



Monitoring the World via Radio

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Easy Antennas for the SWL

by Mark Coady

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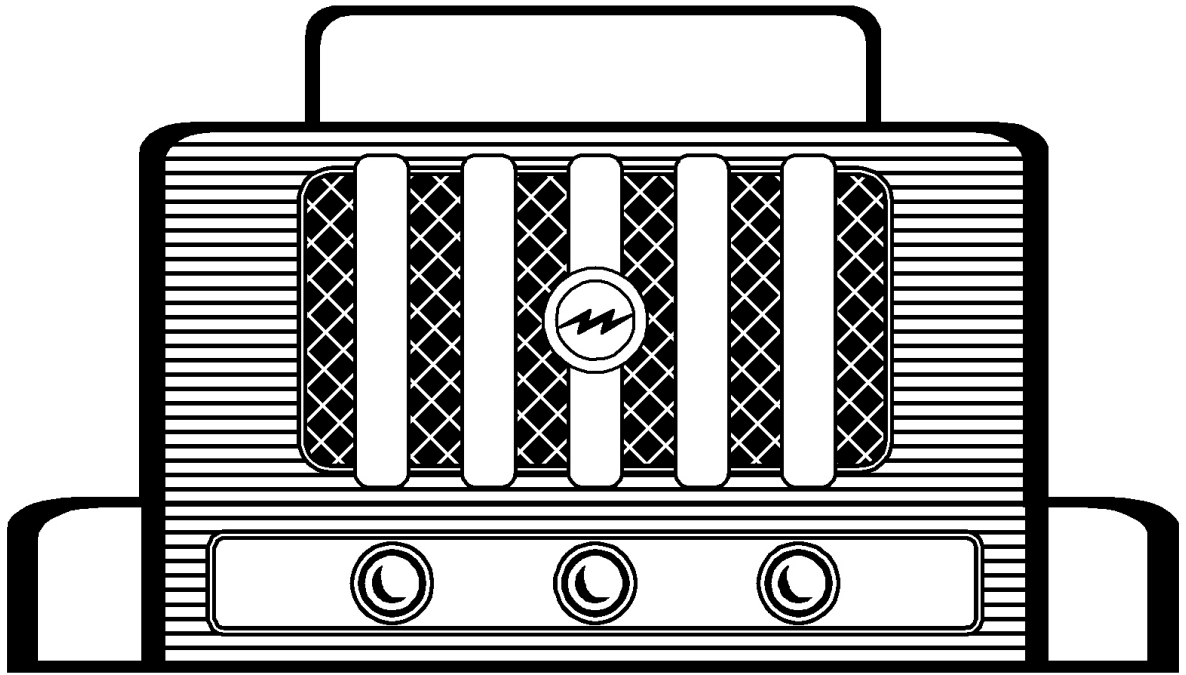
Introduction

This booklet is designed for those who are relying on a receiver's whip antenna or the simple and short wire antennas that are included with most of today's portable receivers. While today's receiver technology certainly gets the most out of simple antennas it cannot deliver much in the way of fainter signals. To paraphrase the title of an old Radio Netherlands booklet, you need to "Give your antenna some air!" and erect a proper outdoor antenna that can deliver signals to your receiver that, until now, you have had little hope of hearing.

And you don't have to be a rocket scientist to design an antenna that will snag much more DX than you are currently hearing. You just have to be ready to experiment with your own situation and find a design that works best for you. And it doesn't have to be a daunting task to figure out desired antenna length and resonant frequency. The formulas for the various types of antenna are really quite simple and are, in fact, all related.

There is something here for every shortwave listener who wants to get more out of their receiver whether you live on a farm in the country or a small lot in the city. By reading this booklet and trying out some of the designs, all of which I have tried over my several decades in the hobby, I am quite confident that you will soon be hearing great DX thanks to your new outdoor antenna.

73's and Good Luck



Section One: Wire Antennas

1. The Basic Random Wire (or Longwire)

Most of us started in this great hobby with the basic random wire. Other names that have been used are longwire and inverted L. It is the easiest antenna to erect and is the basis for all other designs.

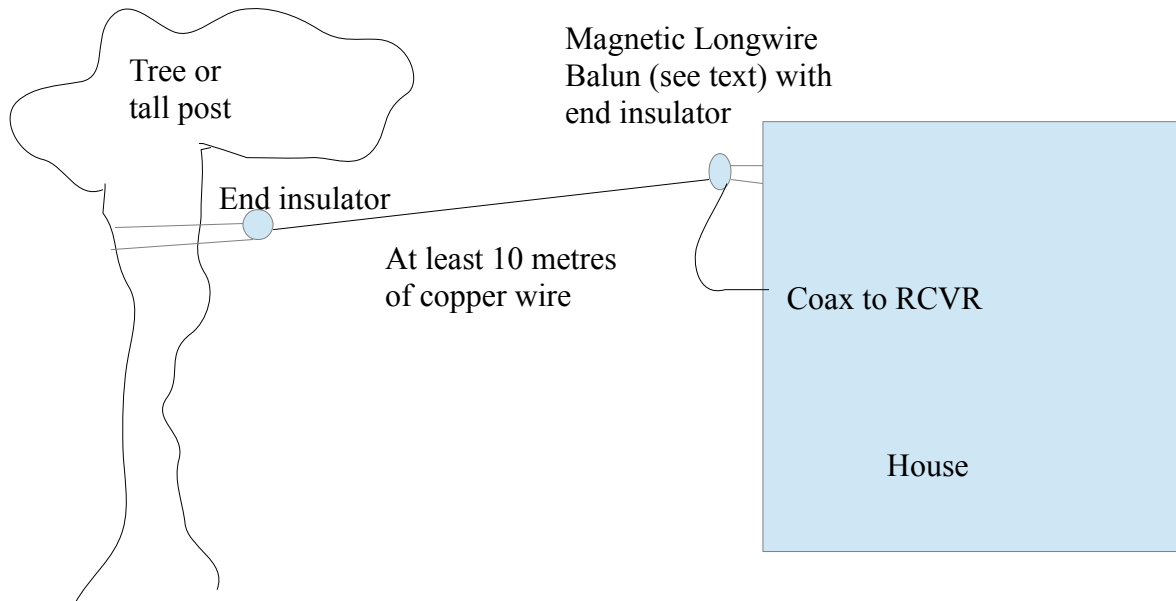


Fig 1: The Basic Random Wire Antenna

This antenna is the simplest you can use and should be mounted as high as possible to get it away from all sources of noise and interference. While the inverted L, as it was once known, had a single wire lead-in, with today's EMI and RFI, it is important to have a shielded input from the antenna to the receiver using coax cable and a Magnetic Longwire Balun (MLB)*. This is an omnidirectional antenna design when kept to less than a hundred feet. In lengths beyond that it can become somewhat directional.

*Magnetic longwire baluns (MLB) are found in the section **Stuff You Can Use.**

2. The Beverage Antenna

A variation of the random wire is the Beverage antenna. This antenna is very long - several wavelengths in fact. As such, it requires a fair bit of real estate to work effectively. A Beverage cut for the 60 meter band would be a minimum of 120 metres or 393 feet in length. It does not need to be mounted very high and in some circumstances can be laid directly on the ground especially over rocky terrain. It is bidirectional when connected like a random wire or becomes a narrow beam antenna when the far end (away from the receiver) is grounded with a wirewound resistor of at least 500 Ω . The more wavelengths the Beverage is cut for greatly narrows the beam but increases received signal strength. In areas of significant EMI or RFI a Magnetic Longwire Balun (MLB)* will be required to match the antenna to the coax lead-in.

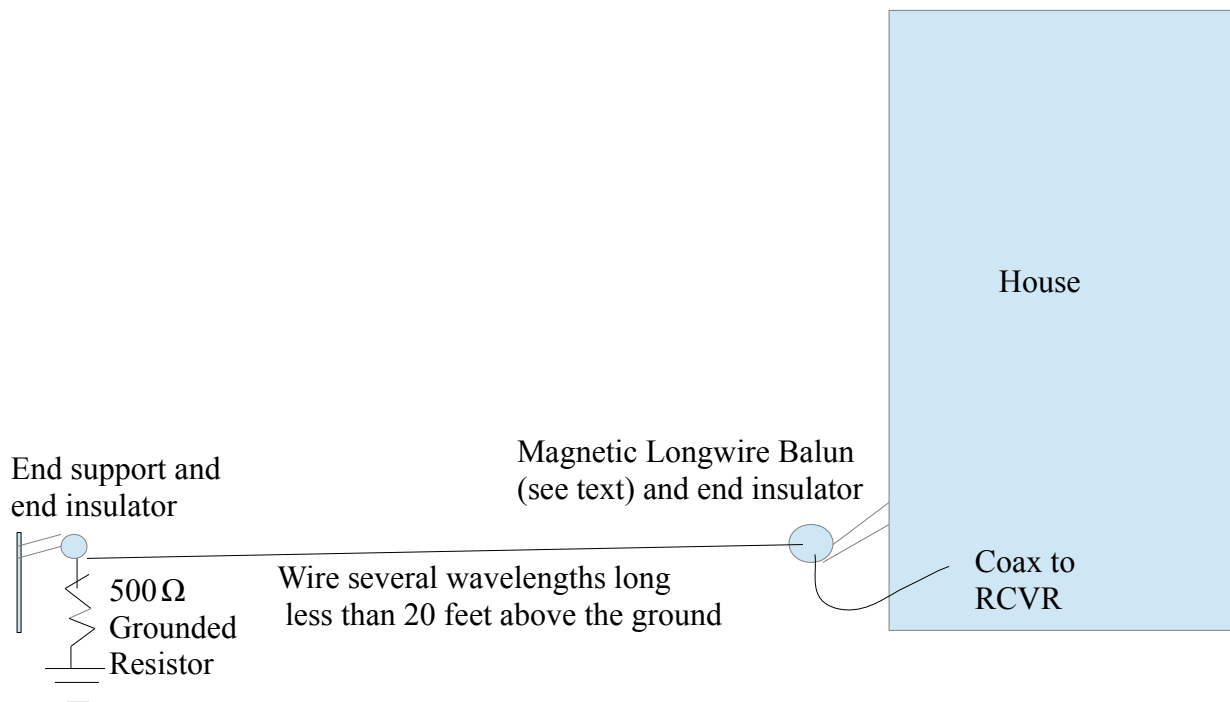


Fig 2: The Beverage Antenna

I used to use a bidirectional 300 metre north/south beverage at Longford Mills DX Camps the ODXA used to host in the 80s that was just laid on the rocky terrain and successfully logged Antarctica on 6012 KHz.

*Magnetic longwire baluns (MLB) are found in the section **Stuff You Can Use.**

3. The Windom Antenna

The windom antenna is almost as old as the random wire.

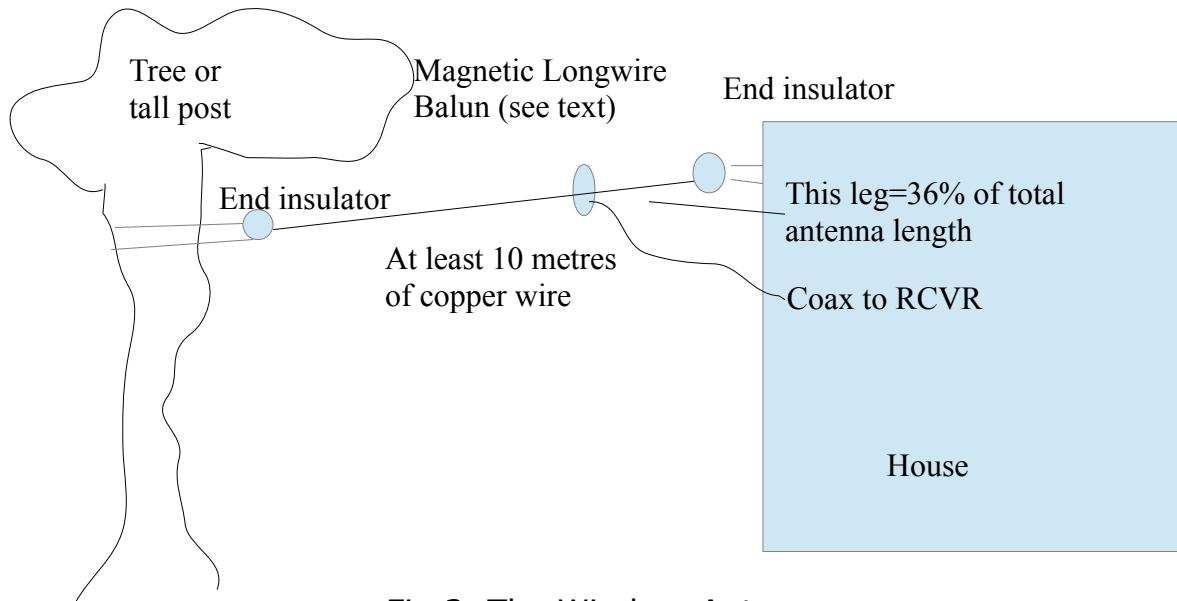


Fig 3: The Windom Antenna

This antenna is basically a random wire but with the lead-in mounted away from the end closest to the receiver some 36% of the overall length of the wire. So, using the example shown in Fig 3 of a ten metre wire, the lead-in would be 3.6 metres from the end insulator closest to the house. While the original design called for a single wire lead-in, with today's EMI and RFI it is important to have a shielded input from the antenna to the receiver using coax cable and a Magnetic Longwire Balun (MLB)*. This is an omnidirectional antenna design that is supposed to have more signal gain than a random wire.

*Magnetic longwire baluns (MLB) are found in the section **Stuff You Can Use.**

4. The Half-Wave Dipole

The half-wave dipole has been an antenna of choice for many hams and SWLs for many decades. It is the basic unit you see in directional antenna arrays like Yagi Beams. In its simplest form it is a wire between two supports that is separated in the middle by a balun where the coax to the receiver connects. The formula for figuring out a dipole is $L=468/f$ where L is the overall length of the antenna (both halves combined) in feet and f is the resonant frequency in MHz.

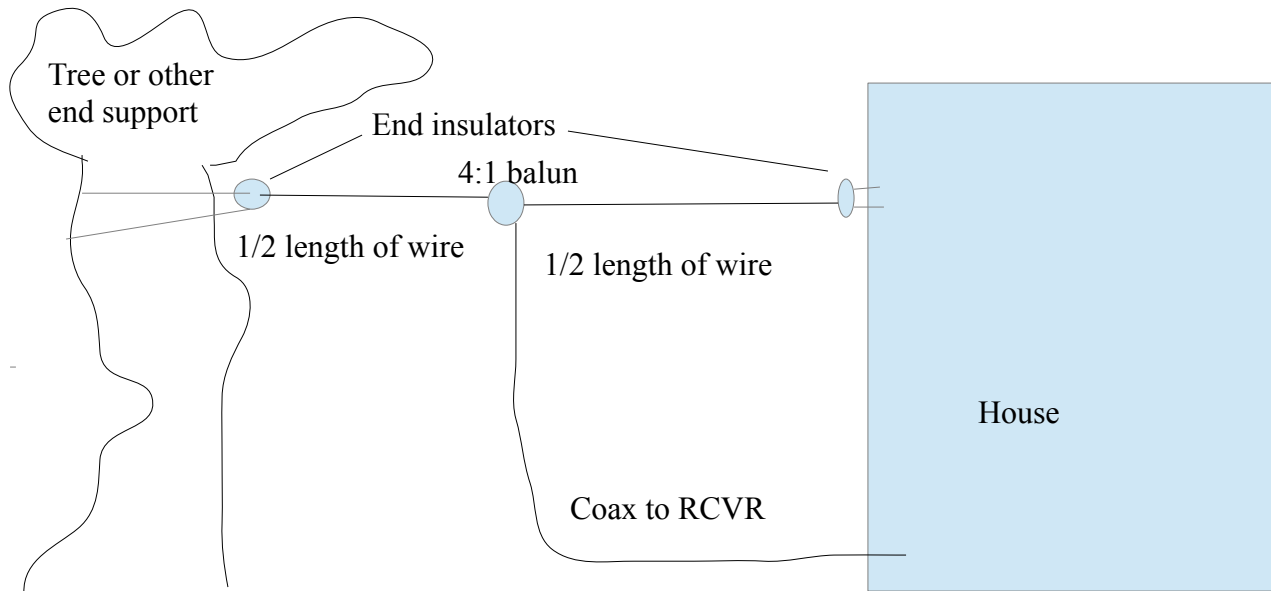


Fig 4: The Half-Wave Dipole Antenna

The dipole is bidirectional 90 and 180 degrees from its horizontal axis or the best signals come in broadside to how it is run. Using the example of a 10 metre space to run the antenna in the backyard, this half-wave dipole would resonate at roughly 14 MHz which is pretty well mid-way in the HF spectrum.

Variations include running one or more shorter elements in combination with the main element that only meet at the balun. This is called a multi-band dipole.

5. The G5RV Dipole

This is a variation on the basic half-wave dipole that was designed by a long-dead British amateur radio operator with the call sign of G5RV. The two horizontal elements are 51 feet in length and attach to 450 Ω ladder line. It is best to make a plastic form with four holes in it where they all attach - one each for both sides of the antenna and ladder line. The ladder line is attached to a 1:1 balun just above ground level and then coax is run to the receiver. Solder all connections.

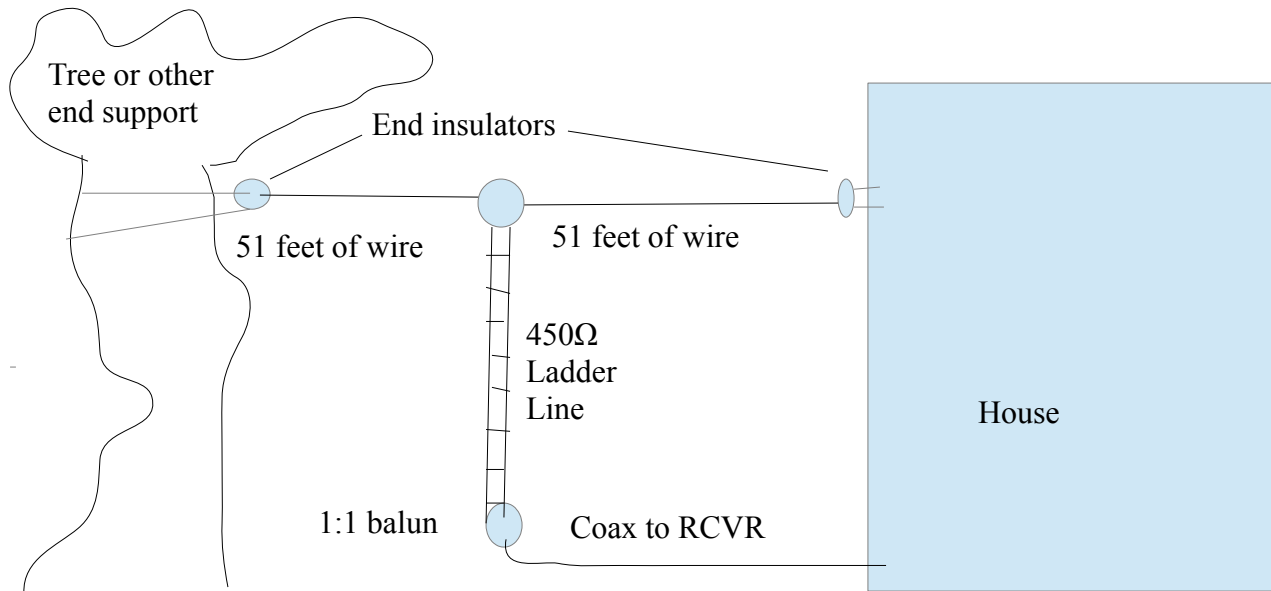


Fig 5: The Half-Wave Dipole Antenna

The G5RV tends to resonate around 14 MHz which is pretty well mid-way in the HF spectrum and makes it a good general antenna.

Variations of this antenna have seen it cut in half to two horizontal elements totalling 51 feet (G5RV Junior) and mounting it as an inverted vee antenna.

6. An Eco-friendly Vertical Antenna

Vertical antennas can be the easiest to erect. Just take a hunk of wire and support it in a tree and hook it to your receiver. What can be easier than that? Well, how about an easy vertical that uses household garbage as its form? Mailing tubes or even the tubes that Christmas wrapping paper is rolled on often find their way to the local landfill site. Turn that garbage into a form for a vertical antenna. It's simple and it works.

Take a cardboard tube and punch a couple of holes near the top and bottom. Take the cheapest wire (even scrap) that you can find and use the holes at one end of the tube to tie it off. Wind the wire around the outside of the tube and tie it off at the bottom. Bare each of the ends and repeat the process for each cardboard tube that you have. Wrap the tubes in electrical tape and apply silicon as a waterproofing and wrap again. Solder the tubes together. Solder a Magnetic Longwire Balun (MLB)* to the wire at the bottom and attach a coax cable between the MLB and your receiver and then mount the antenna as high as possible.

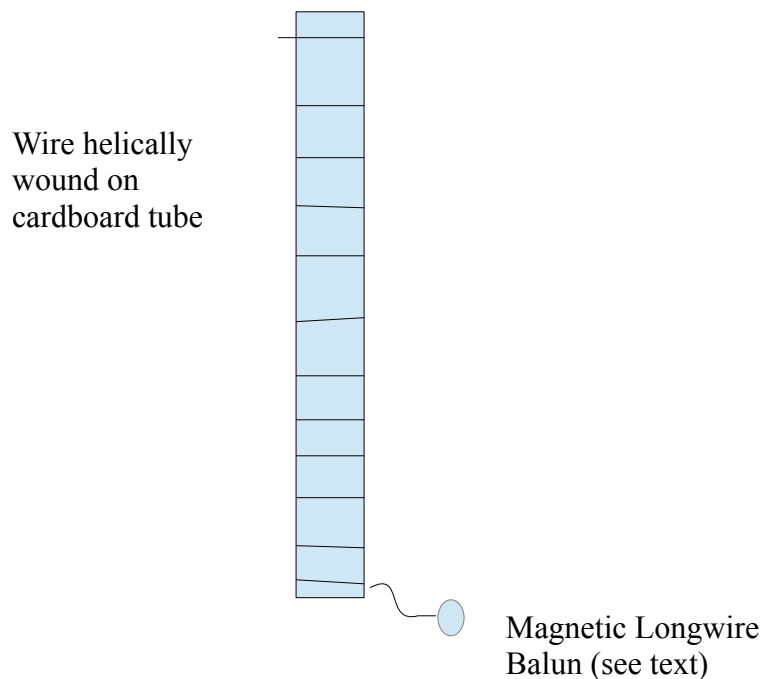


Fig 6: The eco-friendly vertical antenna

*Magnetic longwire baluns (MLB) are found in the section **Stuff You Can Use.**

7. A Perimeter Loop

A Perimeter Loop (also called a Sky Wire) is a loop antenna that is horizontal to the ground. The idea is to run the antenna as high as possible around the perimeter of a house lot or just the backyard. It is supported by posts or ropes from trees. As with all loop antennas the formula for figuring out overall length is $L = 1005/f$ where L is the length of all sides of the loop combined in feet and f is the resonant frequency in MHz. It is an omnidirectional design but is said to have fairly good gain properties over other designs including half-wave dipoles. Because it does not take up a lot of room in the backyard the rest of the family will not find it offensive as it does not detract from their outdoor activities.

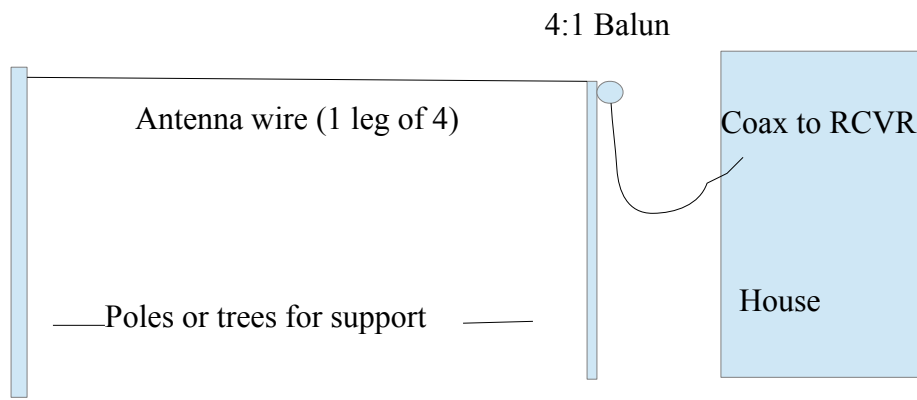


Fig 7: Basic Perimeter Loop

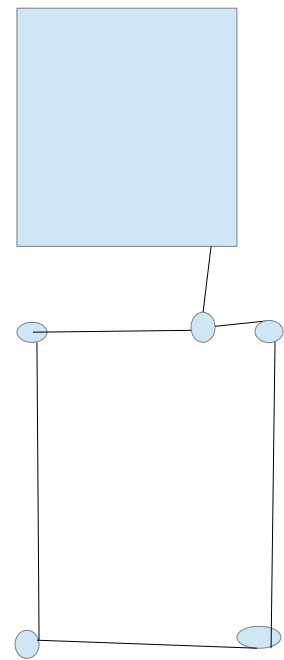


Fig 8: Overhead View

8. The Tilted Terminated Folded Dipole

Often abbreviated as TTFD or T2FD this is an omnidirectional sloper-like folded dipole. It requires a fair bit of planning and work. In fact, this is the most labour intensive antenna. There are two separate formulas that have to be worked out before assembling it. The nice thing is that the entire antenna can be constructed indoors - in a shop, basement, or a garage - and taken outside only when it is time to erect it. And the fact that this is a very quiet and effective antenna makes all of the work well worthwhile.

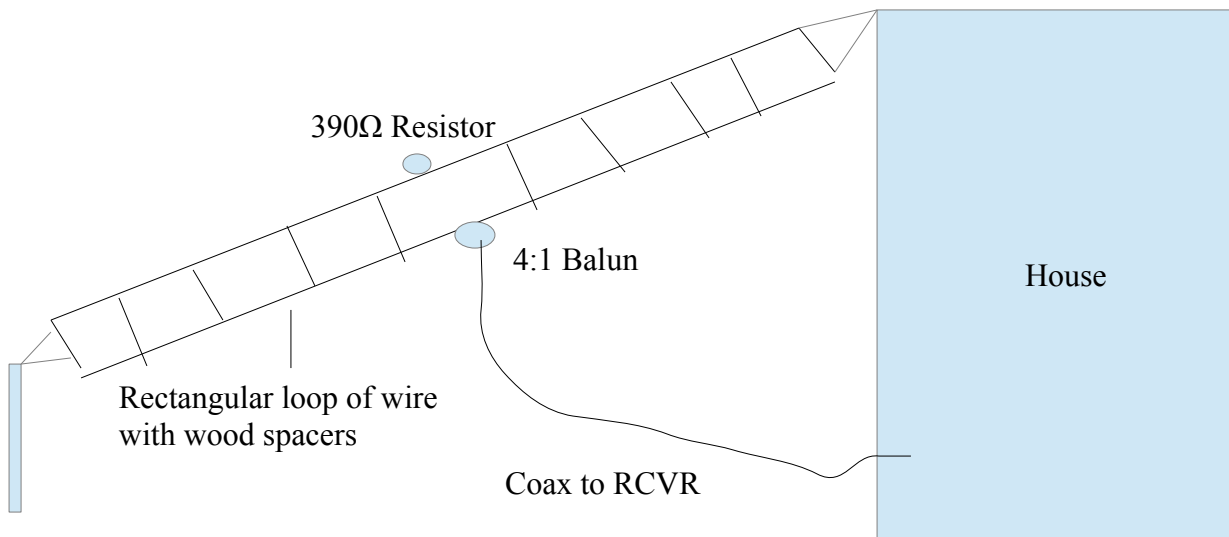


Fig 9: The Tilted Terminated Folded Dipole

Basically this is a gigantic rectangular loop that is separated in two spots - at the 4:1 balun and directly opposite of it at the 390Ω resistor. The two sides are kept apart by spacers - usually narrow wood dowels with holes drilled in each end to allow the wire to feed through.

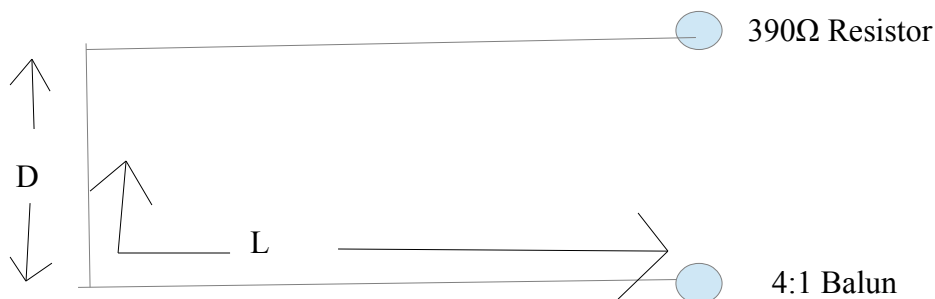


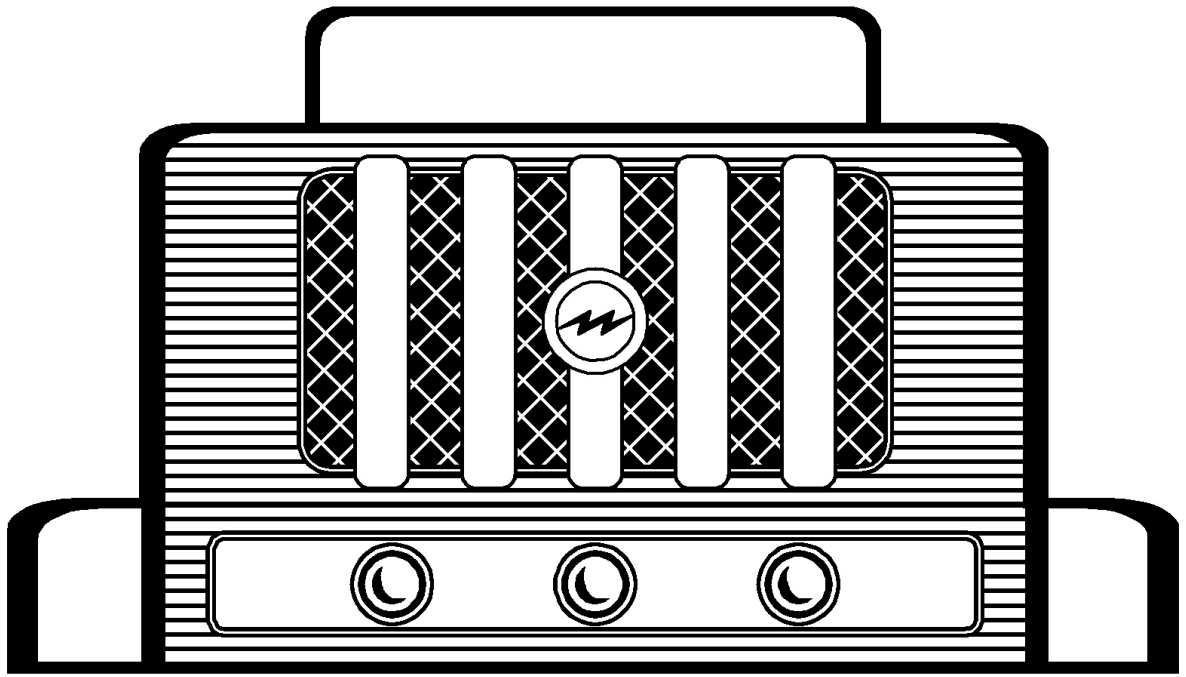
Fig 10: Exploded view for understanding the formulas

Keep referring to the exploded view shown in Fig 10. The first formula to figure out is $D=9.8/f$ where D is the distance between the two horizontal legs in feet and f is the frequency in MHz. The next formula, which is related, is $L=164,000/f$ where L is the distance in feet between the 390 Ω resistor (or the 4:1 balun) to the end of the leg plus one half of the value of D and f is the frequency in KHz.

Like the previous loaded sloper, we will use the example of roughly 10 metres as the space to erect this antenna. We will try for an antenna that resonates at 10 MHz. $9.8/10 = 0.98$ so the value of D is 1 foot. Every spacer will be one foot in length. $164,000/10,000 = 16.4$. One half of D is 0.5 so the distance between the 390 Ω resistor (or the 4:1 balun) and the end of each leg will be 15.9 feet. Round it off at 16 and you get a total of 66 feet of wire in this antenna or two halves of 33 feet.

Reread from Fig 10 on down over and over until you understand that you are going to be taking some time, preferably indoors, to assemble this antenna. Think about connecting the coax before you take it outside. Then, with rope at each end, hoist it up and secure it as shown in Fig 9.

There is a lot of brain work required to plan for this antenna along with a fair bit of construction but it is well worth it. If you are in an area of a lot of noise you will find that this antenna does not pick up nearly as much of it as other designs. And because this is being used as a receiving antenna, rather than one for transmitting where a mismatch can be the difference between a faint QSO or no QSO, you don't have to be as precise in your measurements.



Section Two: Loaded Antennas

9. A Window Mount Diamond Antenna

This antenna is for apartment dwellers who cannot have an external antenna. It uses load coils in a diamond shape and is hung from either a drapery track or a suction mount clip on the window itself. It does not replace an outdoor antenna but will outperform the whip antenna on your receiver.

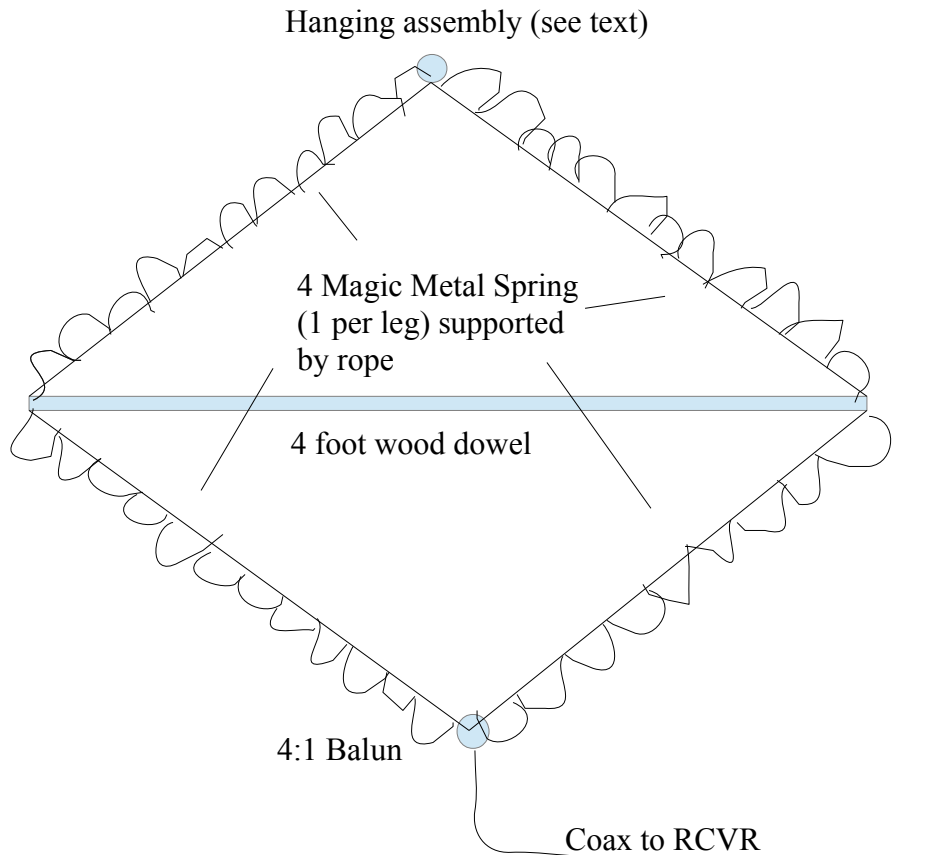


Fig 11: The Window Mount Diamond Antenna

A four foot wood dowel keeps the diamond shape intact along with the hanging assembly at the top and the balun at the bottom. A hole is drilled through each end of the dowel and a rope is fed to act as a support for the four Magic Metal Springs* which are soldered together except at the bottom where they are soldered to the 4:1 balun. Run coax from the balun to your receiver.

* Magic Metal Springs are mentioned in the section **Stuff You Can Use.**

10. A Loaded Sloper

Sloper antennas have been popular and are still being marketed as ready-made units and in kit form. The basic premise has one end of the antenna mounted up in the air such as the peak of a roof of a house or near the gutter and the bottom of the antenna is mounted on a fence or even staked to the ground. They usually have some load coils inserted that lower the resonant frequency.

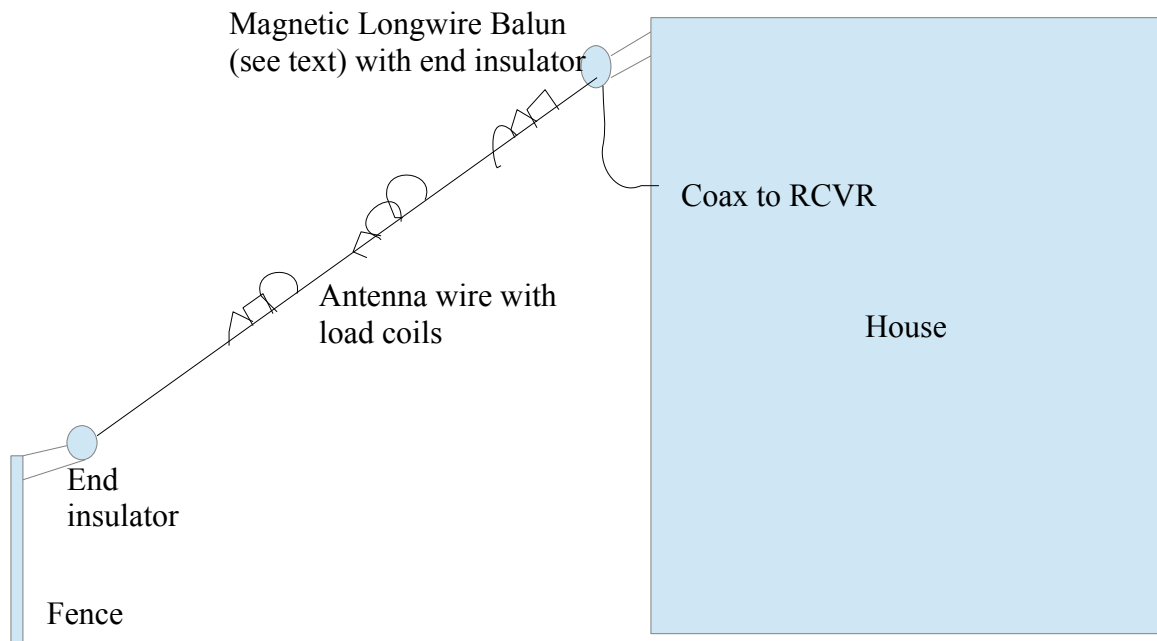


Fig 12: A loaded sloper antenna

The example I will use has space for a ten meter piece of wire to run from the top of the house to the fence in the yard. Start by ensuring a Magnetic Longwire Balun (MLB)* is attached to the end insulator at the top of the house. Cut the wire into four pieces with lengths of one, two, three, and four meters. Solder one end of the one meter piece to the MLB and the other to one of the loading coils. Solder a two meter piece between this coil and another. Solder the three and four meter pieces in a like fashion and terminate the four meter piece to the end insulator at the fence. Run your coax from the MLB to your receiver.

Depending on how high the top end gets to be this can also be built as a windom antenna with the MLB mounted 36% down from the top end taking into account the electrical length of any load coils.

*Magnetic longwire baluns (MLB) are found in the section **Stuff You Can Use**

11. A Loaded Inverted Vee Dipole

An inverted vee dipole is used in circumstances where there just isn't enough real estate for a full-length dipole. As the name suggests, the antenna forms an upside down letter V. It needs to have one central support (a pole, tree, or a rope between poles or trees) to affix the apex of the V. The ends of each leg are staked to the ground. Because it is not a horizontal dipole it is also a bit more omnidirectional. The formula for figuring out the overall length is $L=498/f$ where L is the length of each leg combined and f is the resonant frequency in MHz. By inserting load coils in the middle of each leg we can further lower the resonant frequency.

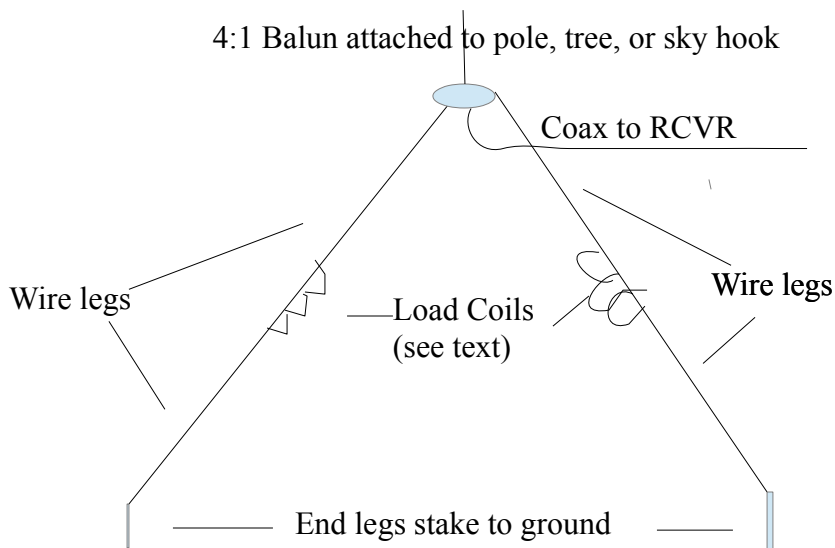


Fig. 13: The basic design

As depicted in Fig. 13 a loading coil is inserted in each of the wire legs. The coils can be home built or adapted from various slinky toys. The top of each leg is attached to a 4:1 balun and the bottom to stakes driven into the ground. Solder all connections and attached a coax cable between the balun and your receiver.



Photo 1: One of the author's loaded inverted vee dipoles

12. A Compact Loaded Delta Loop

A delta loop is a bidirectional loop antenna that takes the form of a triangle rather than a square or a circle. As with all loop antennas the formula for figuring out overall length is $L=1005/f$ where L is the length of all sides of the loop combined and f is the resonant frequency in MHz. The delta loop can be erected with its apex attached to a central support (a pole, tree, or a rope between trees) or it can be inverted so that the apex is at ground level. By inserting load coils in the middle of each leg we can lower the resonant frequency even more and allow the delta loop to be of a manageable size where it can be easily rotated making it a beam antenna.

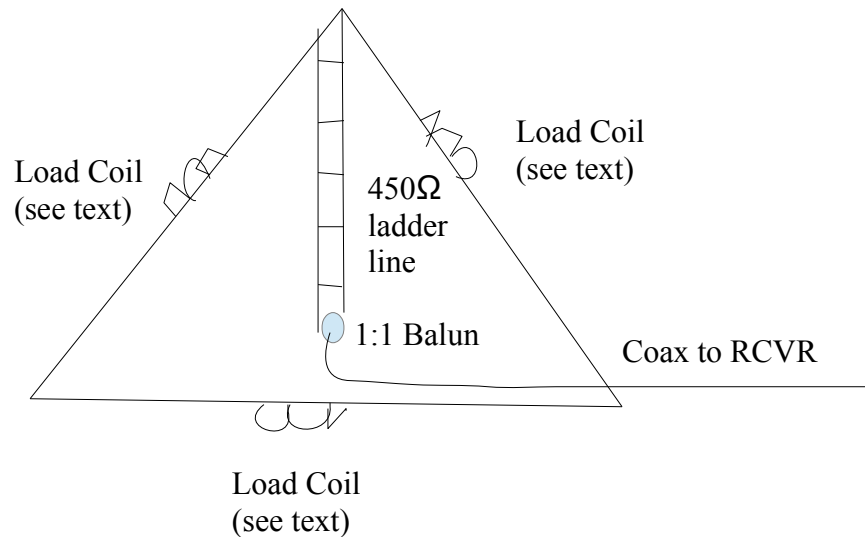
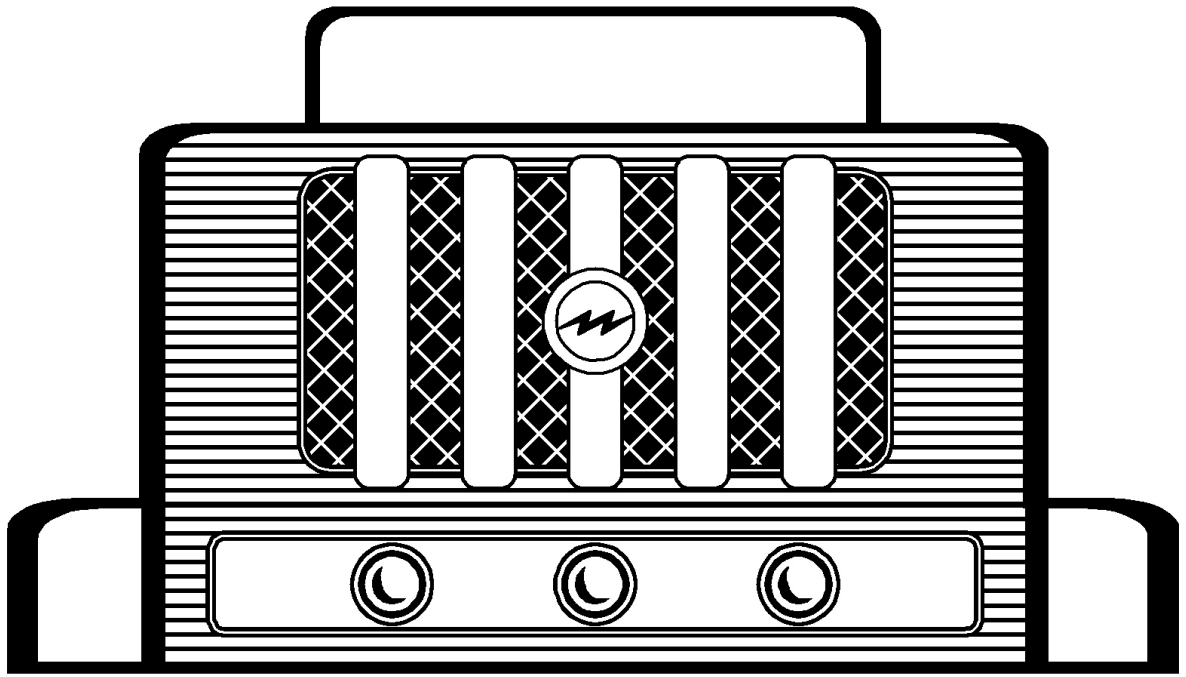


Fig 14: Basic loaded delta loop

All legs and the load coils are soldered together except the apex where the two legs are soldered to a length of 450Ω ladder line which, in turn, is soldered to a 1:1 Balun where a coax cable connects it to the receiver. A wood frame or plastic pipe can be used as a mount for this antenna and it can be made as small as 12 feet tall with a 12 foot long base making it easily steerable and it will become something of a stealth antenna that your neighbours will not find offensive.

With such a 12X12 antenna I successfully logged AFN from Diego Garcia on 4319 KHz with only 3 KW of power.



Section Three: Helpful Advice

Stuff You Can Use

Raising Antennas Canadian-Style

DXers have used a variety of methods to feed antenna wire through tree branches from bows and arrows to fly fishing rods but I prefer a truly Canadian method.

From Photo 3 you might think this is Hockey Night in Canada but it's not. The lowly Canadian invention, the hockey puck, is one of the best tools for raising antennas up high in trees. Hockey pucks are hard rubber discs of 3 inches (7.5 cm) in diameter and an inch (2.5 cm) thick. They weigh between 4 and 5 ounces (60 g) and are quite durable. Drill a hole through them and feed a rope or lanyard through the hole and you have the perfect counterweight for sending your antenna skywards. Add as many as required for the job at hand.



Photo 2: A hockey puck makes for an excellent counterweight

Magnetic Longwire Balun

A Magnetic Longwire Balun (MLB) is used for balancing the high-Z resistance of a simple wire antenna to a coaxial cable that feeds the signal from the antenna to the receiver input. While older receivers allowed for a single wire input and worked quite well with them, with the amount of electromagnetic (EMI) and radio frequency (RFI) interference in our lives today, it is imperative that we shield the signal lead-in to our radio shacks so that unwanted signals are rejected or at least mitigated. Otherwise a perfectly good antenna becomes useless.

The basic circuit is shown in Fig 15 while Photo 3 shows a completed coil - three

or more of which are inserted into the circuit to perform the function of balancing the input with a 9:1 match.

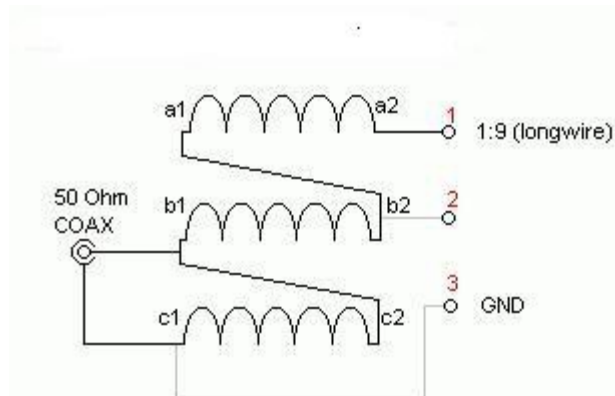


Fig 15: shows the basic circuit

Photo 3: shows a coil form on a toroidal core.

The coils can be easily made by winding fine wire like litz on a toroidal core but they can also be found on EBay as ready made units. The next step is to mount the coil assemblies inside a weather proof enclosure with an alligator clip that is soldered to the antenna wire and an SO-239 jack for connecting the coax to the receiver.



Photo 4: A completed Magnetic Longwire Balun (MLB)

Other Baluns

Dipoles antennas are not truly balanced. They require some kind of a balun to properly match them to the coax cable to the receiver. While they are readily available from ham radio dealers it is possible to build them using the same basic construction properties and the same types of coils as the magnetic longwire balun. An example of the circuit for a 1:1 balun is shown below. Adding more coils will adjust the balancing ratio. You will also need an extra alligator clip so that both sides of the antenna are connected. Ensure all connections are soldered.

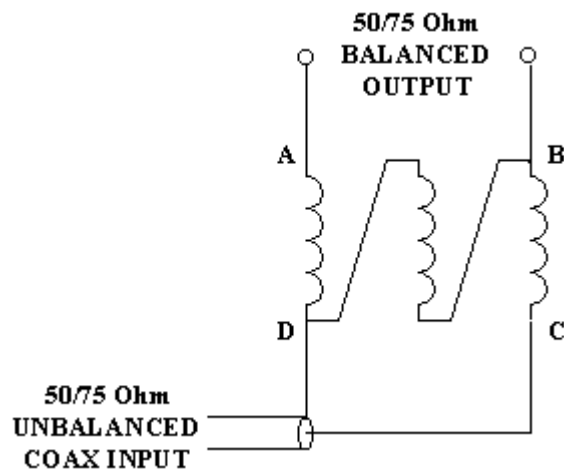


Fig 16: Basic circuit for a 1:1 balun

Load Coils

Load coils have long been used for a variety of functions. Telephone companies used to deploy them to increase the range of voice services on rural and long distance cables. Hams and DXers use them to insert an electrically-greater length of wire in a physically small space. Thus, by using them, the resonant frequency of antennas can be lowered allowing for a better antenna system in a small area.

They are easy enough to build. Even something flimsy like toilet paper rolls can be put to use as a coil form but wooden dowels and pieces of PVC pipe make great ones. Drill holes in either end to feed hook up wire through and simply wrap it around the dowel or pipe starting at one end and ending at the other leaving some slack on each end for connecting to your antenna wire or another load coil. Just make sure each one is the same length and contains the same amount of wire otherwise you may end up with a bit of a mismatch.

I am a big fan of using slinky-like toys for load coils. The original Slinky toy

contains about 20 metres of metal in its coils. To ensure that they don't short out the toy is extended to about 8 feet in length so it does take up a fair bit of space. They seem to give an electrical length of 13 metres.

A smaller variation is the Magic Metal Spring sold at dollar stores. In Canada it is imported by Handee Products of Montreal. It is only about an inch and a quarter in diameter but contains 9.75 metres of metal. It only has to be extended about 24 inches so that the individual coils don't short out. So, four of these can sit in the same space as a single extended Slinky toy. In practice these coils give an electrical distance of between 5 and 6 metres.

It was these Magic Metal Spring toys that I used in the loaded inverted vee dipole that is described on page 10. Three of them were inserted inside of each PVC conduit (as shown in Photo 1) and soldered together.

Tools on the Trade

As well as the items that make up erecting an antenna, such as wire, tape, silicone, baluns, end insulators, and the like, there are a number of tools that are essential to the success of the operation. A good selection are shown in Photo 5.



Photo 5: The tools of the trade

Certain tools are no-brainers: such as various pliers, knives, scissors, and wire strippers. Some that don't immediately come to mind can make the task of erecting an antenna less stressful such as: a Butane torch that can be used as a soldering iron outdoors; a Volt-Ohm Meter for checking continuity. Some VOM meters will also measure capacitance, inductance, and frequency with audible voice readouts.



Photo 6: A Yaeger Frequency Counter and an MFJ-207

Another handy tool is an antenna analyzer for having some way of checking SWR and resonant frequency. While stand-alone units that do all of this with digital readouts are quite pricey the MFJ-207 is an analogue unit that can be found on EBay for a reasonable price. It has an RF output so, with just a few inches of wire and a separate frequency counter (also available for a reasonable price on EBay), you can check SWR and have a digital readout of the resonant frequency of the antenna under construction.

Be Sure and Be Safe

I retired from Bell Canada in 2010 after 32 years of service. There was not a single day go by that safety was not drilled into us. Bell's attitude was that no job was to be done or activity undertaken if it could not be done safely. And so must you practice safety first when installing and maintaining antennas. Here are some steps you can take to ensure that you are still healthy enough to enjoy listening to shortwave radio.

1. Always ensure that the antenna can be erected safely. If you need help - get it! Don't rely on rickety ladders and the like.
2. Use the proper tools. If you need a knife, don't substitute a screwdriver. If you don't have the proper tool, buy it. You can always use them elsewhere. See Photo 5 on page 15 for a view of a selection of the proper tools you should have.
3. Ensure that no antennas can ever come into contact with overhead hydro wires. If necessary, move your shack to the opposite side of the house to facilitate this.
4. If you are going to be digging or drilling into the ground or driving stakes call your local telephone, gas, and hydro utilities so that they can advise you if there are any buried utilities where you wish to work. While this is common sense and the law in some jurisdictions many do not heed this warning. Doing this ahead of time helps to avoid service disruptions and can save your life if you were planning on digging where buried hydro or gas lines are located.
5. Ensure that a proper lightning arrestor is inserted where the coax enters the house and that it provides a proper path to ground that is independent of your RF and household hydro grounds. Always disconnect your equipment from your antennas before an electrical storm and if you are going to be away from your shack. Static build up and near misses can be almost as dangerous to your equipment as a direct strike.
6. As with other sensitive equipment in your home, such as computers, telephone systems, and expensive electronics, invest in surge protected powerbars and ensure that the circuit they are being plugged into is properly grounded. Some newer powerbars even provide limited protection from EMI and RFI which can help eliminate or mitigate local RF noise problems.
7. And when all else fails follow the old farming saying "Make hay while the sun shines." Do spend part of each spring and summer repairing broken antennas or replacing damaged ones with new ones.



Photo 7: The author's home after 25 cm snowfall

In areas with harsh winter climates, like where I live, working on antennas in snow and sleet and bone-chilling temperatures is something to be avoided. For that reason, I always try to have at least three antennas available before the winter DX season sets in. If one fails due to repeated bashing by the elements, I still have two to fall back on and I don't have to go out into the elements to effect repairs. If you simply must go out in the elements to fix a broken antenna exercise extreme caution and dress for elements. If your hands are getting too cold to do intricate work then get back indoors and warm up.

Conclusion

Designing and building your own antennas can be a rewarding part of the hobby. It can also raise your standing in the DX community as you can then be of assistance to those who, for various reasons, cannot erect their own antennas.

The point of this booklet is just to get you weaned off of whip antennas and those cheap pieces of wire that come with a lot of receivers and get you started in erecting a good outdoor antenna. If you want to get more involved in this aspect of the hobby there is a plethora of well written books on the topic from sources like the American Radio Relay League (ARRL) and CQ Communications. The two I rely on the most, however, are both by the late Joe Carr. "Receiving Antenna Handbook" and "Loop Antenna Handbook" are both still in print and available from Universal Radio.

Now go out and give your antenna some air!

About the Author



Mark Coady has been in the hobby for over 40 years and has been an active member of the Ontario DX Association for over 30 of those years. He has written numerous articles for the ODXA over that span and has edited its monthly, now weekly, shortwave loggings column for well over a decade. Antenna design has become a passionate sideline of the hobby for him and he loves to impart his advice and experiences to others. Retired after a long career with Bell Canada, Mark lives just outside of Peterborough, Ontario with his wife, Susan, and four cats and, of course, his beloved shortwave radio receivers.