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SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J2357

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Submitted for recognition as an American National Standard

Application guidelines for Electronically Driven and/or Controlled Exterior Automotive Lighting Equipment

1. *Scope*—The purpose of this SAE Recommended Practice is to aid in the effective application of automotive exterior lighting equipment driven by electronic devices. This document covers integral and non-integral systems including electronically driven Fog lamps.

2. *References*

2.1 Applicable Publications—The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of the identified standard shall apply .

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

SAE J387—Terminology—Motor Vehicle Lighting
SAE J575—Tests for Motor Vehicles Lighting Devices and Components
SAE J1113-1—Electromagnetic Compatibility Measurement Procedures for Vehicle Components (Except Aircraft) (60Hz to 18GHz)
SAE J1113-2—Electromagnetic Compatibility Measurmen Procedures and Limits for Vehicle Components (Except Aircraft)—Conducted Immunity, 30 Hz to 250 kHz—All Leads
SAE J1113-3—Conducted Immunity, 250 kHz to 5000 MHz, Direct Injection of Radio Frequency (RF) Power
SAE J1113-4—Immunity to Radiated Electromagnetic Fields—Bulk Current Injection (BCI) Method
SAE J1113-11—Immunity to Conducted Transients on Power Leads
SAE J1113-13—Electromagnetic Susceptibility Measurement Procedures for Vehicle Components—Part 13: Electrostatic Discharge
SAE J1113-21—Road Vehicles—Electrical Disturbances By Narrowband Radiated Electromagnetic Energy—Component Test Methods—Part 21: Absorber Lined Chamber
SAE J1113-22—Electromagnetic Compatibility Measurement Procedure for Vehicle Components—Part 22: Immunity to Radiated Magnetic Fields From Power Lines
SAE J1113-23—Electromagnetic Compatibility Measurement Procedure for Vehicle Components—Part 23: Immunity to Radiated Electromagnetic Fields, 10 kHz to 200 MHz, Stripline Method
SAE J1113-24—Electromagnetic Compatibility Measurement Procedure for Vehicle Components—Part 24: Immunity to Radiated Electromagnetic Fields, 10 kHz to 200 MHz, TEM Cell Method
SAE J1113-25—Electromagnetic Compatibility Measurement Procedure for Vehicle Components—Part 25: Immunity to Radiated Electromagnetic Fields, 10 kHz to 200 MHz—Tri-Plate Method
SAE J1113-27—Electromagnetic Compatibility Measurements Procedure for Vehicle Components—Part 27: Immunity to Radiated Electromagnetic Fields

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SAE J1113-41—Limits and Methods of Measurement of Radio Disturbance Characteristics of Components and Modules for the Protection of Receivers used On Board Vehicles
SAE J1113-42—Electromagnetic Compatibility—Component Test Procedure—Part 42: Conducted Transient Emissions
SAE J1211—Recommended Environmental Practices for Electronic Equipment Design
SAE J1383—Performance Requirements for Motor Vehicle Headlamps
SAE J1455—Joint SAE/TMC Recommended Environmental Practices for Electronic Equipment Design (Heavy Duty Trucks)
SAE J1690—Flashers
SAE J1812—Function Performance Classification for EMC Immunity Testing
SAE J1843—Accelerator Pedal Position Sensor For Use With Electronic Controls In Medium and Heavy-Duty Vehicle Applications
SAE J2009—Discharge Forward Lighting System
SAE J2087—Daytime Running Lamps for Use on Motor Vehicles
SAE J2139—Testing for Lighting Devices and Components Used on Vehicles 2032 mm or More in Overall Width

2.1.2 ANSI PUBLICATION—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ANSI Z535.4-1998—Product Safety Signs and Labels

2.1.3 IEC PUBLICATIONS—Available from International Electrotechnical Commission, 3, rue de Verambe, P.O. Box 131, 1211 Geneva 20, Switzerland.

IEC 50:1990—IEC International Dictionary on Electrical and Electronic Terms
IEC 60801-2:1991—Electromagnetic Compatibility for Industrial Process Measurement and Control Equipment—Part 2: Electrostatic Discharge Requirements

2.1.4 IEEE PUBLICATION—Available from IEEE, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331.

ANSI/IEEE Std 100-1996—Standard Dictionary of Electrical and Electronics Terms

2.1.5 FEDERAL PUBLICATIONS—Available from the Superintendent of Documents, U. S. Government Printing Office, Mail Stop: SSOP, Washington, DC 20402-9320.

49CFR564—Replaceable Lightsource Information (Part 564)
49CFR571.108—Lamps, Reflective Devices and Associated Equipment (FMVSS108)

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

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

SAE J1889—L.E.D. Lighting Devices

3. Definitions

3.1 Conducted Emissions—Conducted emissions are transients and/or other disturbances observed on the external terminals of a device during its normal operation. (SAE J1113-1)

3.2 Daytime Running Lighting System—A system that actuates the Daytime Running Lamps when the Ignition switch is ON and the headlamps are OFF.

3.3 DC to AC converters—A class of device used for conversion of a direct current input supply voltage to an alternating current output supply with a well-specified or controlled frequency and waveform.

3.4 Discharge Lamp Ballast (Automotive ballast)—A device for stabilizing the lighting characteristics of a discharge lamp. The ballast contains all the necessary circuitry to ignite a lamp and cause it to operate within a specified power profile range. It controls the required light output characteristics of the automotive discharge lighting system. The ballast may consist of one or more separate components.

3.5 Discharge Light (Source)—A family of electric lamps that produces visible light by a stabilized arc. (SAE J387)

3.6 DRL - Daytime Running Lamps—Steady burning lamps that are used to improve the conspicuity of a vehicle from the front and front sides when the regular headlamps are not required for driving. (SAE J2087)

3.7 DUT - Device Under Test—Abbreviation for Device Under Test.

3.8 Electromagnetic Compatibility (EMC)—The ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbance to anything in that environment. (IEC 50: 1990)

3.9 Electrostatic Discharge (ESD)—A transfer of electrostatic charge between bodies at different potentials, occurring prior to contact or induced by an electrostatic field.

3.10 Flasher—A device installed in a vehicle lighting system that has the primary function of causing lamps to flash when a switch is activated. Secondary functions may include the visible pilot indication for the signal system and an audible signal to indicate the flasher is operating. The most common classifications for flashers include turn, hazard warning, combination and alternating flashers. (SAE J1690)

3.11 Forward Lighting System—The system comprised of all the subsystems and components mounted on a vehicle in such a manner as to provide road illumination in front of the vehicle.

3.12 Immunity (Electromagnetic - to a disturbance)—The ability of a device, equipment, or system to perform without degradation in the presence of an electromagnetic disturbance. (IEC 50:1990)

3.13 Immunity Level—The maximum level of a given electromagnetic disturbance incident on a particular device, equipment, or system for which it remains capable of operating at a required degree of performance. (IEC 50:1990)

3.14 Incandescent Source (Filament Lamp)—A lamp in which visible light is primarily produced by a filament heated to incandescence by an electric current. (SAE J387)

3.15 Integral Lighting Electronic Control System—A lighting system comprised of one or more Electronic control modules that are integrated within the housing of the Lamp Assembly.

3.16 Interference (Electromagnetic)—Degradation of the performance of equipment, transmission channel, or system caused by an electromagnetic disturbance.

3.17 Lamp Assembly—The Lamp Assembly is the portion of the lighting device(s) that is to be tested to SAE J575 or SAE J2139.

3.18 Life—Time in hours “ON” and number of starting cycles of a lighting component during which it meets its operational characteristics under specified test conditions. (SAE J2009)

3.19 Lighting Electronic Control Module—A unit containing electronic controlling elements, converters, regulators, or actuators that controls or modifies the parameters of a lighting system.

3.20 Lumen Maintenance (Light Source)—The change in the light output of a light source or lighting system referenced to the initial performance, over time.

3.21 Non-Integral Lighting Electronic Control System—A lighting system in which the electronic control module is not contained in the Lamp Assembly.

3.22 Pulse Width Modulation (PWM) Modules—A system of modulation where the duty cycle of discrete pulses are varied by the leading, trailing or both edges to represent an output signal where the duty cycle of the pulse is proportional to the value represented. (SAE J1843)

3.23 Radiation (Electromagnetic)—The phenomenon by which energy in the form of electromagnetic waves emanates from a source in space.

3.24 Signal Marking Lighting Systems—A system that actuates and flashes the hazard or turn signal lights when the hazard warning switch or turn signal switch is actuated, respectively.

3.25 Smart Lighting—A lighting system that is able to respond to an external stimulus and modify its lighting characteristics without interaction from the user.

3.26 Solid State Light Source—A light source in which visible light is primarily produced by photon emission from excited electrons in a semiconducting material.

3.27 Susceptibility (Electromagnetic)—The inability of a device, equipment, or system to perform without degradation in the presence of an electromagnetic disturbance. (IEC 50:1990)

3.28 System—An assembly of methods, procedures or techniques united by regulated interaction to form an organized whole.

3.29 TEM (Transverse Electromagnetic Mode) Cell—A chamber used to measure or inject RF energy from or into a DUT to determine its RF radiation or susceptibility. This devices operates on the TEM principle that states the electric field vector is everywhere perpendicular to the direction of wave propagation.

3.30 Voltage Dividers—The voltage divider is a network that provides one or more voltages from a single voltage supply. (ANSI/IEEE Std 100-1996)

3.31 Voltage Regulators—Voltage regulators accept an unregulated input voltage and produce from it a constant, controllable output voltage that can be used as a supply voltage for other circuits or devices. (ANSI/IEEE Std 100-1996)

4. Lighting Codes, and Markings

4.1 Lighting Codes—SAE J2357 may be referenced on lighting devices that comply with the guideline.

4.2 Marking—Markings or labels that are used on lighting electronic control devices shall comply with 49CFR564 and 49CFR571.108.

Lighting electronic control devices using colors to denote the level of safety shall comply with ANSI Z535.4.

5. ***Tests*—**Figure 1 defines the testing categories for Integral and Non-Integral Lighting Electronic Controls Modules. This chart is to be used as a guideline in determining the appropriate test schedule for systems under evaluation.

Additional information and rationale can be found in Section 7 of this Guideline.

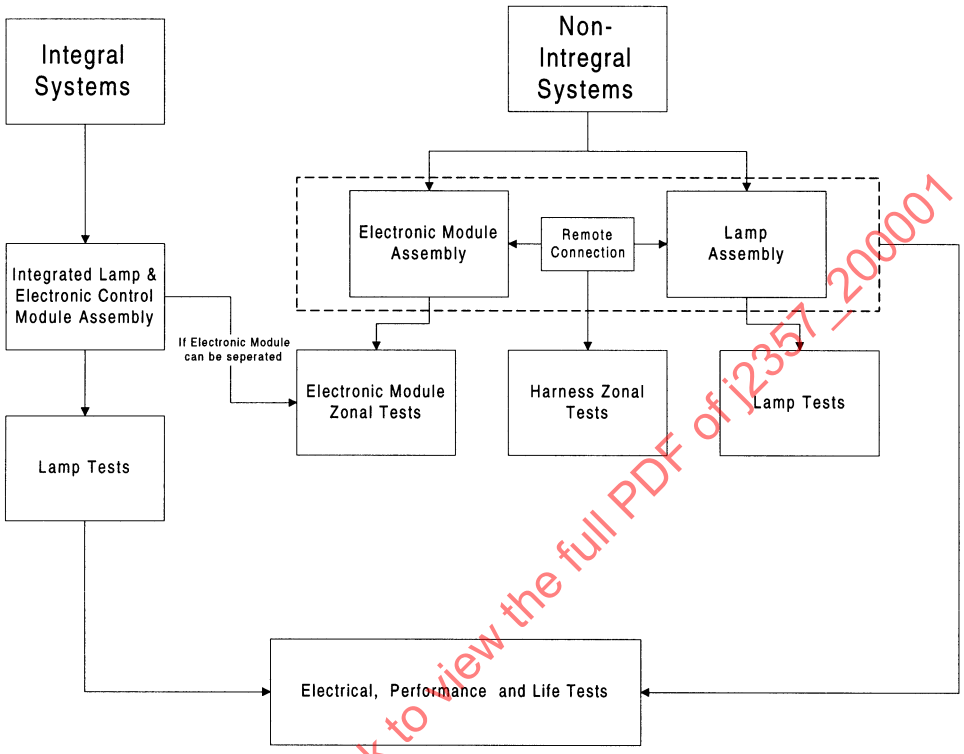

FIGURE 1—TEST CATEGORY CHART FOR INTEGRAL AND NON-INTEGRAL LIGHTING ELECTRONIC CONTROL MODULES

5.1 **Electromagnetic Compatibility—**The SAE J1113 series addresses methodologies for testing the electromagnetic emissions and immunity characteristics of vehicular modules and components.

The following sections reference specific parts of SAE J1113 applicable to lighting electronic controls.

5.1.1 ELECTROMAGNETIC INTERFERENCE—SAE J1113-1 General and Definitions

5.1.1.1 Conducted Emissions

5.1.1.1.1 Transient Waveform—SAE J1113-42 “Apparatus,” “Benchtop Descriptions,” “DUT Operating Conditions,” and “Data Acquisition Procedure.”

5.1.1.1.2 Additional Tests—SAE J1113-41 Sections “Conducted Emissions—Component/Module” and “Test Procedure.”

5.1.1.2 Radiated Emissions

5.1.1.2.1 Absorbed Lined Chamber—SAE J1113-41 Sections “Radiated Emissions—Component/Module” and Test Procedure “Test as Narrowband disturbances 150kHz to 1000MHz.”

5.1.1.2.2 TEM Cell Method—SAE J1113-41 Sections "Radiated Emissions—Component/Module" and "Test Procedure." The TEM Cell method may be used for measurements for frequency ranges below 172 MHz.

5.1.2 ELECTROMAGNETIC SUSCEPTIBILITY (IMMUNITY)—SAE J1113-1 General Definitions

5.1.2.1 *Conducted Immunity*—Conducted immunity testing consists of three tests. The first test evaluates Magnetic fields radiated from power lines, the second from conducted transients, and finally the injection of RF power.

RF power immunity testing can be performed by using either Direct or Bulk Injection methods.

5.1.2.1.1 Power Leads 30 Hz to 250 MHz—SAE J1113-2 Figure 1 "Test Setup for Measuring Conducted Immunity, 30 Hz to 250 MHz, Power Leads."

5.1.2.1.2 Conducted Transients—SAE J1113-11 Test Severity Levels per Appendix B.

5.1.2.1.3 Direct Injection 250 kHz to 500 MHz—SAE J1113-3 Test Severity Levels per Table B1 and Frequency Band per Table B2.

5.1.2.1.4 Bulk Injection 250 kHz to 500 MHz—SAE J1113-4 Test Severity levels per Appendix A.

5.1.2.2 *Radiated Immunity*

5.1.2.2.1 Low Frequency Tests:—Radiated Low frequency immunity testing consists of two tests. The first test evaluates Magnetic fields radiated from power lines and the second from RF Electromagnetic fields.

RF Electromagnetic low frequency immunity testing can be performed by using either Stripline, TEM Cell or Tri Plate methods.

5.1.2.2.1.1 Power Lines—SAE J1113-22 Immunity to Radiated Magnetic Fields from Power Lines.

5.1.2.2.1.2 Stripline Method—SAE J1113-23 Immunity to Radiated Electromagnetic Fields, 10kHz to 200 MHz, Stripline Method.

5.1.2.2.1.3 TEM Cell Method—SAE J1113-24 Immunity to Radiated Electromagnetic Fields, 10kHz to 200 MHz, TEM Cell Method.

5.1.2.2.1.4 Tri Plate Method—SAE J1113-25 Immunity to Radiated Electromagnetic Fields, 10kHz to 200 MHz, Tri-Plate Method.

5.1.2.2.2 High Frequency Tests—Radiated high frequency immunity testing consists of one test, with two possible test methods. Use either of the following two methods.

5.1.2.2.2.1 Absorbed Lined Chamber—SAE J1113-21 Road Vehicles—Electrical Disturbances by Narrowband Radiated Electromagnetic Energy—Component Test Method—Absorber Lined Chamber

5.1.2.2.2.2 Reverberation Chamber—SAE J1113-27 Immunity to Radiated Electromagnetic Fields—Reverberation Chamber Method

5.1.2.3 ESD (Electrostatic Discharge)

SAE J1113-13 Section “Test Equipment”
SAE J1113-13 Section “Test Setup and Procedure”
Test levels as defined in Appendix A of J1113-13

Functional Status, Region of Performance Test Signal Severity level as defined in SAE J1113-1 and SAE J1812.

5.2 Environmental

5.2.1 THERMAL CYCLE—Test to a minimum of 9 power temperature cycles as specified in the following sections. (See Table 1.)

TABLE 1—THERMAL CYCLE TEST PARAMETER SUMMARY(1)

DUT Configuration	Thermal Cycle Zonal Maximum Temperature SAE J2357 Figure 3	Thermal Cycle Profile 1 SAEJ2357 Figure 2	Thermal Cycle Profile 2 SAE J1383 Thermal Cycle Profile	Thermal Cycle Test SAE J1383 Thermal Cycle Test	Power Switching Cycle SAE J575 Plastic Warpage Test
Integral and Non-integral Lighting Electronic Control Modules					
Headlamp					
Lamp Assembly				R	
Lighting electronic control module (if separable)	R	R			
Non-Headlamp					
Lamp Assembly			O		O
Lighting electronic control module (if separable)	R	R			R

1. Legend: R = Required O = Optional (see 7.2.1)

5.2.1.1 Modules As Part of the Lamp Assembly—If the lighting electronic control module is part of the lamp assembly, (headlamp or non-headlamp), the assembly shall be subjected to a power temperature cycle test per SAE J1383 “Thermal Cycle Test.” However, for non-headlamp applications, the DUT shall be exercised according to the cycle times specified in SAE J575 Plastic Warpage Test instead of the switching profile of SAE J1383 Thermal Cycle Profile. In addition, if the lighting electronic control module can be operated, (meet functional requirements), while separated from the lamp assembly, the module shall be tested per procedure of 5.2.1.2.

5.2.1.2 All Other Module Configurations—If the module is not part of the lamp assembly, it shall be subjected to a power temperature cycle test. The DUT (or lighting electronic control module) shall be powered with the same or equivalent load as used for lamp assembly operation and be tested in a test fixture in its design orientation.

For headlamp applications, the thermal cycle test is specified per SAE J1383 “Thermal Cycle Test” and for non-headlamp applications, the power switching cycle is specified by SAE J575 “Plastic Warpage Test,” Cycle Times and the thermal cycle profile is specified by SAE J1383 “Thermal Cycle Profile.”

For the lighting electronic control module, the temperature profile for all applications is specified per Figure 2. The electronic module shall be cycled with a minimum temperature of –40 °C and a maximum temperature per applicable zone as outlined in Figure 3.

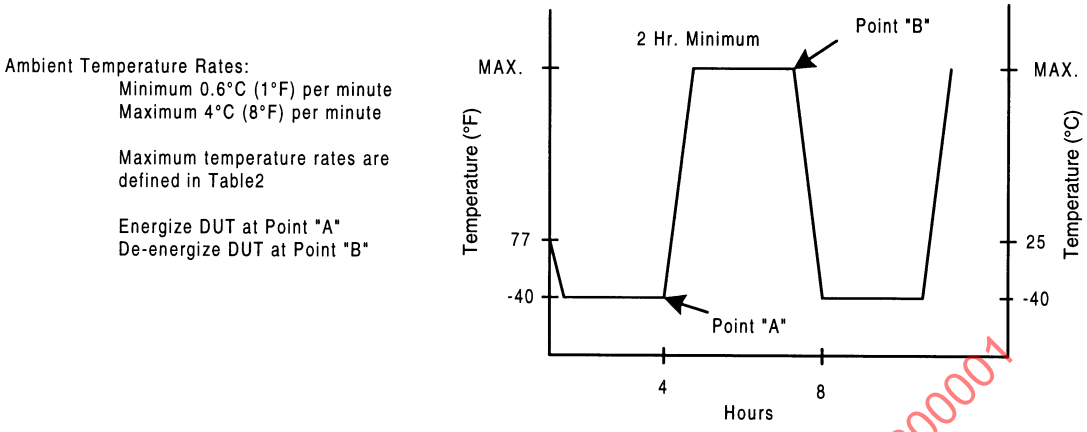

FIGURE 2—8 H TEMPERATURE CYCLE PROFILE

5.2.2 THERMAL SHOCK—This test is for integral and non-integral lighting electronic control modules. Integral lighting systems may be tested for thermal shock without the light source(s) included in the system.

Thermal soak time (T_{soak}) is dependent on the DUT thermal mass and chamber size. T_{soak} must be experimentally determined. The internal DUT temperature must stabilize at the desired chamber temperature plus an additional 15 min. T_{soak} will be a minimum of 30 min but increases with mass.

A thermal shock cycle is defined in the following steps:

a. Soak the DUT in a temperature chamber set at –40 °C for T_{soak}.
b. Transport the DUT to a high temperature chamber within a maximum of 60 s. The high temperature setting is specified on the temperature zone chart. (See Figure 3.)
c. Soak the DUT in the high temperature chamber for T_{soak}.
d. Transport the DUT to a low temperature chamber set at –40 °C within a maximum of 60 s.

Repeat the thermal shock cycle, steps a to d, until 15 cycles are completed.

5.2.3 HUMIDITY/MOISTURE—The DUT (Device Under Test) shall be mounted on the test fixture in its design orientation.

5.2.3.1 Modules as Part of the Lamp Assembly—The assembly shall be tested per the appropriate application:

Discharge Forward Lighting: Per SAE J2009, “Humidity.”
Non-discharge headlamps: Per SAE J1383 “Humidity Test.”
All others: Per SAE J575 “Moisture Test.”

5.2.3.2 All Other Module Configurations—All other modules shall be tested by either Humidity testing, Immersion testing, or Splash testing as specified in SAE J1211 Table 13 “Environmental Extreme Summary” for the module location on the vehicle.

5.2.3.2.1 Humidity Test—Subject the module to 5 cycles (120 h) of SAE J1211, “Recommended Test Methods,” per Figure 3A “24 Hr. Cycle,” (Figure 4 in this document). The module shall operate continuously at normal load stress conditions from the 6th hour through the 24th hour of each cycle. Frost shall be induced as appropriate for the location of the module on the vehicle as recommended in Table 13, “Environmental Extreme Summary” of J1211.

CHEMICAL RESISTANCE TESTING & ZONAL TEMPERATURE REQUIREMENTS				
Description of Location in Vehicle			Temp °C	List of Chemicals
Zone 1 - Under Hood (Engine Compartment)	Away from Heat Source	Well ventilated with cool air from outside engine compartment	95	1. Engine oil 2. Transmission fluid 3. Brake fluid (near brake & ABS systems) 4. Coolant 5. Window washer fluid 6. Grease 7. Soap for cleaning engine compartment 8. Battery acid (near the battery only) 9. Clear Lacquer 10. CaCl2 (Calcium Chloride) 11 Power steering fluid 12. Degreasers 13. Steam 14. Freon 15. Ether
		Well ventilated	115	
	Near heat source		150	
Zone 2 - Body Exterior (Lower Exterior Body and Underbody, Upper Exterior Body)	Outer Body Exterior (including bumpers, side view mirrors, roof etc.)		85	1. Kerosene 2. Fuel (including gasoline, methanol, etc.) 3. Leather wax 4. Car wax and silicone protectants 5. Window glass cleaner 6. Car wash soap 7. Window washer fluid 8. Damper oil (near air suspension valve or height control system) 9. CaCl2 (Calcium Chloride) 10. Undercoating materials 11. Rear axle oil 12. Axle grease 13. Vinyl plasticizers
	Under-body (including Suspension)	Near Trans. or Differential	125	
		Drivetrain - High Temp	177	
		Away from heat source	85	
		Near exhaust (with protection)	150	
	Near Brake Pad/Rotor			
Zone 3 - Body Interior	Package Tray		107	1. Leather Wax 2. Anti-mist spray 3. Soap for cleaning 4. De-odorizer spray 5. Coffee, tea, cola, etc. 6. Vinyl plasticizers
	Floor-Passenger Compartment	Near (underbody) heat source	115	
		Away from (underbody) heat source	85	
	Instrument Panel	Front	85	
		Top	115	
	Luggage Compartment (Trunk)	Away from (underbody) heat source	85	1. Engine oil 2. Coolant 3. Window washer fluid 4. Grease 5. Battery acid (near battery only) 6. Kerosene 7. Fuel (near fuel filler door) 8. Window glass cleaner 9. Cleaning soap
		Near (underbody) heat source	115	
	Door Interiors	Near top (in upper areas heated by sunlight)	105	1. Undercoating materials
		Mid and lower portions	85	

FIGURE 3—CHEMICAL RESISTANCE TESTING AND ZONAL TEMPERATURE REQUIREMENTS

5.2.3.2.2 Immersion Test—Heat the module to the maximum temperature of SAE J1211 Table 1, for the module location on the vehicle and operate at max. load until the module's internal temperature stabilizes. Immersion test the module within 5 min per SAE J1211 "Immersion and Splash Recommended Test Method" to a depth of 0.15 m. The module shall be operating or non-operating during the test as defined by the user.

5.2.3.2.3 Splash Test—Heat the module to the maximum temperature of SAE J1211 Table 1 for the module location on the vehicle and operate at maximum load until the module's internal temperature stabilizes. Splash test the module within 5 min per SAE J1211 section 4.4.3. The module shall be operating or non-operating during the test as defined by the user.

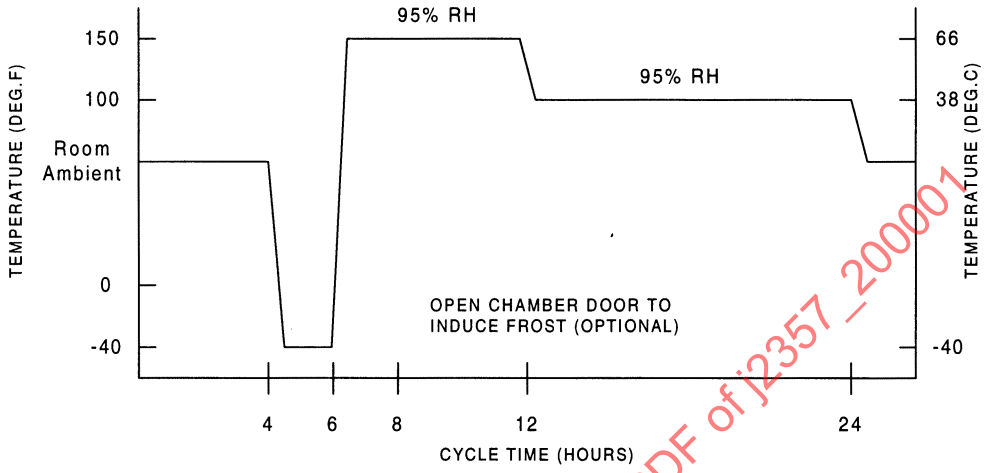

FIGURE 4—24 H HUMIDITY CYCLE

5.2.4 CHEMICAL RESISTANCE TEST—The DUT shall be mounted on a test fixture in its design orientation.

5.2.4.1 *Modules As Part of the Lamp Assembly*—If the lighting electronic control module is part of the headlamp assembly (Integral), the assembly shall be tested per the appropriate application:

Discharge Forward Lighting - SAE J2009, "Chemical Resistance Test".
Non-Discharge Forward Lighting: - SAE J1383, "Chemical Resistance Test".

5.2.4.2 *All Other Modules Configurations*—All other modules shall be tested by selecting applicable chemicals and temperature from Figure 3 based on the modules location on the vehicle. Brush the specified chemical solutions onto the DUT and then hold the DUT at the specified temperature for 96 h.

5.2.5 CORROSION TEST—The DUT shall be mounted on a test fixture in its design orientation.

5.2.5.1 *Modules As Part of the Lamp Assembly*—If the lighting electronic control module is part of the headlamp assembly (Integral), the assembly shall be tested per the appropriate application:

Discharge Forward Lighting: - SAE J2009, "Corrosion Test."
Non-Discharge Forward Lighting: - SAE J1383, "Corrosion Test."
Non Headlamp Assemblies: Per SAE J575; "Corrosion Test."

5.2.5.2 *All Other Modules Configurations*—All other modules determine from SAE J1211, Table 13, "Environmental Extreme Summary," if the salt spray testing is specific for the location on the vehicle. If the salt spray testing is specified, test to SAE J575 "Corrosion Test." The module shall be operating or non-operating as defined by the user.

5.3 Mechanical

5.3.1 VIBRATION

SAE J575 Vibration Test (Application Specific)
SAE J1211 Vibration Test (Application specific)
Random vibration profile as shown in Table 2 and Figure 5.

TABLE 2—RANDOM VIBRATION PROFILE LEVELS

Break Point Frequency (Hz) Passenger Compartment RMS G Level = 2.5G	Break Point Frequency (Hz) Engine/Trunk Compartments RMS G Level = 3.5G	Power Spectral Density (G^2/Hz) Engine/Trunk Compartments RMS G Level = 3.5G
10	10	0.02
20	20	0.05
40	100	0.05
800	800	0.001
1000	1000	0.001

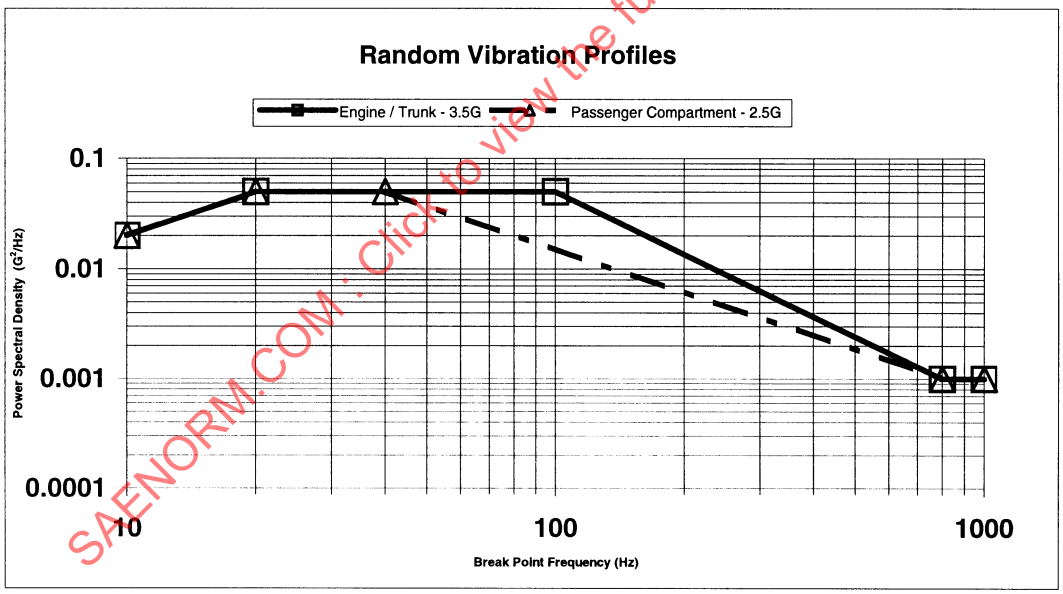

FIGURE 5—RANDOM VIBRATION PROFILE PLOT

5.4 Electrical

5.4.1 OPERATING VOLTAGE AND CURRENT—The DUT shall be placed in normal operating position/orientation at room ambient conditions, and a power supply/source shall be used which meets the criteria as specified.

5.4.1.1 *Design Nominal*—The DUT shall be energized with 12.8 V DC ± 0.1 V DC (proper polarity observed) and allowed to reach steady-state operating condition. The functional characteristics of the DUT shall be measured as specified for the particular DUT and the steady-state current measured. The DUT shall be de-energized and allowed to cool.

5.4.1.2 *Extended Voltage Range*—The DUT shall be tested to 5.4.1.1 but energized with 9.0 V DC ± 0.1 VDC. Additionally, the voltage shall be decreased by 0.2 V increments until the DUT fails to operate (meet its functional characteristics) and the lower limit operating voltage [LLOV] recorded. The DUT shall be de-energized. Next, the procedure in 5.4.1.1 is repeated with the DUT energized with 16.0 V DC ± 0.1 V DC. Lastly, the voltage shall be increased to 18.0 V DC ± 0.1 VDC, and the steady-state current recorded.

5.4.1.3 *Extended Temperature Range*—The DUT shall be tested to 5.4.1.1 and 5.4.1.2 at an ambient Upper Temperature [UT] as specified in Figure 3, ±5 °C. Then 5.4.1.1 and 5.4.1.2 shall be repeated for the DUT at an ambient Lower Temperature [LT] of –40 °C ± 5 °C.

5.4.1.4 *Reverse Voltage*—The DUT shall be energized with (–)12.8 VDC ± 0.1 VDC, allowed to reach steady-state (if applicable) and the current recorded.

5.4.2 CURRENT RANGE—Current limits and testing parameters based on the design current draw of the device.

5.5 Life and Maintenance

5.5.1 LIFE—Test the DUT to the SAE guideline per the appropriate light source

5.5.1.1 *Filament Sources*—SAE J1383 “Filament Rated Average Lab Life Test” for systems employing filament sources.

5.5.1.2 *Non-Filament Sources or Electronic Controls*—SAE J2009 “Life” for systems employing non-filament sources and /or electronic controls.

5.5.2 LUMEN MAINTENANCE—Test the DUT to the SAE guideline per the appropriate light source.

5.5.2.1 *Filament Sources*—SAE J1383 “Luminous Flux Maintenance Test” for systems employing filament sources.

5.5.2.2 *Non-Filament Sources or Electronic Controls*—SAE J2009 “Photometric Maintenance” for systems employing non-filament systems and/or electronic controls.

6. Requirements

6.1 Electromagnetic Compatibility

6.1.1 ELECTROMAGNETIC INTERFERENCE—The DUT must be tested per the appropriate functional status specification as defined in Appendix A from J1113-1 (Figure A1.). Most regulated exterior lighting functions will be Class C, Region I devices. The classifications of non-regulated, non-essential lighting devices are to be determined by the OEM supplier.

6.1.1.1 Conducted Emissions

6.1.1.1.1 Transient Waveform Limits—The DUT must meet the appropriate severity limit from SAE J1113-42 Table A1, "Transient Waveform Limits," for the functional status classification determined in 6.1.1.

6.1.1.1.2 Additional Requirements—The DUT must meet J1113-41 Table 4, "Limits For Broadband Conducted Disturbances On Power Input Terminals (Peak or Quasi-Peak Detector)" Table 6, "Limits For Broadband Conducted Disturbances On Control/Signal Lines (Peak or Quasi-Peak)" and Table 7, "Limits For Narrowband Conducted Current Disturbances On Control/Signal Lines (Peak Detector)," Class 1 noise levels for the appropriate frequency ranges

6.1.1.2 Radiated Emissions

6.1.1.2.1 Absorber Lined Chamber—The DUT must meet SAE J1113-41 Table 8, "Limits For Component Broadband Radiated Disturbance (Peak or Quasi-Peak Detector)," and Table 9, "Limits for Narrowband Component Radiated Disturbance (Peak Detector)" Class 1 noise levels for the appropriate frequency.

6.1.1.2.2 TEM Cell Method—TEM Cell requirements may be substituted in 6.1.1.2.1 for the frequency band ranges below 172 MHz. The DUT in the TEM Cell measurements must meet SAE J1113-41 Table 10, "Disturbance Limits," Class 1 requirements.

6.1.2 ELECTROMAGNETIC SUSCEPTIBILITY (IMMUNITY)

6.1.2.1 Conducted Immunity

6.1.2.1.1 Power Leads 30 Hz to 250 MHz—The DUT must meet SAE J1113-2 Table A1 "Recommended Levels." Test levels as determined by SAE J1113-1 Appendix A.

6.1.2.1.2 Conducted Transients—The DUT must meet SAE J1113-11 Table B1, "Pulse Amplitude Severity Selection Table for 12 V Systems," for 12 V Systems, (or Table B2, "Pulse Amplitude Severity Selection Table for 24 V Systems," for 24 V systems) for the functional status classification from 6.1.1.

6.1.2.1.3 Direct Injection 250 kHz to 500 MHz—The DUT must meet SAE J1113-3 Figure A1 for the functional status classification determined in 6.1.1.

6.1.2.1.4 Bulk Injection 250 kHz to 500 MHz—The DUT must meet SAE J1113-4 Figure A1 for the functional status classification determined in 6.1.1.

6.1.2.2 Radiated Immunity

6.1.2.2.1 Low Frequency Tests

6.1.2.2.1.1 Power Lines—The DUT must meet the suggested peak magnetic field intensity levels as defined in SAE J1113-22 Figure A1, "Suggested Test Severity Levels," for the status classification from 6.1.1.

6.1.2.2.1.2 Strip Line Method—The DUT must meet SAE J1113-23 requirements for the functional status from 6.1.1.

6.1.2.2.1.3 TEM Cell Method—The DUT must meet SAE J1113-24 requirements for the status classification from 6.1.1.

6.1.2.2.1.4 Tri-Plate Method—The DUT must meet SAE J1113-25 requirements for the status classification from 6.1.1.

6.1.2.2.2 High Frequency Tests

6.1.2.2.2.1 Absorber Lined Chamber—The DUT must meet SAE J1113-21 Figure A1 for the functional status classification from 6.1.1.

6.1.2.2.2.2 Reverberation Chamber—The DUT must meet SAE J1113-27 Figure C1 for the functional status classification from 6.1.1.

6.1.2.3 ESD (Electrostatic Discharge)—After testing as specified in 5.2.1.1, the DUT shall meet the requirements of 6.4.1.1.

6.2 Environmental

6.2.1 THERMAL CYCLE

6.2.1.1 Module As Part of the Lamp Assembly—If the module is part of the headlamp assembly, then the assembly shall meet the requirements of SAE J1383 "Thermal Cycle Test." For non-headlamp applications, the (excluding the load) shall not distort or degrade to prevent the normal operation of the lamp assembly. The module shall meet the requirements in 6.2.1.2 of this document.

6.2.1.2 All Other Module Configurations—The module must be functional after the tests in 5.2.1.2 of this document and any degradation shall not affect its performance. If the lamp assembly is tested, then it shall not distort or degrade to prevent normal operation of the lighting electronic control module.

6.2.2 THERMAL SHOCK—The DUT shall be capable of meeting a minimum of 15 cycles of thermal shock.

The DUT must pass functional parametric tests and a mechanical degradation shall not affect the electronic lighting control module's functionality.

6.2.3 HUMIDITY/MOISTURE

6.2.3.1 Modules As Part of the Lamp Assembly—If the module is part of a lamp assembly, the assembly shall meet per the appropriate application:

Discharge Forward Lighting: The requirements of SAE J2009 "Humidity Test."
Non-discharge headlamps: The requirements of SAE J1383 "Humidity Test."
All others: The requirements of SAE J575 "Water Spray Test Requirements" or "Water Submersion Test Requirements."

6.2.3.2 All Other Module Configurations—All modules shall operate throughout the test. After completing the Humidity, Immersion, or Splash test there shall be no degradation in performance or visible signs of deterioration or damage such as: swelling of hydroscopic materials; electrical shorts, binding or moving parts; loss of lubricants between moving parts; oxidation and/or corrosion; breakdown of surface coatings; degradation of image transmission through optical elements.

6.2.4 CHEMICAL RESISTANCE TEST

6.2.4.1 Modules As Part of the Lamp Assembly—If the lighting electronic control module is part of the headlamp assembly (Integral), the assembly shall meet per the appropriate application:

Discharge Forward Lighting - The requirements of SAE J2009, "Chemical Resistance Test."
Non-Discharge Headlamps - The requirements of SAE J2183 "Chemical Resistance Requirement."

6.2.4.2 *All Other Module Configurations*—After completing the test there shall be no degradation in performance or visible signs of deterioration or damage, such as: degradation of materials (cracking, softening, warping, etc.); deterioration of label adhesives; discoloring of materials; smudging of inks and dies.

6.2.5 CORROSION TEST

6.2.5.1 *Modules As Part of the Lamp Assembly*—If the lighting electronic control module is part of the headlamp assembly (Integral), the assembly shall meet per the appropriate application:

Discharge Forward Lighting: - The requirements of SAE J2009, "Corrosion Test."
Non-Discharge Headlamps: - The requirements of SAE J2183 "Corrosion Requirement."
Non-Headlamp Assemblies: - The requirements of SAE J575 "Corrosion Test Requirements."

6.2.5.2 *All Other Module Configurations*—All other modules shall meet the SAE J575 "Corrosion Test Requirements." Also the module shall operate properly throughout the test. After completing the test, there shall be no degradation in the performance or damage such as: swelling of hygroscopic materials, electrical shorts, binding of moving parts, loss of lubricants between moving parts, breakdown of surface coatings, degradation of electrical components/circuits, degradation of image transmission through optical elements.

6.3 Mechanical

6.3.1 VIBRATION—Upon completion of the vibration test procedure, there shall be no observed rotation, displacement, cracking, or rupture of parts of the device (except bulb filaments or headlamp light source filaments) which would result in the failure of any other tests contained in this document. Cracking or rupture of parts of the device affecting its mounting shall also constitute a failure.

The DUT shall meet the requirements of 6.4.1.1.

6.4 Electrical

6.4.1 OPERATING VOLTAGE AND CURRENT REQUIREMENTS—The DUT shall meet the following requirements as tested per procedures outlined in 5.4.1.

6.4.1.1 *Design Nominal*—The DUT shall operate within the functional characteristic requirements for the particular DUT and require less than the maximum specified steady-state current allowed.

6.4.1.2 *Extended Voltage Range*—The LLOV measured shall be less than or equal to the design lower limit operating voltage [DLLOV] as specified by the manufacturer, and the DUT shall not exceed the maximum specified steady-state current. From the design nominal voltage to the DLLOV, the DUT may operate within ±25% of nominal functional performance characteristics. The DUT shall operate at 18.0 V DC and shall not exceed the maximum specified steady state current.

6.4.1.3 *Extended Temperature Range*—At extended temperature range operation from DLLOV to 18.0 V DC, the DUT may operate within ±50% of nominal functional performance characteristics.

6.4.1.4 *Reverse Voltage*—The DUT, if designed with reverse voltage protection, shall shut down or may not operate at all. The current draw shall not exceed its normal operating value. When the polarity is returned to normal and the DUT is re-energized, it shall operate as specified in 6.4.1.1. If the DUT is not designed with reverse voltage protection it is not required to operate as specified in 6.4.1.1.

6.4.2 CURRENT RANGE—The current draw for the DUT shall not exceed go below the specified design maximum or minimum current rating at the completion of the electrical tests.

6.5 Life and Maintenance

6.5.1 LIFE—Evaluate the DUT to the SAE guideline per the appropriate light source

6.5.1.1 *Filament Sources*—SAE J1383 “Filament Rated Average Lab Life” for systems employing filament sources.

6.5.1.2 *Non-Filament Sources or Electronic Controls*—SAE J2009 “Life” for systems employing non-filament sources and/or electronic controls.

6.5.2 LUMEN MAINTENANCE TEST—Evaluate the DUT to the SAE guideline per the appropriate light source

6.5.2.1 *Filament Sources*—SAE J1383 “Luminous Flux Maintenance” for systems employing filaments.

6.5.2.2 *Non-Filament Sources*—SAE J2009 “Photometric Maintenance” for systems employing non-filament sources and/or electronic controls.

For long life sources, maintenance shall be measured at 70% of life or 1400 h, whichever is less.

7. ***Supporting Statements—***This document specifically addresses Forward Lighting, Daytime Running, Fog lamps, Signaling, and Marking lighting systems.

Light sources addressed by this document are:

a. Incandescent (e.g., Halogen)
b. Discharge (e.g., Neon, Metal Halide)
c. Solid State (e.g., Light Emitting Diodes, Electro-luminescent)

Electronic devices applicable to this document are:

a. Ballasts for Discharge Lamps
b. Lighting control modules, (such as, but not limited to; Automatic Dimming Leveling and Aiming, Smart lighting)
c. PWM (Pulse Width Modulation) Modules
d. Lighting electrical power converters, (such as, but not limited to; DC to AC Converters, Voltage Regulators, and Voltage dividers)

Environmental product requirements applicable to this document for lighting electronic control modules, but not limited to are:

a. Temperature
b. Humidity and Moisture
c. Vibration and Shock
d. Chemical corrosion

Electrical product requirements applicable to this document are:

a. Operating Voltage and Current
b. EMC (Electro-Magnet Compatibility) which includes product susceptibility, radiated and conducted emissions

7.1 Electromagnetic Compatibility—With the increasing amount of electrical and electronic content on vehicles, electromagnetic compatibility has become a significant concern. Electromagnetic disturbances occur during the normal operation of many components/systems on the vehicle. Disturbances can be generated over a broad frequency range and may be distributed to on-board electronic devices by conduction or radiation. These disturbances can potentially result in a temporary malfunction or even permanent damage to electronic equipment. Therefore, the electromagnetic environment in which electronically driven and/or controlled exterior automotive lighting equipment is required to operate must be considered.

The writers of SAE J1113 also participated in drafting ISO TC 22 Subcommittee 3 documents and CISPR Subcommittee D documents. The SAE EMC documents are the only ones that specifically address EMC issues for the automotive environment. SAE J1113 is the appropriate standard to reference for lighting electronic control modules. SAE J1113-1 provides EMC related definitions and a general overview of the test methodologies defined in SAE J1113.

7.1.1 ELECTROMAGNETIC INTERFERENCE—Electromagnetic interference (EMI) test methodologies address electromagnetic disturbances emitted by a module or component which may interfere/degrade the performance of other components, modules, or systems. The emissions may be conducted or radiated. SAE J1113 defines several classifications and provides recommended disturbance limits for each classification. It is the responsibility of the vehicle manufacturer to determine the appropriate classification and modify the limits if required. The types of disturbance sources addressed include broadband (e.g., a headlamp leveling motor), narrow band (e.g., a smart lighting module containing a microprocessor), and transient (e.g., the switching of inductive loads such as a motor).

7.1.1.1 Conducted Emissions—SAE J1113-41 provides limits and test methods for measuring conducted emissions (narrow band and broad band) in the frequency range of 150 kHz to 108 MHz. SAE J1113-42 addresses limits and test methods for conducted transient emissions.

7.1.1.2 Radiated Emissions—SAE J1113-41 Table 8 and Table 9 provides limits and test methods for measuring radiated emissions (narrow and broad band) in the frequency range of 0.15 MHz to 960 MHz. TEM Cell measurements for radiated emissions are also addressed in SAE J1113-41 Table 10 and can be substituted for the lower frequencies of 0.15 MHz to 172 MHz.

7.1.2 ELECTROMAGNETIC SUSCEPTIBILITY (IMMUNITY)—Electromagnetic susceptibility (EMS) test methodologies address the ability of a module/component to perform without degradation in the presence of an electromagnetic disturbance. Thus, EMS considers the immunity of a device to electromagnetic disturbances (conducted and radiated). SAE J1113 defines functional status classifications that indicate the operational status of a function provided by an electrical/electronic device. Regions of performance are defined which specify the expected performance of a device when exposed to given levels of disturbance. Recommended test signal severity levels are provided for various types of electromagnetic disturbances.

7.1.2.1 Conducted Immunity—SAE J1113-2 provides requirements for conducted immunity testing from 30 Hz to 250 kHz. SAE J1113-11 defines test methods for evaluating immunity to conducted transients on power leads.

7.1.2.2 Radiated Immunity—SAE J1113-3 (direct radio frequency injection), SAE J1113-4 (bulk current injection), SAE J1113-23 (Stripline), SAE J1113-24 (TEM cell), and SAE J1113-25 (Tri-plate line) define equivalent radiated immunity test methods appropriate for the lower frequency ranges (<500 MHz). The fundamental differentiation for the various methods is the use of different types of test equipment. This allows flexibility in the choice of instrumentation to be used in evaluating radiated immunity. SAE J1113-21 (absorber lined chamber) addresses radiated immunity testing over the 10 kHz to 18GHz range. SAE J1113-27 (reverberation chamber) provides methods for radiated immunity testing over the higher frequency range of 500 MHz to 2 GHz.

7.1.2.3 *ESD (Electrostatic Discharge)*—All lighting and electronic components are handled by human at some point in the manufacturing, shipping, receiving and maintenance product cycle. The human body will transfer Electrostatic Discharges to the product during these processes. The ESD standard should simulate these situations. After the product has been tested, it should not be damaged.

SAE J1113-13 defines several classifications and provides appropriate test procedures based on research of a human body Electrostatic Discharge. In addition, SAE J1113-13 has been based on the International Electrotechnical Commission standard IEC 60801-2.

7.2 **Environmental—**Testing requirements for traditional lighting devices in their traditional locations on a vehicle have long been established. Lighting electronic controls may be located in various locations of the vehicle for which no lighting related testing requirements have been previously identified. Therefore, the challenge is to establish environmental criteria for the various locations of the vehicle that lighting electronic control modules may be located.

It is recommended that SAE J1211 be used whenever the tests described in the document are applicable. Although the intent of SAE J1211 is to provide design goals based on component location on the vehicle, it does not clearly define standardized laboratory tests applicable to those locations. Therefore, some embellishments are needed, which are contained in the wording of this document.

7.2.1 THERMAL CYCLE—Thermal cycle testing is fundamental in the evaluation of how robust the design of a lamp assembly and lighting electronic control module is for the intended application.

In the evaluation of headlamp and non-headlamp systems that employ integral electronic control modules testing is done with the power applied over a limited temperature range suitable for headlamp applications. In addition, for those applications that are not headlamps the appropriate thermal cycle profile is chosen from SAE J575 Table 1.

Since the lighting electronic control module is susceptible to failure due to thermal cycling, an additional test of the electronic portion of the assembly to possibly greater extremes in temperature is recommended if the module can be operated outside the lamp assembly. A suitable load is used that permits the module to operate outside the lamp assembly provided it meets its functional requirements.

Lamp assemblies with integral lighting electronic control modules are tested in less severe environments than a non-integral lighting electronic control module.

The tests outlined in SAE J2357 are referred to Table 1 and Figure 3 of this document. Table 1 is included as a aid to understanding the sections contained in 5.2.1. Thermal cycle profiles indicated in Table 1 by an "R" are required and "O" are optional. Optional testing is recommended when improved system reliability is desired. Figure 3 is a composite table identifying the maximum temperatures used in the thermal cycle profile found in Figure 2 relative to the zone the lighting electronic control module will be used.

7.2.2 THERMAL SHOCK—Non-operational Thermal Shock testing is useful to verify the DUT's functionality after exposure to sudden changes in temperature. Thermal shock is a common test for lighting electronic control modules, but not for lighting systems. Therefore, this test is specified for both integral and non-integral lighting systems.

For integral systems, the system supplier should consider the lighting source and determine if it can or should be exposed to the thermal shock. The supplier can test the lighting electronic control module without the lighting source and test the electronics for functional parameters after the thermal shock.