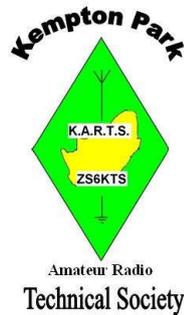
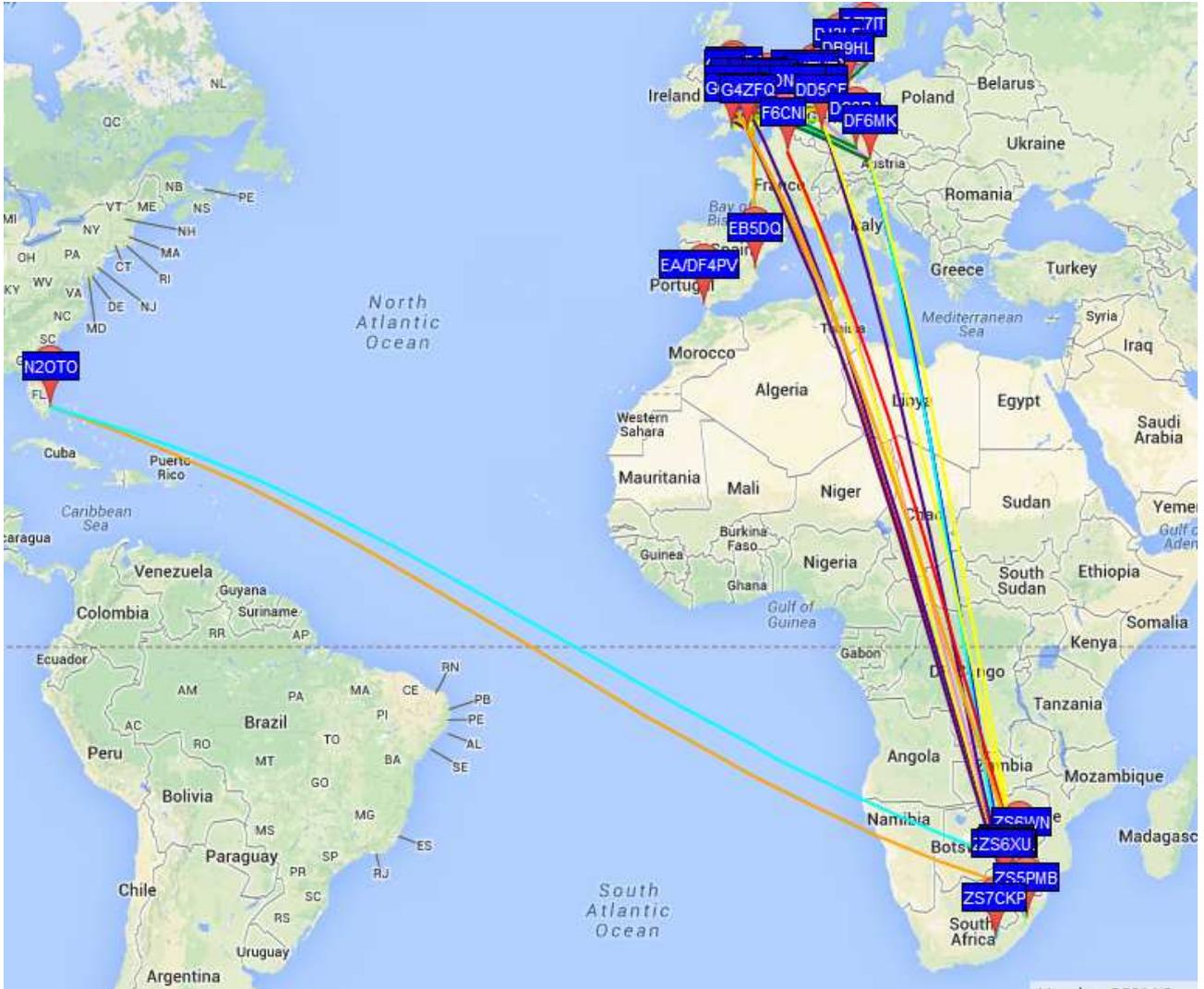


QUICK TUTORIAL TO START USING WSPR FOR RX



Written by
 (c) Stewart Moss
 ZS6SGM
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Introduction

If you are interested in the mysteries of propagation then WSPR is the tool at your disposal. To experience this fascinating tool, all you need is an SSB transceiver, simple antenna, a computer, internet access and an optional sound card interface to connect the transceiver to your computer.

WSPR is short for Weak Signal Propagation Reporter and is pronounced “Whisper”.

It is important to note right away that WSPR is not a QSO mode. It is used to broadcast a position, call sign and power level and see who hears and decodes it. Reports of these decodes can be sent and tracked on a central website. <http://www.wsprnet.org>

The WSPR software reports the signal to noise ratio of received stations and also other data. When the spots are uploaded WSPRnet calculates the distance between the stations.

The mode that is implemented by WSPR is called MEPT-JT. MEPT means Manned Experimental Propagation Transmitter. The JT part is Joe Taylor's initials.

Joe Taylor K1JT also developed the mode WSJT which is used for “moon-bounce” communication. In 1993 Joe Taylor shared a Nobel Prize in Physics with Russell Hulse, for some work they did in their field of Astrophysics. He obtained his license as an Amateur Radio operator as a teenager and as a result became interested in radio-astronomy.

This tutorial covers the reception and decoding of WSPR only. TX will be covered in later tutorial.

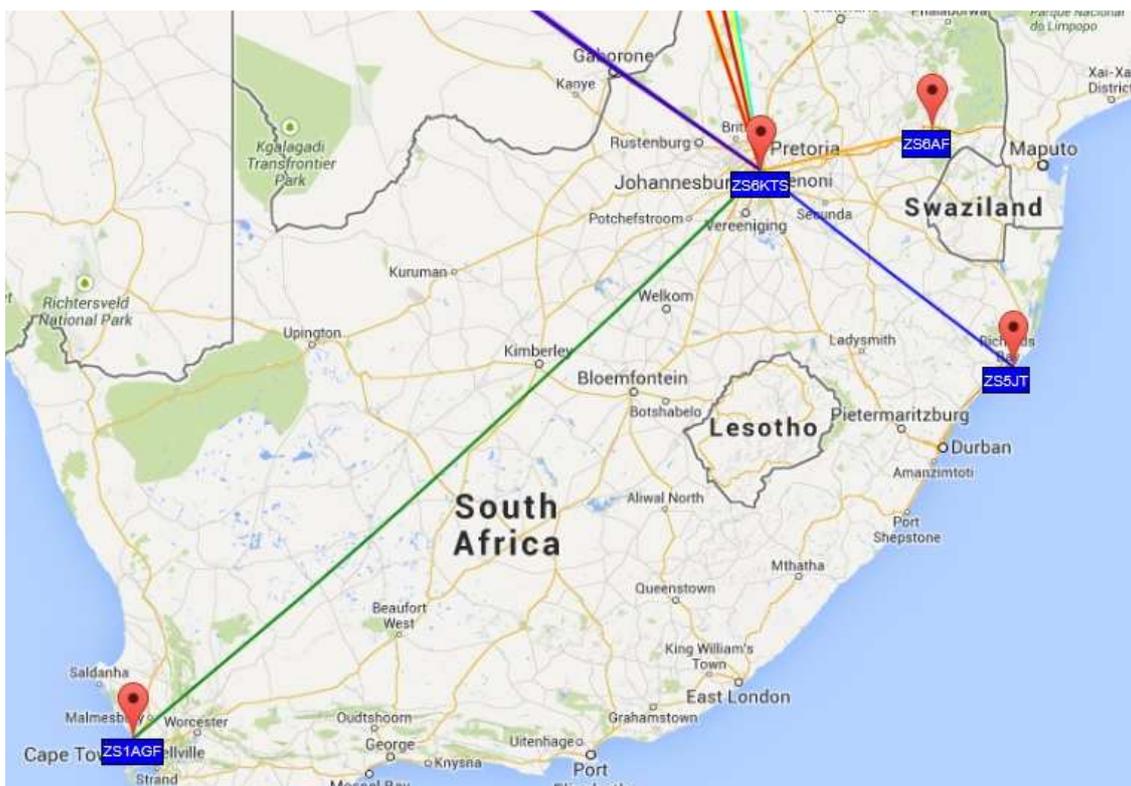


Figure 1: A sample of 60m activity in South Africa over a 24hr period in early 2014

Decide what you want to do

This is important. Do you want to TX only, RX only or TX and RX?

One of the joys of WSPR is being able to receive, decode and report WSPR signals on amateur frequencies you might not be able to transmit on. WSPR can decode really faint signals; so who knows what you may hear. The ZS6KTS beacon has been decoded on 5 MHz using 20W with an inverted V antenna at more than 13000kms.

Requirements

The following is needed for the WSPR software to work correctly.

1. Time: Accurate and synchronized time. (Normally by GPS or Internet but it is possible to get right by hand). In the next section there is a recommendation for software to use. The transmitting and receiving station need to be **not more** than 2 seconds apart. K1JT says “For optimum results your computer should be accurate to within ± 1 second”. G4FQZ adds “This will allow for +/- on both RX and TX stations”. WSPR starts transmitting on exactly the start of a randomly chosen even minute and will transmit for basically 2 minutes. The transmission ends at the start of the next even minute. The website <http://time.is> will allow you to check your computer time using a web browser.
2. Computer: A computer with a speaker and a microphone at the very least. Computer should have an internet connection running some time synchronization software. The receiving computer should be a reasonable spec and not an “old clunker” more than 5 years old. The TX computer can be an old clunker or even a cheap microprocessor with a GPS clock. Most of the computing power is in decoding the signal. This is especially true when dealing with decoding multiple transmissions at the same time.
3. Radio Station and antenna: If you are RX only you can get really good results using a wide band “active loop” antenna hanging in a tree with a cheap Software Defined Radio dongle or usb box. ZS6KTS beacon is decoded in a number of locations in Europe on this configuration. RX has also been achieved with a laptop right next to the rig and WSPR running and the levels set correctly. For local HF RX a long insulated wire lying on the floor does fine. The rig must not drift more than 2hz per minute. TX requires the full setup including a “radio interface board” to supply audio to the computer and trigger PTT. WSPR supports CAT control too, so you can change frequency and “band hop” automatically. To make a beacon station which will not decode anything, simply unplug the PC microphone in port (or mute the microphone or line in.)
4. Location: You need your current location as a grid locator. E.G. ZS6KTS beacon is KG43cw. WSPR transmits only 4 digits of the locator but does report 6 digits via the internet if “upload spots” is ticked.
5. Callsign: As a convention, if the station is a listening station not an amateur radio station, they should still use an appropriate and identifiable call sign. Callsign out of your license region should have a suffix in the following format ZS6KTS/ZS1 for ZS6KTS operating in ZS1 province.

Hearing and Recognizing WSPR Signals

It sounds like a continuous high pitched tone for about 2 minutes. The tone starts on one second after the even minute and will continue for 1 min 50 sec. Its a high pitched tone, hard to discern from QRM. Sometimes this will end with the call sign in fast CW. However it only lasts two minutes and is repeats on the same frequency. The WSPR waterfall helps you visualize this audio pattern more easily. This is why the WSPR waterfall updates so slowly.

Bandwidth

The WSPR signals are 6 Hz wide. The software will decode 100 Hz either side of the Centre Frequency (see settings below), which gives a total receive bandwidth of only 200 Hz. However this is plenty of space to play around in, even during narrow band QRM.

Getting Started

Firstly you need to download the WSPR software. At the time of writing the latest version was WSPR v2.21, but it was not easy to find.

You download the WSPR software from <http://www.physics.princeton.edu/pulsar/K1JT/wspr.html> Please run version 2.12 or higher (2.11 on Linux).

You need to be able to synchronize your time with the internet or a GPS device. A really good program to use for synchronizing time via the internet on Windows is Meinberg. It is a collection of open source programs which automatically keeps your computer time in sync.

Install the Meinberg software on Windows and South African users should select the Africa region when prompted.

The recommended location to download Meinberg is as follows, but a Google search will also turn up the correct location.

<http://www.meinbergglobal.com/english/sw/ntp.htm>

The name of the correct download at the time of writing this tutorial is:
ntp-4.2.6p5@london-o-lpv-win32-setup.exe (2.80 MB)

Connect to the internet and you are ready to go!

Let's Find Someone to Decode!

Open the WSPR website <http://www.wsprnet.org>

The “**Activity**” tab on the website will show all the reporting TX and RX stations. It will be grouped by band. The website lists the TX frequency of each station. Choose the best band for given conditions and stations listed. (Eg 10m is great at night) Remember you only need to RX so don't worry too much about having the wrong antenna for the band.

The WSPR frequencies for each band have fixed frequencies.

WSPR makes its easy to find transmitting stations by having a drop down list of bands available.

You can choose the band you want from the Band Menu and the Dial Frequency and TX Frequency boxes will be updated with the correct information. You use the supplied Dial frequency on your radio (in Upper side band mode).

If you choose “Other” in the drop-down shown above then some versions of WSPR will save the frequency you enter. This will avoid over-writing the default frequencies.

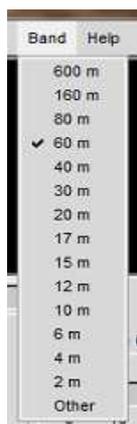


Figure 2: Band Menu in WSPR software

However some bands have different WSPR frequencies for different parts of the world and will be different from the standard list of frequencies.

For Example: For the 60m band in Europe, the TX Frequency 5.290Mhz (Dial Freq 5.2885Mhz) is used. **BUT** The TX Frequency for South Africa is 5.250Mhz (Dial Freq 5.2485Mhz).

WARNING: THIS IS SOON CHANGING SOUTH AFRICA IS MOVING TO 5.290Mhz VERY SOON

So be alert at all times especially when changing bands. Be aware of your regulations and band plan.

Choose a frequency where there are stations you want to decode. You don't need to enter the exact frequency displayed in the activity page, you can round down. E.g. ZS6KTS transmits on 5.250040

MHz but the receiving station should set their TX frequency to 5.250 MHz. As long as the signal you want is within 100Hz of the TX frequency you should have no problem decoding signals.

Plug in your interface board if you are using one, or get the computer's **microphone** as close as possible to the radio speaker. WSPR likes to use low power and low gains. Rather turn everything way down (to 1%) and you can turn it up as you test. You can use the attenuator on your rig too.

Tuning the radio

The radio should be on USB. The Dial Frequency can be read from the WSPR software if you are using a standard WSPR frequency and have selected the correct band from the Band Menu.

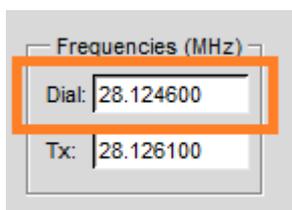


Figure 3: The standard WSPR dial frequency on 10m (USB).

USB dial frequency is 1.5 KHz lower than the actual transmitted frequency (centre frequency). Recall that the centre frequency (TX frequency) is the frequency reported on the Activity page. So if the frequency is non-standard (as defined by the WSPR standard frequencies), you need to do some calculations.

The frequency of a TX station seen on the activity page is only the set frequency if no spots of that station are reported. Otherwise it is the AVERAGE of all the stations reporting. (An off-frequency receive station will slew this average.) A receive station will normally report the centre frequency.

You need to take the centre frequency you want to decode and subtract 1.5 KHz to calculate the Dial Frequency for USB. For example ZS6KTS is transmitting on 5.250 MHz (The actual frequency may be a few Hz out) and the USB dial frequency is 5.2485 MHz (1.5 KHz down). WSPR decoding is done +/- 100Hz of Centre Frequency.

Formula:

USB Dial Frequency = TX centre Frequency – 1.5 KHz

Example: Dial Freq = 5.250 MHz – 1.5 KHz = 5.2485 MHz

Example EU 60m WSPR: Dial Freq = 5.2887Mhz – 1.5 KHz = 5.2872 Mhz

Example from Figure 3 (above): Dial freq = 28.126 Mhz – 1.5 KHz = 28.1245 MHz (100Hz out so be sure to enter this actual figure back into the Dial Frequency box).

It is usual to quote the Centre frequency and the operator needs to calculate the correct dial frequency.

Tune your radio to the specified dial frequency (+/- any error due to inaccuracy of the receiver).

Please Note: a reasonable degree of precision is required, not all radios are precisely on tune. Some radios, maybe older ones, can be far enough out that they miss the WSPR segment entirely if the operator does not compensate for this.

Another point about WSPR is the requirement for receiver stability. WSPR is not tolerant of more than about 4Hz drift in the 2-minute cycle.

PLEASE NOTE: Turn off **AGC** on the radio. You can use a noise blanker. Joe K1JT says “Usually it is not critical whether AGC is on or off. A good default procedure is to leave it on, and set the desired audio level by reducing the RF gain. In effect this means that AGC will be activated only when very strong signals are present in the pass-band. Slow-recovery AGC settings are generally not desirable for WSPR”.

IMPORTANT Check the WSPR software dial frequency setting agrees with your radio.

The WSPR Website

Visit: <http://www.wsprnet.org>

You can keep track of your spots (both TX and RX) using the “**Database**” functionality on the website.

You can download CSV data files, updated daily from the “**Downloads**” page.

There is also a useful “**Map**” on the website.

If you are registered on the WSPR website (which is not compulsory) then you can use the “**Chat**” functionality on the website. This will allow you to get help or to co-ordinate easily especially when signals are weak. The Chat is highly recommended and really takes this mode to the next level when decoding really faint signals.

Screenshot of WSPR software

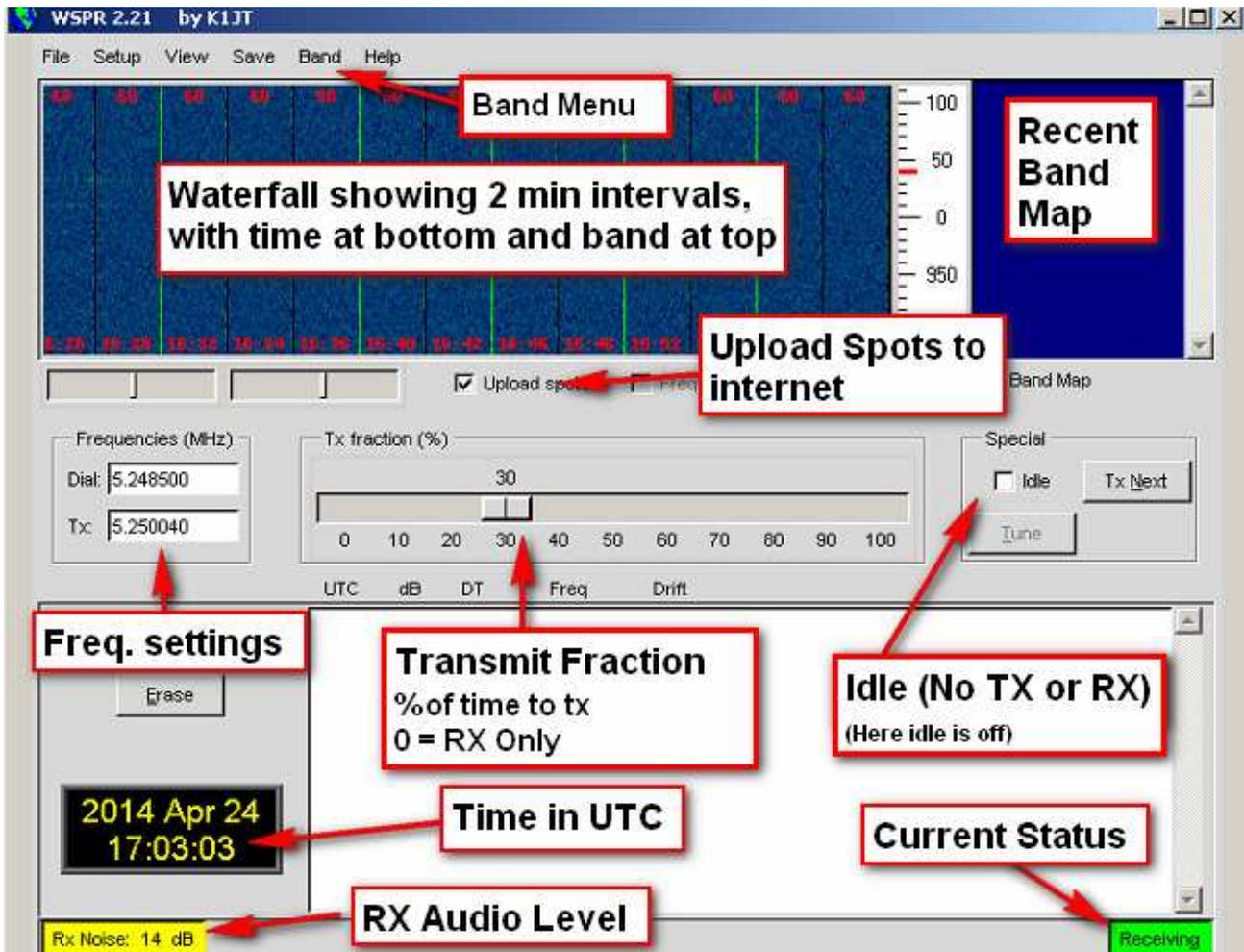


Figure 4: A labelled screen shot of the WSPR software after it has been running a while.

When the software is first started the waterfall is black. The waterfall is only updated every two minutes

The Waterfall runs from right to left. The fuzzy dots are the signals. Each segment on the waterfall, separated by a black or yellow line, represents a full two minutes. The time at the start of each segment is at the bottom of the display. The vertical separation lines have the following meanings. The black line represents the end of a two minute window; the yellow line represents the end of a two minute window and a two minute transmission (if TX is enabled).

Time is displayed in UTC.

Running the WSPR software

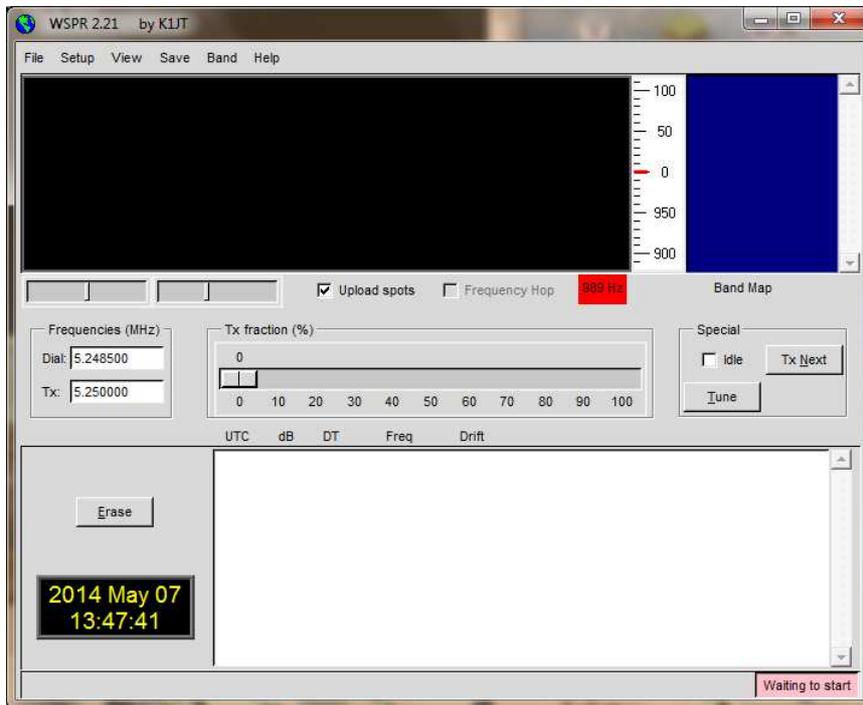


Figure 5: WSPR software after it has just opened.

You can now open the WSPR software.

NB: Ensure that the IDLE box is ticked, until you are ready to RX.

We first need to configure everything correctly.

Below is an example of how the ZS6KTS beacon was configured at one stage.

Choose *Setup* from the menu and choose “*Station Parameters*”

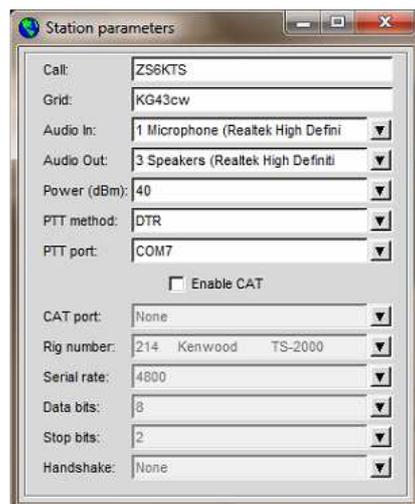


Figure 6: Station Parameters Screen

Enter your Callsign and Grid location into the screen. Enter your power in dBm by choosing the nearest dBm to the actual power you are transmitting.

If you are using an interface board, choose the PTT port, and the PTT method. (RTS or DTR is normally standard). Also configure CAT if you happen to have your transceiver configured for it. Some use VOX successfully although it is not recommended. Some commercial radio/computer interfaces incorporate VOX.

The Audio IN port and Audio Out port should be chosen automatically but if it is not then chose any setting that makes sense. This is where your sound card supplies the audio, either via microphone or Audio In port. The output audio can come from headphone or speaker port.

UNTICK the Idle check box immediately to enable RX.

The ZS6KTS beacon runs on 60m, exact frequency of 5.250040 MHz. It is 40Hz up to move away from local and DX QRM. This also makes room for other stations that might transmit on the def

Receiving and Decoding Only

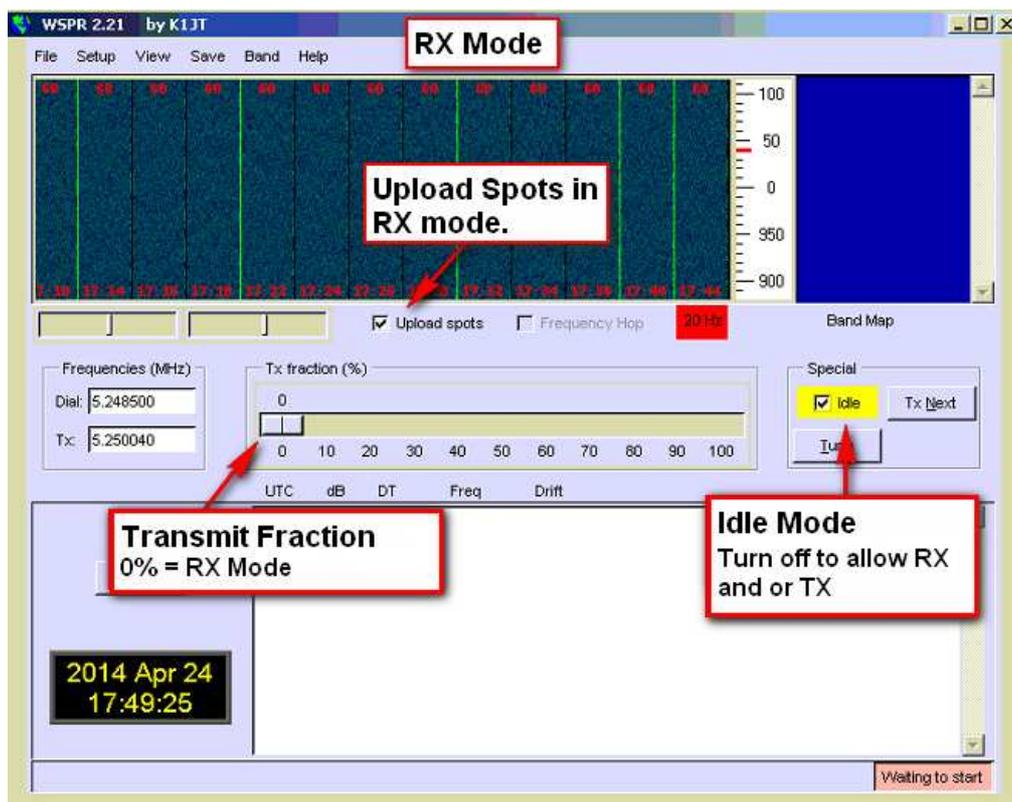


Figure 7: Configuration of WSPR for RX only.

To start listening set the TX fraction to 0%. Un-check the Idle Box (i.e. Turn off Idle to allow for RX and TX). If you are connected to the internet choose "Upload Spots". You can upload all your spots later on if you need to or you find it did not upload a few.

On the left hand side are two **very important settings**.

These are the **Dial Frequency** and the **TX Frequency**.

In the case of the ZS6KTS beacon the dial frequency as we worked out before was 5.2485Mhz. We tune our radio to this frequency and enter the **actual** real live USB dial frequency in the Dial box. If you cannot do 500 Hz increments, then enter the real live USB dial frequency that you can get in the box.

Equipment that only has 1KHz steps will need a special configuration, a BFO of 1000 or 2000 will be required. G4FQZ is not sure that TX can be accommodated.

The TX Frequency is the frequency the WSPR signal is being transmitted on. This is the frequency listed on the Activity page of WSPRnet.org. The TX Frequency will determine where WSPR will try to decode WSPR signals.

Please note: The software will decode 100 Hz either side of the centre Frequency

Decoded call signs appear as a list on in the box and in the band map. WSPR transmissions show up as bright yellow and orange lines in the waterfall.

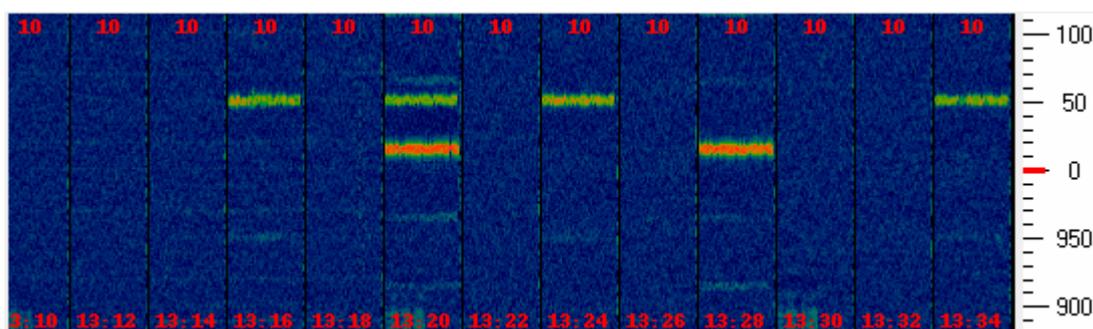


Figure 8: Multiple decodes of strong local stations in the WSPR waterfall.

Adjust your audio input levels to set the RX Audio level to a level above 11dB and below 20dB. This allows WSPR to decode into the noise. Figure 9, below, shows the RX Audio level, in the bottom left hand corner of WSPR.

If the colour is silver or grey then the audio is too low.

If the colour is red then the audio is too high.

The colour is yellow when it is at the correct level.



Figure 9: Audio level at a suitable level to decode into the noise under normal conditions.

Troubleshooting RX decodes

Sometimes WSPR does not decode a signal even though a signal is showing up clearly in the waterfall.

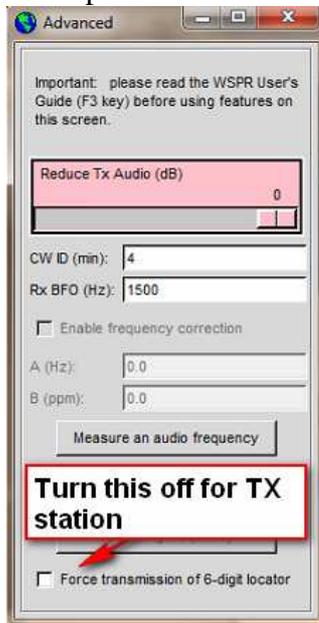
Here are some hints to help you diagnose the problem.

1. Ensure your time is correct and the transmitting station is correct time. If you are sure your time is correct you can try adjust your time by 2 seconds either way to see if the transmitting station is out. Keep adjusting your time if you are sure this is the problem. The transmitting station might not have its time correctly synchronized.

The website <http://time.is> will allow you to check your computer time using a web browser.

2. Ensure the radio is on Upper Side Band and the dial frequency is correct according to the calculations you made.
3. Ensure that your RX Audio level is above 10dB and below 20dB when nobody is transmitting. This will allow WSPR to “hear” into the noise and decode sub-noise signals. The RX Audio box (as shown in the screenshot on page 6) should be yellow when the audio level is good enough.
4. The receiver stability. If waterfall is causing the horizontal WSPR lines to appear wavy, leave the rig to warm up and stabilize. This can take up to an hour. The problem is worse if I engage RIT while warming up. Normally WSPR signals are flat. If your lines are wavy it may indicate instability in your receiver. Drift needs to be less than 2 Hz per minute. Try getting better stability with a different receiver.
5. Faulty wiring. eg bad cable or connector between rig and computer. This can cause the stability problems.
6. If the incoming signal is too strong and is splattering (visually) in the waterfall. The audio needs more attenuation. Try reducing your audio levels to the PC or trimming down your adjustment POT on your interface board.
7. In the WSPR software ensure the Dial Frequency and TX Frequency boxes have the correct details in them.
8. Connect to WSPR website and use the “**Chat**” functionality to ask for assistance.
9. Sometimes the trace is just too weak. Wait until the next transmission cycle to see if it is the band conditions.
10. When transmitting choose a frequency which is not used by more than one station as this will reduce conflicts and will give a better visual in the waterfall. This will allow you to see the signal and how strong the trace was.

11. Ensure the transmitting station is not transmitting a 6 digit locator. This can sometimes cause problematic decodes. This is found under Advanced Settings



12. Calibration!!!! – Please read the WSPR documentation.
13. Multiple Decodes... Multiple decodes happen with strong signals. These are reported to the website, but they are cleaned up on a daily basis. Attenuate your signal.
14. Laptop QRM – Caused by switching mode power supply.
15. Confirm that AGC and all fancy rig settings are off (eg notch filters and PBT etc) and that you are running as barefoot as possible into the computer. TURN off graphic equalizers, room enhancements, Microphone Boost or 3d effects on sound card on the computer (ie make the computer barefoot).