

# OWNER'S GUIDE & INSTALLATION INSTRUCTIONS

## Thru-Hull Speed/Temp Sensor with Valve

Models: S650 and ST650

U.S. Patents: 4,898,029; 5,186,050. Australian Patent 605,281.  
Canadian Patent 1,313,775. Japanese Patent 1851014

**IMPORTANT:** Please read these instructions completely before proceeding with the installation. These instructions supersede any other instructions in your instrument manual if they differ.

### CAUTION: NEVER USE SOLVENTS

Cleaners, fuel, paint, sealants, and other products may contain strong solvents, such as acetone, which attack many plastics greatly reducing their strength.

### Applications

- **Plastic** housing recommended for fiberglass or metal hulls only. Never install a plastic housing in a wood hull since swelling of the wood may overstress the plastic causing a fracture.
- **Bronze** housing recommended for fiberglass or wood hulls only. Never mount a bronze housing in a metal hull because electrolytic corrosion will occur.
- **Stainless steel** housing recommended for metal hulls to prevent electrolytic corrosion.
- Never install a metal housing in a vessel with a positive ground system.

### Tools and Materials

Water-based or mineral spirits based antifouling paint  
(mandatory in salt water)

Safety goggles  
Dust mask

Electric drill with 10mm (3/8") or larger chuck capacity

Drill bit 3mm or 1/8"

Hole saw 51mm or 2" (plastic or bronze housing)  
57mm or 2-1/4" (stainless steel housing  
in a metal hull)

Countersink tool (installing a flush housing)

Sandpaper

Mild household detergent or weak solvent (such as alcohol)

File (installation in a metal hull)

Marine sealant

Additional washer [for aluminum hull less than 6mm (1/4") thick]

Slip-joint pliers (installing a metal housing)

Zip-ties

Installation in a cored fiberglass hull (see page 3)

Hole saw for hull interior 60mm or 2-3/8"

Fiberglass cloth and resin

or Cylinder, wax, tape, and casting epoxy

### Pre-Installation Test

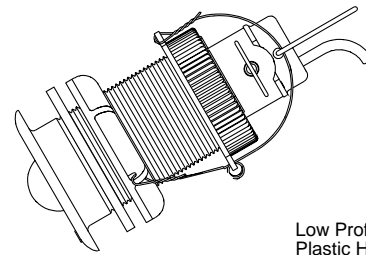
Connect the sensor to the instrument and spin the paddlewheel. Check for a speed reading (and the approximate air temperature if applicable). If there is no reading or it is inaccurate, return the instrument to the place of purchase.

### Antifouling Paint

Marine growth can accumulate rapidly on the sensor's surface reducing performance within weeks. Surfaces exposed to salt water *must* be coated with antifouling paint. Use **water-based or mineral spirits based** antifouling paint only. Never use ketone based paint, since ketones can attack many plastics possibly damaging the sensor.

Record the information found on the cable tag for future reference.

Part No. \_\_\_\_\_ Date \_\_\_\_\_



Low Profile  
Plastic Housing

It is easiest to apply antifouling paint before installing the sensor, but allow sufficient drying time. Reapply paint every 6 months or at the beginning of each boating season. Paint the following surfaces (see Figure 1):

- Outside wall of the paddlewheel insert below the lower O-ring
- Paddlewheel cavity
- Paddlewheel
- Exterior lip of the housing and valve assembly
- Bore of the valve assembly up 30mm (1-1/4")
- Blanking plug below the lower O-ring including the exposed end

### Mounting Location

Turbulence-free water *must* flow over the paddlewheel at all speeds. Choose an accessible spot inside the vessel. Allow a minimum of 280mm (11") of headroom for the height of the housing, tightening the nuts, and removing the insert.

- **Displacement hull powerboats**—Locate amidships near the centerline.
- **Planing hull powerboats**—Mount well aft to insure the sensor is in contact with the water at high speeds.
- **Fin keel sailboats**—Mount on or as close as possible to the centerline and forward of the fin keel 300–600mm (1–2').
- **Full keel sailboats**—Locate amidships and away from the keel at the point of minimum deadrise.

**Caution:** Do not mount the sensor in an area of turbulence or bubbles: near water intake or discharge openings; behind strakes, fittings or hull irregularities; or behind eroding paint (an indication of turbulence).

**Caution:** Never mount the sensor directly ahead of a depth transducer, since turbulence generated by the paddlewheel's rotation will adversely affect the transducer's performance, especially at high speeds.

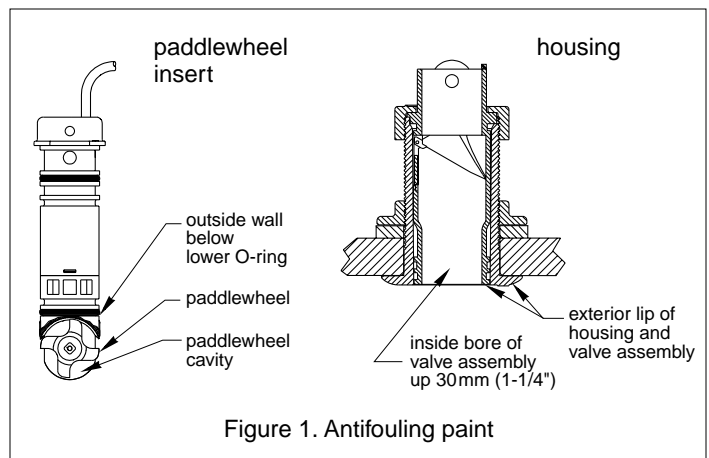


Figure 1. Antifouling paint

## Installation

**Cored fiberglass hull**—Follow separate instructions on page 3.

### Hole Drilling

**Warning:** Always wear safety goggles and a dust mask.

1. Drill a 3mm or 1/8" pilot hole from inside the hull. If there is a rib, strut or other hull irregularity near the selected mounting location, drill from the outside.
2. Using the appropriate size hole saw, cut the hole from outside the hull.  
**Flush housing**—Use a countersink tool to create a "seat" in the hull.
3. Sand and clean the area around the hole, inside and outside, to ensure that the sealant will adhere properly to the hull. If there is any petroleum residue inside the hull, remove it with either mild household detergent or a weak solvent (alcohol) before sanding.  
**Metal hull**—Remove all burrs with a file and sandpaper.

### Bedding

Apply a 2mm (1/16") thick layer of marine sealant around the lip of the housing that contacts the hull and up the sidewall of the housing. The sealant *must* extend 6mm (1/4") higher than the combined thickness of the hull, washer(s), and hull nut (see Figure 2). This will ensure there is sealant in the threads to seal the hull and to hold the hull nut securely in place.

**Stainless steel housing in a metal hull**—To prevent electrolytic corrosion, the stainless steel housing *must* be isolated from the metal hull. Slide the isolation bushing onto the housing, then apply additional sealant to the surfaces of the bushing that will contact the hull.

### Installing

**Caution:** Never pull, carry, or hold the sensor by the cable as this may sever internal connections.

1. From outside the hull, push the housing into the mounting hole using a twisting motion to squeeze out excess sealant (see Figure 2). *Align the arrow on the lip of the housing to point forward toward the bow.* If the sensor is not installed on the centerline, angle the housing slightly toward the centerline to align it with the water flow.
2. From inside the hull, slide the washer onto the housing.  
**Aluminum hull less than 6mm (1/4") thick**—Use an additional rubber, fiberglass, or plastic washer. *Never use bronze since electrolytic corrosion will occur. Never use wood since it will swell, possibly fracturing the plastic housing.*
3. Screw the hull nut in place *being sure* the notch on the upper rim of the housing and the corresponding arrow on the lip are still positioned forward toward the bow. (If your plastic housing has wrenching flats, *do not* clamp tightly, possibly causing the housing to fracture.)  
**Plastic hull nut**—Hand-tighten only. *Do not* over tighten.  
**Metal hull nut**—Tighten with slip-joint pliers.  
**Wood hull**—Allow for the wood to swell.

4. Remove any excess sealant on the outside of the hull to ensure smooth water flow over the paddlewheel.

**Warning:** The O-rings must be intact and well lubricated to make a watertight seal.

5. After the sealant cures, inspect the O-rings on the valve assembly (replace if necessary) and lubricate them with the silicone lubricant supplied (see Figure 3).
6. Slide the valve assembly into the housing *being sure* to engage the key in the notch.
7. Screw the plastic cap nut in place and **hand-tighten** only. *Do not* over tighten.
8. Attach one pull ring to the paddlewheel insert (see Figure 5). Similarly, attach a pull ring to the blanking plug.
9. Inspect the O-rings on the paddlewheel insert (replace if necessary) and lubricate them with the silicone lubricant supplied.
10. Slide the paddlewheel insert into the housing with the arrows on the top pointing forward toward the bow. Seat it into place with a pushing twisting motion until the keys fit into the notches. The arrows on the top of the insert, the notch in the housing, and the arrow on the lip will be aligned. *Be careful* not to rotate the housing and disturb the sealant.
11. Attach one safety ring to one end of the retaining pin. Slide the retaining pin through the valve assembly and paddlewheel insert. Attach the second safety ring to the retaining pin (see Figure 2).

**Warning:** Always attach the safety wire to prevent the insert from backing out in the unlikely event that the cap nut fails or is screwed on incorrectly.

12. Attach the safety wire.

**Plastic housing**—Attach the safety wire to one eye in the hull nut. Thread the **short** emergency plug onto the wire. Lead the wire in a counterclockwise direction and thread it through one eye in the cap nut. Thread the wire through the eye a second time. Then lead the wire through the pull ring and the second eye in the cap nut. Twist the wire securely to itself.

**Metal housing**—Wrap one end of the safety wire tightly around the housing and twist it together with the long end. Thread the **short** emergency plug onto the wire. Lead the wire straight up and through one eye in the cap nut. Loop the wire through the pull ring and twist it securely to itself.

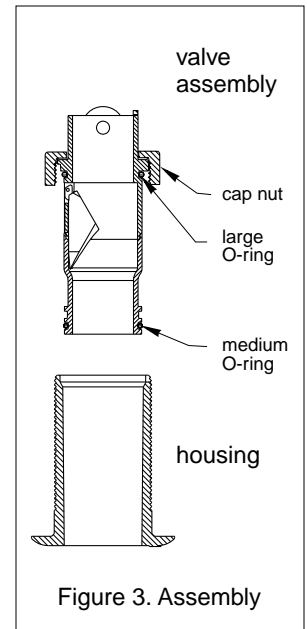


Figure 3. Assembly

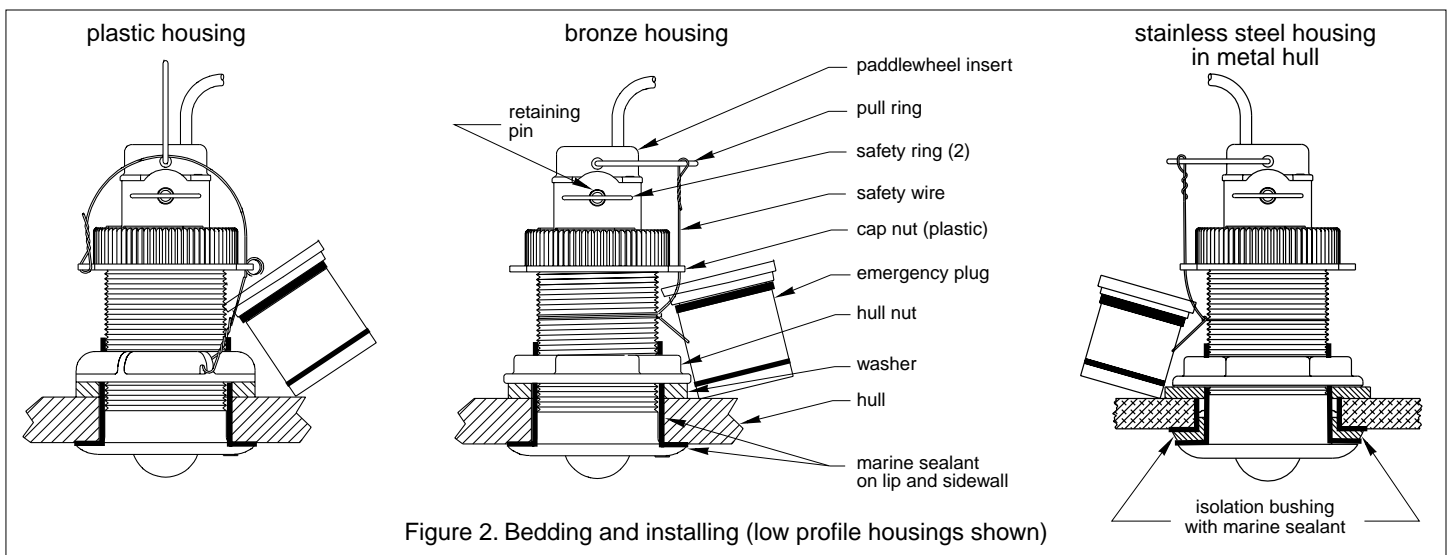


Figure 2. Bedding and installing (low profile housings shown)

**Caution:** If your sensor came with a connector, do not remove it to ease cable routing. If the cable must be cut and spliced, use Airmar's splash-proof Junction Box 33-035 and follow the instructions provided. Cutting the cable or removing the connector, except when using Airmar's junction box, will void the warranty.

- Route the cable to the instrument *being careful* not to tear the cable jacket when passing it through the bulkhead(s) and other parts of the boat. To reduce electrical interference, separate the sensor cable from other electrical wiring and the engine. Coil any excess cable and secure it in place with zip-ties to prevent damage.
- Refer to the instrument owner's manual to connect the sensor to the instrument.

## Checking for Leaks

**Warning:** Never install a thru-hull sensor and leave the boat in the water unchecked for several days.

When the boat is placed in the water, **immediately** check around the thru-hull sensor for leaks. Note that very small leaks may not be readily observed. It is best not to leave the boat in the water for more than 3 hours before checking it again. If there is a small leak, there may be considerable bilge water accumulation after 24 hours. If a leak is observed, repeat "Bedding" and "Installing" on page 2 **immediately**.

## Installation in a Cored Fiberglass Hull

The core (wood or foam) *must* be cut and sealed carefully. The core *must* be protected from water seepage, and the hull *must* be reinforced to prevent it from crushing under the hull nut allowing the housing to become loose.

**Warning:** Always wear safety goggles and a dust mask.

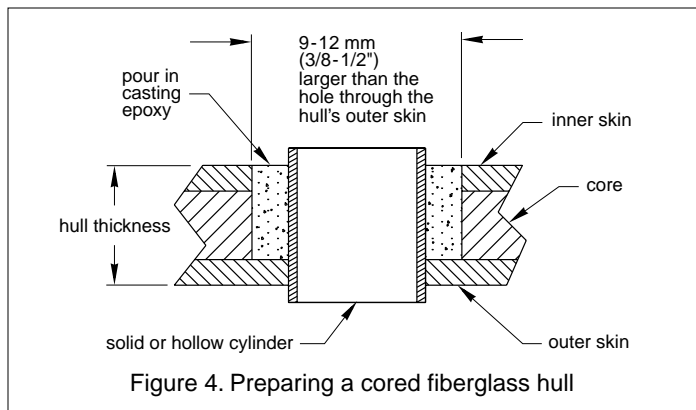
- Drill a 3mm or 1/8" pilot hole from inside the hull. If there is a rib, strut, or other hull irregularity near the selected mounting location, drill from the outside. (If the hole is drilled in the wrong location, drill a second hole in a better location. Apply masking tape to the outside of the hull over the incorrect hole and fill it with epoxy.)
- Using the 51 mm or 2" hole saw, cut the hole from outside the hull through the *outer skin* only (see Figure 4).
- From inside the hull, use the 60mm or 2-3/8" hole saw to cut through the *inner skin* and most of the core. The core material can be very soft. Apply only light pressure to the hole saw after cutting through the inner skin to avoid accidentally cutting the *outer skin*.
- Remove the plug of core material so the *inside* of the outer skin and the inner core of the hull are fully exposed. Sand and clean the inner skin, core, and the outer skin around the hole.

**Caution:** Completely seal the hull to prevent water seepage into the core.

- If you are skilled with fiberglass, saturate a layer of fiberglass cloth with a suitable resin and lay it inside the hole to seal and strengthen the core. Add layers until the hole is the correct diameter.

Alternatively, a hollow or solid cylinder of the correct diameter can be coated with wax and taped in place. Fill the gap between the cylinder and hull with casting epoxy. After the epoxy has set, remove the cylinder.

- Sand and clean the area around the hole, inside and outside, to ensure that the sealant will adhere properly to the hull. If there is any petroleum residue inside the hull, remove it with either mild household detergent or a weak solvent (alcohol) before sanding.
- Proceed with "Bedding" and "Installing" on page 2.



## Operation, Maintenance, Repair, & Parts

### How the Valve Works

The sensor incorporates a self-closing valve which minimizes the flow of water into the vessel when the paddlewheel insert is removed. The curved flap valve is activated by both a spring and water pressure. Water pushes the flap valve upward to block the opening so there is no gush of water into the boat.

**WARNING: The valve is not a watertight seal!**  
Always install the paddlewheel insert or the long blanking plug secured with the retaining pin, safety rings, and safety wire for a watertight seal.

### Using the Long Blanking Plug

To protect the paddlewheel, use the *long* blanking plug when the boat will be kept in salt water for more than a week, the boat will be removed from the water, or aquatic growth build-up on the paddlewheel is suspected due to inaccurate readings from the instrument.

**Warning:** The O-rings must be intact and well lubricated to make a watertight seal.

- Inspect the O-rings on the *long* blanking plug (replace if necessary) and lubricate them with the silicone lubricant supplied or petroleum jelly (Vaseline®) (see Figure 5).
- Remove the paddlewheel insert from the housing by removing the safety wire, one safety ring, and the retaining pin.  
**Do not remove the cap nut** (see Figure 2).
- Grasp the pull ring and remove the paddlewheel insert with a slow pulling motion.  
**Note:** In the unlikely event that the paddlewheel insert cannot be removed, see "Servicing the Valve Assembly" on page 4.

**Warning:** Always attach the safety wire to prevent the insert from backing out in the unlikely event that the cap nut fails or is screwed on incorrectly.

- Slide the *long* blanking plug into the housing with the arrows on the top pointing forward toward the bow. Seat it into place with a pushing twisting motion until the keys fit into the notches (see Figure 5). Secure it with the retaining pin, safety rings, and safety wire (see Figure 2).

### Servicing the Paddlewheel Insert

Aquatic growth can impede or freeze the paddlewheel's rotation and *must* be removed. Use a stiff brush or putty knife to remove the growth and clean the surface with mild household detergent. If fouling is severe, push the paddlewheel shaft out using a spare shaft or a 4D finish nail with a flattened point. Then, lightly wet sand the surface with fine grade wet/dry paper.

The water lubricated paddlewheel bearings have a life of up to 5 years on low-speed boats [less than 10kn (11MPH)] and 1 year on high-speed vessels. Paddlewheels can fracture and shafts can bend due to impact with water borne objects and mishandling in boat yards. O-rings *must* be free of abrasions and cuts to ensure a watertight seal. A replacement Paddlewheel Kit 33-113 is available.

1. Using the new paddlewheel shaft, push the old shaft out about 6mm (1/4"). With pliers, remove the old shaft (see Figure 5).
2. Place the new paddlewheel in the cavity with the flat side of the blade facing the same direction as the arrows on the top of the insert.
3. Tap the new shaft into place until the ends are flush with the insert.
4. Install two of the small O-rings.
5. Place the remaining two small O-rings on the *long* blanking plug.
6. To re-install the paddlewheel insert, see "Installing" steps 9 through 12 on page 2.

### Servicing the Valve Assembly

Should the valve fail, remove it for servicing. A replacement Paddlewheel & Valve Kit 33-415 is available.

1. Remove the **short** emergency plug from the safety wire (see Figure 2).

**Warning:** The O-ring must be intact and well lubricated to make a watertight seal.

2. Inspect (replace if necessary) and lubricate the O-ring with silicone lubricant or petroleum jelly (Vaseline®).

**WARNING:** When the valve assembly is removed, always insert the short emergency plug with the **cap nut** and safety wire for a watertight seal.

3. Unscrew the cap nut. With the **short** emergency plug ready in one hand, remove the paddlewheel insert and valve assembly as one unit by pulling upward on the pull ring. Rapidly insert the **short** emergency plug to minimize the flow of water into the boat.

**Note:** The plug is not secure until the cap nut is in place.

4. To free the cap nut, remove the paddlewheel insert from the valve assembly by removing one safety ring and the retaining pin. Grasp the insert by the pull ring and pull slowly upward.

**WARNING:** If the insert is caught in the valve assembly trapping the cap nut, **TEMPORARILY** hold the **short** emergency plug in place with the safety wire. Then, separate the insert from the valve assembly. If they cannot be separated and the sensor must be left unattended, cut the cable [a minimum of 1 m (3') from the insert] to free the cap nut. Later, splice the cable using Airmar's Junction Box 33-035.

**Warning:** Always use the **cap nut** and safety wire to secure the short emergency plug for a watertight seal.

5. Secure the short emergency plug with the cap nut. **Hand-tighten** only. Do not over-tighten. Re-attach the safety wire.
6. Separate the valve assembly from the paddlewheel insert.
7. Clean, repair, or replace the valve assembly, so the flap valve moves freely and seats against the valve housing (see Figure 5).

**Warning:** The O-rings must be intact and well lubricated to make a watertight seal.

8. To reinstall the valve assembly and paddlewheel insert, inspect (replace if necessary) and lubricate the O-rings on the valve assembly and the paddlewheel insert with silicone lubricant or petroleum jelly.
9. Remove the safety wire and cap nut from the emergency plug. With the valve assembly ready in one hand, remove the emergency plug. Rapidly slide the valve assembly into the housing *being sure* to engage the key in the notch. Screw the cap nut in place **hand-tightening** only. *Do not* over tighten.

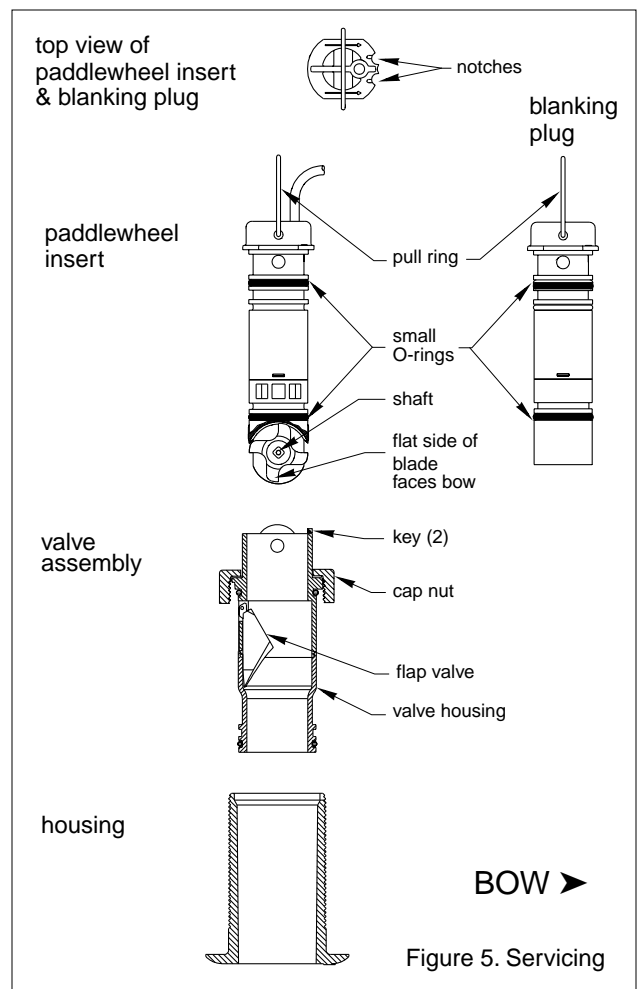


Figure 5. Servicing

**Warning:** Always attach the safety wire to prevent the insert from backing out in the unlikely event that the cap nut fails or is screwed on incorrectly.

10. Re-install the paddlewheel insert and secure it with the retaining pin and safety rings. Attach the safety wire to the short emergency plug, the cap nut, and pull ring (see Figure 2).

### Sensor Replacement

The information needed to order a replacement Airmar sensor is printed on the cable tag. *Do not* remove this tag. When ordering, specify the part number and date.

### Replacement Parts

If you have purchased a plastic housing and have a wood hull or desire greater strength, purchase an Airmar metal housing. If you have purchased a low profile housing and prefer a flush housing, see below. Obtain the following parts from your marine dealer or instrument manufacturer.

Part	Airmar Part Number	
Blanking Plug	33-376-01	
Paddlewheel Kit	33-113	
Paddlewheel & Valve Kit	33-415	
Cap Nut	04-011	(plastic)
	02-029	(bronze)
Hull Nut	04-004	(plastic)
	02-030	(bronze)
	02-530-02	(stainless steel)
Isolation Bushing	04-186-1	
Housing, Nut & Washer	33-100	(bronze, low profile, B17)
	33-224-01	(bronze, flush, B21)
	33-091-01	(bronze, flush, B119)
	33-094-01	(stainless steel, SS557)
	33-092-01	(plastic, flush, P314)
	33-217	(plastic, flush, P217)