

Submitted for recognition as an American National Standard

Plug-In Relay Test Methods

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1. Scope—This SAE Standard covers standard test methods for environmental, mechanical, and electrical testing of plug-in relays used in surface vehicle electrical systems.

1.1 Purpose—This proposal specifies standard test conditions for the evaluation of plug-in relays used in surface vehicle applications.

2. References

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein. Unless otherwise specified, the latest version of SAE publications shall apply.

2.1.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1113-42—Electromagnetic Compatibility—Component Test Procedure—Conducted Transient Emissions

2.1.2 CEI/IEC PUBLICATION—Available from International Electrotechnical Commission, 3 rue de Vaembe, Geneva, Switzerland

CEI/IEC 529 (Code IP)—Degrees of Protection by Enclosures

2.2 Related Publications—The following publication is provided for information purposes only and is not required part of this document.

2.2.1 NATIONAL ASSOCIATION OF RELAY MANUFACTURERS PUBLICATION—Available from National Association of Relay Manufacturers (NARM), Milwaukee, WI 53217.

Relay Engineer's Handbook

3. Definition

3.1 UOS—Unless otherwise specified.

4. Technical Requirements

4.1 Mounting Conditions—To ensure proper function and to avoid physical damage, it is recommended to mount the relays in connectors/test fixtures so that:

- a. The relay insertion force does not exceed the retention force of the weakest relay terminal (100 N for 2.8 to 6.3 mm, 150 N for 9.5 mm).
- b. The relay terminals do not bend.
- c. There is a minimum 5 mm gap to the next relay (for heat dissipation).
- d. The wire size is appropriate for the load to dissipate heat from the relay (see Table 1 for wire size recommendations).

NOTE—The wire size, type, and length information is recommended as the default if not otherwise specified by the end user.

TABLE 1—WIRE SIZE RECOMMENDATIONS⁽¹⁾⁽²⁾

Test Load (amp)	Acceptable Wire Gage Metric (mm ²)	Acceptable Wire Gage Customary (ga)
0.5 - 15.0	1.0	16
15.1 - 20.0	2.0	14
20.1 - 30.0	3.0	12
30.1 - 40.0	5.0	10
40.1 - 55.0	8.0	8

1. The recommended wire type for all set-ups is stranded copper with thin wall cross-linked polyethylene insulation capable of withstanding 125 °C.
2. The recommended wire length for all connections is 2.5 to 3.0 m.

4.2 Test Methods

4.2.1 PARAMETRIC (ELECTRICAL)

4.2.1.1 Test Set-Up for 12 V Systems

4.2.1.1.1 Power Supply—The power supply shall comply with the following specification:

- a. Output current—Capable of supplying the continuous and surge currents of the design loads.
- b. Regulation
 1. Dynamic—The output voltage at the supply shall not deviate more than 1.0 V from 0 to a maximum load (including inrush current) and shall recover within the area generated by the equation

$$1.0V(1 - e^{-t/T}), T = 100 \mu s \quad (\text{Eq. 1})$$
 2. Static—The output voltage at the supply shall not deviate more than 2% with changes in static load from 0 to maximum (not including inrush current) for static line voltage variations.
- c. Ripple Voltage—Maximum 75 mV peak-to-peak

4.2.1.2 General Test Conditions

- a. Ambient temperature—23 °C ± 5 °C
- b. All measurements are to be performed with the relay oriented in the same position.
- c. Relay shall not be in close proximity to metal surfaces.
- d. Condition Contacts—Cycle with any suitable test current and voltage up to rated load for a minimum of 5 times.
- e. Monitor Contacts—With any suitable test current up to rated load and open circuit voltage as specified for the rated load.
- f. Linear ramp-up and ramp-down of coil voltages may be substituted for stepped ramps; however, this may alter the test data slightly.

4.2.1.3 *Pull-in Voltage*

4.2.1.3.1 Definition—Minimum voltage applied to the relay coil that causes the relay contacts to close (switch on).

4.2.1.3.2 Test Method

- a. Apply a voltage across the coil terminals, starting with an applied voltage of 0 to 3.0 V. Increment up at 0.10 to 0.25 V increments and record contact closure (pull-in voltage).
NOTE—Ramp-up rate of 0.1 to 5.0 V/s.
- b. Contact closure is defined as the voltage drop across the contacts being less than or equal to 10% of the applied voltage.

4.2.1.4 *Seal Voltage*

4.2.1.4.1 Definition—Minimum voltage applied to the relay coil that causes the armature to rest against the core (full travel).

4.2.1.4.2 Test Method

- a. Apply a voltage across the coil terminals, starting with an applied voltage of 0 to 3.0 V. Increment up at 0.10 to 0.25 V increments and record contact closure (pull-in voltage).
NOTE—Ramp-up rate of 0.1 to 5.0 V/s.
- b. Monitor coil current using a suitable oscilloscope and current probe or other suitable current monitoring methods.

NOTE—Inductance change, results in a negative current spike.

4.2.1.4.3 Alternate Method

- a. Apply a voltage across the coil terminals, starting with an applied voltage of 0 to 3.0 V. Increment up at 0.10 to 0.25 V increments and record contact closure (pull-in voltage).
NOTE—Ramp-up rate of 0.1 to 5.0 V/s.
- b. Increase the voltage to nominal voltage then reduce the voltage until the relay drop outs.
- c. Increase the voltage to the pull-in voltage from step "a" and reduce the voltage until the relay drops out. If the difference between this voltage and the voltage from step "b" is minimal, typically <1V, the seal voltage is the pull-in voltage.
- d. If the drop-out voltage difference is not minimal, increase the voltage to a level above the pull-in voltage and repeat step "c". If this voltage results in a minimal difference in the drop-out voltage, then this voltage is the seal voltage.
- e. Repeat step "d" until a minimal difference in drop-out voltage occurs.

4.2.1.5 *Drop-Out Voltage*

4.2.1.5.1 Definition—Maximum voltage applied to the relay coil that causes the relay contacts to open (switch-off).

4.2.1.5.2 Test Method

- a. Apply a voltage greater than the seal voltage across the coil to insure the armature is sealed. Ramp or step down based on power supply at 0.1 to 5.0 V/s at 0.1 to 0.25 V increments until contacts open.
- b. Contact opening is defined as the voltage drop across the contacts being greater than 10% of the applied voltage.

4.2.1.6 *Coil Resistance (or equivalent)*

4.2.1.6.1 Definition—The coil circuit DC resistance as measured from the relay coil.

4.2.1.6.2 Test Method I—(No semiconductor components are present)

- a. Directly apply the probes of a digital or analog multi-meter to relay terminals.
- b. Measure and record the resistance.

All measurements shall be made before powering the coil or after sufficient cooling time to assure the device is at ambient temperature. The resistance of the test leads shall be subtracted from the measurement value, unless a four wire "Kelvin" method is utilized. The multi-meter used shall be capable of reading 0.1 Ω or less.

4.2.1.6.3 Test Method II—(Semiconductor components are present)

- a. Apply rated voltage across the relay coil terminals.
- b. Measure and record the total current draw as the voltage drop across a 1 Ω 1% precision series resistor or digital ammeter, then calculate equivalent resistance using ohm's law.

All measurements shall be made on the device after it has stabilized at ambient temperature. The resistance of the test leads and semiconductor shall be subtracted from the measurement value, unless a four wire "Kelvin" method is utilized.

4.2.1.7 *Contact Voltage Drop*

4.2.1.7.1 Definition—Voltage drop arising from the contact resistance of contacts when a current has been applied to the relay.

4.2.1.7.2 Test Method

- a. Apply a constant current of 0.5 A at rated voltage through each set of relay contacts.
- b. Measure and record the voltage drop with a digital or analog multi-meter or any other methods of monitoring voltage at the output terminals after the contacts stabilize. (The multi-meter must have a resolution of 0.0001 V.
- c. Repeat steps a and b with rated load or 10 Amps maximum for devices rated greater than 0.5 A.

4.2.1.8 *N.O. Contact Bounce*

4.2.1.8.1 Definition—The time elapsed from the relay energizing until the contacts stabilize.

4.2.1.8.2 Test Method

- a. Apply one channel of the oscilloscope across the relay coil terminals.
- b. Apply another channel of the oscilloscope across B+ and normally open contact terminals. Trigger on application.
- c. Apply rated voltage across the coil terminals to switch the rated load current or 10 A maximum.
NOTE—Signal must be bounce free.
- d. Measure and record the time in milliseconds from coil energization until contacts stabilize.