All Hands On Tech

When Is Water The Same As Ground?

Bjarne Hansen, S/V Hoku Pa'a

Many cruisers choose to install a ham or marine SSB radio aboard, to chat on the nets and exchange email while at sea. If this is you, then you are probably interested in getting the clearest signal, the most range, and the least interference with other onboard electronics. A key component of a radio system is its antenna, and there are several things you can do that will improve its performance. Increasing the height of your mast is one, but let's skip that and look at some easier options.

Most folks don't realize it, but the wire poking up in the air (often the backstay) referred to as the antenna, is really only the top half of the antenna system. A transmitting radio pushes an alternating electric current between the backstay and 'something else'. That something else is whatever is attached to the tuner's ground, and it forms the bottom half of the antenna system*. So when you transmit, your radio causes current to flow in your backstay while an opposite current flows in the ground.

There are several ways to provide that ground connection for the radio and, as with everything on a boat, none are Cheap, Easy, and Perfect at the same time.

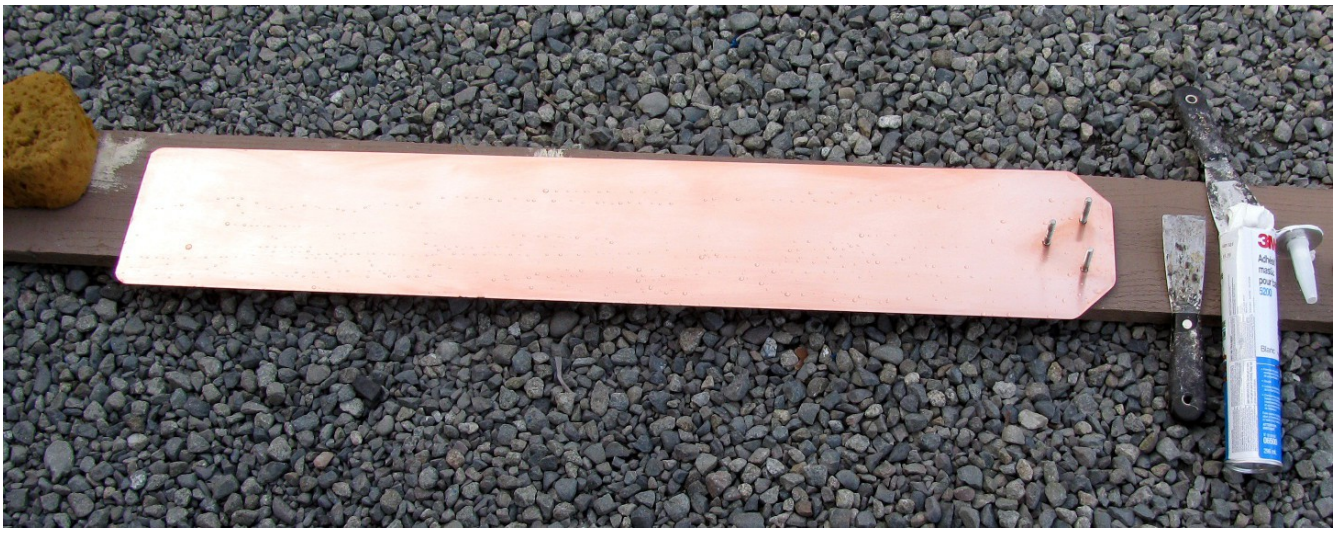
In the category of Easy, there is the KISS-SSB Counterpoise (approx $200 from http://www.kiss-ssb.com/). It is a coil of bundled wires of varying lengths, which you unroll into your bilge or other out-of-the-way place. The idea is to have at least one wire in the bundle be a resonant length for the frequency you are using, such that the ground current flows in that wire. Their web site states the KISS-SSB does “the same thing ham operators have been doing for nearly a century.“ While true, one should realize that this is what hams resort to when they don't have access to a perfect ground. Counterpoises are necessary when your antenna is sited over dry, poorly-conducting soil that has high resistance to ground currents. Boats, however, float in an almost ideal ground (oceans of conductive seawater) – you just need to connect to it.

Which brings up a second way of providing a radio ground: a steel or aluminum hull. This probably qualifies as Perfect, but may not be Cheap nor Easy for everyone.

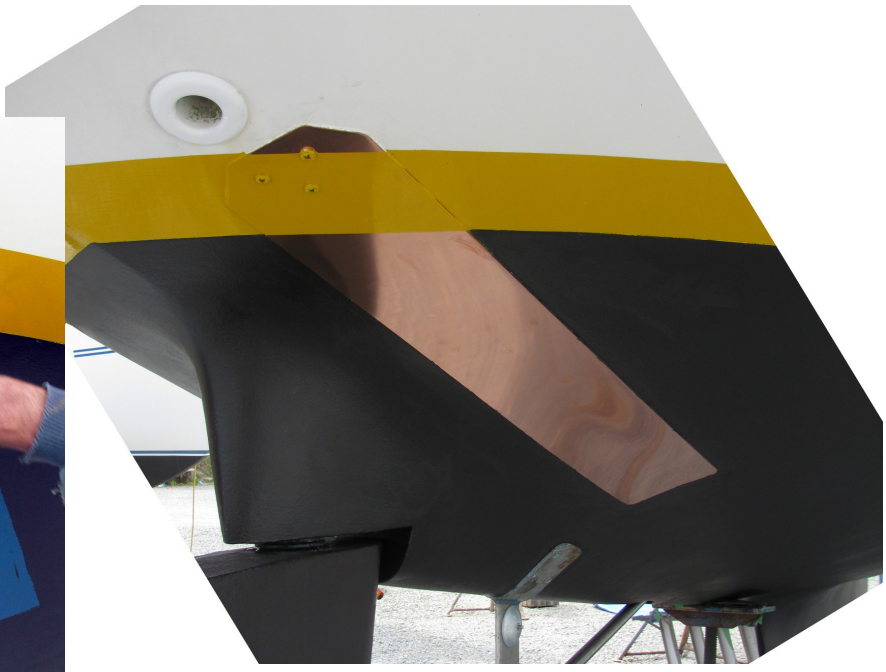
If you have a plastic or timber boat, then the traditional recommendation has been to line a significant portion (100 square feet is frequently mentioned) of the inside hull with copper foil and attach that to your tuner's ground connection. This provides a counterpoise like the KISS-SSB (imagine the copper foil as being a huge number of wires of many lengths, all spread out) and can work well, but is dauntingly difficult unless done when the boat is built.

How about a direct wire connection to the sea? Bronze throughulls and rudder posts can work very well: read for instance the test results (link below) reported by well-respected ham & sailor Gordon West when he compares four different ground choices on the same 40 foot sailboat. One of his conclusions: “If you are installing your own marine SSB or ham radio system and are looking for an easy way to ground it, start by grounding to a convenient underwater bronze through-hull near where the tuner is mounted in the lazarette.”

If you don't have a conveniently located piece of underwater metal, you can buy and install one such as the Dynaplate. West Marine sells three sizes ranging from 6” x 2” ($73) to 18” x 6” ($470) and though the manufacturer recommends the biggest size for ham/marine SSB use, note that Gordon West's testing suggests that the smallest size (which is similar in size to a throughull) should perform fine.



On Hoku Pa'a we didn't have any submerged bronze throughulls near the antenna tuner, so we decided to install a metal plate. For $68 at Metal Supermarket we got a 36” x 6” sheet of 0.050” thick copper. This thickness needs tin-snips to cut, and should last decades in the water. From Fastenal, $15 got us three bronze bolts, nuts and washers. While hauled-out, we scraped bottom paint from a rectangular outline, shaped the plate to the hull with a mallet (with soft tempered copper it is quite manageable) and glued it on with 3M 5200. Three bronze bolts located above the waterline provide a good electrical connection to a copper foil strip inside the hull running up to the tuner.



Radio performance has been great, and as one might expect there hasn't been any significant sealife growing on the copper plate. It took less time to install than several square metres of foil would have, and was less expensive than a Dynaplate. My educated opinion is that it performs better than a KISS-SSB would in the same installation, but I haven't had the opportunity to perform a direct comparison. If you have one you are willing to move over to our boat for a few hours, we could try some tests similar to Gordon's.

Of course, there are lots of radio system installation details hidden inside the boat. They can be covered in future articles if there's interest. Stay tuned.

Further Details:

Gordon West (WB6NOA) operates a Ham radio school and has been electronics editor at SAIL magazine. His research report on boat radio grounding systems is at: http://www.kp44.org/ftp/SeawaterGroundingFor_HF_Radios_byGordonWest.pdf

The Wikipedia entry (http://en.wikipedia.org/wiki/Monopole_antenna) for monopole antennas (which is what virtually every boat uses at HF frequencies) describes how the radiation pattern is formed between the antenna and ground.

I haven't defined every term used in this article. If on-line searches still leave you confused, drop me a line and I'll try to point you in the right direction.

Footnotes:

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* this also explains why having a deficient radio ground can cause sporadic malfunctions of instruments, autopilots and other electronics. The antenna's electric field is set up between the backstay and the closest least-resistance ground, which may be your autopilot's ground – causing currents to flow in the autopilot. Improving your radio system ground will reduce these stray currents and should reduce the severity of the interference.