KX0R's BLT Mods – General

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Here are some of the modifications you can do to extend the frequency range of your BLT:

1. Increase or decrease the number of turns on the main inductor.
2. Change the capacitance of the variable capacitors
3. Change the core material
4. Put taps on the main inductor to add a high-frequency range
5. Change the configuration – use a different circuit

I've done all of these things, so next I'll expand on each idea above with what I've learned.

1) There's nothing sacred about the main inductor/transformer (L1, L2, L3) in the BLT. If you wind it by the manual, you'll get good performance on several ham bands, probably 40, 30, and 20 meters, maybe 17, depending on your antenna and feedline.

If you add turns to L1, you'll lower the frequency of operation. Doubling the number of turns for L1 will multiply the inductance by about 4, which will make the frequency about half what it was previously, if the capacitors are left the same. There are a couple of key points if you change L1:

1. If you increase L1's turns, you may want to increase the turns on secondary windings L2 and L3. L2 and L3 should increase roughly in proportion to L1. So if you double the turns on L1, you may want to double L2 and L3 as well. There's nothing critical about any of this – L2 and L3 determine the impedance ratio of the transformer; you may want to change either or both, depending on the load you want to match.

2. If you increase L1 very much, like to get down to 160 meters, you'll need to use a smaller wire gauge. L1 should be a single flat winding if possible – not overlapped over itself.

3. L2 and L3 can be wound between the turns of L1, or over the top of L1. L2 and L3 can be separate windings, as in the manual, or L3 can be taps on L2.

4. Symmetry should be maintained – all three windings should be balanced with respect to the ground tap on L1. If you add or remove turns at one end, do the same at the other end of the winding. The number of turns on L1 should be the same on each side of the ground tap.

2) If you increase or decrease the capacitance of the variable capacitors, you can tune to lower or higher frequencies, as well as match a wider range of impedances.

1. C3 is the main tuning cap. C3 must be multiplied by about 4 to move the frequency down to half what it was previously, assuming that L1 is unchanged.

2. C2 is the input cap, and it affects both frequency and impedance. You may need to increase C2 if you can't match a low impedance near the low frequency tuning limit.

3. C2 and C3 can be increased by substituting larger polyvaricons. These are no longer in production, so they're hard to find. I found some units totaling about 546 pf, and these work well for the 160 and 80 meter bands.

4. Small switches and capacitors can be added to increase the capacitance of C2 and C3. I used SPDT/CENTER OFF mini toggle switches because they offer three values of capacitance: position 1, position 2, and none. They'll fit below or above C2 and C3 if you're careful. Micro toggle switches are OK also.

5. I used dipped mica caps to increase C2 and C3. These are good because they have high Q and are rated for several hundred volts. Even with QRP, C2 and C3 may see RF voltages well above 100V.

6. I found that at high frequencies, like above 18 MHz, the tuning of C3 was sometimes near minimum capacitance and critical. On some of my tuners I added a switch to select just the 60 pf section of the dual-section polyvaricon. This reduces the minimum capacitance slightly, and it makes the tuning easier to adjust on the higher bands.

3) The stock BLT uses a T106-2 core. This has a permeability of 10, which is ideal for the lower bands. For higher frequencies some other toroid cores are better.

1. The T106-6 core is the same size as the T106-2, but the permeability is 8.5; the T106-6 core has lower loss at higher frequencies than the T106-2. If you use a T106-6, you'll need more turns of wire for the same frequency as the T106-2; but you'll also be able to hit higher frequencies with the same number of turns and similar capacitance.

2. I recommend the T106-6 core if you're interested in customizing a BLT for 20, 17, 15, 12, and/or 10 meters.

3. Other powdered iron cores may work fine. For example, a T80-6 should work OK for the upper HF bands. There's nothing critical about these cores at QRP levels. You'll have to experiment or calculate to determine how many turns you need.

4. I built a BLT that covers 15,12,10, and 6 meters. The core is a T80-10; type 10 material has a permeability of 6. L1 has 6 turns. L2 has 4 turns, and it's tapped for 2 turns for L3.

5. I doubt that most ferrite cores would be suitable, since we need a high-Q tuned circuit.

4) If you add a pair of taps to L1, you can create a high frequency range on any BLT.

1. The taps are placed symmetrically on each side of L1. If you have 8 turns on each side of L1 (16 turns total), you might put your taps at 5 turns each side of the ground tap (3 turns from each end).

2. You can add a tap by scratching the magnet wire's insulation with an Xacto knife, tinning the copper, and soldering a piece of wire to the tap.

3. You'll need to add a DPDT mini toggle switch in the center of the BLT's front panel, right above the TUNE/OPERATE switch SW1. The new switch is wired to select either the ends of L1 or the new taps.

4. The LED is moved over on the panel above C2.

5. The closer the taps are to the ground tap of L1, the higher in frequency you can tune to.

6. The turns ratios of L1 to L2 and L3 with the new taps aren't the same as with the entire winding of L1, but good matches may be obtained anyhow.

7. If your new taps are too close to the ground tap of L1, you won't have the right ratios to match low impedances easily, because you still have the original number of turns on secondaries L2 and L3. You can play around with the turns on L3 and find a compromise that works for the bands and loads you want to work with; 4T on L3 might work OK on both ranges.

5) Other circuits can be used to change how the BLT operates.

1. The stock BLT is a relatively balanced design, with the tap on L1 at its center. This is not really a true Z match, but it works well over a somewhat limited range of frequencies.

2. The real Z match is a double-tuned circuit; it usually employs a 2-section variable capacitor to achieve two modes of resonance using a tap on the coil/transformer.

3. I built a "BLT" based on the original Z-match. I used dual 273pf polyvaricons in the double-tuned circuit.

4. My Z-match BLT will match loads from below 1.8 to above 30 Mhz…but…

5. The Z match suffers from poor balance on the higher frequencies, due to stray capacitance and a lack of symmetry. It will tend to match in common mode rather than balanced mode when used with some high-Z loads at the higher frequencies. The result is poor balance on the transmission line.

6. The Z match is a bad choice for matching difficult high-Z loads, running a 40M dipole on 20M, etc.

7. The Z match might be a good choice if you want to use it mostly on the lower bands, or with low-Z or unbalanced loads.

8. There are many variables in the Z match, like where the taps are on the coil, how the capacitors are configured, etc.

9. If you like to experiment with tuners, the Z match is an amazing circuit.

10. The BLT could be built with the original circuit, but with a link or separate winding (L4) for the input. C2 could connect from the bottom of the link to ground. This circuit would resemble the balanced tuners used decades ago.

11. Many other circuits that will work are possible. The BLT is a great starting point.

Here are a few common-sense tips will help you get the most out of any modifications you try:

1. Use convenient hook-up wire for adding any parts, taps, switches, etc. Teflon is ideal because it's low loss and the insulation doesn't melt. #26 and #28 are easy to work with.

2. Make wire connections short. Keep everything neat.

3. Be careful soldering to the polyvaricons. They don't like excess heat. Some mini-toggle switches can't take much heat either.

4. As you add more parts, it's hard to avoid conflicts. Try not to run RF wires alongside each other – maintain separation to reduce stray coupling.

5. Be sure that you don't create a "shorted turn" by the method you use to mount the large toroid for L1/L2/L3. A metal screw through the center is OK, along as it connects to nothing going back around to the chassis.

6. Make sure any switches you add don't short to the polyvaricons.

7. With care you can add many parts to extend the performance of your BLT.

8. As you add parts, you may need to label controls, so you can remember what the switches do, which range is which, etc.

It's easier to build a whole BLT for a different frequency range than to make all the mods to extend one unit to numerous bands. Consider building at least one BLT for the middle bands, another for the low bands, and maybe a third one for the upper HF bands.

If you try to force the unit to operate far outside its design range, losses will increase, and performance may suffer. It's easier and better to make a new BLT for 160M and 80M than to modify the stock unit to go down that far by adding capacitors, etc. The addition of a pair of upper range taps (see above) is a good mod. Adding switches for extra capacitance for C2 and C3 may be just what you need to match a lower band. Remember that adding too many variables will make it harder to find a good match.

Don't expect the make a BLT that covers 160 through 10 meters, with great efficiency and balance over the whole range, while matching everything from 1 ohm to 10K, resistive and reactive. It isn't going to happen. Remember that this gadget is a converter of complex numbers, and while it covers a big range of frequencies and impedances, the math limits what can be done with any set of components.

The SWR bridge in the BLT is good over a very wide frequency range. You can substitute 100 ohm 1W metal oxide resistors (MO) to make it a little more rugged, and the accuracy will be fine. The bridge I use at 50 Mhz uses the MO resistors.

The mod in the manual to add a switch and BNC output for unbalanced operation is a "must have" mod. You need this if you use coax on the output, run a vertical, hook up a dummy load, etc.

A good tool for working on BLT's is an antenna analyzer, such as the MFJ-259B. With a set of small resistors, you can verify the frequencies and loads you can match, without having to use a transmitter. Be sure to set your BLT into "Operate" mode when using your analyzer to test matches.

I've made many measurements on my BLT's. Without getting into details, the losses are generally low when you're matching resistive loads with reasonable impedances. Losses increase when you feed very low and very high impedances, or highly reactive loads, especially with both in combination. When you're in the field, the thing to watch for is sharp, critical tuning – this indicates a bad combination of resistance and reactance, or a less-than-ideal configuration of the settings on the tuner.

Experiment with your BLT(s), and don't hesitate to make changes when you can see a way to reach a particular goal. This is a great matching device, and it will let you do amazing things with low power and real antennas.