DC Systems

with

Embedded Diagnostics

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Measuring Insulation Resistance

When an electronic component is in perfect condition it will have a very high resistance between power and ground. As a component gets used and is subject to the elements, resistance from power to ground may drop causing leakage current. When the resistance drops enough to trip a breaker, leakage current becomes a ground fault. Low Insulation Resistance can happen inside the component and anywhere along the power wires.

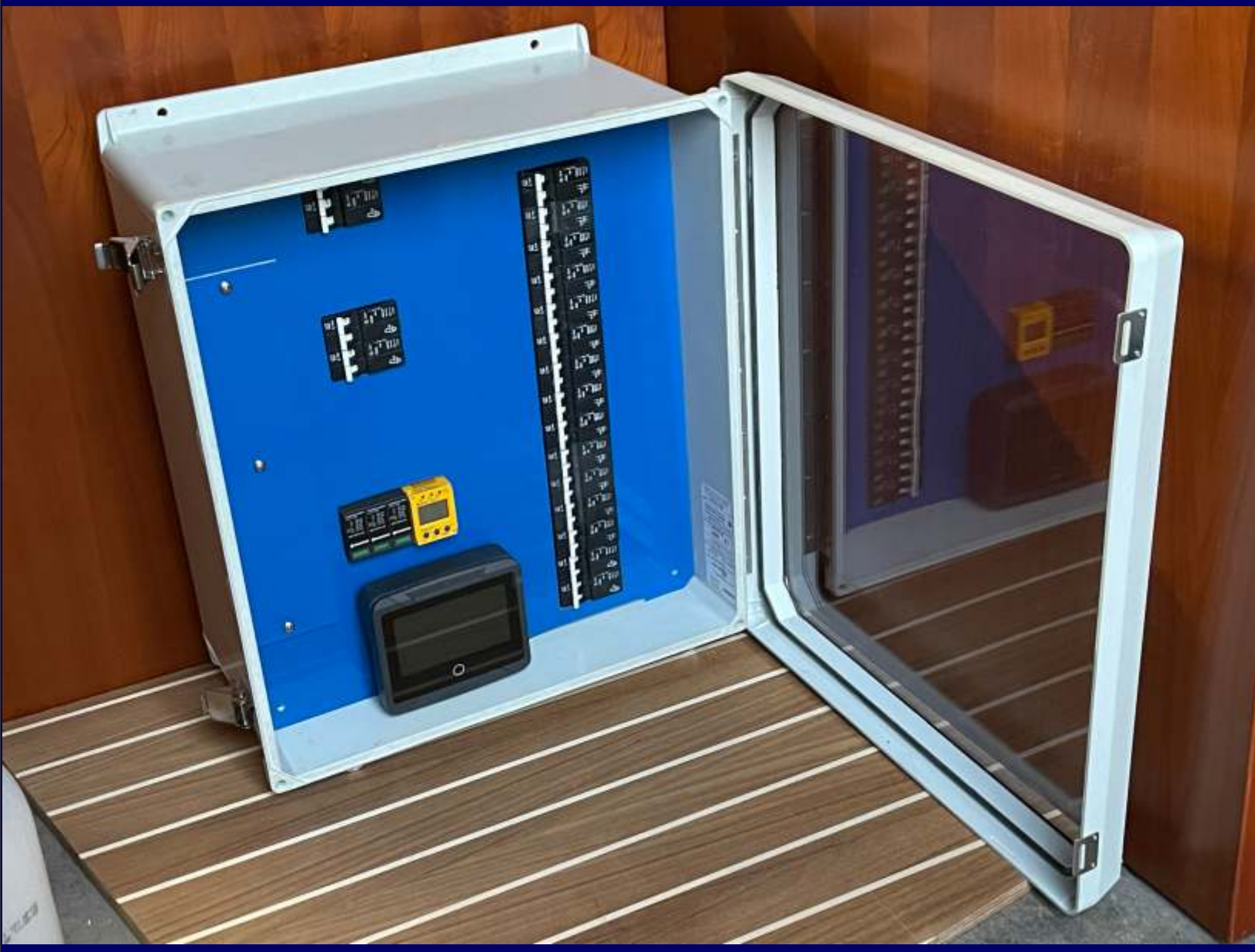
In a grounded DC system, the negative is tied to ground. Negative Leakage current and ground faults go undetected while current transfers improperly through the grounding system in a parallel path to the power conductors. The negative current flows inversely proportionate to the resistance. Most of the negative power will transfer through the negative conductors, while small amounts of negative power will transfer through the grounding conductors. The system will show no signs of this negative transient current, and will remain operational, however current passing through damp or wet grounding systems can cause significant corrosion.

If there is leakage current within the component between positive and ground, then small amounts of positive current will be lost to the grounding system. This positive leakage current in small amounts can cause a great amount of corrosion. When positive leakage current becomes great enough, it becomes a ground fault and renders the component inoperable by tripping the breaker.

Any leakage current passing through the grounding system is indicative of a developing fault, and tends to grow slowly over time. Leakage current is detectable by testing the resistance to ground on both the positive and negative conductors of the circuit. This is known as monitoring insulation resistance.

A system built with diagnostics embedded is relatively easy to build. Each DC component is supplied with 3 wires, similar to any AC circuit. A diagnostic switch lifts the DC Negative to Ground Bond, disables all AC on board the boat, and enables the Insulation Resistance Monitor. Tracking the baseline resistance to ground over time, gives a captain a sound measure of the health of each component on the DC Grounding System. This provides information that can be used to determine maintenance schedules which increases reliablity and uptime, an essential requirement for working and cruising boats, and of great value to aluminum vessels protecting the integrity of the aluminum hull.

Main DC Distribution



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Start Breakers Enclosure

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Regional Enclosures

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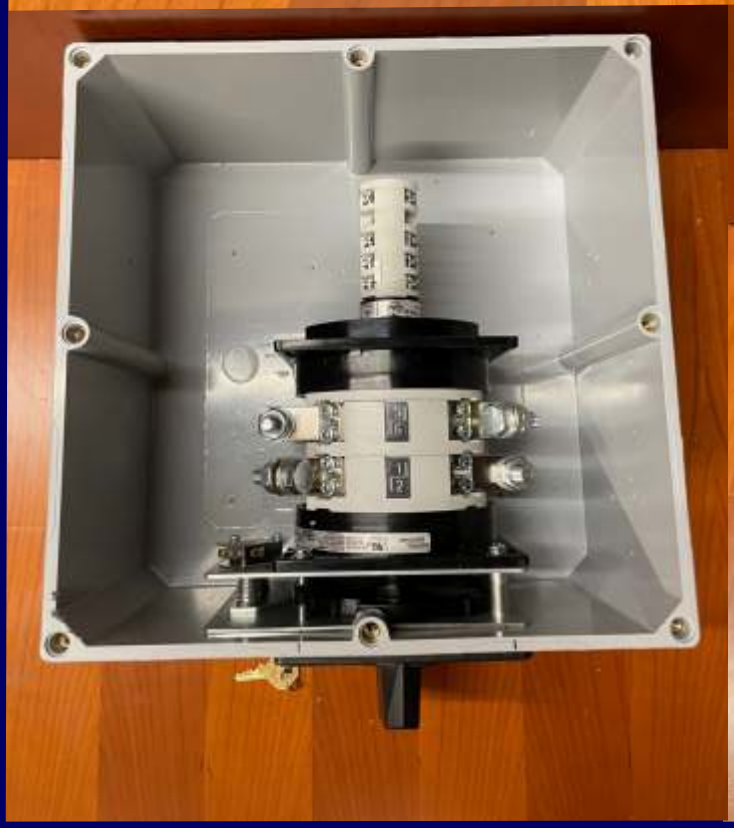
Diagnostics Switch



Directions

1

Run. Everything is fully grounded. Ground Leakage detection off.
DC-Ground bond is made. Everything is operational.
Surge can be enabled.

2

Run with System Wide Diagnostics
DC-Ground Bond is Open. AC is disabled
DC Shield wires are bonded to Battery Negative.
Insulation Monitor is Enabled and measuring resistance of all battery negative and shields to ground, and measuring resistance of battery positive to ground. Turn off all breakers to find baseline resistance of shields and cases to ground.

On Sea Trial, turn everything on. Measure total resistance to ground. Add 10 Percent overhead and set alarm 1 on Bender at that point. Add 100 percent overhead and use that as the 2nd alarm set point.

3

Test Individual Components
Shield is bonded to ground
House Battery is Floating
AC is disabled
Bender is Enabled and testing battery negative resistance to ground and battery positive resistance to ground for each device or devices that are powered on. Record Results. Look for Change.

Choose a Resistance Monitor

IR 425

Standard Isolation Resistance Monitor
2 Alarm Set Points
Calculates total resistance and displays as a sum total of positive resistance plus negative resistance.
Has Power only in test mode.

Optional Resistance Monitor
- larger display
- remote display option
- more menu selections
- tracks fault by time
- fault analysis + -
- resistance graph over time
- high impact
- web connection
- analogue outputs
- voltage monitoring
- resistance monitoring
- capacitance monitoring
- continuous operation

ISO 685

Designed on Solidworks

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Features and Benefits

Marine House Distribution with Embedded Diagnostics provides information to verify the integrity of your Marine Electrical System on every single component on your boat, and the combined health of the entire electrical house system.

-mitigates corrosion to practically nothing and monitors the rest.
-can detect Hot Slip Conditions
-can protect against intermittent hot slip conditions.
-gives a health check for components
-provides predictive Diagnostics.
-Repair or Replace Items Early for Vessel Reliability
-mounts everything in sealed waterproof PVC boxes
- with waterproof strain relief seals for the cables. -
- architecture uses the electrical system for fault management by providing a DC Grounding system for all DC components.

DC Grounding Architecture follows the same Tree configuration of the electrical system. The DC system is a 3 wire system and by design keeps the grounding system clean from any DC faults.

SYSTEM WIDE HEALTH CHECK. GROUND FAULT LEAK IDENTIFICATION. PREDICTIVE DIAGNOSTICS, ENERGY MONITORING HANDSOME FIBERGLASS ENCLOSURE, YOUR COLORS

KNOW YOUR BOAT - ASK FOR MARINE HOUSE DISTRIBUTION with EMBEDDED DIAGNOSTICS

Health Testing and Diagnostics

When monitoring the health of a component, it is important to test it when it is in good operation to see what the baseline resistance and power consumed is. Anomolies in Power consumption may indicate internal faults.

After the initial test, each individual test will tell its own story. If Resistance decreases, then the potential for current to flow increases. When most faults occur they will go from very high resistance to very low resistances over a period of time, Monitoring with alarms catches anomolies and most times give some warning.

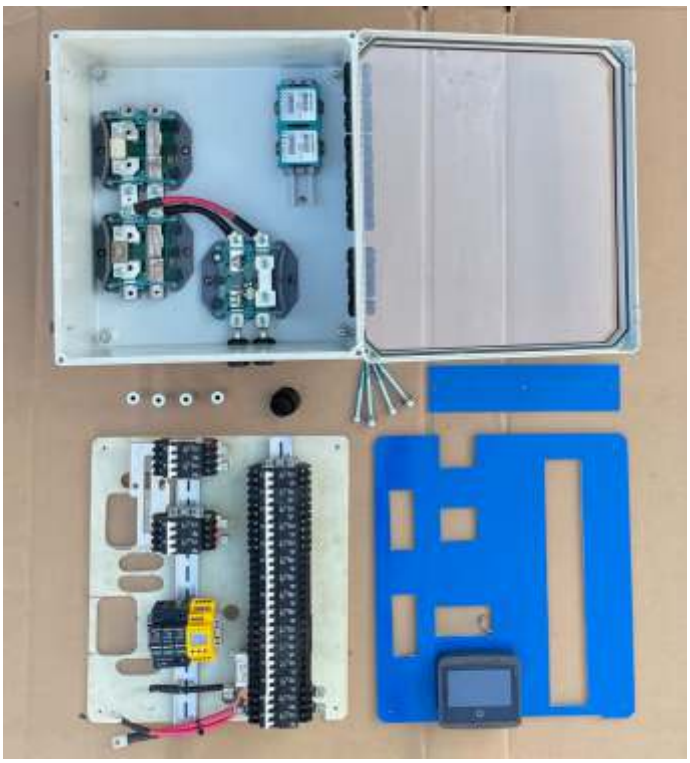
The system will measure the combined resistance of everything to ground in the test run mode. If any one component changes, so will the sum total. Finding the component that changed requires switching to the test mode and turning off every switch until the fault goes away.

The system cannot test or run or diagnose an open circuit condition. If a component is not working at all, then test for power at the component.

For complete information, track resistance, volts, amps and watts consumed for all operating conditions.

Circuit Design and Fabrication

Circuits Designed, Solid Modelled, and Built



to Specification

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Waterproof Construction

Fiberglass with Clear Door:
House & Start Enclosures

PVC with Clear Door:
Subpanels & AC Panels

Waterproof Strain Reliefs

Insulated and Isolated for Maximum Protection

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Main Fuses and Breakers

Double Pole Circuit Protection
Separate Buses for Charging and Loads
Fuse Protection
Component Health Test
System Health Test
Feeds 7 load and 3 charging panels plus windlass

Order Sheet

12 -24 volts (Optional 48 volts)
200 amps DC
Expandable up to 100 circuits
Level 1 and 2 Diagnostics
Component Health Diagnostics
Hot Slip Detection
Hot Slip Protection
Identifies Stray Current Paths
40 amp Bidirectional DC Transfer Charge
25 amp Start Battery Plastic Cased Mastervolt Chargers
30 amp Isolation Transformer
2 KW Inverter Charger
200 Amp DC Grounding System
Engine Start Bank Isolation
GFCI Smart Shorepower Cord
System Resistance Monitor ISO 685 Upgrade
Component Resistance Monitoring
Component Health Check
Lightning Mast
Lightning Suppression
Power Conditioning
Clean DC output
Current and Voltage Monitoring
Time to Go Observations
Aluminum Vessel Protections
NMEA 2000

System Requirements

An electrical system architecture that supports comprehensive diagnostics includes:

1) **Double Pole Breakers on every circuit so each circuit can be isolated**
2) **A 3 wire DC system supporting a DC Grounding System**
3) **A DC Grounding System that bonds all DC shields and cases together**
4) **Isolation Mounting for all DC components**
5) **Inverter Charger (if pass through AC is required.)**
6) **Additional Chargers in Plastic Cases to maintain AC/DC isolation**
7) **An Isolation Transformer**
7) **A Diagnostics Switch**
8) **An Insulation Resistance Monitor**
9) **External Sensors with Metrics for Hot Slip Detection**

These Basic Requirements are not much different from how vessels are normally wired, yet provide a treasure trove of data that can be used to maximize uptime, increase reliability and provide logic for maintenance scheduling.

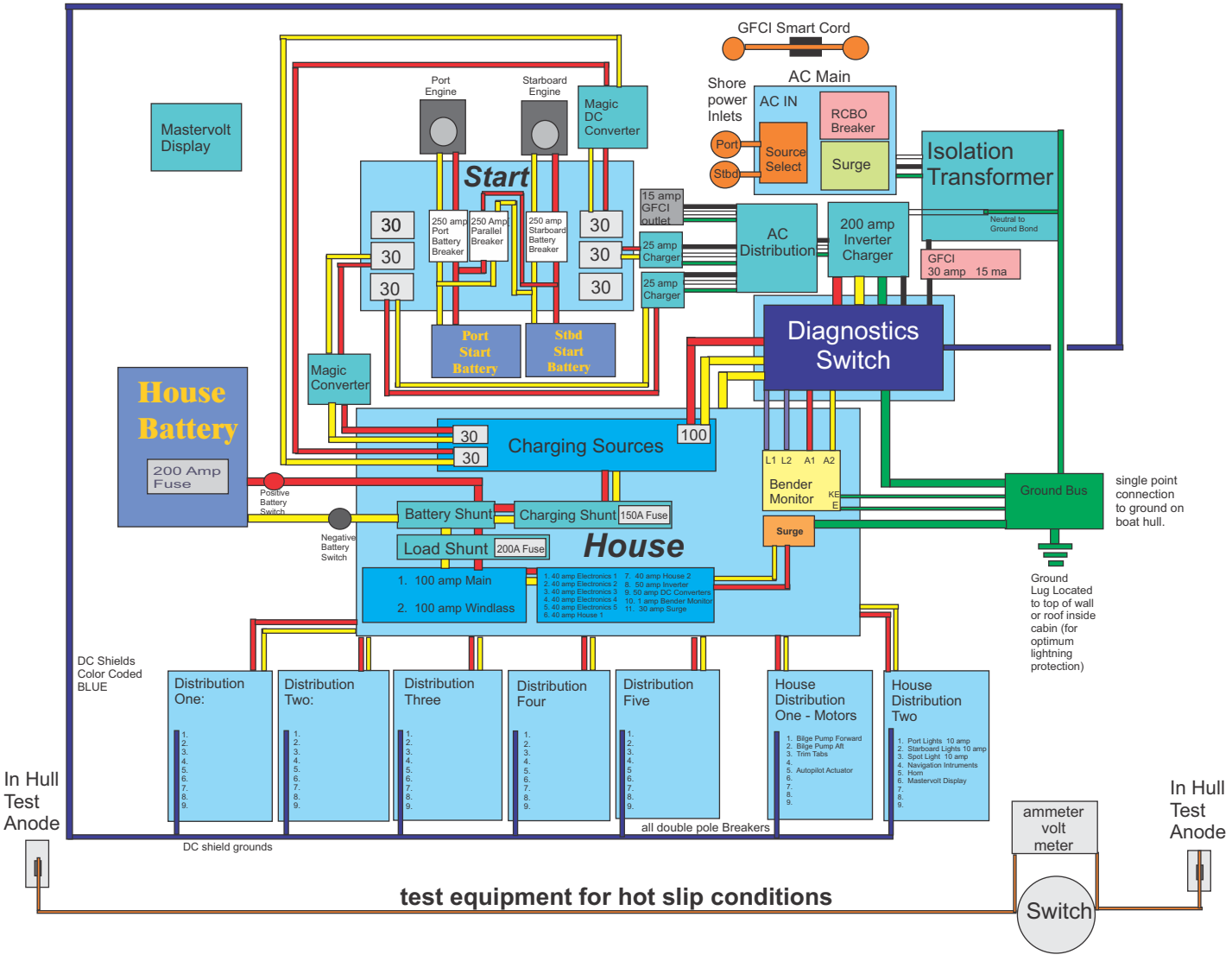
On Board Diagnostics are incredibly useful for workboats and cruising boats.

The best way to monitor the integrity of an aluminum boat hull is with On Board Diagnostics.

On Board Diagnostics provide a simple solution for a very complex problem. Complete Diagnostics of the entire electrical system can be finished with accuracy within minutes by the captain, instead of days by a marine electrician. Its like having your marine electrician with you, wherever you go.

Appendix 1 - Schematic

Aluminum Vessel with Two Outboard Motors



Appendix 2

Shield Resistance Log
Electrical Integrity Log
Fault Log

Shield Resistance Log

Shields Resistance to Ground	Ohms		Change		

Electrical Integrity Log

Component	Ohms	Volts	Amps	Watts	Fuse
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					

Electrical Integrity Log

Component	Ohms	Volts	Amps	Watts	Fuse
17. Chartplotter					
18. Chart with Radar Standby					
19. Chart with Radar Transmit					
20. Radar Only					
21. VHF					
22. VHF Transmit					
23. DSM					
24. GPS					
25. Weather					
26. Autopilot					
27. Augmented Reality					
28.					
29.					
30.					
31.					
32.					

Electrical Integrity Log

Component	Ohms	Volts	Amps	Watts	Fuse
33. Network Router 1					
34. Network Router 2					
35. Network Router 3					
36. Network Router 4					
37. Network Router 5					
38. Network Router 6					
39. HD-SDI Converter					
40. HD-SDI Converter					
41. POE					
42. POE					
43. POE					
44.					
45.					
46.					
47.					
48.					

Electrical Integrity Log

Component	Ohms	Volts	Amps	Watts	Fuse
49.					
50.					
51.					
52.					
53.					
54.					
55.					
56.					
57.					
58.					
59.					
60.					
61.					
62.					
63.					
64.					

Electrical Integrity Log

Component	Ohms	Volts	Amps	Watts	Fuse
65. Bilge Pump Forward					
66. Bilge Pump Aft					
67. Trim Tabs					
68. Windlass					
69. Wipers 1					
70. Wipers 2					
71. Wipers 3					
72. Horn					
73. Spot Light					
74. Navigation Lights					
75. Interior Lights Port					
76. Interior Lights Starboard					
77.					
78.					
79.					
80.					

Fault Log

Fault Date	Ohms	+	-	Sym	
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					

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On Board Diagnostics for Working, Cruising and Aluminum Boats

by

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DC-G
GROUNDED