



**TLUM2**  
**LUMINANCE SENSOR**  
**FOR**  
**TUNNEL LIGHTING CONTROL SYSTEMS**  
**INSTALLATION AND MAINTENANCE MANUAL (IMM)**

**PLC** Transportation  
*Control Systems*

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**1 OVERVIEW**

The TLUM2 is a Luminance Sensor designed to provide an analog signal, measuring the light that a motorist sees from the roadway, portal and sky as they approach and enter a tunnel, to a Tunnel Lighting Controller.

**1.1 The Sensor**

The TLUM2 utilizes a blue-enhanced photometric sensor, a trans-impedance amplifier, and a signal converter to produce a linear, analog signal.

**1.2 Power**

The TLUM2 requires 24VAC @ 50VA to operate properly.

**1.3 Circuit Protection**

The TLUM2 utilizes two surge suppressors; one for the 24VAC power and one for the DC current loop signal.

**1.4 Analog Signal**

The TLUM2 provides a linear, analog, output signal that is proportional to the light it measures. This is accomplished through a 4-20mA current loop. The range of the TLUM2 is 0-10,000 Candelas per square meter (Cd/m<sup>2</sup>).

**1.5 Environmental Protection**

The TLUM2 is housed in a weatherproof, NEMA 4 enclosure with a Lexan window. The housing is protected from solar heat by a sun shroud and includes a heater/defroster that will maintain a minimum of 35°F internal temperature to prevent icing and condensation during cooler seasons.

**1.6 Mounting**

The TLUM2 should be mounted 1 stopping-distance away from tunnel portal, facing the portal so that the sensor observes the ambient light that the motorist is experiencing. It can be pole or wall mounted.

**1.7 Wiring**

The TLUM2 requires 5 field conductors. 3 - #14 AWG conductors are utilized for the 24VAC power and a single, shielded, twisted-pair of #14 AWG wire are needed for the analog signal. These conductors will terminate at 5 terminal blocks within the TLUM2 enclosure.

## 2 THE SENSOR

### 2.1 Function

- 2.1.1 The TLUM2 tunnel luminance sensor provides analog measurement in Candelas per square meter (Cd/m<sup>2</sup>) that target reflected and ambient light at each traffic direction's entrance portal.
- 2.1.2 TLUM2 Tunnel luminance sensors see a restricted field of view, e.g. 20° and are aimed at the tunnel portals composing the field of vision that a driver at a safe stopping distance before entering the portal.
- 2.1.3 Long distance signal transmission, up to 1,000 feet, is accomplished through a 4-20mA current loop.
- 2.1.4 The TLUM2 sensor is capable of measuring outdoor ranges of 0 to 10,000 Cd/m<sup>2</sup>.

### 2.2 Process

- 2.2.1 The TLUM2 tunnel luminance sensor utilizes a blue-enhanced sensor with a photometric filter accuracy of 1% total area error (with a CIE function error of 2%) to provide analog measurement in Cd/m<sup>2</sup>.
- 2.2.2 An analog module amplifier (TIA) in the sensor enclosure provides sensitivity adjustment for the sensor. The TIA has gain and offset adjustments and amplifies the signal from the luminance sensor to 0 – 10 VDC. The output voltage becomes the input to the voltage-to-current converter (V/I).
- 2.2.3 The V/I module converts the 0 – 10 Volt input to the desired 4 – 20mA output.
- 2.2.4 The current output passes through a DC surge suppressor (SSDC) and then out to the tunnel lighting controller.
- 2.2.5 A differential analog input reads the 4-20ma reading
- 2.2.6 The DC current returns to the TLUM2.

### 3 POWER

3.1 The TLUM2 operates on 24VAC power.

#### 3.2 External

3.2.1 If the TLUM2 is connected to a PLC-Multipoint T4 or T5 series Tunnel Lighting Controller (TLC), a properly fused and protected 24VAC circuit is provided specifically for this purpose in the control panel.

3.2.2 If the TLUM2 is connected to a non-PLC-Multipoint TLC, a 24VAC @ 90VA minimum circuit must be supplied to the TLUM2 via 3 #14 AWG conductors (L, N, and GND).

3.2.3 If the TLUM2 is connected to a non-PLC-Multipoint TLC, it is highly recommended that the power circuit is properly fused in the TLC and has proper surge protection.

#### 3.3 Internal

3.3.1 Inside the TLUM2, the 24VAC power passes through an AC surge suppressor (SSAC).

3.3.2 The 24VAC power circuit powers the enclosure's 20W heater/defroster (PCB) and AC/DC converter.

3.3.3 The AC/DC converter provides 24VDC to the DC/DC converter and the signal converter.

3.3.4 The DC/DC converter provides  $\pm 15$ VDC to the trans-impedance amplifier (TIA).

#### 3.4 Local Power Option

3.4.1 The TLUM2 can be placed at a maximum distance of 1000' from the controller.

3.4.2 This restriction is due to the drop in 24 VAC power at distances beyond 1000'.

3.4.3 At 1000' distance, the 24 VAC input power is reduced to 21 VAC. This is the minimum voltage required for the TLUM2 power supply to function correctly.

3.4.4 If the TLUM2 is installed beyond 1000' from the controller, then the TLUM2 local power option (TU24) must be selected.

3.4.5 The TU24 option places a local control power transformer on the light pole or wall to step down from any one of the line voltages of 480/277/120 VAC to 24 VAC.

3.4.6 With the local power option, the TLUM2 can be up to 2000' maximum from the controller.

3.4.7 Local power Option wiring gauge requirements are identical as described above.

**4 CIRCUIT PROTECTION**

- The TLUM2’s 24VAC power circuit and the 4-20mA current loop are protected by individual UL 497B listed, High Energy Silicon Avalanche Diode (SAD) surge suppressors with a Peak Pulse Current of 46.5A.
- It is highly recommended that corresponding surge suppression be located in these circuits in the TLC enclosure.
- All PLC-Multipoint TLC enclosures have appropriate surge suppression in their design.

**5 ANALOG SIGNAL**

- The TLUM2 provides a linear, analog, output signal that is proportional to the light it measures.
- The various components described in Section 2.2 produce a 4-20mA current loop output signal.
- The photosensitivity range of the TLUM2 is 0-10,000 Cd/m2.
- 4mA = 0 Cd/m2 and 20mA = 10,000 Cd/m2.
- Linearity +/- 2% at 70°F (21°C).
- Accuracy - Overall Tolerance: ±12% over the specified light & temperature range.

**6 ENVIRONMENTAL PROTECTION**

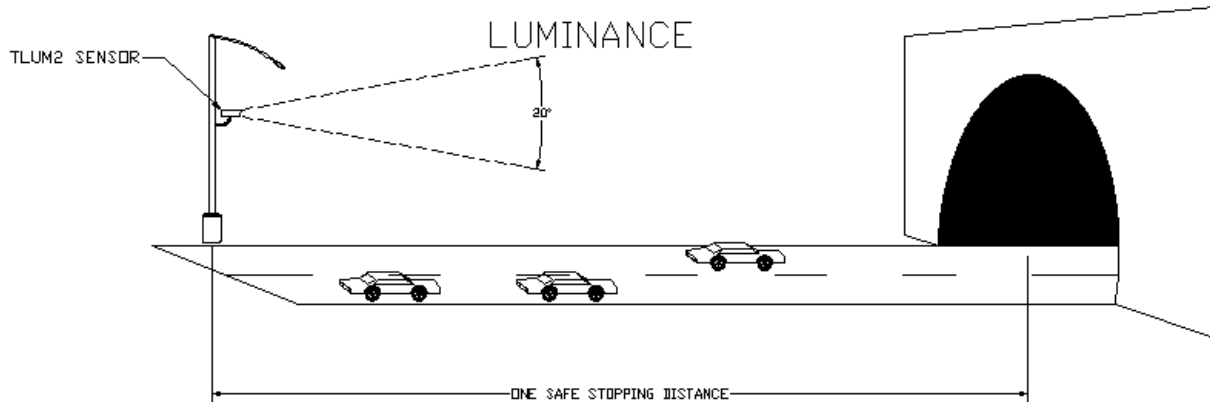
- The TLUM2 is housed in a weatherproof, NEMA 4 enclosure with a Lexan window.
- Wiring enters the enclosure through pre-punched penetrations which also have weatherproof strain relief fittings.
- The TLUM2 housing is protected from solar heat by a sun shroud.
- The TLUM2 housing is protected from accumulated snow and ice through the use of a thermostatically controlled heater that will activate to maintain a minimum 35° F internal temperature.
- The device turns on at 50°F (10°C) and turns off at 80°F (27°C).
- The TLUM2 enclosure features a lockable hasp.

## 7 MOUNTING

The TLUM2 can be pole or wall mounted. Mounting the TLUM2 correctly is important for three reasons; functionality, survivability, and electrical concerns.

### 7.1 Designed Functionality

- 7.1.1 The TLUM2 should be mounted one safe stopping-distance away from the tunnel portal. (See AASHTO Table)
- 7.1.2 The TLUM2 is targeted to the portal of the tunnel aiming at a scene consisting of the tunnel portal facade, roadway and surrounding terrain
- 7.1.3 The TLUM2 sees a restricted field of view composing the field of vision of a motorist at one safe stopping-distance before entering the portal.
- 7.1.4 The targeted area is a 20° angle; approximately equal to the motorist's visual cutoff between the hood and roof of a car (i.e. sight through the windshield).
- 7.1.5 Please review the Typical Mounting Location Diagram and AASHTO Stopping Sight-Distance Table (Abbreviated).
- 7.1.6 For a more detailed Table that also takes into account road grades, please consult the IES publication RP-22-11. See Table.



Typical Mounting Location Diagram

<b>Traffic Speed</b>	<b>Stopping Sight Distance (Feet)</b>
30 mph	200
40 mph	305
50 mph	425
60 mph	570
70 mph	730

AASHTO Stopping Sight-Distance Table (Abbreviated) from IES Pub. RP-22-11

**7.2 SURVIVABILITY**

The TLUM2 is typically mounted at a minimum height of 15’ and positioned on the side of the tunnel approach roadway out of the range of snow clearing equipment.

**7.3 Electrical**

- 7.3.1 The TLUM2 can be placed at a maximum distance of 1000’ from the controller.
- 7.3.2 This restriction is due to the drop in 24 VAC power at distances beyond 1000’.
- 7.3.3 At 1000’ distance, the 24 VAC input power is reduced to 21 VAC. This is the minimum voltage required for the TLUM2 power supply to function correctly.
- 7.3.4 If the TLUM2 is installed beyond 1000’ from the controller, then the TLUM2 Local Power Option (TU24) must be selected.
- 7.3.5 The TU24 option places a local control power transformer on the light pole to step down from 480/277/240/120 VAC to 24 VAC.
- 7.3.6 With the local power option, the TLUM2 can be at a 2000’ maximum from the controller.
- 7.3.7 Local Power Option wiring gauge requirements are identical as described in the Wiring Gauge Requirements section above.

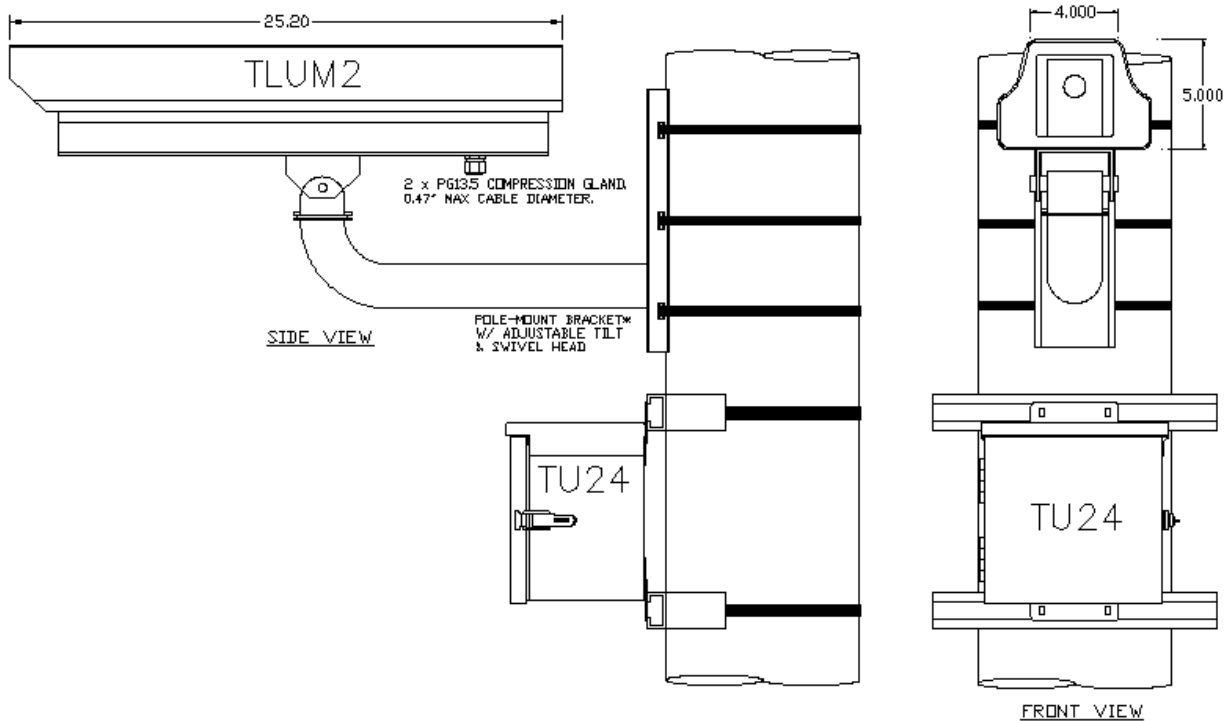
**7.4 POLE MOUNT**

- 7.4.1 The Pole Mount bracket features a manually adjustable swivel head and a cable feedthrough hole to conceal wiring.
- 7.4.2 Multiple mounting holes on the tilt table provide maximum 360-degree horizontal positioning of the TLUM2 enclosure.
- 7.4.3 The Pole Mount bracket must be mounted on vertical pipes or poles having a 3-inch to 8-inch diameter.



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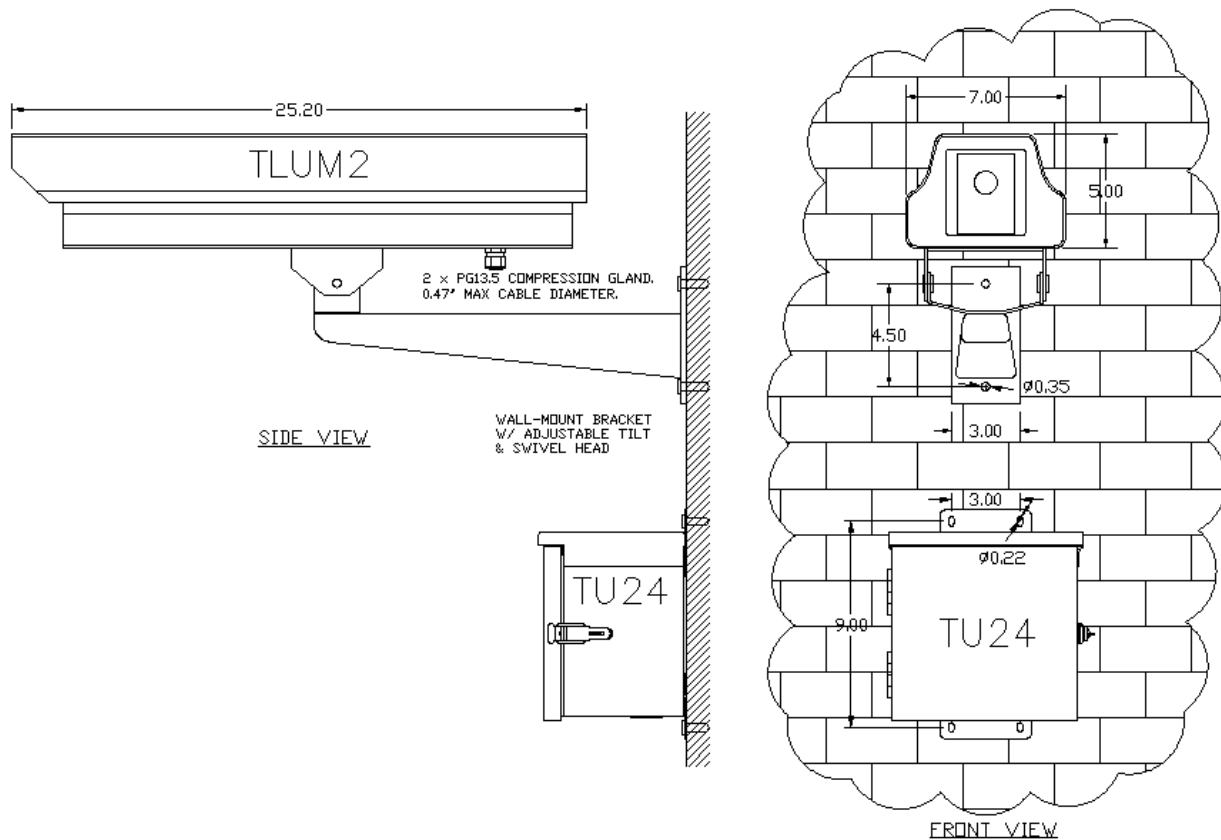
- 7.4.4 Mounts are secured to the pipe or pole with 3 stainless steel mounting straps (supplied).
- 7.4.5 Two ¼-20 mounting bolts (supplied) are required to secure the TLUM2 enclosure to the mount.
- 7.4.6 The Local Power Option TU24 can be pole mounted with a provided pole-mounting kit if ordered.
- 7.4.7 Please review the Typical Pole Mount Application.



Typical Pole Mount Application

## 7.5 WALL MOUNT

- 7.5.1 The Wall Mount bracket features a manually adjustable swivel head.
- 7.5.2 Multiple mounting holes on the tilt table provide maximum 360-degree horizontal positioning of the TLUM2 enclosure.
- 7.5.3 The Pole Mount bracket must be mounted to a wall or other vertical surfaces.
- 7.5.4 Two ¼-20 mounting bolts (supplied) are required to secure the TLUM2 enclosure to the mount.
- 7.5.5 The Local Power Option TU24 can also be wall mounted.
- 7.5.6 Please review the Typical Wall Mount Application.



Typical Wall Mount Application

## 8 WIRING

### 8.1 TLUM2

8.1.1 The TLUM2 requires 5 field conductors for installation.

8.1.2 The field conductors must be a minimum of 14AWG wire gauge for compliance with the 1000' maximum distance.

8.1.3 The 24 VAC power connection requires three conductors.

8.1.4 The 4-20mA signal connection requires one shielded, twisted pair.

8.1.5 The TLUM2 has 5 terminal blocks for these connections that are assigned as follows:

TB1-1 24 VAC Line

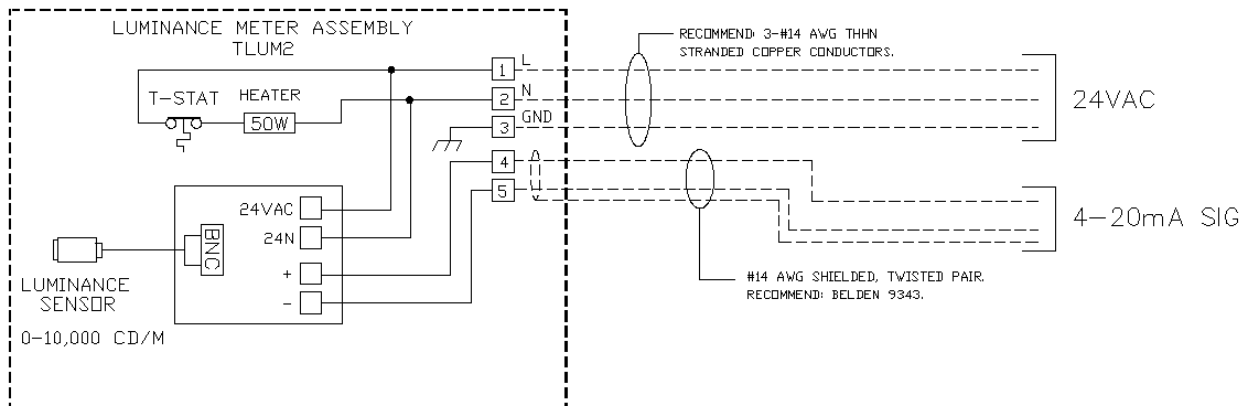
TB1-2 24 VAC Neutral

TB1-3 Ground

TB1-4 4 – 20mA signal

TB1-5 4 – 20mA return

8.1.6 Please review the Field Wiring Schematic.



Field Wiring Schematic

### 8.2 TU-24 WIRING

8.2.1 The TU-24 (Local Power Option) has multiple primary voltages which it can utilize to provide 24VAC to the TLUM2.

8.2.2 These include, 480VAC, 277VAC, 240VAC, and 120VAC.

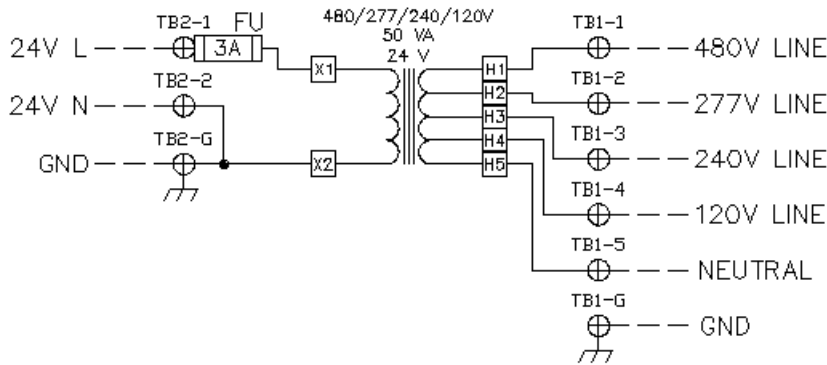
8.2.3 All primary voltages are single phase.

8.2.4 The TU-24 multi-tap transformer leads are each brought out to terminal blocks.

8.2.5 Only one primary voltage input must be used to power the transformer.

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8.2.6 Please review the TU24 Wiring Schematic.



TU24 Wiring Schematic

8.3 CONTROLLER

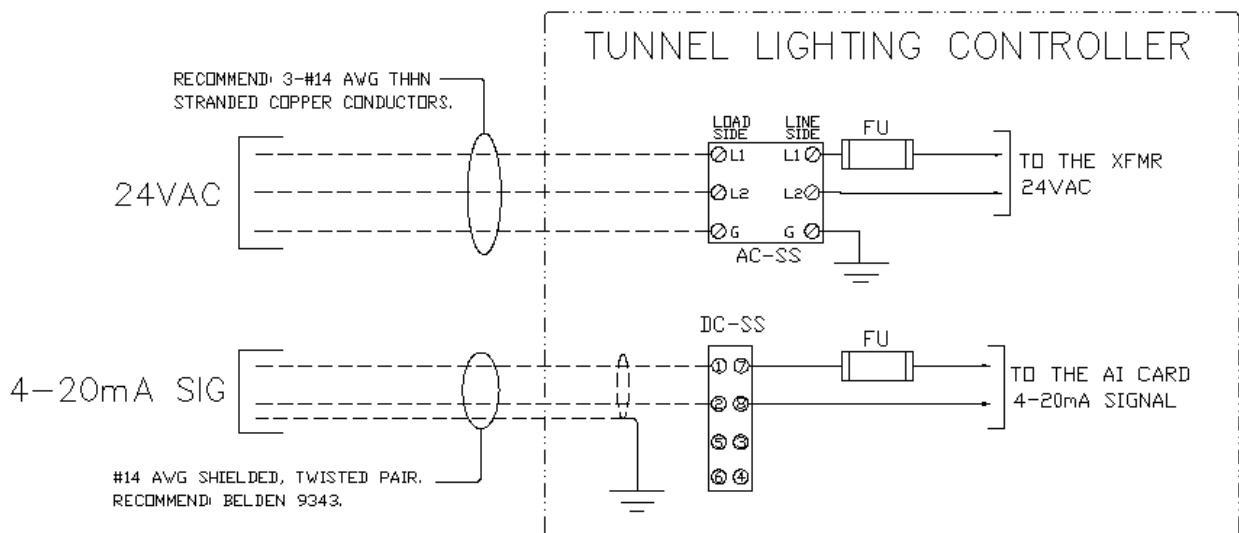
8.3.1 Typically, the Tunnel Lighting Controller will provide fused and surge protected 24VAC power to the TLUM2.

8.3.2 If the TLUM2 is located more than 1000' from the controller, it is recommended that a TU24 Local Power Option be used to provide 24VAC power to the TLUM2.

8.3.3 The TU24 will transform 480/277/240/120 VAC to 24VAC.

8.3.4 Typically, the Tunnel Lighting Controller will provide a surge protected terminal block to connect the TLUM2's 4-20mA signal to an Analog Input.

8.3.5 Please review the Typical Controller Wiring Schematic.



Typical Controller Wiring Schematic

## 9 OPERATION

This section defines the operational states of the TLUM2.

### 9.1 Unpowered State

Unpowered State: defined as device has no heating active, device sends 0mA signal to the controller which interprets this as “not working.”

### 9.2 Power-On State

Power-On State: defined as device can activate heating; 4-20mA signal is available within 1 second of powering on.

### 9.3 Normal Operation

Normal Operation: defined as device can activate heating element, sensor outputs 4-20mA signal scaled as 0 – 10,000 Cd/m<sup>2</sup>.

Controlled lighting circuits will switch on or off in a manner described in Diagram 1.

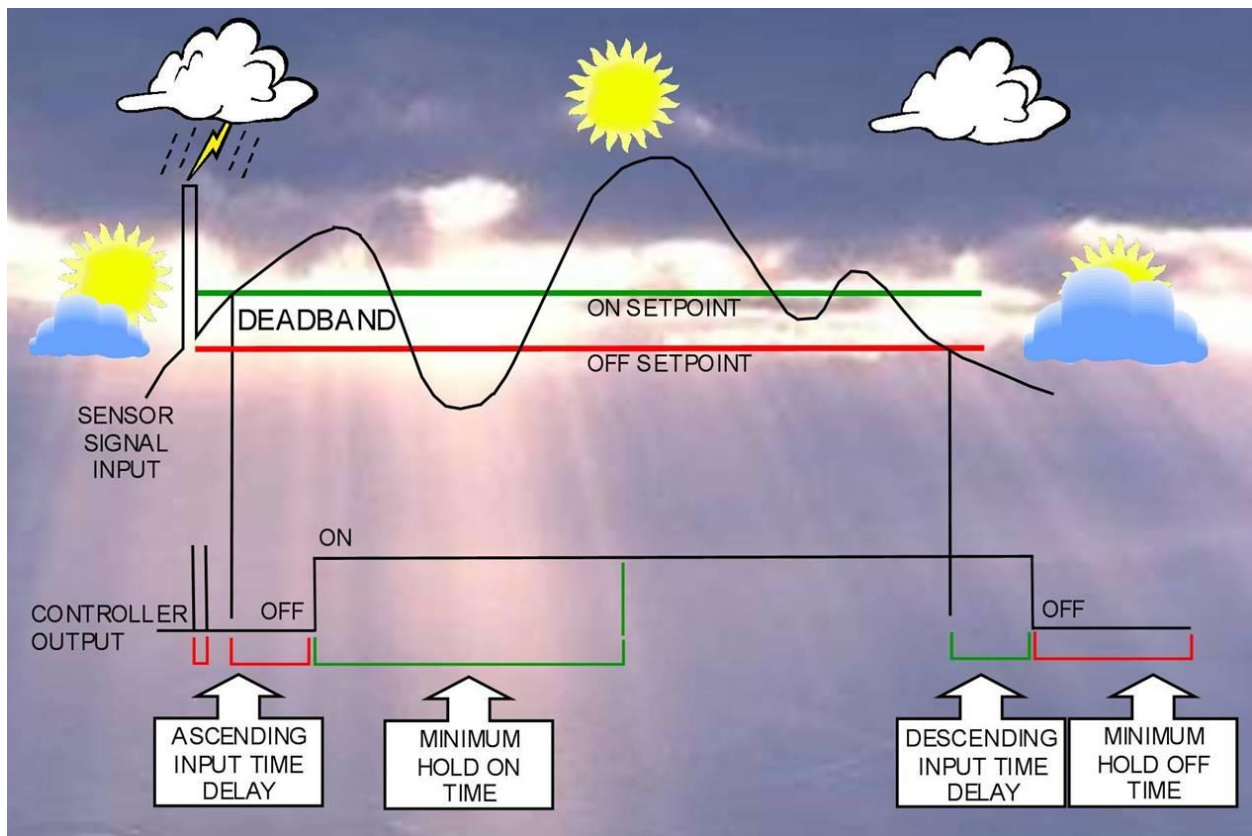


Diagram 1

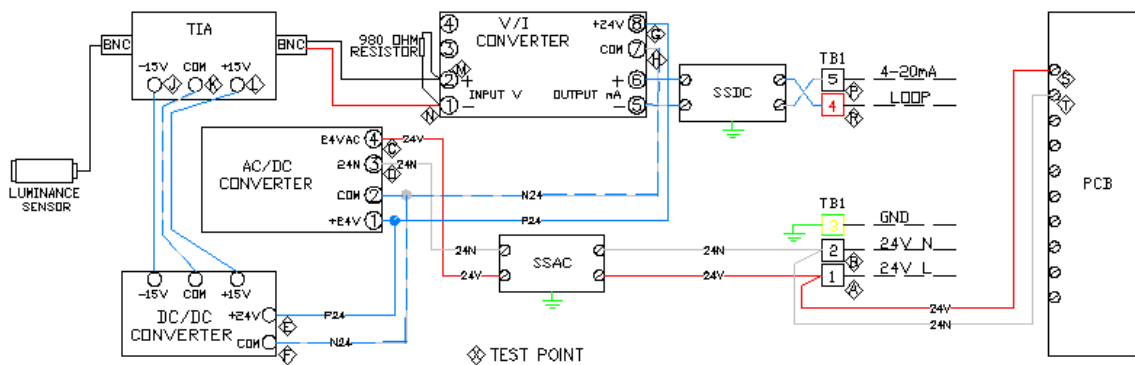
## 10 TROUBLESHOOTING

- The TLUM2 is a very precise light measuring instrument that has been manufactured and calibrated with great attention to sustaining accuracy for many years.
- In the event of a malfunction, the TLUM2 will probably need to be returned to PLC-Multipoint for servicing and recalibration.
- Before returning it, a few tests can be performed to determine if the problem is with the TLUM2 or external to it.
- If a voltage or signal does not appear where it should and power is being properly supplied, the problem will likely be a loose connection or malfunctioning component.

Please review the TLUM2 Troubleshooting Chart and the TLUM2 Component Test Schematic to guide you in these tests.

CHECK	TEST
POWER FROM TLC OR TU24	CONFIRM 24VAC POWER AT TEST POINTS A & B.
POWER TO HEATERS	CONFIRM 24VAC POWER AT TEST POINTS S & T.
AC SURGE SUPPRESSOR	CONFIRM 24VAC POWER AT OUTPUT OF SSAC.
POWER TO AC/DC CONVERTER	CONFIRM 24VAC POWER AT TEST POINTS C & D.
POWER TO DC/DC CONVERTER	CONFIRM 24VDC POWER AT TEST POINTS E & F.
POWER TO V/I CONVERTER	CONFIRM 24VDC POWER AT TEST POINTS G & H.
POWER TO TIA	CONFIRM +15VDC POWER AT TEST POINTS J & K.
POWER TO TIA	CONFIRM -15VDC POWER AT TEST POINTS L & K.
SIGNAL TO V/I CONVERTER	CONFIRM 0-10VDC SIGNAL AT TEST POINTS M & N. 0V IN DARK, 10V IN BRIGHT LIGHT.
SSDC & SIGNAL TO TLC	CONFIRM 4-20mA SIGNAL AT TEST POINTS P & R. 4mA IN DARK, 20mA IN BRIGHT LIGHT.

TLUM2 Troubleshooting Chart



TLUM2 Component Test Schematic

## 11 SPECIFICATIONS

Sensor Type:	Blue-enhanced Photo Diode
Sensor Ranges:	Factory Calibration 0-10,000 Cd/m <sup>2</sup>
Housing:	NEMA 4
Input Voltage:	24VAC
Compliance Voltage:	24VDC +/- 1VDC
Field of View:	20°
Protection:	Fused and MOV AC Input and DC Output Surge Suppressor Peak Pulse Current of 46.5A
Accuracy:	Repeatability +/- 1% Linearity +/- 2% at 70°F (21°C) Temperature +/- 10%
Overall Tolerance:	+/- 12% over the specified light & temperature range
Operating Temp:	-40°F to 140°F (-40°C to 60°C)
Internal Heating Element:	ON at 50°F (10°C) and OFF at 80°F (27°C)
Sensor Output:	4.0 - 20mA + .1/ - .1mA
Notes:	Photometric filter accuracy of 1% total area error w/ a CIE function error of 2%
Power Requirement:	24VAC, minimum 50 VA
Sensor Dimensions:	5.5"W x 17"L x 4.25"H
Mounting:	Pole or Wall mount
Communication:	4 – 20mA with controller
ROHS Compatibility	2002/95/EC
Listing:	UL508A, CAN/CSA C22.2 NO 14-M91