

**Marine Circuit Breakers****1. Scope**

This recommended practice covers the requirements of magnetic or thermal circuit breakers for use in marine applications for 50 V DC or less.

**1.1 Purpose**

The purpose of this recommended practice is to ensure that the specified protection device will reliably provide overcurrent protection.

**1.2 General**

Circuit protection devices will normally be mounted in either enclosed accommodation spaces, open cockpits, or engine spaces. Environmental requirements differ depending upon the mounting location. Manufacturer's rating for ambient temperature variation should be considered when choosing a circuit breaker. Additionally, the electrical circuit parameters may vary and consideration must be given to available short circuit current, as well as system voltage, to ensure reliable repetitive operation of the circuit breaker under fault conditions. There are also general mechanical and electrical requirements such as shock/vibration and temperature which must be evaluated to ensure that the device is suitable for electrical service in a marine application.

**1.3 Rationale**

This standard was reviewed and contains minor editorial corrections from the previous published version.

**2. References****2.1 Applicable Publications**

The following publications form part of this specification to the extent specified herein. Unless otherwise specified, the latest issue of SAE publications shall apply.

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## SAE J1428 Revised JAN2006

### 2.1.1 SAE PUBLICATION

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001, WEB: <http://www.sae.org>.

SAE J1171—External Ignition Protection of Marine Electrical Devices  
SAE J378—Marine Propulsion System Wiring

### 2.1.2 ASTM PUBLICATIONS

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, WEB: <http://www.astm.org/>.

ASTM B 117—Standard Practice for Operating Salt Spray (Fog) Apparatus  
ASTM D 1735—Standard Practice for Testing Water Resistance of Coatings Using Water Fog Apparatus

## 3. Definitions

### 3.1 Circuit Breaker

A device designed to interrupt a circuit when the current exceeds a predetermined value.

#### 3.1.1 TYPE A CIRCUIT BREAKER

A circuit breaker designed for submersion. It is intended to be water tight and designed such that water will not enter any internal portion when the device is subjected to the sealed device test of SAE J 1171.

#### 3.1.2 TYPE B CIRCUIT BREAKER

A circuit breaker designed to be water resistant. These devices when mounted according to the manufacturers recommendation can withstand spray, rain or splashing.

#### 3.1.3 TYPE C CIRCUIT BREAKER

A circuit breaker not intended to be exposed to splash, spry, or rain.

### 3.2 Trip-Free Mechanism

A mechanism by which the breaker mechanism will trip when subjected to a fault current, opening the circuit in a manner that the contacts will not remain closed, even if the operating handle (or reset device) is held in the "on" or "reset" position.

### 3.3 Manual Reset Mechanism

Manual reset circuit breakers are non-cycling units which are initially opened by overcurrents, but which remain open until manually reset.

### 3.4 Manufacturer's Must Trip Rating

The maximum trip time at the minimum must trip current specified by the manufacturer measured in minutes.

### 3.5 Non-Trip Time

The minimum time the breaker must carry rated current measured in minutes.

## 4. Construction Requirements

### 4.1 Environmental Tests

4.1.1 Marine circuit breakers shall be constructed of corrosion resistant materials. After being subjected to 100 h of Salt Fog as described in ASTM B 117, the device must remain fully functional and meet the performance requirements of section 6.

#### 4.1.2 TYPE A

A water tight circuit breaker is recommended for any application where the circuit breaker may become submerged. To be considered a water tight circuit breaker, the circuit breaker must pass the conditions in 6.3 and then be submerged 14 in below the surface of a 5% solution of salt water for 1 h. After removal from the solution, the external portion of the circuit breaker is to be washed with tap water and dried. The circuit breaker must then pass the conditions in 6.1 and 6.2. Water tight circuit breakers complying with this recommended practice, except those covered in 4.1.3, are designated Type A.

#### 4.1.3 TYPE B

A weatherproof circuit breaker is recommended for use in areas where the circuit breaker will be subjected to rain, spray, or splashing. To be considered weatherproof when mounted in the manufacturer's recommended manner, the circuit breaker shall be subjected to a 5% salt water spray test as described in ASTM D 1735, for 96 hours. At the completion of the test, the external portion of the circuit breaker shall be washed with tap water and dried. There shall not be more than 10 mA flowing when tested in accordance with 6.1 and shall meet the requirements of 6.2. Weatherproof circuit breakers complying with this recommended practice, except those covered in 4.1.2, are designated Type B.

#### 4.1.4 TYPE C

Circuit breakers complying with this recommended practice, except for those covered in 4.1.2 and 4.1.3, are designated Type C.

4.2 The breaker operating mechanism shall be of the trip-free type.

4.3 Automatic reset devices are not to be used except if the circuit breaker is furnished as an integral part of another piece of equipment for the purpose of providing running overload or over temperature protection.

## SAE J1428 Revised JAN2006

### 4.4 Termination Means

- 4.4.1 Blade terminals shall be flat blades complying with SAE J858 Electrical Terminals Blade Type. These terminals must be capable of withstanding a disconnect force of 6 lb for 1 min when tested as described in SAE J378 Marine Engine Wiring, under the section "single friction terminals."
- 4.4.2 Screw type terminations shall have a minimum size of M4 for metric screws or number 8 (0.164 in diameter) for inch size screws.
- 4.4.3 External solder lugs must provide for a mechanical means of securing the wire such as insertion or wrapping to form a mechanical lock.
- 4.4.4 External leads which are terminated internally, shall be considered pigtails and, if the exposed wire is less than 17.7 mm (7 in) long, shall not be smaller than number 18 gage stranded. Longer lengths shall not be smaller than number 16 AWG gage stranded wire and shall be an appropriate size for the circuit breaker as specified in Table 2.

### 4.5 Markings

The breaker shall be marked with the following information:

- 4.5.1 Manufacturer's identification.
- 4.5.2 Rated current as designated in Table 1.
- 4.5.3 Voltage rating.
- 4.5.4 Amperage interrupting capacity as in 7.3. (If not practicable, may be marked on package.)
- 4.5.5 Marine circuit breakers that are to be qualified as external ignition protected, shall comply with and be marked as prescribed in SAE J1171.

**TABLE 1—MAXIMUM TRIPPING TIME IN MINUTES**

Current Rating in Amperes	200% Trip Time <sup>(1)</sup>	Manufacturer's Must Trip Rating	Non-Trip Time in Minutes
0-30	2	60	240
31-50	4	60	240
51-100	6	120	240
101-225	8	120	240

1. The 200% trip time is the time in minutes to trip when the device is subject to a current of 200% of the rated current.

- 4.5.6 In addition to the requirements 4.5.5, Marine circuit breakers complying with this recommended practice shall be marked with their DC ratings, and the words "MARINE" and "SAE J1428 Type A," "SAE J1428 Type B," or "SAE J1428 Type C," whichever is applicable, arranged in any suitable manner.

## **5. Mounting Location Requirements**

### **5.1 Enclosed Accommodation Spaces**

Devices intended for mounting in these locations shall meet the following as *minimum* requirements:

#### 5.1.1 ENVIRONMENTAL TESTS

See 4.1.3 of this recommended practice (Type C device).

### **5.2 Open Cockpits**

Devices intended for mounting in these locations shall meet the following as *minimum* requirements.

#### 5.2.1 ENVIRONMENTAL TESTS

See 5.1.3 of this recommended practice (Type B device).

### **5.3 Engine Spaces, Battery Spaces, Fuel Tank Spaces, and Compartments Containing Fuel System Components**

Devices intended for mounting in these locations shall meet the following as *minimum* requirements:

#### 5.3.1 ENVIRONMENTAL TEST

See 4.1.2 of this recommended practice (Type B device).

#### 5.3.2 EXTERNAL IGNITION PROTECTION PER SAE J1171

The SAE J1171 test shall be run at the completion of the electrical test requirements, Section 7 of this recommended practice. SAE J1171 is not required in installations that have diesel fuel as the only fuel source.

## **6. Electrical Test Requirements**

### **6.1 Dielectric Test**

The sample breaker is to be tested as follows:

#### 6.1.1 DIELECTRIC VOLTAGE WITHSTAND

The device shall be capable of withstanding for 1 min the application of a 60 Hz essentially sinusoidal potential of 500 V rms between:

6.1.1.1 Live parts and mounting (if metallic) with the contacts open and closed.

6.1.1.2 Terminals of opposite polarity with the contacts opened.

6.1.1.3 Live parts of different circuits.

Leakage of the breaker dielectric material in excess of 5 mA constitutes a failure.

6.1.2 TEST PROCEDURE

The device is to be tested by a suitable 500 volt-ampere or larger capacity transformer, whose output voltage is essentially sinusoidal and can be varied. The applied potential is to be increased from zero until the required test value is reached, and is to be held at that level for 1 min. The increase in the applied potential is to be at a substantially uniform rate and as rapidly as is consistent with its value being correctly indicated by the voltmeter. A test transformer with a capacity of less than 500 volt-amperes may be used if provided with a suitable voltmeter to directly measure the applied potential.

6.2 Calibration

The ratings of devices shall be checked an ambient temperature of  $25 \pm 2^\circ\text{C}$  ( $77 \pm 2^\circ\text{F}$ ) using wire from Table 2.

6.2.1 The breaker shall trip in accordance with Table 1.

**TABLE 2—WIRE SIZE REQUIREMENTS FOR CALIBRATION TEST**

Circuit Breaker Rating (Amperes)	AWG Wire Size (gage size)	Metric Wire Size (mm <sup>2</sup> )
1 and below	20	0.5
2–6 incl.	18	0.8
7–10 incl.	16	1.0
11–15 incl.	14	2.0
16–20 incl.	12	3.0
21–25 incl.	10	5.0
26–40 incl.	8	8.0
41–50 incl.	6	13.0
51–60 incl.	6	13.0
61–90 incl.	4	19.0
91–120 incl.	2	32.0
121–150 incl.	0	50.0
151–200 incl.	00	62.0

TABLE 3—DC TEST SOURCE FOR SHORT CIRCUIT TEST

System Nominal Voltage and Battery Capacity	Main Breaker	Branch Circuit Breaker
<b>Systems Less Than 32 V (Nominal)</b>		
Cold cranking amperes—650 or less	1500 A	750 A
Cold cranking amperes—650–1100	3000 A	1500 A
Cold cranking amperes—over 1100	5000 A	2500 A
<b>Systems 32 V or More (Nominal)</b>		
Cold cranking amperes—1250 or less	3000 A	1500 A
Cold cranking amperes—over 1250	5000 A	2500 A

### 6.3 Short Circuit

Devices to be tested shall be connected to a DC test source with voltage at least rated and current availabilities as indicated in Table 3.

#### 6.3.1 CONNECTION MEANS

The breaker shall be connected as in Figure 1 utilizing a total of 8 ft of wire (positive-through breaker-to negative) of the conductor size indicated in Table 4.

6.3.2 Short circuit current availability is dependent on the system battery capacity installed in a boat. Table 3 may serve as an application guide, as well as stating the current availabilities, at the breaker terminals, required for this test. Note that a shunt connected oscillograph should be connected in the test circuit described in Figure 1. Voltage measured open circuit at the circuit breaker terminals shall be in accordance with Table 5.

#### 6.3.3 OPEN/CLOSE

A breaker shall be subjected to the following tests at the current in Table 3 with 2 min minimum between tests.

1. Close to open
2. Open to close to open
3. Close to open

At the end of this test, it shall then be checked as in Table 1 at the 200% rate.

6.3.4 Failure to open the circuit, any visible structural damage to the breaker, or failure to calibrate within the limits of Table 1 after this test shall constitute a failure.

### 6.4 Endurance Test

The sample breaker shall be tested as follows: