



To: SUPERSEDED ^{BY} <i>EI 02-017</i> <i>EFFECTIVE 5/8/03</i>		New York State Department of Transportation ENGINEERING INSTRUCTION	EI 98-007
Title: TRAFFIC SIGNAL LIGHT EMITTING DIODE (LED) MODULES			
Distribution: <input checked="" type="checkbox"/> Manufacturers (18) <input type="checkbox"/> Surveyors (33) <input checked="" type="checkbox"/> Main Office (30) <input checked="" type="checkbox"/> Consultants (34) <input type="checkbox"/> Local Govt. (31) <input checked="" type="checkbox"/> Contractors (39) <input checked="" type="checkbox"/> Regions/Agencies (32) <input type="checkbox"/> _____ ()	Approved:  <hr/> P. J. Clark, Deputy Chief Engineer, Design <u>03/04/98</u> <small>Date</small>		

EFFECTIVE DATE. This Engineering Instruction is effective with department contracts let on or after May 21st, 1998.

PURPOSE. Modify Section 724-04 - Traffic Signal Heads, to allow the use of Light Emitting Diode (LED) technology in our Traffic Signal System.

BACKGROUND.

Light Emitting Diode (LED) Traffic Signal Modules are inserts that can be installed in any standard signal head. These modules replace the bulb, reflector, socket, gasket, and lens assembly of the conventional incandescent signal section.

The LED modules' energy consumption is approximately 8 watts for a 300 mm red arrow, 12 watts for a Pedestrian Hand, and 20 watts for a 300 mm red ball. Energy consumption of incandescent bulbs is 135 watts, 116 watts, and 135 watts respectively. LEDs are designed to last 10 years, and incandescent bulbs are generally designed to last one year. Not only do they last longer, resulting in lower maintenance costs and reduced liability for outage-related accidents, but they use less power. LED modules are easy to retrofit, easy to maintain and result in immediate savings. When possible, their use should be preferred over incandescent bulbs in new and existing installations. Hence their use in traffic signals installations is encouraged and approved by the Department.

Currently, there are two LED colors (Red & Green) for Traffic Signal Heads and one color (Portland Orange) for Pedestrian Signal Heads that meet the Institute of Transportation Engineers (ITE) specifications for intensity and chromaticity.

The disadvantage of LED modules is their initial cost. However, the payback of these units, at current module prices and metered electric charges, is approximately one year for red arrows, less than one year for pedestrian hands and three years for red balls in traffic signals with metered electric billing. Green LED modules are more expensive than red modules, but it is expected that this price will decrease in the near future. Despite the higher price of green LED modules, their use can still be of great advantage if they are installed in signals that are not easily serviceable, or in signals located in remote locations (far from maintenance shops), resulting in signal crew travel time savings. Also, even though the electricity savings payback time is longer for energy-face billed signals, significant labor savings may result when they are used at remote location signals.

DESIGN CONSIDERATIONS.

Since the main advantage of these units is reduced power consumption, it is advantageous to start its initial deployment in metered signals first until energy-face rates for unmetered signals are renegotiated. Due to the low cost per kilowatt-hour which is currently paid under the flat-rate (unmetered) electric service, it may not be possible to justify the use of these LED modules based on electricity savings alone. However, there are other considerations such as increased reliability and longer life which will greatly reduce relamping and emergency bulb-out calls.

The new Federal Manual on Uniform Traffic Control Devices, due to be published by 2000, will require the use of symbols (MAN/HAND) instead of letter messages (WALK and DONT WALK) for pedestrian signal indications. Designers should begin using the attached specifications for new pedestrian signal installations to allow the display of symbols only. Since the MAN LED symbol does not meet ITE color requirements, a combination of a HAND LED and an incandescent MAN should be considered. Since the HAND display (Don't walk symbol) is displayed for the vast majority of the time as compared to the walk display, significant savings can result when the HAND LEDs are used.

To obtain the best unit price for these modules and to maintain uniformity in our Signal System, the modules will be supplied by the State. The purchase of these modules will be accomplished through an annual statewide purchasing contract. Specifications and Item Numbers for the installation of these modules have been approved and are listed below.

Specifications and Item Numbers for furnishing and installing LED signal modules have also been approved and will be used under special circumstances when, authorized by the Regional Traffic Engineer, the Contractor is required to provide the LED modules.

To install an LED module into a standard section head, it is necessary to remove the bulb, lens, gasket, reflector, ring reflector and socket from the section. A standard section without these accessories has been designated as a "Type I" Signal Section. Use of Type I signal sections with LED modules should reduce the item cost. Designation of a complete LED signal section can be accomplished by using two items: an LED module and a Type I signal section.

To allow the use of polycarbonate signal sections with LED modules, Specifications and Item Numbers for polycarbonate signal section heads have also been approved and are included below.

When LEDs are provided on federal-aid construction contracts, the description and the estimated number of modules to be furnished shall be included in the Form TE200b following established procedures, to assure proper reimbursement

TRANSMITTED MATERIAL.

Attached are specification shelf notes revising the requirements for Section 724- TRAFFIC SIGNAL HEADS for the January 2, 1995 Specification book and the following list of item numbers related to LEDs.

Item No	Item Description
680.810101M	TRAFFIC SIGNAL MODULE - 300 mm, Red Ball, LED
680.810102M	TRAFFIC SIGNAL MODULE - 300 mm, Red Arrow, LED
680.810103M	(Reserved for TRAFFIC SIGNAL MODULE - 300 mm, Yellow Ball, LED)
680.810104M	(Reserved for TRAFFIC SIGNAL MODULE - 300 mm, Yellow Arrow, LED)
680.810105M	TRAFFIC SIGNAL MODULE - 300 mm, Green Ball, LED
680.810106M	TRAFFIC SIGNAL MODULE - 300 mm, Green Arrow, LED
680.810107M	TRAFFIC SIGNAL SECTION - Type I, 300 mm
680.810301M	TRAFFIC SIGNAL MODULE - 200 mm, Red Ball, LED
680.810302M	TRAFFIC SIGNAL MODULE - 200 mm, Red Arrow, LED
680.810303M	(Reserved for - 200 mm, Yellow Ball, LED)
680.810304M	(Reserved for - 200 mm, Yellow Arrow, LED)
680.810305M	TRAFFIC SIGNAL MODULE - 200 mm, Green Ball, LED
680.810306M	TRAFFIC SIGNAL MODULE - 200 mm, Green Arrow, LED
680.810307M	TRAFFIC SIGNAL SECTION - Type I, 200 mm
680.810308M	INSTALL BALL/ARROW LED TRAFFIC SIGNAL MODULE
680.810401M	TRAFFIC SIGNAL SECTION - Polycarbonate, Fiberoptic Dual Indication Arrow
680.810501M	TRAFFIC SIGNAL SECTION - Polycarbonate, Strobing Signal Indication
680.8106M	TRAFFIC SIGNAL SECTION - Polycarbonate, 300 mm
680.810601M	TRAFFIC SIGNAL SECTION - Polycarbonate, Type I, 300 mm
680.8107M	TRAFFIC SIGNAL SECTION - Polycarbonate, 200 mm
680.810701M	TRAFFIC SIGNAL SECTION - Polycarbonate, Type I, 200 mm
680.813101M	PEDESTRIAN SIGNAL MODULE - 300 mm, HAND symbol, LED.
680.813102M	(Reserved for PED SIGNAL MODULE - 300 mm, MAN symbol, LED)
680.813103M	PEDESTRIAN SIGNAL SECTION - TYPE I, 300 mm
680.813104M	INSTALL LED PEDESTRIAN SIGNAL MODULE

These item numbers replace and supersede any regional item number that has been previously assigned for the same item description.

CONTACT.

Questions regarding this Engineering Instruction should be directed to Guillermo Ramos of the Traffic Engineering and Safety Division at (518) 457 7436.

TRAFFIC SIGNAL HEADS

Make the following *changes* to the Standard Specifications of January 2, 1995.

Page 6-179, above line 5, *add* the following:

"LED Traffic Signal Modules	724-04"
"LED Pedestrian Signal Modules	724-04"

Page 6-184, below line 45, *add* the following:

"LED Traffic or Pedestrian Signal Modules, which are supplied by the State, shall be installed in new or existing traffic or pedestrian signal heads as shown on the plans or as ordered by the Engineer. When new traffic or pedestrian signal sections are replaced with LED modules, the replaced materials shall remain the property of the Department. When the Contractor is required to furnish the LED module, unless otherwise waived, the Contractor shall submit to the Regional Director within 30 days following the award of contract, detailed specifications and catalog cuts of the equipment he/she proposes to install."

Page 6-191, below line 2, *add* the following:

680-3.36 LED Traffic Signal Module. LED Traffic Signal Modules shall be installed in Type I Traffic Signal Sections according to the requirements of 680-3.21 Signal Heads.

680-3.37 LED Pedestrian Signal Module. LED Pedestrian Signal Modules shall be installed in Type I Pedestrian Signal Section according to the requirements of 680-3.21 Signal Heads.

Page 6-191, below line 13, *add* the following:

"	Fiberoptic Pedestrian Signal Section
Fiberoptic Dual Indication Arrow	LED Traffic Signal Module
LED Pedestrian Signal Module	Type I Traffic Signal Section
Type I Pedestrian Signal Section"	

Page 6-193, below line 22, *add* the following:

680-5.21 LED Traffic Signal Module. The unit price bid shall include the LED module and installation on the signal head.

680-5.22 LED Pedestrian Signal Module. The unit price bid shall include the LED module and installation on the signal head.

680-5.23 Type I Traffic Signal Section. A Type I Traffic Signal Section is a standard or a polycarbonate traffic signal section without reflector, reflector ring, lens, and lamp receptacle. The unit price bid shall include housing, door, visor and incidentals to make an individual Type I Signal Head Section.

680-5.24 Type I Pedestrian Signal Section. A Type I Pedestrian Signal section is a standard pedestrian signal section without lens. The unit price bid shall include housing, door, visor and incidentals to make an individual Type I Pedestrian Signal Section.

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680-5.25 LED Traffic Signal Module Installation. Under this item the Contractor shall install Ball or Arrow LED Traffic Signal Modules, which are supplied by the State, at locations shown on the plans and as ordered by the Engineer. The unit price bid shall include the cost of labor, materials, and equipment necessary to complete the work as shown on the plans or as ordered by the Engineer. This item shall be measured for payment as the number of 200mm or 300mm Ball or Arrow LED Traffic Signal Modules installed in accordance with the contract documents or as ordered by the Engineer.

680-5.26 LED Pedestrian Signal Module Installation. Under this item the Contractor shall install Pedestrian Signal Modules, which are supplied by the State, at locations shown on the plans and as ordered by the Engineer. The unit price bid shall include the cost of labor, materials, and equipment necessary to complete the work as shown on the plans or as ordered by the Engineer. This item shall be measured for payment as the number of LED Pedestrian Signal Modules installed in accordance with the contract documents or as ordered by the Engineer.

Page 6-194, below line 22, *add* the following:

680.810101M	Traffic Signal Module - 300 mm, Red Ball, LED	Each
680.810102M	Traffic Signal Module - 300 mm, Red Arrow, LED	Each
680.810105M	Traffic Signal Module - 300 mm, Green Ball, LED	Each
680.810106M	Traffic Signal Module - 300 mm, Green Arrow, LED	Each
680.810107M	Traffic Signal Section - Type I, 300 mm	Each

Page 6-194, below line 24, *add* the following:

680.810301M	Traffic Signal Module - 200 mm, Red Ball, LED	Each
680.810302M	Traffic Signal Module - 200 mm, Red Arrow, LED	Each
680.810305M	Traffic Signal Module - 200 mm, Green Ball, LED	Each
680.810306M	Traffic Signal Module - 200 mm, Green Arrow, LED	Each
680.810307M	Traffic Signal Section - Type I, 200 mm	Each
680.810308M	Install Ball/Arrow LED Traffic Signal Module	Each

Page 6-194, below line 25, *add* the following:

680.810401M	Traffic Signal Section - Polycarbonate, Fiberoptic Dual Indication Arrow	Each
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Page 6-194, below line 26, *add* the following:

680.810501M	Traffic Signal Section - Polycarbonate, Strobing Signal Indication	Each
680.8106M	Traffic Signal Section - Polycarbonate, 300 mm	Each
680.810601M	Traffic Signal Section - Polycarbonate, Type I, 300 mm	Each
680.8107M	Traffic Signal Section - Polycarbonate, 200 mm	Each
680.810701M	Traffic Signal Section - Polycarbonate, Type I, 200 mm	Each

Page 6-194, below line 33, *add* the following:

680.813101M	Pedestrian Signal Module - 300 mm, Hand Symbol, LED	Each
680.813103M	Pedestrian Signal Section - Type I, 300 mm	Each
680.813104M	Install LED Pedestrian Signal Module	Each

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Page 7-236, in line 23 and line 24, *replace* the entire sentence with the following:

"MATERIAL. Unless otherwise specified, all signal head housings shall be made of Aluminum alloy of one of the following compositions:"

Page 7-245, in line 8, *delete* the word "aluminum"

In line 13, *add* the following: "A heavy plastic mylar (or equivalent) water shield shall be used to prevent possible water leaks from dripping onto the lamps."

Page 7-246, in line 8, *delete* the word "aluminum"

In line 38, *replace* the entire paragraph "BASIS OF ACCEPTANCE" with the following:

G. Standard Polycarbonate Traffic Signal Heads

GENERAL. In addition to applicable material requirements for §724-04, A, Standard Signal Heads, the following additional requirements apply to Polycarbonate Traffic Signal Heads.

MATERIALS. The traffic signal housing, visor and door shall be made of injection molded polycarbonated resin which shall be capable of withstanding a 95 N.m impact without fracture or permanent deformation.

Material used in the construction of the signal housing door, visor and lens shall be resistant to heat generated by the signal bulb. No deformation or discoloration shall be evidenced when 116 watts bulbs are used in 200 mm signal sections and 150 watt bulbs are used in 300 mm signal sections. The plastics shall be ultra-violet and heat stabilized and flame retardant.

The signal housing, door and visor shall be dark green and the color shall be fully impregnated into the polycarbonate resin.

Visor shall be made of one piece with a minimum thickness of 2 mm. The rear edge of the visor shall be provided with four mounting lugs for attaching the visor to the door using screws. The inside of the visor shall be dull black in color. Unless otherwise specified all signal heads shall be provided with cap-type visors.

CONSTRUCTION. The housing shall have a minimum thickness of 2.3 mm. The housing shall be of one piece construction and the door shall be of one piece construction.. Both the 200 mm & 300 mm housings are to be designed in the same manner so when used in combination heads the design will match each other.

The top and bottom opening of each housing shall have integral serrated bosses that will provide positive positioning of the signal head to eliminate undesirable rotation or misalignment of the signal head between sections. Each opening accommodates standard 1.5 NPS pipe fittings and brackets.

Doors shall be hinged by two lugs and mounted to the housing using stainless steel pins. The door of each signal section shall be one-piece with a minimum thickness of 2.3 mm.

A neoprene gasket shall be provided between the body of the housing and the door. The doors shall be forced tightly against the gasket and housing by simple stainless steel locking devices. A slotted air cored neoprene lens gasket shall provide a positive seal between the lens and the signal door and between the lens and the reflector holder.

The gasket shall be an unbroken circular gasket with a "U" shaped cross section. The gasket and lens shall be held tightly into the door by four stainless steel clips and screws that shall allow easy removal of the lens and gasket from the door without removal of the door in the field.

The reflector shall be alzak aluminum. Reflector rings shall be manufactured from die cast aluminum, hinged from one side to allow the reflector assembly to open without use of tools. The lamp receptacle shall be permanently focused to the reflector and held in place by a corrosion-resistant wire spring bail so that it can be removed without

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the use of tools. The center section shall contain a terminal barrier block having quick-disconnect terminals for the lamp receptacle leads and screw terminals for field wires.

H. Ball LED Traffic Signal Module

In addition to applicable material requirements for §724-04, A, Standard Signal Heads, the following additional requirements apply to Ball LED Traffic Signal Sections.

GENERAL. This specification refers to definitions and practices described in publication ST-008B "Vehicle Traffic Control Signal Heads" published by the Institute of Transportation Engineers (ITE)," referred to in this document as "VTCSH." LED traffic signal modules shall be designed as retrofit replacements for existing signal lamps and shall not require special tools for installation. They shall be a single, self-contained device, not requiring on-site assembly for installation into an existing traffic signal housing. The module shall be sealed to provide a weather tight enclosure and an insulating covering for all electrical connections and electronic components and shall fit securely in the housing. It shall connect directly to existing electrical wiring by means of push on type connectors.

Retrofit replacement LED modules shall fit into traffic signal housing built to the VTCSH Standard without modification to the housing. Installation of the retrofit replacement LED signal module into an existing signal housing shall only require the removal of the existing lamp components (i.e., lens, lamp, gaskets, and reflector).

MATERIALS. Materials used for the lens and signal module construction shall conform to ASTM specifications for those materials. The LED sources shall be made of the Aluminum- Indium-Gallium-Phosphorus (AlInGaP) type.

Each LED signal module shall be identified on the back side with the manufacturer's trade mark, serial number, voltage rating, Volt-Ampere rating, power consumption (watts) and, if applicable, a vertical indexing indicator (i.e., "up arrow," or the word "UP" or "TOP").

Each LED signal module shall have a sticker attached stating compliance to the ITE standard for Color and Luminous Intensity as specified in the VTCSH.

LED Signal Module Lens. A retrofit LED signal module assembly shall replace the existing colored signal lens.

The "Red" LED signal module lens shall be tinted with the appropriate color to enhance on/off contrast. The material used to tint the lens shall not affect the luminous intensity or chromaticity and shall be uniform across the face of the lens. The "yellow" and "green" units may be supplied with a clear lens. If a polymeric lens is used, a surface coating or chemical surface treatment shall be used to provide front surface abrasion resistance.

The module lens shall be replaceable without the need for replacing the complete module unit.

Optical Requirements. The measured chromaticity coordinates of LED signal modules shall conform to the chromaticity requirements of Section 8.04, Limits of Chromaticity Coordinates and the associated Figure 1 of the VTCSH standard.

The light output distribution for circular (Ball) LED traffic signal modules shall be as defined in Section 11.04 and Table 1 of the VTCSH standard. The minimum luminous intensity values for LED traffic signal modules shall be, at a line voltage of 120 ± 3 volts rms, as listed in Table 1 of the VTCHS standard. Variations in operating line voltage of between 80 and 135 volts rms should have minimal effect on luminous output of the signal module.

LED signal modules shall be designed so, that when operated over the specified operating ambient temperature and voltage ranges during the first 60 months of field operation, the luminous intensity of the unit shall not fall below 60% of the minimum intensity values of the VTCHS standard.

Performance Tests. Prior to shipment, each LED signal module shall be energized (burned-in), for a minimum of 24 hours, at rated voltage, and at a 100 percent on-time duty cycle. This test shall be conducted at the rated voltage in an ambient temperature of 60°C. Any failure within an LED signal module occurring during burn-in shall be cause for rejection.

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After burn-in procedure is completed, the following additional tests shall be performed. These tests shall be performed at rated operating voltage and at 25°C unless otherwise specified.

Each Ball LED signal module shall be tested for rated initial intensity. A single point measurement with a correlation to the minimum intensity requirements specified herein may be used.

All units shall be powered off for a period of 1 second and then powered back on. Any unit failing to turn on after power restoration shall be rejected. This test shall be performed a minimum of 10 times.

A sample of 10% of units on the order shall be randomly selected and tested in a flashing mode of operation, at 50 percent duty cycle with a 0.5 sec on time, and for a 24 hour period at 60°C. Any unit failing to function properly shall result in failure of the entire lot from which the sample was selected. Should this occur, the entire quantity ordered shall be tested as described above, with units not functioning properly being rejected.

Each LED signal module 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.

Each LED signal module shall be tested to ensure light output at 80 and 135 volts without adverse operational effects. Each LED signal under test shall be operated at each voltage level for a time period of five minutes. Signal modules illuminating with any adverse operational effects shall be rejected.

CONSTRUCTION.

Electrical. All wiring and terminal blocks shall meet the requirements of Section 13.02 Wiring of the VTCSH standard. Each wire shall be approximately 1 m long.

The LED signal module shall operate with 60 ± 3 Hz AC line voltage ranging from 80 volts to 135 volts rms. The circuitry shall prevent flicker over this voltage range. Rated voltage for all optical and power measurements shall be 120 ± 3 volts rms.

The signal module 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, 1992.

The individual LED light sources shall be wired so that a catastrophic failure of one LED light source will not result in the loss of illumination of more than 20 percent of the remaining LED light sources.

Each LED signal module shall be designed so that there is no noticeable light output when connected to rated voltage through an impedance of 15 k Ω (either resistive or capacitive).

The signal module shall be designed so that, under normal operation, an AC voltage of no greater than 10 volts rms shall be developed across the unit when it is connected in series with any value of impedance greater than 15 K Ω and for any applied voltage between 80 and 135 volts rms that is connected across this series combination.

The unit shall be designed so that a normally functioning signal module will generate the needed current to prevent a Model 215 Current Monitor from detecting a loss of current over the voltage range of between 95 and 135 volts rms. The minimum current required to prevent the Model 215 monitor from detecting a loss of current is a 500 milliamp peak AC or pulsed current with a minimum pulse width of 3 msec. Signal modules designed to specifically generate current pulses to prevent the monitor from tripping shall, as a minimum, generate 6 pulses per second. Generated current pulses shall be evenly spaced, with the first pulse generated immediately after application of AC power to the unit. (Additional information regarding the operation of the Model 215 Current Monitor can be obtained in the "New York State Transportation Management Equipment Specifications").

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The unit shall be designed to sense a loss of light output due to catastrophic LED failures of between 25 and 40 percent. Loss of light output due to LED failure will not be detected for losses of less than 25 percent but will be detected for any loss of light greater than 40 percent. The unit, upon sensing a valid loss of light, will do the following:

- A) Convert to a device that exhibits an impedance of a 500 Kohms minimum to the AC line to allow a Model 210 conflict monitor to detect this failure.
- B) Within 1 sec turn off any current generating circuitry to allow a Model 215 current monitor to detect this failure.

The LED signal module and associated on board circuitry shall meet Federal Communications Commission (FCC) Part 15 regulations concerning the emission of electronic noise.

All printed circuit boards used in the design shall be coated with a conformal coating containing an ultraviolet tracer.

The maximum apparent power of a module at 120 ± 3 volts RMS shall not exceed: 30 volt-amps (VA) on a 300 mm units or 20 volt-amps (VA) on a 200 mm units. The LED signal module shall provide a power factor of 0.90 or greater. Total harmonic distortion (current and voltage) induced into an AC power line by a LED module shall not exceed 20 percent.

The unit shall be operationally compatible with traffic signal equipment (i.e., controllers, conflict monitors, current monitors, switch packs, flashers) currently in use by the New York State Department of Transportation.

Environmental Requirements. The LED signal module shall be rated for use in the ambient temperature range of -40° to $+74^{\circ}\text{C}$. The LED signal module shall be sealed against dust and moisture intrusion per the requirements of NEMA Standard 250-1991 for Type 4 enclosures to protect all internal LED and electrical components. The LED signal module shall be capable of operating at rated voltage in an environment of $+74^{\circ}\text{C}$ /85% RH for 1000 hours without the formation of internal condensing moisture.

The lens of the LED signal module shall be capable of withstanding ultraviolet light (direct sunlight) exposure for a minimum time period of five years without exhibiting evidence of deterioration.

I. Arrow LED Traffic Signal Module

In addition to applicable requirements of §724-04, H, **Ball LED Traffic Signal Module**, the following additional requirements apply to Arrow LED Traffic Signal Modules.

MATERIALS. Each unit shall have a sticker attached stating compliance to the ITE standard for Color as specified in the VTCSH.

LED Signal Module Lens. The "Red Arrow" LED signal module lens shall be tinted with the appropriate color to enhance on/off contrast.

The "Arrow" of the LED signal module shall have a size, shape and color that conforms to the VTCSH standard. The Arrow LED signal modules shall not require a specific orientation or have a variance in light output, pattern or visibility for any mounting orientation.

Optical Requirements. Arrow LED signal modules shall be designed so, that when operated over the specified operating ambient temperature and voltage ranges during the first 60 months of field operation, the signal is clearly visible and attracts attention for a distance of at least 400 m under normal atmospheric conditions.

The measured chromaticity coordinates of LED signal modules shall conform to the chromaticity requirements of Section 8.04, Limits of Chromaticity Coordinates and the associated Figure 1 of the VTCSH standard.

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CONSTRUCTION.

Electrical. The maximum apparent power of Arrow LED modules at 120 ± 3 volts RMS shall not exceed: 20 volt-amps (VA) on 300 mm units or 15 volt-amps (VA) on 200 mm units.

J. Hand LED Pedestrian Signal Modules

In addition to applicable requirements of §724-04, A, **Standard Signal Heads**, and §724-04, C, **Standard Pedestrian Signal Heads**, the following additional requirements apply to Hand LED Pedestrian Signal Modules.

GENERAL. This specification refers to definitions and practices described in publication ST-011B "Pedestrian Traffic Control Signal Indications" published by the Institute of Transportation Engineers (ITE), referred to in this document as "PTCSI."

Pedestrian LED traffic signal modules shall be designed as retrofit replacements for the message bearing surface of a pedestrian signal housing built to the PTCSI Standard. The LED signal module shall fit into existing pedestrian traffic signal housings without the need to modify the housing or modify/remove the reflector. The module shall be sealed to provide a weather tight enclosure and an insulating covering for all electrical connections and electronic components.

Installation of the retrofit replacement Pedestrian LED signal module into an existing pedestrian signal housing shall be accomplished without the use of special tools and only require the removal of the existing message bearing surface and insertion of the retrofit replacement into the area once occupied by the removed assembly. The module shall fit securely in the housing. It shall connect directly to existing electrical wiring by means of push on type connectors or by using the existing screw-based socket. Hardware for electrical connection shall be supplied.

The message bearing surface of the module shall be supplied with the "HAND" symbol that complies with PTCSI standard for this symbol for a message bearing surface of the size specified. This message bearing surface shall be designed so that it can be removed from the sealed unit for replacement without further damage to the module.

MATERIALS. Materials used in the signal module construction shall conform to ASTM specifications for those materials. The LED sources shall be made of the Aluminum-Indium-Gallium-Phosphorus (AlInGaP) type.

Each Pedestrian LED signal module shall be identified on the back side with the manufacturer's trade mark, serial number, voltage rating, nominal operating current rating, and if necessary a vertical indexing indicator (i.e., "up arrow," or the word "UP" or "TOP").

Each unit shall have a sticker attached stating compliance to the ITE standard for chromaticity as defined in the PTCSI.

Optical Requirements. The measured chromaticity coordinates of Pedestrian LED signal modules shall conform to the chromaticity requirements of Section 5.3, Color and the associated Figure C of the PTCSI standard. All modules supplied shall be Portland Orange in color.

Pedestrian signal modules shall be designed so, that when operated over the specified ambient temperature and voltage ranges during the first 60 months of field operation, the unit shall attract the attention of, and be readable to, a viewer (both day and night) at all distances from 3 m to the full width of the area to be crossed.

Performance Tests. Prior to shipment, each LED signal module shall be energized (burned-in), for a minimum of 24 hours, at rated voltage, and at a 100 percent on-time duty cycle. This test shall be conducted at the rated voltage in an ambient temperature of 60°C . Any failure within an LED signal module occurring during burn-in shall be cause for rejection.

After the burn-in procedure is completed, the following additional tests shall be performed. These tests shall be performed at rated operating voltage and at 25°C unless otherwise specified.

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All units shall be powered off for a period of 1 second and then powered back on. Any unit failing to turn on after power restoration shall be rejected. This test shall be performed a minimum of 10 times.

A sample of 10% of units on the order shall be randomly selected and tested in a flashing mode of operation, at 50 percent duty cycle with a 0.5 sec on time, and for a 24 hour period at 60°C. Any unit failing to function properly shall result in failure of the entire lot from which the sample was selected. Should this occur, the entire quantity ordered shall be tested as described above, with units not functioning properly being rejected.

Each LED signal module 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.

Each Pedestrian LED signal module shall be tested to ensure light output at 80 and 135 volts without adverse operational effects. Each Pedestrian LED signal under test shall be operated at each voltage level for a time period of five minutes. Signal modules illuminating with any adverse operational effects shall be rejected.

CONSTRUCTION.

Electrical. The Pedestrian LED signal module shall operate with 60 ± 3 Hz AC line voltage ranging from 80 volts to 135 volts rms. There shall be no light flicker over this voltage range and light output over this range shall be nearly constant so that the signal module maintains the attraction characteristics as defined above.

The Pedestrian signal module 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, 1992.

The individual LED light sources shall be wired so that a catastrophic failure of one LED light source will not result in the loss of illumination of more than 20 percent of the remaining LED light sources.

Each Pedestrian LED signal module shall be designed so that there is no noticeable light output when connected to rated voltage through an impedance of 15 k Ω (either resistive or capacitive).

The signal module shall be designed so that, under normal operation, an AC voltage of no greater than 10 volts rms shall be developed across the unit when it is connected in series with any value of impedance greater than 15 K Ω and for any applied AC voltage between 80 and 135 volts rms that is connected across this series combination.

The LED signal module and associated on board circuitry shall meet Federal Communications Commission (FCC) Part 15 regulations concerning the emission of electronic noise.

The maximum apparent power of the unit shall not exceed 15 volt-amps (VA) at 120 ± 3 volts rms.

All printed circuit boards used in the design shall be coated with a conformal coating containing an ultraviolet tracer.

The unit shall be operationally compatible with traffic signal equipment currently in use by New York State Department of Transportation.

Environmental Requirements. The LED signal module shall be rated for use in the ambient temperature range of -40° to +74°C.

BASIS OF ACCEPTANCE. Acceptance of signal heads, sections, and/or LED signal modules will be based on manufacturer's certification of compliance with these specification requirements, a list of the serial numbers of the units being supplied, copies of all applicable test reports on the signal modules, and signature of the person responsible for certifying the tests. In addition, LED module model number and manufacturer's name must be listed either on the latest NYS Signal Lab Approved Products List or the Qualified Products List.