A lot of us tend to build things from articles or handbooks and really give little thought as to how the device actually works. VE3ERP takes us on the hunt for the elusive Trap Troll to find (not the meaning of life) out how they actually work and how to design our own.

Trap Dipoles for Dummies

The Secrets of Trap Dipole Design Revealed In Plain Language!

BY GEORGE MURPHY*, VE3ERP

I am a real dummy when it comes to understanding antenna theory. However, that didn't stop me from trying to find a trap dipole design to cover both my favorite traditional HF phone band and one of the newer WARC bands. I couldn't find a design in any of the handbooks in my library, nor in any other place, that gave a complete description of how to design *any* trap dipole.

After much browsing, I finally did find an excellent not too technical paper[1] I could understand. This started me on a trail of fascinating clues, culminating in a HAMCALC (version 36 or later)[2] computer program. Early in my Sherlock Holmesing I discovered why the handbooks are somewhat vague and cagey about trap dipoles: The design process is neither simple nor straightforward, involving some nasty forays into the wilds of Iterative Algebra and beyond. For those of us who would rather not get involved in mathematical explanations, I offer the following findings about the trap dipole.

What It Is

A typical trap dipole is shown in fig. 1(A). It is a combination of fig.1(B), a simple 1/2-wave dipole, and fig.1(C), a short off-center loaded dipole which has no capacitors, only inductors. If you are not familiar with short off-center loaded dipoles, just picture two mobile whips (the kind with a loading coil somewhere near the middle) assembled base-to-base horizontally, with the center conductor of a coaxial line feeding one and the braid feeding the other.

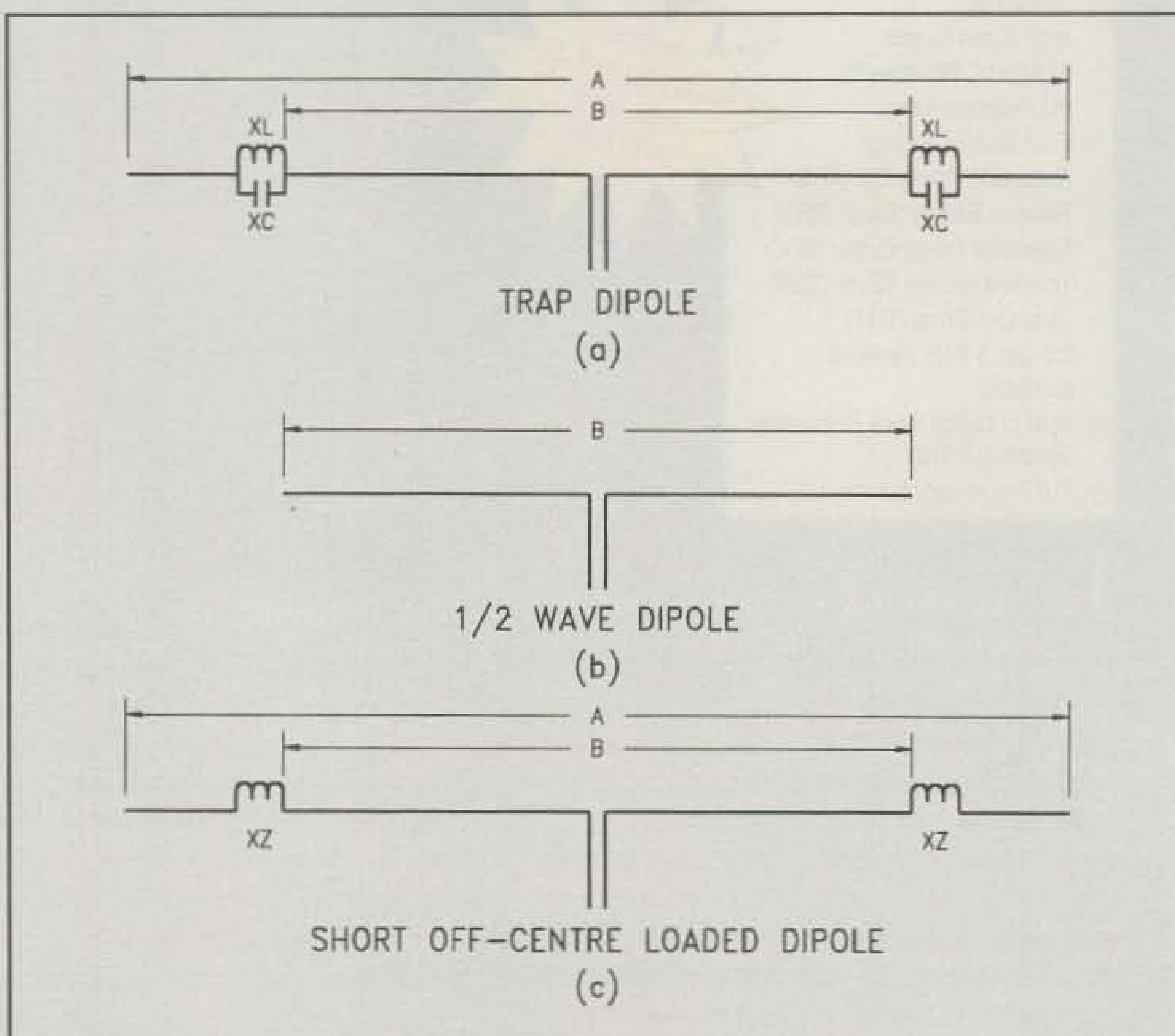

Fig. 1– The evolution of a trap dipole.

How It Works

Each trap in fig.1(a) consists of a an inductor and a capacitor in parallel. The reactances (XL and XC, respectively) of each component vary with frequency; when the frequency is the resonant frequency of the dipole, then XL is equal to XC. This creates an extremely high impedance which prevents RF from travelling past the trap. At other frequencies the reactances of the trap components combine to form a single reactive component. At frequencies

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HIGHER FREQ.		LOWER FREQ.			TRAP					
	B		A	Xz	L				C	
MHz	FEET	MHz	FEET	ohms	uH	FORM DIA.	No. OF TURNS	LENGTH	pF
28.837 (10m)	16.23	24.940	17.87	1263	2.03	1.050 in.	13	2.15 in.	15
		21.224	20.17	591					
		18.118	23.04	382					
		14.174	29.01	238					
		10.125	41.02	147					
		7.148	59.52	97					
		3.742	118.53	49					
		1.897	240.10	24					
24.940 (12m)	18.77	21.224	20.94	1094	2.26	1.050 in.	14	2.26 in.	18
		18.118	23.65	545					
		14.174	29.34	298					
		10.125	40.98	172					
		7.148	59.21	111					
		3.742	117.93	54					
		1.897	239.43	27					
21.224 (15m)	22.05	18.118	24.52	1118	2.81	1.315 in.	13	2.30 in.	20
		14.174	29.74	452					
		10.125	40.69	232					
		7.148	58.36	142					
		3.742	116.54	68					
		1.897	237.81	34					
18.118 (17m)	25.83	14.174	30.71	738	3.22	1.315 in.	14	2.34 in.	24
		10.125	41.05	297					
		7.148	58.14	171					
		3.742	115.70	79					
		1.897	236.71	39					
14.174 (20m)	33.02	10.125	42.23	546	4.20	1.315 in.	17	2.72 in.	30
		7.148	57.97	253					
		3.742	113.82	106					
		1.897	234.10	51					
10.125 (30m)	46.22	7.148	57.97	515	5.75	1.660 in.	16	2.59 in.	43
		3.742	112.15	156					
		1.897	230.60	71					
7.148 (40m)	65.47	3.742	112.11	259	8.00	1.660 in.	21	3.39 in.	62
		1.897	226.60	103					
3.742 (80m)	125.07	1.897	220.85	264	16.45	2.375 in.	23	3.74 in.	110

Fig. 2– Design considerations for building your own trap dipole antenna. Values are based on #12 AWG wire construction with trap reactances near 375 ohms. Coil form sizes are schedule 40 black plastic pipe.

above the trap's resonant frequency the trap behaves as a capacitor, and below the resonant frequency the trap behaves as an inductor. Therefore, in fig.1(C) the single inductance XZ is actually the trap behaving as an inductor. What it all boils down to is this: When you have a dual-band trap antenna, you are running a 1/2-wave dipole at the higher frequency and an off-center loaded dipole at the lower frequency.

How To Make It Work

Let me lead you down the garden path for a few steps:

1. Decide what size wire you want to use for your antenna.

2. Determine center frequencies of two selected bands of interest. Depending on how fiddly you want to be, these may be the center of an entire band, or the center of any particular part of a band.

3. Determine length B of the 1/2-wave dipole, fig.1(B), for the higher of the two selected frequencies.

4. Determine values of the trap components. Any values of inductor L and capacitor C will work as long as their reactances are equal at the frequency of the higher of the two bands selected. Equal but relatively low reactances will produce high Q but very narrow bandwidth traps. Equal but relatively high reactances will produce more acceptable bandwidth, but at the expense of reduced Q. Reactances in the range of 300–450 ohms are recommended. Decide on a reactance (375 ohms is a good place to start) and calculate the values of C and L at the resonant frequency of the 1/2-wave dipole, fig.1(B).

5. Select a standard-value capacitor as near as possible to the optimum value determined in step 4.

6. Find or design the trap inductor.

7. Find reactance of each trap component at the lower of the two selected frequencies using the values of L and C determined in step 4.

8. Find net reactance XZ, fig.1(C), of the trap at the lower of the two selected frequencies.

9. Calculate length A, fig.1(C), for the lower of the two selected frequencies, from known factors B (step 3), XZ (step 8), and the diameter of the wire (step 1) to be used.

Final Comments

Since this article is primarily about design, I won't get into component selection or construction details. You can find this information in almost any amateur radio handbook.

Bench test the traps for resonance at the selected higher frequency before assembling the antenna and, if necessary, alter the coil turn spacing to adjust the frequency. As with most antennas, be prepared to do some pruning to achieve minimum SWR in your particular site environment. Antenna height, feedline factors, soil conditions, surrounding trees and buildings, and many other local conditions all affect performance. Prune only the wire lengths, as any further changes to the traps may upset the apple cart and you may have to start all over again.

If you want to design a trap dipole, you have a choice of three ways to do it:

a. The EASY way.
b. The HARD way.
c. The BEST way.

If you choose *a*, the easy way, then select one from fig. 2. It has already been designed for you. If you choose *b*, you can track down the same sources I had to find and do all the calculations by hand. Or, if you choose *c*, you can use your computer to design a trap dipole in the length of time it takes to make two keystrokes and enter four numbers—about 12 seconds. The 36 antennas listed in fig. 2 were designed (including the coils) in less than 10 minutes.

Now if only I could figure out how to program my VCR. . . .

Footnotes

1. *The ARRL Antenna Book*, 14th edition, pages 8–3 to 8–5.

2. HAMCALC is FREE software containing more than 200 programs (including trap dipole design) of interest to radio amateurs and professionals. To obtain it on an MS-DOS/Windows 3 1/2 inch diskette send USA$5 (to cover costs of materials and airmail anywhere in the world) to the author, George Murphy, VE3ERP, at the address shown at the beginning of this article. ■