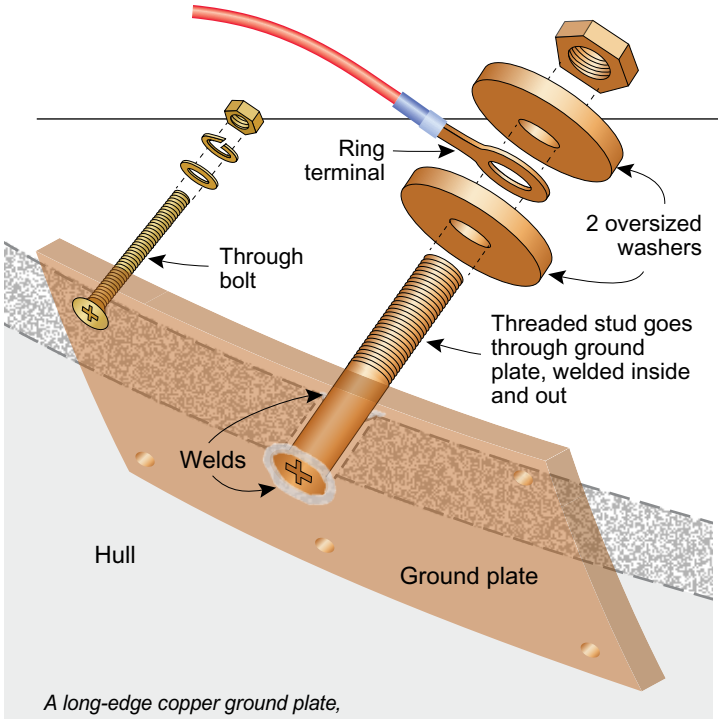
TASK SHEET

Ground Plate Installation



A long-edge copper ground plate, with a welded central fastener to ensure low-resistance electrical contact, gives a vessel a fighting chance to dissipate the electrical energy from a lightning strike.

TOOLS:

- drill, bits, and countersink
- grinder
- reciprocating saw
- TIG or MIG welder and copper welding rods/wire
- common hand and measurement tools

LUBRICANTS, SEALANTS, ADHESIVES:

- polyurethane or polysulfide sealant
- mineral spirits
- conductive paste
- corrosion inhibitor

MATERIALS:

- ¼″-thick (6mm) oxygen-free electrical-grade copper (Other dimensions depend on application.)
- ⅜″ (9.5mm) bronze flathead fasteners, nuts, washers, and lock washers. If available, a pure-copper fastener should be used for the welded conductor stud. Otherwise, use bronze.

ABYC STANDARD:

- E-11, TE-4

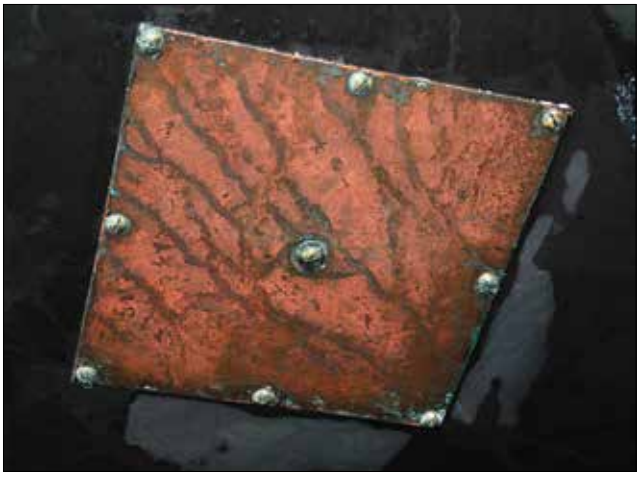
Text and photographs by Steve D'Antonio

INTRODUCTION:

A ground plate provides an adequate connection between a vessel's systems—bonding/grounding, lightning protection, SSB radio—and the surrounding seawater. (When applied to SSB radios, the plate is commonly referred to as a counterpoise.) It is equally important to systems on powerboats and sailboats.

While the science of lightning strikes as they relate to small craft is anything but settled, studies indicate that the greatest potential to dissipate strike current can be gained from the longest possible plate edge rather than the greatest surface area. Therefore, a 2″ x 72″ (51mm x 1.83m) rectangular plate is preferable to a 12″ x 12″ (305mm x 305mm) square plate, even though both are 144 sq in/929.04cm^2. (That's the ABYC required *minimum* size for a lightning ground plate, but larger never hurts.) Similarly, the minimum acceptable thickness for a ground plate is 3⁄16″ (5mm) but ¼″ (6mm) is preferred.

ABYC's guidance on ground plates: "A lightning grounding terminal for a boat should consist of a metal surface (copper, copper alloys, stainless steel, aluminum, or lead) that is in contact with the water, having a thickness of at least 3⁄16 in (5mm), and an area of at least one square foot (0.1m^2). It should be located as near as possible to directly below the lightning protective mast to minimize any horizontal runs in the primary (main) conductor."



Ground plates should be a minimum of 1 sq ft (144 sq in/305mm^2) and made from solid copper. Note the central welded stud on this plate.

TASK SHEET

GROUND PLATE INSTALLATION

While other metals are acceptable, copper is preferred for its high conductivity and corrosion resistance.

This Task Sheet applies to fiberglass-reinforced plastic (FRP) hulls. Ground plates are unnecessary on metal hulls, and may contribute to delignification on timber hulls if the vessel is equipped with a cathodic protection system. Lightning ground, cathodic protection, DC grounding, and AC safety grounds should be interconnected—a requirement for ABYC compliance. (For more on bonding and grounding systems, see "Bonding Basics" in *Professional BoatBuilder* No. 138.)

PROCEDURE:

1. Measure and lay out the available space: Choose a location for the ground plate that will remain submerged under all conditions of sail and heel. If the plate will be used as part of the lightning-protection system, it should be as close as possible to the base of the mast or primary down-conductor. Orient a rectangular plate fore-and-aft to present the least water flow resistance. You must have access to the inside of the vessel where the plate will be through-bolted. With all these considerations in mind, determine the size of the plate and establish the length and width.

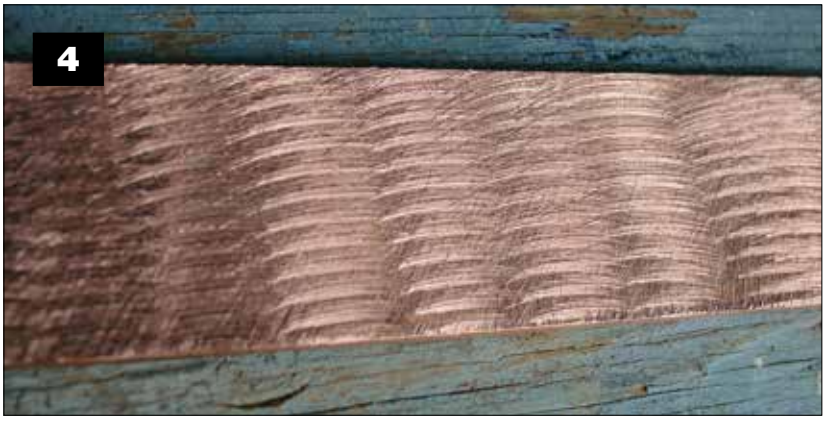
2. Obtain the plate, cut, and drill: Order or procure from your stock department a plate of the appropriate dimensions. (McMaster Carr Supply www.mcmaster.com is a reliable supplier for this material; do not use material from stock unless its composition can be verified.) The plate should be 100%-pure oxygen-free electrical-grade copper ¼″ thick. Cut it to fit the prepared dimensions. Bevel the edge of the plate that will face forward to prevent objects from snagging on it after the vessel is returned to service. All other edges should remain square. Drill holes to accommodate ⅜″ bolts on 12″ centers. If the plate is more than 4″ (102mm) wide, you must install dual rows of fasteners, staggered where possible. Never use tapping screws to secure the plate to the hull. Drill and countersink holes in the plate to accommodate the fasteners in locations that will not interfere with structures within the vessel. Create a template if necessary.

3. Dry-fit the plate, and drill holes in the hull: Place the plate (or template) against the hull in the chosen location, and mark where the holes will be drilled. You may need a suitable length of timber or a jackstand and blocking to hold the plate in place. Centering punches may be useful for marking the exact center of each hole. Drill a ¼″ pilot hole through the hull in a location that is at or close to the center of the plate. Make certain there are no critical structures—tanks, stringers etc.—inside the boat in this area. Find the hole inside the boat, and verify it is where you believe it should be. Using it as a reference point, verify that the additional bolt holes will be clear of any internal structures. After this is done, drill the remaining holes at full size from outside the hull (you may choose a slightly larger drill bit, 25⁄64″ or 13⁄32″). Bevel or countersink these holes slightly so they will retain sealant. After the holes are drilled, hold the plate up to the hull, and place fasteners in all the holes to ensure a proper fit. Adjust if necessary, and then trace the outline of the plate onto the hull.

Note: If the hull is cored, properly close-out the core material at each hole. Those instructions can be found in the Task Sheet "Installing Hardware in Cored Composites," in PBB No. 189.

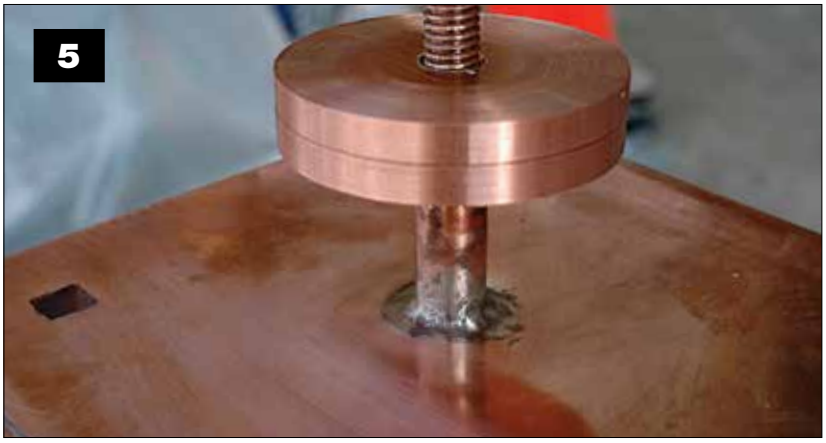
Dry-fitting a ground plate using shims and jackstands ensures that holes for through-bolt f asteners are exactly where they need to be. This long, narrow plate's square holes will engage carriage bolt fasteners.

4. Prepare hull and plate for installation: Using a 180-grit sanding disc, grind all bottom paint off the plate's footprint on the hull until you have exposed either gelcoat or an epoxy barrier coat (take care *not* to grind more than ½″–1″ (13mm–25mm) beyond the perimeter of the footprint). Using the same grit sandpaper, grind the flat surface of the plate that will be placed against the hull.



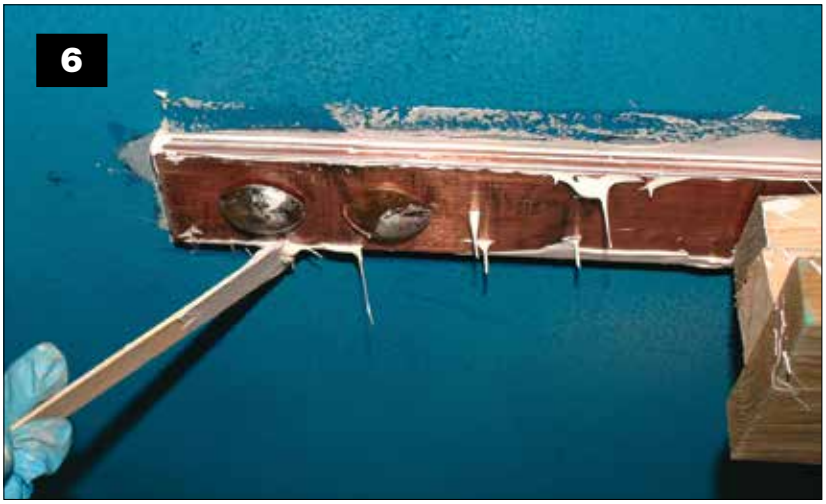
The backside of this plate has been profiled by grinding to better retain the bedding c ompound.

5. Weld the bronze (pure copper, not copper-plated, if available) fastener to the plate: Run the fastener used as a stud through the hole in the center of the plate. TIG-weld the bolt to the plate on the side that will register against the hull *as well as* the side exposed to the water. Make certain the weld bead will not interfere with placing the plate against the hull. Grind the hull or weld bead if necessary to accommodate it. With a multimeter, check for continuity between this fastener and the plate; resistance should be less than 1 ohm. Using a letter punch set, or engraver stamp, engrave the outside of the plate adjacent to this fastener with the words THIS FASTENER WELDED (the weld bead should be obvious). In the center of the plate inscribe the words DO NOT PAINT in letters at least 1″ high.



Conductors will attach to this copper stud fitted with large copper washers. Welded on both sides to provide a good low-resistance electrical connection, the stud passes through the plate.

6. Coat the backside of the plate with sealant and install: Wash the plate, the fasteners, and the hull surface with mineral spirits. Blow-dry with compressed oil-free air, or blot dry with a *lint-free rag*. Do not drag or wipe the rag over the profiled surface, as this may deposit rag material. This surface must be absolutely clean, dry, and free of contamination—oil, wax, dust, and grease. Even oil from your fingers will contaminate this surface, so avoid touching the prepared plate. Apply a liberal amount of bedding compound to the backside of the plate and spread evenly using a clean putty knife or plastic resin spreader. Hold the plate up to the hull, push the welded fastener through the hull first and then place each additional fastener through its respective hole (an assistant inside should be ready to receive them, placing a flat washer, a lock



Thorough bedding is important. Ideally there will be no water between the back of the plate and the hull,

Be sure that bedding compound doesn't obscure the plate's important square edge, while the leading edge should be beveled so lines and objects in the water won't snag on it.

These two cables are the same gauge, but the wire on the right is not suited for lightning protection or any marine application; its untinned, hard-drawn conductors are susceptible to stress failure as well as corrosion. The fine-strand tinned conductor on the left is ideal for grounding, bonding, and lightning mitigation.

Because the connection to the ground plate is always in the bilge, bonding and lightning systems are especially vulnerable to corrosion, so taking anticorrosion measures is crucial.

washer, and a nut onto each one as they come through). Torque all the fasteners to obtain ample sealant squeeze-out. Clean all excess sealant using a resin spreader first. *Do not use alcohol* to clean excess sealant, as it will inhibit curing of polyurethane sealant. You can use mineral spirits to remove any remaining sealant. This will keep water from finding a path behind the plate or to the weld. There should be no voids visible between the plate and the hull. Any gaps between these two surfaces must be completely filled with sealant. Do not form a fillet with the sealant to fair the plate to the hull. The hard edge of the plate should be exposed. Once the sealant has fully cured, retorque the fasteners.

7. Connections: Affix or tether an engraved or laminated placard with the words MAKE ALL CONNECTIONS TO THIS STUD adjacent to the welded fastener inside the boat. While the physics of this connection are somewhat complex and variable, radio frequency and lightning current that flow to a ground plate do so primarily on the surface of any wires attached to it. Therefore, unless wires are very large, they have little effectiveness. Cabling used for lightning connections should be large—4 AWG (21mm^2) for primary and #6 AWG (13mm^2) for secondary conductors—tinned and stranded, and run as straight and as directly as possible to the welded fastener, particularly for the primary down- and/or mast connection. For necessary direction changes, form sweeps as opposed to sharp 90° turns. Make connections with solderless closed-end terminals, heat-shrunk to keep bilgewater at bay. Contact surfaces of all connections should be coated with conductive paste and clamped tightly between two bronze nuts and washers, or copper if available. Note: While bronze nuts, washers, and lock washers should be used to physically secure the plate and stud, those fasteners should not have to be disturbed to make electrical connections. (All fasteners exposed to seawater, including in the bilge, must be bronze or copper, *not* brass.) SSB connections should be made solely with copper ribbon or foil (1/20″/1.3mm minimum thickness) that is attached to the welded stud.

For ground plates, the longer the edge the better, so narrow rectangles are ideal. Because it is be connected to the vessel's anticorrosion bonding system and thus to hull anodes, the copper ground plate is not self-antifouling. It will require periodic cleaning as it cannot be painted.

8. Once connections are complete, spray with a corrosion inhibitor that will not wash off easily, such as CRC Heavy Duty Corrosion Inhibitor.

9. After the vessel is launched, check for leaks, and perform radio checks and a standing-wave ratio test if an SSB has been connected to the ground plate. PBB

About the Author: *For many years a full-service yard manager, Steve now works with boat builders and owners and others in the industry as Steve D'Antonio Marine Consulting. He is an ABTC-certified Master Technician and sits on that organization's Engine and Transmission and Hull and Piping Project Technical Committees. He is also technical editor of* Professional BoatBuilder.