Harmonic Sensing of Tank Center

The new harmonic find routine, builds a table with four entries in it. Each entry, in the table, is the mathematical absolute difference between the odd harmonic multiplier and the even harmonic multiplier.
Two parameters are passed at call time. Both values represent frequencies were either a local minima or local maxima were found. These frequencies are well below the *center* frequency of the inductor tank. Since harmonics occur in a linear *order* when stimulated by the microcontroller, we choose to take the 9th and 8th … or the 7th and 6th … or the 5th and 4th and so on (for the odd harmonics).

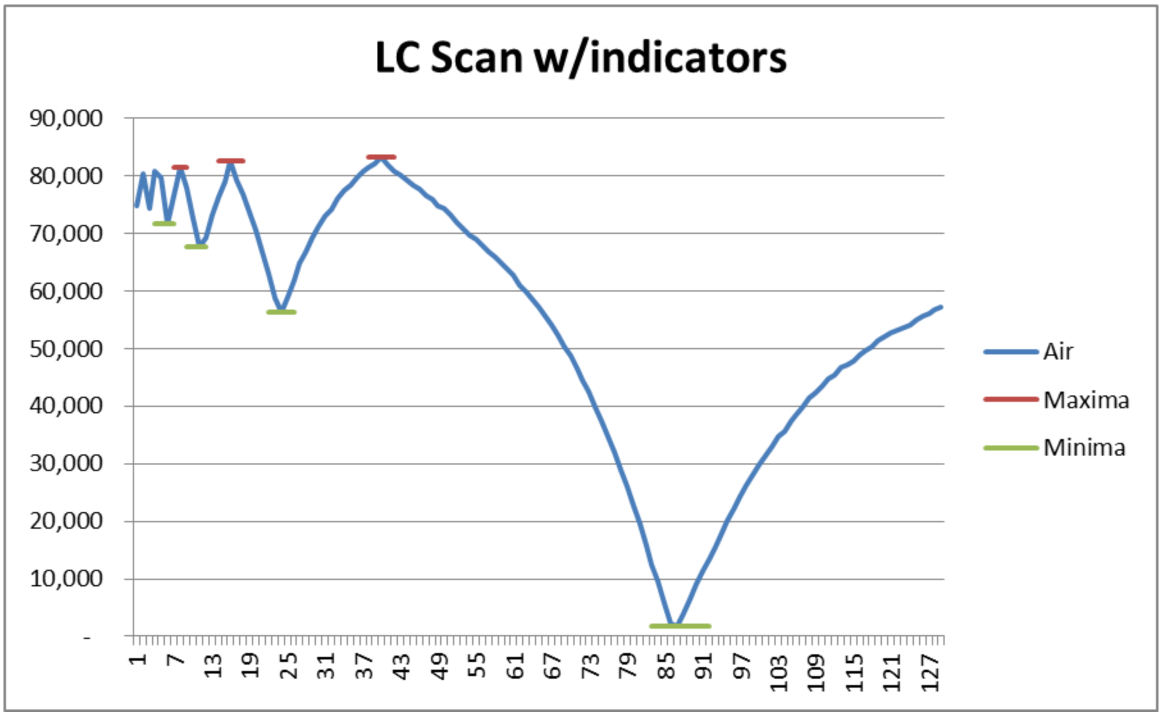


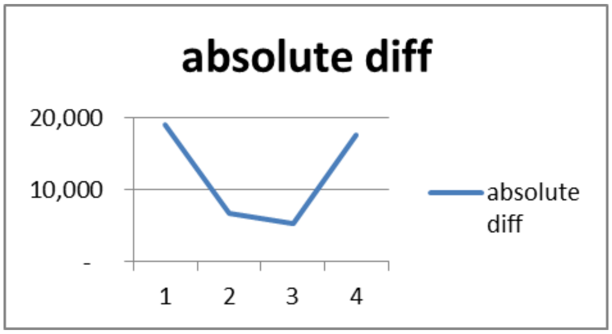
Figure 1 Graph of LC Tank on Propeller

This is an actual scan of my tank, beginning at 20 kHz and ending at 320 kHz. The scan was made with 128 evenly spaced samples. I have marked some of the local minima's and local maxima's on the graph. The scan data labeled 'air' has nothing inserted through the center of the tank, so I call it 'air' for lack of a better term.

As you can see from the shape of the wave in the graph, the tank is reacting to every harmonic that exists. Each of the <u>even</u> harmonics 'peak', and each of the <u>odd</u> harmonics bottom out to create a 'notch'. If we pick an odd-even pair of frequencies from the above scan data at random and place them in a worksheet table, we get:

		Harmonic			
	Reading	**3**	**5**	**7**	**9**
	Freq	**2**	**4**	**6**	**8**
Odd	31,165	93,495	155,825	218,155	280,485
Even	37,255	74,510	149,020	223,530	298,040
	absolute diff	18,985	6,805	5,375	17,555

And if we plot the 'absolute diff' values only from above, we have:



Where, now it becomes evident that the 3^{rd} table entry is the harmonic pair we have just found, with the least difference. These pair of frequencies are $1/7^{th}$ and$1/6^{th}$ of *center*. And they may be used to accurately predict the frequency of *center* for the attached LC tank. For these values shown above, we get the following results:

Predicted	Center	220,843	Hz
Measured	Center	219,356	Hz
	Diff	1,487	Hz
	error	0.678%	

And this prediction is from the $1/7^{th}$ and $1/6^{th}$ readings … yielding a result less than 1% different from the actual *center* frequency of the tank. And it did it with less than 20 readings of the tank total!

However, if the 4^{th} entry in the table becomes the minimum difference for a pair of odd-even locals, you cannot trust that they accurately describe the center of the tank. In such a case, you need to rescan the tank with a higher 'seed' frequency and re-test the new pair. Until, the odd-even harmonic pair 'rank' less than 9^{th} or you run out of spectrum to test.

The end result, of finding the tank *center* using this scheme of harmonic sensing, has three effects:

1. It scans a ***large*** spectrum of possible *center* frequencies *very* quickly!
2. Because the scans are preformed away from *center*, the effect of 'radio noise' is reduced.
3. Even though the propeller is limited to 128 MHz on any given pin, a *center* can be found at much higher frequency! Depending on the 'Q' of the tank.