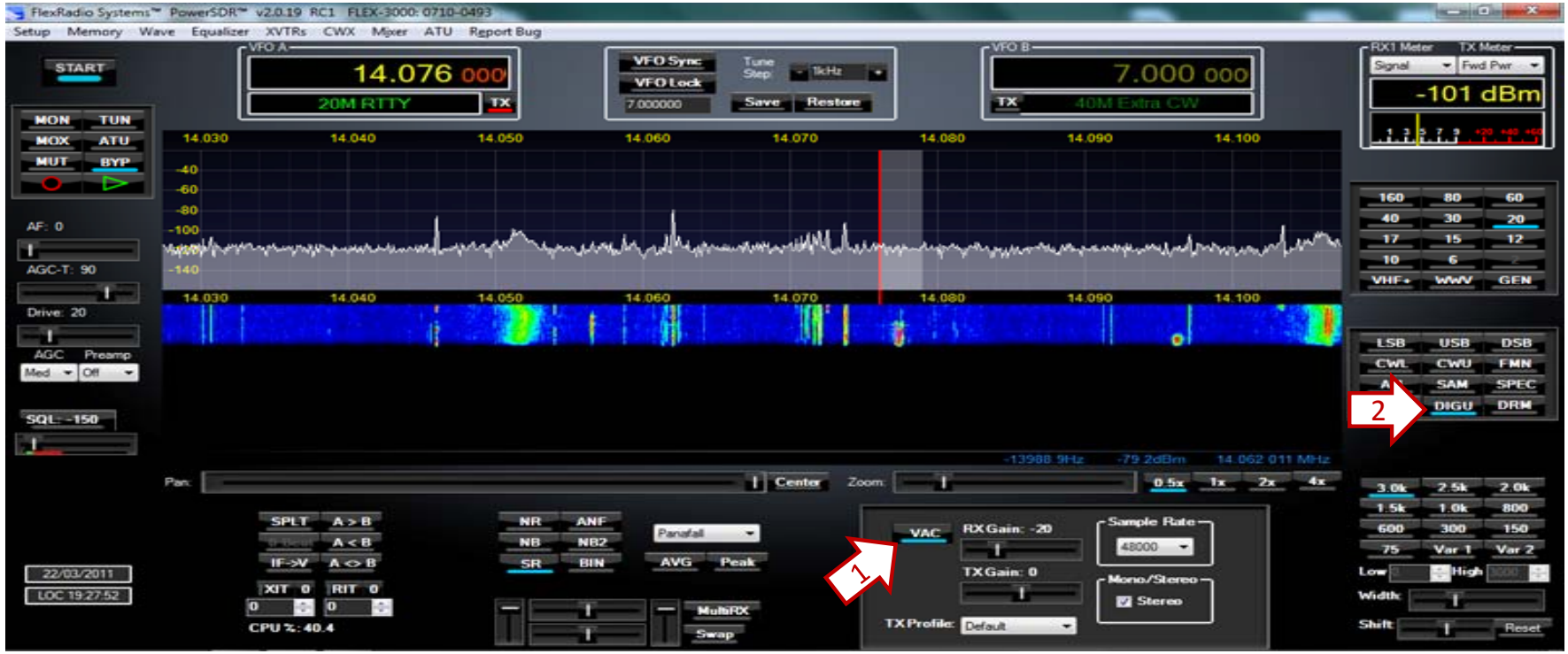
JT65: Final Words



Part of using the JT65 software should include automatic submission of PSKR reports which serve to provide a centralized real-time propagation map. You can view the results at:

http://pskreporter.info/pskmap.html

JT65 Troubleshooting: No RX



Two important settings to verify in the PowerSDR software are:

1. VAC. The virtual audio cable must be enabled for the PowerSDR software to output the received audio to other applications (i.e. JT65-HF)

2. DIGU. The mode selection must be set to digital upper sideband

JT65 Troubleshooting: No TX

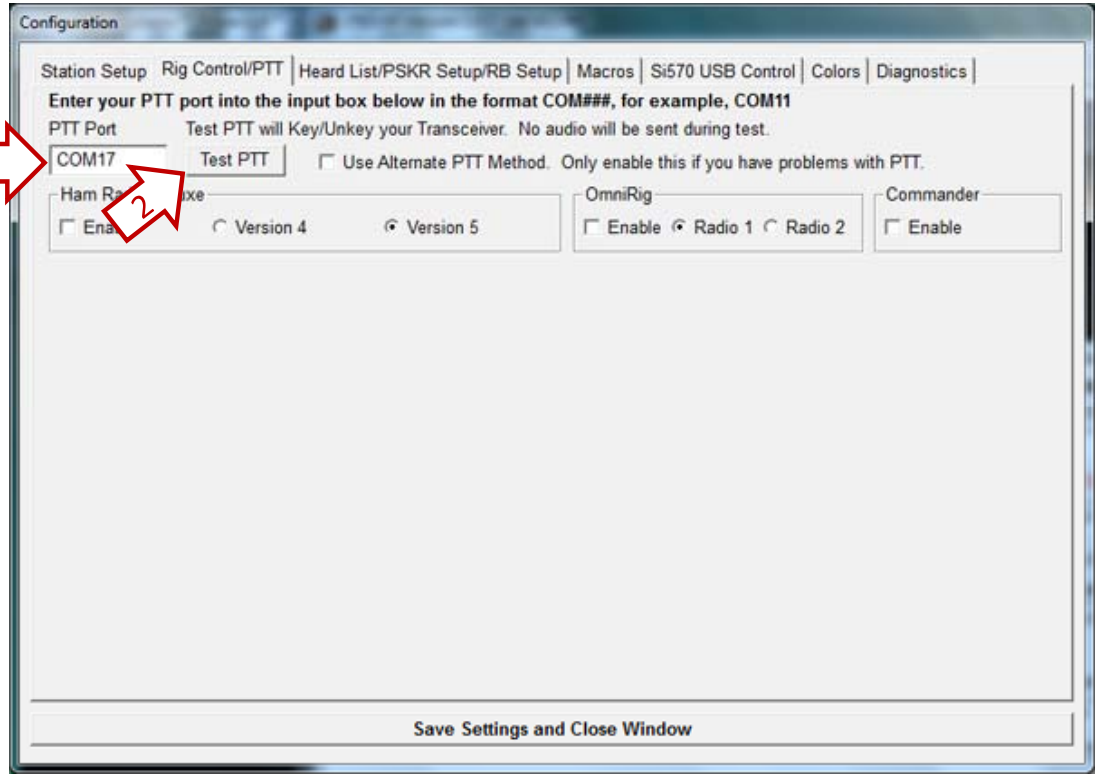
If you are unable to transmit in the JT65 software, be sure that the PTT Port is set to:

1. COM17

Test this by clicking on:

2. Test PTT

If you are still unable to transmit, try shutting down the JT65-HF software as well as PowerSDR.



Next, ensure there are no other radio related applications running which include: Fldigi, Ham Radio Deluxe, Digipan, etc.

Restart PowerSDR and JT65-HF and review all of the settings (as per this guide)

Conclusion

Hopefully you are now familiar with the basic operating procedures for using the JT65 mode of HF digital communications. Please remember this is a QRP oriented mode, and it is considered bad operating practice to produce more than 30W output power.

I wish you all the best of luck using this fantastic mode – I have no doubt we will see regular JT65 (and related) contacts to the far reaches of the globe using very little power in the upcoming increase in solar activity.

If you have any suggestions for this operating guide, or have any corrections to be made, please do not hesitate to let me know on the OVMRC forum or by email.

Thanks for reading!
73,

James Buck – VE3BUX
james@ve3bux.com