Transmitting Loops Revisited

The interest in large HF-band loops remains high. Here are some ideas that you can apply toward multiband loop construction.

By Doug DeMaw, W1FB
ARRL Contributing Editor
PO Box 250
Luther, MI 49656

Lee Aurick (W1SE/4) and I described low-height delta loops in October 1984 *QST*.[1] Since that paper appeared in the journal, Lee and I have had a continuous flow of letters from readers. Many questions have been asked about possible variations in the loop design and configuration. I must say that our typewriters have been busy! This article provides the answers to many of the questions we have fielded since 1984, and includes some new information.

Using the 80-meter Loop on 1.8 MHz

One of the often asked questions about the 80-meter full-wave loop is, "Can I use this antenna on 160 meters?" The answer is "yes and no." Rather nebulous, eh? First, I will say that loop performance on half the fundamental frequency is miserable. A closed half-wave loop can be force fed with a Transmatch in order to provide an SWR of 1:1 for the transmitter and receiver, but the antenna gain will be somewhat less than that of a half-wave dipole. Some Transmatches will not have sufficient tuning range to obtain an SWR of 1. Transmatches that have variable capacitors with small plate spacing will arc and overheat at high power levels when a half-wave closed loop is used. Because of these problems, my answer to the earlier question is "no." But there is a "yes" part for the question also.

Fig 1 shows the arrangement I used in 1986 for loop operation from 160 through 10 meters. You will see that it is not a loop by definition. The point electrically opposite the feed terminals is open. This arrangement is frequently referred to as a half-wave open loop (at 160 meters in this example). Technically speaking, an antenna is not a loop unless it consists of a *closed* circuit. So much for semantics!

The antenna in Fig 1 was used during the summer period in closed form. I did not use the 160-meter band then, owing to QRN. The loop was cut for 3.8 MHz in accordance with $L_{feet} = 1005/f_{MHz}$. This arrangement worked effectively from 80

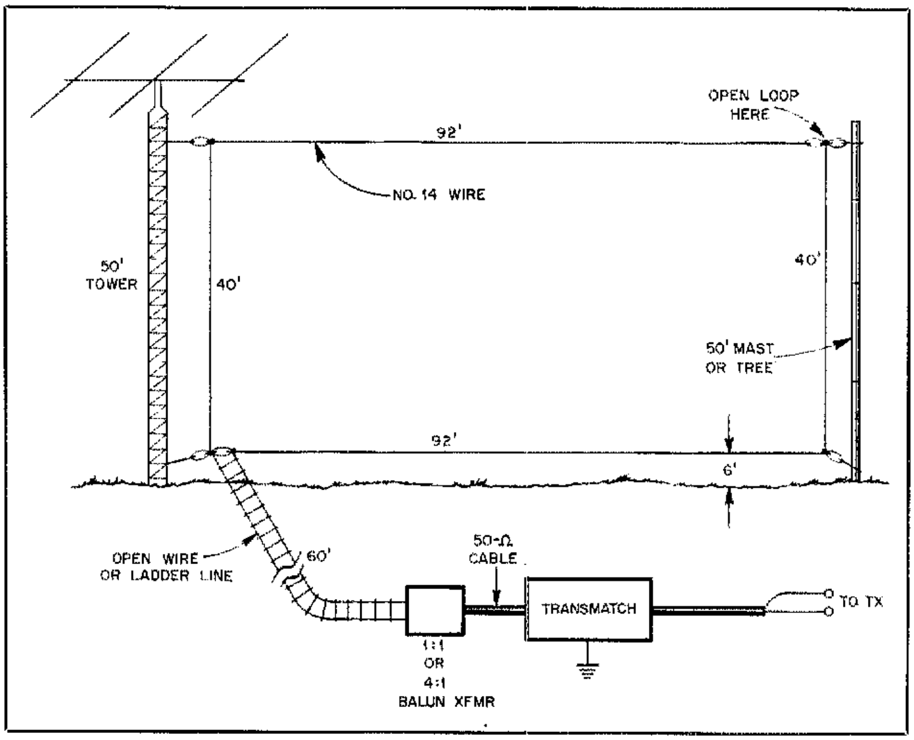

Fig 1—Dimensions for a full-wave rectangular loop that is suitable for use from 160 through 10 meters. At 1.8 MHz it operates as a half-wave open loop (misnomer). See text for further information.

[1]D. DeMaw and L. Aurick, "The Full-Wave Delta Loop at Low Height," *QST*, Oct 1984, pp 24-26.

through 10 meters by virtue of the balun transformer and Transmatch. On 40 meters the SWR was no greater than 1.4:1 across the band, without the Transmatch. A 4:1 balun transformer was used.

Opening the Loop

As may be seen in Fig 1, the antenna consists of two independent wires, each 132 feet long. In essence, we now have an inverted L antenna (top section and left-hand vertical wire). The bottom section and right-hand vertical wire serve as a counterpoise against which the top section is worked. This eliminates the need for a collection of buried radial wires, although a good ground screen will provide better overall performance for an inverted L than can be expected from a simple counterpoise, as shown.

My results on 160 meters with this antenna were excellent. I had good coverage within the US, and I had no trouble working European and South American stations with 500 watts of output power. Performance on the bands from 80 through 10 meters was similarly impressive.

Antenna Height

The experts may argue that a loop so close to the ground is not worth considering. Needless to say, the greater the loop height the better it will perform, especially for DX operation (lower radiation angle). I find this to be generally true when feeding the loop at the center of the top or bottom wires (horizontal polarization). However, with the lower corner feed as shown in Fig 1, polarization is principally vertical, and the radiation angle appears to be fairly low. The rectangular format is necessary for me because my antenna supports are only 50 feet high: The more rectangular the loop becomes, the lower the gain with reference to a completely circular loop. The latter shape yields the greatest gain.

A question often asked is, "How can I fit a loop onto my small city lot? Can I distort the shape and fit it into the available space?" I have found that almost any convenient shape will work, provided the loop is resonant at the operating frequency. A recent letter from Cal Simsen, W7WXW, contained a sketch of his "somewhat" delta loop. The shape conforms to the support-pole height and space he has available. This is shown in Fig 2. Despite the antenna not forming an equilateral triangle, he reports excellent multiband performance. Bill Martinek, W8JUY, has an 80-meter delta loop strung between two tall trees. He has the apex down, and that is where he feeds the loop. The top of the triangle is substantially longer than the two sides, but the system works very nicely on all HF bands. I have seen other loop antennas that had shapes I will not attempt to describe. Irrespective of the Ugly Duckling appearance, the users reported good results. Take heart if you have limited space for a loop. Don't be afraid to experiment with odd antenna shapes!

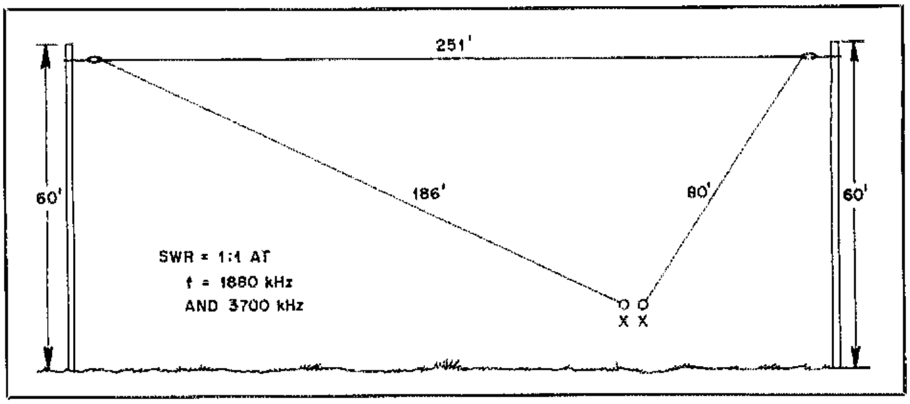

Fig 2—Details for the nonuniform delta loop used at W7WXW. It works well even though it is not an equilateral triangle.

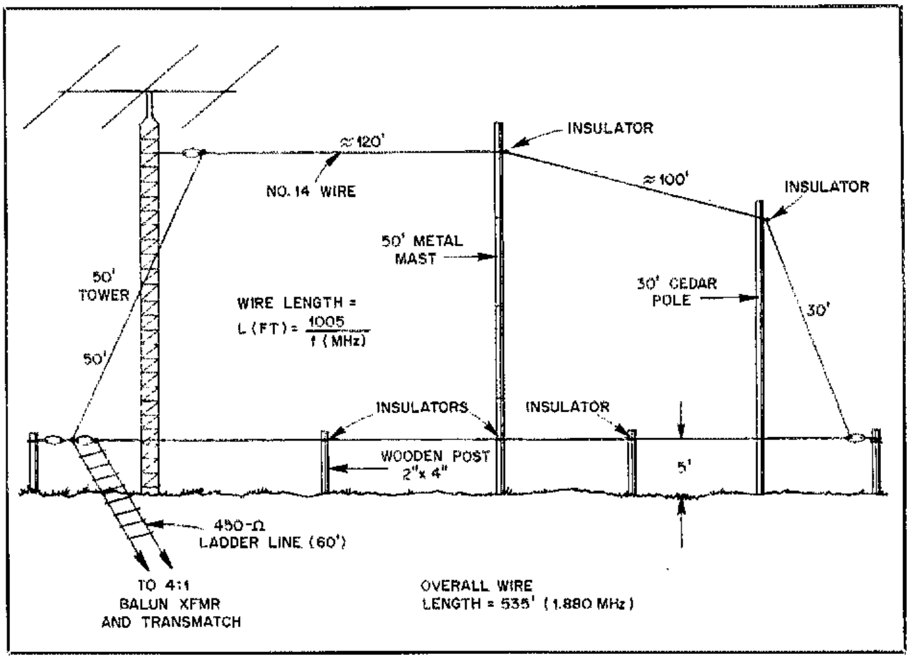

Fig 3—Arrangement used at W1FB for a multiband loop. Lower corner feed yields vertical polarization and a low radiation angle. This somewhat rectangular loop is low to the ground, but it performs nicely from 160 through 10 meters. Feed-line length is not critical provided the length of the 50-Ω cable between the balun transformer and the Transmatch (see Fig 1) is less than 15 feet. The balun transformer must be designed for use at 1.8 MHz and higher.

Vertical Versus Horizontal Loops

Another common question I have been asked is, "Will a horizontal loop (parallel to ground) work as well as a loop that is erected vertically (perpendicular to ground)?" At this point I always ask the person what his frame of reference is. How good is good, or what do you mean by "good"? That term is a mighty broad one!

I have used horizontal and vertical loops a number of times. My experience indicates that a horizontal loop is a poor performer for DX unless it is a half wavelength or greater above ground. The closer it is to earth the higher the radiation angle. You may compare this to a two-element beam antenna. The ground acts as the reflector in this example. Horizontal loops that are close to ground (¼ wavelength or less, for example) shoot the signal skyward on the fundamental frequency of the antenna. This can provide super results for short-haul work (300 to 1000 miles on 80 meters), and this type of loop may greatly outperform an 80-meter dipole at 60 or 80 feet. If this loop is operated on its harmonics, various radiation angles result, and the system can offer reasonable performance on the bands above the lowest resonant frequency of the loop. I once used a diamond-shaped loop on Montserrat (VP2MFW) that was 60 feet high and 1000 feet on a leg. It was parallel to ground and fed with a balun transformer and 50-Ω cable. The DX performance from 160 through 10 meters was phenomenal. (However, it was erected on a cliff next to the ocean, and at least 20 additional dB in the signal reports was a result of the exotic call sign!) I would not hesitate to recommend a parallel loop of that type if you have room for it.

Choice of Wire

Rule no. 1 is to use large enough wire to avoid damage during ice and wind storms. No. 14 or 16 Copperweld® is good if you don't make sharp kinks in it. Kinking cracks the copper covering, and the steel core will eventually rust through. Use gentle bends when handling this wire.

I use stranded no. 14 wire in my loops, and it seems to endure nicely. Some amateurs have reported problems when using plastic- or cloth-insulated wire. They could not make the antenna resonate when using the $1005/f_{MHz}$ formula. I suspect that the insulation changes the propagation factor of the wire and causes the resonant frequency to be lower than the calculated value. I have not attempted to prove this theory, but it's worth investigating.

A 160-10 Meter Rectangular Loop

I no longer use the antenna in Fig 1. I decided it would be better to erect a full-wave loop for 160 meters, even though it would be *very* rectangular in shape. This antenna is shown in Fig 3. You will note that three supporting structures are required, owing to the long span of the top and bottom loop wires. Thus far the performance on 160, 80 and 40 meters is excellent. Although the antenna is broadside north and south, it appears to work well to the east and west on the three bands. Maximum directivity should be in the plane of the loop on harmonic frequencies, and the strength of the European and Oceanian signals on 80 and 40 meters tends to bear out this theory. I have copied VK signals at RST 579 on 1.833 MHz at 1100Z (September 1987), although I did not care to enter the pileup.

I have observed also that the 160-meter loop is superior to my triband Yagi on 20 meters part of the time, respective to signal-strength readings on European signals. It depends upon the time of day and on propagation conditions at a given instant. This is because the loop has, in theory at least (with lower corner feed), a lower radiation angle than the tribander has at only 55 feet above ground. There are times, however, when the strength of monitored DX signals with the Yagi exceeds those with the loop by 3-6 dB. The loop is always quieter (QRN) than is the Yagi. This is characteristic of a closed loop, and it can really pay off on 160 and 80 meters during weak-signal reception.

Closing Comments

Full-wave loops present a feed impedance of approximately 115 ohms. At harmonic frequencies the loop impedance varies from 80 to 250 ohms, as observed during my measurements. You may check the resonant frequency of your loop by observing the frequency at which the SWR is lowest (resistive condition) or by connecting a small 6-turn loop of wire across the feed terminals and checking the resonance with a dip meter.

Loops are affected less than are dipoles by nearby conductive objects. Maybe this is because a loop antenna has a low Q. This characteristic causes the antenna bandwidth to be somewhat greater than it is for a half-wave dipole or vertical antenna. A square or circular loop has a greater aperture (capture area) than a dipole, and hence has a slight gain over a dipole.

I hope this update answers your questions. Perhaps it will inspire you to try this fine antenna, even though it may be necessary for you to adopt a nonuniform antenna shape.

New Books

HANDBOOK OF PRACTICAL IC CIRCUITS

By Harry L. Helms, KR2H. Published by Prentice-Hall, Inc, Englewood Cliffs, NJ 07632. First edition, 1987. Hardcover, 6 × 8 inches, 163 pages, $34.95.

Open any piece of electronic gear these days and you'll find ICs. These "black boxes" can be mystifying for the beginner in electronics. Harry Helms' book provides enough information to show an interested beginner how to design and build with linear and digital integrated circuits.

The book is an IC "cookbook"; as Mr Helms states in the preface, "This book is a collection of IC 'recipes.' The emphasis here is not on designing IC applications circuits 'from scratch,' but rather on working, debugged circuits that are ready to be used." Mr Helms begins with a short chapter introducing ICs. Included is some information on their history, the techniques used to fabricate ICs and the different "families" of linear and digital ICs. The first chapter also features some general information about power-supply requirements and construction tips. The rest of the book provides the recipes. Beginning with op amps in Chapter 2, Mr Helms introduces the more commonly used ICs and shows a few simple circuits that can be built with each chip. Chapter 2 also contains information on using audio-amplifier and comparator ICs.

Chapter 3 contains more information on linear circuits, including the popular 555/556 timer ICs, voltage-controlled oscillator and function-generator chips, phase-locked-loop devices and voltage-regulator ICs. Sample circuits are provided for each chip, along with short descriptions of the ICs and their applications.

TTL ICs are covered in Chapter 4. The chapter begins with a very good overview of TTL, including tips on building with TTL ICs. The chapter continues with descriptions of some of the more common TTL ICs, and again Mr Helms gives a general discussion and provides sample circuits for each IC.

Chapter 5 provides information about using CMOS ICs. A chart showing the commonly used CMOS IC part numbers is provided, along with pinouts and sample circuits for many of the typical CMOS ICs.

Chapter 6, "Tying It All Together," discusses interfacing TTL and CMOS ICs and describes some simple interface circuits. Debugging and troubleshooting are also covered in this final chapter. A section in this chapter shows the reader where to go for more information and lists the addresses of several major IC manufacturers. This way, the reader is not left to fend for himself; Mr Helms makes it clear that this book cannot provide all the information required to design and build with integrated circuits.

This is a useful book. It is rather small for the $34.95 price tag, but the information provided is basic and fundamental. Many useful circuits are shown in the book. Along with the tutorial discussions, *Handbook of Practical IC Circuits* is a source of useful reference information. This is the kind of book that ends up dirty, slightly torn and splattered with solder, within easy reach on a corner of a builder's bench.—*Bruce S. Hale, KB1MW*

Strays

THANKS FOR THE HELP!

While he was on Guam, George Mateyko, N1BEX/5, ran a request for information on the HB35T TET 5-element HF antenna in Strays. George was overwhelmed by the response, and the antenna worked fine. George would like to thank those who responded; he reports he is now back stateside in Martha, Oklahoma and the antenna is still working fine.