Marine Antennas

Spare the whip and spoil the communications

Imagine if all radio waves were visible to the human eye. We'd all be walking around in darkness akin to a black hole, assuming of course radio waves are black rather than, say, white or pink. Who knows? We do know, however, that for every radio, there must be an antenna. And marine antennas must be the most indestructible of any as they take the most abuse. In addition to salt and water, marine antennas endure horrendous momentum stresses as they cross the seas.

In this, part one of a series, we'll address general aspects of antennas such as types, purchasing, optimization, installation and operation. Subsequent articles will deal with various aspects of antennas in greater technical depth.

We categorize antennas into three groups: navigation, communications and entertainment. Since encyclopedias could be written encompassing all three categories, we'll limit our discussion in this installment to communications—VHF, SSB, satellite and cellular.

VHF

Purchasing a VHF antenna has more to do with the type of vessel you have than anything else. Small vessels require small antennas with the converse true for larg-

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Antenna Manufacturers

Comrod A/S (VHF/HF-SSB/Cellular)
Tau, Norway
www.comrod.com
+(47) 5174 0500

Digital Antenna (VHF/HF-SSB/Cellular)
Sunrise, FL
www.digitalantenna.com
954-747-7022

Furuno USA (VHF/HF-SSB/Satcom)
Camas, WA
www.furuno.com
360-634-9300

G.A.M. Electronics (VHF/HF-SSB/Cellular)
Manchester, NH
www.gamelectronicsinc.com
603-627-1010

Globalstar (Satcom)
San Jose, CA
www.globalstar.com
408-933-4000

Glomex Marine Antennas
(VHF/HF-SSB/Cellular)
Sarasota, FL
www.glomex.it
941-355-3381

Iridium (Satcom)
Leesburg, VA
www.iridium.com
703-724-8437

JRC (VHF/HF-SSB/Satcom)
Seattle, WA
www.jrc.co.jp
206-654-5644

KVH Industries (Satcom)
Middletown, RI
www.kvh.com
401-847-3327

Metz Communication (VHF)
Laconia, NH
www.metzcommunication.com
603-528-2590

Morad (VHF/HF-SSB)
Seattle, WA
www.morad.com
206-789-2525

SP Radio (Sailor) (VHF/HF-SSB/Satcom)
Houston, TX
www.sailor.dk
713-378-2100

SEA (VHF/HF-SSB/Satcom)
Mountlake Terrace, WA
www.sea-dmi.com
425-771-2182

Shakespeare (VHF/HF-SSB/Cellular)
Columbia, SC
www.shakespeare-marine.com
800-227-1590

er vessels. But no matter what type of boat you have, your main concerns need to be gain, Standing Wave Ratio and mounting height.

Gain

We tell one antenna from another by its effective radiating power (ERP). Expressed in decibels (dB), marine antennas most commonly rate as 3, 6 or 9dB, with the rule of thumb being that the higher the gain, the longer the range. Here again, however, you must consider your vessel type when choosing which gain you want since the width of the transmission beam narrows as the gain increases. In other words, a 26-foot center console fishing boat that pitches, yaws and rolls probably doesn't want a 9dB antenna, because as the antenna pirouettes in rough waters, the radio will experience signal fade. Larger, more stable vessels can take advantage of 9dB or even higher gain antennas.

Shakespeare offers very simple calculation tables to let a buyer determine the best antenna choice for any given boat:

3dB: Antenna tip height (in feet) above the water line x 1.15 = range in statute miles.

6dB: Antenna height (in feet) above the water line x 1.42 = range in statute miles.

9dB: Antenna height (in feet) above the water line x 1.52 = range in statute miles.

SWR

The other critical decision a buyer must make concerns Standing Wave Ratio. SWR rates exactly how much of the transmission signal actually reaches its destination. Don Henry of Shakespeare Electronics explains, "SWR, in simple terms, is a measure of antenna efficiency. The term's numeric representation is a ratio of numbers, 1:1 being perfect, indicating how much of the transmitter's signal actually gets radiated by the antenna. SWR measurements of 3:1, 4:1, etc. indicate high-reflected or wasted energy absorbed into the transmission media such as antenna mechanics, cable or connectors. This wasted energy doesn't reach the final destination, with the result being poor transmission or reception of signals."

Since we don't live in a perfect world, you're unlikely to ever find an antenna rated at 1:1. According to Henry, the theoretical perfect antenna with a 1:1 ratio simply doesn't exist. However, the industry tries hard to keep SWR under 1.5:1. Your goal as a buyer is to search for an antenna with as close to a 1:1 SWR rating as possible.

Another less well-known consideration you shouldn't overlook concerns the shape of your transmission. With each different dB rating comes a different shape broadcast beam, some rounder and some more elongated. What few people realize is that these beams can exit the antenna in many different directions. You should be looking for an antenna with a low angle of radiation. The lower the radiation angle, the closer to straight out to the horizon your signal will travel.

Price should actually be the least important criteria when choosing an antenna. With all other things being equal, the antenna represents about the only thing you can alter to improve your radio's performance.

Installation

Since the U.S. government limits VHF transmission power to 25 Watts, you have no legal way to increase a unit's power output. VHF qualifies as line-of-sight technology so the only way to increase your actual transmission/reception range lies in your choice and placement of the antenna. Obviously, logic dictates that the higher above the water's surface you can mount your antenna, the greater distance you'll be able to cover when communicating. In other words, an antenna at the top of a sailboat mast will broadcast farther than the same antenna mounted on a cabin side four feet above the water's surface. Of course, the longer the wire run between the antenna and radio, the more signal loss you suffer. You could easily lose 3 to 5 dB in 100 feet of cable. Make sure that on longer wire runs, you choose the appropriate cable for the distance to minimize signal loss.

Marine antennas operate in a punishing environment of corrosive salt, extreme movement and, sometimes, freezing spray. Yet they must deliver top performance 24/7.

When shopping for the right antenna, keep your eye on gain, mounting height and SWR–or Standing Wave Ratio.

RFI

Sometimes it seems that almost everything else aboard a boat can interfere with a VHF. Depth sounders, fluorescent lights, engines, pumps, radars, other radios, plasma TV screens, cellular telephones and the like all can pose problems. So some considerations when mounting an antenna and running wire include the following:

- Keep the antenna and cable away from fluorescent lights.
- Route the antenna cable at least 3 feet away from plasma TV screens, other radio antenna cables, depth sounder transducer, engines, and other antennas. Likewise, mount the VHF antenna at least 3 feet away from any other radio or navigation antennas.
- Use only quality coaxial connectors on each end and to connect cable extensions if you need them.
- Do not coil coaxial antenna cable neatly. Rather, store it in a random jumble or a figure-eight coil to prevent interference or magnetic anomalies.

Mounting

As we said earlier, marine antennas take lots of abuse and the momentum loads can be astonishing. They don't call them "whip" antennas for no reason. Smaller boats with short antennas needn't be as concerned with momentum loading. But larger vessels with taller antennas must always add at least one mid-length support in addition to the antenna-mounting base.

If you never plan to go under a low bridge, you needn't worry. If you do, most bridges won't open if only your antennas exceed the bridge's height limitations. In these instances, or if you trailer your boat, you'll want a mount with a ratchet adjustment allowing you to lay the antenna(s) down.

Optimization

Using the finest quality connectors, cables and putting them all together as perfectly as possible optimizes your VHF system better than anything else. However, Shakespeare's VHF signal strength measuring meter can tell you if your installation job was less than perfect. It works by measuring the SWR of the antenna system including the antenna, cabling and connectors.

Antenna Construction

In its most basic form, an antenna is nothing more than a piece of wire cut to a specific length for a given frequency. Manufacturers take "elements" and stack them on top of each other to alter the dB rating, linearly stacking a second and third element on top of the first.

For example, you can opt for the least expensive fiberglass antenna and it will work fine for a while. But the marine environment starts wearing on it immediately until down the road, you experience something called antenna bloom. You usually discover this when you raise or lower your antenna and end up with a load of fiberglass filaments stuck in your palm.

To avoid this, you take the next step up in quality to an antenna with a thicker wall and perhaps a high-gloss, polyurethane finish. These more expensive antennas will also likely have better elements inside.

The next step up finds antennas with brass tubing replacing the internal cable, and so on. Bottom line – more cost means the tubing gets fatter which improves bandwidth and consequently efficiency. The ultimate antenna consists of silver-plated brass and copper elements.

Small runabouts and sailboats often opt for stainless steel whip antennas for space and/or durability reasons. As with quality where you should buy the best antenna you can afford, we recommend that you get the most appropriate antenna possible for your boat.

SSB

Single sideband, also called HF for high-frequency, broadcasts in the frequency range of 3 to 30 MHz. Recreational vessels most commonly use radios with 150 to 400 Watts, though commercial models of up to 1,000 Watts or more are available.

SSB use has waned since the advent of satellite telephony, especially with the introduction of portable, handheld satphones and affordable connection fees.

Today, offshore boaters most commonly use HF radio for vessel-to-vessel communications when the 20-25 mile range of a VHF radio just won't do. Offshore recreational fisherman often use it to keep track of where "the bite" is taking place between the many northeast canyons at the edge of the Continental Shelf.

Single sidebands produce two types of signals: ground waves and sky waves. Since the ground wave broadcasts short distances in all directions from the antenna base, beware of annoying nearby boats with your HF transmissions.

Sky waves, on the other hand, head up into the sky where they bounce off the ionosphere and ricochet back down to earth a long distance away. Different frequencies bounce off the ionosphere at different altitudes. Simple geometry dictates that this will result in your signal traveling different distances depending on the frequency. The higher the frequency, the farther the signal travels.

Since all the atmospheric layers change shape by expanding and contracting depending on temperature, time of day and time of year, expect your lower frequency signals to travel farther during daylight hours when the sun heats the atmosphere, causing it to expand, moving the reflection point higher. Higher frequency signals travel farther at night, as the table below shows.

The shortcoming of the SSB unit and antenna comes in the mid-distance ranges. If the up and down path of the signal represent

FAQ's

VHF

Q. *Your radio gets a nasty, whiny whirring noise that seems to match rpm of engine.*

A. *The engine is interfering with the radio reception. It could be that the antenna cable runs near the engine. Check that. If not, consider putting an ignition-noise filter in place. Also check to be sure no computers, plasma TV screens, fluorescent lights, light dimmers or other radio antenna cables operate or run near the antenna cable.*

HF/SSB

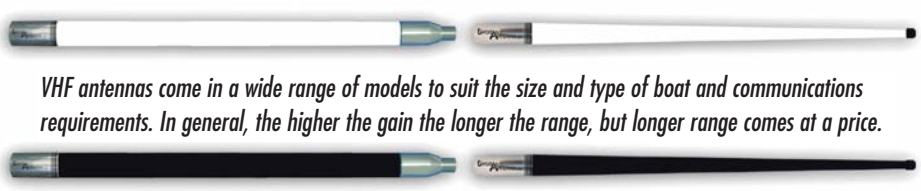
Q. *You can hear people broadcasting from all over the world, but your transmissions seem to suffer from a distinct lack of strength.*

A. *Insufficient ground area is your likely problem. Try finding more earth sources to enlarge your grounding plane.*

Cellular

Q. *You call your friend and though you hear the phone ring, nobody answers.*

A. *He's probably not home.*



VHF antennas come in a wide range of models to suit the size and type of boat and communications requirements. In general, the higher the gain the longer the range, but longer range comes at a price.

the two sides of the triangle, the base of the triangle suffers, in this instance, from a no-reception zone. This dead or "skip" zone grows larger as you go higher in frequency. In other words, choose your transmission frequency wisely, basing it upon where the receiver you're calling is located.

Expected Transmission Distances By Frequency

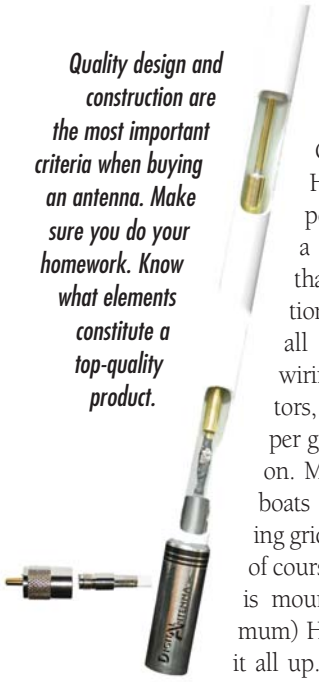
Freq Band	N.M Day	N.M. Night
2 MHz	100	300
4	300	800
6	400	1000
8	500	1200
12	2000	800
16	4000	TBD
22	Worldwide	TBD

Purchasing

Your marine electronics dealer will help you match all the components of your SSB. Get the best unit and antenna you can within your budget, remembering that a cheap radio with a top-quality antenna works far better than an expensive radio with a cheap antenna.

Overview

Before we even start explaining the antenna installation process, we strongly recommend that you hand the entire job over to a Certified Marine Electronics Technician—called a CMET. Mounting an HF antenna on a powerboat represents a far easier process than a sailboat application. The latter requires all manner of special wiring, backstay insulators, antenna tuner, copper grounding grid and so on. Most large production boats today have grounding grids built-in as a matter of course. All you have to do is mount a 23 foot (minimum) HF antenna and hook it all up. If you're ordering a new boat, make sure the builder installs a grounding grid during construction.



Quality design and construction are the most important criteria when buying an antenna. Make sure you do your homework. Know what elements constitute a top-quality product.

The Counterpoise

A counterpoise is one of two major factors in optimizing the performance of an HF radio. Defined as a conductor or system of conductors used as a substitute for earth or ground with an antenna system, a counterpoise or grounding plane most frequently consists of a mesh screen made of copper, to which copper foil connects the antenna. An HF ground plane should cover at least 100 square feet.

The other major factor is the antenna tuner, which, for optimum performance, should be mounted as close to the antenna as possible.

Installation

So, you still insist on doing this yourself, eh? Bottom line is that it isn't so much difficult as it is time consuming and frustrating. Then let's consider a fiberglass, inboard boat.

You need to determine what your ground will be. In any onboard radio, consider the ground as the rock cliff from which your transmission launches itself. Without that firm base to push off from, the signal just falls into the sea.

Being Grounded

Here's an interesting fact explaining why you should use copper strap rather than wire throughout the grounding system for your SSB. At the frequencies at which HF radio operates, the electricity runs on the surface of the ground wires rather than through them. Because of this unusual occurrence a copper strap 2 to 4 inches wide and .001 to .013 inches thick offers much less impedance (resistance at a given frequency) than wire with relatively little surface area. Connect ground straps from the radio to the counterpoise, water tanks (obviously not fuel tanks), engine block, keel bolts (in the case of a sailboat) and any other grounded metal.

Antenna Tuners

As we said earlier, locate the antenna tuner as close as possible to the antenna base, preferably under the deck or inside a coaming or cabin side—out of the weather. Connect the antenna feed GTO-15 wire with a soldered ring connector. Be sure to loosen or remove the drain screw in the bottom of the tuner so condensation can't collect inside.

Satellite

With so much navigation, communication and entertainment bouncing off satellites today, you can find a satellite antenna for virtually any purpose. However, we'll stick to communications for the needs of this article.

Depending on the size and needs of your vessel, you can find antennas to fit your available space that will handle voice communications, data or both. This is certainly a job for a CMET, so we'll just give you an overview rather than chapter and verse on installation.

Communications via INMARSAT's geosynchronous orbit satellites have been a reliable property for hundreds of thousands of customers for more than 20 years. Though lower-orbit satellite systems like Iridium and Globalstar have endured rough starts, they seem to be coming out of the woods slowly but surely.

Purchasing

Certainly the first determination a prospective buyer of satellite communications must make is what he or she needs to accomplish by using such a system. Simple voice communications, e-mail, faxing and data transfer all require different systems, with differing access speeds and of course, different pricing structures, both for hardware and subscription/usage.

Next, if your needs are strictly voice or voice and data, you might want to consider a handheld phone. Affordable to both purchase and use, these new models have excellent global coverage. Of course, you need to be on deck with a clear line to the sky when using one. Fixed-mount systems, though more expensive to buy and sometimes to use, allow you to hook multiple phones into the system and come in out of the rain while calling.

The ease with which satellite systems can be used belies the sophistication of the hardware. Though the user will scarcely recognize any difference between use at home/office and onboard, the equipment needed bears

Inside the fiberglass shell is the business end of an antenna. Look closely at manufacturers' "cutaway" photos and drawings of their products and ask questions about design and materials used. Comrod provided this cutaway.

significant difference in complexity and cost. For any communications other than straight voice, the antenna must be able to point within 1 to 2 degrees of a satellite hovering more than 22,000 miles up, all while the boat is rolling, pitching and yawing. This requires a gyro-stabilized platform. Straight voice communications can get away with lower frequencies and, therefore, smaller, omni-directional antennas requiring less power. Since these don't need to point directly at the satellite, they don't need stabilization. Less hardware and power equates to less cost. Want e-mail, internet or fax ability? You'll need higher data transfer rates, a larger antenna and a heftier change purse. Why bigger? The laws of physics dictate that higher power and data rates require a larger antenna. In other words, being ruthless in your evaluation of your offshore communication needs will likely save you big bucks.

Finally, check the coverage area of any system you consider. Some handle coastal, some global. Some have coverage holes here and there. If you don't want to be saddled with your phone call terminating unexpectedly because you've sailed outside your satellite's coverage "footprint," determine that the system you want will cover you where you plan to travel.

Installation

Look at a cruise ship some time. See the domes way up high, the ones that are about the size of a Volkswagen? Those are top-of-the-line satcom antennas that handle voice, data and faxing. Without even seeing your vessel, we'd bet that you don't have room for one of those. So determine where you plan to install your antenna prior to purchasing your satcom system. Remember, too, that satcom, being a line-of-sight technology, must have an unobstructed view of the heavens. And unfortunately, unlike some other technologies today such as VHF and cellular, you can't combine your satellite TV and satcom antenna into one unit.

Cellular

We've noticed that among nearshore fishermen, the cellphone has in many instances, replaced the VHF for boat-to-boat communications due to the privacy factor. If one captain happens upon a hot bite and wants to notify his two best friends to come join him, he doesn't want the other 50 boats in the area to know about it and doesn't want to spend the extra money for a scrambler on his DSC-VHF. So he calls them on his cellphone. However, that works only within about 20 miles of shore-based towers.

Over the past few years, several manufacturers have introduced fixed-mount cellular antennas into which you can plug your cellphone while aboard, effectively raising the altitude of the broadcast signal higher than your ear. It represented an incremental improvement, but recently, antenna manufacturers have begun building remote cellular antennas that also have a signal amplifier in the system.

Digital Antenna's wireless amplifier/repeater boosts signal strength up to 50 miles. It can accommodate several cell phones in use simultaneously.

Shakespeare recently licensed Motorola's amplifier technology for use in its cellular antenna/repeater/amplifier. With it, you have the advantage of both an elevated antenna and boosting the power output from cellular-industry standard 250 milli-amps back up to the 3 Watts of the bag-phones of yore. The amplifier adjusts the output to match whatever the cellular tower in use demands for optimum signal clarity. **ME**

About the author

Dean Travis Clarke is executive editor of *Sport Fishing, Marlin ,Fly Fishing in Salt Water* and *Boating Life* magazines, and host of Sport Fishing Magazine TV on OLN.