Specification for Testing Gas Discharge Light Source Subsystem

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SPECIFICATION FOR TESTING GAS DISCHARGE LIGHT SOURCE SUBSYSTEM

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SUMMARY OF CONTENTS

1. SCOPE

This specification is a general level subsystem light source specification that establishes test requirements of a Gas Discharge Light Source (GDLS) subsystem for use on passenger vehicles.

The completed test data to this test specification is intended to be provided to the OEM by the Tier one lamp set maker as part of the lamp assembly PPAP. Re-testing shall be required if any portion of the approved GDLS experiences a design, manufacturing or component change.

This document shall be applied to systems that meet the requirements for design, performance and validation established by government standards.

The subsystem is defined as the ballast, igniter and light source and shall be tested as a subsystem and considered one test sample for the entire test sequence. A failure of any component in the test sample shall constitute a failure of the entire sample. Substitution or replacement of only the light source shall be allowed during testing. Failure of the light source more than once in a tested system shall constitute a failure of the GDLS. *If other manufacture's components are intended to be approved for use in the GDLS, then those possible combinations of components shall be considered a new GDLS and shall also be tested.*

Additional testing may be required by individual OEM's to meet specific EMC, quality, reliability and durability objectives.

The following tests are to be performed under the following conditions:

- New light source (capsule) or ballast design
- Design or process change made to an existing capsule or ballast, which could affect the outcome of the test
- Completion of one calendar year as noted in the "ANNUAL TESTS" Table shown in the Appendix. *(Note: Production process control data, collected at a shorter interval per an approved control plan, may be substituted if approved by customer's responsible engineer and purchasing representative.)*

2. SAFETY PRECAUTIONS

HID bulbs have pressurized gas inside, may contain mercury, and require special handling. They can burst or shatter if scratched or dropped.

HID ballasts utilize high voltages to strike the arc. Use caution when handling.

Wear appropriate eye protection, gloves, and shielding when performing any tests on bulbs covered by this specification.

Use caution when handling a bulb that has recently been energized. These bulbs operate at a very high temperature.

Protect operating lamps from contact with liquid and moisture. Liquid contacting a hot bulb can cause it to shatter.

Hold the bulb only by the base. Do not touch the glass portion of the bulb with bare hands.

This specification may involve hazardous materials, operations, and equipment. This specification does not purport to address all the safety concerns associated with its use. It is the responsibility of whoever uses this specification to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2.1 HIGH VOLTAGE IDENTIFICATION/LABELING

The GDLS shall meet the requirements of SAE J1673 - High Voltage Wiring Assembly Design. If a high voltage label is used, it shall meet the requirements of ISO 2575 Symbol M06 shown here.

ISO 2575 Symbol M06

3. REFERENCE STANDARDS

In the event of a conflict between the text of this specification and the documents cited herein, the text of this specification takes precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained. The latest issue of reference documents shall apply.

- (FMVSS) Federal Motor Vehicle Safety Standard No. 108
- (CMVSS) Canada Motor Vehicle Safety Standard No. 108
- Part 564 of Federal Motor Vehicle Safety Standard No. 108
- CIE Publication 13.3 Dated 1995
- ECE-Regulation 98, Uniform Provisions Concerning The Approval Of Motor Vehicle Headlamps Equipped With Gas-Discharge Light Sources
- ECE-Regulation 99, Uniform Provisions Concerning The Approval Of Gas-Discharge Light Sources For Use In Approved Gas-Discharge Lamp Units Of Power-Driven Vehicles

- AIAG/APQP-2: Chrysler, Ford, and General Motors Advanced Product Quality Planning and Control Plan Reference Manual
- AIAG/MSA-3: Measurement Systems Analysis Reference Manual
- AIAG/FMEA-3: Potential Failure Mode and Effects Analysis Reference Manual (SAE J1739)
- AIAG/PPAP-3: Chrysler, Ford, and General Motors Production Part Approval Process Manual
- ASTM B117 (Standard Practice for Operating Salt Spray [Fog] Testing Apparatus)
- Chrysler, Ford, and General Motors Quality System Requirements-QS-9000 Manual
- AIAG Fundamental Statistical Process Control Reference Manual

- IEC 60068-2-1, Cold
- IEC 60068-2-2 Ba, Dry Heat
- IEC 60068-2-14 Na, Rapid Change of Temperature With Prescribed Time of Transition
- IEC 60068-2-14 Nb, Change of Temperature with Specified Rate of Change
- IEC 60068-2-27 Ea, Mechanical Shock
- IEC 60068-2-32 Ed, Free Fall
- IEC 60068-2-64, Vibration
- ISO TC 22/SC 3/WG 13 N139 Road vehicles-Environmental conditions and testing for electrical and electronic equipment – Part 1: General
- ISO TC 22/SC 3/WG 13 N140 Road vehicles-Environmental conditions and testing for electrical and electronic equipment – Part 2: Electrical loads
- ISO TC 22/SC 3/WG 13 N142 Road vehicles-Environmental conditions and testing for electrical and electronic equipment – Part 3: Mechanical loads
- ISO TC 22/SC 3/WG 13 N141 Road vehicles-Environmental conditions and testing for electrical and electronic equipment – Part 4: Climatic loads
- ISO 2575 Index M – Electrical Functions in General and Electric Road Vehicles
- SAE/USCAR – 2, Performance Standard for Automotive Electrical Connector Systems.
- SAE/USCAR – 12 Wiring Component Design Guidelines
- SAE/USCAR – 20 Field Correlated Life Test Supplement To SAE/USCAR-2
- SAE/USCAR – 21 Performance Specification for Cable-To-Terminal Electrical Crimps
- SAE J575 - Test Methods and Equipment for Lighting Devices and Components for Use on Vehicles Less Than 2032 mm in Overall Width
- SAE J578 - Color Specification
- SAE J1330 Photometry Laboratory Accuracy Guidelines
- SAE J1344 – Marking of Plastic Parts

- SAE J1383 - Performance Requirements for Motor Vehicle Headlamps
- SAE J1673 – High Voltage Wiring Assembly Design
- SAE J2009 Discharge Forward Lighting System and Subsystems
- SAE J2357 Application Guidelines for Electronically Driven and/or Controlled Exterior Automotive Lighting Equipment
- VDA 260 Marking Standard – Federation of the Automobile Industry
- Q7-K: Chrysler, Ford Motor Company and General Motors QS-9000 Supplier Quality Requirements

**Copies of the AIAG Manuals can be obtained from AIAG (Automotive Industry Action Group) by calling (248) 358-3570 or by writing to AIAG, Dept. 77839, Post Office Box 77000, Detroit MI 48277-0839, Attn: Customer Service.

4. DIAGRAMS AND DEFINITIONS

4.1 APPENDICES

Diagrams are provided at the end of this specification to clarify the details of the test procedures. A Glossary of Terms is also included in the Appendix.

5. GENERAL REQUIREMENTS

5.1 RECORD RETENTION

Supplier must maintain a file for the storage of laboratory reports and calibration records, and establish a record retention policy concerning these records in accordance with QS-9000 and PPAP requirements. These records need not follow a standard format, but must present the required data in an orderly, professional manner. The file must be made available to any and all customer personnel upon request, including—but not limited to—representatives from the following areas: product engineering, purchasing, quality, and reliability.

5.1.1 Objectives of Record Retention

Following are the main objectives for retention of test documents or records:

1. Retain records that will evidence compliance so that the supplier can appropriately respond when or if product compliance is challenged. Files must exist for the storage of all laboratory records, data, and calibration records. The files must be available at any time for audit or inspection.

2. Retain records as needed to assist in evidencing the exercise of "due care" in matters relating to product compliance, government requirements, or product liability.
3. Comply with statutory requirements for the maintenance and retention of specific records.

5.1.2 Retention Methods

Methods of retention may include retention of original documents, the use of film, or the use of electronic storage equipment. Records shall be stored so that they are accessible in a reasonable amount of time. Storage areas should provide adequate protection from unauthorized access, moisture, and fire.

5.2 SAMPLE DOCUMENTATION AND RETENTION

Engineering test samples must be identified by Industry Accepted Trade Number and manufacturer's serial number unless otherwise noted. Documentation must identify the type of test performed and describe special tests that are not a part of this specification. (Reference QS-9000 and PPAP requirements.)

5.2.1 Required Data Package

Supplier must submit the data package for the appropriate level of submission to the customer's responsible engineer and purchasing division for approval signatures.

5.2.1.1 PRODUCTION PROCESS APPROVAL

The GDLS design shall be capable of meeting the requirements of Automotive Industry Action Group (AIAG) document "Production Part Approval Process" (PPAP) and GM document GM-13901 PPAP General Motors Operating Policy.

5.2.2 Sample Retention

Samples tested to attain part approval must be retained by the bulb manufacturer for a period of time specified in the PPAP Manual.

5.3 POWER SOURCES

Supplier must use voltage regulated DC power sources for all tests to simulate an automotive battery and charging system.

5.3.1 Output Current

The power source must be capable of supplying a continuous output current as required by the design loads, including inrush current. Where required to simulate automotive inrush current conditions, an automotive battery or batteries with sufficient cold cranking amps may be connected in parallel with the power supply.

5.3.2 Output Voltage

The power source must be capable of supplying an output voltage that must not deviate more than 1.0 volt from the nominal setting over the entire load range (including surges). The power source must recover 63% of its maximum excursion within 5.0 milliseconds. Ripple voltage must not exceed 500 mV peak to peak. Power supplies used for photometric measurements must conform to SAE J1330.

5.4 EQUIPMENT TOLERANCES

Supplier must use test setups and equipment capable of measuring test parameters (expressed in nominals) within the limits found in Equipment Tolerance Table.

Equipment Tolerance Table

Test Chamber Temperature/Humidity	nominal ± 3°C Relative Humidity ± 5%
Time	nominal ± 0.5%
Forces	nominal ± 0.1 N
Distances	nominal ± 0.1 mm
Voltages	nominal ± 0.01 V for photometrics
	nominal ± 0.1 V for all other tests
MSCD	nominal ± 2.0%

NOTE: This table is not to be used for performance dependent variable (Refer to section Measurement Accuracy).

5.5 MEASUREMENT ACCURACY

Meters and gauges used to assess the performance dependent variable, as defined by the basic function of the test sample, must have a smallest unit of measure one order of magnitude less than the least significant digit specified. For example, even though a 0.6 mm and 0.60 mm wire might be the same diameter, calipers capable of 0.01 mm resolution may be used to measure the first wire, but a micrometer with 0.001 mm resolution is needed for the second wire.

5.6 TEST REPEATABILITY AND CALIBRATION

5.6.1 Equipment Repeatability

All measurement equipment used for product evaluation must be repeatable to within 10% of the part tolerance according to Chrysler, Ford, and General Motors Measurement Systems Analysis Reference Manual.

5.6.2 Equipment Calibration

Equipment re-calibration/re-certification timing is to be calculated based on the capability of any individual instrument to retain its "Manufacture Stated Accuracy" between recall periods. However, this time shall not exceed one year.

5.6.3 Laboratory Masters (Photometry Only)

Lamps which are traceable to known standards are laboratory masters. Each supplier must use laboratory masters for comparison measurements, calibration of test equipment, and for evaluating long-term drift in test equipment.

5.7 TEST DEFAULT CONDITIONS

Tests shall be accomplished under conditions and methods specified herein. When specific test conditions are not given, the following basic conditions apply: Reference ECE R99 Annex4

1. Test the bulb in the operating orientation as specified in ECE R99 Annex 4, sub-paragraph, “BURNING POSITION”.
2. Voltage input to ballast…… 13.5 Vdc
3. Perform tests or measurements at the following ambient temperature.....25°C +/ - 5°C
4. The GDLS shall be seasoned / aged (except as noted in individual tests) in accordance with ECE Regulation 99 Annex 4.

When a test implementation or method is not specified in detail, the exact method and test equipment implementation shall be developed by the Supplier.

It is the intention of this specification that the gas discharge light source, used as part of the GDLS, shall meet the Technical Requirements as stated in Section 3 of ECE Regulation 99 “Uniform Provisions Concerning the Approval of Gas-Discharge Light Sources for use in Approved Gas-Discharge Lamp Units of Power-Driven Vehicles”.

5.8 TEST SHARING WITHIN LIGHT SOURCE FAMILIES

The results of tests performed on one light source type may, in some cases, be used to indicate the capability of another light source type within the same family. For example, a crush test performed

on a D1-S, type may be used as a demonstration of the glass strength of D1-R, D2-S and D2-R types made by the same process from the same glass from the same source. Sound judgment must guide this practice. Light sources within the same family that share components such as glass envelopes, lead wires, electrodes, bases, fill gases, etc., may be able to share test results. The customer will be the final authority on whether this surrogate data may be used.

5.9 TEST FAILURE PROCEDURE

Should a test failure occur, the customer (Quality, Purchasing, and Design/Release Engineer) shall be notified immediately. When contact cannot be immediately made, stop the test until the requesting party can be contacted.

5.10 CONTROL PLANS

Supplier must maintain a control plan, consistent with the AIAG, for each light source, ballast and ignitor type that contains appropriate controls to ensure that all the significant/critical characteristics covered by the tests in this document are met.

5.11 RELIABILITY PROGRAMS AND METHODS

5.11.1 Reliability Growth and Ongoing Quality Improvements

Suppliers must establish and implement a plan to improve demonstrated product quality and reliability. They must establish procedures for analyzing and correcting end-of-line defects and predominant failure modes identified by the field return program. True reliability growth occurs when design changes to the GDLS or manufacturing process are made to eliminate the failure modes.

5.11.2 Notification of Process Changes

Suppliers must notify the customer of manufacturing process, material, or design changes to determine if resubmission for PPAP approval is required.

5.11.3 Quality/Reliability Improvement Tools

Suppliers must use appropriate methods to improve the quality and reliability of their products in accordance with QS-9000. Examples of such methods are Field Return Programs, Design Failure Mode Effects Analysis (DFMEA), Process Failure Mode Effects Analysis (PFMEA), and Fault Tree Analysis (FTA) or Fishbone Diagrams. Further information on these methods is available from the Automotive Industry Action Group (AIAG).

5.12 HAZARDOUS MATERIAL RESTRICTION

Any regulated substance that is identified by any federal, state, provincial, or local government unit or automotive manufacturer, shall not be used in the manufacturing process of any GDLS components. Any GDLS components manufacturer that is currently supplying hazardous material in a component will submit a timeline to General Motors, Ford, and Chrysler for the removal of said product.

Materials selected for use in the GDLS shall not produce corrosive or deleterious fumes under manufacturing, assembly, operating or test conditions stated herein. Materials used within the Discharge Light Source shall meet the intent of this requirement consistent with specific need to obtain required light output characteristics.

5.12.1 RECYCLABILITY

The GDLS is considered a recyclable item and the design shall utilize recyclable materials where practical.

5.12.1.1 RECYCLING INFORMATION

The GDLS shall be marked with recycling information with either specific instructions or molded marking in accordance with SAE J1344 or VDA 260, as appropriate.
The light source shall be marked to indicate the presence of mercury, if appropriate.

5.12.2 ITEM DIAGRAM

A block diagram for the GDLS and interfacing elements is shown in Figure 3.1.1-1. Internal partitioning, content, design and construction details to meet requirements of this specification are at the discretion of subsystem supplier except as otherwise specified herein.

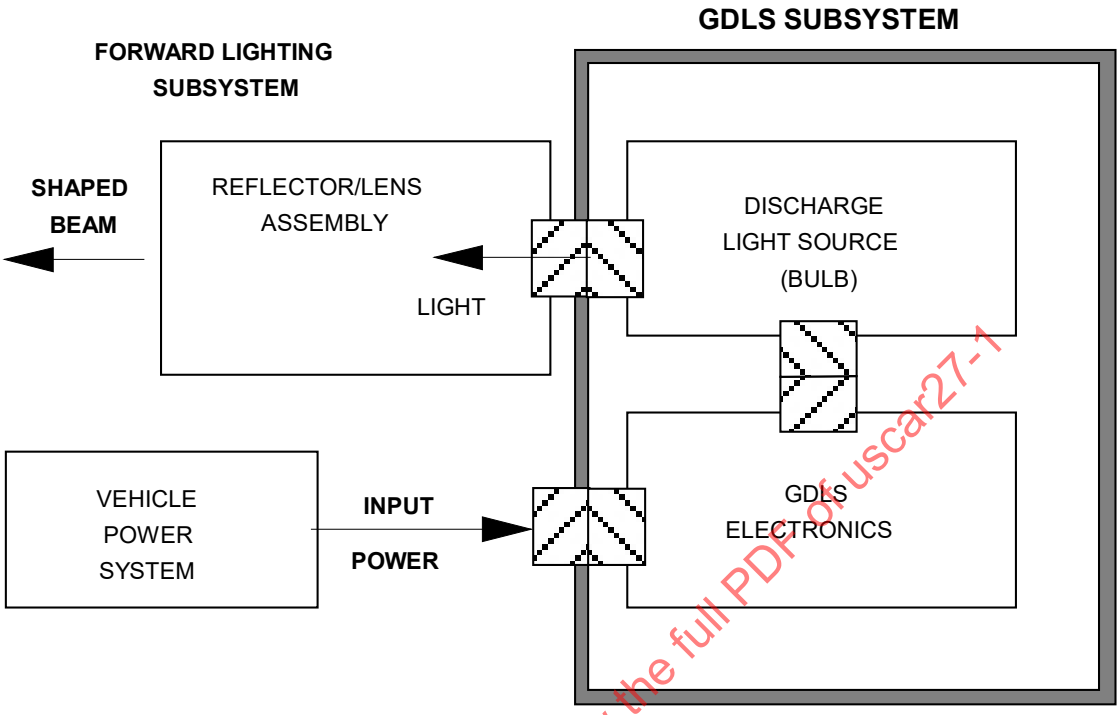


FIGURE 3.1.1-1

6. ENVIRONMENTAL

Tests shall be conducted on GDLS representative of production assemblies. Unless otherwise specified in any individual test, for purposes of environmental testing, nominal voltage V_{nom} shall be design voltage, low voltage V_{low} shall be 9.0 volts and high voltage V_{high} shall be 16.0 volts. The operating voltage shall be nominal for 80%, low for 10% and high for 10% of the functional tests and/or cycles.

The GDLS shall be designed to meet all performance requirements while exposed to steady state or oscillating ambient temperatures ranging from ≥-40 °C to ≤105 °C. Maximum temperature excludes local temperature rise from heat generated by Discharge Light Source during operation when installed into headlamp housing.

6.1 TEMPERATURE SOAK

Temperature soak simulates the GDLS exposed to hot and cold temperatures for prolonged periods of time during storage or use.

Reference IEC 60068-2-2, Dry Heat Test Ba (T_{max} is 105 °C) for a minimum duration of 96 hours and IEC 60068-2-1, Cold Test Aa (T_{min} is -40 °C) for a minimum duration of 24 hours.

6.1.1 Test and Measurement Apparatus

1. Environmental Chamber (circulating air type) Capable of T_{Min} = -40 °C and T_{Max} = 105 °C
   - The environmental chambers shall be capable of maintaining the atmosphere at the appropriate temperature for the test in any region where the specimen is placed.
   - The absolute humidity in the chambers shall not exceed 20 g/m^3
   - The air in the chambers shall be circulated. Air velocity measured close to the test specimen shall be not less than 2 m/s.
2. Power Source
3. GDLS Mounting Fixture
   - The GDLS shall be tested using mounting or supports with low thermal conduction, such that for practical purposes the specimen is thermally isolated. When testing several specimens simultaneously they shall be so placed that free circulation should be provided between specimens and between chamber surfaces.
   - The Discharge Light Source may be mounted in a lamp housing or otherwise protected during this testing; however, all interfaces, connectors and wiring must be exposed.

6.1.2 Procedure

1) Mount the GDLS on the fixture using the devices attachment points. No component of the GDLS shall come into contact with the chamber surfaces.
2) Power the GDLS for 1 minute at 13.5 Vdc.
3) Remove power from GDLS during temperature soak.
4) Set chamber settings to T_{max} and a maximum 50% relativity humidity and allow to stabilize.
5) Soak at T_{max} for 96 hours.
6) At the end of the 96 hour soak, power the GDLS for 1 minute at 16.0 Vdc.
7) Remove power from GDLS.
8) Allow to cool to room temperature.
9) Lower the chamber temperature to $T_{min.}$ and allow to stabilize.
10) Soak at T_{min} for 24 hours.
11) At the end of the 24 hour soak, power the GDLS for 1 minute at 9.0 Vdc.
12) Remove power from GDLS.
13) Allow the chamber to reach room temperature.
14) Power the GDLS for 1 minute at 13.5 Vdc.

6.1.3 Acceptance Criteria

1) The GDLS shall not show any evidence of visible fractures, warpage or deformation.
2) The light source shall illuminate continuously each time it is powered.

6.2 THERMAL SHOCK IN AIR (TS).

6.2.1 Purpose

The GDLS shall be designed to withstand thermal stresses due to power cycling and rapid changes in ambient temperature without degradation in performance.

The Discharge Light Source may be mounted in a lamp housing or otherwise protected during this testing; however, all interfaces, connectors and wiring must be exposed.

This is an accelerated test to evaluate failure mechanisms, which may be driven by mismatches in coefficients of thermal expansion.

6.2.2 Test and Measurement Apparatus

1. Environmental Chamber (circulating air type) #1 @ T_{Min} = -40 °C
2. Environmental Chamber (circulating air type) #2 @ T_{Max} = 105 °C

- The environmental chambers shall be capable of maintaining the atmosphere at the appropriate temperature for the test in any region where the specimen is placed.
- The absolute humidity in the chambers shall not exceed 20 g/m^3
- The volume of the chambers and the air velocity shall be such that after insertion of the test specimens, the temperature within the chambers shall be within the specified tolerance after a time of not more than 10% of the exposure time.
- The air in the chambers shall be circulated. Air velocity measured close to the test specimen shall be not less than 2 m/s.

3. Power Source
4. GDLS Mounting Fixture
   - The GDLS shall be tested using mounting or supports with low thermal conduction, such that for practical purposes the specimen is thermally isolated. When testing several specimens simultaneously they shall be so placed that free circulation should be provided between specimens and between chamber surfaces.
   - The Discharge Light Source may be mounted in a lamp housing or otherwise protected during this testing; however, all interfaces, connectors and wiring must be exposed.

6.2.3 Procedure.

Reference IEC 60068-2-14 Na. Upon agreement, this test can be performed during the development process without a case (or with a modified case).

1. Test Chamber #1 and #2 shall be stabilized to T_{Min} and T_{Max} respectively, prior to inserting test specimens.
2. The GDLS shall soak at T_{Min} for 10 minutes and then transferred to test chamber #2.
3. Transfer time between chambers shall not exceed 30 seconds.
4. The GDLS shall soak at T_{Max} for 20 minutes.
5. Repeat steps 2 through 4 for a minimum number of 300 cycles. (refer to Table Combined Thermal Shock / Power Temperature Cycling)
6. Lamp and ballast shall be energized once daily for 10 minutes at 105 °C and once daily at –40 °C for the last 2 minutes of the 10 minute soak.
7. Test shall be stopped if light source fails to illuminate when energized.

6.2.4 Acceptance Criteria.

The light source shall illuminate each time it is operated and at the completion of the test.

6.3 THERMAL SHOCK WATER

6.3.1 Purpose.

To verify the GDLS functionality after exposure to sudden changes in temperature after a cold water splash on a hot system/component. The aim is to simulate driving through water in the wintertime. This applies to GDLS devices that lie in the splash area, (e.g. ballast mounted external to the lamp assembly).

6.3.2 Test and Measurement Apparatus

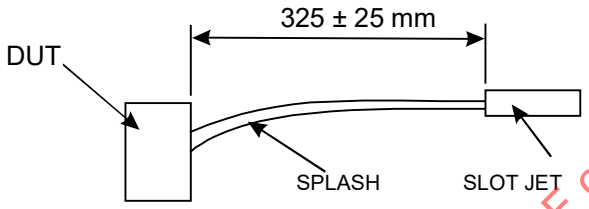
1. Spray Chamber
2. Spray Nozzle (Reference ISO WD 16750-4 N142)
    - Jet specification: Slot jet, see Figure 13.
    - Width of jet slot: 1.2 mm
    - Length of jet 220 mm
    - Water flow: (1.00 to1.33) l/s
3. Test Fluid – de-ionized water with 3% fine Arizona dust according to ISO 12103-1; 5 % NaCl may be added
4. GDLS Mounting Fixture
    1. GDLS mounted as in vehicle position, accommodating any ballast sealed connections and mounting surfaces. (Vehicle lamp assembly may be used)
    2. Distance between the spray jet and the GDLS surfaces shall be 325mm +/- 25mm (water shall be applied over the complete width of the exposed surfaces of the GDLS components)

6.3.3 Procedure

1. The GDLS is to be electrically connected as in the vehicle in the normal driving mode and continuously monitored. Any sealed connections on the ballast shall simulate vehicle interface. The GDLS light source shall be inside an enclosure such as a lamp assembly to shelter the arc tube from water.
2. Test cycle: Heat the GDLS exposed components to 105 °C and hold this temperature for 30 min. Use a waterproof electrical connection.
3. Splash the hot GDLS exposed component with cold water from one direction while being in as-installed position. If the equipment is splashed from various directions in the vehicle, then these directions shall be taken into account. Provided that this is the case, a new GDLS may be used for each splash direction. The width of the splash directed at the GDLS shall always be greater than the width of the GDLS. If GDLS of considerable size are splashed that prove too big for one jet, several jets shall be arranged in a row to produce a line of splash impact on the GDLS.
4. Repeat the cycle. If the test is conducted with several GDLSs at the same time, a jet for splashing shall be provided for each GDLS.
5. Number of cycles: 100

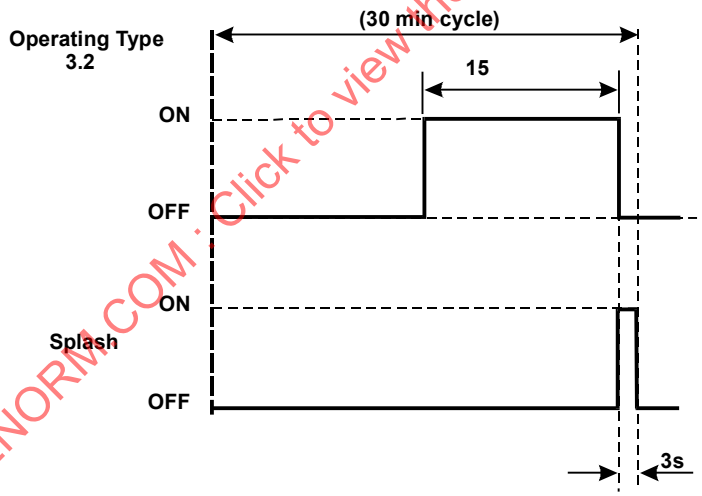
6. Holding time at Tmax: 30 min
7. Transition duration: < 20 s (For manual transition of GDLS between temperature storage and splashing)
8. Water temperature: 0 °C to +4 °C
9. Splashing duration: 3 s
10. GDLS bulb to be energized at nominal voltage during the last 15 min at 105 °C

DUT Location with Respect to Slot Jet



DUT mounting according to as-installed condition in vehicle.

Splash Cycle



6.3.4 Acceptance Criteria

The GDLS light source and ballast must operate during test and meet requirements of SAE J2009 (modified) pertinent sections for light up and luminous intensity after the test.

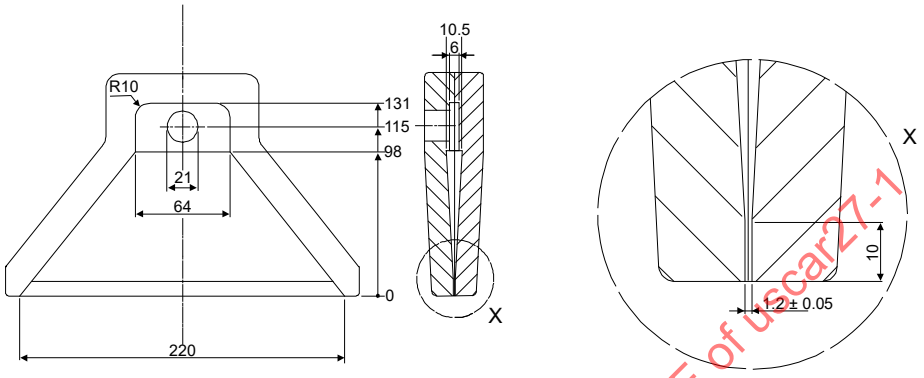


FIGURE 13: Spray Nozzle

Temperature Range	Temperature Difference		n-PTC-Test	Cycle Time - min		Sample Size n	N-Test	Number of Cycles		Test Time
	Service	Test		Thermal Shock	Power Temp			Thermal Shock	Power Temp	Days
(-40…+105)°C	70	145	1182	30	59	18	1329	300	729	36.1
	70	145	1182	30	59	18	1329	564	201	20
	70	145	1182	30	59	23	1176	300	576	29.9
	70	145	1182	30	59	23	1176	488	200	18.4

Table: Combined Thermal Shock / Power Temperature Cycling

6.4 POWER TEMPERATURE CYCLE TEST.

6.4.1 Purpose.

The purpose of this test is to determine if the GDLS is able to meet specification requirements when subjected to the power and temperature cycling stresses that cause failures related to mechanical attachments, integrated circuit dies, electro migration and solder creep.
The number of combined thermal shock and power temperature cycles shall be determined from the Table: Combined Thermal Shock / Power Temperature Cycling
Any one row from table may be selected to meet the requirements of this section.

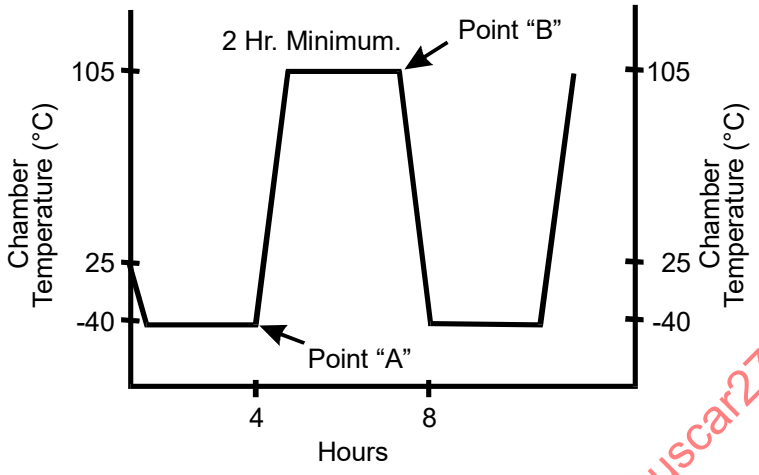
Samples shall operate normally during and at the conclusion of testing.

6.4.2 Procedure.

The temperature cycle testing shall be performed according to IEC 60068-2-14 Nb. The input/ output cycling shall be scheduled such that the required minimum number of 1 life cycles, as shown in the following table, for each function is evenly distributed and achieved during the total PTC test. The test parts shall be powered between points “A” and “B” of the Temperature Cycle Profile chart. The control instrumentation must be capable of synchronizing the GDLS on/off time with the chamber temperature transitions.

Minimum Number of 1 Life Cycles	
(This table is to be filled out by Engineering)	
Function	Number of Cycles
On / Off	200 minimum

Temperature Range	-40 °C to 105 °C
Operating Type	Normal operating mode with continuous monitoring.
Temperature Transition Rate	(3 ± 2) °C/min or modified with the approval of Engineering
Dwell time after temperature stability in the chamber has been reached	The time at -40 °C should be 10min minimum. The time at 105 °C should be 20 min minimum.
Minimum number of thermal cycles	200 or the appropriate number to meet the 1 life usage cycles.
Power on	At the end of the cold soak – Point “A”
Power off	At the end of the hot soak – Point “B”
Supply Voltage	% of Operational Cycles V_{low} 10 V_{nom} 80 V_{high} 10



TEMPERATURE CYCLE PROFILE

Per SAE J 2357 – apply power at end of cold soak, turn off at end of hot soak. Transition rate to be 3 +/- 2 deg C/min. Change Device Internal Temp to Chamber Temperature.

Figure 11: Power Temperature Cycle Profile Criteria.

Any inputs/outputs in an incorrect state or any incorrect on vehicle messages shall be considered a nonconformance to specification requirements.

6.4.3 Purpose.

This is an accelerated test to evaluate failure mechanisms, which may be driven by mismatches in coefficients of thermal expansion.

6.5 SALT FOG/SPRAY

6.5.1 Purpose

This test is designed to show the GDLS's ability to withstand exposure to salt spray and fog as experienced in coastal regions and road salt environments. The Discharge Light Source (bulb) is presumed to be mounted within headlamp assembly. This specification assumes that the ballast is mounted external to lamp housing.

6.5.2 Test and Measurement Apparatus

Salt Spray Chamber per ASTM B117

6.5.3 Procedure

1. The GDLS shall be set up in the “On Vehicle Position” such that they will not be exposed to dripping moisture. The vehicle interface connector and associated harness shall be connected to the parts at all times during this test with the opposite end of the harness kept outside the chamber or sealed off at the end.
2. The GDLS require four 30 minute salt-water applications during the ambient environment soak for each of the required test cycles. Each application should be spaced (1.5 ± 0.01) hour apart. Each step shall be run immediately after the previous step.
   a) Ambient Environment Soak – 8 hour at ambient room temperature with a relative humidity of (30 … 50) %.
   b) Humid Environment Soak – 8 hour at a temperature of +49 °C and a relative humidity of (95…100) %.
   c) Dry Environment Soak – 8 hour at a temperature of +60 °C and a relative humidity ≤30%.
   Note: One test cycle totals 24 hours
3. During 7th hour of Dry Environment soak apply power to the GDLS for 15 minutes.
4. Repeat steps 2 and 3 for a total of 10 test cycles.
5. After the final cycle, verify function of the GDLS within 1 hour. The GDLS shall also be inspected for signs of corrosion. An external and connector cavity inspection is required at this time; an internal inspection is optional. The GDLS shall not be cleaned (?? Typically rinsed with deionized water) prior to proceeding onto other tests in the test sequence.

6.5.4 Acceptance Criteria

The acceptance criteria for corrosion is not limited to conditions as observed at the end of the Salt-Spray Test. Since corrosion could start and continue at different parts of the test sequence, the corrosion acceptance criteria may apply to the entire sequence.

a) Failure of the GDLS to function is not acceptable.
b) Structural corrosion damage that reduces any structural physical properties of a material at the corrosion site is not acceptable. Structural corrosion damage is defined as corrosion related to material loss or degradation that weakens the physical properties related to the structural integrity and strength of the device/assembly/packaging. These properties include, but are not limited to, yield strength, hardness, pierce strength, mass buckling or flex resistance, etc.
c) Some external (cosmetic) corrosion, that does not affect performance characteristics of the system, may be allowed on surfaces, with agreement of customer.

6.6 HUMIDITY

Reference IEC 60068-2-38-Z/AD Cyclic Temperature/Humidity Test.

6.6.1 Purpose

The purpose of this test is to determine in an accelerated manner the resistance of specimens to the deteriorative effects of high temperature/humidity and cold conditions.

This cyclic temperature/humidity test is designed to reveal defects in test specimens caused by breathing as distinct from the absorption of moisture.

The test employs temperature cycling at high-relative humidity and will produce a “breathing” action. The accelerated breathing and the effect of the freezing of trapped water in cracks and fissures are the essential features of this composite test.

6.6.2 Test and Measurement Apparatus

1. One chamber capable of the following two parameters or two separate chambers.
    a. Temperature and humidity of 25 °C ± 2 °C to 65 °C ± 2 °C and 93% ± 3% relative humidity (rh) during constant and rising temperatures and 80% rh and 96% rh during falling temperature periods.
    b. The second low temperature must be maintained at -10 °C ± 2 °C.
2. Test Fixture(s) with GDLS light source center axis mounted horizontal to the ground and ballast(s) mounted in any intended design position(s).
3. The GDLS connector that interfaces to the vehicle shall have a representative mating connector with sealed pigtail wires or plugged to avoid wicking of water through the wires.
4. The GDLS shall not be powered during exposure to the humidity cycles.

6.6.3 Procedure

1. Verify GDLS meets the requirements of Section LIGHT OUTPUT AT START-UP & STEADY STATE OUTPUT prior to running this test.
2. Mount the GDLS to the test fixture(s) and place in the test chamber.
3. Expose the GDLS to the following humidity cycle(s).
4. **Temperature humidity sub-cycle** - Applicable to all cycles, see Figures 6.6.3-A and 6.6.3-B. At “zero time” of every 24 h cycle, the chamber condition shall be controlled to a temperature of 25±2°C and relative humidity of 93±3%.

    a) The temperature of the chamber shall be continuously raised to 65±2°C in a period of between 1.5 and 2.5h. During this period, the relative humidity shall remain within the limits 93±3%.

b) The temperature and relative humidity in the chamber shall be maintained at 65±°C and 93±3% respectively until 5.5 h after the start if the cycle.

c) The temperature shall then be allowed to fall to 25±2°C in a period of between 1.5h and 2.5h. During this period, the relative humidity shall remain within the limits 80% and 96%.

d) Beginning 8h after the start of the cycle, the temperature shall again be continuously raised to 65±2°C in a period of between 1.5 and 2.5h. During this period, the relative humidity shall be 93±3%.

e) The temperature and relative humidity in the chamber shall be continuously raised to 65±2°C and 93±3% respectively until 13.5h after the start of the cycle.

f) The temperature shall then be allowed to fall to 25±2°C in a period of between 1.5 and 2.5h. During this period, the relative humidity in the chamber shall remain within the limits 80% to 96%.

g) The chamber shall then continue to run at a stabilized temperature of 25±2°C and relative humidity of 93±3% until the start of the cold sub-cycle or until the end of the 24h cycle, as appropriate.

5. **Cold Sub-Cycle** - Applicable to any five of the first nine cycles (see figure 6.6.3-A).
   a) Following the completion of the temperature humidity sub-cycle (a-f in Figure 6.6.3-A), the chamber is maintained at a temperature of 25±2°C and relative humidity of 93±3% for a period of at least one but not more than 2h.

   b) The specimen shall then be exposed to cold by lowering the temperature of the chamber or transferring to a second chamber. If the specimen is transferred from one chamber to another, the transfer should be completed within a period of 5 min. Beginning 17.5h after the start of the cycle, the ambient temperature of the chamber shall be reduced to -10±2°C. The temperature shall be reached 18h after the start of the cycle.

c) Beginning 18h after the start of the cycle, the temperature shall be maintained at -10±2°C. This temperature shall be reached 18h after the start of the cycle. No requirement for humidity is prescribed during the entire cold sub-cycle.

d) Beginning 21h after the start of the cycle, the temperature shall be raised to 25±2°C. This temperature shall be reached 22.5h after the start of the cycle (see Figure 6.6.3.1-A). If the specimen is transferred from one chamber to another, the transfer shall be completed within a period of 10min to 15min.

e) The temperature of the chamber shall be maintained at 25±2°C until the 24h cycle is completed. During this period, the relative humidity shall be 93±3%.

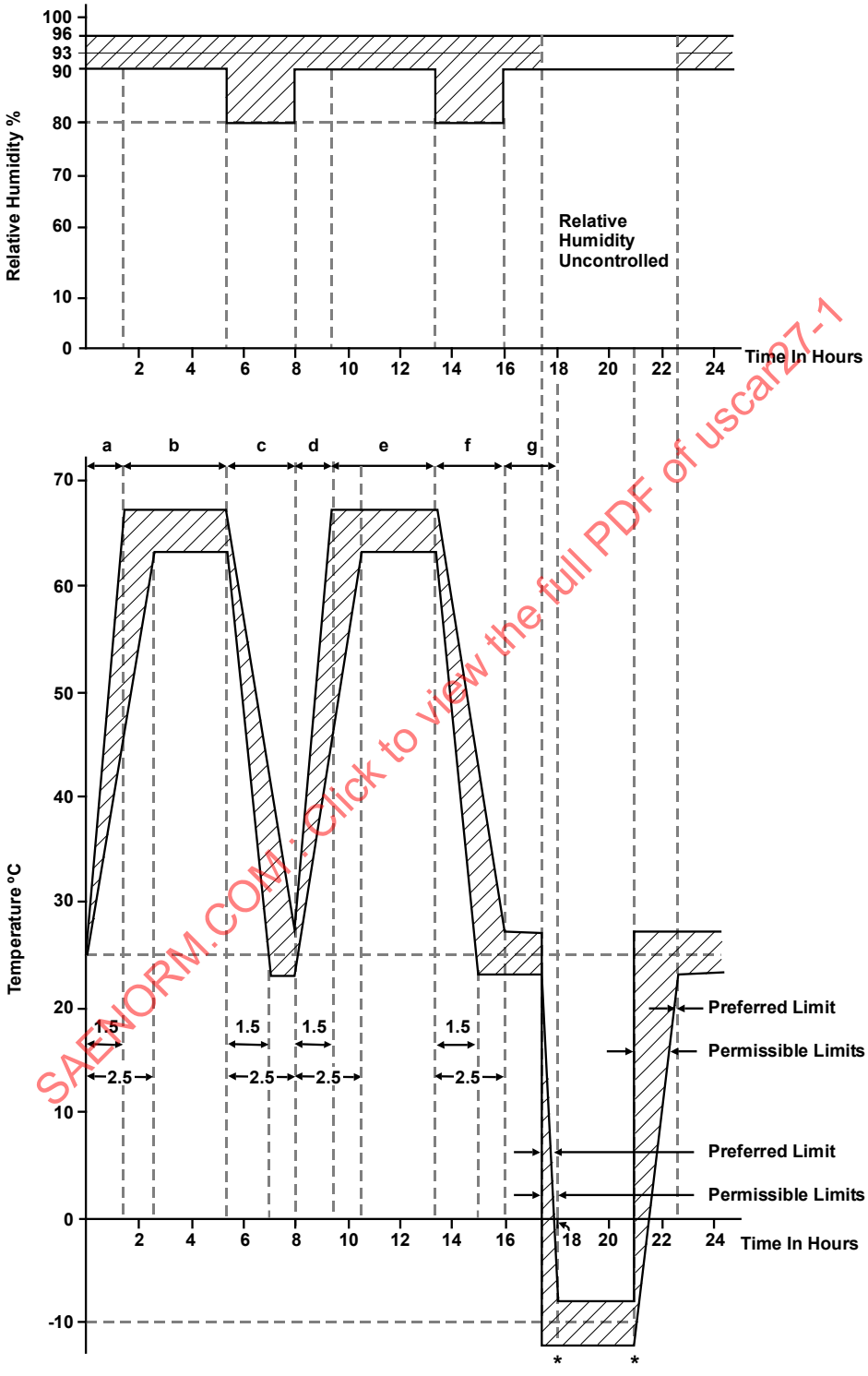
6. **24 Hour Cycles With No Exposure to Cold** - This is applicable to the remaining four of the first nine cycles (Figure 6.6.3-B). Cycles which do not include a cold sub-cycle following the humidity temperature sub-cycle are the same as described in Humidity Procedure a-g, except that in paragraph g the chamber shall be maintained at a temperature of 25±2°C and relative humidity of 93±3% until the 24h cycle is completed.

7. **Final Cycle** - In the final (10^{th}) cycle, following the completion of the temperature and humidity sub-cycle, the chamber is maintained at a temperature of 25±2°C and relative humidity of 93±3% for a period of 3.5h.

8. Remove parts from chamber.

6.6.4 Acceptance Criteria

The GDLS shall meet the requirements of Section LIGHT OUTPUT AT START-UP & STEADY STATE OUTPUT within one hour and after 24 hours after removal from the test chamber.



* Tolerance on time at these points ± 5 min.

Figure 6.6.3-A: Humidity Cyclic Test

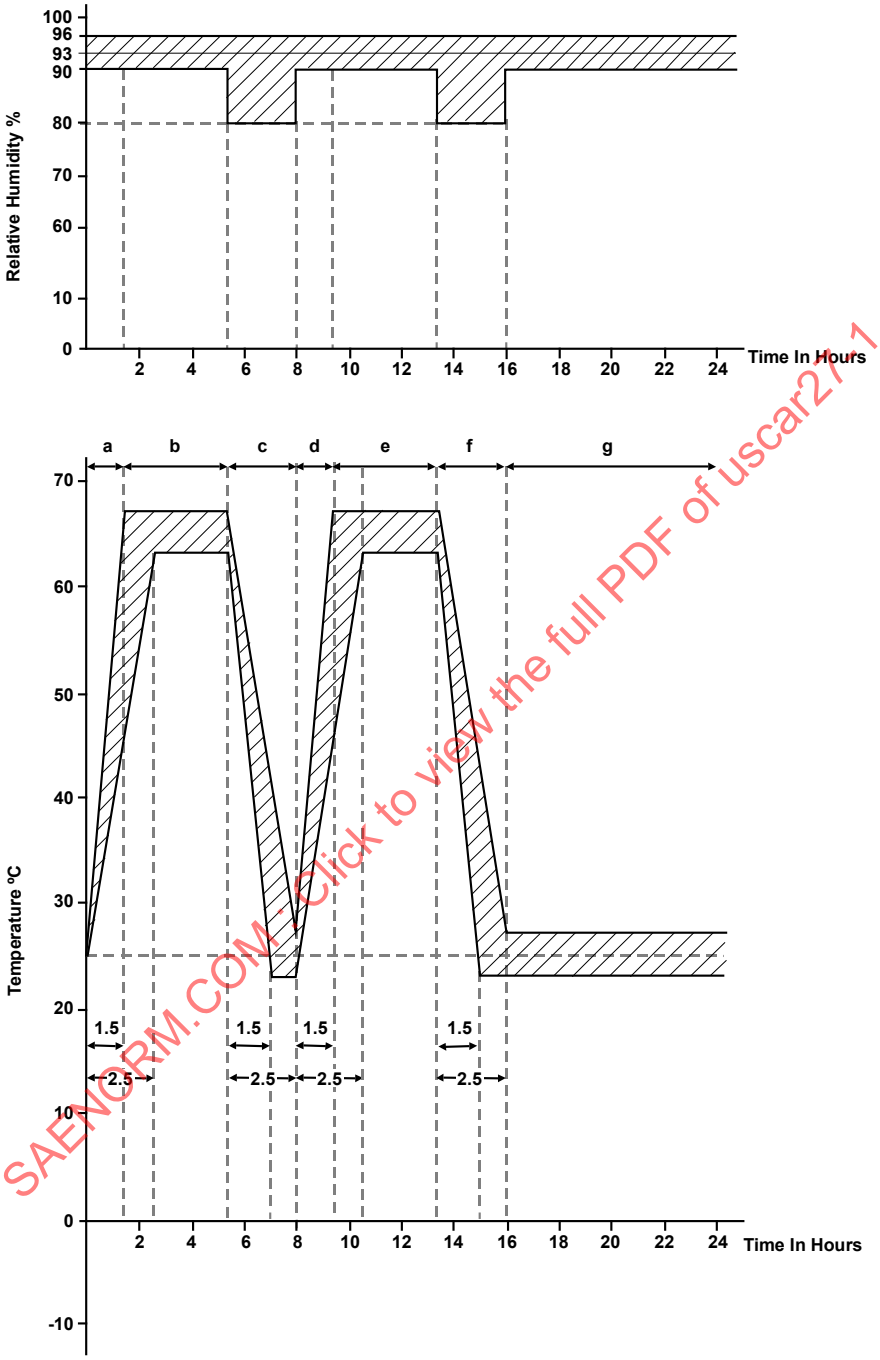


Figure 6.6.3-B: Humidity Cyclic Test without Exposure to Cold

6.7 ALTITUDE

Reference IEC 60068-2-13. Low Air Pressure

6.7.1 Purpose

The test simulates pressure conditions due to operating at 4,850 m and being shipped in an unpressurized aircraft at 10,400 m.

6.7.2 Test and Measurement Apparatus

Test Chamber capable of maintaining pressure at 25kPa and 55kPa ± 5% or ± 0.1kPa, whichever is larger.

6.7.3 Procedure

1. Place test specimens in the chamber.
2. Connect the GDLS to the vehicle interface connector and associated harness.
3. Apply specified design voltage to the GDLS.
4. Verify each sample lights up and stays lit for 5 minutes.
5. After 5 minutes turn off power.
6. Lower atmosphere in the chamber to 55kPa at a rate not to exceed 10kPa per minute and maintain for 16 hours.
7. Every 15 minutes, repeat step 3 & step 5.
8. Every 4th hour repeat step 4 in addition to steps 3 & 5.
9. At the end of the16 hour test, change chamber to 25kPa at a rate not to exceed 10kPa per minute and allow the test chamber to reach steady state.
10. Soak the samples for an additional 16 hours without applying power.
11. After the 16 hour soak, allow the chamber to return to normal atmospheric conditions at a rate not to exceed 10kPa per minute.
12. Repeat step 4 within 2 hours after pressure is normalized.

6.7.4 Acceptance Criteria

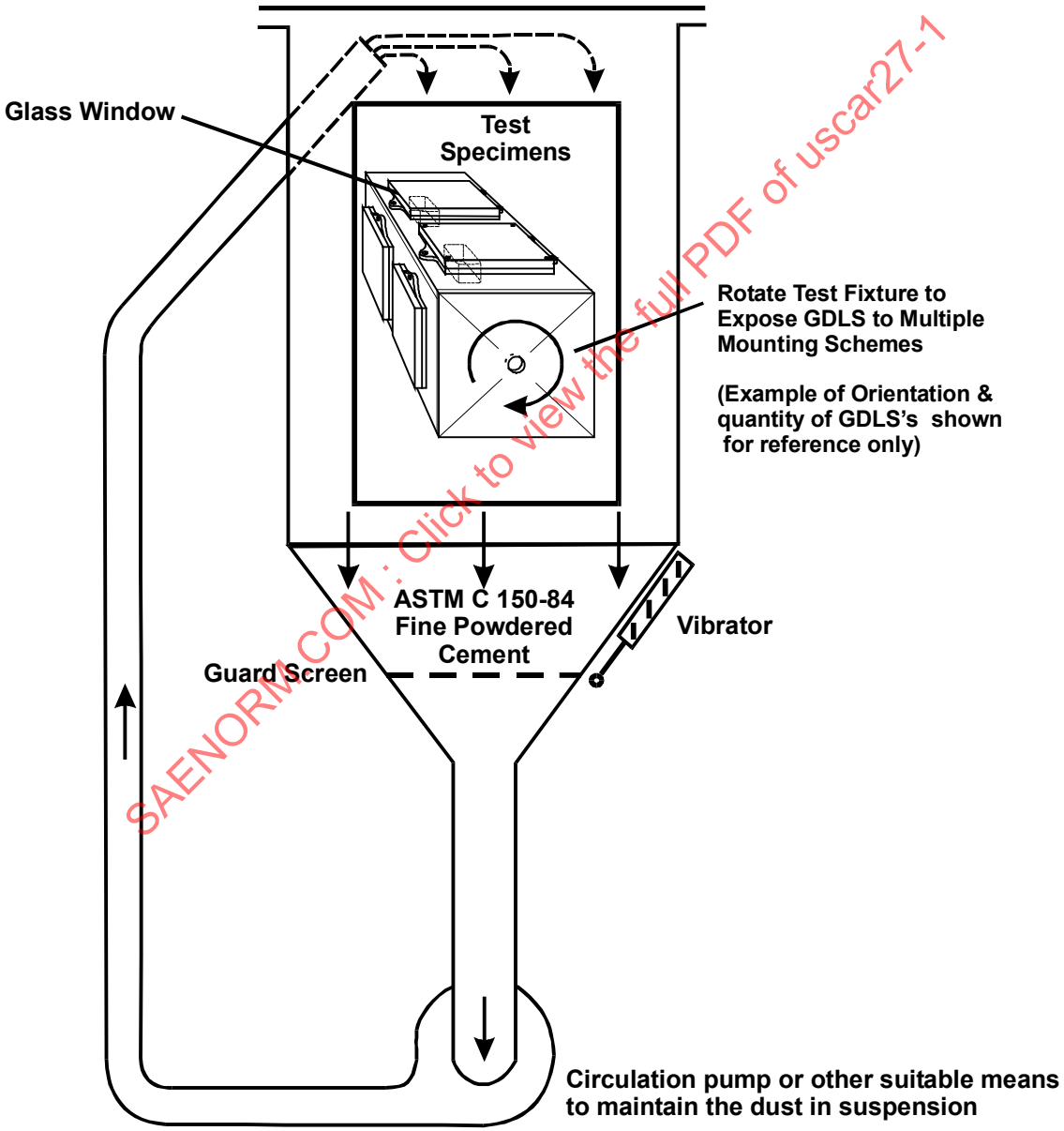
Samples must light up and remain lit every time step 4 above is performed.

6.8 DUST

The GDLS shall be designed to withstand exposure to environmental sand and dust concentrations of fine and coarse particulates during in-service use without degradation in electrical performance. The Discharge Light Source (bulb) is presumed to be mounted within headlamp assembly.

6.8.1 Test and Measurement Apparatus

- Dust test set up (Reference SAE J 575) (see figure)
- Fine powered cement in accordance with ASTM C 150-84 – 3kg to 5 kg dust suspension in a maximum 2 m^3 test chamber volume.
- Mating connectors
- Fixture with surface and sealed compartment to mount any connections intended to be sealed to the interior of a lamp assembly (see figure)



Dust Test Set Up Figure

6.8.2 Procedure

1. Mount the GDLS to the test fixture inside the dust chamber with mating connectors installed. (see figure)
2. Rotate test fixture at one revolution per minute to expose multiple sides of the GDLS to the circulating dust
3. Agitate the dust every 15 minutes for 6 seconds during a total test period of 8 hours.

6.8.3 Acceptance Criteria

The protection is satisfactory if, on inspection, dust has not accumulated in a quantity or location such that, as with any other kind of dust, it could interfere with the correct operation of the equipment or impair safety. No dust shall deposit where it could lead to unintended electrical conductive paths or interference with intended electrical conductivity.

The protection is satisfactory if no deposit of dust is observable inside the enclosure at the end of the test.

6.9 WATER SPRAY

This test subjects the GDLS to wet conditions such as road splash, extreme condensation, rain or deliberate washing. The discharge light source (bulb) is presumed to be mounted within a headlamp reflector assembly.

Suppliers are cautioned that electronic components mounted internally or externally to the lamp housing will undergo further moisture testing as part of lamp validation.

6.9.1 Test and Measurement Apparatus

- Spray Chamber and table per DIN 40050 Part 9 Degree of Protection Code 4k or JIS D 0203 Test S2.

6.9.2 Procedure

1. The Ballast is to be mounted with all sealed interfaces connected as in vehicle.
2. Perform Water Spray per DIN 40050 Part 9 Degree of Protection Code 4k or JIS D 0203 Test S2.
3. Test duration shall be for one hour.
4. Remove samples from chamber and within 5 minutes apply power for 10 minutes.
5. Remove power and allow drying at room temperature for twenty-four hours and re-applying power for 10 minutes.

6.9.3 Acceptance Criteria

The GDLS shall illuminate the light source and maintain illumination as long as power is applied.

6.10 FLUID RESISTANCE

6.10.1 Purpose

This test evaluates the material compatibility when exposed to various fluids commonly found in and around road vehicles. . The Discharge Light Source is presumed to be mounted within headlamp assembly.

6.10.2 Test and Measurement Apparatus

- Laboratory Fume Hood
- Stainless steel tanks or Pyrex beakers
- Explosion-proof Heat Chamber

6.10.3 Procedure

1. A minimum of 1 GDLS assembly per test fluid is required. Assembly must include all applicable components, seals, etc.
2. Completely coat at least 1 test sample with each fluid listed in TEST FLUIDS.TABLE Fluids are to be stabilized at specified temperatures. Each sample is to be coated in one fluid only, unless otherwise requested.

CAUTION: Follow all Federal, state, and local safety regulations, standards, and procedures when performing this test.

3. Do NOT shake off any excess fluid. Leave the samples "wet" and store them in a suitable area at room temperature for one week. Do not allow samples coated in different fluids to touch each other and do not allow any dissimilar fluid drippings to intermingle.
4. At the conclusion of the storage period, samples may be dried sufficiently to allow inspection and to avoid contamination of test apparatus.

TEST FLUIDS TABLE

FLUID TYPE	FLUID DESCRIPTION*	STABLIZATION TEMPERATURE °C
Brake Fluid	SAE RM66-XX**	50 ± 5
Oil	ISO 1817, Oil No. 2	50 ± 5
Gasoline	ISO 1817, liquid C	25 ± 5
Engine Coolant	50% ethylene glycol + 50% distilled water	50 ± 3
Automatic Transmission Fluid	Dexron III	50 ± 5
Windshield Washer Solvent	50% Isopropyl Alcohol + 50% Water	25 ± 5
Power Steering Fluid	ISO 1817, Oil No. 3	50 ± 5
Diesel Fuel	90% ISO 1817, Oil No. 3+ 10% P-Xylene	25 ± 5
E85 Ethanol Fuel	85% Ethanol + 15% ISO 1817 liquid C	25 ± 5
Tar Remover	45% Xylene + 55% Petroleum base mineral spirits	25 ± 5

*Solutions are determined as percent by volume
**Use latest available SAE reference fluid
See appendix B for suggested fluid source list

6.10.4 Acceptance Criteria

The GDLS shall operate after exposure to the fluids. The fluid shall not melt, crack, craze, or crystallize the surface of the part. Graphics and labeling appliqués shall not chip, crack, dissolve, or be removed upon application of the fluid.

7. MECHANICAL

The GDLS shall be designed to meet performance criteria when exposed to mechanical stresses that may be encountered during vehicle assembly and operation. Conformance to this requirement shall be demonstrated as follows:

7.1 STEADY STATE LOADS (CRUSH)

7.1.1 Purpose

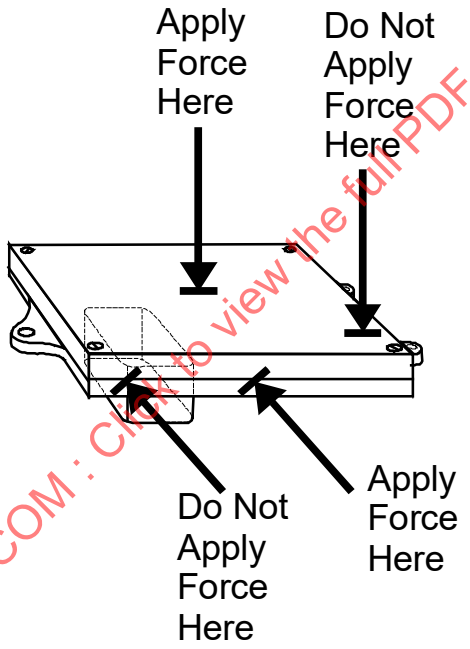
This test simulates an external load placed on the GLDS' exposed surface(s).

7.1.2 Test and Measurement Apparatus

1) 13mm diameter probe
2) Force gauge

7.1.3 Procedure

1) The GDLS shall be set up to allow testing on all external surfaces with a 13.0 mm or larger diameter area.
2) Subject the GDLS to an evenly distributed 110 N force about any 13.0 mm diameter area for 1.0 s. See diagram for load Placement.



7.1.4 Acceptance Criteria.

The GDLS shall be capable of meeting the continued testing as shown in Appendix C “Test Sequence”

7.2 VIBRATION

Reference IEC 60068-2-64, random vibration & IEC 60068-2-14 Nb Change of Temperature

7.2.1 Purpose.

The vibration test profiles check the GDLS for strength when subjected to simulated vehicle vibration levels while exposed to a change of temperature.

7.2.2 Test and Measurement Apparatus

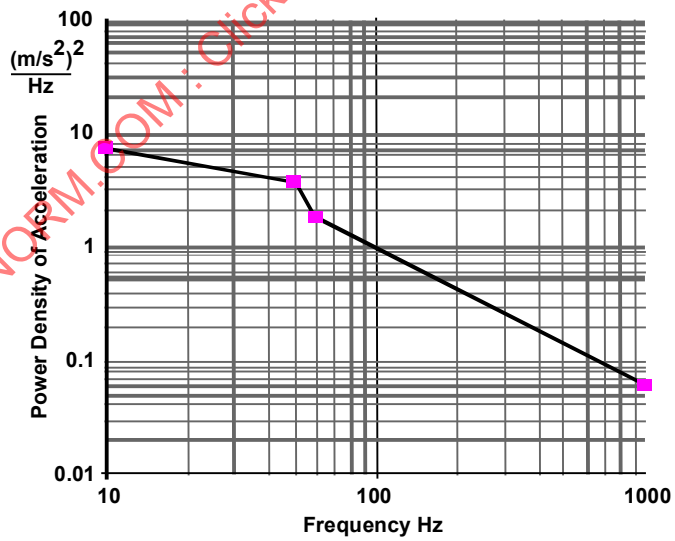
- Vibration table mounted inside a hot/cold temperature chamber capable of -40 °C to 125 °C.
- Power supply
- Monitoring Device

7.2.3 Procedure.

1. Subject GDLS to vibration load testing and to temperature change simultaneously during the vibration test cycle.
2. The GDLS shall be electrically operated and continuously monitored while on test.
3. Test duration is 8 h for each X, Y, Z co-ordinate axis of the GDLS. RMS acceleration value = 20.9 m/s^2
4. The test cycle is defined in vibration profile and temperature chart below.
5. Verify that the GDLS illuminates the light source during the “on time”.

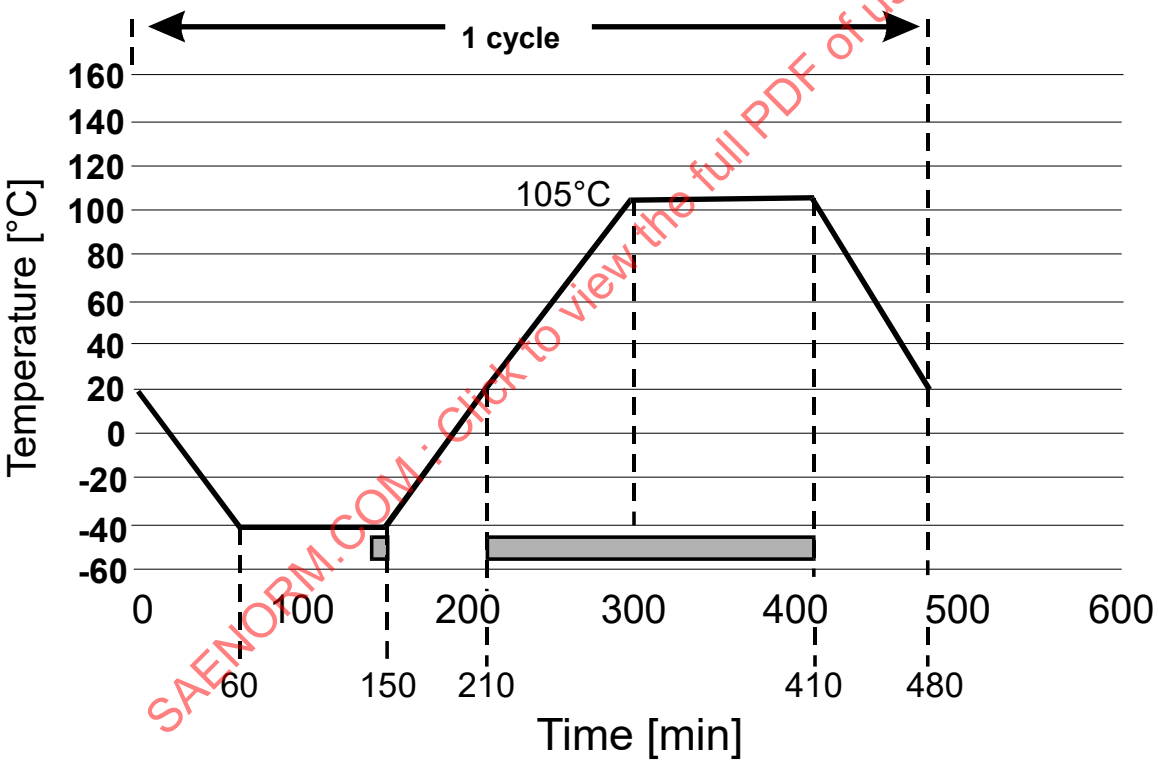
NoteReference IEC 60068-2-64, random vibration & IEC 60068-2-14 Nb Change of Temperature.

Random Broadband Vibration Profile



Frequency – Hz	Acceleration Power Density – $(m/s^2)^2/Hz$	Power Spectral Density – g^2/Hz
10	7	0.073
50	3.5	0.036
60	1.75	0.018
1000	0.06	0.0006

Temperature Cycle



- Denotes GDLS "ON TIME"

7.2.4 Acceptance Criteria.

1. Any inputs/outputs in an incorrect state shall be considered a nonconformance to specification requirements.

2. The GDLS shall be able to withstand the above vibration levels without damage resulting in degradation of performance, objectionable squeak, rattle, or non-functional operation.
3. The GDLS must illuminate the light source during the entire duration of “on times”.

7.3 MECHANICAL SHOCK

Reference IEC 60068-2-27 Ea.

7.3.1 Purpose.

The purpose of this test is to determine if the GDLS is able to meet specification requirements when subjected to the mechanical stresses resulting from driving conditions such as potholes and minor collisions.

7.3.2 Test and Measurement Apparatus

- Power Supply
- Shock Tester
- Test Fixture that rigidly holds the Ballast and burner.

7.3.3 Procedure

1) Mount the GDLS to the shock test fixture. (Accelerometer measurement must be taken at the ballast). Wire harness between the ballast and the burner shall not be secured to the test fixture.
2) Connect the GDLS to the vehicle interface connector and associated harness.
3) The shock test must be performed independent of the vehicle installation position.
4) The GDLS Shall be connected and powered during the test.
5) The Test pulse shall be 100g half sine wave for a period of 11 ms
6) The GDLS shall be subjected to 3 shocks in both directions for each of the three axes. 3 x 6 = 18 total.

7.3.4 Acceptance Criteria.

The GDLS samples shall light up during testing and remain lit for 5 minutes after the last test pulse.

7.4 FREE FALL (DROP)

Reference IEC 60068-2-32, Ed

7.4.1 Purpose.

To determine if the GDLS, with the exception of the light source, is able to meet specification requirements or to show significant damage so as to not be used in assembly when subjected to the mechanical stresses encountered by being dropped from a one-meter height.

7.4.2 Test and Measurement Apparatus

- Test Surface shall be a smooth, hard, rigid surface made up of concrete or steel.
- 1 meter measuring device.

7.4.3 Procedure.

1) Select three GDLS samples with light source removed.
2) GDLS is not connected.
3) Drop the GDLS from a height of 1 m
4) Repeat step 3 for each of the remaining two axes.
5) Repeat steps 3 and 4 for the other two samples.

7.4.4 Acceptance Criteria.

- If there is no visible external damage to the GDLS, then the GDLS shall have no internal damage and the GDLS samples shall light up and remain lit for 5 minutes after the test.

- If there is visible external damage to the GDLS and the damage is judged by Engineering to be insignificant, then the GDLS shall have no internal damage and the GDLS samples shall light up and remain lit for 5 minutes after the test.

- If there is visible external damage to the GDLS and the damage is judged by Engineering to be significant, then the GDLS does not have to light up.

8. ELECTRICAL

8.1 JUMP START (OVER-VOLTAGE) AND REVERSE POLARITY

8.1.1 Purpose

The GDLS shall be immune from damage due to positive over-voltage and reverse polarity voltage applied to the input connections.

8.1.2 Test and Measurement Apparatus

Power supply capable of 30 Vdc and 8 amps steady state/30 amps inrush

8.1.3 Procedure for Jump Start (Over-Voltage)

1. Turn on the power supply and set the power supply voltage to 26V±0.5
2. Turn off the power supply
3. Connect the power supply to the battery input of the GDLS
4. Turn on the power supply for 1 minute.
5. Turn off power supply and disconnect from the GDLS
6. Turn on power supply and adjust voltage to 13.5V±0.1
7. Turn off power supply and connect GDLS
8. Turn on power supply and verify that GDLS illuminates

8.1.4 Procedure for Reverse Polarity

1. Turn on the power supply and set the power supply voltage to -13.5V+1/-0.5
2. Turn off the power supply
3. Connect the power supply to the battery input of the GDLS
4. Turn on the power supply for 2 minutes.
5. Turn off power supply and disconnect from the GDLS
6. Turn on power supply and adjust voltage to 13.5V±0.1
7. Turn off power supply and connect GDLS
8. Turn on power supply and verify that GDLS illuminates

8.1.5 Acceptance Criteria

GDLS must illuminate in step 8 of each test.

8.2 BATTERY VOLTAGE DROPOUT

8.2.1 Purpose

The GDLS shall be immune from damage due to decreases in battery voltage due to engine cranking or battery rundown.

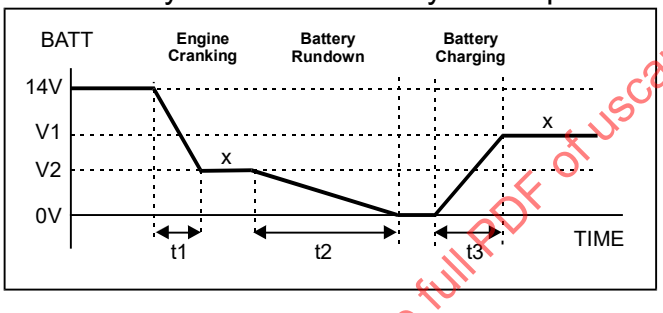
8.2.2 Procedure

1. Soak the GDLS un-powered until its temperature has stabilized to -40 °C
2. Set up the battery voltage dropout waveform shown in Battery Rundown Test Cycle Graph.
3. Power up the GDLS and apply the battery voltage dropout test waveform per test cycle #1 as shown in Battery Rundown Test Cycle Table.
4. Verify GDLS illuminates at (X) point, between the t_1 and t_2 time intervals shown in Battery Rundown Test Cycle Graph.
5. Verify GDLS illuminates at (X) point after the t_3 time interval at V_1 voltage.
6. Repeat steps (1) through (5) for test cycles 2 through 4.
7. Repeat steps (2) through (6) at 105 °C.

Battery Rundown Test Cycle Table

Test Cycle	Voltage (V)		Time (s)		
	V_1	V_2	t_1	t_2	t_3
1	10.0	6.0	0.01	10	1
2	10.0	6.0	0.1	600	10
3	10.0	6.0	0.5	3600	120
4	10.0	6.0	1	28800	7200

Battery Rundown Test Cycle Graph



8.2.3 Acceptance Criteria

The GDLS shall illuminate at point (X) after t_3 and function normally.
The GLDS may, but is not required to illuminate at point (X) between t_1 and t_2.

8.3 SUPERIMPOSED ALTERNATING VOLTAGE

8.3.1 Purpose

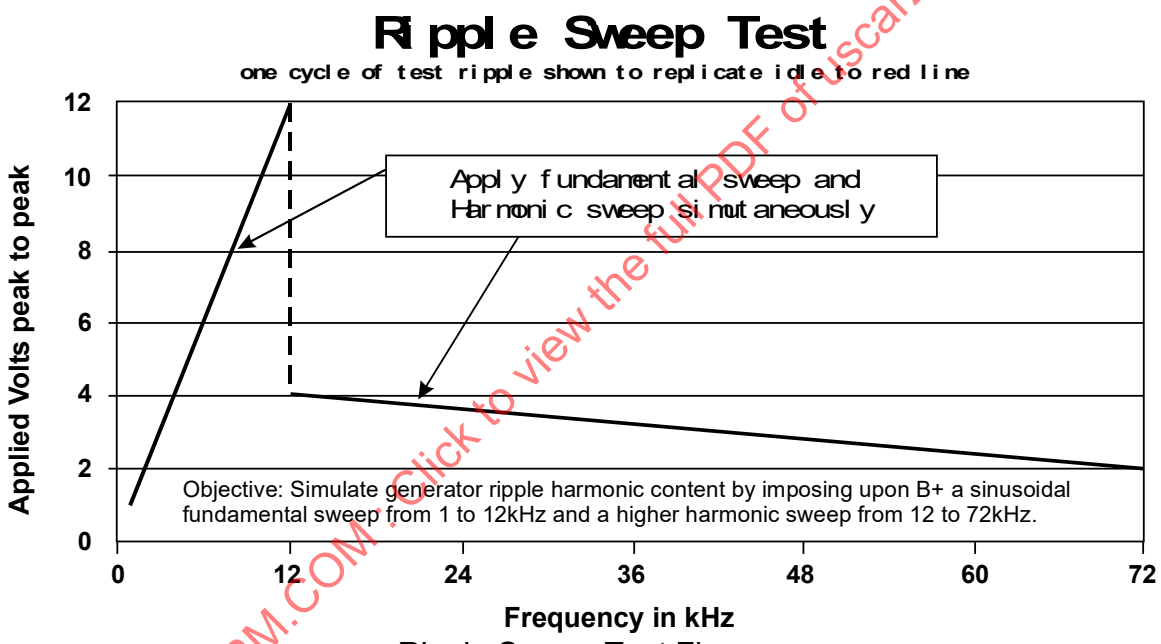
The GDLS shall be immune from damage when the supply voltage is super-imposed with a sinusoidal alternating voltage.

8.3.2 Test and Measurement Apparatus

- Power Supply
- Waveform Generator
- Environmental Chamber capable of -40 °C to 105 °C

8.3.3 Procedure

1. Mount the sample inside the temperature chamber.
2. Connect Power Supply to samples.
3. Lower and stabilize temperature at -40 °C.
4. Setup the Superimposed Alternating Voltage Test according to Ripple Sweep Test Figure.
5. A sweep time of 1 minute to 5 minute is to be used.
6. Power the GDLS and inject the specified wave form for 2 hours.
7. Raise and stabilize temperature at 105 °C.
8. Repeat steps 4 through 6.



Ripple Sweep Test Figure

8.3.4 Acceptance Criteria

Verify samples light up and remain lit for the entire duration of the test.

8.4 SHORT CIRCUIT

8.4.1 Purpose

The GDLS shall be immune from damage due to intermittent and continuous short circuit conditions.

8.4.2 Test and Measurement Apparatus

- Temperature Chamber
- Power Supply
- Programmable Controller Device

8.4.3 Procedure

1. Mount sample inside the thermal chamber.
2. Disconnect light source from the system and create a switch able short circuit at connector.
3. Raise and stabilize the chamber temperature to 105 °C.
4. At time t=0 seconds apply 16.0 ±0.1V to ballast.
5. At time t=15 seconds apply short circuit condition for 330 seconds.
6. At t=360 seconds remove the power.
7. At t=480 seconds repeat steps 4 through 7 until 85 cycles are complete.
8. After completing 85 cycles connect a light source and verify the correct operation of the GDLS.
9. Remove the light source again and repeat steps 4 through 8 except with 9.0 ± 0.1V applied to ballast.
10. Lower and stabilize the chamber temperature to -40 °C and repeat steps 4 through 8 with 9.0 ± 0.1V applied to the ballast.
11. Adjust power supply voltage to 16 ± 0.1V and repeat steps 4 through 8.

8.4.4 Acceptance Criteria

The GDLS system shall illuminate and stay lit when the light source is attached and the system powered. The GDLS shall not generate any feedback through the power connection.

8.5 OPEN CIRCUIT

8.5.1 Purpose

The GDLS shall be designed so that an open circuit fault shall not prevent any other interface from meeting its requirements. Additionally, the GDLS shall return to normal operation after the open circuit condition is removed.

8.5.2 Test and Measurement Apparatus

- Power Supply
- High Voltage Switch
- Oscilloscope

8.5.3 Procedure

1. Set up test with High Voltage Switch between ballast and light source on ground wire.
2. Apply power to GDLS.
3. Open switch for 2 minutes.
4. Close switch.

8.5.4 Acceptance Criteria

The GDLS shall illuminate when switch is closed. The GDLS shall not generate any feedback through the power connection.

8.6 ISOLATION

8.6.1 Purpose

This test is to verify that the GDLS meets the requirements for electrically isolated adjacent terminals and metal housings.

8.6.2 Test and Measurement Apparatus

- Megohmeter
- Thermal Chamber

8.6.3 Procedure

1. Allow the GDLS to normalize for 1 hour at room temperature.
2. Heat the GDLS in the Thermal Chamber to 70 °C.
3. Apply a test Voltage of 500V DC for 60 seconds to the GDLS as follows.
    - Between electrically isolated and adjacent terminals,
    - Between electrically isolated terminals and electrically isolated metal housing,
    - Between electrically isolated terminals and an electrode wrapped around the housing (i.e. metal foil. sphere bath) in the case of plastic material housing.

8.6.4 Acceptance Criteria

- Isolation resistance shall be greater than 1MΩ.
- Any portion of the GDLS that utilizes or directs a voltage greater than 42.0 VDC or 30 VAC RMS shall be isolated to a minimum of 10 Meg ohms between power line and grounds

8.7 INPUT CURRENT SURGE

8.7.1 Purpose

The GDLS shall be designed such that upon either turn-on or fault recovery, the peak input current as measured at the GDLS input terminals shall not damage vehicle circuit or wiring.
This is a worst-case requirement and will normally be tested at the minimum starting voltage.

8.7.2 Test and Measurement Apparatus

- Oscilloscope
- Power Supply
- Current Probe

8.7.3 Procedure

1. Run this test during the Light Output at Start Up and Steady State Output Test with the voltage set to Vmin.
2. Using the oscilloscope, monitor the current draw of the GDLS power connection and capture the waveform. Provide waveform as part of PPAP submission.

8.7.4 Acceptance Criteria

At the GDLS input terminals the current shall not exceed 30 amperes during the first 100 milliseconds of operation, except for ignition pulses not to exceed 250 microsecond duration, 20 amperes in the next 5 seconds and 10 amperes thereafter decreasing to design current level at steady state conditions within 120 seconds.

8.8 STEADY STATE INPUT POWER

8.8.1 Purpose

This test is designed to verify power usage parameters of the GDLS are met during normal operation.

8.8.2 Test and Measurement Apparatus

- Oscilloscope
- Power Supply
- Current Probe

8.8.3 Procedure

1. Run this test during the Light Output at Start Up and Steady State Output Test with the voltage set to 13.5 Vdc.