

Micro-BITX Calibration Instructions
January 2019
Steve N3SB

The Micro-BITX frequency alignment process has been a common question on the CCARC email reflector over the past month or so, as more radio kits are being completed and fired up for the first time. The instructions available on the web don't seem to line up with the behavior of the radio when calibration is attempted. This document will hopefully help you through the VFO and BFO calibration process.

The notes herein are applicable to version 4.3 of the Micro-BITX software. You can determine what software version is running on your radio by powering on your unit and reading the version displayed on the LCD. See the picture below. The software version is shown on the top line of the LCD.



In order to calibrate your Micro-BITX, you need to be able to connect your radio to an antenna, and tune in a signal with a known frequency. Time and frequency standards stations such as WWV (5.0, 10.0, 15.0, and 20.0 MHz) or CHU (3.33, 7.85, and 14.67 MHz) are good choices. You can also use a shortwave broadcast station, but you may find them more difficult to tune in when they're broadcasting music. I like using WWV.

Before starting this procedure, you should let your Micro-BITX warm up for 30 minutes or so. All internal frequencies needed by the radio are generated on the Raduino module by an SI5351A clock generator IC. The SI5351A generates these signals from a single 25 MHz crystal, so the frequency stability of your radio is ultimately dependent on this crystal. There's a voltage regulator on the

Raduino module which runs a bit warm, and this heat will affect the frequency of the 25 MHz crystal. So, give the unit some time to warm up for best results.

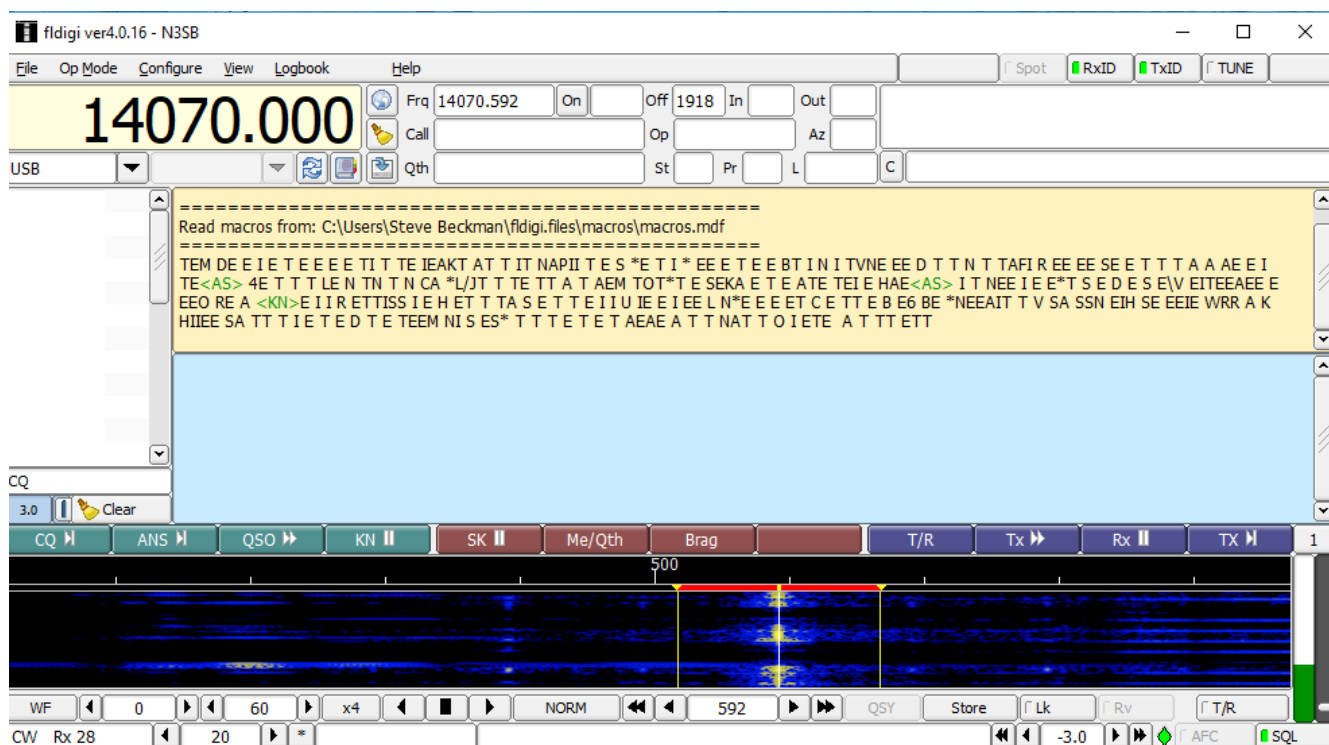
The calibration process uses software routines to correct for the frequency error of this 25 MHz crystal. The correction factors derived from the calibration process are stored in non-volatile memory (EEPROM) in the Raduino module. The basic process for calibration is to make a change in the calibration parameter – either VFO or BFO – save it to the EEPROM, then see what results you have. It's an iterative process. In fact, every time you use the calibration routine, your previous calibration settings are erased, so you need to keep notes on your previous settings.

I have chosen to use WWV at 15.0 MHz as an example. You will get best results if you use a higher frequency for your calibration, but it's not critical. I've roughly calibrated this radio before, so my settings are fairly close to begin with. WWV sounded fairly closely tuned in at 15.000.050 on my dial.



Start by tuning in the station you've chosen for calibration. Most of the time, WWV transmits either a 500 Hz or a 600 Hz tone, and transmits a 1000 Hz tone at the start of the minute. (There are exceptions, so refer to the schedule on WWV's Wikipedia page to get the all the details.) I use FLDigi running on a laptop sitting near my radio and acoustically coupled to it, to measure the frequency of that tone. I select the CW mode in FLDigi, and use the waterfall magnifier to zoom into the lower frequencies – the magnifier displays x1 by default but you can click on it to get x2 and x4 magnification as well.

After listening to WWV for a few minutes, I could determine the station's operating pattern so that I knew when it was transmitting the 600 Hz tone and when it was transmitting the 500 Hz tone. I slowly turned the VFO until I got a tone close to 600 Hz or 500 Hz on the waterfall depending on the minute.



My radio display read a bit high – 15.000.050. Pretty close. The 600 Hz tone I should have been receiving was also at actually 592 Hz. Let's see if we can get the calibration closer. I turned the VFO to read 15.000.000 MHz, then entered the calibration menu to make an adjustment.

Press the VFO knob to enter the menu, and turn the knob until you get to the Settings menu. See below.



Press the VFO knob. The top line of the LCD will briefly display a “Settings On” message, then show the calibrate menu below. Note: you will be able to enter the settings menu again and make changes until you either turn the settings menu back off again, or you remove power from the radio.



This is the VFO Calibration Menu. Press the VFO knob again, and the radio will enter the calibration adjustment mode, shown below. Note that the radio will go into transmit, however there will be no power output generated. The Calibration factor always starts at 0 – shown at the top right of the LCD. As you turn the knob, this calibration factor will slowly change. You can dial in a negative or a positive calibration factor, depending on what your radio requires. There are two important things to keep in mind: 1) the calibration factor always starts at 0, so keep notes while you’re performing the calibration, and 2) although the calibration factor changes slowly while you are turning the VFO knob, internally the calibration factor is being adjusted in finer steps that you cannot see on the display. In order to get a real close calibration, you will have to pay attention to how far past the displayed change in value you turn the VFO knob. A quick glance at the software suggests there may be 10 invisible steps in between the change in calibration factor that you can see on the display.

This is an iterative process. Start by dialing in a calibration factor of 10, then tap the VFO knob. The radio will return to receive. Listen to see if it sounds like its getting closer to being on frequency. You may have to exit the menu system entirely and tune around with the VFO knob to determine how close you are. Make notes. Write down the VFO frequency that gives you a signal that sounds like its on frequency. Then go back into the calibration adjustment mode again and try a different calibration factor. As you get closer to the correct calibration factor, you will not need to exit the menu system. Just tap the VFO knob to enter calibration mode, dial in a new calibration factor, and tap the VFO knob again to listen to the result. Remember that each time you enter calibration mode you start at 0 again, so keep notes.



BFO Calibration is done using the BFO Calibration Menu. The BFO calibration will not affect VFO calibration. While you are performing the BFO calibration, you will hear the received frequency change (if you happen to be listening to a signal) however the received frequency will be restored when you exit the menu. The BFO adjustment does affect the tonal quality of received signals. The effect is like an IF shift adjustment. You can adjust the BFO to get the tonal quality that you like. If you have the BFO calibration too far off, however, you will cut off the lower audio frequencies or the higher audio frequencies. You can get the BFO adjustment so far off that you are receiving the wrong sideband, so you won't be able to tune in sideband signals and make them sound intelligible.

As was the case with the VFO calibration, previous settings are not retained, so keep good notes. Go to one of the lower bands, such as 80 or 40 Meters, and with an antenna connected, find a clear frequency. Turn up the volume so that you can hear the background static. Enter the BFO calibration mode by pressing the VFO knob to get into the menu system, then turn the knob until the BFO Setup menu is displayed. See below. If you cannot find this menu, then you will need to enable the adjustment menu, as described earlier. If you have been following along and just finished VFO calibration, then your setup menu is still enabled.



Press the VFO knob to enter the BFO adjustment mode, and turn the VFO knob while listening to background static. You will see the BFO frequency displayed on the LCD. See below. The pitch of the static will start being high. As you turn the BFO up in frequency, the pitch will go lower, and will eventually start going back up again. You want to choose a lower BFO frequency that gives you a normal background static sound. This process can be iterative, so keep notes. After dialing in a BFO calibration that sounds good, press the VFO knob again. This will throw you completely out of the menu system, so you will have to go back into it to make further changes. Be careful to not accidentally enter the VFO calibration mode or you'll lose that calibration setting!



After you've made an adjustment to the BFO calibration, go find an SSB signal and see if it sounds good to you. Don't use an AM signal as it won't prove that you have the BFO set up to receive the right sideband. If you cannot tune in any sideband signals and make them intelligible, you may have set the BFO to the wrong side. Go back and try it again. I also try tuning in some strong CW signals. I like to have the BFO adjusted so that CW signals are only heard on one side of zero beat. Mine works well set to 11.996.5 MHz.

The Microprocessor in the Raduino is an Atmel ATMEGA328, which is the very same device used in Arduino modules. All the software developed for the Micro-BITX has been written in the Arduino IDE, and is available for download so that you can see it, change it, and download your new code into the Raduino and try it. This is one of the best features of the Micro-BITX radio, as it allows you to change its behavior to suit your tastes.