KR1S Hoop Loop Ultralight Radio Antenna

Construction
The KR1S Hoop Loop is built on a 23-inch quilting hoop, purchased at Jo-Ann Fabrics. The base is seven inches in diameter and is sold as the mounting plate for clocks. Having a turntable made it possible to solidly mount the hoop to the base. The antenna has three turns of #24 magnet wire. The radio antenna is replaced with a matching transformer. This transformer operates in a way that wasn't apparent to me until someone more knowledgeable explained it.

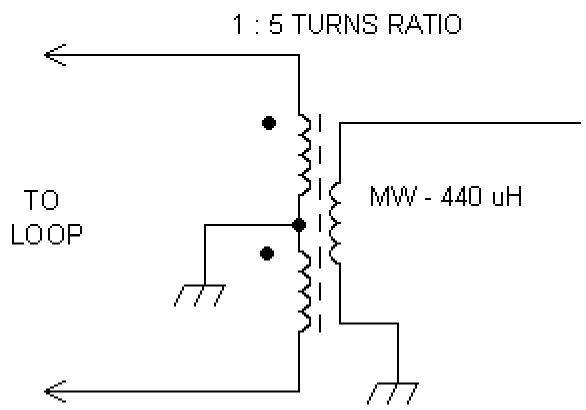
Theory
The matching transformer steps up the inductance or impedance of the antenna. The transformation ratio of the transformer is the square of the turns ratio. If the turns ratio is 1 : 5, the transformation ratio is 1 : 25. A 16-uH antenna is transformed to 400 uH at the secondary. This inductance appears in parallel with the transformer secondary inductance, and that parallel inductance is what the radio tries to tune. Therefore, that parallel inductance should be within the range of 180-450 uH for a Tecsun DSP radio. For medium-wave reception, higher inductance is not helpful, and about 250 uH would be good. You calculate the total inductance of two inductors in parallel by dividing the product of their inductances by the sum. It turns out that a transformer secondary inductance of 440 uH, a 1 : 5 turns ratio and a 16-uH antenna presents an inductance of 210 uH to the radio.

The transformed inductance is tuned by switched capacitors on the radio integrated circuit. The antenna impedance is transformed up by the primary-to-secondary turns ratio, so the chip sees the combination of transformer and antenna as a tuned antenna system.

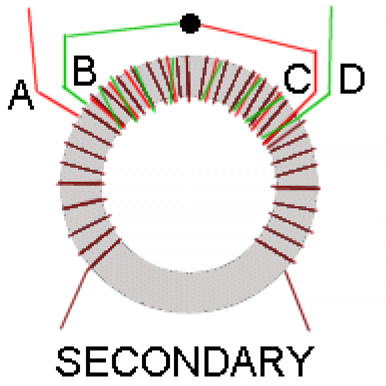
A 1/8" mono headphone jack is installed on the side of the radio where the wrist strap formerly attached. The core nicely fits into the space between the end of the internal antenna and the side of the case.

The antenna doesn't have to have three turns, or be any particular size. Keeping the antenna inductance below 20 uH reduces the number of turns required and presents a relatively low impedance to the transmission line. It also allows for a transformer turns ratio commensurate with good coupling. A difference of one turn on a three-turn antenna has a huge effect on inductance. If you use a different size hoop or another loop configuration, you'll have to calculate the number of turns needed to keep the loop inductance in the range of 10-20 uH, assuming a turns ratio of 1 : 5.

This drawing shows a schematic of the matching transformer.



The primary is a center-tapped bifilar winding, with total reactance closely matching the loop's reactance. I say "closely matching" because the primary winding must have an even number of turns. I got this idea from one of the co-inventors of the SiLabs DSP chip, the same "knowledgeable source" mentioned above. As he explained it, using a bifilar winding with grounded center tap, common-mode signals see one-quarter of the primary inductance. Reducing common-mode pickup leads to deeper nulls, especially on stronger local stations.



This drawing shows how the transformer is wound. I used different colors for clarity, but of course you can use the same color magnet wire for all windings; you'll only have to sort out the bifilar primary windings with an ohmmeter. Twist the bifilar primary wires lightly together. Two turns per inch is good enough. After winding, B and C are connected together and to the ground side of the secondary (connection not shown). A and D are the antenna terminals.

This modification removes the internal antenna. If you install the transformer outside the radio, you can use a shorting-type monaural jack to select the internal antenna when the external antenna is disconnected. Then, however, the leads connecting the transformer to the circuit board will be slightly longer, adding stray capacitance. If the transformer is mounted right on the plug, the system should still resonate across the band.

Using a Hoop Loop with four turns instead of three will raise its reactance and require more turns on the transformer primary, which could improve signal strengths, but my sense is that any improvement would be slight. If longwave is your primary interest, it's worth trying.

Hoop Loop -- The Movie
Chris Knight, N0IJK posted a YouTube video of his Hoop Loop in action.

http://www.youtube.com/watch?v=NG3m7aoKp98

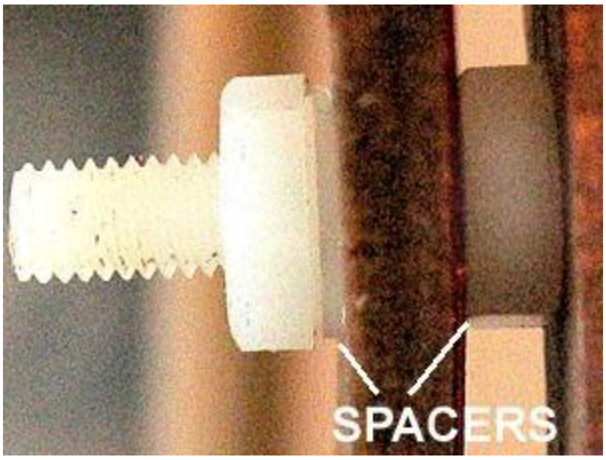
Puttin' On The Litz
If you're blue, and you don't know where to go to
Why don't you go where signals flits? Puttin' on the Litz

I came into a short piece of 165/46 Litz wire and replaced the three turns of #24 magnet wire. Before-and-after checks on 530, 1000 and 1700 kHz showed no difference in signal strength with the Litz. Magnet wire should be fine for the Hoop Loop. Toroids and short pieces of magnet wire are available from Kits and Parts.

The Hoop Loop on LW
The Hoop Loop has done well on LW (150-500 kHz) using a 2700- to 3500-uH secondary on the matching transformer. You'll need a large -61 core; I recommend an FT140-61 wound with 28-gauge magnet wire. A Hoop Loop with more turns may pay off on LW. The radio needs to see a combined inductance of 2000 uH or more. Obtaining that parallel combination with a reaonsble coil means using a much higher turns ratio, to transform the antenna inductance to around 6400 uH. A 1 : 20 ratio will work with a 16-uH antenna, but a lower ratio (more turns on the primary) would have less loss. I made a 2650-uH coil on an FT114-61 core. In the first two nights of listening I logged 10 countries, and nine European and African LW broadcast stations! The 1.14-inch core is too small unless you use very thin wire, but it's the largest I had. Use a 1.40-inch core (FT140-61). The combined inductance is about 1850 uH, which is a little low. A 3375-uH inductance (150 turns, FT140-61) with 4 bifilar turns on the primary will work. An antenna inductance of about 135 uH would allow for a better turns ratio (1 : 5, as for the medium-wave transformer) with the same secondary inductance.

The Hoop Loop Goes Sideways
Sometimes, tilting a loop antenna will make nulls even deeper and sharper. After some consideration, I came upon a page at Radio Intel, that gave me the answer. The author also used a 23-inch hoop, but made a loop that resonates with 365 pF. I cut the top half off the outer hoop, and added some weight to the bottom of the base to make the Hoop Loop more stable. As part of the winding is now exposed, a coat of polyurethane will hold the wires in place. A quick daylight test showed I could null a local on 1230 kHz 17 dB deeper by turning *and* tilting the loop than by turning alone.

I used 10-32 Nylon machine screws, nuts and washers. The washers are positioned as shown in this photo.



With the spacers located as shown, you can tighten the nuts so the loop tilts smoothly and easily, but doesn't droop when you let go.