POWER FILTER TECHNICAL MANUAL

1	Introduction to Cathodic Protection	p.	2
2	Damage from Electrolysis	p.	2
3	Power Filter	p.	4
4	Connection of the Power Filter	p.	5

1 Introduction to Cathodic Protection

Each metal acquires a determined electrical potential that is measured by a reference electrode. If the potential of the metal is lowered below a determined value, (specific to each metal), we can ensure that the metal will not oxidize, even when submerged in aggressive saltwater (ocean/sea water).

This technique of corrosion prevention is known as Cathodic Protection.

Cathodic Protection can be achieved by two methods:

- Applying very negative (potential) metals such as Aluminum, Zinc or Magnesium metals to the metal you wish to protect. The disadvantage of this technique is that the metals dissolve in the water requiring periodic replacement. This technique is known as *Cathodic Protection through the use of Sacrificial Anodes*.
- Applying a determined negative potential to the protected metal. This is achieved by injecting negative current into the protected metal while simultaneously sending positive current into the seawater through the use of Activated Titanium Anodes. The principle advantage of this method is that the Titanium Anodes, unlike sacrificial anodes, have a useful life of more than 20 years. This technique is known as *Cathodic Protection through Impressed Current*.
  To inject the needed DC current (direct current) regulators are used to administer current based on potential readings from a reference electrode. Using this technique we can ensure that each metal maintains the limits of immunity thus conserving the metal without oxidation.

2 Damage from Electrolysis

Boats that are moored in marinas and are connected to shore power have recently been detected as having abnormally high losses of zinc anode material during short periods of time without any logical explanation. This situation is alarming because if the boat is not removed from the water, the anode will disappear (completely dissolve) losing its protective power against corrosion, and causing irreparable harm to the submerged portion of the boat.

This is a case of what is commonly called ***Electrolysis.*** This case involves the marina or dock area as the cause of damage to the zinc anodes cutting the useful life by a significant percentage and resulting in serious damage to the vessel.

The phenomenon is explained in **Figure 1**. The cause is simpler than it appears.

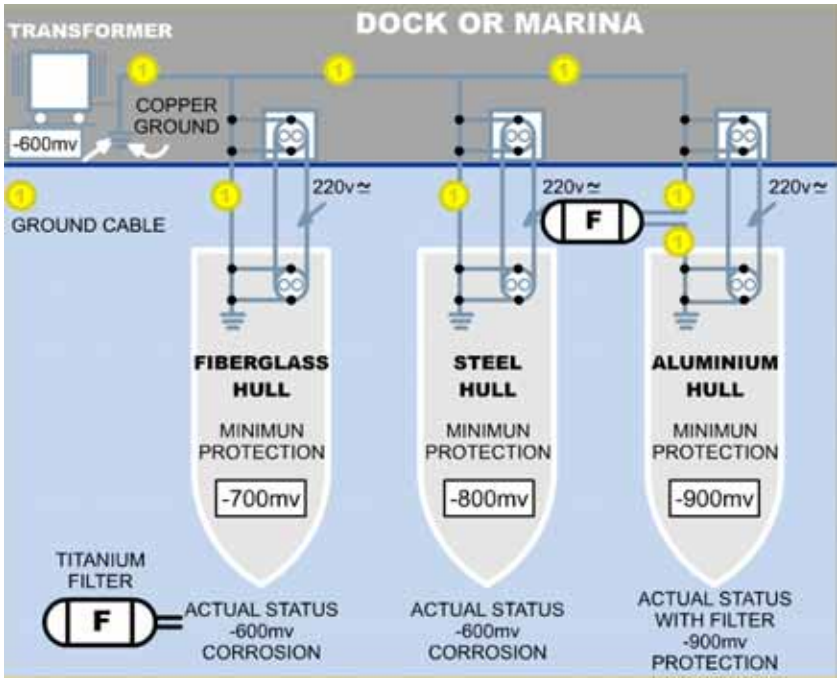


Figure 1: Sample connections (with and without filter) to a dock or marina.

When we connect a power cable from the boat to the outlet in the marina, we also connect to the ground cable (1) (normally yellow or green), and effectively uniting the metallic parts of the boat (motor, metal hull, propeller, etc.) with the metallic submerged parts of the boat next to it and any other boats connected to the ground. When connected to the metallic parts of all the other boats and the marina docks as well, the individual cathodic protection for each boat cannot handle the overwhelming draw causing the potential of each boat to fall below the threshold of protection.

Safety norms require that boats be connected to the ground at the marina to protect people from dangerous currents due to failed isolation or shorts allowing those currents to drain through the ground (by means of the grounding cable) and impeding propagation of currents that could hurt people.

3 Power Filter

The Power Filter solves the previous problem by isolating the boat in the marina exposed to continuous low tension currents from other boats and allowing each boat to maintain its proper potential without affecting the marina or the other boats connected to shore power. Additionally, in case of isolation failure or shorts, the filter acts as a perfect conductor for discharging unwanted dangerous currents to earth/ground.

The filter is made of a titanium-based material without electronic components, making it impervious to current spikes that would normally harm them (ex. electrical storms). The design is symmetrical and it is installed by soldering to the two ends of the cable to the cut green/yellow ground cable.

For the system to function, the filter must be submerged in seawater anytime the boat is in port and connected to shore power. If the filter were not submerged, the boat would lose the ability to discharge power to the ground due to any insulation failure or short in the system.

Figure 2: Standard Power Filter 25A.

The conductivity of the filter in AC current is achieved through activated titanium anodes submerged in an electrolyte (liquid conductor of current) such as seawater. The Titanium Power Filter performs the same function as the isolation transformer with additional advantages such as less weight, less cost and practically maintenance and error free operation.

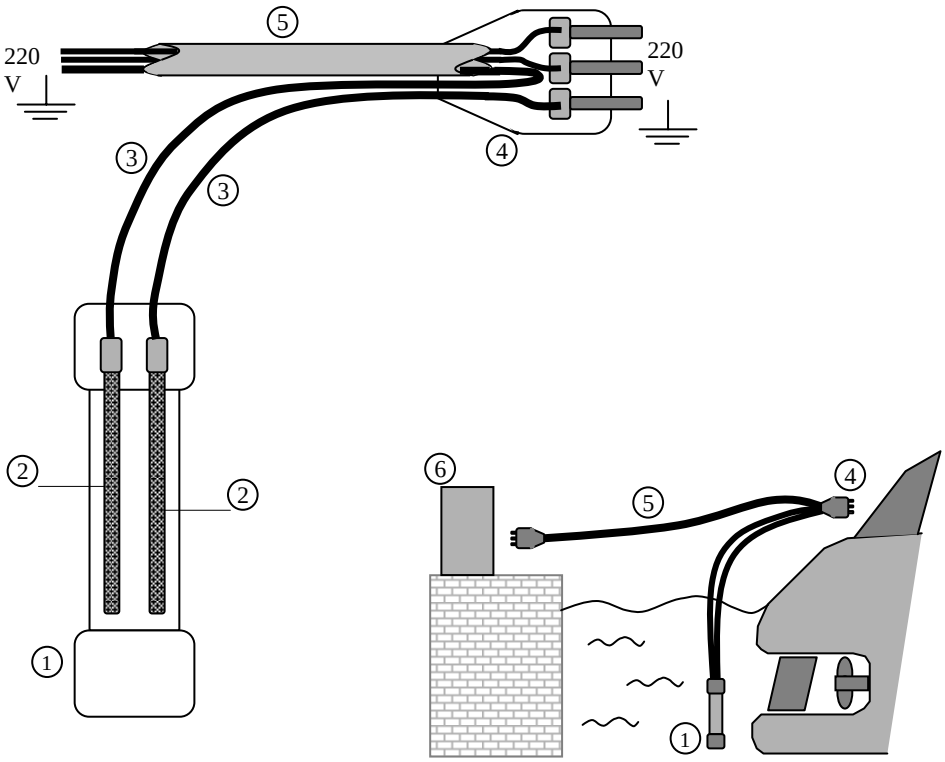
The power filters are capable of draining 25, 100 and 250 amps of AC current up to 380 volts in a few minutes. In Illustration 2 the standard 25A filter is shown.

4 Connection of the Power Filter

Following the schematic (on the next page) we will pass the ground cable from the dock/marina through the filter, cutting and uniting each point with the two cables that come out of the filter. It can be attached to the boat or the outlet at the dock. We unite the two cables applying tin solder and connecting them to smaller diameter cables so that they can fit in the outlet. The length of the cable for splicing purposes should not exceed 20cm. and the diameter should be at least 1mm² or bigger. The splice should also be impermeable to water.

The Filter can also be left permanently in the shore power outlet of the dock In this case you have to put as many filters in each power exit as there are outlets. Because they are permanent, they can be submerged and hidden away from the power source.

As far as depth is concerned it is enough simply to have the filter submerged without the chance of any part coming out of the water for any reason (tide, wave action, etc.). The standard length of cable for the filters is 2 meters and they are designed to resist seawater perfectly. If for some reason one wants to extend the cable, pay special attention to avoid having the spliced area submerged in the seawater because damage could occur to the internal connections between the copper and the titanium of the filter.



Titanium Power Filter

1 Titanium Power Filter submerged in water
2 Activated Titanium electrodes
3 Cable to outlet (ground cable)
4 Boat power outlet
5 Power cable
6 Power source 110V-220V