



**GUIDE FOR**

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**DIRECT CURRENT (DC) POWER DISTRIBUTION  
SYSTEMS FOR MARINE AND OFFSHORE  
APPLICATIONS**

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**American Bureau of Shipping  
Incorporated by Act of Legislature of  
the State of New York 1862**

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## Foreword

This Guide has been developed to provide guidance for the design, installation, testing and survey of Direct Current (DC) power distribution systems for marine and offshore applications. It is intended to establish safety guidelines for owners, operators, shipyards, designers, manufacturers and integrators. For requirements applicable to conventional AC systems (such as AC generator protection, AC subsystem harmonic distortions and frequency variations), see Part 4, Chapter 8 of the *ABS Rules for Building and Classing Marine Vessels* and Part 4, Chapter 3 of the *ABS Rules for Building and Classing Mobile Offshore Units*.

The installation of power electronic conversion equipment and DC consumers as well as the use of energy storage systems (ESS) and renewable energy is increasing in the marine and offshore industries. ABS recognizes the application of DC distribution technology in support of the electric propulsion and the integration of generators, ESS and DC loads. DC distribution systems are independent from a fixed frequency and such non-frequency-related DC systems offer the opportunity for more efficient operations. This can include varying generator speed and voltage according to the demands of vessel services and propulsion loads. The DC distribution arrangement has benefits such as flexible equipment arrangement, increased fuel efficiency, low vibration noise, and reduced electrical equipment size and weight.

Although there exist recommended practices and guidelines which address the subject, specific industry standards for comprehensive shipboard DC systems are few. In addition, various integrators and vendors are currently implementing and using different design concepts and technologies for the integration of electrical components into DC power distribution systems. This Guide addresses the general safety aspects of system design, DC system components, testing and survey, and risk assessment.

This Guide becomes effective on the first day of the month of publication.

Users are advised to check periodically on the ABS website [www.eagle.org](http://www.eagle.org) to verify that this version of this Guide is the most current.

*We welcome your feedback. Comments or suggestions can be sent electronically by email to [rsd@eagle.org](mailto:rsd@eagle.org).*



## GUIDE FOR

# DIRECT CURRENT (DC) POWER DISTRIBUTION SYSTEMS FOR MARINE AND OFFSHORE APPLICATIONS

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## SECTION 1 General

### 1 Introduction

ABS recognizes the application of DC distribution technology in the marine and offshore industries and its benefits for improving system arrangement flexibility and energy efficiency. This Guide has been developed to facilitate the effective integration of DC distribution equipment into onboard electrical systems.

Such DC power distribution systems distribute DC power from electrical sources to various vessel services and propulsion loads through a DC bus architecture along with power electronic converters. This distribution setup is used in lieu of a traditional AC main switchboard and transformers.

Although there are some similarities between traditional AC power distribution systems and DC power distribution systems, they have different protection and control philosophies. The AC system requirements should not be applied to DC distribution systems directly. This Guide is intended to provide supplemental requirements to the DC electrical systems currently included in the *ABS Rules for Building and Classing Marine Vessels (Marine Vessel Rules)* and the *ABS Rules for Building and Classing Mobile Offshore Units (MOU Rules)*.

Since there could be interconnections between AC systems and DC distribution systems, the applicable AC system requirements in Part 4, Chapter 8 of the *Marine Vessel Rules* and Part 4, Chapter 3 of the *MOU Rules* are still to be complied with as appropriate.

### 3 Scope

This Guide provides the requirements of specific safety aspects associated with the use of shipboard direct-current (DC) power distribution systems.

This Guide is to be used in conjunction with and as a supplement to Part 4 of the *Marine Vessel Rules* and the *MOU Rules*, or other ABS Rules as applicable.

For vessels certified to the 1974 SOLAS Convention, as amended, items shown as “other approved means” are subject to the vessel flag State Administration approval, as applicable.

This Guide covers the DC power distribution systems on board vessels with low voltage DC (LVDC) up to 1500 V.

The following Sections of the Guide are intended to address the fundamental and general safety aspects of system design, DC system components, testing and survey, and risk.

### 5 Application

This Guide is applicable to marine and offshore assets designed, constructed, or retrofitted with a DC power distribution system, where electrical power sources, vessel major loads, and/or energy storage systems are connected to the DC bus directly or via power electronic converters.

The optional notation **LVDC-DIST** may be granted to those assets that meet the requirements of this Guide.

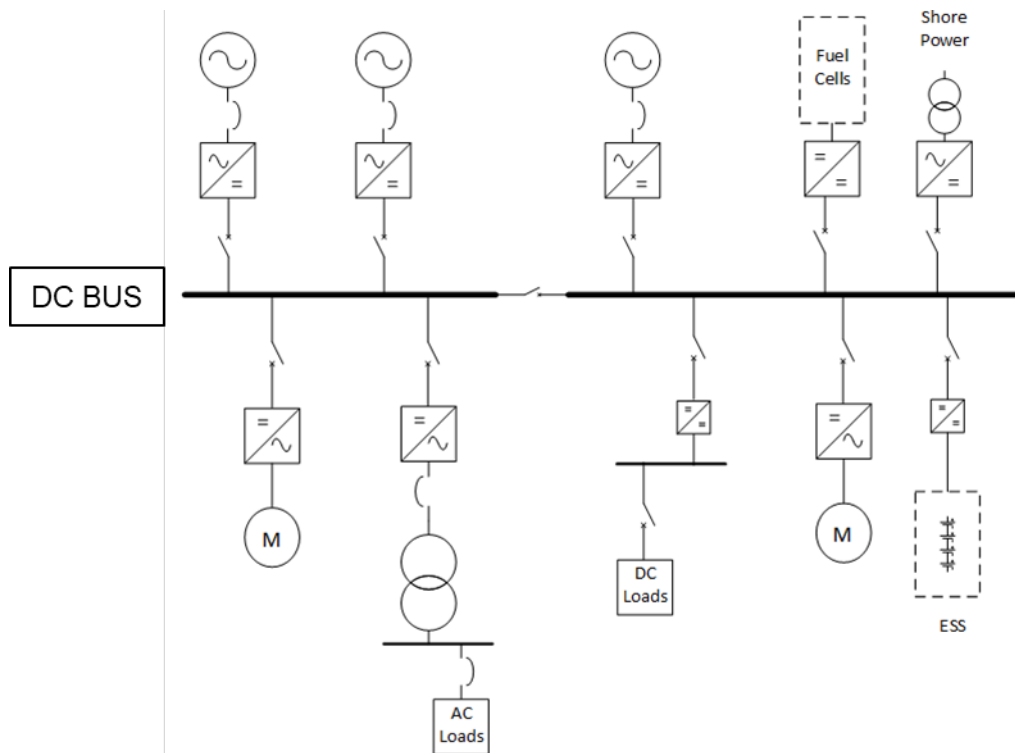
When ABS Type Approval for DC distribution system equipment is requested, applicants should contact ABS for the approval process. For ABS Type Approval Program requirements, please refer to the *ABS Rules for Conditions of Classification (Part 1)*. Alternative certification schemes are also available as documented in 1-1-A3/5.5 of the *ABS Rules for Conditions of Classification (Part 1)*.

## 7 Terminology

**Low Voltage DC (LVDC).** Low voltage DC in this Guide refers to voltages up to and including 1500 V DC.

**DC Power Distribution System.** An onboard electrical power distribution system, where electrical power sources, vessel loads, and/or energy storage systems are connected to the DC bus directly or via power electronic converters. See Section 1, Figure 1 for an example of a DC Power Distribution system.

**FIGURE 1**  
**Example of a DC Power Distribution System**



**Note:** Fuel Cells will be considered as energy storage systems if it is provided with bi-directional power flow arrangements (which also allow the generation of fuel from electricity), otherwise fuel cells will be considered as electrical power sources.

**Electronic Power Conversion.** Change of one or more of the characteristics of an electric power system essentially without appreciable loss of power by means of electronic valve devices. (Clause 3.1.15 of IEC 60146-1-1:2009)

**Power Electronic Converter (PEC).** An operative unit for electronic power conversion, comprising one or more electronic valve devices, and auxiliaries if any. (Clause 3.1.16 of IEC 60146-1-1:2009)

**Notes:** The following are examples of power electronic converter types typically used in DC power distribution systems:

- AC to DC rectifiers between AC generators/AC shore power and the DC bus
- DC to AC inverters between the DC bus and AC motor loads/AC subsystems
- DC to DC converters between DC bus and DC loads/DC subsystems
- DC to DC bi-directional converters between Energy Storage Systems (ESS)/Fuel Cells and the DC bus

**Semiconductor Converter.** An electronic power converter with semiconductor valve devices. (Clause 3.1.19 of IEC 60146-1-1:2009)

## 9 Abbreviations and Acronyms

The following abbreviations and acronyms are applied to the terms used in this Guide:

|            |                                                   |
|------------|---------------------------------------------------|
| AC:        | Alternating Current                               |
| AC/DC:     | Alternating Current to Direct Current Conversion  |
| DC:        | Direct Current                                    |
| DC/AC:     | Direct Current to Alternating Current Conversion  |
| DC/DC:     | Direct Current to Direct Current Conversion       |
| DP:        | Dynamic Positioning                               |
| ESS:       | Energy Storage Systems                            |
| FAT:       | Factory Acceptance Test                           |
| FMEA:      | Failure Modes and Effects Analysis                |
| IEC:       | International Electrotechnical Commission         |
| IEEE:      | Institute of Electrical and Electronics Engineers |
| IEP:       | Integrated Electric Propulsion                    |
| IGBT:      | Insulated Gate Bipolar Transistor                 |
| LVDC:      | Low Voltage Direct Current                        |
| LVDC-DIST: | Low Voltage Direct Current - Distribution         |
| PEC:       | Power Electronic Converters                       |
| PMS:       | Power Management System                           |
| THD:       | Total Harmonic Distortion                         |

## 11 References

### 11.1 ABS

*ABS Rules for Building and Classing Marine Vessels (Marine Vessel Rules)*  
*ABS Rules for Building and Classing Mobile Offshore Units (MOU Rules)*  
*ABS Guide for Use of Lithium Batteries in the Marine and Offshore Industries (Lithium Battery Guide)*  
*ABS Guide for Use of Supercapacitors in the Marine and Offshore Industries (Supercapacitor Guide)*  
*ABS Guide for Dynamic Positioning Systems (DPS Guide)*  
*ABS Guidance Notes on Risk Assessment Application for the Marine and Offshore Oil and Gas Industries*  
*ABS Guidance Notes on Failure Mode and Effects Analysis (FMEA) for Classification*  
*ABS Advisory on Hybrid Electric Power Systems*

### 11.3 Industry Standards

IEC 61557 *Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. - Equipment for testing, measuring or monitoring of protective measures*  
IEC 60664 *Insulation coordination for equipment within low-voltage systems*  
IEC 61439 *Low-voltage switchgear and controlgear assemblies*  
IEC 60092 *Electrical installation in ships*  
IEC 62447 *Safety requirements for power electronic converter systems and equipment*