5 things to consider

when selecting your

Centre Fed Dipole, Yagi, or Stacked Array Antennas

AMPHENOL PROCOM

connect with confidence

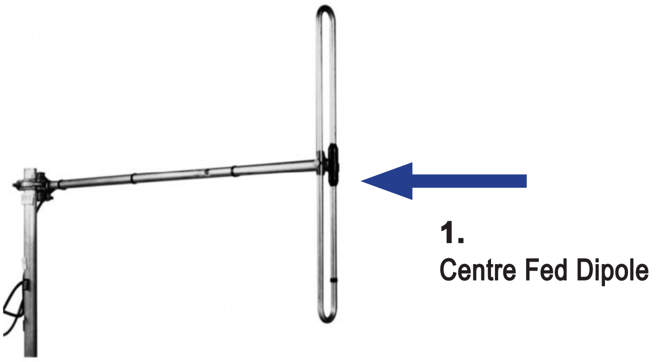
1. Model Selection

The Centre Fed Dipole[1] is the building block for many Omni and Directional Antennas in this product family. In this section we will look at how those building blocks are put together, how by adding multi dipoles - or by manipulating a single or multiple dipole - we can change the electrical characteristics to better suit our communication network.

Centre Fed Dipole

The Centre Fed Dipole is an Omnidirectional Antenna.

In free space, these will have 0dBd of gain; however, if it is mounted on a metal mast, the pattern and gain will change slightly depending on the distance between dipole and mast.

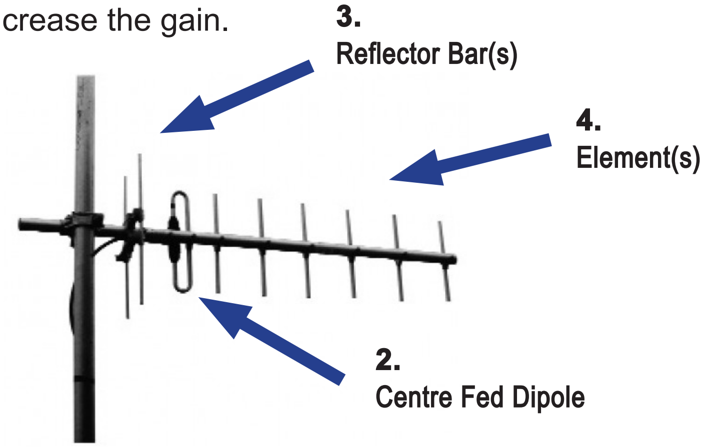


The manufacturer will be able to tell you the optimal distance as this depends on the frequency the antenna is tuned to. Whilst it's the simplest of the antennas it also the most crucial. Optimise these antennas for the best performance and other derivates below will greatly benefit.

Yagi Antennas

Yagi Antennas use the Centre Fed Dipole. The dipole is manipulated to give various different electrical responses. The first change a designer will make is to add a boom that the Centre Fed Dipole[2] is mounted on. This boom will have a reflector bar(s)[3] mounted directly behind the dipole fixed to the boom. This makes the antenna directional, basically pushing the radiation from the dipole forwards.

Further steering of the antenna beam comes from adding elements[4] in front of the dipole which tightens the pattern (reduces the beam width) and as a consequence of physics will increase the gain.



The more gain you want, the more elements you need and the less beam width we have. You need to be mindful that the boom cannot support an unlimited number of elements, since it will eventually bend under its own weight.

1. Model Selection

Stacked Dipoles

Stacked Dipoles are exactly as they sound. Take 2,4,6 or even 8 Centre Fed Dipoles and mount (stack) them above each other onto one common boom and you can get several different responses depending how they are arranged around the boom. The distance between the dipoles will depend on the frequency used.

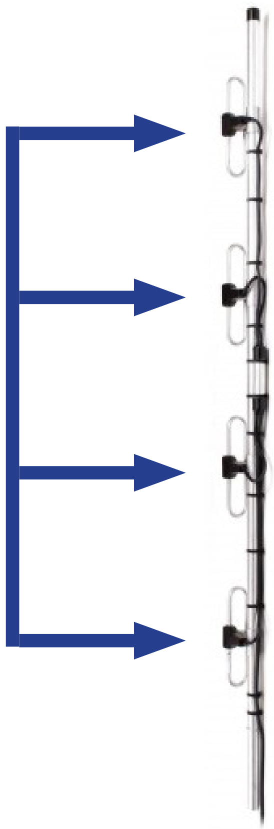
The most common way is to mount them vertically on the mast[5], pointing in the same direction (all facing forwards). This approach gives you a high gain Directional Antenna. **The more dipoles you stack the higher the gain.**

Alternatively, you can mount the dipoles at 90 degrees to each other. So, if you had 4 dipoles stacked 90 degrees from each other you would see the antenna pattern was omnidirectional. This is not so common now since people prefer to use Omnidirectional end Fed or Colinear Antennas.

The last thing to note is the feed system when stacking dipoles. There is one feed cable that runs the entire length of the boom and that splits off to connect to each dipole.

Some manufactures offer something rather clever at this point. The split can be manipulated in such away, that it will slightly delay the phase of the signal hitting each dipole. The result is you can offer down tilt. This process is described below in section 3: ”Electrical Characteristics”.

5.
4 dipoles stacked pointing in the same direction



2. Materials

Like all external antennas, the environment will have an impact on them. The material selection the manufacture uses to construct the antenna varies greatly. Therefore, the service life also differs greatly. A manufacturer using the best materials will offer service life of 10 years plus.

Aluminium

Aluminium is the material of choice for this product group. Its malleable enough to bend and shape, lightweight, and highly resistance to corrosion.

However, there are many different grades used and this greatly influence the sevice life and the price.

A solid robust design will use a grade similar to 6082-T6. This is a heat-treated, structurally strong alloy used in highly stressed applications (not just antennas), giving the best balance of strength and corrosion protection.

Some of the lower cost antennas will use inferior quality base materials, such as “split” or rolled aluminium tube. You can expect reduced service life, maybe only 2-3 years in total.

Balun Encapsulation

There are entire books written on what and how to design a Balun. The name Balun is made up from two words; balanced and unbalanced.

Baluns are used to match the impedance between the balanced dipole and the unbalanced feed cable; basically, it’s the part of the antenna where the feeder cable joins the dipole. We protect the Balun by either injection moulding over the top of it (pictured below), or we can use a two-piece box that is potted using epoxy polyester.

Do check that the materials used on the Balun’s are UV stabilised. Otherwise the plastic will breakdown after time, exposing the Balun to moisture, that will unbalance the system, resulting in poor performance or a completely dead antenna.

AMPHENOL PROCOM

2. Materials

Element Clamps

Element Clamps as insignificant as this might seem, the material the elements clamps are made from, and the quality of mechanical support they give the elements hugely contributes to the integrity and longevity of the antenna. Its highly recommended that cast metal clamps are used, as pictured below.

Plastic element clamps will breakdown as time passes, if they are not UV stabilised.

This will result in at least the elements spinning free on the boom of the Yagi. It will also affect the pattern of the antenna and can make the it susceptible to static noise.

3. Electrical Characteristics

Gain

This is a guideline, so we are going to skip past all the technical parameters. There is a lot of "spec-man-ship" that goes on here, so make sure to compare apples to apples when looking at gain values.

Some datasheets will show gain measured in dBd and other in dBi. It's like measuring in inches or centimetres; to convert, the dBd value is always 2.15 less than the dBi value.
For example 0dBd is equal to 2.15dBi.

Pattern Tilt

Pattern Tilt is a really useful feature found in high end stacked dipole products.
It's used to tilt the pattern so it will cover users directly below the mast, or to avoid crashing into other parts of your network, or other peop le's networks.

This is typically an electrical parameter, built into the RF feed system of the antenna, that is fixed during manufacturing and typically offered with a range from 0-12 degrees. This option is fixed and needs to be chosen at point of order; it cannot be changed in the field. Selecting the correct down tilt is usually figured out by the installer and/or the network coverage plan.

Passive Intermodulation (PIM)

Passive Intermodulation briefly speaking, is a form of harmonic noise that can occur in RF components and products like antennas. Typically, PIM occurs when there is a mix of two strong RF signals in one device.
In some configurations, this will cause interference in the receive channel.

High end, low-PIM products will be constructed to minimise this, and if you are operating or planning a multi carrier network like LTE and Public Safety, you really need to have this feature.

The industry standard value is -153dBc (3rd Order, 2 x Tx @ 43dBm). Anything lower, like -143dBc, PIM measured in the 5th order, or with carrier levels lower than 43dBm may not be suitable for LTE or Public Safety networks. Make sure and check the specifications carefully.

4. Bandwidth

Bandwidth and VSWR are two parameters that you need to ensure are “like for like” when comparing several manufactures products.

Bandwidth

Bandwidth is basically the frequency at which the antennas is optimised to receive and transmit.

For example, a typical antenna covering a DMR, LMR or PMR system could have a bandwidth of 380-430 MHz.

VSWR

VSWR will be mentioned alongside this. Let us say it has a VSWR of 1.5:1 - what we are really looking at here is how much of the power that is fed into the antennas gets reflected back down into the transmitter. A VSWR of 1.5:1 means that about 4% power is reflected back to the transmitter. Easily managed.

Typically, VSWR of 1.5:1 is a good level for an antenna; lower values (like 1.3:1) are better and are often seen in high power antennas.

But be careful, because sometimes tricks are played, and specification “stretched” to say 380-430MHz @ VSWR 2.0:1 still acceptable, but on the limits. This is basically saying at the same frequency previously mentioned a whole lot more power is being reflected (around 11%).

If you see a VSWR of 2.5:1, that is 18% reflected power, and VSWR of 3.0:1 is 25%. This becomes unmanageable and can greatly affect the performance of your system.

5. Brackets & Accessories

Brackets and clamps offerings for these products are plentiful, each severing a different purpose for a multitude of environments in which the antennas will be mounted.

The ’Norstel’ Solution

For Yagi and Dipole Antennas, the basic clamp to fit the antenna to a vertical pole is called a ‘Norstel’ clamp or double-coupler. It is usually supplied with an increasing sleeve to fit to the clamp to the antenna boom. This will protect the boom and since the clamping pressure is equally applied, resulting in the boom being held tight without any deformation.

The Norstel solution fits a narrow range of mast diameters, however, for some apllications a different clamp or additional accessories may be required.

Larger cross over clamps, available with different sized U-bolts, will allow the antennas to be fitted to a larger range of mast diameters or shapes.

Wall mounting Pole Kits

Wall mounting pole kits, for fixing the mast pole to a wall is another solution to consider. When antennas are mounted directly on the mast leg, you may want a bracket that can compensate for the rake of the tower.
There are solutions for this too.

Consider The Environmental Condition

Finally, the environmental conditions at the site may give cause for careful consideration. Large antennas in high wind sites may need bracing. Certainly, speak to the antenna manufacturer about solutions for this.

Make sure whatever clamp(s) you buy they have a good surface treatment to endure the long time that they will be outside in harsh environments.

Here to help

At antennaPRO we take a consultative approach to our customers' requests.

If you have a question, need some support or cannot find what you are looking for, we are here to help.

Contact our team on 01227 743099 or sales@antennapro.co.uk.