

Alachua County Developing BITX40 for ARES Training

Part Two

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In the previous article of this innovative “short-kit” inexpensive single sideband HF (40 meter) transceiver, I went over its features and advantages, and how to install a free Integrated Development Environment, find improved free software generated by other hams, and install it into the Arduino-based digital VFO of this fascinating little rig. (See: <http://arrl-nfl.org/wp-content/uploads/2014/06/00-QST-NFL-November-2017-update.pdf>, pp. 3-5). Faster than I could even get the final portion of this article written, the production group in India has released a 2nd transceiver (the uBitX <http://www.hfsignals.com/index.php/ubitx/>) that is now an all-HF-band transceiver with a general communications receiver capable from 3-30 MHz, and a dual-MOSFET transmitter output stage that should outperform the original BitX40. Quite significant upgrades to that device have now been developed by the volunteer community: <http://ubitx.net/>

However, some of the upgrades that are wise to install on the original design will probably transfer over to the newer, multi-band design, so I'm finishing up the list here for the less expensive BitX40.

Once these improvements are added, Alachua ARES members and others can have an inexpensive transceiver for WINLINK or other training, that can do all the following:

- operates on both 80 and 40 meters, for SSB, digital, or CW (using FLDIGI or small hardware modification not described here)
- has A & B VFO's
- operates both upper and lower sideband
- has built-in receiver protection against strong nearby transmitters
- has digitally accurate frequency display on all bands without further calibration
- can potentially be used to receive any HF frequency
- can have digital frequency control by WINLINK software, and possibly others

You do not have to perform all of these upgrades; you can pick and choose which ones fit your needs the best, but some give you several upgrades at once --- upgrading your Raduino software will make huge improvements in multiple areas.

1. MOST IMPORTANT: Improved protection from nearby very strong signals. The original Bitx40 has transistor Q13's base exposed directly to the receiving antenna – very strong nearby transmitters (think: Field Day) can potentially exceed the reverse base-emitter junction rating and dump considerable and damaging energy into the transistor, destroying it. (One anecdotal report had a 60 mA dial lamp being lit by a receiving antenna near to a fellow running 2 kW.) The solution to this is one that is used in many receiver front ends, and also has application to EMP protection: back-to-back silicon diodes that will clamp the input to 0.7 volts peak. Identify terminal 12 on relay K1 and place two 1N914 (or similar) back to back diodes from there to ground as shown in the accompanying photo:

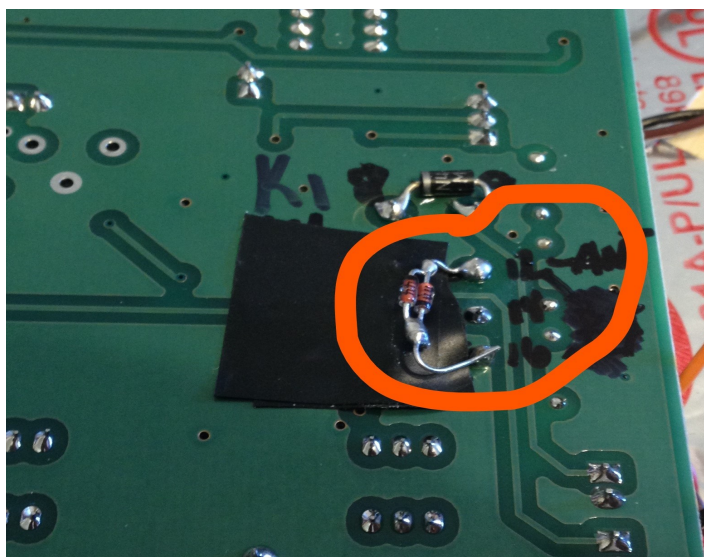


Figure 1: Two back to back diodes added from Relay K1 terminal 12 to ground, encircled in orange.

2. **Relay Back-EMF protection.** Diode D7 in the production run was misplaced and doesn't protect the relay switching device (be it a transistor, switch, opto-isolator) from the inductive back-emf of relay K1. Add a proper reverse diode across the coil of relay K1, pin 8 (cathode) to pin 9 (anode), as shown in Figure 2.



Figure 2: Reverse diode across relay K1. Use any silicon power diode, such as 1N4002 or 1N4007.

3. **Increasing microphone gain:** stock BitX40's might require a good set of lungs but the included electret microphone DOES work well and can even be added to some "furniture" to make a nice handheld or desk mic. You can also wire in an amplified CB microphone. Adding about an additional 4-6 dB of gain can help. Try carefully soldering a 33 ohm $\frac{1}{4}$ or $\frac{1}{8}$ watt resistor across (in parallel) with the chip resistor R123 (100 ohms) in the emitter of Q12, or use an external preamp if you wish.

4. **Adding 80 meter reception to the receiver.** The original design's 7 MHz bandpass filter won't allow 80 meter reception, but the Raduino is otherwise happy to dial to that band. A 470pf silver-mica capacitor can be connected across the bandpass filter to allow reception on 80 meters. Connect one end to the junction of C1 and L1, and the other end to the junction of L3 and C6. Use the SETTINGS menu options to expand the allowed frequency range to include 80 meters. An improved sketch (see #6) will make moving from band to band even easier.

5. **Adding 80 meter transmission to the transmitter:** The 40 meter low pass filter built into the BitX40 after the power amplifier stage is not sufficient for 80 meter operations. However, QRPkits has an inexpensive 80M LPF that can be added to the output using BNC cabling.

<http://www.qrpkits.com/ezseries.html#ezlpf> Another version available from qrp-labs:
<https://www.qrp-labs.com/lpokit.html>

6. **Improved sketch that improves 80 & 40 meter operation** and allows quick transition between the bands. With this sketch, when you leave one band, the “frequency jumps” will move much faster until you near the next ham band, making it convenient to change bands. (If you add a jumper completely across the 40 meter bandpass filter (and are willing to deal with some images) you can make it receive many more frequencies.) Go to <https://github.com/ggibby1/BitX40-1.24-FT857d> and click on, download, compile and install *raduino_v1.24GLGchangesWorkingCopyBreadPanwithCAT2.ino* from that repository, after saving your original sketch.

7. **Perfect Frequency Calibration:** If you have access to a digitally accurate communications receiver, you can measure two crystal frequencies in the BitX40, apply corrections to the control sketch of the Raduino and make it have virtually perfect calibration (to the limit of the accuracy of your frequency measurement). This is because the BFO (beat frequency oscillator) is crystal controlled, and with an insulated “antenna” wire near the single 12.0000 MHz crystal you can easily pick up enough signal to measure the actual BFO crystal frequency. The VFO is digitally derived from a 25 MHz crystal on the Raduino board, and using a sketch that forces 25.0000 MHz output you can determine the actual frequency of that crystal also --- they tend to be 4 kHz high. Apply the corrections to the two defined frequencies in the control sketch and you now have a perfectly calibrated transceiver, without needing any offsets outside 0 in the calibration routines. Download and temporarily install *raduino_v1.24GLG25MHZONLY.ino.ino.ino* from the GitHub repository at: <https://github.com/ggibby1/BitX40-1.24-FT857d> to force your Raduino to generate what it thinks is a 25.000 MHz signal so you can measure what it really is – the apply correction to the line that begins with

```
#define SI5351BX_XTAL
```

For further accuracy do the same with the BFO oscillator.

8. **Computer control:** Although it might not work with all CAT controlling software, a simple routine added to the control sketch of the Raduino can make it emulate a Yaesu FT-857d for purposes of frequency control, giving you 9600 baud, 8N1 control of the transceiver for WINLINK purposes. The *raduino_v1.24GLGchangesWorkingCopyBreadPanwithCAT2.ino* sketch mentioned above includes Yaesu emulation and works with WINLINK and with PC-ALE, but so far not with FLDIGI.

9. **Reducing audio squeal and transmit/receive pop:** Add a 1K resistor in series with the wire to the middle terminal of audio gain control potentiometer to reduce or eliminate squeal at lower volume settings. Audio amplifiers Q16 and U1 remain “on” for the first second or so into transmission and this causes an objectionable “pop” and transmitted signal amplification --- there are several solutions for this from an audio turn-off switch using a 2N7000 MOSFET (https://groups.io/g/BITX20/topic/simple_audio_muting_circuit/4995877?p=Created,...20,1,0,0) to a simple 2N3904 switch to more quickly discharge C114, for which the author has a small number of printed circuit boards.

The Bitx20 online forum is a beehive of information and activity related to this fascinating little SSB transceiver. <https://groups.io/g/BITX20> Check it out!