Marine VHF Antennas (aerials) and their installation

By John Schofield

It is a simple fact that the potential performance of a marine VHF radio is limited by the quality of the antenna and its installation. A badly designed antenna fitted with undersized cable and imperfect connections will make the performance of even the most exquisite and expensive radio unacceptable.

A penny in the antenna is worth a pound in the radio.

It is important to select the right antenna and to install it in such a way that it maximises the performance of the radio or AIS engine to which it is attached.

VHF radio range is line of sight, so height above sea level and a clear view to the horizon are the most important factors in achieving maximum range. On a yacht the most suitable antenna location is, therefore, at the top of the mast. Two boats, each with a masthead antenna 60′ above sea level, can theoretically communicate at about 22 miles. A transmitter at a coast station, perhaps 1000 feet above sea level, could communicate with these same boats at closer to 50 miles. On a power boat you have to do what you can to place the antenna as high as possible above sea level – on a radar arch or an extension pole.

For those who wish to do the maths themselves the formula is: Range in nm is equal to 1.4(vH1) +1.4(vH2), where H1 and H2 are the heights of the antennas in feet. The constant, 1.4, takes into account the fact that the radio waves bend slightly so they can 'look' over the horizon some distance. In certain atmospheric conditions much greater ranges have been noted but this can't be relied upon.

Selecting an antenna

Antenna gain, the apparent increase in signal power achieved by focusing the radio signal, is expressed in decibels – dB. Gain is related to antenna length: In broad terms a 9′ (3m) antenna increases the signal strength eightfold, a 6′ (2m) antenna fourfold and a 3′ (1m) antenna, the best selection for masthead applications, doubles signal strength.

Beware of quoted antenna gain figures! Gain can be expressed in different ways depending upon the standard to which the gain is being compared. It can be compared to a theoretical antenna called an isotropic antenna (dBi) and it can also be compared to a ½ wave dipole antenna (dBd). It can be compared to either of these antennas operating in free space or when used over a reflecting surface such as the ocean which adds further gain. Because of this, antennas with the same actual gain can be credited with a higher or lower gain figure depending on who writes the ad copy! Most often a 3′ (1m) antenna will have a quoted gain of 3dBi, but you may also see 0dBd or 5.1 dBi or even 6dB quoted for exactly the same antenna.


Metz Manta


AlphaOne

It is best to ignore published gain figures and select a 3′, 6′ or 9′ antenna appropriate to your application. My advice is to look no further than a good quality 3′ whip antenna such as the Metz Manta or the AlphaOne for most boat applications. Here's why:

Antenna 'gain' is not a gain in power – the antenna cannot create power – it's a focusing of the available power to give the effect of increasing that power. It's like adjusting the focus on a torch (flashlight); you can illuminate a wide area to a particular intensity or, by focusing the beam, you can illuminate a small area to a greater intensity. That's how higher gain is achieved in a marine antenna – the radiating beam is more narrowly focused. If you could see the radiating pattern emanating from a 1m (3′) antenna it would look like a fat doughnut, from a 3m (9′) antenna it would look like a pizza.

As the focusing of your light beam intensifies you have to point the torch more precisely at what you want to illuminate. It's just the same with the antenna. To be useful the focused beam must be pointing at the horizon and not at the sea or the sky and this is near impossible on a bobbing boat – especially at the top of a mast. So, big gain is not necessarily a good thing because in the undulating environment of a small boat some portion of a broad doughnut-like beam will be pointing at the horizon most of the time whereas a flat focused beam will spend much of its time pointing uselessly at the sea or the sky.

Hence the universally accepted practice of choosing a 3′ (1m) whip antenna for masthead applications. I believe that even on RIBs, motorboats and other deck-level applications it's better to use a short antenna mounted on an extension pole rather than a taller antenna with its narrowly focused beam.

Another measure of antenna performance is the VSWR – Voltage Standing Wave Ratio. This is, in very simple terms, a measure of the amount of the transmission power that is lost in the antenna system. If the antenna system were perfect and the entire signal power leaving the radio was transmitted by the antenna (and its cables and connections) the VSWR would be 1:1. Sadly this is not achievable, but getting as close as possible is a worthy aim. A VSWR of 2:1 over the whole system represents a ½ dB loss in signal strength and is barely acceptable.

To achieve or, preferably, better this performance the antenna itself should have the best possible VSWR. A top quality antenna such as the Metz Manta or the AlphaOne will have a VSWR of less than 1.5:1.

Other criteria for selecting a marine antenna, particularly one for masthead mounting, would be:

- Perfect sealing of the coil housing.
- Resistance to UV degradation. Clearly all stainless steel construction wins hands down.
- Resistance to bird strikes. Again, a stainless steel whip is less vulnerable than a rigid plastic one.
- Ability to be removed when the mast is taken down. This is when the antenna is particularly vulnerable and those with factory crimped connections cannot be removed without removing all the cable with them. The connection at the antenna should be an SO239 socket which takes the standard PL259 connector.
- Low weight and windage.
- Multiple mounting options.

Once the antenna has been selected we can turn to the other components of the antenna system; the cable and connectors.

Coaxial cable: Marine VHF applications require 50 ohm coax. TV cable is 75 ohm and is not suitable. Suitable cables include RG-58 (smallest), RG-8X, RG-8U and RG213 as well as some other less common variations. RG-213 is the same size as RG-8U (10mm) but with completely waterproof and ultra-violet resistant insulation. RG-213 is more difficult to work with when it comes to making connections and is very expensive, so probably best left to superyachts.

RG58 (5.5mm) is only suitable for runs of no more than 6m (20′). RG-8X (7mm) is recommended for runs up to about 20m (65′) and RG-8U for longer runs. (This is also the recommendation of the IOC and ISAAF as the best means of achieving their Cat 1 offshore race requirement for an antenna feeder cable with less than 40% loss)

Marine coax must be tinned copper, both the braid and the stranded centre core. Braid coverage is important – over 95% is excellent, below 90% not acceptable. A foil barrier around the dielectric is a bonus. A good UV resistant cover is essential for longevity.

Marine coaxial cables with PL259 plugs.

Connections: One of the biggest causes of failure in an antenna system is faulty connections. These allow water into the coaxial cable causing corrosion of the braid and centre conductor. So, high quality connectors are required.

The cable terminal at the radio is the PL-259 plug. This plug fits the SO239 socket fitted to all VHF radios. A PL259 connector also mates with the SO-239 socket as fitted to the Metz Manta, AlphaOne and other top quality antennas.

Some antenna manufacturers use factory fitted pressure crimped connections but these are subject to corrosion and need special tools to create the connection. Remember, you should be able to remove the antenna when the mast is taken down for winter storage.

Two lengths of cable can be connected together using two PL-259 connectors and a barrel connector.

 PL259 plugs

Cable installation: An ideal installation would have the cable make an uninterrupted run from the antenna connector to the radio socket but this is not always practical. A good compromise is to make the connection inside the boat, out of the harsh marine environment. A cable access port, such as the Cableport, through which the entire PL259 plug will pass allows an interior connection to be made without the need to remove the plug when removing the mast. The masthead connection and any other exterior connections should be protected with self-amalgamating compression tape such as Bandit tape.

 Cableport

If the cable is inside the mast it should be restrained to prevent tangling with halyards or other cables, and to avoid the maddening rapping of the cable against the mast. Modern mast sections have in-built channels through which the cable can be run. Older masts should, if at all possible, have a conduit fixed inside. As a last resort the cable can be fitted with groups of three plastic cable ties at about 1m intervals, with the tails of the cable ties radiating out to the interior wall of the mast. This will hold the cable off the mast wall somewhat, but will not avoid abrasion from halyards or other cables.

On wooden masts it is usual for the cable to be run externally.

A top quality antenna such as the Metz or the AlphaOne, combined with the correct cable and well made connections, will release the full potential of your VHF radio.