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With their kind re-print permission, I provide here a small PDF file treatise on Meandering Line Antennas (MLA)

Relatively compact looped-vertical antennas that have been and are surprisingly effective and broadband in coverage, seeing use in amateur/SWL receive and transmit uses.

When you read the write-up one will see what I mean by some installations use one "unit/panel", others two, and I am told that there's even a "triple play" unit around as well.

One of the "lost art" antennas, there may be some semblance of a resurgence in them, even with the current rise in copper wire/stranded wire costs, etc.

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The MLA Project

By Arthur Hernandez and Harold Faretto

We have been working on special antenna for the past year that has some surprising results and would be a great tool to any radio hobbyist. This antenna would be small enough to fit on an apartment balcony or small inter-city residential lot, capable of covering the multi-bands from the BCB through the entire HF band. It started with the idea from the old radio rule of thumb, more wire in the air equals more signal and combining impedance cancellation techniques. That got our curiosity and so we started off by searching for information on impedance cancellation principals. We first ran across the extremely interesting article called “Non-Inductive Resistor” which was written for AEC-NASA as a “Tech Brief” by Richard Davis. Without going into great detail he used a special technique of construction to cancel out inductance while reducing the physical size, called the Moebius Loop, Ref (1) and (2). Another way to incorporate inductance-canceling windings is called a caduceus coil but we did not explore this, Ref (3).

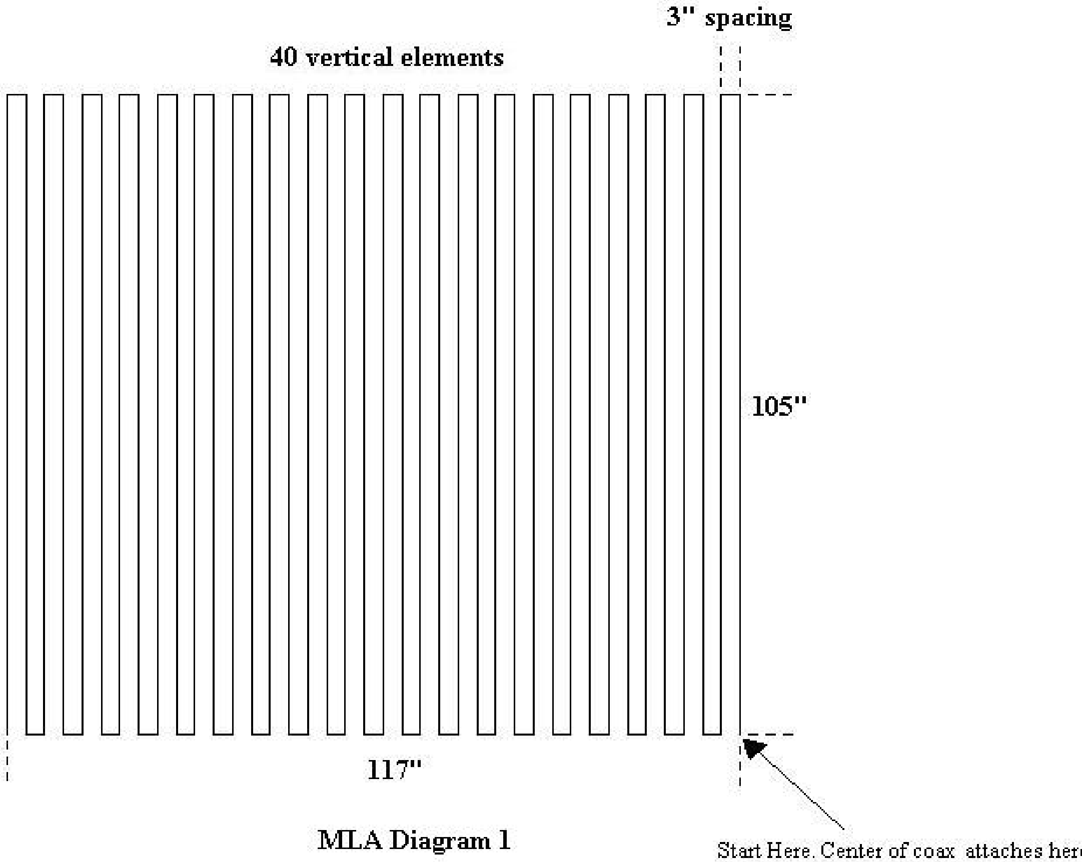
This antenna design has already been developed and patented for military data and communications by BAE Systems, formerly Sanders (a Lockheed Martin Company), Ref (4). They called it the Meandering Line Antenna (MLA) but only used this technique for UHF and above frequencies. Presently they use this technology in cell phones, GPS, RFID, laptop networking that needed high gain, ultra wide band antennas without external tuning.

Basic MLA Theory:

Conventional antennas is found to have a fundamental frequency and harmonics – example a 1.8MHz resonant antenna will also have harmonic resonance at 3.6, 7.2, 14.4, and 28.8 MHz. However the MLA does not exhibit this characteristic. As the frequency increases the next resonance frequency lowers which is opposite to conventional antennas. Inductance causes a loss of gain and efficiency. So this special type of winding causes each element to cancel the inductance of the other, leaving only the resistance of the wire and a small fraction of the inductance compared to large coils and maintains a good Q factor. The more important factor provided by folding the wire is that the cancellation of opposite polarity currents from the other elements, resulting in a higher average impedance along the folded element as the number of folds increases. Folding offers the possibility of reducing the size of an antenna while still maintaining a high-radiation resistance at resonance. At resonance the MLA is claimed to exhibit the gain of a yagi antenna, Ref (5). Formulas and other technical data can be found in Refs (6), (7).

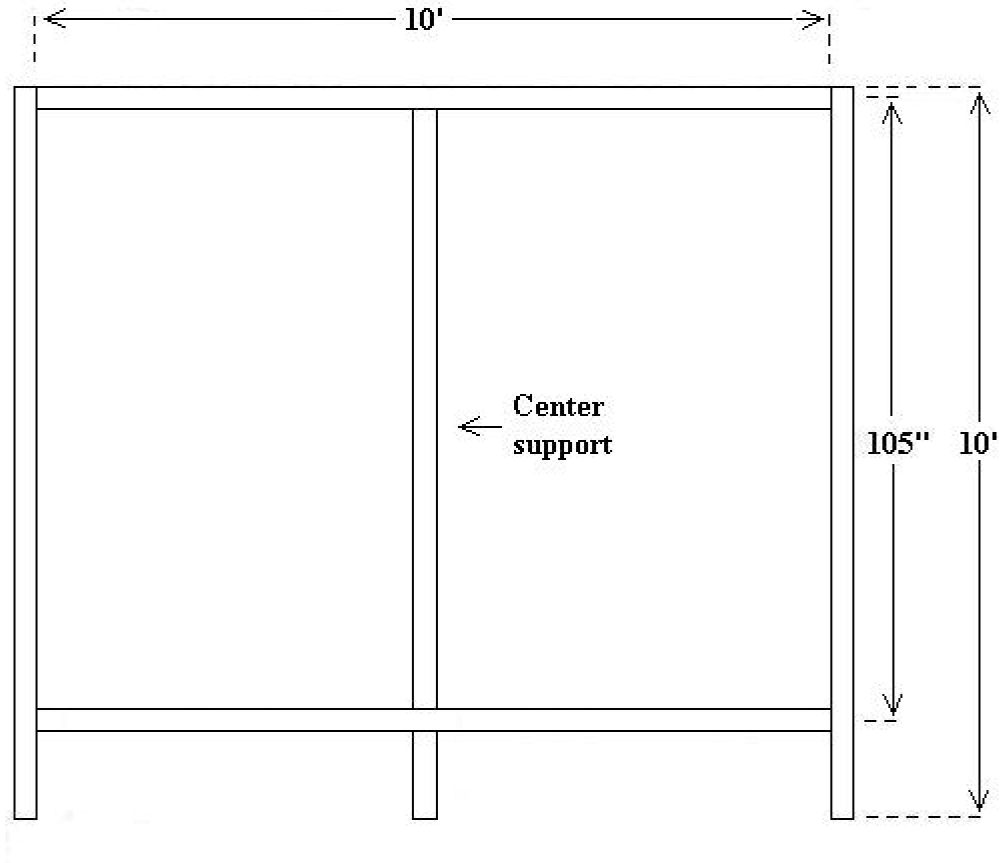
Construction:

An individual can build this antenna for personal use without infringement of BAE/SkyCross patents. That said here is the construction of a MLA for MW/HF. Our final MLA was built using single 360 feet long, solid copper wire zigzagging up and down making 40 vertical elements with 3 inch spacing. See diagram 1.



MLA Diagram 1

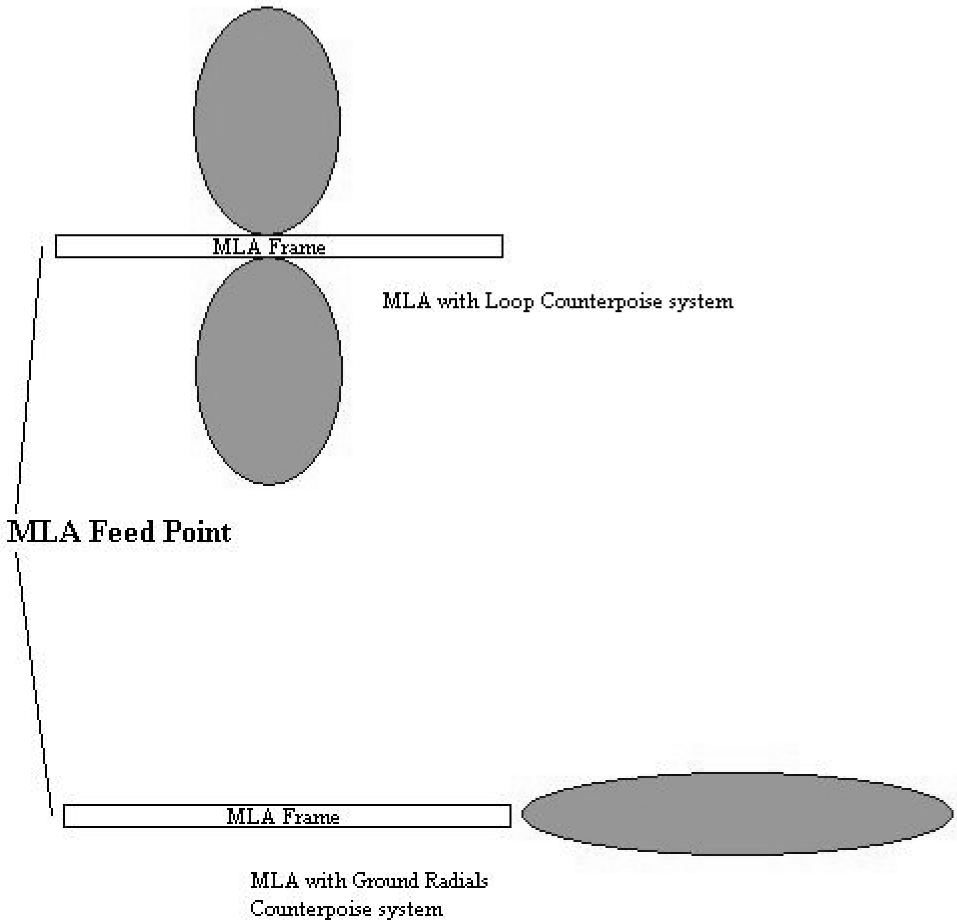
We used a 2’X4’X 10’ box wood frame to support this mass of wire. See diagram 2.



MLA Diagram 2

We did not want the wire close to the ground level so that the snow and rain would not affect it, we raised the bottom 2X4 by 13.5 inches. A center support made of another 2X4 to reduce sagging of the wood and avoid re-tensioning of the wire after a couple of months. 10d finishing nails were hammered at 3 inch intervals along the top and bottom of the 2X4 woods. Now comes the winding of the wire. For ease of winding and avoid sagging issues, stand the wood frame up vertically and brace securely. Now wind wire using diagram 1as reference. Insulate the nails and wire from wood using ¼” irrigation plastic tubing if not using insulated wire. If this is not done then when the wood frame becomes wet you will lose signals.

At this point you need decide if you want to use a ground radial or loop counterpoise system. Here is the deal. If you use a ground radial system then the antenna will act like a beverage antenna and have an antenna pattern of a single direction. While a loop wire wound around the MLA wooden frame will result in an antenna pattern similar to that of a dipole, two directions. These patterns were developed using a Leader LSG-17 signal generator and field strength meter. See diagram 3.



MLA Diagram 3

Coaxial cable (RG-58, RG-8M, etc) connection is made with the center conductor connected to the feed point end of the MLA and the shield to the counterpoise system, whichever one you chose.

Testing:
Let's now talk about the testing. First is a resonance frequency check. Using a Eico 790 Grid Dip Oscillator and frequency counter we found the following:
Major Resonance Dips (KHz) - 1619, 4439, 6160
Minor Resonance Dips (KHz) - 7916, 9510, 10903, 12188, 13526, 15136, 16783, and 18567. Above this frequency the resonance dips occurred one right after another to the point it was useless to record. As far as we were concerned it was one endless resonance dip out to 30 MHz.

Now using the MFJ-259 Antenna Analyzer we found the following:

Frequency (KHz)	SWR	Impedance
1751	1.9:1	60
4301	1.5:1	65
6290	2.4:1	100

Above this last frequency the impedance and SWR were off scale.

Also measured was the total inductance of the 360 feet of wire, which measured 101 uH but by calculation should have been around 2.7 mH. So yes this form of windings does cancel out inductance. We did not have the test equipment to see the current cancellation. As for polarization we saw this configuration as vertical with both counterpoise systems.

Safety:
Now here comes the only safety tip we would recommend for this antenna. When the wind or snow kicks up a large DC voltage develops and can fry your receiver, it did one of ours and had to be repaired. We installed a 100K ohm, 2-watt carbon resistor at the antenna to bleed off this charge safely with no noticeable attenuation of the signal levels. Any value of 470K to 100K would work just fine. We also tried a NE-2 neon bulb but decided to go back to the bleeder resistor. When the charge built up to 65 volts the neon bulb would fire and you would hear a loud crack sound in your receiver audio (sometimes up to once every ½ second). We felt that the neon bulb was not effective in voltages below 65 volts of static charge, (not good for modern receivers) and found the crack sound annoying. Also be aware if used as a transmit antenna that power levels as low as 100 milliwatts will cause RF burns.

Performance results:
We can honesty say that it is by far better than any known small area antenna or active antennas we have used. The MLA gives SWLers a fighting chance to pick up real DX. Active antennas like the Kaito KA-33, MFJ-1020 and Radio Shack 20-280 increase the noise floor and much DX is hidden in the high noise levels. While indoor longwire antennas such as the Radio Shack 278-1374A, Radio Master P-30 just don't get the signal strength. We have also tried the MLA as a 160 meter amateur band antenna with great results working up/down the entire West Coast. Also tried a smaller version (105” X 105”) on the AM broadcast band for a friend’s part 15 station. In this configuration was able to achieve a 15X distance increase over a standard 3 meter vertical antenna and 2X distance increase over an Isotron 200B antenna. Knowing this antenna has sweet spots (resonance points) a small T or L network antenna tuner could easily fill in the frequencies not covered by resonance points. We tried several antenna tuners such as the MFJ-900, SST T-2 and a homebrewed L-match, which all worked just fine down to 1800 KHz. Antenna tuners should be installed at the antenna feed point.

As a side note we found out that the MLA antenna pattern is influenced by non-resonant parasitic elements within as far as 50 feet. So metallic objects near this antenna will cause a change in the direction of maximum signal.

Future:
The antenna can be made using smaller spacing (nothing smaller than ½” is practical). You can also try smaller height. You can also try horizontal running wires vice vertical. Another idea we came up with was a dual MLA connected into a dipole or folded dipole configuration. A small write up was written about the great feasibility of using the MLA as a 136 kHz LOWFER antenna, Ref (8). Along these lines you could also try other non-metallic frames, even plastic pipe/conduit is possible. It could also be tacked up to a fence. Another great idea is to disguise this antenna by weaving plastic/silk vines and flowers on the wire so as to make it look like a garden trellis. Remember not to use vines or flowers with metal wires in them. The ideas are endless.

This Christmas we wish to give this small gift, done with our own two hands to our fellow Broadcast Band and SWL DXers who has given so much to us over the past decades.

References:
(1) “Non-Inductive Resistor”, AEC-NASA Tech Brief #68-10267 (Aug 1966) by Richard L. Davis
(2) “At Ultra-High Frequencies Electronics Components Take on Weird Shapes!”, Electronics Illustrated (Nov. 1969) by Jorma Hyypia
(3) Symposium – “Scalar EM, Ca” - http://wc6.worldcrossing.com/webx?14@@.1dde2601/55
(4) “Meander Line Antennas”, SkyCross (Aug 2002) by Frank M. Caimi, Ph.D
(5) “The Effect of Conductor Line to Meander Line Antenna Design”, Dec 2007 Asia-Pacific Conference on Applied Electromagnetics Proceedings.

(6) “Efficient Short Meander Antennas”, Technical Topics Scrapbook - All 50 Years, pages 257 and 258 by Pat Hawker, G3VA
(7) “Performance of a Meandered Line as an Electrically Small Transmitting Antenna”, IEEE Trans on Antennas and Propagation, Vol 46, No 12, Dec 1998. Warnagiris and Minardo
(8) ON7YD, Antennas for 136kHz, “2.10 Meander Antenna”, - http://www.strobbe.eu/on7yd/136ant/#Meander