Checking Frequency Calibration Of Your Transceiver

Using WWV and Computer Sound Card

WWV 15 Mhz Antennas

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Overview/Purpose

This document briefly describes a quick and easy method of checking your HF receiver/transceiver end to end frequency calibration using WWV and your soundcard in your PC. This process will enable you to determine if the transceiver has a problem or not and should confirm any suspected error observed by operating the transceiver on air. It is *NOT* to perform *Laboratory* type calibrations.

The carrier of a calibrated frequency reference such as WWV is used by your transceiver in the CW mode to produce a tone which should correspond in frequency to the CW side tone set in your transceiver. The tone is then measured by software such as "Spectrum Lab" using the sound card to determine the transceiver's calibration. In the method described here, it is assumed that sound card and software are roughly correct. When more accurate measurements are required, you will need to calibrate "Spectrum Lab" and your sound card using an external calibrated tone source which is not described here.

This method was shown to me by Andy (VK6OX) when netting my TS2000 onto approx. frequency.

Steps To Check Frequency Calibration

- Confirm or measure the CW sidetone frequency used in the transceiver.
- Determine the approx. freq error of transceiver.
- Connect Transceiver To Soundcard.
- Tune transceiver to WWV.
- Adjust "Spectrum Lab" to enable resolution of audio side tone to within 2Hz.
- Confirm measured results are approx. the error you estimated at the start.

Confirm CW Sidetone Frequency

As we are going to place the transceiver in the CW mode and use the CW sidetone offset to beat with WWV carrier on 15Mhz or 10Mhz and measure the resulting beat frequency, it's important to know what the CW sidetone is set to. In my case the CW sidetone was set to 800Hz. This is either determined in a menu setting on modern transceivers or fixed in older transceivers by hardware. To determine the CW sidetone frequency you will need to check the menu setting or user manual for your transceiver if this is unknown. If your CW sidetone is continuously variable, you will need to set and measure it, which we will describe later.

Determine The Approx. Freq Error Of Transceiver

It is always good practice to have a rough idea of the current calibration error so you can validate the results of the measurements you are about to make. Checking the transceiver against other stations on air should give you a feel for any error. Using the higher bands normally highlights any error more quickly. In my case I suspected the transceiver was about 130Hz low in frequency on the 2m band based on the amount of RIT I had to apply to correct the audio tone when in SSB for most stations. Should the measurements to follow produce results that indicated results that are widely different to this, it would cause you to question and check the measurement setup - in short this is a sanity check of your measurement.

Connect Transceiver to Soundcard

You now need to connect the audio output of the transceiver to the audio input of the sound card in your PC or any external sound card such as SignaLink or Rigblaster for example. This is the same set up you use when working any of the digital modes that use the PC sound card that provide the required audio coupling and DC isolation to ensure good audio coupling without introducing any DC loops that could possibly cause hum etc.

Tune Transceiver To WWV

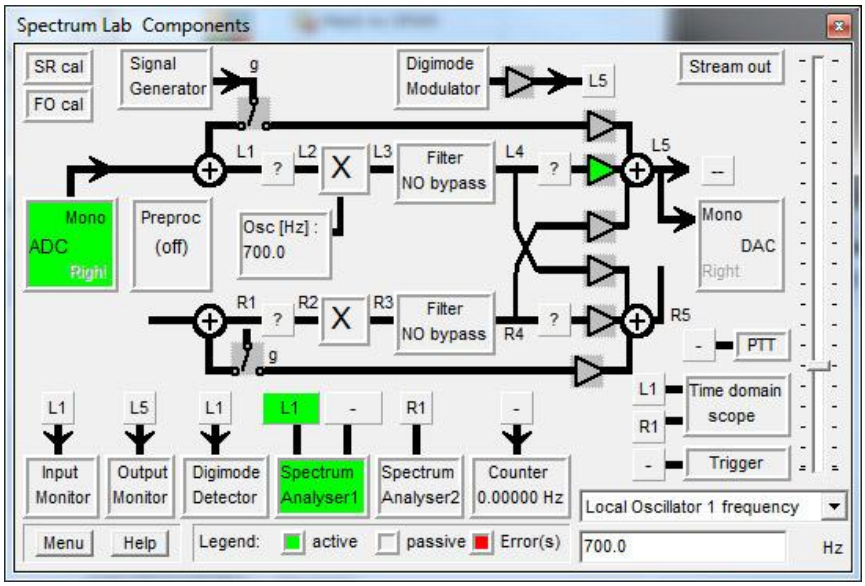
With a suitable antenna connected to the transceiver, tune the transceiver to one of the WWV time and frequency reference sources such as the WWV signal found on 15.000 Mhz. It's important that you set your dial on the nominated frequency without any offsets or RIT activated. With the mode now set to CW, you should now be hearing an audio tone at approx. the frequency of the transceivers CW sidetone frequency you determined earlier.

Adjust "Spectrum Lab" Resolution To Measure Tone

Before you can begin to measure the resulting tone from the WWV carrier you first need to setup Spectrum Lab or the programme of your choice so it's able to resolve the frequency measurement of the tone to within 1 or 2 Hz. To achieve this you will need to adjust things like:

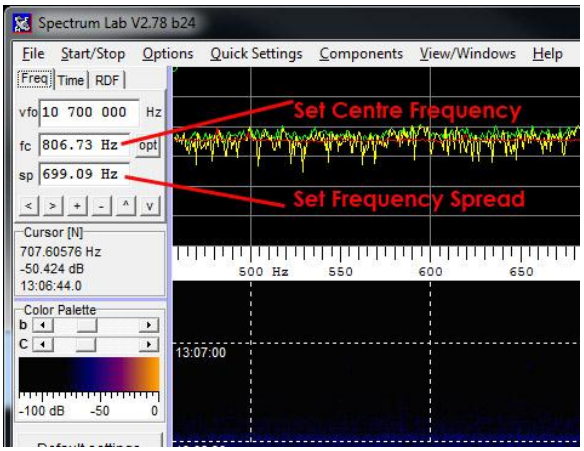
- Centre Frequency of display
- Frequency spread of the display
- Sampling Rate of the sound card
- Level Input to sound card

Before we show you some examples of these settings it's important that you understand the main aim in making these adjustments is to setup Spectrum Lab to focus on the tone in such a manner to allow you to resolve its frequency in your environment. To this end you may find you need set these differently in your environment to achieve this goal.



Spectrum Lab Components window which is good for showing all active components currently being used.

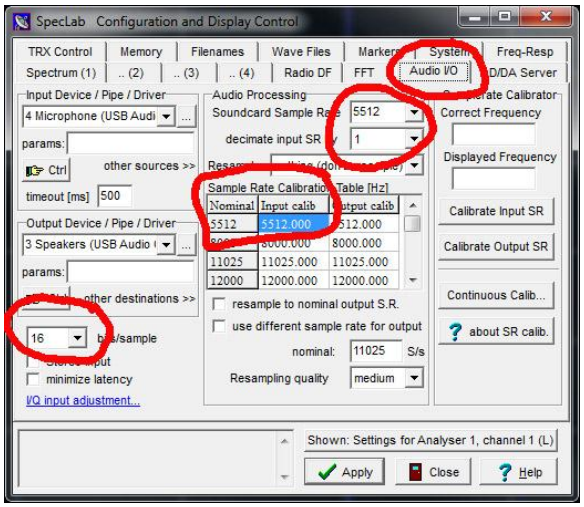
Spectrum Configuration Screens



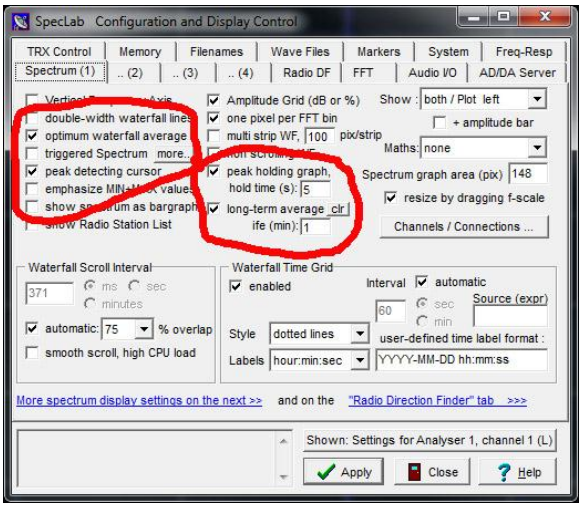
Setting Centre Frequency & Frequency Spread of Display

Note: You type the Centre Frequency directly into fc & sp windows as shown or you can use the mouse and drag the frequency scale or use the <>-+ buttons below the fc & sp windows.

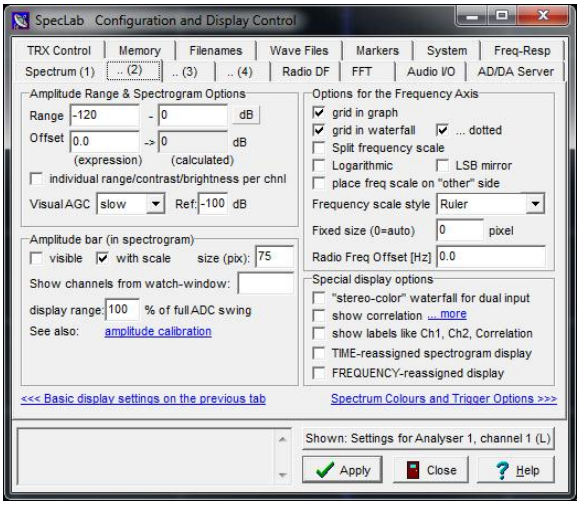
In previous versions of Spectrum Lab, the windows fc & sp maybe labelled MIN & MAX.



Setting Audio Settings



Setting Waterfall Settings



Input Amplitude Range of Spectrogram

Amplitude Scale of Spectrogram

Note: You type the range & offset options as shown; you can use the mouse and drag the frequency scale or use the buttons below the fc & sp windows.

All these configurations can be saved in a file to enable you to quickly switch Spectrum Lab between different configurations.

Reading the CW Side Tone Frequency

Now that you have Spectrum Lab configured, we can now begin measuring the frequency of the CW sidetones on transmit and receive. For those transceivers with a continuously variable sidetone you will first need to measure the CW sidetone frequency on transmit in order to set the frequency to a known frequency which you can match in the next step when tuned to WWV. For those transceivers with a known fixed CW sidetone frequency you can chose to skip the section "Measuring CW Tone Frequency On Transmit", however it would be good to do any way to confirm the CW sidetone frequency you determined earlier, which also confirms the measurement is valid.

Measuring CW Tone Frequency On Transmit

- Place dummy load on transceiver, or setup transceiver to produce CW sidetone with the morse key down without keying the transmitter.
- Change Band/Frequency to one which transceiver is able to transmit on.
- Place transceiver in CW mode.
- Key the transceiver with the "Morse Key".
- Measure the CW sidetone Frequency using Spectrum Lab. You will need to configure Spectrum as described below to make this measurement.
- Change the frequency of the CW sidetone using the transceivers continuously variable sidetone adjustment to a known desirable frequency, such as 800 or 1000Hz.

Reading the CW Side Tone Frequency From WWV

Now that you have Spectrum Lab configured, it should be relatively easy to see the frequency of the CW sidetone tone produced by listening to WWV in the sidetone mode. The yellow graph in the Spectrogram shows the instantaneous amplitude value, green the peak and red the average value. The combination of the three will aid in the checking and adjusting of the transceiver to affect the correct CW tone measured.

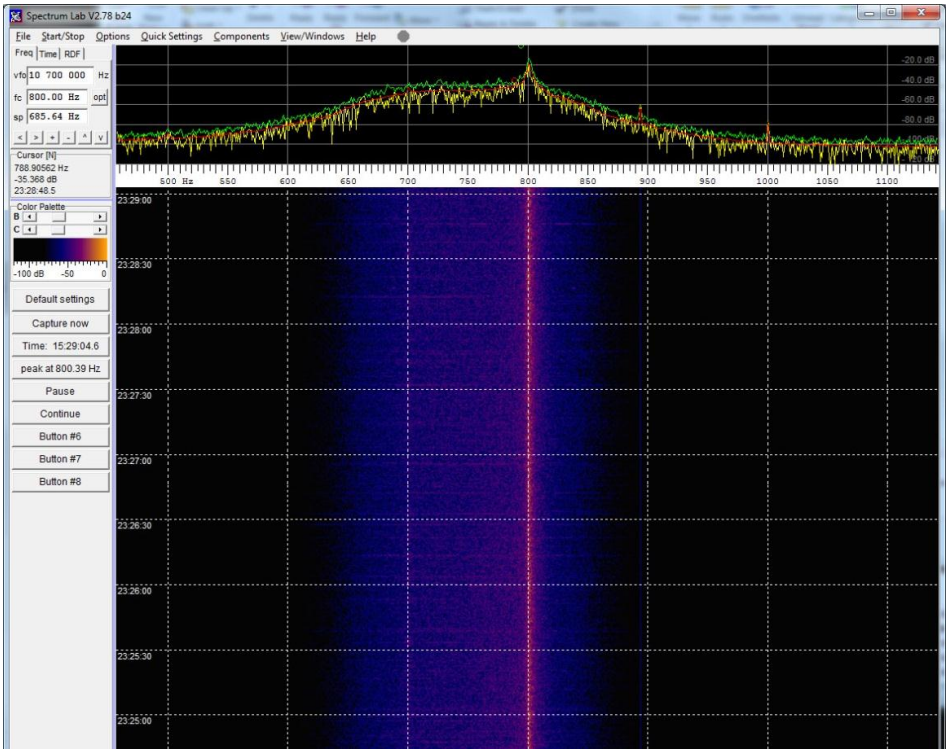
The result over time is displayed in the waterfall and with the frequency scale showing each 5Hz increment, from which you can determine the frequency to within 2Hz.

The difference between the measured frequency and your CW sidetone frequency is the error in the *overall* transceiver error. Depending on what you are correcting, change the transceiver adjustment to show the correct sidetone frequency in Spectrum Lab. In my case a small adjustment to the TXCO fixed the problem; please reference your service manual to determine the appropriate action before attempting any adjustments.

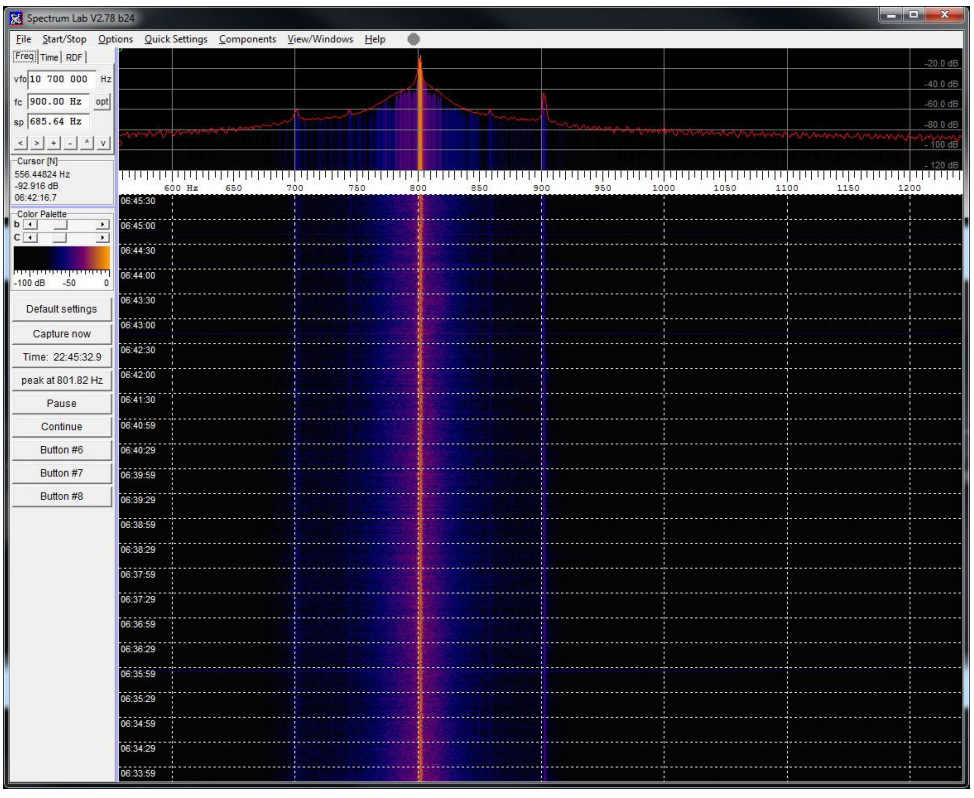
Comments For Transceivers Without TCXO's

If your transceiver does not have a TCXO, you may choose to do this measurement at each end of ***your*** expected temperature operating environment. For example, the measurement could be done as soon as the transceiver has stabilized after switch on, followed by second measurement after a normal period of use using the transceiver, including in transmit mode, with the operating temperature having risen above ambient, to ensure its within specification under these conditions.

Spectrum Screens Measuring CW Sidetone



Spectogram is showing instantaneous, peak hold and average graphs.

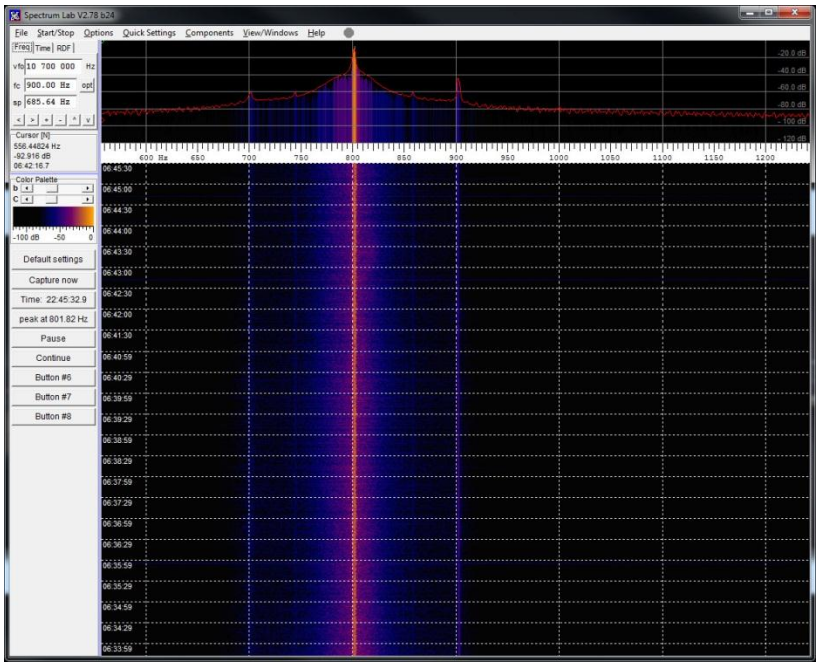


Spectogram is only showing average graph.

A Note of Caution

As you see from screen shot below I had a spurious carrier 100Hz above the WWV signal. This was not normally audible but visible in Spectrum Lab, however there were times when this carrier was stronger than WWV which may lead you use the wrong carrier as your reference signal leading to incorrect results.

I was able to use the DSP in the transceiver to reduce the other carrier and maintain focus on the WWV signal.



Note: I have changed the instantaneous amplitude display in the spectrogram to a bar graph and turned off the peak hold graph.

This was done after making the adjustments which I felt gave a good long term view to confirm the reading.

The important point here is to confirm your results with your estimated calibration you did before starting this process and ensure you are using the WWV carrier. If they are still way off after confirming you are using the correct carrier you may need to check the calibration and settings on your sound card.

Summary

Just a reminder these are the basic steps to follow:

- Determine the current freq. error of transceiver.
- Confirm CW sidetone used in the transceiver.
- Connect transceiver to sound card.
- Tune transceiver to WWV in CW mode.
- Adjust Spectrum Lab to enable freq. resolution audio sidetone to within 2 Hz.
- Confirm measured results are approx. the error you estimated at the start.

In my case, my estimated calibration error was about 130Hz based on correction factors I had to apply to work WSPR and 144Mhz SSB. The measurement confirmed this error and after changing the transceiver calibration I removed all my corrections and the transceiver works fine on WSPR and 144Mhz SSB without them. Not bad when NO expensive test equipment was used to achieve this !