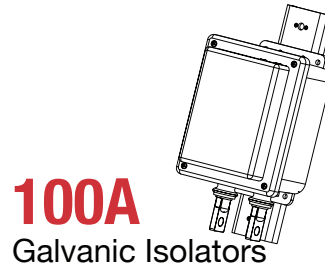


The Marine Galvanic Isolator (GI)

Literature and Installation Instructions



INTRODUCTION

The DEI Marine Galvanic Isolator (GI) is a fail-safe, solid-state DC isolation/ AC coupling device for marine applications with exceptional product performance and certifications to ABYC A-28. Galvanic isolators are desirable whenever a boat is connected to AC shore power, due to a galvanic circuit, which can cause corrosion of the boat and its drive system components. Due to the difference in the potential of the hull and drive system metal compared with the shore grounding system or other boats, a galvanic current, which causes corrosion, can flow. A galvanic isolator is installed in series with the shore power cable grounding conductor to prevent the flow of galvanic current thereby preventing the galvanic corrosion. A typical installation schematic is shown in Figure 5.

Fail-Safe Criteria

In the marine industry, the criteria for galvanic isolators is defined by the American Boat and Yacht Council (ABYC) recommended standard A-28. Due to recommendations to the A-28 galvanic isolator committee about the need to retain safety grounding under all conditions, as required by the U.S. National Electrical Code for all similar applications outside of A-28, the standard makes provision for “fail-safe” galvanic isolators. To be considered “fail-safe,” an independent laboratory must confirm that the isolator will either remain fully functional or remain a permanent, effective grounding path if it fails, when subject to the ultimate current-carrying capability of the grounding conductor (i.e. the energy required to melt the conductor).

This important safety feature eliminates the need for a monitoring system, which is no longer required for fail-safe units because the safety concerns of a product compromising the grounding conductor have been removed.

Did You Know?

All DEI Marine products are certified and exceed ABYC A-28 requirements. In fact, DEI Marine was responsible for introducing fail-safe design in galvanic isolators to the marine industry.

PRODUCT OVERVIEW

DEI Marine manufactures fail-safe Galvanic Isolators, which have been tested and certified to ABYC A-28 publication, by Imanna Laboratory, Inc.

Our extensive experience with solid-state grounding devices and “decouplers” dates back to 1983, manufacturing conservatively designed products for high power applications in the power utility, pipeline, and railroad markets. Dairyland manufactures isolators for other industries that have identical construction to the Galvanic Isolator line, and which have been fully tested and listed by Underwriters Laboratories to US and Canadian electrical codes (NEC, CSA, etc) for safety grounding and suitability for hazardous locations. The units were further tested by UL/Demko to meet European requirements. These electrical codes are much more demanding than the ABYC A-28 standard, where fail-safe construction is not optional, but required. All DEI Marine Galvanic Isolators are considered “Fail-Safe Plus®” or “Fail-Safe MAX®”, defined in the following sections.

DEI Marine offers Galvanic Isolators rated 30A, 50/60A, 100A, and 200A. The scope of A-28 covers ratings through 100A, but the 200A model has similar construction to the certified models, with a full 200A continuous current rating (plus overload margin per ABYC).

Fail-Safe Plus®

Fail-Safe Plus® models not only meet the fail-safe test criteria in A-28, but also have considerably higher AC fault current ratings than are required and have substantial lightning current ratings which are not required by A-28.

Fail-Safe Max®

Fail-Safe Max® models provide even higher performance than Fail-Safe Plus models, in that they have higher fault current ratings and will still be fully functional and meet all requirements of A-28 after being subject to the fail-safe test criteria (i.e. the energy required to melt the conductor).

Key Features

- Verified Fail-Safe construction
- Highest AC fault current ratings
- No monitoring system required per ABYC A-28
- Rated for lightning current. No other known galvanic isolators have published lightning current ratings

Additional Unique Features

- Ignition protected
- Longest warranties offered in the industry
- Certified to ABYC A-28 as “Fail-Safe”
- Compact design
- Designed for cool operation - no heat sinks needed
- Prevents the flow of galvanic current with super imposed AC current well above the 3A minimum required by A-28
- Designed to meet stringent NEC land-based grounding requirements (exceeds marine requirements)

PRODUCT CAPABILITIES

Blocking Voltage

Per ABYC A-28, the DEI Marine model GI family has a DC blocking voltage of at least 1V. At a voltage below this value, the GI blocks the flow of DC current and allows AC current to pass. At voltages above the blocking voltage, such as could occur from an AC fault or lightning, the GI is a bi-directional conduction device that readily allows all current to flow, thereby safely limiting the voltage on the boat.

System Voltage

DEI Marine Galvanic Isolators are strictly current rated and can be used on any voltage class system. Since A-28 requires a system voltage rating on the nameplate, all DEI Marine Galvanic Isolators are name-plated for use on systems of 600Vac or less.

DC Leakage Current

For a given DC voltage across the GI, there will be a small DC leakage current. This value will be negligible (less than 1mA) at the worst-case galvanic voltage difference anticipated across the device, and well below the limits in ABYC A-28. The leakage current is a corrosion-causing current that is minimized with the DEI Marine design.

Steady-State AC Current

Galvanic isolator models are rated to carry the steady state AC current for which the shore power cable is rated. The ratings offered by DEI Marine are 30A (which has been certified and nameplated for 35A continuous to satisfy European requirements for a 32A rating), 50/60A (for a single 50A shore cord or two 30A shore cords), 100A (for a single 100A shore cord or two 50A shore cords), and 200A (for a single 200A shore cord or two 100A shore cords).

Exceptions:

If the shore power steady-state current rating is different from the above values, choose a GI rating that exceeds the shore power rating. When in doubt about ratings, contact DEI Marine.

AC Fault Current

All DEI Marine Galvanic Isolators are designed to exceed the ABYC A-28 ratings for AC fault current. When a boat is connected to shore power, if a fault on the boat occurs, the isolator will be exposed to fault current until the appropriate breaker operates. DEI offers models that have assured fail-safe operation, based on testing to the equivalent failure level of the shore power cable grounding conductor required for a given current rating. An even higher level of performance and protection is offered in the “Fail-Safe Max” line, with units that remain fully functional after being exposed to the fail-safe isolator test criteria in A-28. Following are the fault ratings of all DEI models, in amperes rms symmetrical, for both the Fail-Safe Plus® and Fail-Safe Max® classes. For comparison, per the A-28 standard, non-fail-safe galvanic isolators are only required to be tested for one cycle at the fault current ratings shown below, for three consecutive times. DEI marine products greatly exceed all requirements.

AC Fault Current Ratings (Amps AC-RMS Symmetrical)		
Model	Fault Rating	Product Class
GI-30A-FSP	3kA for 13 Cycles	Fail-Safe Plus®
GI-50/60A-FSP	5kA for 10 Cycles	Fail-Safe Plus®
GI-100A-FSM	5kA for 198 Cycles	Fail-Safe MAX®
GI-200A-FSM	5kA for 198 Cycles	Fail-Safe MAX®

Lightning Surge Current

Although not a requirement of A-28, DEI Marine has established substantial lightning current ratings for all Galvanic Isolators. The lightning surge current rating should not be confused with the AC fault current rating. Lightning has a very different waveform, with a faster rise time, a shorter duration, and much less energy than for an AC current waveform of the same peak current. However, lightning develops much larger voltage differences along the current flow path than AC, resulting in arcing, equipment damage, or personnel risks. Lightning current ratings for DEI Marine Galvanic Isolators were established by subjecting the galvanic isolator to representative lightning current in a high power test laboratory per the requirements of ANSI C62.11.

The waveform used for DEI Marine testing is described as an industry standard 4x10 μ s waveform. This describes a lightning waveform where the rise time is 4 microseconds to peak value, followed by decay to one-half of peak in 10 microseconds. The following models have the peak current rating stated.

Lightning Surge Current Rating		
Model	Fault Rating	Product Class
GI-30A-FSP	75A Peak	Fail-Safe Plus®
GI-50/60A-FSP	100kA Peak	Fail-Safe Plus®
GI-100A-FSM	100kA Peak	Fail-Safe MAX®
GI-200A-FSM	100kA Peak	Fail-Safe MAX®

FEATURES AND CHARACTERISTICS

Certification

The DEI Marine line of Galvanic Isolators was tested and certified by Imanna Laboratory, Inc of Rockledge, FL to the ABYC A-28 standard, July 2008 publication. As defined in the standard, all DEI Marine products are "Ignition Protected" and "Fail-Safe," or beyond the requirements of fail-safe as previously described (i.e., Fail-Safe Plus and Fail-Safe Max).

* Note: While ABYC A-28 standards do not specify requirements for a 200A device, DEI's 200A Galvanic Isolator was tested to the criteria that would apply if the requirements of A-28 were extended to this rating.

Solid-State Design

The DEI Marine Galvanic Isolator utilizes solid-state components in proven designs supplied to the energy industries since 1983. The design has an instantaneous response to voltage, initiating voltage clamping immediately when the voltage attempts to exceed the blocking level. The design includes a non-polarized capacitor. All DEI Marine products are fail-safe by design.

Warranty.

Due to the conservative design, DEI Marine offers long term warranties. The warranty for a Fail-Safe Plus class product is 7 years, and for a Fail-Safe Max class product is 10 years. During the warranty period, any model will be repaired or replaced due to failure for any cause.

Field Testing/Maintenance

The Galvanic Isolator can be field tested with a multi-meter and clamp on DC ammeter. Testing procedures are included in the installation instructions. The Galvanic Isolator is completely maintenance-free.

Enclosure

The 30A and 50/60A models are packaged in a molded, non-metallic enclosure rated IP68. See Figure 1 and 2. The 100A and 200A models are packaged in a molded, non-metallic fiberglass enclosure rated NEMA 4X. See Figures 3 and 4.

Polarity/Electrical Connection

The Galvanic Isolator terminals do not include polarity marks because it is bi-directional and symmetrical in design. However, the terminals are marked as "Boat Ground" and "Shore Ground" to avoid confusion or inadvertent bypassing of the device. Conductors are to be terminated with one-hole cable lead connectors (user furnished) by bolting, using the hardware supplied by DEI Marine. The connector should be sized for a 5/16" diameter bolt for 30A and 50/60A models, and for a 1/2" diameter bolt for the 100A and 200A models. Torque values are included in the installation instructions.

Number of Operations

The number of times that the Galvanic Isolator can be subject to its rated lightning or AC fault current rating is virtually unlimited, provided the operations are not immediately repetitive.

Energy Requirements

None. The device is completely passive.

Ambient Operating Temperature

-45°C to +65°C

Did You Know?

The fail-safe characteristics of DEI Marine Galvanic Isolators remove the safety concern of a galvanic isolator compromising the grounding conductor, eliminating the need for monitoring, per ABYC A-28. Monitoring will still be required for isolators made by others that are not certified as fail-safe.

INSTALLATION INSTRUCTIONS

WARNING

To avoid injury or death from electrical shock when installing the Galvanic isolator, the boat should not be connected to shore power and there should be no power to the AC panel.



Pre-Installation Tests

Before proceeding with installation of the galvanic isolator, disconnect the shore cord (or shore cords where dual shore cords are on a boat) so there is no AC power to the panel and close all AC circuit breakers. Also check for and de-energize any inverters that could supply AC power to the panel. Measure the resistance between the boat ground and neutral. Confirm that this resistance value is 25,000 ohms or greater per ABYC E-11, after which the GI can be installed as described in the next sections. If the resistance is less than 25,000 ohms there is a ground-neutral by-pass that must be corrected or the isolator will not isolate the vessel.

Mounting

The GI is to be installed in series with the ship-to-shore grounding conductor as illustrated in Figure 1, which is extracted from the ABYC standard A-28. Although Figure 1 shows a single-phase system, the GI can also be used on a three-phase system. Securely mount the GI in a location where it can easily be inserted in the grounding conductor as illustrated in Figure 1 and as described in the following section.

Polarity

The standard GI has symmetrical voltage blocking characteristics; therefore polarity is not relevant. However, the terminals are marked "Boat Gnd" and "Shore Gnd" to avoid confusion or inadvertent by-passing of the device. Connect the terminal of the GI marked "Boat Gnd" to the boat grounding system. Connect the other terminal marked "Shore Gnd" to the grounding conductor in the shore power cable that goes to the shore power cable connector. When one 50/60A galvanic isolator is used for dual 30A services on a boat, the grounding conductor from each shore power cable will be connected to the terminal marked "Shore Gnd." There cannot be any other connections to the boat from the grounding conductor on the "Shore Gnd" side of the GI because this would by-pass the isolator.

Lead Connections/ Torque Values

The GI is furnished with terminal pads for securing compression terminals crimped to insulated leads. Leads and ring type compression terminals appropriate for the current rating selected are user furnished. These ring terminals are secured by bolting, using the hardware supplied by DEI. The terminal should be sized for a 5/16" (or 8mm) diameter bolt for 30A and 50/60A models, and for a 1/2" (or 12mm) diameter bolt for the 100A and 200A models. Recommended torque values are 17 to 19 ft-lb (23 to 26 N-m) for the 5/16" bolt and 53 to 57 ft-lb (72 to 77 N-m) for the 1/2" bolt.

Monitoring

The DEI Fail-Safe Plus and Fail-Safe Max line of Galvanic Isolators are not provided with a monitor because in A-28, July 2008 publication, monitoring has been eliminated as a requirement for galvanic isolators classified as Fail-Safe per A-28.

Testing After Installation

After installation, test should be conducted to confirm that the boat electrical wiring is correct and that the GI is functioning properly. Test should be performed by qualified personnel, using appropriate safety practices. For Test 3 the boat must be in the water. A multimeter with an ohms scale and a diode checking function is required.

① To confirm that the GI is installed without any by-pass connection, momentarily short the terminals of the GI to remove any residual charge that may be on the internal capacitor. Using a multimeter set to the lowest ohms scale, connect a meter lead to each GI terminal while observing the meter. If the resistance reading starts at zero ohms and slowly begins increasing, the GI is not by-passed.

If the resistance reading remained fixed at near zero ohms, the GI may be by-passed or it may be internally shorted. To determine which condition exists, disconnect all leads to the GO "Shore Gnd" terminal and repeat the above ohmmeter test. If the resistance now slowly increases, the GI was by-passed. Find and eliminate the by-pass connection and retest to confirm. If the meter reading remains fixed and near zero ohms, the GI is internally shorted and must be replaced.

② This test applies when the boat is in the water. Following boating industry accepted procedures, connect the shore power cord (or cords) to the dock AC power source.

Measure the DC voltage across the GI terminals to determine if there is any galvanic voltage present. This voltage should be well below the +/- 1.1 volt blocking level of the GI, and could, but would not normally be, zero.

③ This is a definitive test to determine whether the GI is fully functional and is recommended for a new installation, as an annual test, or whenever the operation of the GI may be in question. This test uses a multimeter and will take about 15 minutes to conduct, however Test 5 is an equivalent test that can be conducted in about one minute, but requires an auxiliary 1.5Vdc battery (one AA suitable) with clip leads for connection to the GI terminals. (This battery tester is provided by the user, or upon request DEI can suggest a source for a suitable battery tester. E-mail contact@dairyland.com and ask for "Info on GI Battery Tester".) Disconnect the boat completely from shore power (including both shore power cords where one galvanic isolator is used for dual services).

Momentarily short the terminals of the GI together to completely remove any residual charge that may be on the internal capacitor. Using a multimeter set to the diode checking function,

connect the positive lead to the terminal labeled "Boat Gnd" and the negative lead to the terminal labeled "Shore Gnd." The meter should show a voltage reading that very slowly increases from zero at a rate on the order of one to several millivolts per second, depending on the characteristics of the multimeter. This test will take about 5 to 10 minutes since a multimeter is very current limited and DEI GIs utilize a higher capacitance value than other GIs.

- If the voltage instantly increases to the 0.8 to 0.9 volt range, the capacitor is defective (i.e. open circuit).
- When the test time is extended until there is no further appreciable increase in voltage, the voltage reading will increase to about 0.80 to 0.90 volts. (Once the voltage increases to a value greater than 0.55 volts, then both diodes in the GI are almost certainly functional, but it is suggested that the test be taken to its limit. If the voltage increases above 0.90 volts, the diodes may be open circuit, a condition that should never be encountered with any DEI marine galvanic isolator.)
- If the voltage only increases to about 0.45 volts or slightly less, then one diode is shorted.
- If the voltage does not increase at all, then both diodes are shorted, or the capacitor is shorted, or the GI is by-passed. To determine whether the GI is by-passed, go to Test 3. If the GI was not by-passed, it is failed.

④ Assuming that the above test was successful, remove the meter leads, momentarily short the GI terminals to remove any residual charge on the capacitor, then connect the meter leads to the GI in the reverse direction (positive lead to "Shore Gnd" and negative lead to "Boat Gnd") and repeat the above test to confirm that all components are functional for the alternate polarity.

⑤ This is an equivalent to Test 4 that requires a 1.5Vdc battery (one AA suitable) with clip leads. Connect a multimeter, set for dc volts, across the GI terminals. Then connect the 1.5V battery source across the GI terminals, first with one polarity and then the opposite polarity, and only long enough to take a reading (several seconds) or the battery will rapidly deplete. Following is a summary of typical results for a functional GI and for a defective GI. Replace any GI that does not meet the requirements of a "Functional GI."

Functional GI: Voltage quickly rises to slightly over 1.3V. When source is removed, voltage decays to about 0.85V in about 30 seconds, then further decays very slowly after that. (If a GI does not meet the Functional GI test, change the battery and retest in the event the battery is depleted.)

One Diode Shorted: Voltage quickly rises to the 0.7V to 0.85V range.

Two Diodes Shorted: Voltage increase minimal or zero.

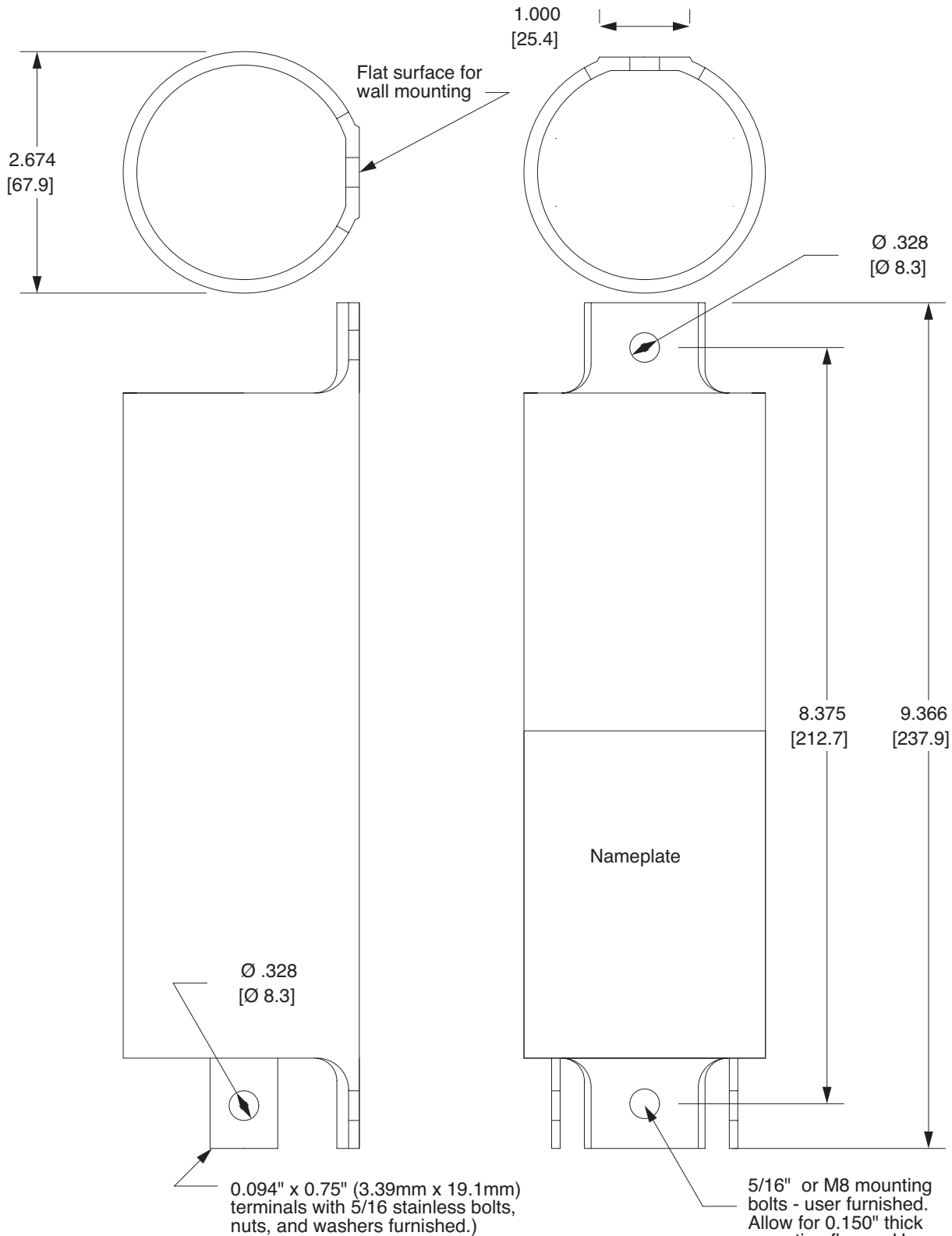
Capacitor Open: Voltage quickly rises to slightly over 1.3V. When source is removed, voltage immediately drops to zero (no gradual decay as for a Functional GI).

Capacitor Shorted: Minimal, if any, voltage increase (less than 1V). When source is removed, voltage immediately drops to zero.

Open Circuited Diodes: Voltage quickly rises to 1.5V (battery voltage) and then slowly decays. This condition should never be encountered due to the fail-safe design.

If any results are not as expected, or a GI appears to be failed, contact DEI.

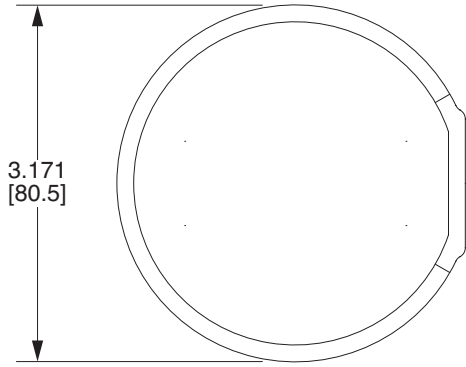
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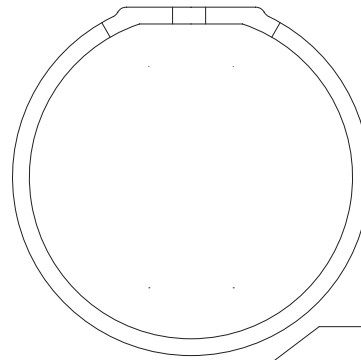
Scale: 1" = 1.5"

Dairyland Electrical Industries, Inc.
 30A GI-30A-FSP or FSM Outline
 GI-30A-11
 Feb. 27. 2007

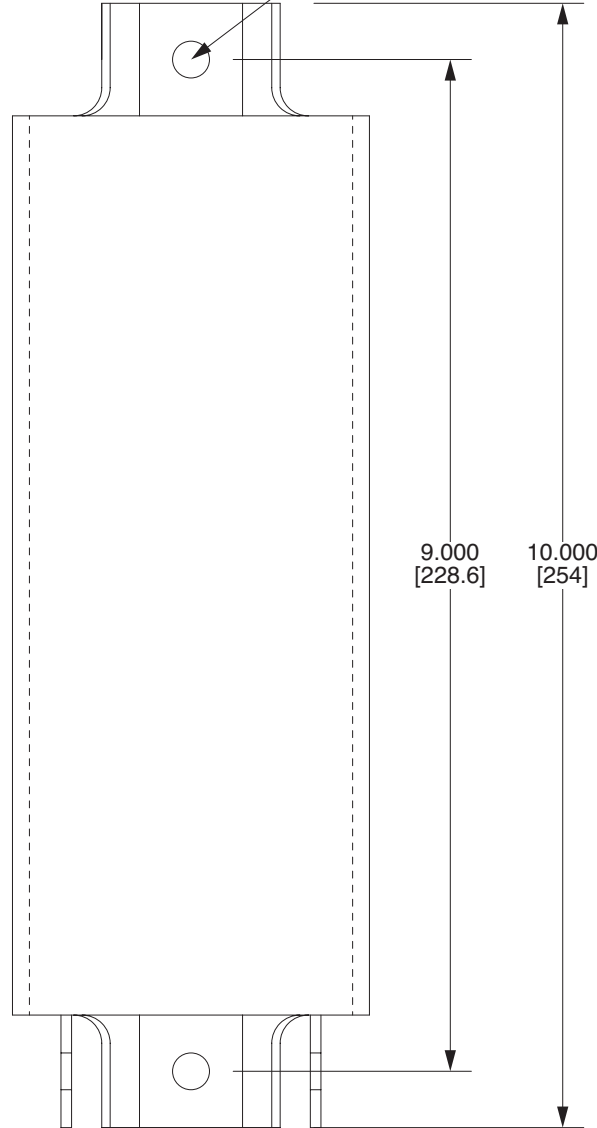
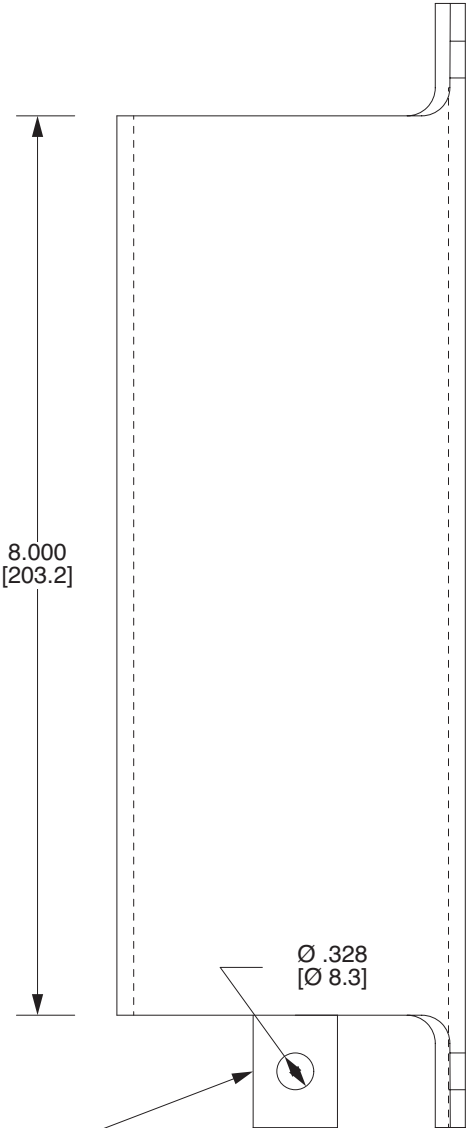
Outline Drawing: GI-50/60A-FSP



1.0" wide flat for mounting



5/16" or M8 mounting bolts-user furnished. Allow for 0.150" (3.81mm) thick mounting flange. Use flat washer (provided) under bolt head.

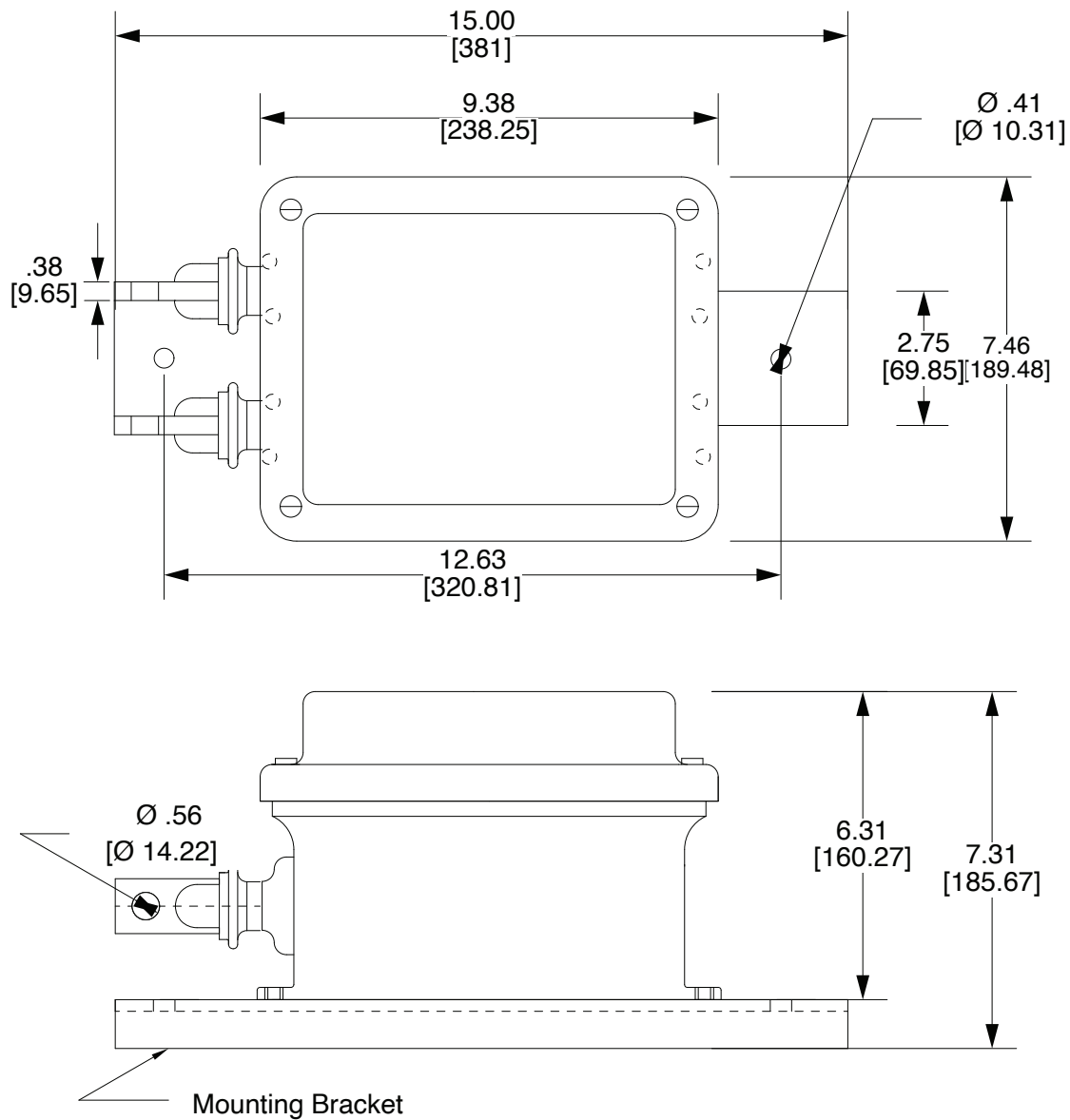


0.094" x 0.75" (3.39mm x 19.1mm) terminals with 5/16" stainless steel bolts, nuts, and washers furnished.

Scale: 1" = 1.5"

Dairyland Electrical Industries, Inc.
GI-50/60A- Outline
Dwg. D-016-P4
Tol: +/-0.010
12.18.07

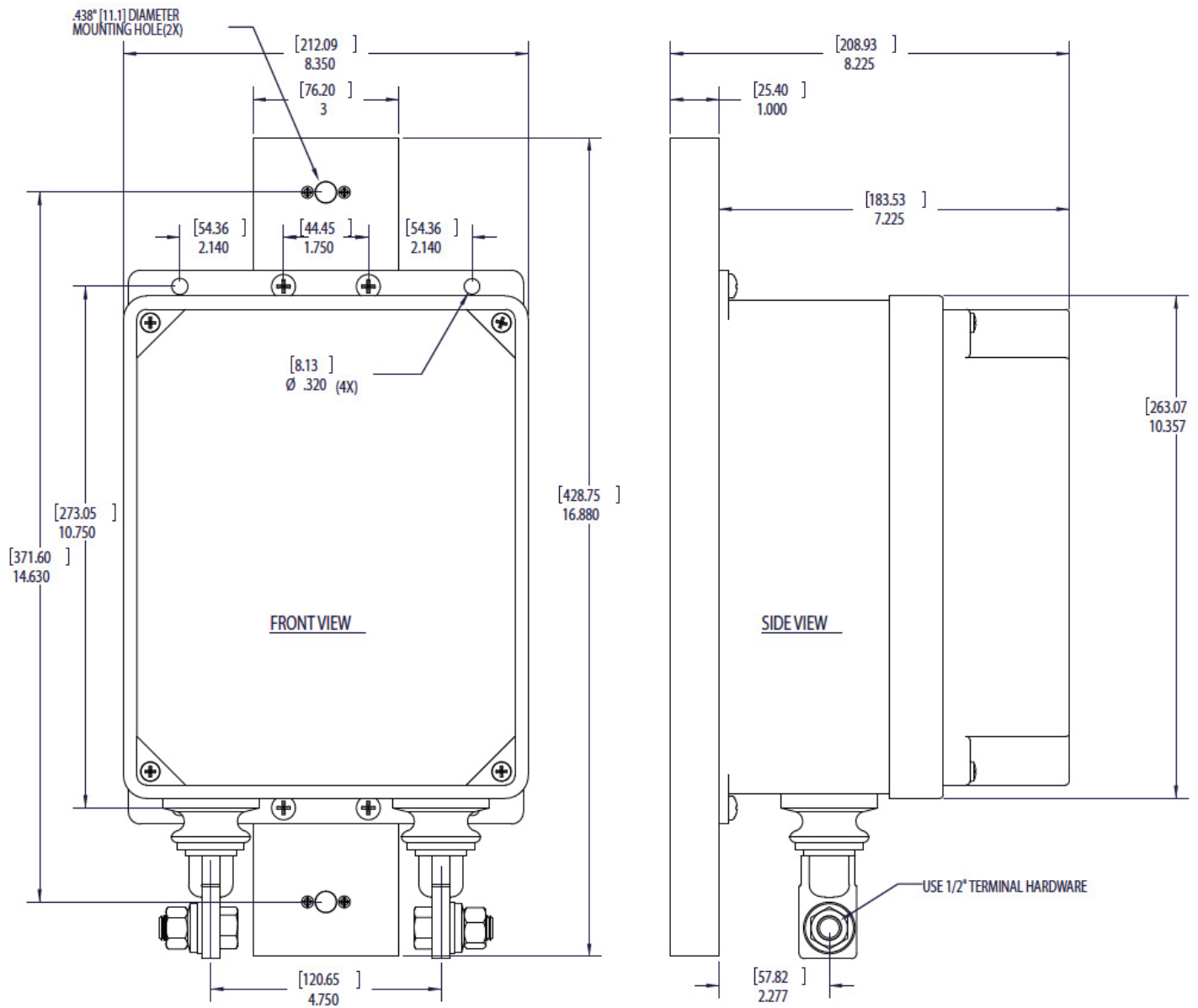
Outline Drawing: GI-100A-FSM



Note:

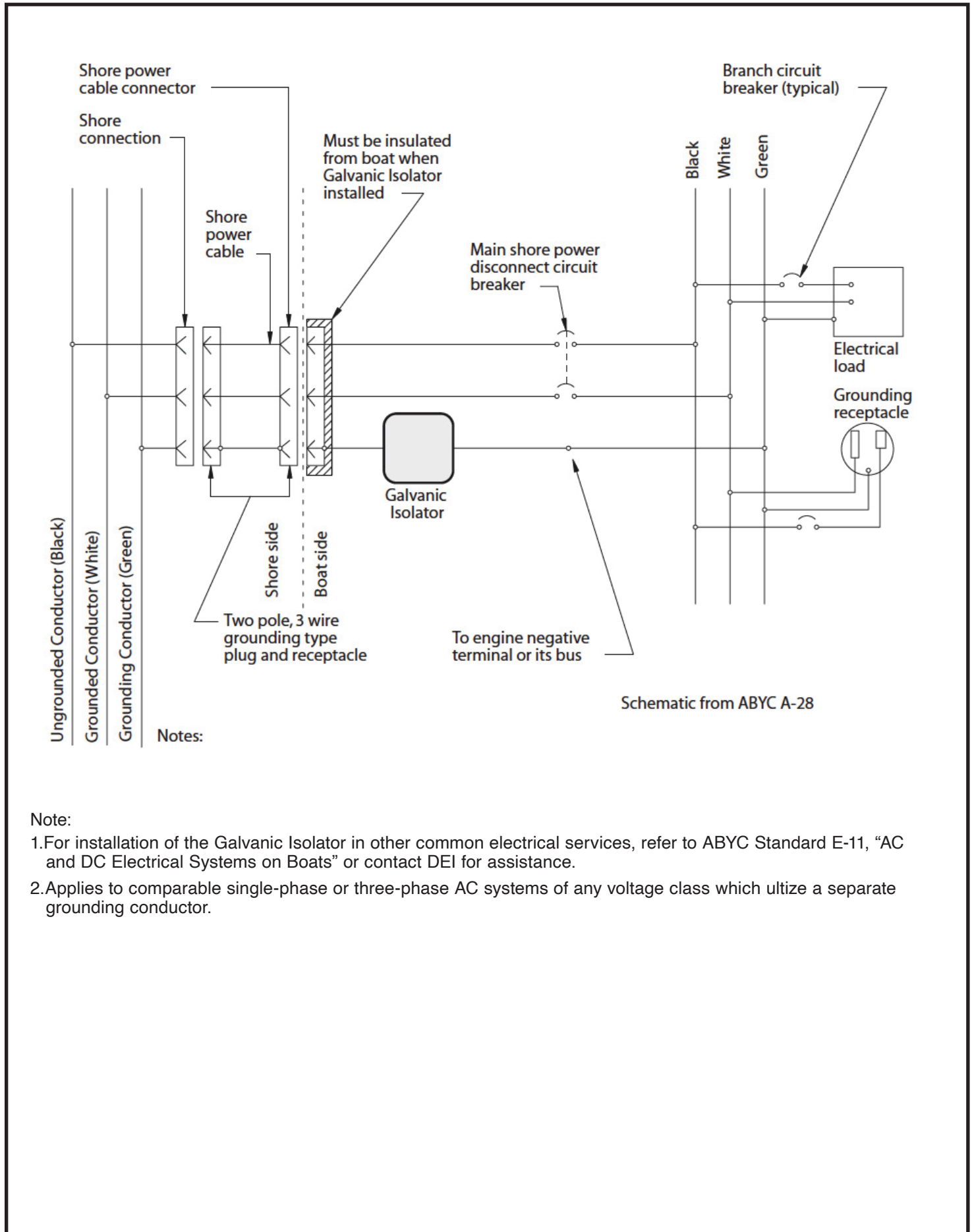
- 1.If desired, the mounting bracket furnished can be removed and the galvanic isolator can be mounted using the flanges on the enclosure. Four inner mounting holes are located on the 1.75" x 8.75" centers and four outer mounting holes are located on 4" x 8.88" centers.
- 2.Mounting with the bracket provided requires (2) 3/8" (10mm) bolts and mounting by using the enclosure flange requires (4) 1/4" (6mm) bolts - user furnished.
- 3.Terminal bolts (1/2" diameter) are finished with nuts and washers, not shown.
- 4.Compression connectors for leads - user furnished.
- 5.Dimensions in inches and millimeters.

Outline Drawing: GI-200A-FSM



1. The furnished C-Channel mounting bracket may be removed and the Galvanic Isolator can be mounted using the flanges of the enclosure and the dimensioned mounting holes.
2. Mounting with the bracket provided requires (2) 3/8" (10mm) bolts and mounting by using the enclosure flange requires (4) 1/4" (6mm) bolts - user furnished.
3. Terminal bolts (1/2") are furnished with nuts and washers (not shown)
4. compression connectors for leads are user furnished.
5. Dimensions in millimeters and inches.

Typical Installation of a Galvanic Isolator for Marine Vessel Application



Note:

1. For installation of the Galvanic Isolator in other common electrical services, refer to ABYC Standard E-11, "AC and DC Electrical Systems on Boats" or contact DEI for assistance.
2. Applies to comparable single-phase or three-phase AC systems of any voltage class which utilize a separate grounding conductor.