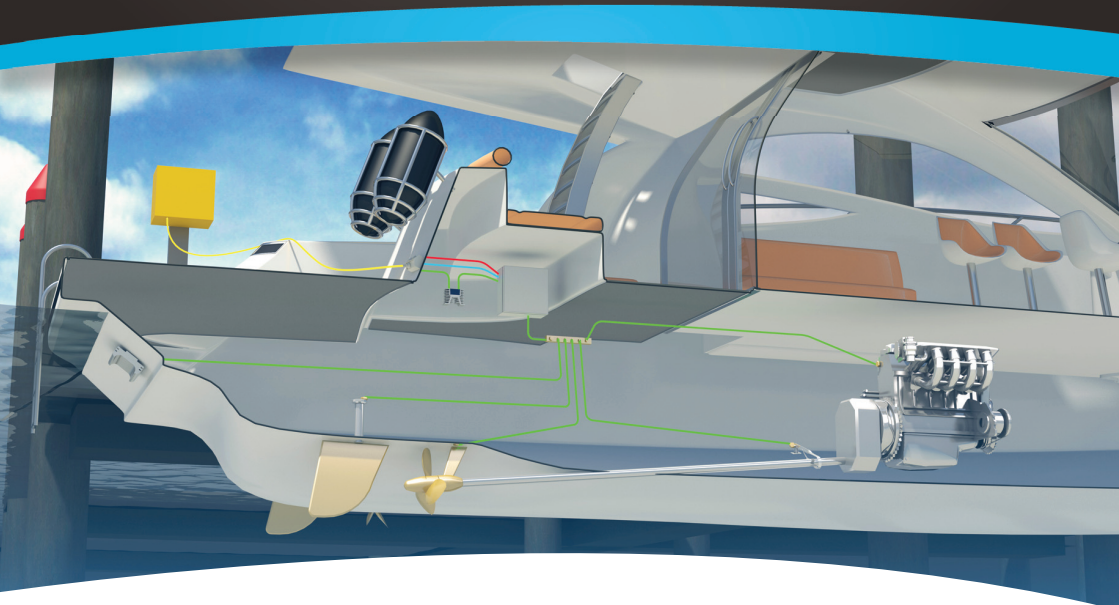




# Marine Protection Systems



**The Marine Protection Systems Cathodic Protection Monitoring and Testing Kit enables users to check protection levels of their vessel and to identify faults in the cathodic protection system.**

The MPS silver /silver chloride test electrode is used to measure the electro-chemical potential of your vessel and is used as a reference point for voltage measurements in units of millivolts (mV).

The MPS Cathodic Protection Monitoring Meter CP-411 measures the voltage potential difference between the reference electrode and the metal or cathodic bonding system under test. The voltage measurements should be recorded in the enclosed Data Results Table.

The Cathodic Protection Monitoring and Testing Kit includes:

- MPS Cathodic Protection Monitoring Meter CP-411
- MPS Test Electrode (reference electrode) with 10m lead and protective wetting-cap
- MPS Sensing Probe with lead
- BNC Adaptor, Carry case and Instructions

## INSTRUCTIONS FOR USE:

1) Unplug the shore power cable and disconnect the batteries from DC circuits. Disconnecting for a period of 24 hours prior to testing will allow equalization and more accurate measurements.

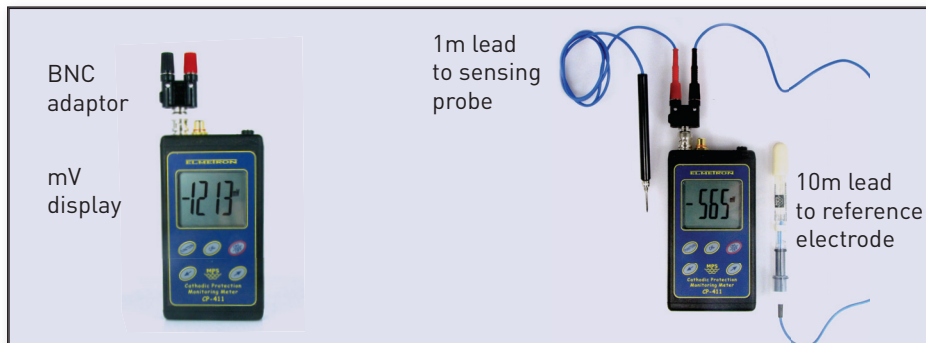
2) Attach BNC Adaptor to the Cathodic Protection Monitoring Meter CP-411 and plug the reference electrode into the black port on the BNC Adaptor. Power up the meter by pressing the **On/Off** switch and ensure the display shows a reading in mV. If the display shows a pH value, press and hold the **Function** switch and then navigate to mV. Once set to mV, the meter will remain in that state. The MPS Cathodic Protection Monitoring Meter CP-411 is now ready to use. After use, switch the meter off by depressing the **On/Off** switch. To conserve battery power, the meter will switch off automatically after several minutes of inactivity.

3) Remove the protective wetting-cap carefully from the bottom of the reference electrode. Note that the cap is filled with fresh water to ensure that the electrode remains clean and free of contaminants. Plug the sensing probe into the red positive port on the BNC Adaptor.

4) Lower the reference electrode into the water ensuring that the electrode is not touching any submerged metallic objects. It is recommended that the reference electrode is lowered to approximately the depth of the propeller in the water.

5) Place the sensing probe on the exposed metal from within the vessel's hull. It may be necessary to remove any protective coatings on the exposed metal, depending on the product used. It is recommended that the exposed metallic fittings in many circumstances be coated with a suitable compound to provide further protection from oxidization.

6) Record the voltage reading generated from the test point in the table provided overleaf. Repeat the process on all exposed metallic fittings and record results.



DATA RESULTS TABLE:

VESSEL DETAILS	RESULTS:	RESULTS:
FITTING	PORT	STBD
Reference Anode		
Trim Tabs		
Rudder Post		
Keel Bolts		
Shaft		
Shaft Bracket		
Shaft Grounding Strap		
Main Engine		
Main Engine Inlet		
Gear Box		
Header Tank Inlet		
Water Tank Inlet		
Genset Inlet		
Inlet Valve (Other)		
Inlet Valve (Other)		
Inlet Valve (Other)		
Inlet Valve (Other)		
Other fitting		
Other fitting		

PLEASE PHOTOCOPY TEMPLATE FOR FUTURE USE.

## INTERPRETING DATA:

The American Boat & Yacht Council (ABYC) E-2 Cathodic Protection provides for a cathodic protection system to be capable of inducing and maintaining a minimum negative shift of 200mV relative to the potential of the least noble metal being protected. Det Norske Veritas (DNV) suggests a negative shift of 100mV to 300mV. In simple terms the most negative or least noble metal in a galvanic circuit should utilize a sacrificial anode with at least 200mV voltage shift in water for protection.

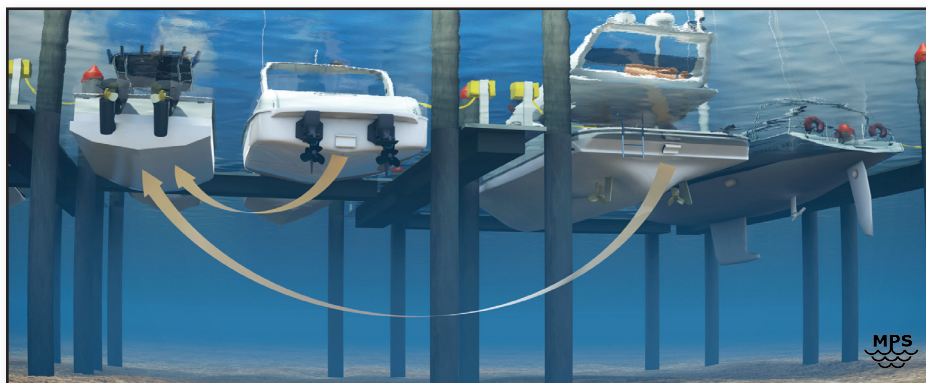
## BONDING:

- 1) Compare the voltage data recorded from the test points to the initial reference test point sacrificial anode.
- 2) An effective galvanic circuit will provide for readings within 30mV of each submerged metallic fitting test point. In the event that the readings between the test points are greater than 30mV it will be necessary to reconstruct the electrical fitting. It is necessary to consider the length / diameter of cable run in reference to voltage drop when considering the threshold for variance.

## PROTECTION:

- 1) The most negative or least noble metal in a galvanic circuit should utilize a sacrificial anode with a 200mV to 300mV voltage shift in water. Note voltage at the test point, the initial reference test point or the sacrificial anode.
- 2) Compare the voltage of the reference test point to other test points.
- 3) Refer to the ABYC guidance for a cathodic protection system to be capable of inducing and maintaining a minimum negative shift of 200mV relative to the potential of the least noble metal being protected to determine whether the test point is over protected, under protected or providing adequate protection levels.

Further guidance and instruction to undertake testing is documented in ABYC E-2 Cathodic Protection Clause E-2.Ap.3 Sacrificial Anodes - Measurement and Application. For further information refer to the Galvanic Series of Metals as follows:



**\*GALVANIC SERIES OF METALS IN SEA WATER  
WITH REFERENCE TO Ag/AgCl REFERENCE CELLS:**

ANODIC OR LEAST NOBLE

Magnesium and Magnesium Alloys	-1600 to -1630
Zinc	-980 to -1030
Aluminum Alloys	-760 to -1000
Cadmium	-700 to -730
Mild Steel, Wrought Iron, Cast Iron	-600 to -710
13% Chromium Stainless Steel, Type 410 (active in still water)	-460 to -580
18-8 Stainless Steel, Type 304 (active in still water)	-460 to -580
Ni-Resist	-460 to -580
18-8, 3% Mo Stainless Steel, Type 316 (active in still water)	-430 to -540
Inconel (78%Ni, 13.5%Cr, 6%Fe) (active in still water)	-350 to -460
Aluminum Bronze (92% Cu, 8% Al)	-310 to -420
Nibral (81.2% Cu, 4% Fe, 4.5% Ni, 9% Al, 1.3% Mg)	-310 to -420
Naval Brass, Yellow Brass, Red Brass, Muntz Metal	-300 to -400
Tin	-310 to -330
Copper	-300 to -570
50-50 Lead- Tin Solder	-280 to -370
Admiralty Brass (71% Cu, 28% Zn, 1% Sn)	-280 to -360
Aluminum Brass (76% Cu, 22% Zn, 2% Al)	-280 to -360
Manganese Bronze (58.8% Cu, 39%Zn, 1%Sn, 1%Fe, 0.3%Mn)	-270 to -340
Silicone Bronze (96% Cu Max, 0.80% Fe, 1.50%Zn, 2.00% Si, 0.75% Mn, 1.60% Sn)	-260 to -290
Bronze-Composition G (88% Cu, 2% Zn, 10% Sn)	-240 to -310
Bronze ASTM B62 (thru-hull)(85%Cu, 5%Pb, 5%Sn, 5%Zn)	-240 to -310
Bronze Composition M (88% Cu, 3% An, 6.5% Sn, 1.5% Pb)	-240 to -310
13% Chromium Stainless Steel, Type 410 (passive)	-260 to -350
Copper Nickel (90% Cu, 10% Ni)	-210 to -280
Copper Nickel (75% Cu, 20% Ni, 5% Zn), Lead	-190 to -250
Copper Nickel (70% Cu, 30% Ni)	-180 to -230
Inconell (78% Ni, 13.5% Cr, 6% Fe) (passive)	-140 to -170
Nickel 200	-100 to -200
18-8 Stainless Steel, Type 304 (passive)	-50 to -100
Monel 400, K-500 (70% Ni, 30% Cu)	-40 to -140
Stainless Steel Propeller Shaft (ASTM 630:#17 & ASTM 564: # 19)	-30 to +130
18-8 Stainless Steel, Type 316 (passive) 3% Mo	0.0 to -100
Titanium	-50 to +60
Hastelloy C	-30 to +80
Stainless Steel Shafting (Bar) (UNS 20910)	-250 to +60
Platinum	+190 to +250
Graphite	+200 to +300

CATHODIC OR MOST NOBLE

CORROSION POTENTIAL RANGE IN mV

\*ABYC E-2 Cathodic Protection Table 1.

## \*RECOMMENDED RANGE OF PROTECTION BASED ON Ag/AgCl REFERENCE CELL:

HULL MATERIAL	mV RANGE
Fibreglass	-550 to -900
Wood	-550 to -600
Aluminium	-900 to -1100
Steel	-800 to -1050
Non-metallic with aluminium drives	-900 to -1050

If a vessel is **over protected** it will be subjected to an increased instance of marine growths, encounter blistering of protective coatings (cathodic disbondment) and materials surrounding the cathodes will come under increasingly severe alkali attack. If a vessel is **under protected** it is either freely corroding or prone to corrosion.

### EARTH LEAKAGE:

It is possible to test for earth leakage from on board electrical systems on the cathodic protection of the vessel by reconnecting the batteries and then turn on one circuit at a time, checking the mV reading at any fitting. If at any time the voltage reading changes, then there is a leak into the bonding system and the dive on the circuit is causing damage.

Earth leakage testing is recommend to be undertaken by a qualified marine electrician, especially when addressing DC corrosion travelling on the AC (240V in Australia) systems earth wire from shore or within a vessel.

### OTHER FACTORS AFFECTING CATHODIC PROTECTION REQUIREMENTS:

- WATER VELOCITY – the cathodic protection requirements will increase with the increased water current flow or water velocity.
- WATER TEMPERATURE – the increased conductivity in warm water increases the rate of galvanic activity.
- SALINITY – salt water has a higher rate on conduction that fresh water.
- ACIDITY – the lower the pH of the water the higher the rate of corrosion.
- PROTECTIVE COATINGS – increased current requirements for cathodic protection with the reduction of protective coating on the submerged metals.

### MAINTENANCE AND CARE:

- Ensure that the MPS Test Electrode is cleaned with fresh water and ensure that it is not damaged.
- Fill the protective wetting-cap with tap water or slightly salty tap water and replace.
- Ensure all components are securely stored in the carry case and store in a dry, secure place.

\*ABYC E-2 Cathodic Protection Table 2.