GO Transit Signals & Communications – Wayside LED Signal Module Specification

Specification 34 42 02

Revision 01
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Preface

This is the second edition of the Wayside LED Signal Module Specification. This revision includes updates due to changes in AREMA standards, return on experience from lessons learned, and adding a compliance matrix.

This document was developed by the Signals & Communications Office, Engineering and Asset Management Division, Capital Projects Group, Metrolinx.

Suggestions for revision or improvements can be sent to the Metrolinx Signals and Communications office, Attention: Director of Signals and Communications, who shall introduce the proposed changes to the Metrolinx Signals and Communications office. The Director of the Signals and Communications office ultimately authorizes the changes. Be sure to include a description of the proposed change, background of the application and any other useful rationale or justification. Be sure to include your name, company affiliation (if applicable), e-mail address, and phone number.

December 2024

Revision	Date (DD/MM/YYYY)	Description of Changes
00	08/04/2020	Initial release
01	06/12/2024	General updates and formatting

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1. Scope

1.1. General

1.1.1. This specification defines the technical requirements for Wayside Light Emitting Diode (LED) Signal Modules.

2. Abbreviations

AREMA	American Railway Engineering and Maintenance-of-Way Association
CENELEC	European Committee for Electrotechnical Standardization
IESNA	Illuminating Engineering Society of North America
CIE	Commission Internationale d'Eclarage
LED	Light Emitting Diode
NEMA	National Electrical Manufacturers Association
SI	International System of Units
VMICS	Vital Microprocessor-Based Interlocking Systems

3. Definitions

Term	Definition
Burn-In Process	The procedure by which a Wayside LED Signal Module is energized at an ambient temperature for a specified time duration to cause an early electronic component mortality failure to occur and to detect any component reliability problems before the product is shipped to the end user for installation.
Candela (cd)	SI unit of luminous intensity. The candela is the luminous intensity (lm), in a given direction, of a source that emits monochromatic radiation of wavelength 540 nm and that has a radiant intensity in that direction of 1/683 W per steradian (sr) (1 cd = 1 lm/sr).
Chromaticity	The colour of the light emitted by a Wayside LED Signal Module, specified as x-y or x and y chromaticity coordinates on the chromaticity diagram according to the 1931 Commission Internationale d'Eclairage (CIE) standard Observer and Coordination system.
LED Light Source	A single light-emitting diode (LED), or an array of LEDs.
Light Stabilization Procedure	The procedure whereby a Wayside LED Signal Module is energized at a given temperature for a specified time duration to stabilize the light output.
Lumen (lm)	SI unit of luminous flux. Luminous flux emitted in unit solid angle [steradian (sr)] by a uniform point source having a luminous intensity of 1 candela (1 lm = 1 cd x 1 sr).
Luminance (Lv)	For a given direction, at a given point on a real or imaginary surface, (Lv) luminance is defined by the formula: $Lv = d\Phi v / (dA \cdot d\Omega \cdot \cos \theta)$ Where $d\Phi v$ is the luminous flux transmitted by an elementary beam passing through the given point and propagating in the solid angle $d\Omega$ containing the given direction; dA is the area of a section of that beam containing the given point; θ is the angle between the normal to that section and the direction of the beam (footlambert, cd/m^2).
Luminous Intensity (Iv)	The Luminous Intensity of a source in a given direction is defined as the luminous flux $d\Phi v$ leaving the source and propagating in the element of solid angle $d\Omega$ containing the given direction, divided by the element of solid angle ($Iv = d\Phi v / d\Omega$ cd).
Luminous Flux (Φv)	Quantity derived from radiant flux Φe by evaluating the radiation according to its action upon the CIE standard photometric observer (lumen).

Lux (lx)	SI unit of illuminance. Illuminance produced on a surface area of 1 square metre by a luminous flux of one lumen uniformly distributed over that surface (1 lx = 1 lm/m^2).
Power Consumption	The electrical power in watts consumed by the Wayside LED Signal Module when operated at nominal operating voltage and ambient operating temperature.
Radiant Flux (Φe)	The total power emitted, received, or passing in the form of electromagnetic radiation. It is measured in watts.
Rated Voltage	The nominal or design operating voltage of the Wayside LED Signal Module; the voltage at which rated watts, candelas, and life are determined.
Rated Watts	The average initial power consumed when the lamp is operated at rated voltage.
Wayside LED Signal Module	An array of LEDs and a lens that together are capable of providing a circular signal indication. A Wayside LED Signal Module shall be capable of replacing the optical unit of an existing railway wayside searchlight signal.

4. Photometric Requirements

4.1. Luminous Intensity

4.1.1. The initial luminous intensity value for Wayside LED Signal Module under all normal operating conditions (i.e., the temperature range of -40°C to +70°C and the voltage range of 8.5 to 16 V DC nominal) shall not be less than the values shown in Table 4-1 below. Table entries show the minimum candela values at different horizontal viewing angles.

4.1.2. Table 4-1: Candela Values vs Horizontal Viewing Angles

Horizontal Viewing Angle	0°	±3°	±6°	±8°	±10°	±11°	±12°
Red	800	600	225	125	65	40	20
Yellow	2300	1700	500	175	115	90	65
Green	800	500	225	125	65	40	20

4.1.3. In addition, measurable luminous intensity values (greater than 0 candelas) shall be maintained at a 0° horizontal viewing angle for vertical viewing angles extending up to 60° from the vertical axis.

4.2. Chromaticity

4.2.1. The Wayside LED Signal Module shall produce a uniform red, yellow or green output that conforms to the chromaticity definitions in the AREMA C&S Manual Part 7.1.10 (Recommended Design Criteria and Functional/Operating Guidelines for Signal Roundels, Lenses, Discs, and Cones).

4.2.2. Chromaticity is measured using x, y, and z numbers to determine the ratio of the amount of one primary colour to the total amount of all three necessary to reproduce a given colour, which may be considered as the respective proportions of the red, green, and blue primaries in colour. Since the sum of x, y, and z always equals unity, the chromaticity is adequately specified by giving the numbers x and y, or red and green.

a) The requirement for red chromaticity is:

   i. y is not greater than 0.288, and y is not less than 0.998 – x.

b) The requirement for yellow chromaticity is:

   i. y is not greater than 0.430, and y is not less than 0.384 and 0.862 - 0.783x, and

   ii. x is not less than 0.554.

c) The requirement for green chromaticity is:

   i. y is not greater than 0.817 - x, and y is not less than 0.506 – 0.519x and 0.150 + 1.068x; and

   ii. y is not less than 0.554.

d) The requirement for lunar chromaticity is:

i. y is not greater than 0.510x + 0.186, and y is not less than 0.510x + 0.170; and

ii. x is not greater than 0.441, and x is not less than 0.329.

4.3. Uniformity

4.3.1. The ratio of the greatest and least luminance of the Wayside LED Signal Module shall not exceed 5:1, when measured over average areas of 500 mm^2.

4.4. Rise Time

4.4.1. The maximum rise time from zero intensity to full intensity, and the maximum fall time from full intensity to zero intensity, shall be 75 ms.

5. Physical and Mechanical Requirements

5.1. Wayside LED Signal Module Design

5.1.1. The Wayside LED Signal Module, and associated railway wayside signal housing, shall be designed to replace the existing signal module holder, reflector, lens, and railway wayside signal housing, without requiring modification of the existing mechanical, structural, or electrical components of the wayside signal structure. The Wayside LED Signal Module shall be compatible with Vital Microprocessor Based Interlocking Systems (VMICS) equipment employed on Metrolinx property. An LED Wayside Signal may be a single unit capable of being directly mounted in a signal head and directly connected to the existing control circuitry.

a) Wayside LED Signal Module shall be 200 mm to 210 mm in size.

b) Wayside LED Signal Module shall be tri-colour LEDs (i.e., red, yellow, and green) in one aspect unit for new installations.

c) Wayside LED Signal Module shall have sun phantom reducing features and shall be easy to install and align to properly focus the signal aspect.

d) Wayside LED Signal Module shall comply with AREMA C&S Manual Part 7.1.5.

e) Wayside LED Signal Module shall be compatible with the following tests as defined in AREMA C&S Manual Part 7.1.5.

5.1.2. Cold Filament Test

a) The test will verify that the wiring and associated circuitry are intact within the Wayside LED Signal Module.

5.1.3. Hot Filament Test

a) This test will verify that 50% of the individual aspect LEDs in the Wayside LED Signal Module are operable.

5.1.4. Light Out Detection Test

a) This test will verify that the Wayside LED Signal Module is still operable at the minimum level; and

b) For Wayside LED Signal Module, the minimum operable level is considered 50% of the installed LEDs.

5.1.5. Any gasket or similar sealing provisions shall be made of a material in accordance with the AREMA C&S Manual Part 15.2.10 (Recommended Functional Guidelines for Gasket Material Suitable for Circuit Controllers, Signal Cases and Other Signal Apparatus Housings).

5.2. Environmental Requirements

5.2.1. The Wayside LED Signal Modules shall operate over an ambient temperature range of -40 °C (-40°F) to +70 °C (+158 °F) per MIL-STD-883, Test Method 1010 and AREMA C&S Manual Part 11.5.1. The Wayside LED Signal Modules shall tolerate storage temperatures from -55 °C (-67 °F) to +85 °C (+185 °F) as per AREMA C&S Manual Part 11.5.1.

5.2.2. The Wayside LED Signal Modules shall be protected against dust and moisture intrusion per the requirements of NEMA Standard 250-1991, sections 4.7.2.1 and 4.7.3.2, for Type 4X NEMA enclosures.

5.2.3. The Wayside LED Signal Modules shall meet the mechanical vibration and shock requirements per the AREMA C&S Manual Part 11.5.1 (Recommended Environmental Requirements for Electrical and Electronic Railroad Signal System Equipment).

5.2.4. The Wayside LED Signal Module lens shall be in accordance with AREMA C&S Manual Part 7.1.10 and shall be UV stabilized as per AREMA C&S Manual Part 7.1.6.

5.3. Identification

5.3.1. The Wayside LED Signal Module shall be clearly identified with the following information:

a) Wayside Railway Signal: LED, Tri-colour;

b) Beam Deflection Classification: Universal;

c) Operating Voltage;

d) Current Consumption at Nominal Operating Voltage;

e) Serial Number;

f) Part Number; and

g) Date of Manufacture.

5.3.2. If the Wayside LED Signal Module or its components require orientation, they shall be prominently and permanently marked with an indexing arrow.

6. Electrical Requirements

6.1. Transient Voltage Protection

6.1.1. Wayside LED Signal Modules shall be protected against lightning and other voltage surges in input, output and power supply leads when installed in conjunction with external surge protection as described in AREMA C&S Manual Part 11.2.1 (Recommended General Practices for Electrical Surge Protection for Signal Systems).

6.1.2. The average current of the Wayside LED Signal Modules shall not exceed 2 A when the voltage is within the nominal operating range of 8.5V to 16 V.

6.2. LED Drive Circuitry

6.2.1. Wayside LED Signal Modules for use with existing relay and processor-based systems shall operate within the specifications defined by the AREMA C&S Manual Part 7.1.5.D (Recommended Design Criteria and Functional/Operating Guidelines for LED Light Unit Used in Wayside Signal Applications – LED Wayside Signals for Use with Existing Relay or Processor-based Systems).

6.2.2. Wayside LED Signal Module for use with alternative control interfaces shall operate within the specifications defined by the AREMA C&S Manual Part 7.1.5.E (Recommended Design Criteria and Functional/Operating Guidelines for LED Light Unit Used in Wayside Signal Applications – LED Wayside Signals for Use with Alternative Control Interfaces).

6.3. Dielectric and Electromagnetic Interference

6.3.1. Wayside LED Signal Module circuitry shall comply with the dielectric requirements for Class B, equivalent in AREMA C&S Manual Part 11.5.1, D.7 (Recommended Environmental Requirements for Electrical and Electronic Railroad Signal System Equipment).

6.3.2. Wayside LED Signal Module circuitry shall comply with the electromagnetic interference requirements for Class B, equivalent in AREMA C&S Manual Part 11.5.1, D.6 (Recommended Environmental Requirements for Electrical and Electronic Railroad Signal System Equipment).

6.3.3. Wayside LED Signal Modules shall comply with the requirements of the Federal Communication Commission, with reference to Class A emission limits referenced in Federal Communication Commission (FCC) Title 47, Subpart B, Section 15.

6.4. Safety Assurance Requirements

6.4.1. The Wayside LED Signal Module shall be designed in accordance with the safety assurance requirements specified in AREMA C&S Manual Part 7.1.5.C.5 (Recommended Design Criteria and Functional/Operating Guidelines for LED Light Unit Used in Wayside Signal Applications – Design).

6.4.2. Wayside LED Signal Module shall meet the CENELEC - EN 50129 standard criteria.

6.4.3. Wayside LED Signal Modules shall be rated for at least 100,000 hours of continuous operation under normal operating conditions.

7. Quality Assurance Requirements

7.1. Quality Assurance Program

7.1.1. Wayside LED Signal Module shall be manufactured in accordance with a vendor quality assurance (QA) program. The QA program shall include two types of quality assurance: design quality assurance, and production quality assurance. The production quality assurance shall include statistically controlled routine tests to ensure minimum performance levels of the Wayside LED Signal Module built to meet this specification.

7.2. Record keeping

7.2.1. QA process and test results documentation shall be kept on file for a minimum period of seven years.

7.3. Conformance

7.3.1. Wayside LED Signal Module designs that do not satisfy design qualification testing, and the production quality assurance testing performance requirements, shall not be labelled, advertised, or sold as conforming to this specification.

7.4. Production Quality Assurance Testing

7.4.1. Production runs of Wayside LED Signal Modules shall be statistically sampled according to standard production quality assurance procedures. The sample Wayside LED Signal Modules shall be subjected to the following quality assurance tests.

7.4.2. Wayside LED Signal Module Burn-In

a) All sample Wayside LED Signal Modules shall be powered for a minimum of 24 hours, and at an ambient temperature of 60°C (140°F) prior to undergoing the following tests. The burn-in test shall be repeated for each colour.

7.4.3. Maintained Minimum Luminous Intensity

a) All sample Wayside LED Signal Modules for each colour shall be tested for their on-axis luminous intensity after one hour of sustained operation. The measured luminous intensity shall be at least 400 cd after allowing for the worst-case effects of temperature (-40 °C to +70 °C) and voltage over the nominal operating range; and

b) All sample Wayside LED Signal Modules for each colour shall be tested for their on-axis luminous intensity after one hour of sustained operation at a set flashing rate. The measured luminous intensity shall be at least 400 cd after allowing for the worst-case effects of temperature (-40 °C to +70 °C) and voltage over the nominal operating range.

8. Submittals

8.1.1. Contractor shall submit a compliance report for all the technical requirements in this specification.

8.1.2. Contractor shall submit all test certificates to confirm that the Wayside LED Signal Module is compatible and has been successfully integrated with the various VMICS lamp drivers employed on Metrolinx property. This includes all versions of executive-level software employed on Metrolinx property. If requested, the contractor shall demonstrate to Metrolinx's satisfaction the Wayside LED Signal Module is compatible with the associated VMICS it is intended to operate with.

9. Compliance Matrix

Manufacturer:		**Revision:**	
Contract Number:		**Project Name:**	

Section	Criteria	Comply	Do Not Comply	N/A	Notes / Comments
4.1.1	Luminous intensity				
4.1.2	Luminous intensity viewing angles				
4.1.3	Luminous intensity values				
4.2.1	AREMA C&S Manual Part 7.1.10				
4.3.1	Uniformity				
4.4.1	Rise Time				
5.1.1	Wayside LED module requirements				
5.1.2	Cold filament test				
5.1.3	Hot filament test				
5.1.4	Light-out detection test				
5.1.5	Gasket requirement				
5.2.1	Operating temperature range				
5.2.2	Environmental protection				
5.2.3	Mechanical vibration				
5.2.4	Wayside LED lens				
5.3.1	Identification				
5.3.2	Orientation arrow				
6.1.1	Lightning and other voltage surges				
6.1.2	Average current draw				
6.2.1	AREMA C&S Manual Part 7.1.5.D				
6.2.2	AREMA C&S Manual Part 7.1.5.E				
6.3.1	AREMA C&S Manual Part 11.5.1 D.7				
6.3.2	AREMA C&S Manual Part 11.5.1 D.6				
6.3.3	FCC Title 47, subpart B, section 15				
6.4.1	AREMA C&S Manual Part 7.1.5.C.5				
6.4.2	CENELEC – EN 50129 standard				
6.4.3	Continuous hours rating				
7.1.1	QA program				

Section	Criteria	Comply	Do Not Comply	N/A	Notes / Comments
7.2.1	QA process and documentation				
7.3.1	Conformance				
7.4.1	Statistical sampling				
7.4.2	LED module burn-in				
7.4.3	Minimum luminous intensity				
8.1.1	Compliance report				
8.1.2	Test certificates and compatibility				