Performance Specification of the
Institute of Transportation Engineers

Pedestrian Traffic Control Signal Indications - Part 2: Light Emitting Diode (LED) Pedestrian Traffic Signal Modules

Prepared by Joint Industry and Traffic Engineering Council Committee

Adopted March 19, 2004

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STANDARD ITE METRIC CONVERSION INSERT

During the service life of this document, use of the metric system in the United States is expected to expand. The following common factors represent the appropriate magnitude of conversion. This is because the quantities given in U.S. Customary units in the text, tables or figures, represent a precision level that in practice typically does not exceed two significant figures. In making conversions, it is important to not falsely imply a greater accuracy in the product than existed in the original dimension or quantity. However, certain applications such as surveying, structures, curve offset calculations, and so forth, may require great precision. Conversions for such purposes are given in parentheses.

Length
1 inch = 25 mm (millimeters—25.4)
1 inch = 2.5 cm (centimeters—2.54)
1 foot = 0.3 m (meters—0.3048)
1 yard = 0.91 m (0.914)
1 mile = 1.6 km (kilometers—1.61)

Volume
1 cubic inch = 16 cm^3 (16.39)
1 cubic foot = 0.028 m^3 (0.02831)
1 cubic yard = 0.77 m^3 (0.7645)
1 quart = 0.95 L (liter—0.9463)
1 gallon = 3.8 L (3.785)

Speed
foot/sec. = 0.3 m/s (0.3048)
miles/hour = 1.6 km/h (1.609)

Temperature
To convert °F (Fahrenheit) to °C (Celsius), subtract 32 and divide by 1.8.

Area
1 square inch = 6.5 cm^2 (6.452)
1 square foot = 0.09 m^2 (0.0929)
1 square yard = 0.84 m^2 (0.836)
1 acre = 0.4 ha (hectares—0.405)

Mass
1 ounce = 28 gm (gram—28.34)
1 pound = 0.45 kg (kilograms—0.454)
1 ton = 900 kg (907)

Light
1 footcandle = 11 lux (lumens per m^2—10.8)
1 footlambert = 3.4 cd/m^2 (candelas per m^2—3.426)

Pedestrian Traffic Control Signal Indications - Part 2: Light Emitting Diode (LED) Pedestrian Signal Modules - A Purchase Specification of the Institute of Transportation Engineers, prepared by the ITE Joint Industry and Traffic Engineering Council Committee.

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This document has been adopted as an Equipment Standard of ITE.

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1. Purpose

The purpose of this specification is to provide the minimum performance requirements for the LED "walking person" and "hand" icon pedestrian signal modules (hereafter called module or modules). This specification includes the following three sizes (nominal message bearing surface): 406mm x 457 mm (16 in x 18 in), 305mm x 305mm (12 in x 12 in), and 229 mm x 229 mm (9 in x 9 in). This specification is not intended to impose restrictions upon specific designs and materials that conform to the purpose and the intent of this specification. 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." This specification applies to modules purchased after the effective date of this specification. This specification is not restricted to any specific LED technology.

2. Definitions

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

2.1. **Burn-In Procedure.** The procedure by which a module is energized at an ambient temperature for a specified period of time.

2.2. **Chromaticity.** The color of the light emitted by the icons that comprise the LED Pedestrian Signal Module, specified as x, y chromaticity coordinates on the chromaticity diagram according to the 1931 Commission Internationale d'Eclairage (CIE) standard observer and coordinate system.

2.3. **Duty Cycle**. The fraction of time during a specified time period that either the walking person or hand icon is energized, expressed as a percent of the specified time period.

2.4. **Hard Coat**. A surface coating or a film used to provide front surface abrasion resistance for the emitting surfaces of the LED Pedestrian Signal Module.

2.5. **LED Light Source.** A single light emitting diode (LED) or an array of LEDs.

2.6. **LED Pedestrian Signal Module (The Module).** An array of LEDs and lens that provide a pedestrian signal indication consisting of a "walking person" and/or "hand" icon.

2.7. **Luminous Intensity.** The luminous flux per unit solid angle in a given direction, expressed in candela (cd).

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

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

2.10. **Power Factor (PF).** PF equals Watts divided by Volt-Ampere (VA) or the ratio of power consumption in Watts to Volt-Amperes.

2.11. **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.

2.12. **Turn Off Time.** The amount of time required after removal of the nominal operating voltage for neither the walking person nor hand icon of the module to show any visible illumination.

2.13. **Turn Off Voltage.** The voltage below which there is no visible illumination from an emitting surface of the module.

2.14. **Turn On time.** The amount of time required for either the walking person or hand icon of the module to reach 90% of its full illumination**.**

2.15. **Volt-Amperes.** The product of root-mean-square (RMS) line voltage and RMS line current measured with true RMS meter.

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. New installations: For new installations, the minimum size of the message bearing surface of a module shall be determined by the length of the intended crosswalk, but in no case shall it be less than 229 mm x 229 mm. The sizes of the message bearing surfaces shall be in accordance with the dimensions given in Table 1.

Table 1—Dimensions of Signal Sizes

Class	Message Bearing Surface Height X Width	Crosswalk Length[1]	Minimum Message Size Height X Width
1	229mm x 229mm (9" x 9")	≤18.2m (≤60')	152mm x 89mm (6" x 3.5")
2	305mm x 305mm (12" x 12")	>18.2m (>60')	229mm x 134mm (9" x 5.25")
3	406mm x 457mm (16" x 18")	>18.2m (>60')	297mm x 178mm (11" x 7")
4	406mm x 457mm (16" x 18")	>18.2m (>60')	305mm x 190mm (12" x 7.5")

[1] Class 2, 3, & 4 signal indications may be used when the crosswalk length exceeds 18.2m (60').

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 Tinting (Optional) - The lens shall be tinted or shall use transparent film or materials with similar characteristics.

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

3.2.4 Hard Coat (Optional) - If requested, on a non-frosted polymeric lens a surface coating or a film shall be used to provide front surface abrasion resistance.

3.2.5 The configurations of the walking person icon and hand icon are illustrated in Figure 1 and Figure 2 respectively.

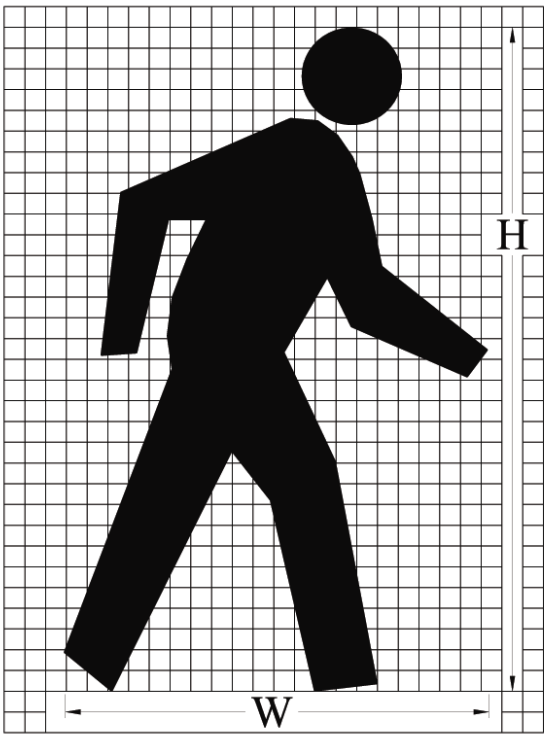


Figure 1—Walking Person icon

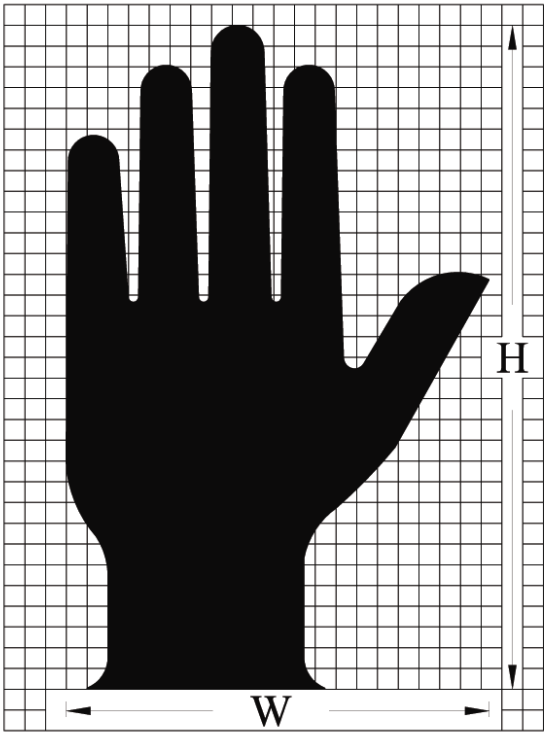


Figure 2—Hand icon

3.3 Environmental Requirements

3.3.1 The module shall be rated for use in the ambient operating temperature range, measured at the exposed rear of the module, of -40°C to +74°C (-40°F to +165°F).

3.3.2 The module shall be protected against dust and moisture intrusion per the requirements of MIL-STD-810F Procedure I, Rain and Blowing Rain.

3.3.3 The emitting surfaces of the module shall not crack, craze or yellow under exposure to sunlight over the service life of the module.

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 supply for the module may be either integral or packaged as a separate module. The power supply may be designed to fit and mount inside the pedestrian signal housing adjacent to the module.

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 module shall be made of UL94VO flame retardant materials. The lens of the module 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 number and serial number.

3.6.2 The following operating characteristics shall be identified: nominal operating voltage, power consumption, and Volt-Ampere. The load for the walking person and hand icons are to be stated separately.

3.6.3 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 inside a pedestrian signal housing.

3.6.4 Modules conforming to this specification, may have the following statement: "Manufactured in Conformance with the Pedestrian Traffic Control Signal Indications - Part 2: Light Emitting Diode (LED) Pedestrian Signal Modules." on an attached label.

4. Photometric Requirements

4.1 Luminance, Uniformity and Distribution

4.1.1 For a minimum period of 60 months, the maintained minimum luminance values for the modules under the operating conditions defined in Sections 3.3.1 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^2;
- Hand: 1,400 cd/m^2.

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, and the purchasing agency may wish to consult the issue with the manufacturer.

4.1.2 The uniformity of the walking person and hand icons' luminance shall meet a ratio of not more than 1 to 5 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 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 hand icon. The colors for these icons shall conform to the following color regions, based on the 1931 CIE chromaticity diagram:

Walking Person—White:

Blue boundary: $x = 0.280$.

1st Green boundary: $0.280 \leq x < 0.400$
$y = 0.7917 \cdot x + 0.0983$.

2nd Green boundary: $0.400 \leq x < 0.450$
$y = 0.4600 \cdot x + 0.2310$.

Yellow boundary: $x = 0.450$

1st Purple boundary: $0.450 \leq x < 0.400$
$y = 0.4600 \cdot x + 0.1810$.

2nd Purple boundary: $0.400 \leq x < 0.280$
$y = 0.7917 \cdot x + 0.0483$.

	White	
Point	*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

Hand—Portland Orange:

Yellow boundary: $y = 0.390$

White boundary: $0.600 \leq x \leq 0.659$
$y = 0.990 - x$

Red boundary: $y = 0.331$.

	Portland Orange	
Point	*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 Δx and Δy 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.

- Hand—Portland Orange:

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

5. Electrical

5.1 General

All wiring and terminal blocks shall meet the requirements of Section 13.02 of the VTCSH standard. Two secured, color code

1 m (39 in) long 600 V, 20 AWG minimum, jacketed wires, conforming to the National Electrical Code, rated for service at +105°C, are to be provided for electrical connection.

The following color scheme shall be used: Orange for Hand, Blue for Walking Person and White for the common.

5.2 Voltage Range

5.2.1 The modules shall operate from a 60±3 Hertz ac line power over a voltage range from 80 VAC RMS to 135VAC RMS.

5.2.2 Nominal operating voltage for all measurements shall be 120±3 VAC RMS.

5.2.3 Fluctuations in line voltage over the range of 80VAC RMS to 135VAC RMS shall not affect luminous intensity by more than ±10 percent.

5.2.4 The LED circuitry shall prevent flicker at less than 100 Hz over the voltage range specified in Section 5.2.1.

5.2.5 Low Voltage Turn Off: There should be no visible illumination of the module when the applied voltage is less than 35 VAC RMS.

5.2.6 Turn-On and Turn-Off Time: Each icon of the module shall reach 90% of their full illumination (turn-on) within 75 msec of the application of the nominal operating voltage. The modules shall not be illuminated (turn-off) after 75 msec of the removal of the nominal operating voltage.

5.2.7. Default Condition: For abnormal conditions when nominal voltage is applied to the unit across the two-phase wires (rather than being applied to the phase wire and the neutral wire) the pedestrian signal unit shall default to the hand symbol or shall be blank.

5.3 Transient Voltage Protection

5.3.1 The module's on-board circuitry shall include voltage surge protection to withstand high-repetition noise transients and low-repetition high-energy transients as stated in Section 2.1.6, NEMA Standard TS-2, 1998, or the latest version.

5.4 Nighttime Dimming (Optional)

5.4.1 When requested, the module circuitry shall allow a reduction of the intensity of the light output in response to an input from the traffic signal controller

5.4.2 Dimming, if provided and conforming to Section 5.4.1, shall diminish light output to levels established to match threshold ambient light conditions. The dimming may be in stepped increments or may be continuously variable. The minimum light output when dimmed shall not be less than thirty (30) percent of the maintained

minimum luminance values shown in Paragraph 4.1.1.

5.5 Electronic Noise

The modules and associated on-board circuitry shall conform to Class A requirements of Federal Communications Commission (FCC) Title 47, SubPart B, Section 15 regulations concerning the emission of electronic noise.

5.6 Power Factor (PF) and AC Harmonics

5.6.1 The modules shall provide a power factor of 0.90 or greater when operated at nominal operating voltage, and 25ºC (77ºF).

5.6.2 Total harmonic distortion induced into an AC power line by the module, operated at nominal operating voltage, at 25ºC (77ºF) shall not exceed 20 percent.

5.7 Controller Assembly Compatibility

The current draw shall be sufficient to ensure compatibility and proper triggering and operation of load current switches and conflict monitors in existing signal controller units.

6. Quality Assurance

6.1 General

Unless otherwise specified all of the tests will be conducted at an ambient temperature of 25°C and at the nominal operating voltage of 120 VAC RMS.

6.1.1 Quality Assurance Program: The 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 the 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 that do not satisfy the requirements of this specification, as evaluated by the design qualification testing (section 6.4) and the production quality assurance testing (section 6.3) shall not be labeled, advertised, or sold as conforming to this specification.

6.2 Manufacturers Serial Numbers

Each module shall be identified with the manufacturer's name, model and serial number.

6.3 Production Quality Assurance (QA) Testing

All modules shall undergo the following Production Quality Assurance testing prior to shipment. Failure of any module to meet requirements of these QA tests shall be cause for rejection. QA test results shall be maintained per the requirement of Section 6.1.2.

6.3.1 Production Luminance Test: All modules 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.

6.3.2 Power Factor: All modules shall be tested for power factor to the requirements of Section 5.6.1. A commercially available power factor meter may be used to perform this measurement. Failure of the requirements shall be cause for rejection.

6.3.3 Current: All modules shall be measured for the amount of current consumption. The measured current values shall be compared against current values resulting from design qualification measurements in Section 6.4.5.1. Measured current values in excess of 120 percent of the design qualification current values shall be cause for rejection.

6.3.4 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. Presence of any such defects shall be cause for rejection of the module.

6.4 Design Qualification Testing (refer to flow chart in Attachment 2)

6.4.1 Design Qualification testing shall be performed on new module designs, and when a major design change has been implemented on an existing design. 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), and followed by the Lens Abrasion Test (6.4.3.4). 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 3.6.4, all tested modules must comply with the acceptance/rejection criteria for the Environmental Tests (6.4.3), Photometric & Colorimetric Tests (6.4.4), Lens Tests (6.4.5), 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 conduced 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.

If the module is equipped with a remote power supply unit, then the test shall be conducted with the remote power supply unit attached to the clamping device holding the LED signal module to the test apparatus.

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 shall be provided that clearly demonstrates that the

external lens complies with the requirements of section 3.3.3.

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 a change in haze of the surface under test greater than 15% or if the module extinguishes itself 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 74ºC (165ºF). 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 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 (77ºF) and 74ºC (165ºF) will change more than 10% over time, the manufacturer shall 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 must include data for the following temperature points: 0°C (32ºF), 25°C (77ºF), 50ºC (122ºF) and 74ºC (165ºF).

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 5.6.2. 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 5.2.5. 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 5.2.6. 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 per the requirements of Section 5.5, with reference to Class A emission limits referenced in Federal Communications Commission (FCC) Title 47, SubPart B, Section 15.

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 2-1998. 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 5.6.

6.4.5.10.1 Acceptance/Rejection Criteria: The failure of any module to meet the applicable requirements of Sections 5.2 through 5.6 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).

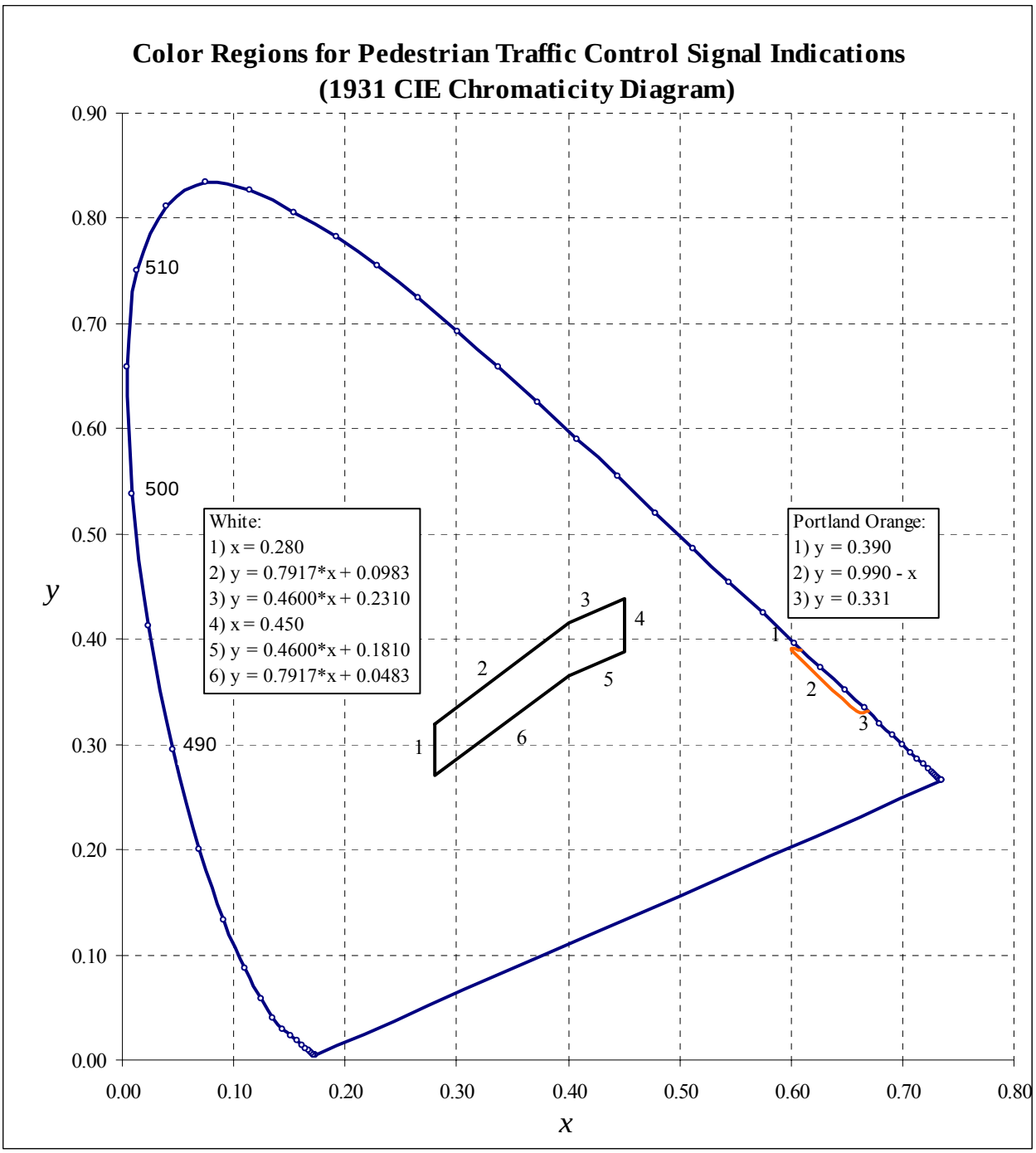
6.4.5.11.1 Load Switch Compatibility. The sample set shall be tested for compatibility and proper operation with load current switches. Each module shall be connected to a variable ac voltage supply. The ac line current into the module shall be monitored for sufficient current draw to ensure proper load 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 kΩ 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 kΩ resistor. A 220 kΩ 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 kΩ 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 then 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.

ATTACHMENT 1



ATTACHMENT 2