Antenna Workshop

So how do you improve your Amateur Radio station? Ian Keyser G3ROO maintains you should always start with the antenna - as he explains in this article, especially written to give you an overview of common antenna types.

I'm no guru on antennas but after 50 years of experimenting, I've just about tried every known design and in doing so, have come to understand the basics of antenna design. I think that most of us have **Les Moxon G6XN**'s book *Antennas for all Locations* as a 'Bible', but for the beginner this may prove to be too heavy a tome to start with! So, this article is written to give an overview of common antenna types but no designs are included as these are readily available in magazines and handbooks.

There are two configurations of antennas, those mounted vertically and those mounted in the horizontal plane. Which type each antenna is, will be immediately apparent when you look at them! Vertical antennas are vertical in construction and horizontal are horizontal. They, in the vast majority of cases, radiate vertically or horizontally polarised signals as their name implies.

But polarisation is not important at this stage, it's sufficient to realise that horizontally polarised signals are received better on horizontally polarised antenna and vertically polarised signals are better on vertical antennas. This is more important on v.h.f. as there is usually very little polarisation twisting between transmitter and receiver. On h.f. this is rarely the case, once the signal has been reflected from the ionosphere, the angle of polarisation can be anything!

Ground Mounted

Vertical antennas can take two forms, ground mounted systems and those which are elevated. It is important to differentiate between these as those ground mounted only have (or need) half their elements. The reason for this must be understood before we proceed. The easiest way to visualise a ground mounted system, is to take a mirror and place it flat on a table. Now take a pencil and stand it upright in the centre of the mirror and think of this as a vertical antenna.

From a short distance away, look back at your little 'antenna farm' and you will see your vertical pencil and, reflected within the mirror, another inverted pencil 'under the ground' of your mirror. This is your missing element that is present in an elevated system! Of course, the mirror is a near perfect light reflector and the ground is a relatively poor reflector of radio signals. That implies that we have to do our utmost to make sure that our ground will reflect the signals to the best of our ability. Earthing is a very important subject and will be covered to a greater extent later.

So, which measurements do we use in antenna design? Should we measure in feet and inches or in metres. I maintain that in designing antenna systems, it's far more practical to 'measure' in fractions of wavelengths. This enables us to easily convert any design into actual measurement for any frequency we desire.

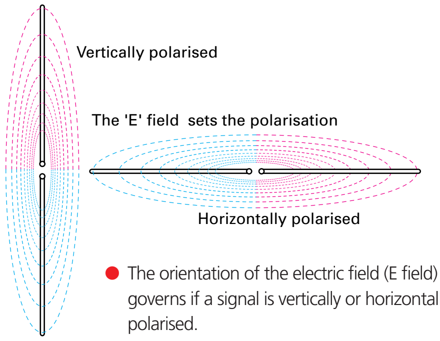
To convert frequency (in MHz) to its wavelength, divide the figure 300 by the frequency (in megahertz) to get the wavelength in metres. Of course, the opposite holds good as well, divide 300 by the wavelength (in metres) to get the frequency in MHz. You'll see other figures used for wavelength to imperial (feet and inches) conversions in articles, but the results will be almost the same.

It's important to realise that a resonant free space antenna will be a different length to ground and elevated system antennas above ground due to the influence of ground and objects nearby. In general terms an antenna near ground or other object will be physically slightly shorter at resonance.

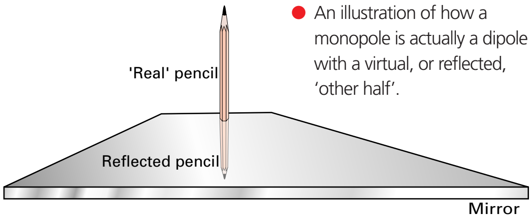
Dipoles And Loops

Generally speaking antennas fall into the two further categories of dipoles and loops. Immediately I can imagine hearing cries of 'what about verticals and inverted L antennas'. In both these cases, these come under the category of dipoles with their second element as a 'reflection' in the ground. Dipoles are fed in the centre and have an overall length of half a wavelength, however, they can be used with any odd number of half wavelengths.

Antennas are balanced systems and must be fed accordingly. Connecting coaxial cable directly to the centre of a dipole should not be considered as the system will not operate as expected. In practice, it can very easily increase the chances of causing TVI (but that is another topic!). Dipoles must always be fed with a balun (BALanced to UNbalanced transformer) at the centre.

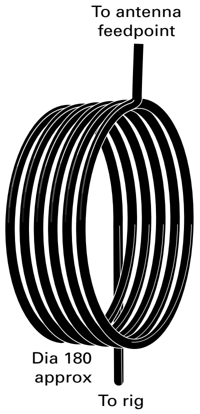


- The orientation of the electric field (E field) governs if a signal is vertically or horizontally polarised.

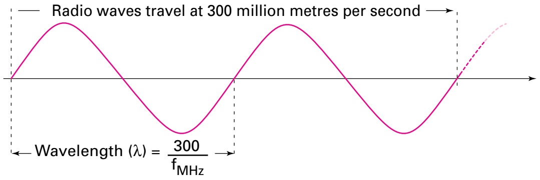


- An illustration of how a monopole is actually a dipole with a virtual, or reflected, 'other half'.

- (right) A balun may be created from several turns of coaxial cable, formed into loops with a diameter of around 150-200mm.



- (below) As radio and light wave travel at 300 000km/s then dividing 300 by the frequency in megahertz gives the full wave length directly in metres.



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The problem with coaxial cable, is its integration into an antenna system. Most antennas are balanced and require the balun. This adds cost and losses to a system, the two things as amateurs we try to avoid. Also if the outer pvc sheathing of the coaxial cable is damaged, water will get in and render the coaxial cable useless after the first few drops of rain.

The other alternative is to use twin feeder, which has many advantages over coaxial cable though it has a few disadvantages. The advantages are lower cost, many times greater lifetime and can even be home constructed if we are dealing with high impedance line. Low impedance lines, such as 75Ω feeders, cannot be home constructed due to the close spacing.

Feeder Disadvantage

One of the twin feeder's disadvantages is that it has to be kept clear of other objects, but in practice that is easy to achieve. It's even possible to use twin feeder up a tower and around a rotator to feed a beam antenna. We tend to think of twin feeders to be low loss systems, but do not fall into this trap! High impedance twin lines generally have far lower loss than coaxial cable systems, but medium grade 75Ω twin feeder can have a loss in excess of 10dB per 100m at 28MHz!

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To confuse things further, a horizontal loop will radiate a horizontally polarised signal if mounted reasonably high, but if mounted very close to a groundplane, the polarisation will be predominantly vertical! The so-called 'magnetic loop' is a self resonant circuit and I am not at all sure if we shouldn't consider these as a separate category.

Polar Diagrams

You will no doubt have seen an antennas' polar diagram (or plot) in magazine articles and wondered what they are! There's nothing magic about them at all. They are just lines joining points in space of equal signal strength, drawn with the antenna as in the centre. These lines enable us to see the direction of maximum radiation and other directions where there is little or no radiation. The further the line is from the centre the stronger the signal will be in that direction. The polar diagram of a dipole antenna in free space is like a big 'doughnut' with a tiny centre hole and the antenna poked through its centre.

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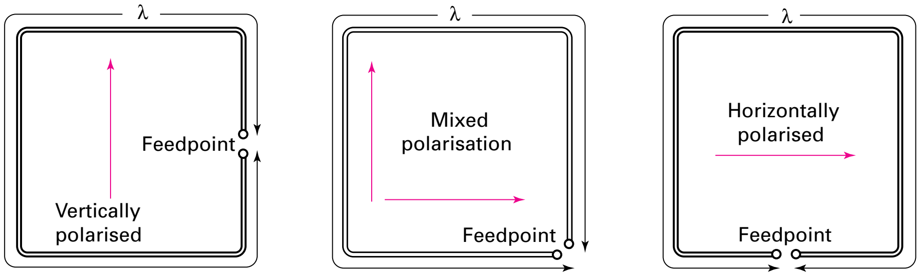
By adding extra lengths of wire of the correct length and spacing from the dipole we are able to distort the diagram even more, forcing the radiation from an unwanted direction into a wanted direction. By this method we can increase the gain of the antenna in a wanted direction and so increase our signal strength.

An added advantage to increasing our signal in one particular direction, and often even more important, is that we also receive signals less strongly from the unwanted directions and so experience less interference. The old adage 'If we cannot hear 'em, we cannot work 'em' is very true!

Beam Antennas

Beam antennas can be either vertical or horizontal, ground mounted or elevated. The idea is to place radiating elements so that in one required direction, the radiated signals will be in phase and so reinforce the



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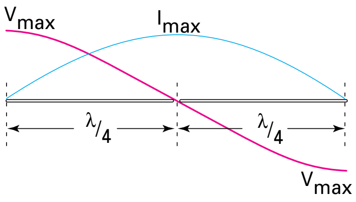

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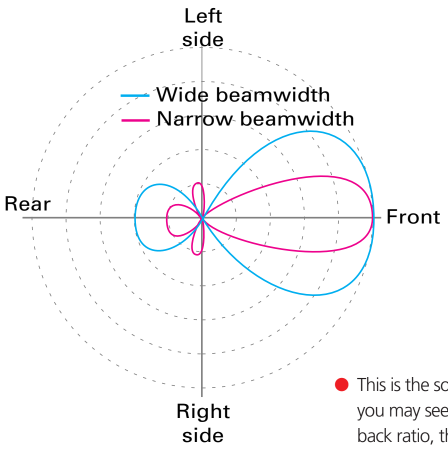

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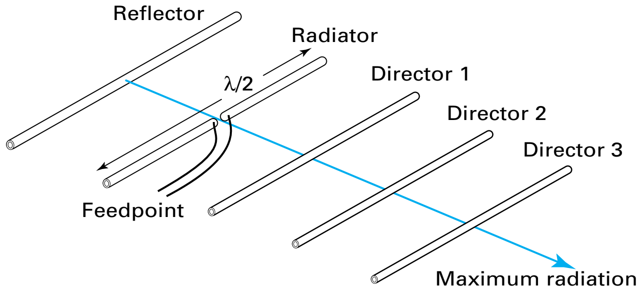

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In the smaller garden a useful monoband beam can be made of four quarter wave verticals in a square formation and fed via a phasing box. Correct spacing and cable lengths are required as well as a good earth system, but the results far outweigh the effort involved. Take heart, in a lot of cases the work involved in practice is far less than that envisaged during the planning stage!

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The length and spacing of each element has to be carefully adjusted for correct operation, but as mentioned earlier the advantages on receiver are well worth the effort. The advantages on transmit are less as the increase output power could be achieved by the use of a linear amplifier.

All antenna systems must be earthed for safety reasons, static electricity can build up on a well insulated antenna system and this must be discharged to remove the possibility of a very unpleasant 'belt'. As mentioned earlier vertical ground mounted systems must be earthed and well earthed if they are expected to work. I'm not talking about a single earth rod, but multiple earth rods over as large an area that we can manage.

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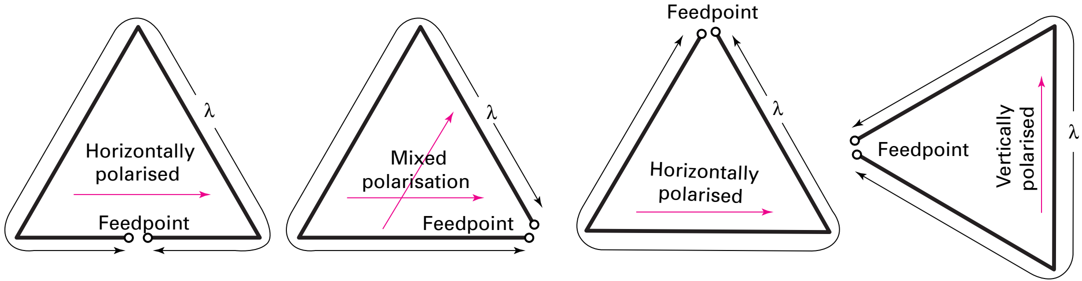

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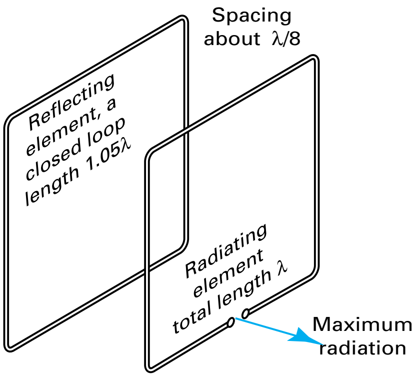

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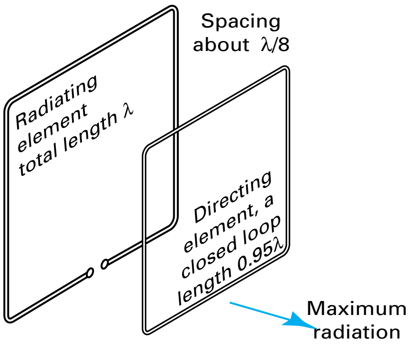

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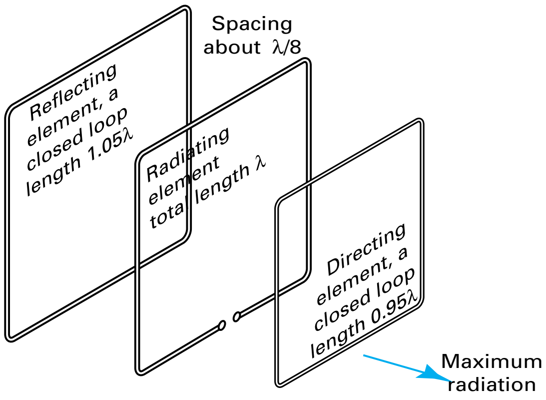

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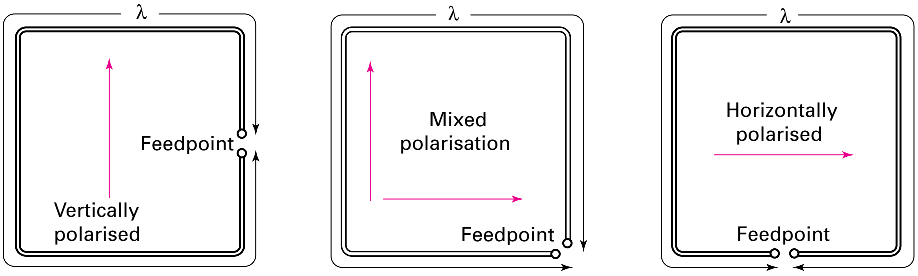

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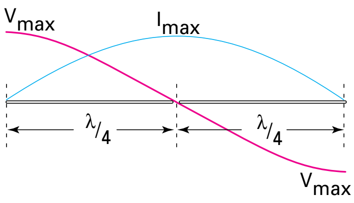

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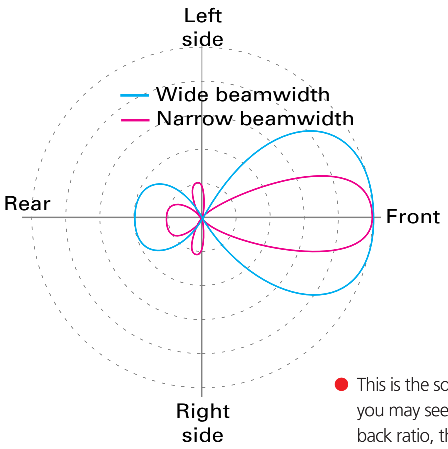

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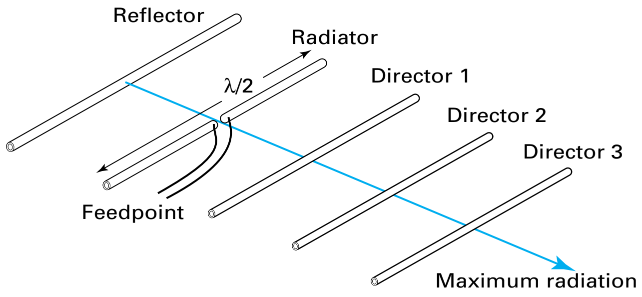

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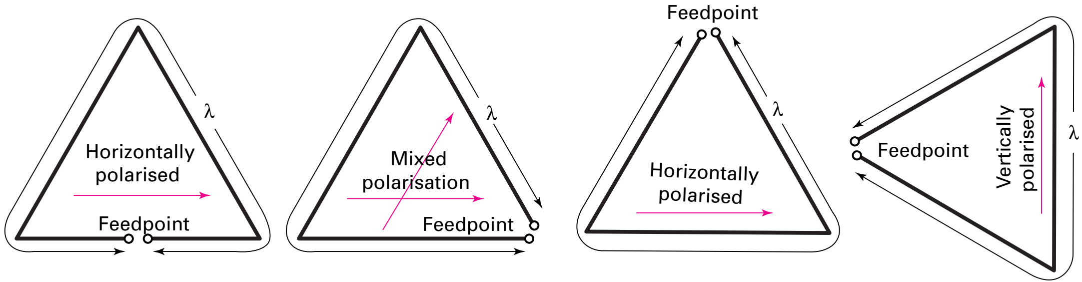

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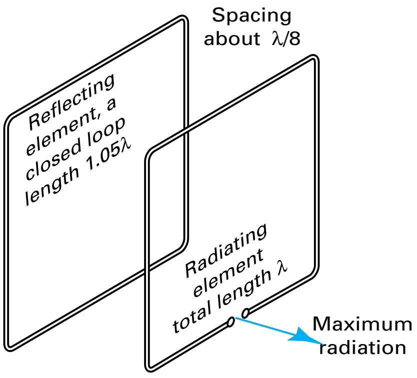

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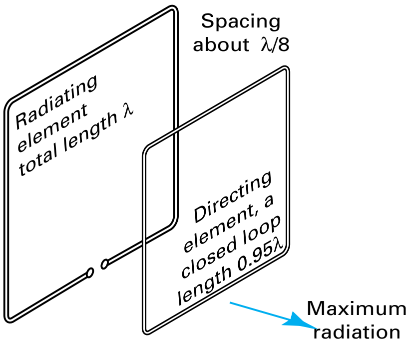

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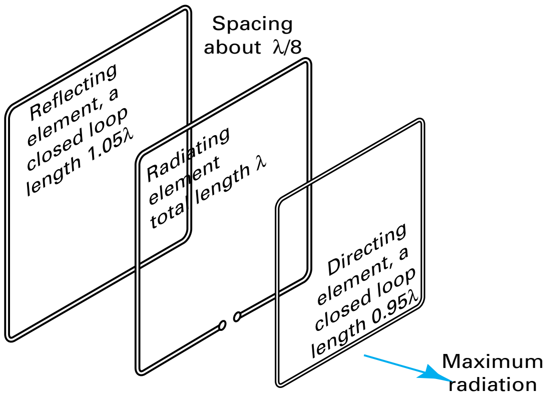

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