DIRECTION FINDING (DF) AND RECEIVING LOOPS

A Series of Loops Covering 3.4 – 148 MHz

Direction finding and receiving loops differ from transmitting loops in that they do not require the extremely low loss, high voltage, and high current characteristics of transmitting loops. They are usually shielded to minimize spurious signal pickup and maximize directivity. The shielding adds capacitance which reduces the maximum frequency at which a given size loop will resonate. Portability and ease of rotating (possibly out the window of a moving vehicle) limit size to about 18" in diameter.

During my recent experimentation using hardline for transmitting loops (with the shield as the loop conductor) I realized that the light weight and rigidity of ½" bare Aluminum hardline would be ideal for receiving and DF loops. For these loops the hardline is used like regular coax with the center conductor forming the resonant loop and the shield acting as a shield and physical support. The 75Ohm impedance and foam dielectric offer higher frequency operation for a given size loop than 50Ohm or solid dielectric cable. The ½" hardline runs about 16pF/ft. Smaller foam dielectric 75Ohm CATV cables (eg. RG6) are also about 16pF/ft and the air dielectric RG62 weighs in at a really low 13pF/ft.

For frequencies below 7MHz a traditional multi-turn loop (inside a single shield with gap at top) might be a better alternative than the single turn hardline loop in order to get a wider tuning range with smaller capacitors. A single 18" turn is tad over 1uH and will only tune down to 7MHz with a 410pF capacitor. Just 3 turns gives over 10uH and lets you tune below 3MHz with the same capacitor. The shield capacitance goes up some, however, and you'll lose a little on the high end.

The table below summarizes the Rx/DF loops that I have built recently and some construction details are given a couple pages later. I have not added the shielding around the tuning networks at the bottom of the loops yet and will wait until that is completed[*] to evaluate the gain, directivity and pattern. Note that as shown with the gaps at the top and bottom the loops are horizontally polarized. The loop would have to be shifted 90 degrees in its plane (gaps now on sides) to get vertical polarization. For ease of rotation in the vertical configuration it would be nice to have a handle that could be used either way - just add another "T" on one side. A quick test of the 2M loop showed nulls with the loop horizontally polarized and the source either vertical or horizontal. I consider his encouraging but inconclusive due to all the metal and wires in the shack. Some open field testing and calibration is needed.

[*] Shields now installed with insignificant shift in frequencies. No evaluation yet.

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Loop Construction Data

Loop	Main Loop Dia	Mat'l	Feed Loop Dia	Band	Tuning Cap. Range	Fixed Cap (Padder)	Capacitance Range For Band	Freq Range For Band	Notes
1	18"	½" HL	6.25"	A	12-410	0	12-410	7.0-15.0	Single section 12-410pF cap.
1				B		300	312-710	5.0-7.0	Various extra cap. added in
1				C		570	582-980	4.2-5.0	parallel to lower frequency
1				D		900	912-1310	3.6-4.2	
1				E		1200	1212-1618	3.4-3.7	
2	8"	½" HL	3"	A	8-100	0	8-100	20-44	Section 1 of a 2 section cap. Low output & Q above 30MHz
2				B	16-380	50	66-430	10-22	Add section 2 which is 8-280pF
3	4"	½" HL	1.5"	A	5-50	0	5-50	40-80	
4	3"	RG-58	NA	A	1.3-8	0	1.3-8.0	144-148	

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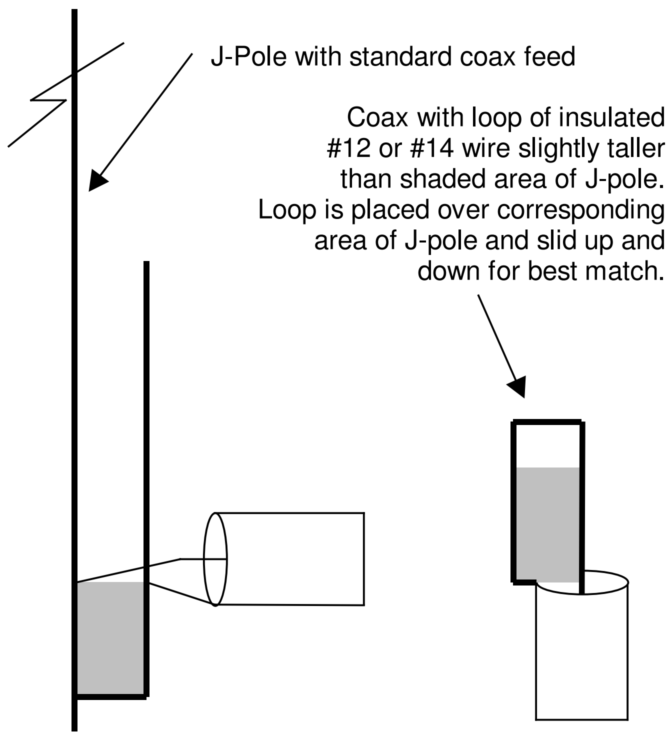
Using "Loop" Coupling / Feed to Loop and Other Types of Antennas

All of the Rx/DF loops except the 2Meter loop use "loop" coupling to the transmission line. Note that loop coupling / feed can be used on several types of antennas. Take a J-Pole as an example. It is easy to visualize the loop formed by the bottom portion of the ¼ wave stub between where the coax normally attaches and crossbar at the very bottom of the J (the shaded area in the drawing). To convert this to loop coupling just make a loop of insulated wire on the end of the coax about the same size as the loop formed by the J-Pole elements. The connection of the loop wire to the coax should be insulated a waterproofed. The loop should be rectangular and as wide as the center-to-center spacing of the sides of the ¼ wave stub section. The length of the loop should be slightly longer than the distance from the bottom of the ¼ wave stub section up the point where the coax would normally be attached. This allows you to vary the coupling just like moving the coax attachment point up and down by instead sliding the loop up and down – much easier. When you have the optimum point cinch the loop down with a few tywraps
The feed loops for the Rx/DF antennas are shielded for the same reasons as the main loop and are constructed from RG-58 coax. Both the J-Pole loop described above and the Rx/DF feed loops are completely insulated. There is no electrical contact between the main loop and the feed loop. See construction details on next page. All the energy (Tx or Rx) is inductively coupled.



DIRECTION FINDING (DF) AND RECEIVING LOOPS

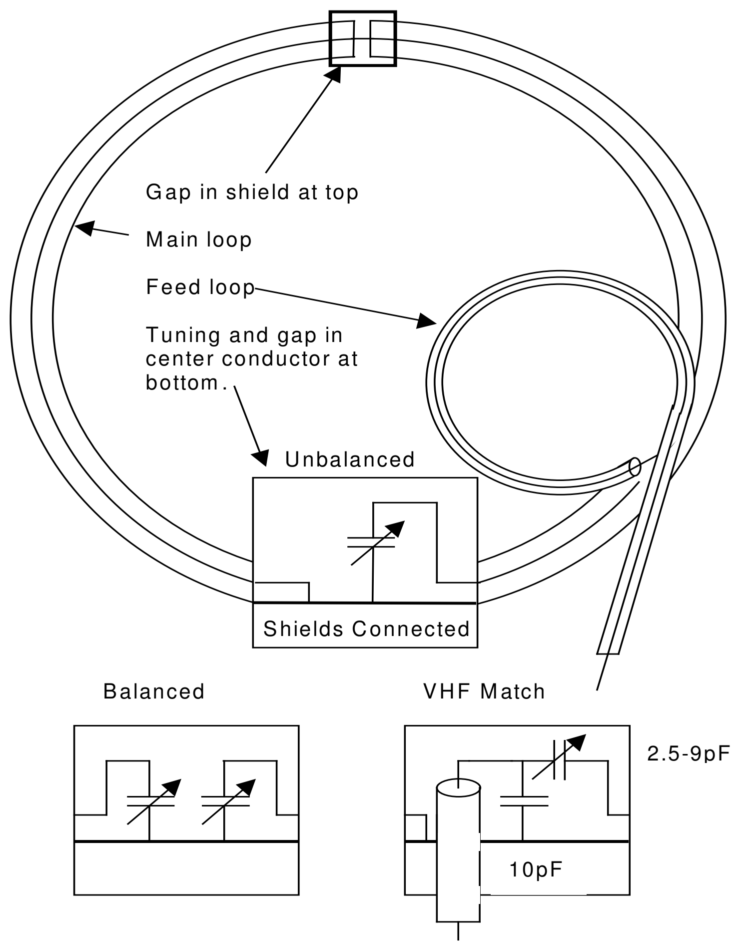
SINGLE TURN SHIELDED LOOP CONSTRUCTION FOR RECEIVING AND DIRECTION FINDING

To get the highest frequency coverage for a given size loop use cable with foam dielectric as it has less capacitance than solid dielectric. Also, for the same dielectric and diameter 75Ohm cable has less capacitance than 50Ohm cable. To extend a loop's coverage to lower frequencies switch in padder capacitors in integer multiples of the main tuning capacitor or use multiple tuning capacitors with different ranges. Also, the split / balanced configuration covers a higher frequency range than the single / unbalanced version.

There is a gap in the center conductor at the bottom of loop. Shield from two sides bridged with Alum. or copper strap (use OxGuard or Noalox) held by small SS hose clamps. Center cond. is grounded to shield on one side and to tuning capacitor on other side. Or, a two section or butterfly cap. may be used with one section connected to each center cond. as in "Balanced" fig.

VHF (2M) loops can be matched somewhat differently as shown. This one was made with a 3" loop of RG58, a fixed capacitor of 10pF and a variable of 2.5 – 9pF. It all has to be very tiny so that the lead length parasitic values don't swamp the desired design. This one fit on a 1" x 1-3/16" scrap of PC board and was only ¼" thick. For optimum performance all these loops should have shielded compartments at the base of the loop.

Cut a 1/16" or so gap in shield at top of loop with tubing cutter or hacksaw. Do not cut through dielectric or center conductor. Clean out any snivels or filings and fill gap with epoxy. Cut a piece of ½" CPVC 5/8" long for 4" loop or 1-1/4" for larger loops and cut lengthwise down one side. Slip over gap then super glue.



Coax feed loop is approx. 1/3 the dia. of the main loop. Strip ½" of outer jacket and shield/braid from the end of the coax being careful not to cut through the dielectric.

Strip ¼" of dielectric from end to expose ¼" of center conductor. Put a short piece of heat shrink over the end of the jacket and shield leaving the ¼" of center conductor exposed.

Come back 3 times the desired diameter (9" for a 3" dia. feed loop.) and strip off a ¼" section of outer jacket being careful not to cut through the braid. (Cutting a *few* wires won't hurt.)

Slip a 1" long piece of large heat shrink that will fit over two pieces of coax over the end o the coax but not past the gap in the jacket. Tin the braid in the gap, form the loop as shown, and solder the center conductor to the exposed braid in the gap. Slip the large heat shrink over the just soldered connection and heat.

Tywrap the feed loop to the main loop. For the flimsy 8" feed loop slip a piece of ¼" ID plastic icemaker hose over the coax between the gap and the end.

For best results use solid, low impedance connections with considerable surface area. Several inches of thin dangling wire will completely ruin the characteristics of the loop.

In the far field maximum signal should be received when the source is perpendicular to the loop axis.

09/09/07 W4CWG

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