



SURFACE VEHICLE RECOMMENDED PRACTICE

J2139™

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(R) Tests for Signal and Marking Devices Used on Vehicles
2032 mm or More in Overall Width

RATIONALE

Many tests within SAE J2139 are identical or similar to tests found in SAE J575. These tests will reference SAE J575 in this document, so any future revisions will only be needed in one document, SAE J575.

The tests moved to SAE J575 are:

- Moisture Intrusion
- Dust
- Corrosion
- Photometry
- Warpage Test for Devices with Plastic Components
- Thermal Cycle

1. SCOPE

This SAE Recommended Practice provides standardized laboratory tests, test methods, and performance requirements applicable to signal and marking devices used on vehicles 2032 mm or more in overall width.

2. REFERENCES

2.1 Applicable Documents

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

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https://www.sae.org/standards/content/J2139_202503/

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J575	Test Methods and Equipment for Lighting Devices for Use on Vehicles Less than 2032 mm in Overall Width
SAE J577	Vibration Test Machine and Operation Procedure
SAE J1455	Recommended Environmental Practices for Electronic Equipment Design in Heavy-Duty Vehicle Applications
SAE J2357	Application Guidelines for Electronically Driven and/or Controlled Exterior Automotive Lighting Equipment

2.2 Related Documents

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J387	Terminology - Motor Vehicle Lighting
SAE J576	Plastic Material or Materials for Use in Optical Parts Such as Lenses and Reflex Reflectors of Motor Vehicle Lighting Devices
SAE J578	Chromaticity Requirements for Ground Vehicle Lamps and Lighting Equipment
SAE J1330	Photometry Laboratory Accuracy Guidelines
SAE J1889	LED Signal and Marking Lighting Devices
SAE J2577	Heavy Duty Lamp Electrical Connector Standard
SAE J2721	Recommended Corrosion Test Methods for Commercial Vehicle Components

2.2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM B117	Method of Salt Spray (Fog) Testing
ASTM C150-84	Specification for Portland Cement
ASTM E308-85	Standard Method for Computing the Colors of Objects by Using the CIE System

3. DEFINITIONS

3.1 DISCHARGE SIGNAL LIGHTING (DSL) SYSTEM

A vehicular lighting system used in signal and marking applications. The DSL system is composed of a discharge light source, interconnecting wiring, and a signal or marking lighting assembly.

3.2 DISCHARGE LIGHT SOURCE

An electric light source in which light is produced by a stabilized electric discharge through an ionized gas. The light source consists of a sealed glass/tube envelope wall and ballast. The size, shape, and color will depend on the application (for example, but not limited to, neon or fluorescent lamps).

3.3 LIGHT EMITTING DIODE (LED) LIGHTING DEVICE

A lighting device in which light is produced by an LED or an array of LEDs.

3.4 LIGHTING DEVICE LIGHT CENTER

The geometric center of the light source or sources used to illuminate the device function or the geometric center of the illuminated area if the light output is produced indirectly.

3.5 INCANDESCENT LIGHTING DEVICE

A lighting device in which light is produced by a filament being heated to incandescence by an electrical current.

3.6 INTEGRATED ELECTRONIC COMPONENT

Electronic component(s) integrated within the housing of the lamp assembly, or physically inseparable from the lighting device, used to produce the desired output.

3.7 SAMPLES

Samples submitted for test shall be representative of the device as regularly manufactured and marketed. Each sample shall be securely mounted on the test fixture in its design position and shall include all accessory equipment necessary to operate the device in its normal manner.

3.8 SEALED LIGHTING DEVICES

A lighting device that does not allow the passage of gas or water between the interior environment and the exterior environment.

3.9 TEST FIXTURE

Fixture specifically designed to support the device in its designed operating position during a laboratory test.

3.10 VIBRATION TEST FIXTURE

A fixture specifically designed to support the device in its operating position during the vibration test. The fixture shall not have a resonant frequency in the test range.

4. TESTS

The following sections describe the individual tests which need not be performed in any particular sequence, except as noted in the test procedure. Unless otherwise specified, all tests will be done at an ambient room temperature of $25^{\circ}\text{C} \pm 5^{\circ}\text{C}$. The completion of the tests may be expedited by performing the tests simultaneously on separately mounted samples. However, it is recommended that the design of each device be evaluated to determine if the vibration test or the warpage test affected other tests, in which case those tests shall be performed first.

The following tests in SAE J575 are applicable with modifications as indicated.

4.1 Vibration Test

4.1.1 The Device Under Test (DUT), as mounted on the support supplied, shall be bolted to the anvil end of the table of the SAE J577 vibration test machine.

4.1.2 Test duration is 60 +1/-0 minutes.

4.2 Moisture Intrusion Tests

Choose one or more of the following tests in SAE J575 based on product application and with agreement between the manufacturer and customer.

4.3 Dust Integrity Tests

SAE J575

4.4 Corrosion Test

SAE J575

4.5 Photometry Test

SAE J575

4.6 Warpage Test for Devices with Plastic Components

SAE J575

4.7 Humidity Temperature Test

This test is for lighting devices including, but not limited to, LEDs and discharge signal lighting systems (DSLs) with integrated electronic components. It is a combination test designed to verify operation throughout extremes of temperature and under conditions of high humidity.

4.7.1 Humidity-Temperature Test Equipment

The equipment must be capable of performing the testing described in the temperature profile shown in Figure 1. Note that the 90% relative humidity requirement is applied only during the 38°C part of the profile.

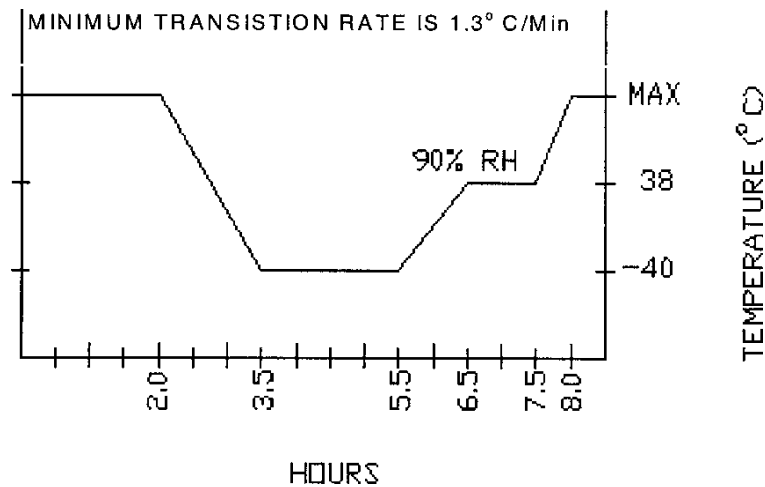


Figure 1 - Combined humidity-temperature profile

4.7.2 Humidity-Temperature Test Procedure

- 4.7.2.1 The DUT shall be mounted and tested in the design position(s) or in accordance with the manufacturer's instructions.
- 4.7.2.2 All drain holes, slots, and openings shall remain open during the test.
- 4.7.2.3 Devices that have a portion protected in service may have that portion of the DUT protected in the same manner during the test.
- 4.7.2.4 The DUT need not be energized during the test cycle illustrated in Figure 1. The maximum test temperature selected shall be appropriate to that expected for the location and use of the device and may not be less than 76 °C. Note that SAE J1455 offers environmental temperature extreme summary tables that may aid in selecting an appropriate maximum temperature. The maximum temperature should be documented in the test report. A minimum of one 8-hour cycle is to be completed. The number of cycles should also be documented in the report.

4.8 Voltage Regulation Tolerance Testing

This test is for lighting devices containing integrated electronic components used to modify the vehicle voltages needed to energize LEDs and discharge signal lighting systems (DSLs), light sources, or incandescent lighting devices.

4.8.1 Voltage Regulation Tolerance Test Equipment

This equipment must be capable of providing the DC voltages, as referenced in 4.8.2.2 for 12-V systems and 4.8.2.3 for 24-V systems. The DC power supply should meet the following specifications:

4.8.1.1 Line Regulation

±0.1%.

4.8.1.2 Ripple and Noise

0.4% maximum.

4.8.1.3 Stability

±0.1%.

4.8.2 Voltage Regulation Test Procedure

4.8.2.1 The DUT shall be mounted and tested in the design position(s) in accordance with the manufacturer's instructions.

4.8.2.2 The DUT shall be subjected to the test conditions for 12-V systems as shown in Table 1.

Table 1 - Voltage conditions

Condition	DC Voltage	Application Time
Minimum Normal Operating Vehicle Voltage	7.0 V	2 minutes
Jumper Starts	24.0 V	2 minutes
Reverse Polarity	-12.0 V	2 minutes

4.8.2.3 The DUT shall be subjected to the following test conditions for 24.0-V systems as shown in Table 2.

Table 2 - Voltage conditions

Condition	DC Voltage	Application Time
Minimum Normal Operating Vehicle Voltage	18.0 V	2 minutes
Jumper Starts	48.0 V	2 minutes
Reverse Polarity	-24.0 V	2 minutes

4.8.2.4 Vehicle Transient Voltage Tests

These tests are to ensure that transient (short duration) voltage changes do not cause failure in lighting devices containing integrated electronic circuits, which are necessary for proper operation of the device.

4.8.3 Vehicle Transient Voltage Test Equipment

4.8.3.1 The vehicle transient voltage test equipment shall be capable of meeting the requirements cited in Tables 3 and 4 for the following requirements: Load Dump, Inductive Load Switching, and Mutual for 12- and/or 24-V applications.

NOTE: Source resistance (ohms) may be changed where applicable in following tables.

Table 3 - Typical 12-V vehicle transient voltage characteristics

Lines	Type	Source (ohms)	Rise (μs)	Open Circuit Equation	Repetition	Energy
Power	Load Dump	0.4	100	$14+86e^{-t/0.4}$	5 pulses at 10-second intervals	(1)(2)
I/O ⁽³⁾	Inductive Switching	20	1	$14+/- 600e^{-t/0.001}$	10 pulses at 1-second intervals	(2)(3)
I/O All	Mutual	50	1	$14+/- 300 e^{-t/0.000015}$	10 pulses at 1-second intervals	(2)

⁽¹⁾ The alternator is capable of outputting much more energy than can be absorbed by commonly used electronic clamping devices. Therefore, when clamping devices are used in electronic modules, caution must be used in the design of the vehicle electrical system to ensure the energy limitations of each clamping device are observed (refer to Appendix B in SAE J1455).

⁽²⁾ The transient waveforms described previously in mathematical form may actually be implemented by diode OR-ing or "combining" a DC and transient voltage.

⁽³⁾ This transient applies to those I/O lines which may be connected to unclamped inductive loads. In addition, the energy available will be $0.5LI^2$, where I is the current through the inductor in amps and L is the inductance in henries.

Table 4 - Typical 24-V vehicle transient voltage characteristics

Lines	Type	Source (ohms)	Rise (μs)	Open Circuit Equation	Repetition	Energy
Power	Load Dump	0.8	100	$28+122e^{(-t/0.4)}$	5 pulses at 10-second intervals	(1)(2)
I/O —(3)	Inductive Switching	20	1	$28+/- 600e^{(-t/0.001)}$	10 pulses at 1-second intervals	(2)(3)
I/O All	Mutual	50	1	$28+/- 300 e^{(-t/0.000015)}$	10 pulses at 1-second intervals	(2)

(1) The alternator is capable of outputting much more energy than can be absorbed by commonly used electronic clamping devices. Therefore, when clamping devices are used in electronic modules, caution must be used in the design of the vehicle electrical system to ensure the energy limitations of each clamping device are observed (refer to Appendix B in SAE J1455).

(2) The transient waveforms described previously in mathematical form may actually be implemented by diode OR-ing or “combining” a DC and transient voltage.

(3) This transient applies to those I/O lines which may be connected to unclamped inductive loads. In addition, the energy available will be $0.5LI^2$, where I is the current through the inductor in amps and L is the inductance in henries.

4.8.3.2 Vehicle Transient Voltage Test Circuit

The circuit in Figure 2 is an example of the basic setup for transient voltage testing, which can also be modified to perform load dump, inductive, and mutual switching. Values for the circuit components can be determined by using the equations in Tables 3 and 4. Note that all three types of test circuits mentioned are designed to have simulated resistance, not just the alternator resistance alone. The reason for this is that actual alternator source resistance by itself is approximately 0.25 Ω, and the realistic load resistance on the rest of the truck system varies. It includes harness system component resistance and other device resistance, connected in parallel on common lines. These devices will all dissipate a part of the total energy. Therefore, surge current should be limited when testing a single device by using series resistance as noted on the test circuit.

NOTE: For inductive switching and mutual testing, the 3 Ω series resistor type and value has to be changed to non-inductive, 20 Ω, and 50 Ω, respectively.

The first equation in Table 3 shows the load dump calculation represented by the exponential function for the discharging of a capacitor. This equation may be simplified as follows:

$$V_{VVV} = V_{VVV} e^{(-t/T)} \quad (\text{Eq. 1})$$

where:

V_c = capacitor voltage at any particular time

V_i = initial voltage

e = 2.7183 (base of natural logarithms)

T = RC time constant

t = particular time which V_c is desired

In Table 3, the load dump equation shows 14 V as the DC output voltage used for nominal 12-V systems; 86 V is the peak voltage for the short duration described by the equation $0.4 = T$ or RC . To design a circuit with the proper time duration, it is necessary to select a capacitor value for C . Figure 3 shows an example using a 22000 μF capacitor. We can calculate a resistor value R using the formula $T = RC$.

EXAMPLE:

$$T = RC$$

$$0.4s = R(22000 \mu F)$$

$$R = 18 \Omega$$

The oscilloscope screen in Figure 4 displays the voltage that the DUT will see during a load dump pulse on a 12-V (14.0-V) system. These scope measurements are made at the DUT connection point without the DUT attached.

NOTE: It takes approximately five time constants (5T) to charge or discharge a capacitor.

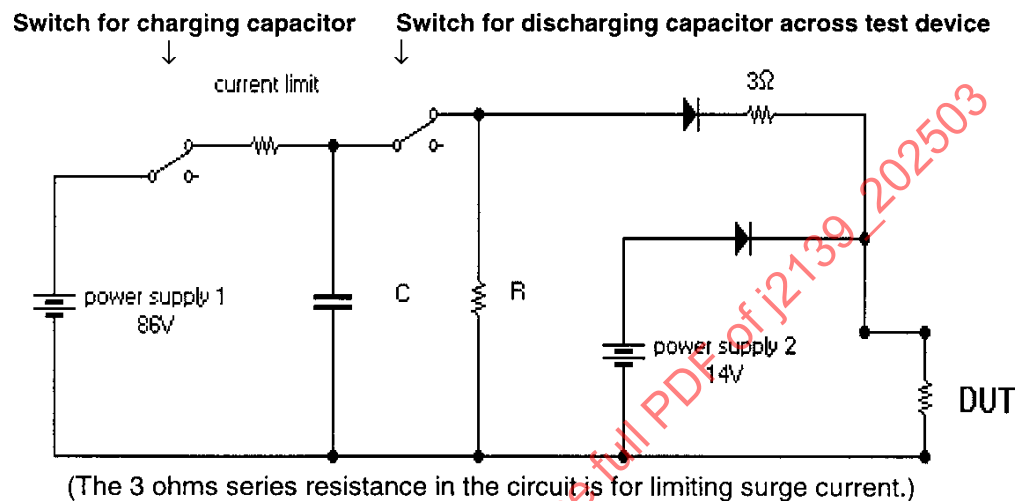


Figure 2 - Load dump testing circuit

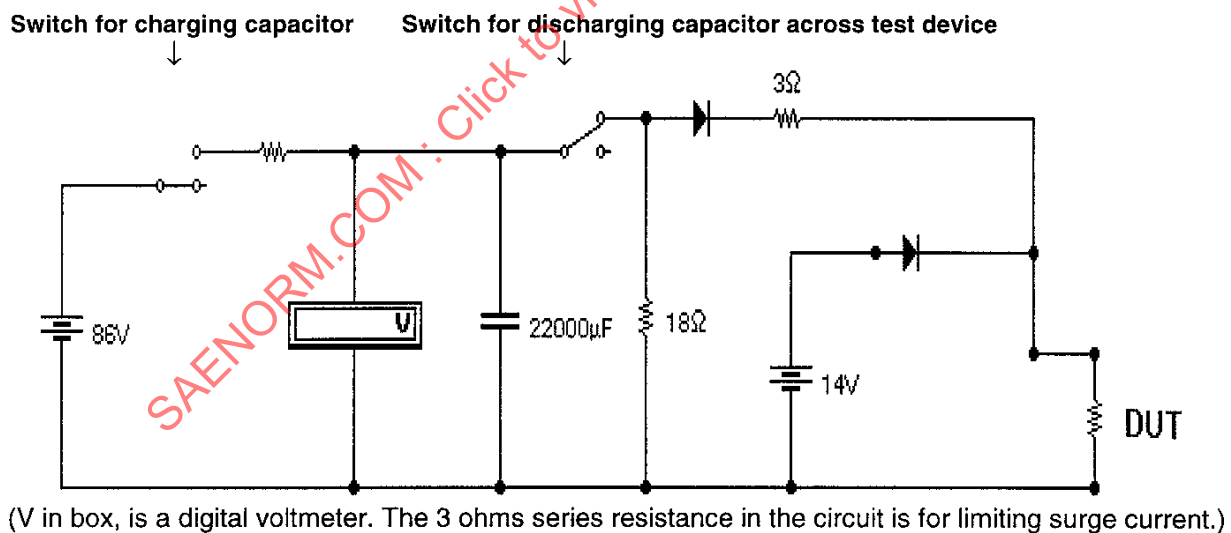


Figure 3 - Example of a load dump testing circuit