

# **LED Pedestrian & Countdown Signal Modules Compliant To: ITE PTCSI - Part 2**

## **Key Features:**

- **Uniform Non-pixillated Appearance**
- **ITE PTCSI – Part 2 Compliance Including Luminance Uniformity and Color Uniformity From -40° C Through +74° C**
- **Transient Suppression Exceeds ITE Requirements**
- **Advanced Failed State Impedance Protection**
- **Turn-on/Turn-off Time < 75 Milliseconds**
- **Textured Lens Reduces Sun Reflections**
- **Conformally Coated Power Supply**
- **All Products Traceable by Serial Number**

## **Types:**

### **16"x18" 120VAC Types**

Side-by-Side Hand & Person

Overlay Hand & Person

Countdown with Overlay Hand & Person

### **12"x12" 120VAC Types**

Hand Only

Person Only

Overlay Hand & Person

Countdown Only

## 1. Purpose

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The purpose of this specification is to provide the minimum performance requirements for LED pedestrian signal modules (hereafter called module or modules) with “walking person”, “upraised hand”, and “countdown digit” icons. This specification includes the following sizes (nominal message bearing surface): 406mm x 457 mm (16 in x 18 in) and 305mm x 305mm (12 in x 12 in). This specification refers to definitions and practices described in “Pedestrian Traffic Control Signal Indications” published in the *Equipment and Materials Standards of the Institute of Transportation Engineers*, referred to in this document as “PTCSI.”

## 2. Definitions

The following definitions are in addition to the definitions in the PTCSI.

**2.1 Catastrophic Failure.** The total loss of visible illumination from the LED light source.

**2.2 Chromaticity.** The color of the light emitted by a module, specified by the  $x, y$  chromaticity coordinates on the 1931 Commission Internationale d’Eclairage (CIE) chromaticity diagram.

**2.3 Conditioning.** Energizing a LED signal module at a specified ambient temperature for a specified period of time, to cause any early electronic component mortality failures to occur and to detect any component reliability problems.

**2.4 Duty Cycle.** The amount of time during a specified time period that a module is energized, expressed as a percent of the specified time period.

**2.5 Abrasion Resistance Material.** A surface coating or integral material that provides outer lens front surface abrasion resistance.

**2.6 LED Light Source.** An array of LEDs mounted on a printed circuit board.

**2.7 LED Pedestrian Signal Module (module).** A signaling unit comprised of an LED light

sources and a related power supply, and any required lenses, which, when connected to appropriate power, provides a pedestrian signal indication.

**2.8 Luminance.** The luminous flux emitted or reflected from a surface, in a given direction, per unit solid angle, divided by the area of the surface, expressed as  $\text{cd/m}^2$ .

**2.9 Minimum Maintained Luminance.** The minimum luminance a module is required to provide throughout service as a pedestrian control signal.

**2.10 Nominal Operating Voltage.** The AC RMS voltage, 120 VAC, at which photometric performance and power consumption are specified.

**2.11 Power Consumption.** The electrical power in Watts consumed by a module when operated at nominal operating voltage and ambient operating temperature range.

**2.12 Power Factor.** The power factor equals Watts divided by Volt-Ampere or the ratio of power consumption in Watts to Volt-Amperes.

**2.13 Total Harmonic Distortion (THD).** THD is the ratio of the root-mean-square (RMS) value of the harmonics to the amplitude of the fundamental component of the AC waveform.

**2.14 Translate.** To move an object along a linear vector, such that the orientation of the object does not rotate relative to the original frame of reference.

**2.15 Turn OFF Time.** The amount of time required after removal of the nominal operating voltage for the LED signal module to show no visible illumination.

**2.16 Turn OFF Voltage.** The voltage below which the LED signal module emits no visible illumination.

**2.17 Turn ON Time.** The amount of time required for the LED signal module to reach 90% of full illumination.

**2.18 Volt-Amperes.** The product of the root-mean-square (RMS) line voltage and RMS line current, measured with true RMS meters.

### 3. Physical & Mechanical Requirements

#### 3.1 General

3.1.1. Usage: Modules shall fit into pedestrian signal housings manufactured in accordance with the ITE PTCSI Standard, March 1985, without modification to the housing.

3.1.2. Installation requirements: Installation of a module into an existing pedestrian signal housing shall only require the removal of the existing optical unit components, i.e., lens, lamp module, gaskets, and reflector; shall be weather tight and fit securely in the housing; and shall connect directly to existing electrical wiring. Installation shall not require special tools.

3.1.3. The sizes of the message bearing surfaces shall be in accordance with the dimensions given in Table 1.

**Table 1—Dimensions of Signal Sizes**

Message Bearing Surface Height X Width	Minimum Message Size Height X Width
305mm x 305mm (12" x 12")	297mm x 178mm (11" x 7")
406mm x 457mm (16" x 18")	297mm x 178mm (11" x 7")

3.1.4 Modules shall completely comply with the ITE PTCSI – Part 2: LED Pedestrian Traffic Signal Modules specification. ETL/Intertek certified test reports are required to verify full compliance to the ITE PTCSI – Part 2: LED Pedestrian Traffic Signal Modules specification.

#### 3.2 The LED Signal Module

3.2.1 The module shall be capable of replacing

the optical component of the pedestrian indication.

3.2.2 The lens shall have a textured surface to reduce glare.

3.2.3 The module lens may be a replaceable part, without the need to replace the complete module.

3.2.4 Abrasion Resistance - A surface coating or integral material shall be used to provide front surface abrasion resistance.

3.2.5 For optimum diffusion of all icons, there shall be a minimum of 1.5 inches of space between the surface of the module lens and the LEDs used to illuminate the icons.

3.2.6 The "Portland Orange" LED's shall be of the latest AllnGaP technology and the "Lunar White" LED's of the latest InGaN technology.

3.2.7 The configurations of the walking person icon and upraised hand icon are illustrated in Figure 1 and Figure 2 respectively. The upraised hand and walking person icons shall be a minimum of 11 inches high and 7 inches wide.

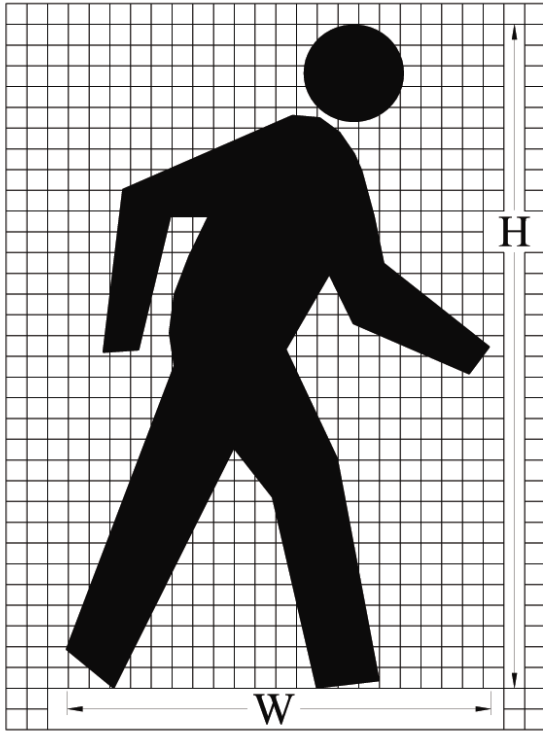
3.2.8 The LED countdown display shall consist of two "7 segment" digits forming the time display. The configuration of the countdown display shall be such that the height of the countdown digits shall be 9 inches and the overall width of the digit display (both digits side-by-side) shall be 7 inches. Each individual 7-segment digit shall be 3.25 inches wide, with 0.5 inches of space between the two digits.

3.2.9 The countdown display shall be MUTCD compliant for crosswalks over 100 feet long.

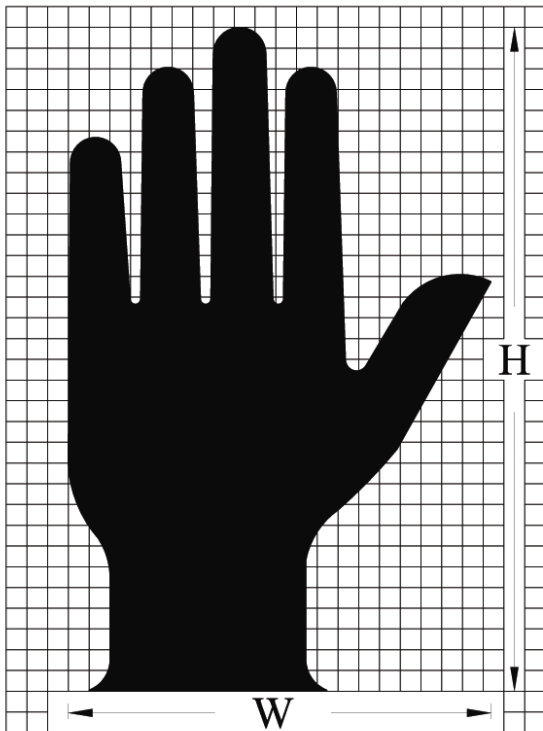
3.2.10 Countdown Drive Circuitry

3.2.10.1 The Countdown Timer portion of the signal shall have a high "off state" input impedance so as not to provide a load indication to conflict monitors and interfere with the monitoring of the pedestrian signals. The input impedance of the countdown circuitry shall maintain

- a voltage reading above 25 VAC to the conflict monitor for a minimum of 4 units connected on the same channel.
- 3.2.10.2 The Countdown Timer drive circuitry shall not be damaged when subjected to defective load switches providing a half wave signal output.
- 3.2.11 Countdown Functionality
- 3.2.11.1 The countdown module shall be compatible with all traffic signal controllers that are fully compliant to NEMA TS-1, NEMA TS-2, Type 170, and Type 2070 traffic signal controller specifications.
- 3.2.11.2 The countdown timer module shall have a micro-processor capable of recording its own time when connected to a traffic controller.
- 3.2.11.3 When connected, the module shall blank out the display during the initial cycle while it records the countdown time using the Walk (Person) & D/Walk (Flashing Hand) signal indications.
- 3.2.11.4 The countdown timer module shall continuously monitor the traffic controller for any changes to the pedestrian phase time and re-program itself automatically if needed.
- 3.2.11.5 The countdown module shall register the time for the walk and clearance intervals individually and shall begin counting down at the beginning of the pedestrian change interval.
- 3.2.11.6 When the flashing Hand becomes solid, the module shall display 0 and then blank-out. The display shall remain dark until the beginning of the next countdown.
- 3.2.11.7 In the event of a pre-emption sequence, the countdown module shall skip the pre-empted clearance time and reach 0 at the same time as the flashing Hand becomes solid.
- 3.2.11.8 Via dip switch settings, in the cycle following a pre-emption call, the signal shall be capable of displaying the correct time and not be affected by the reduced previous cycle. The countdown shall reach 0 at the same time as the flashing Hand becomes solid.
- 3.2.11.9 The countdown timer shall be capable of timing 2 consecutive complete pedestrian cycles outputted by the traffic controller (no steady Hand signal between cycles).
- 3.2.11.10 The countdown module shall have an internal conflict monitor preventing conflicts between the Hand/Person signal indications and the Countdown Timer display.
- 3.2.11.11 The countdown module shall have a user selectable option offering the possibility to countdown the entire duration of the walk and clearance time.
- 3.2.11.12 The countdown module shall have a user selectable option which allows the countdown time to be stored in memory inside the countdown when AC power is removed from the module for extended periods of time.
- 3.2.11.13 The countdown module shall have dip-switches for the following user selectable options: Display "0" during stand-by; Count clearance interval only; Store count value in memory; All LED's "on" (test switch); Disable countdown display; Countdown ped recycle directly back to walk interval from truncated ped clearance interval (per City of Los Angeles specifications)



**Figure 1—Walking Person icon**



**Figure 2— Upraised Hand icon**

### 3.3 Environmental Requirements

3.3.1 All exposed components of a module shall be suitable for prolonged exposure to the environment, without appreciable degradation that would interfere with function or appearance. As a minimum, selected materials shall be rated for service for a period of a minimum of 60 months in a south-facing Arizona Desert installation.

3.3.2 A module shall be rated for use throughout an ambient operating temperature range, measured at the exposed rear of the module, of  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ) to  $+74^{\circ}\text{C}$  ( $+165^{\circ}\text{F}$ ).

3.3.3 A module shall be protected against dust and moisture intrusion, including rain and blowing rain.

3.3.4 The module lens shall not crack, craze or yellow due to solar UV irradiation typical for a south-facing Arizona Desert installation after a minimum of 60 months in service.

### 3.4 Construction

3.4.1 The module shall be a single, self-contained device, not requiring on-site assembly for installation into an existing traffic signal housing. The power supplies for the module shall be integral to the module and shall be conformally coated.

3.4.2 The assembly and manufacturing process for the module shall be designed to assure all internal LED and electronic components are adequately supported to withstand mechanical shock and vibration from high winds and other sources.

### 3.5 Materials

3.5.1 Materials used for the lens and module construction shall conform to ASTM specifications for the materials, where applicable.

3.5.2 Enclosures containing either the power supply or electronic components of the signal module shall be made of UL94 flame retardant materials. The module lens is excluded from this

requirement.

### 3.6 Module Identification

3.6.1 Each module shall be identified on the backside with the manufacturer’s name, model, operating characteristics and serial number. The operating characteristics identified shall include the nominal operating voltage and stabilized power consumption, in watts and Volt-Amperes. The main module label which includes the module’s serial number (or date code) and the model number shall be attached using polyester or vinyl self-adhesive labels. The use of paper labels is not acceptable.

3.6.2 Modules shall have a prominent and permanent vertical indexing indicator, i.e., UP Arrow, or the word UP or TOP, for correct indexing and orientation in the signal housing.

3.6.3 Modules conforming to all requirements of this specification shall have a statement on an attached label which states conformance to the latest version of the ITE PTC SI – Part 2 LED Pedestrian Signal Specification.

## 4. Photometric Requirements

### 4.1 Luminance, Uniformity and Distribution

4.1.1 For a minimum period of 60 months, the minimum maintained luminance values for the modules under the operating conditions defined in Sections 3.3.2 and 5.2.1, when measured normal to the plane of the icon surface, shall not be less than:

- Walking Person: 2,200 cd/m<sup>2</sup>
- Upraised Hand: 1,400 cd/m<sup>2</sup>
- Countdown Digits: 1,400 cd/m<sup>2</sup>

The luminance of the emitting surface, measured at angles from the normal of the surface, may decrease linearly to a value of 50% of the values listed above at an angle of 15 degrees.

The light output requirements in this specification apply to pedestrian signal heads without any visors, hooded or louvered (egg-crate). Addition of such visors may affect the

light output of the signal head.

4.1.2 The uniformity of the walking person, upraised hand, and countdown digit icons’ luminance shall meet a ratio of not more than 1 to 10 between the minimum and maximum luminance values, as measured in 12mm (0.5 in) diameter spots.

4.1.3. When operating within the temperature range specified in Section 3.3.1, the average luminance of the module shall not exceed three times the maintained minimum luminance of the modules, as defined in Section 4.1.1.

### 4.2 Chromaticity

The standard colors for the LED Pedestrian Signal Module shall be White for the walking person and Portland Orange for the upraised hand and countdown digit icons. The colors for these icons shall conform to the following color regions, based on the 1931 CIE chromaticity diagram:

Walking Person—White:

- Blue boundary:  $x = 0.280$ .
- 1<sup>st</sup> Green boundary:  $0.280 \leq x < 0.400$   
 $y = 0.7917 \cdot x + 0.0983$ .
- 2<sup>nd</sup> Green boundary:  $0.400 \leq x < 0.450$   
 $y = 0.4600 \cdot x + 0.2310$ .
- Yellow boundary:  $x = 0.450$
- 1<sup>st</sup> Purple boundary:  $0.450 \leq x < 0.400$   
 $y = 0.4600 \cdot x + 0.1810$ .
- 2<sup>nd</sup> Purple boundary:  $0.400 \leq x < 0.280$   
 $y = 0.7917 \cdot x + 0.0483$ .

Point	White	
	x	y
1	0.280	0.320
2	0.400	0.415
3	0.450	0.438
4	0.450	0.388
5	0.400	0.365
6	0.280	0.270

Upraised Hand and Countdown Digits—Portland Orange:

- Yellow boundary:  $y = 0.390$
- White boundary:  $0.600 \leq x \leq 0.680$   
 $y = 0.990 - x$
- Red boundary:  $y = 0.331$ .

Point	Portland Orange	
	x	y
1	0.6095	0.390
2	0.600	0.390
3	0.659	0.331
4	0.669	0.331

The color regions are illustrated in Attachment 1.

**4.3. Color Uniformity**

The uniformity of the emitted colors shall be such that any color measurement within a 12mm (0.5 in) spot on the emitting surface shall fall within the following regions around the average measured color of the entire emitting surface:

- Walking Person—White:

$$\sqrt{(\Delta x)^2 + (\Delta y)^2} \leq 0.04;$$

where  $\Delta x$  and  $\Delta y$  are the differences in the chromaticity coordinates of the measured colors to the coordinates of the average color, using the CIE 1931 Chromaticity Diagram and a 2 degree Standard Observer.

- Upraised Hand and Countdown Digits—Portland Orange:

The dominant wavelength for all individual color measurements shall be within  $\pm 3$  nm of the dominant wavelength for the average of all the individual color measurements.

**5. Electrical**

**5.1 General**

5.1.1 All wiring shall meet the requirements of Section 13.02 of the VTCSH standard. Secured, color coded, 600V, anti-capillary, 18 AWG jacketed wires, 1 meter (39 in) in length, conforming to the NFPA 70, National Electrical

Code, and rated for service at +105°C, shall be provided.

5.1.2 The following color scheme shall be used for the module’s AC power leads: Orange for the upraised hand and countdown digits, Blue for the walking person, and White for common.

5.1.3 So as to reduce crowding of terminal blocks and housings, modules containing a Hand & Person Overlay display as well as a Countdown Timer display shall have only three wires (1 orange, 1 blue, 1 white) exiting the LED module for electrical connection to intersection field wires.

5.1.4 The AC power leads shall exit the module via a rubber grommetted strain relief, and shall be terminated with quick connect terminals and spade tab adapters. The leads shall be separate at the point at which they leave the module.

**5.2 Voltage Range**

5.2.1 LED signal modules shall operate from a  $60 \pm 3$  Hz AC line power over a voltage range from 80 to 135 VAC RMS.

5.2.2 Fluctuations in line voltage over the range of 80 to 135 VAC shall not affect luminous intensity by more than  $\pm 10$  percent.

5.2.3 The module circuitry shall prevent flicker of the LED output at frequencies less than 100 Hz over the voltage range specified in Section 5.2.1.

5.2.4 Low Voltage Turn OFF: There shall be no visible illumination from the LED signal module when the applied voltage is less than 35 VAC.

5.2.5 Turn-ON and Turn-OFF Time: A module shall reach 90% of full illumination (turn-ON) within 75 msec of the application of the nominal operating voltage. The signal shall cease emitting visible illumination (turn-OFF) within 75 msec of the removal of the nominal operating voltage.

5.2.6. Default Condition: For abnormal conditions when nominal voltage is applied to the Hand and Person phase wires (with each

icon having a neutral return path) the pedestrian signal unit shall default to the hand symbol or shall be blank.

### **5.3 Transient Voltage Protection**

The on-board circuitry of the module shall include voltage surge protection, to withstand high-repetition noise transients and low-repetition high-energy transients as stated in Section 2.1.8, NEMA Standard TS 2-2003. In addition, the module shall comply with the following standards: IEC 1000-4-5 at 3kV with a 2 ohm source impedance, ANSI/IEEE C62, 41-2002; IEC 61000-4-12 (6kV, 200A, 100kHz ring wave).

### **5.4 Electronic Noise**

The LED signal and associated on-board circuitry shall meet the requirements of the Federal Communication Commission (FCC) Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise by Class A digital devices.

### **5.5 Power Factor (PF) and AC Harmonics**

5.5.1 Modules shall provide a power factor of 0.90 or greater when operated at nominal operating voltage, and 25°C (77°F).

5.5.2 Total harmonic distortion induced into an AC power line by a module at nominal operating voltage, and at 25°C (77°F), shall not exceed 20%.

### **5.6 Controller Assembly Compatibility**

5.6.1 The current draw for hand and person icons shall be sufficient to ensure compatibility and proper triggering and operation of load current switches and conflict monitors in signal controller units.

5.6.2 Off State Voltage Decay: When the hand or person icon is switched from the On state to the Off state the terminal voltage shall decay to a value less than 10 VAC RMS in less than 100 milliseconds when driven by a maximum allowed load switch

leakage current of 10 milliamps peak (7.1 milliamps AC).

### **5.7 Failed State Impedance**

The module shall be designed to detect catastrophic loss of the hand/person LED load. Upon sensing the loss of the LED load, the module shall present a resistance of at least 250 kΩ across the hand/person input power leads within 300 msec. The LED light source will be said to have failed catastrophically if it fails to show any visible illumination when energized according to Section 5.2.1 after 75 msec.

## **6. Quality Assurance**

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### **6.1 General**

6.1.1 Quality Assurance Program: Modules shall be manufactured in accordance with a vendor quality assurance (QA) program. The QA program shall include two types of quality assurance: (1) design quality assurance and (2) production quality assurance. The production quality assurance shall include statistically controlled routine tests to ensure minimum performance levels of modules built to meet this specification.

6.1.2 Record Keeping: QA process and test results documentation shall be kept on file for a minimum period of seven years.

6.1.3 Conformance: Module designs not satisfying design qualification testing and the production quality assurance testing performance requirements in Sections 6.3 and 6.4 should not be labeled, advertised, or sold as conforming to this specification.

### **6.2 Manufacturers' Serial Numbers**

Each module shall be identified with the information specified in paragraph 3.6.1.

### **6.3 Production Tests & Inspections**

6.3.1 Production Test Requirements: All modules tendered for sale shall undergo the following Production Testing & Inspection prior to shipment. Failure of a module to meet the requirements of Production Testing & Inspection shall be cause for rejection. Test results shall be

maintained per the requirement of Section 6.1.2.

6.3.1.1 All Production Tests shall be performed at an ambient temperature of 25°C (77°F) and at the nominal operating voltage of 120 VAC.

6.3.2 Production Luminance Test: Hand/Person icons shall be tested for maintained minimum luminance. Any measurement with a correlation to the luminance requirements of Section 4.1.1 may be used. Modules that do not meet the maintained minimum luminance requirements as per Section 4.1.1 shall be rejected.

6.3.3 Power Factor: Hand/Person icons shall be tested for power factor per the requirements of Section 5.5.1. A commercially available power factor meter may be used to perform this measurement. Failure of a module to meet the requirements for power factor (5.5.1) shall be cause for rejection of the module.

6.3.4 Current Consumption Measurement: Hand/Person icons shall be measured for current flow in Amperes. The measured current values shall be compared against the design current values from design qualification measurements in Section 6.4.6.1. A measured current consumption in excess of 120% of the design qualification current value for an ambient temperature of 25°C (77°F) shall be cause for rejection of the module.

6.3.5 Visual Inspection: All modules shall be visually inspected for any exterior physical damage or assembly anomalies. Careful attention shall be paid to the surface of the lens to ensure there are no scratches (abrasions), cracks, chips, discoloration, or other defects. The presence of any such defects shall be cause for rejection of the module.

## **6.4 Design Qualification Testing**

6.4.1 Design Qualification testing shall be performed on the hand/person icons of new module designs, and when a major design change has been implemented on existing hand/person pedestrian signal designs. Modules used in design qualification testing shall be representative of the manufacturer's

proposed normal production.

6.4.1.1 Testing shall be performed once every 5 years or when the module design or LED technology has been changed. Test data shall be retained by the module manufacturer in accordance with Section 6.1.2 or for 60 months following final production of a specific design, whichever is longer.

6.4.1.2 Six modules shall be used in Design Qualification Testing. All six modules shall be subjected to conditioning (6.4.2), followed by the Environmental Tests (6.4.3). Following the Environmental Tests, three modules shall undergo Photometric & Colorimetric Tests (6.4.4). The remaining three modules shall undergo the Electrical Tests (6.4.5) and Controller Compatibility Tests (6.4.5.11). Tests shall be conducted in the order described herein, unless otherwise specified.

6.4.1.3 In order for a module design to be considered acceptable for marking with the label described in 3.6.3, all tested modules must comply with the acceptance/rejection criteria for the Environmental Tests (6.4.3), Photometric & Colorimetric Tests (6.4.4), Electrical Tests (6.4.5), and Controller Assembly Compatibility Tests (6.4.5.11).

6.4.2 Conditioning: Modules shall be energized for a minimum of 24 hours, at 100% duty cycle, in an ambient temperature of +60°C (+140°F).

6.4.3 Environmental Testing:

6.4.3.1 Mechanical Vibration Testing: Three modules shall be tested per MIL-STD-883, Test Method 2007, using three 4-minute cycles along each x, y, and z axis, at a force of 2.5 Gs, with a frequency sweep from 2 Hz to 120 Hz.

6.4.3.2 Temperature Cycling. Temperature cycling shall be performed per MIL-STD-883, Test method 1010. The temperature range shall be per Section 3.3.1. A minimum of 20 cycles shall be performed with a 30-minute transfer time between temperature extremes and a 30-

minute dwell time at each temperature. Modules under test shall be non-operating.

6.4.3.3 Moisture Resistance. Moisture resistance testing shall be performed on a sample of three modules per MIL-STD-810F, Procedure I, Rain and Blowing Rain. The test shall be conducted on a stand-alone unit, without a protective housing. The rainfall rate shall be 1.7 mm/min (4 in/hr) and droplet size shall predominantly be between 0.5 mm and 4.5 mm. The module shall be rotated through 120 degrees and the duration of the test shall be 30 minutes. The module shall be energized throughout the test. The water shall be at 25°C. The wind velocity shall be 80 km/hr (50 mph). Any evidence of internal moisture into the module shall be cause for rejection.

6.4.3.4 Hard Coat Test (Optional): When applicable, a sample of three (3) modules shall be tested in accordance to the abrasion resistance test ASTM D1044. A weight of 500 grams shall be applied on a CS10F wheel for 150 cycles.

6.4.3.5 UV Stabilization: Documentation may be provided that clearly demonstrates that the external lens complies with the requirements of section 3.3.4.

6.4.3.6. Environmental Tests Evaluation: At the conclusion of the Environmental Tests, all the modules will be visually inspected for damage.

6.4.3.7 Acceptance/Rejection Criteria: The loosening of the lens, or any internal components, or evidence of other physical damage, such as cracking of the module lens or housing, or presence of internal moisture after testing shall be considered a failure for the proposed design.

6.4.4 Photometric & Calorimetric Tests: Three of the modules that were subjected to the Environmental Tests shall undergo Photometric & Colorimetric Tests. Unless otherwise specified, these tests shall be performed with the modules energized at nominal operating voltage (120 VAC).

6.4.4.1 Maintained Minimum Luminance: The sample set shall be tested for maintained minimum luminance at both 25°C and 74°C. Prior to making measurements, each module shall be operated at a 100% duty cycle for a minimum of 60 minutes at the test temperature.

6.4.4.2 For elevated temperature testing at 74°C, the modules to be tested shall be mounted in a temperature-testing chamber so that the external surface of the emitting lens is outside the chamber and all portions behind the lens are within the chamber at a temperature of 74°C (165°F). The air temperature in front of the lens of the module shall be maintained at a minimum of 49°C (120°F) during the elevated temperature testing.

Measurements shall be made using a luminance meter located on the physical axis of the module lens at a distance such that the selected aperture samples a spot size of 12mm (0.5 inch) at the lens surface. The position of the luminance meter shall be translated from side to side and up and down, so as to sample nine points across the emitting surface of the module.

The luminance values for the nine points shall be recorded and the average value calculated.

Modules for which the calculated average value of luminance does not meet the requirements of Section 4.1.1 shall be rejected.

6.4.4.3 Luminance Uniformity: The sample set shall be tested in accordance with the requirements of Section 4.1.2, using the recorded values of luminance, at a testing temperature of 25°C. The highest and lowest values of luminance shall be recorded and compared. Modules not meeting requirements of Section 4.1.2 shall be rejected.

6.4.4.3.1 Maximum Luminance: The sample set shall be tested in accordance with the requirements of Section 4.1.3, using the recorded values of luminance, at testing temperatures of 25°C and 74°C. Modules for which the calculated average value of the luminance exceeds the limit established in

Section 4.1.3, at either or both temperature levels, shall be rejected.

6.4.4.4 Chromaticity: From the sample set, two modules shall be measured for chromaticity per the requirements of Section 4.2. Prior to making measurements, each module shall be operated at a 100% duty cycle for a minimum of 60 minutes at +25°C (+77°F). Color measurements shall be made using a spectro-radiometer with a maximum bandwidth of 4 nm, or a colorimeter that has a measurement uncertainty of less than 2.5% over the emission bandwidth of the icon under measurement.

Measurements shall be made by locating the instrument on the axis normal to the emitting surface of the icon, at a distance such that the meter samples a spot size of 12mm (0.5 inch) at the lens surface. The position of the instrument shall be translated from side to side and up and down, so as to sample nine points across the emitting surface of the module.

The chromaticity coordinates of the emitted light at the nine points shall be recorded and the average value calculated. In addition, the dominant wavelengths for the nine sampled points of the hand icon shall be calculated and recorded.

Modules for which the calculated average chromaticity coordinates do not meet the requirements of Section 4.2 shall be rejected.

6.4.4.4.1 Color Uniformity: The sample set shall be tested in accordance with the requirements of Section 4.3, using the recorded values of the chromaticity coordinates (walking person—white icon) or the dominant wavelengths (hand—portland orange icon), from Section 6.4.4.4. Modules not meeting requirements of Section 4.3 shall be rejected.

6.4.4.5 Photometric & Colorimetric Tests Evaluation: At the conclusion of the Photometric & Colorimetric Tests, the measurement data shall be compared to the requirements of Sections 4.1, 4.2 and 4.3.

6.4.4.6 Acceptance/Rejection Criteria: The

failure of any module to meet all of the requirements for maintained minimum luminance (4.1.1) and maximum permissible luminance (4.1.3) at 25°C and/or 74°C, and the requirements for luminance uniformity (4.1.2), chromaticity (4.2), and color uniformity (4.3) at 25°C, shall be considered a failure of the proposed design.

6.4.5 Electrical.

6.4.5.1 Current Consumption: The sample set shall be measured for current flow in Amperes. The measured current values shall be used for quality comparison of Production Quality Assurance current measurements on production modules.

6.4.5.2 Temperature vs. Power Consumption: The sample set shall be tested to measure the change in power consumption in Watts versus the change in temperature over the specified operating temperature range. This data shall be recorded and may be made available to all end users.

6.4.5.3 Power Consumption vs. Long-Term Life: If the rated power consumption of the module at 25°C (77°F) and 74°C (165°F) will change more than 10% over time, the manufacturer may provide documentation showing the projected power consumption in Watts of the module over a period of 60 months from the date of installation. This documentation may include data for the following temperature points: 0°C (32°F), 25°C (77°F), 50°C (122°F) and 74°C (165°F).

6.4.5.4 Power Factor (PF): The sample set shall be measured for power factor per the requirements of Section 5.6.1. A commercially available power factor meter may be used to perform this measurement. The PF shall be calculated separately for each of the icons for the module.

6.4.5.5 Total Harmonic Distortion (THD): The sample set shall be measured for total harmonic distortion per the requirements of Section 5.5.2. A commercially available total harmonic distortion meter may be used to perform this

measurement. The THD shall be measured for each of the icons for the module.

6.4.5.6 Low Voltage Turn Off: The sample set shall be measured to ensure compliance with the low voltage turn-off requirement of Section 5.2.4. To test for this condition each icon must first be fully illuminated at the nominal operating voltage. The applied voltage shall then be reduced to the point where there is no visible illumination. This point must be greater than 35 VAC RMS AC.

6.4.5.7 Turn-On and Turn-Off Times: The sample set shall be measured to ensure compliance with the turn-on and turn-off requirements of Section 5.2.5. The measurement shall be conducted using a two channel oscilloscope to measure the time delay between when the module is energized at 120 VAC RMS and when the light output reaches 90% of full output. A photo-multiplier tube shall be used to measure the light output of the module. The same apparatus shall be used to measure the time delay between when the module is de-energized and when the light output reaches 0% of full output. The time in msec shall be plotted in the X axis and light output shall be plotted in the Y axis.

A module not reaching 90% nominal light output within 75 msec at start-up or still showing light output 75 msec after being de-energized shall be deemed to have failed this test.

6.4.5.8 Electronic Noise: From the sample set, a sample of 2 modules shall be tested. The modules shall be tested for conformance with the requirements of a Class A digital device, as specified in FCC Title 47, Subpart B, Section 15.109(b).

6.4.5.9 Nondestruct Transient Immunity: The sample set shall be tested for transient immunity using the procedure described in Section 2.1.8, NEMA Standard TS 2-2003. Failure to meet these requirements shall be cause for rejection.

6.4.5.10 Electrical Tests Evaluation: At the conclusion of the Electrical Tests, the measurement data shall be compared to the

requirements of Sections 5.2 through 5.7.

6.4.5.10.1 Acceptance/Rejection Criteria: The failure of any module to meet the applicable requirements of Sections 5.2 through 5.7 shall be considered a failure of the proposed design.

6.4.5.11 Controller Assembly Compatibility. Due to the low load current draw and high off-state impedance of modules, testing shall be performed to ensure the module design is compatible and operates properly with load current switches and conflict monitors in NEMA and Type 170 traffic signal control units.

Before performing the following tests, the manufacturer should ascertain which type of signal controller unit(s) the procuring traffic authority customer has in use and tailor these tests to meet the requirements of that type and model of controller unit(s).

6.4.5.11.1 Load Switch Compatibility. The sample set shall be tested for compatibility and proper operation with load current switches. Each module shall be connected to a variable ac voltage supply. The ac line current into the module shall be monitored for sufficient current draw to ensure proper load switch operation while the voltage is varied from 80 VAC RMS to 135 VAC RMS. Failure of the current draw to ensure proper load current switch operation shall be cause for rejection.

6.4.5.11.2 Signal Conflict Monitor (MMU) Compatibility: The sample set shall be tested for compatibility and proper operation with signal conflict monitors. Each module shall be operated from a 135 VAC RMS supply. A 19.5 k $\Omega$  resistor shall be wired in series in the hot line between the module and the ac power supply. A single-pole-single-throw switch shall be wired in parallel across the 19.5 k $\Omega$  resistor. A 220 k $\Omega$  shunt resistor shall be wired between the hot line connection and the neutral line connection on the module. Conflict monitor compatibility shall be tested by measuring the voltage decay across the 220 k $\Omega$  shunt resistor as follows: The single-pole-single-throw switch

shall be closed, shorting out the 19.5 kΩ resistor, allowing the ac power supply to illuminate the module. Next the switch shall be opened, and the voltage across the 220 kΩ shunt resistor shall be measured for a decay to a value equal to or less than 10 VAC RMS within a time period equal to or less than 100 milliseconds. This test shall be repeated a sufficient number of times to ensure that testing occurs at the peak of the ac line voltage cycle.

A voltage decay across the 220 kΩ shunt resistor to a value greater than 10 VAC RMS or a decay time to 10 VAC RMS greater than 100 milliseconds shall be cause for rejection.

6.4.5.11.3 Controller Assembly Compatibility Evaluation: At the conclusion of the Controller Assembly Compatibility Tests, the measurement data shall be compared to the requirements of the specific make and model Controller Assembly with which the module design is intended to operate.

6.4.5.11.4 Acceptance/Rejection Criteria: Failure of the module to draw sufficient current to ensure compatibility with the load current switches in the appropriate Controller Assembly (5.7) and/or failure of the circuit voltage to decay to a value equal to or less than 10VAC RMS within a time period equal to or less than 100 milliseconds (5.7) shall be considered a failure of the proposed design.

6.4.5.12 Failed State Impedance Test: The modules shall be tested for compliance with the requirement for provision of a failed-state impedance (5.7). The test is conducted in two parts: first the module is energized with the LED load disconnected from the power supply to establish the failed-state impedance. Next, the requirement for the failed state impedance is tested. The module shall be operated from a 120 VAC voltage supply.

a) Wire a 50 kΩ resistor in series with the hot line between the module and the AC power supply. A 100 kΩ shunt resistor shall be wired between the hot line connection and the neutral line connection on the module. A single-pole-single-throw switch shall be wired

in parallel with the 50 kΩ resistor. With the switch in the closed position and the LED load disconnected from the module power supply, energize the module for 300ms to establish the failed state impedance (5.7).

b) The second part of the failed state impedance test is conducted to insure that the appropriate failed state impedance is established. The switch is opened and the circuit is energized by the 120VAC voltage supply. The voltage across the 100 kΩ shunt resistor shall be continuously monitored. The voltage shall decay to a value equal to or greater than 70 VAC RMS. For the continuous interval of 500 ms through 1500 ms, after energizing the circuit with an open switch, the measured voltage shall be 70 VAC RMS or greater. The second part of the test shall be repeated 10 times, with the minimum voltage recorded during the continuous interval of 500 ms through 1500 ms, after energizing the circuit with an open switch, recorded as the final test value.

6.4.5.12.1 Failed State Impedance Test Evaluation: At the conclusion of the Failed State Impedance Test, the measurement data shall be compared to the requirement of Section 5.7.

6.4.5.12.2 Acceptance/Rejection Criteria: Failure of the voltage across the 100 kΩ shunt resistor to remain at a value equal to or greater than 70 VAC RMS for the continuous time interval of 500 ms through 1500 ms, after energizing the circuit with an open switch, shall be considered a failure of the proposed design.

## 7. Warranty

7.1 Manufacturers shall provide a written warranty issued by the factory located in the NAFTA country of module origin with the following minimum provisions:

7.2 Modules shall be replaced, repaired or purchase value refunded if the module fails to function as intended due to workmanship or material defects within the first 60 months from the date of delivery.

7.3 Modules which exhibit luminous intensities

less than the minimum specified values within the first 60 months of the date of delivery shall be replaced, repaired or purchase value refunded.

7.4 Upon request, the LED lamp module manufacturer shall provide written documentation of its ability to satisfy a worst-case, catastrophic warranty claim.

7.4.1 A current corporate annual report duly-certified by an independent auditing firm, containing financial statements illustrating sufficient cash-on-hand and net worth to satisfy a worst-case, catastrophic warranty claim is an example of suitable documentation.

7.4.2 The documentation shall clearly disclose:  
a) The country in which the factory of module origin is located  
b) The name of the company or organization that owns the factory of module origin including any and all of its parent companies and/or organizations, and their respective country of corporate citizenship

7.4.3 For firms with business and/or corporate citizenship in the United States of less than seven years, the process by which the end-users/owners of the modules will be able to obtain worst-case, catastrophic warranty service in the event of bankruptcy or cessation-of-operations by the firm supplying the modules within North America, or in the event of bankruptcy or cessation-of-operations by the owner of the factory of origin, shall be clearly disclosed.

## **8. Experience**

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The LED module manufacturer shall provide proof of supply of a minimum of 1,000,000 LED traffic signal modules into North America.

# ATTACHMENT 1

