The distributed capacity twisted loop antenna returns to duty on 80 meters with theories, formulas, and charts.

Roll Your Own Compact 80 Meter Wire Loop

BY JIM McLELLAND*, WA6QBU

If you live, like I do, in one of those "planned" communities that "forgot" to allow amateur antennas in the CC&Rs (Covenants, Conditions, and Restrictions), then this article may just be for you. When I first started hamming at my present QTH, 10 meters was hot and a wire in the attic with a QRP rig was fine. Lately, however, I've found my need for lower HF antennas increasing in inverse proportion to the sunspot cycle (which is going down, in case you haven't noticed).

Unfortunately, no outside antennas of any sort are allowed in my community. This prompted me to develop the DCTL (Distributed Capacity Twisted Loop). It has already proven itself on 40 and 160 meters, and this 80 meter version completes my lower HF antenna system. The loop hangs on the *inside* wall of my shack. It is cheap, portable, and easy to set up. If you don 't have room for 80 meters, or just like to build antennas, try the DCTL, and you too can add another band to your station.

**935 East Cotati Ave., Cotati, CA 94931*

Description

The DCTL is a 28 foot delta loop fed at the bottom apex. The impedance is matched with a shorted hairpin stub, and the resonant frequency is tuned with an open stub. The whole antenna system, including the feedline, is made from 300 ohm twin lead. To complete your understanding of the DCTL, however, you'll probably need to look at fig. 1. Notice the "twist." That's the tricky part that gives it so much distributed capacitance, and what makes such a small antenna work at low frequencies.

Construction

If you refer to fig. 1 and follow these simple steps, you'll have an antenna in about an hour. Use Radio Shack 15-1153 twin lead or the Antennas West Kit listed at the end of the article to make each section.

1. Cut the loop (LL) exactly 28 feet long.

2. Cut the shorted hairpin stub (LZ) exactly 4 ft. 6 in. long.

3. Cut the open stub (LC) exactly 30 in. long.

4. Cut the feed line to any desired length.

The author's 80 meter DCTL enhances the decor of his shack. Notice, however, that his XYL is still smiling.

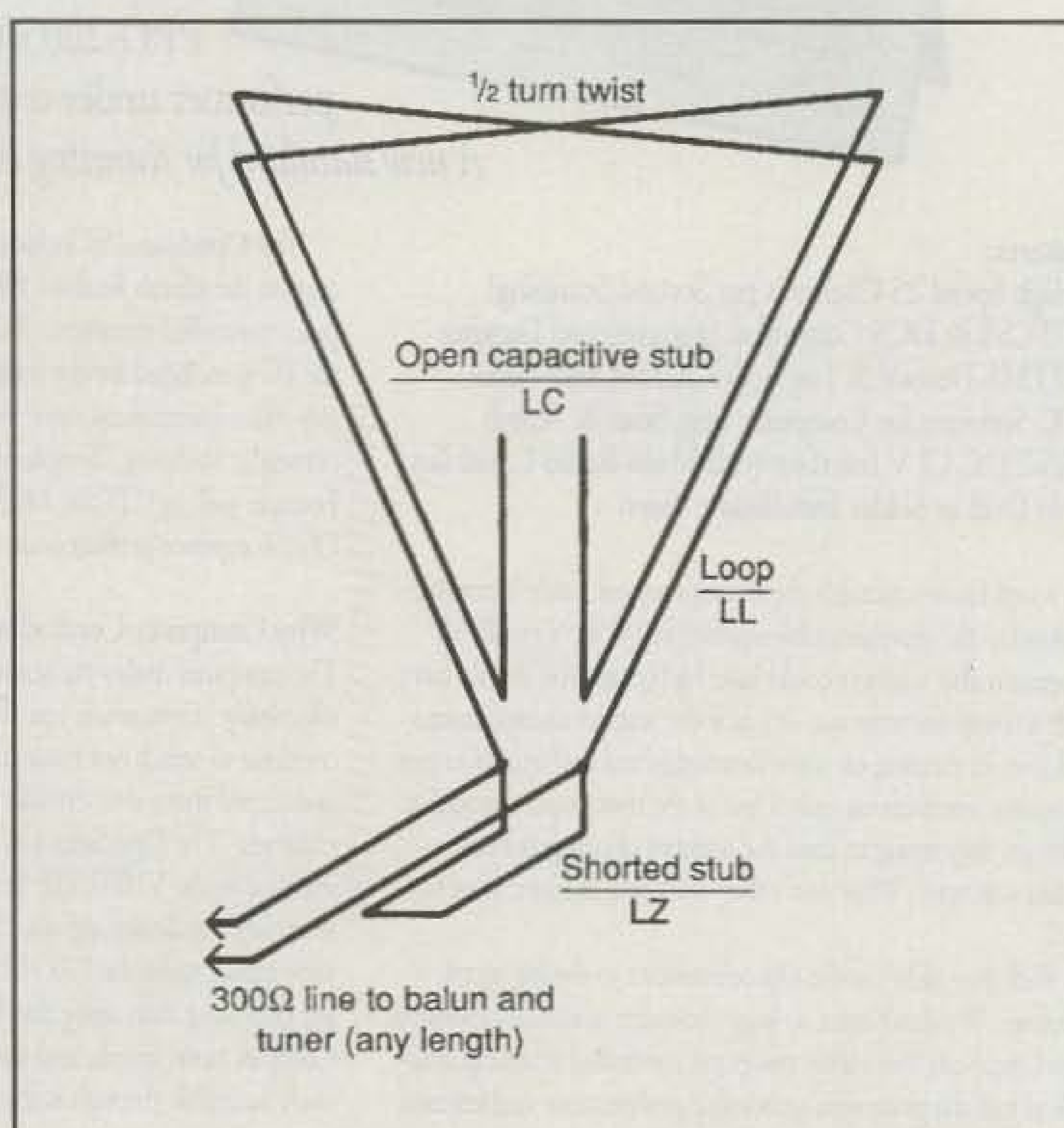

Fig. 1– The 80 meter DCTL dimensions.

5. With a sharp knife, split the end of each section, except for the capacitive stub, two inches down the middle. The capacitive stub only needs to be split on one end.

6. Then strip 1/2 in. of insulation from every pair of wires formed by splitting the section ends.

7. Now, with the 28 ft. loop (LL), locate the wires on opposite ends of the twin lead that **DO NOT** connect to each other. This is critical and is best done with an ohmmeter looking for an open circuit (see fig. 1). Then label as **lead-in**. The other two opposing loop wires connect to the capacitive stub (LC).

8. With the 4 ft. 6 in. hairpin (LZ), short the two wires at one end together, solder, and cover with 1/4 in. shrink tubing.

9. Attach banana plugs to one end of the lead-in section.

10. Slip 1 1/2 in. long pieces of 1/4 in. shrink tubing on every wire end of the 28 ft. loop piece.

11. Solder and heat shrink each connection per fig. 1. **DO NOT** put any two connections close together by taping or by using another piece of shrink tubing. This will cause excessive heating.

I.	Total length in feet	LT	=	$\frac{130}{\text{Frequency MHz}}$
II.	Shorted stub hairpin impedance match	LZ'	=	$\frac{27}{(2 \times \text{Freq. MHz}) - 2}$
III.	Loop length	LL'	=	LT – LZ
IV.	Capacity tuning stub length in inches for a 100 kHz change in frequency	LC''	=	$24 \times \frac{1}{(\text{Freq. MHz}/2)^2}$
V.	Bandwidth in kHz (2–1 SWR points)	BW	=	$\frac{\text{Frequency MHz}}{100}$

Table I– DCTL formulas (for Radio Shack 15-1153 twin lead).

Band	LT	LZ	LL	LC (for 100 kHz) (lower freq.)
2.0	65' 0"	13' 6"	51' 6"	24"
4.0	32' 6"	4' 6"	28' 0"	6"
7.3	17' 10"	2' 2"	15' 8"	1 3/8"
*10.15	12' 10"	1' 6"	11' 4"	1"
*14.44	9' 0"	1' 0"	8' 0"	1/2"
18.14	7' 2"	0' 10"	6' 4"	NA
*21.37	6' 1"	0' 8"	5' 5"	NA
*24.96	5' 2 1/2"	0' 6 1/2"	4' 8"	NA
*28.36	4' 7"	0' 6"	4' 1"	NA

**Please note that data for the starred bands has not been tried, but the formulas worked quite well for all antennas built so far.*

Table II– DCTL band chart.

Installation

After the construction is completed, all that's left is literally to hang it up. Naturally, all the "normal" antenna rules—such as way up high and away from everything—apply, but if you could do all that, you'd have a beam at 100 ft. and probably wouldn't be reading this anyway. So let's consider the worst case—hanging an antenna inside the QTH.

With the feedpoint angle between 60 and 90 degrees, the antenna easily fits on the inside wall of a normal house. I find that a 10 ft. top side and 9 ft. sides down to the feedline work great, and you only need two hooks to make the whole thing work. Find an appropriate wall or other location and hang it up with the feedpoint angle down. The open stub should be away from the other antenna parts, and the shorted stub can hang loose or be twisted loosely around the feedline. Be careful to avoid all metal, especially within or on the outside of the wall, where you might not otherwise think about it. Then connect the antenna through a 4-1 balun to the tuner and rig and you're ready to try it out.

Tuning

Without a tuner, you can find resonance (near 3.5 MHz) by tuning for the lowest SWR or by using a noise or antenna bridge, if you have one. Adjust the resonant frequency by starting with an open stub longer than necessary and trimming it to the desired point. Remember that cutting 6 in. off raises the resonant frequency approximately 100 kHz. I prefer to tune the antenna to the middle of the band on which I want to operate and use my tuner to swing across the band. However, you could just build the antenna for the middle of the band, knowing that it probably will resonate somewhere near where you want it, and use your tuner to do the rest of the work without trimming anything at all. My model, hung from the living room balcony plants, tuned to 3800 kHz with a 6 in. open stub. This was about 100 kHz lower than the formula predicted. The exact frequency depends upon the angle at the feedline and how much capacitive coupling the antenna has to other objects.

I have also built two different remote resonating systems. One uses relays to switch in different lengths of capacitive stub (LC), and the other has two pieces of coax braid taped to opposite outside walls of a piece of 3/4" PVC tubing. They are connected to the LC terminals, and a piece of 1/2 in. copper pipe slides in and out to raise and lower the effective capacitance. All this was done, of course, after the XYL retired for the evening. She did mention, though, that one of her plants is looking poorly! Hmmm . . .

Theory

To understand how the DCTL works, one must first start with some general dipole concepts. Halfwave dipoles in free space resonate with a balanced impedance of about 75 ohms. It is interesting to note that a dipole's resonant frequency lowers when the ends are placed close to a ground plane so that their actual length is a little less than halfwave. Another interesting point is that the impedance also lowers to about 50 ohms (like an inverted Vee). Instead of placing the ends near ground, they can be bent around into a loop (more or less) and placed near each other. Either way, the effect is to cause capacitive coupling between the endpoints. If the loop ends have a high enough capacitor (with a very high voltage rating) between them, then the resonant frequency length will be much less than halfwave and the impedance much lower than 75 ohms. The bandwidth will also be very narrow in comparison to a standard dipole.

The DCTL uses the insulation between

the two conductors in twin lead as dielectric for its capacitor. Furthermore, this capacitor is evenly distributed along the whole length of the loop. At the open ends of the loop a small additional capacitance is added in the form of an open stub to tune the antenna across the band. Without any impedance matching, the basic DCTL resonates at about 1/8 wavelength. Impedance matching adds some inductance and lowers the resonant frequency even further, so the final loop length ends up at about 1/10 wavelength, which is as small as a loop should be while still having enough efficiency to put out any kind of a signal at all.

Matching is necessary because the loop only has about 5 ohms of impedance. This is accomplished with a "hairpin" impedance matching transformer. This is a short-stub device that transforms very low impedances into higher impedances (such as 5 ohms to 300 ohms) by adding some inductance at the antenna feedpoint.

The Final Result

The final DCTL version resonates at 1/10 wavelength, has an impedance of 300 ohms, and has a 2:1 SWR bandwidth 1/100 of the resonant frequency. Also, the radiation pattern is a figure-eight in the plane of the antenna (the opposite of a dipole) with a front-to-side ratio of about 30 dB and an angle of radiation that goes from very low to very high. Also, while checking the pattern with a field strength meter, I was surprised to find that there is a small area on the side with no detectable radiation at all. I actually could follow this dead spot right into the loop's center with no meter indication. Additionally, the feedpoint can be mounted at ground level, which puts the peak at about 0.03 wavelength. Try doing that with a dipole and see what happens. You'll warm the worms in the ground below, but you won't put out much signal.

In comparison, I've had all my models, including the 160 meter version, hanging in the living room for testing with good results. Finally, the noise level is way down. In QSOs signal reports are usually similar on both ends, but my noise level is sometimes six S-units lower than the noise level at the other station. On 80 meters signals are strong with little or no QSB, and I easily can copy all of North America. The station I've worked gave me good reports, and I was surprised that I could also copy Hawaii and New Zealand, although I haven't tried to work stations that far away yet.

So get with it! Try a DCTL on 80 meters or any other favorite band (see Tables I and II for formulas and band chart) and enjoy compact, low-noise operation where you otherwise might not have room to operate at all.

Parts List

Note: All parts needed to build this antenna can be obtained by ordering the Compact Loop Experimenter's Kit. The parts list includes:

Twinlead 5/16 in.—100 ft.
Shrink tubing 3/8 in.—1 ft.
Shrink tubing 3/16 in.—1 ft.
Banana plugs—2
Dacron line—50 ft.
Double split twinlead insulator with hardware—4

Introductory price with shipping is $24. The kit is available from Antennas West, 1500 N. 150 W., Provo, UT 84604 (801-373-8425). ■