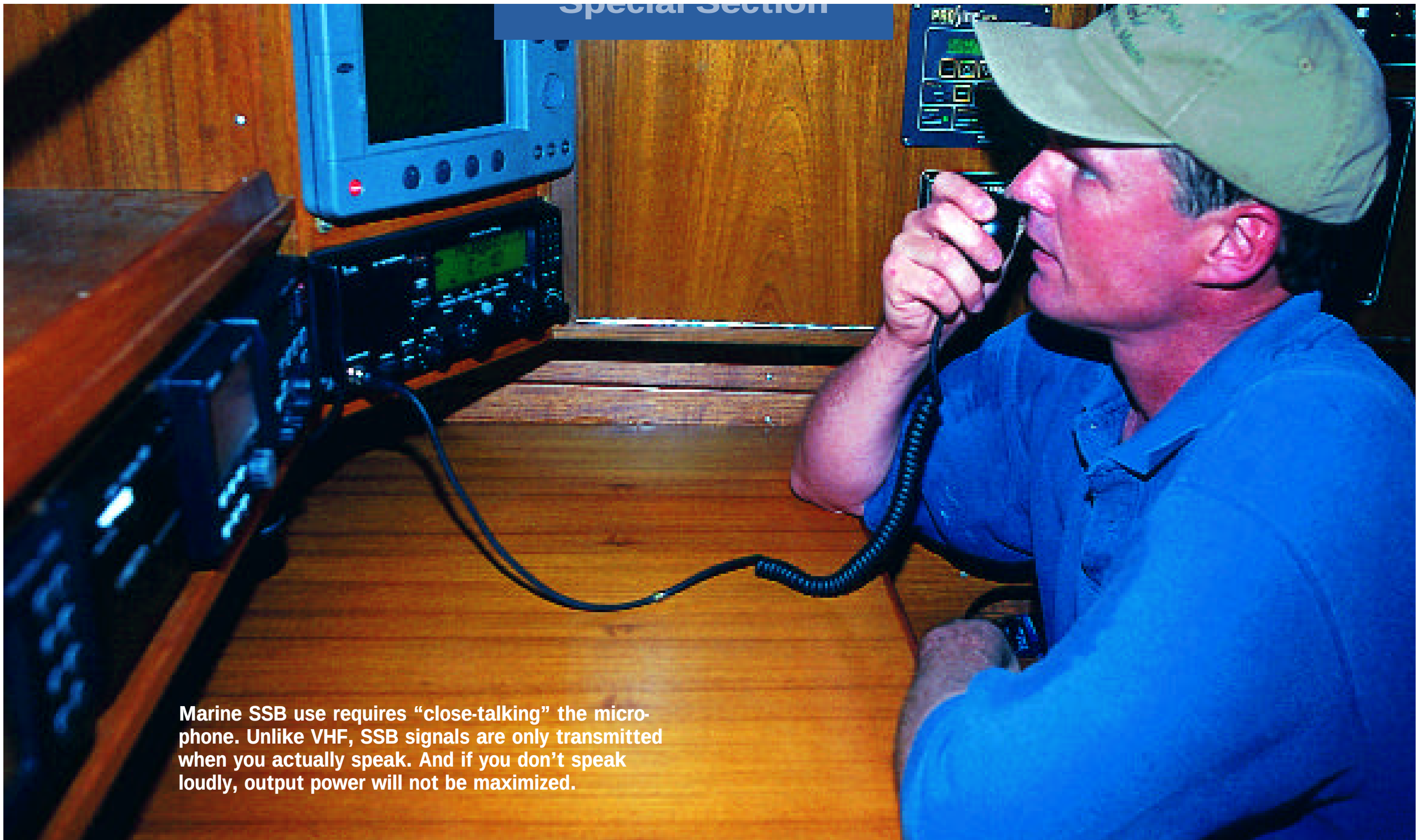


Marine SSB use requires “close-talking” the microphone. Unlike VHF, SSB signals are only transmitted when you actually speak. And if you don’t speak loudly, output power will not be maximized.

COMMUNICATIONS

Setting up single sideband

Proper installation makes the difference

Story and photos by Steve C. D’Antonio

Nearly every oceangoing vessel today, from 40-foot sloop to 1,200-foot aircraft carrier, is equipped with some sort of long-range radio communications, usually in the form of a high-frequency single-sideband transmitter-receiver.

The communications advantages and life-saving potential contained in a good HF SSB will be quickly negated, however, if it is not installed and maintained correctly. I have, in my position as the manager of a boatyard that specializes in preparing offshore vessels, supervised new SSB installations and all too frequently supervised the repair or correction of improperly installed SSB equipment.

A proper antenna installation and how it relates to transmitting a strong signal is of the utmost importance for reliable communications. This also happens to be the simplest component installation of the SSB package. Unless you are a ham operator who is comfortable designing and building your own antenna arrays, chances are, your vessel is equipped with the ubiquitous insulated backstay long-wire antenna. This system, if properly installed, is capable of around-the-world communications, literally. This is tough to get wrong. Have your rigger install some insulators in your backstay, following a few simple guidelines set forth below, and you are done with this segment. However, it is important to keep in mind that an improperly installed antenna system may be capable of little more than line-of-sight range.

Primarily, the antenna must be as long as practically possible, but certainly no shorter than 23 feet. This magic number is not arbitrary, it’s the length of the shortest untuned vertical fiberglass whip antennas that might be used with an SSB transceiver.

Modern digital-display marine single-sideband transceivers are powerful and easy to use, with many set up for use with HF modems for sending email.

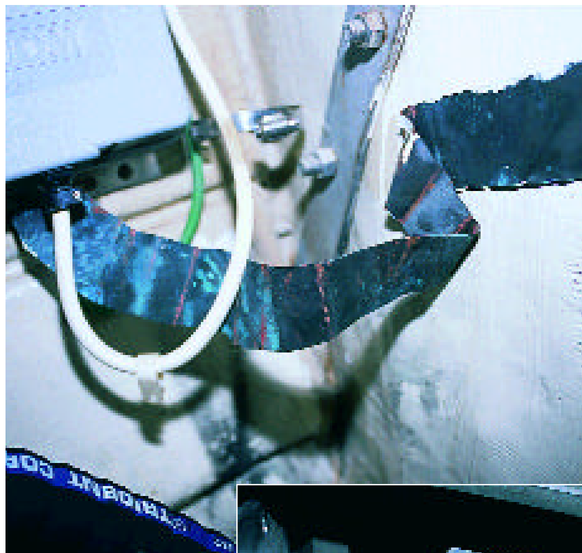
As a result, automatic tuners (more on these later) will tune antennas this short, but no shorter. If you happen to be the owner of a maxi-boat, then you would want to limit backstay antenna length to 120 feet. If your antenna is longer than this, the tuner begins to have trouble electronically shortening it for use on higher frequencies.

The ideal antenna

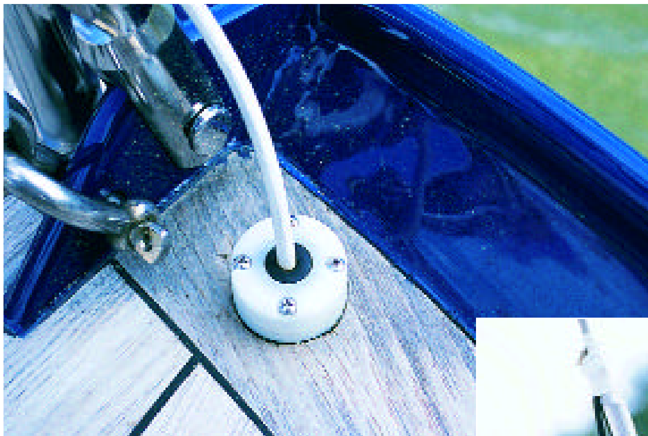
But why the long length to begin with, since VHF does fine with only 3 feet? Without delving too deeply into radio theory, it works something like this: The ideal SSB antenna would be a half-wave dipole, which would be two equal lengths of wire, fed at the middle with coaxial cable. This is what many land-based hams use, and it works very well. The significance of the half-wave is that the antenna, from end to end, is half the length of the radio wave for a given frequency. The formula for determining this is to divide 300 by the frequency in MHz. Therefore, operating on 4 MHz would produce a wavelength of 75 meters, also referred to as the 75-meter band, which calls for a half-wavelength antenna that is 38 meters (125 feet) long. Even if a center-fed dipole were practical aboard the average sailing vessel — and, with a few exceptions, it's not — 125 feet would never work. Additionally, even if a 123-foot antenna could be rigged, it would only be properly tuned for work on 4 MHz. A quarter-wave monopole (no center feed) with a ground plane would be better; it would only require 62 feet of backstay; however, once again, it would only be optimized for one frequency.

The solution to this conundrum is to fool the transceiver into thinking it's connected to a longer- or shorter-length antenna, whichever is needed. This is ingeniously achieved through the use of an antenna tuner, which automatically adjusts inductance and capacitance in order to achieve this electronic ruse.

Most SSB transceiver manufacturers offer matching antenna tuners for their sets. Once installed, keying the microphone will tell the tuner, through a control cable, what frequency you intend to transmit on, the tuner will make a few adjustments, which can usually be heard as a series of clicks and clacks, and the antenna is ready to transmit as efficiently as possible.



Top, copper foil, preferably 3 inches wide, is the best material for HF SSB counterpoise construction. This foil is attached to an exterior hull grounding plate. Left, oxidized foil will continue to work. However, if the connections become fouled with cuprous oxide, performance will fall. Keep all connections coated with an antioxidant spray. Bottom, the antenna tuner is a critical part of the transmitting system. This unit is installed in an aluminum boat, an ideal counterpoise.



Above, GTO cable will suffer if repeatedly stepped on. Use a plastic and rubber through-deck fitting that prevents a sharp metal edge to make contact with the cable. Right, swaged backstay insulators require the services of a rigger for installation.

Tuner installation

Proper installation of the tuner, like the antenna itself, is critical for proper operation. The tuner must be mounted as far from the transceiver as possible, in order to avoid feedback, and as close to the base of the backstay as possible, usually in the lazarette or a sail locker. Shrouds can be used; however, they sometimes do not work as well because they are crowded, from a radio-frequency perspective, by other shrouds and the mast. The backstay of a sloop is ideal or, on a ketch or yawl, the mizzen shroud and/or triatic will work. Remember, 23 feet is the minimum length, but longer is better.

Interconnection between the tuner and the transceiver must be properly executed as well. Radio-frequency energy is conveyed from the transceiver to the tuner by coaxial cable, either RG-8/U, or RG-213/U, preferably the latter. While it's a bit stiffer and therefore more difficult to run, its loss characteristics are superior. Coaxial-cable construction and use is an entire article in and of itself; however, my recommendation is, don't use RG-58/U or RG-8X; these are simply not up to handling the wattage pumped out by SSB sets. In fact, these light-duty cables should only be used for the shortest VHF runs. Because of the lengths involved, I prefer RG-8/U or 213/U for all VHF masthead-antenna installations, as well, although some boat/spar builders will beg to differ, no doubt. My philosophy is, it is more likely that your batteries will be depleted in a distress situation (while experiencing downflooding or engine problems), so why sacrifice a single decibel (dB) more than necessary to transmission loss? Loss, at VHF frequencies, for high-quality marine-grade

(Ancor brand, in this case) RG-8/U is 2.7 dB/100 feet, compared to RG-8X, which is 4.5 dB/100 feet, and RG-58/U, which is 6.1 dB/100 feet. Keep in mind, the best masthead VHF whips only provide a 3-dB gain, which will be quickly negated by higher-loss cables.

Connecting the belowdeck tuner to the antenna calls for the use of a special cable designated as GTO 15. At first glance, this looks very much like RG-58/U coaxial cable. However, it is not, and coaxial cable must never be used for this application. GTO cable is actually single-conductor, lacking the shield that coaxial cable possesses. As a result, the run from the tuner to the stay is actually part of the radiating antenna. It is for this reason that the tuner must be located as close to the GTO cable through-deck penetration as possible. From a health, as well as interference, perspective, the less antenna radiation below deck, the better. In fact, the GTO cable run and the tuner itself should be installed and run where they will remain at least 5 feet from accommodation spaces. For instance, it would be inadvisable to install the tuner in, or run the GTO cable through, a quarter berth. High-wattage RF energy can be harmful to people. Also, avoid allowing the GTO cable to run parallel to grounded/bonded wiring or objects. Depending on what they are, it may be necessary to isolate these objects from ground if an alternate path for the GTO cannot be found. This includes the lower section of the backstay; if this is bonded, the connection should be eliminated.

Many SSB manufacturers recommend that their transceivers be wired directly to the battery. However, if proper wiring practices are observed, a radio may be supplied by ordinary electrical-panel circuit breakers.

Antenna shock

I've had the unfortunate experience of being shocked by a radiating backstay antenna. It is for that reason that I strongly recommend the lower antenna insulator, the device that electrically separates the backstay while remaining mechanically continuous, be installed approximately 6 to 8 feet above the deck. This will allow access to the GTO cable connection at the bottom of the insulated section, while keeping that same section above convenient hand-holding reach.

The upper backstay insulator should be installed approximately 3 feet from the masthead. This will ensure maximum antenna length, while allowing a sufficient gap between the radiating portion of the stay and the spar, which is grounded.

The method that is commonly employed to connect the GTO cable to the stay may appear decidedly primitive, but it is tried and proven. This involves running the GTO cable up the uninsulated portion of the backstay, over the lower insulator and up the insulated wire section about 1 foot, then making a 180° turn, traveling back down the stay about 3 inches. This U-turn will deter water migration into the GTO jacket.

The preparation of the GTO termination is best performed on deck, because it involves heat-shrink tubing and solder. After stripping back insulation to expose approximately 2 to 3 inches of conductor, tin the GTO conductor with solder, even if the individual strands are already tinned. This will also prevent water migration into the strands through capillary action. Place a short length, 3 to 4 inches, of sealant-embedded heat-shrink tubing over the transition between GTO jacket and where the conductor emerges. This will further improve the watertight integrity of the cable. Remove all oxidation by cleaning the backstay, where the GTO will be attached, with a 3M Scotch-Brite pad until it's shiny. Lightly coat the tinned GTO conductor with Thomas & Betts Kopr-Shield and clamp it to the stay, either with two all-stainless , mini hose clamps or an electrician's copper bug nut, sometimes called a kearny nut. Wrap the entire connection with high-quality electrical tape (Scotch 33 is my recommendation); beginning above the connection, work your way down over the connection, then back up again. This will leave the electrical-tape wraps in a thatched-roof configuration, further deterring water ingress. If you prefer, you may cover the black electrical tape with a layer of white; however, don't substitute the white for black, as it is usually of a lower quality.

Finally, secure the GTO cable to the uninsulated lower portion of the backstay with tie wraps. Trim these with a single bevel cutter, melt the trimmed ends or wrap with electrical tape, as the trimmed stubs can be quite sharp. Try to avoid running the cable over the deck, where it will be stepped on. Instead, have it pass into a through-deck fitting located as close to the chain plate as possible. Repeatedly stepping on GTO cable where it exits the deck fitting will eventually lead to some or all of the strands breaking.

Ground-plane truth

The second, and equally as important, half of the antenna system is the ground plane or counterpoise. This could be analogized to the diving board from which your SSB signal jumps. Think of it this way, using an inadequate counterpoise for high-frequency communications is like sailing in light air with a stormsail.

The aforementioned center-fed dipole antenna is made up of two wire halves of equal length. The balance and symmetry of this system is critical to its efficiency as a transmitting antenna. Similarly, the tuned random-length antenna, which is what the backstay system is, utilizes the counterpoise as the balance, much the way a dipole uses its two balanced segments. The importance of a good counterpoise cannot be overemphasized; without it, the random-length wire simply will not work as an effective transmitting antenna.

Installing a counterpoise on a vessel that has hitherto been "groundless" is sometimes a daunting task. It often requires running many feet of copper ribbon throughout the vessel's bilges, lockers and engineering spaces. Unfortunately, the old axiom, there's no such thing as a free lunch, holds true where SSB ground planes are concerned. However, there are a few tricks that will assist the installer in obtaining the best possible counterpoise with the least amount of work.

It is important to note that, at RF frequencies, round wires create inductive reactance, which renders them ineffective for good ground conveyance. All counterpoise installations must use flat sheet metal, preferably copper foil measuring 3 inches wide by 3 millimeters thick. This is the ideal material for counterpoise construction. Resist the temptation to convert to wire for the termination to the transceiver or tuner, the runs must be 100 percent foil.

The foil counterpoise should begin at the antenna tuner and then travel to the transceiver and as many below the waterline metallic masses as possible. Every effort should be made to keep the foil runs located within the hull, below the waterline. Due to the phenomenon of capacitance, RF energy sees this as nearly the same as direct contact with seawater, which is Mother Nature's own, and the best, counterpoise. The other objects to which you should make your foil connections include through-hulls bonded below the waterline, preferably those that are near the antenna tuner first, tanks, the engine block and an internal or external lead keel. (Encapsulated ballast is excellent, again because of the capacitor effect. However, keels utilizing resin mixed with lead or iron-shot are useless as counterpoises.)

In addition to the capacitative effect created by your foil network, a direct connection to seawater with as much surface area as possible is also desirable. This can be achieved, as already mentioned, by attaching copper foil to through-hull fittings and external ballast. Making the attachment to a keel bolt is sometimes a bit of a challenge, but worth the effort. This may be done by either obtaining another keel nut and capturing the foil between this and an existing nut (hint: fold the foil a few times over to strengthen it before cutting the hole for the stud or bolt) or by drilling and tapping a small hole in the keel stud. A quarter- or three-eighths-inch bolt utilizing a large copper washer is then used to secure the foil. Whatever the foil is fixed to, through-hull, tank, keel fastener, etc., clean the area thoroughly with a 3M Scotch-Brite pad and lightly coat the interface with T&B Kopr-Shield before attaching the copper strip. Then, once the connection is complete, spray with CRC Heavy Duty Corrosion Inhibitor. This will keep corrosion and oxidation to a minimum, especially for bilge connections.

Additionally, a copper ground plate may be installed on the hull's exterior. These are available over the counter as sintered bronze units that, because of their granule-type construction, offer a larger surface area than their actual physical size. My preference is for solid copper plate, one-eighth of an inch thick by 3 inches wide by 48 inches long, affixed to the exterior of the hull with bronze through-bolts, well below the waterline, near the base of the mast, ensuring that the edge is exposed and not faired in. This will become an integral and effective component in the counterpoise plan, as well as providing for lightning strike prevention/dissipation, if properly wired. In fact, good RF grounding and an American Boat & Yacht Council-compliant bonding system make for a symbiotic relationship, each enhancing RF performance as well as lightning-strike prevention/dissipation.

Electrically vulnerable

Some skippers are adamant about keeping the RF counterpoise separate from the vessel's DC negative electrical system and, hence, the AC safety ground and bonding network. In my experience, this is very difficult to do, and it leaves the crew in an electrically vulnerable position (see issues 119 and 120 for more on AC electrical safety and bonding). Icom, one of the leading manufacturers of SSB and other radio equipment, agrees, "good RF grounding (counterpoise) techniques will enhance your overall protection from lightning strike."

The final key to good SSB performance is power. Supplying the transceiver with an adequate and reliable source of electricity is paramount to achieving maximum performance and range. I have, on too many occasions, diagnosed poor SSB performance, only to discover that the wires supplying the transceiver were too small for the length of the run, leading to a substantial voltage drop while transmitting. In one case, incredibly, the 15-foot run from the battery to the transceiver was spliced in two locations and made up of three different gauges of wire, all undersized — a dumpster-diving special to be sure.

Most 150-watt SSB transceivers will draw as much as 30 amps at 13.6 volts, while transmitting. The inference here is that the manufacturer expects your engine to be running while you are transmitting, and this isn't a bad idea. Thanks to Ohm's law, as the battery voltage drops, the amperage draw increases. If you are having difficulty establishing contact, check your battery voltage while you are tr ansmitting . If it's less than 12.6, engage a charge source, either the engine or generator. Remember, because SSB is a carrierless transmission, very little current is drawn if you are keying the microphone but not speaking. Only when you speak is the transmitter actually transmitting. I have troubleshot SSB transceivers for customers who complained that they either had difficulty establishing communications or could make no contact at all. However, when I tested the set, it worked perfectly, and I could log several ship-and-shore stations. The problem: The operator was not speaking loudly enough. "Close talking" the mic (don't let your lips actually touch it) is essential. Speak clearly and loudly, and you'll see the difference in your amp draw, amps into the transceiver mean watts out of the antenna.

Assuming the above-mentioned 30-amp draw, if your SSB is located 10 feet from the electrical panel (measured there and back, to take into account both positive and negative conductors), it will require 10-gauge wire. If, however, the radio is wired directly to the battery, as many manufacturers recommend (I do not), and your run is 25 feet, then you will need to use six-gauge wire in order to ensure a voltage drop of no more than 3 percent, the recommended maximum for communications gear.

Whichever method you choose, ensure that the wiring is fit with proper over-current protection, in compliance with the ABYC standards for DC installations. The fuses that are found in-line with most SSB transceiver supply wires are designed to protect the equipment, not the wire run.

From an offshore point of view, next to the EPIRB, your SSB is the most important piece of gear you have when it comes to summoning help. Install it right; test it regularly; maintain it and its related components, and it will be there when you need it. ■

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