LUMAWISE Motion – Logic Output

NOTE
All numerical values are in metric units [with U.S. customary units in brackets]. Dimensions are in millimeters [and inches]. Unless otherwise specified, dimensions have a tolerance of ±0.10 and angles have a tolerance of ±2°. Figures and illustrations are for identification only and are not drawn to scale.

Document Sections

1 INTRODUCTION

The TE Connectivity LUMAWISE Motion – Logic Output (LMLO) offers motion sensing and luminaire dimming control in a robust, easy-to-interface platform. The product is available with a rectangular detection pattern as PN 2445583-1 (30m x 6m field of view when mounted at 5m height) and a circular detection pattern as PN 1-2445583-1 (30m x 24m when mounted at 5m height). The LMLO must be used in conjunction with a suitable lighting controller such as a Networked Lighting Controller (NLC - not included) and cannot control an LED driver or ballast directly.

1.1 Applications

The LMLO is suitable for use in pedestrian walkway, parking, or other outdoor lighting applications which can benefit from the added security and energy savings of a motion-activated luminaire.

1.2 Solution Overview

Figure 1 shows the typical application scenario where the LMLO is intended to be deployed. This diagram and the terminology in Table 1 are used throughout this document to describe functionality, capabilities, and suggested design practice. Use this information to facilitate inquiries and correspondence.

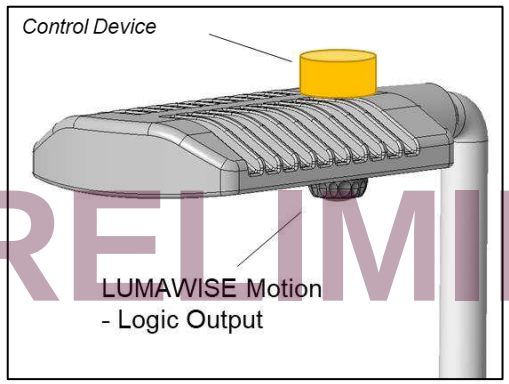


Figure 1. LMLO – Logic Output Typical Application Scenario

1.3 Terminology

Table 1. Terminology

Term/Acronym	Meaning
ANSI	American National Standards Institute
NEMA	National Electrical Manufacturers Association
LMLO	LUMAWISE Motion – Logic Output

2 REFERENCE MATERIAL

2.1 Revision Summary

Date	Revision Description
November 2023	Initial Release

2.2 Customer Assistance

Product Base Part Number X-2445583-X and Product Code K796 are representative of the LMLO. Use of these numbers will identify the product line and help to locate product and tooling information when visiting www.te.com, speaking to your local representative, or calling the product information number.

2.3 Drawings

Customer drawings for product part numbers are available from www.te.com. Information contained in the customer drawing takes priority.

2.4 Datasheet

The Datasheet provided at www.te.com offers general information about the product.

2.5 Specifications

See Product Specification 108-161018 for a full list of specifications, product performance, and test results. For information regarding the keyed mating receptacle 2363638-2 see application spec 114-160106.

3 FUNCTIONAL OVERVIEW

Figure 2 shows a block diagram of the functional blocks of the LMLO. The core functions of the LMLO include:

- Keyed Endurance S Mounting Interface.
- Dual-sensor Infrared motion detection (PIR) for motion activity feedback to connected luminaire controller.
- Ambient light sensor for day/night operation and system use.
- Environmentally reactive sensitivity adjustment for robust performance.

Each of these functions, as well as interface and usage considerations, are detailed in the following sections.

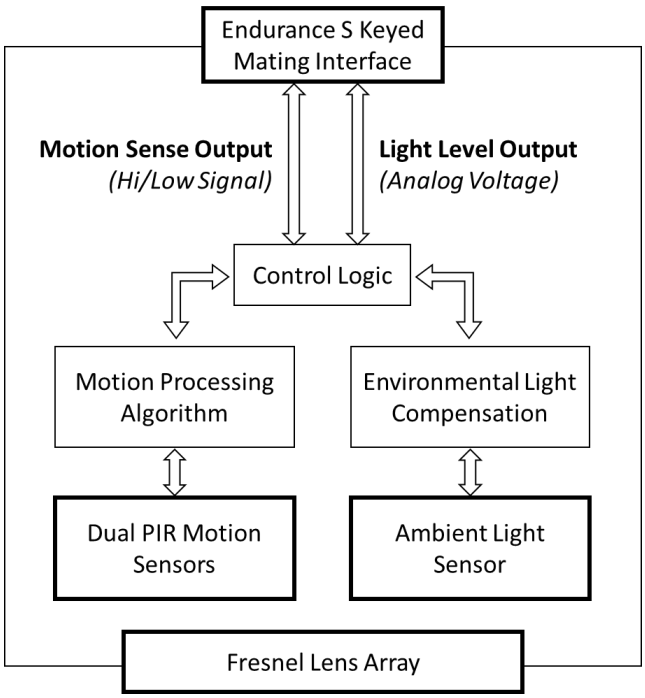


Figure 2. LMLO – Logic Output Functional Block Diagram

3.1 Safety

The LMLO is a fully enclosed device, which cannot be powered except when mated with an appropriately wired receptacle. Normal ESD precautions should be followed when handling the device unmated.

3.2 Environmental

The LMLO is rated for operation in ambient temperatures from -40°C to 65°C.
Ingress protection is rated to IP66.
Impact protection is rated to IK07.

For further information on environmental qualification refer to 108-161018.

4 OUTPUT DESCRIPTION

The LMLO includes a keyed Endurance S mounting interface, TE Connectivity PN 2-2343404-1. The recommended mating receptacle is TE Connectivity PN 2363638-2. The following sections include details of the electrical interface which must be considered to achieve advertised performance.

Pin 1	V IN (10-24V)
Pin 2	GND
Pin 3	Light Output (Analog)
Pin 4	Motion Output (Hi/Lo)

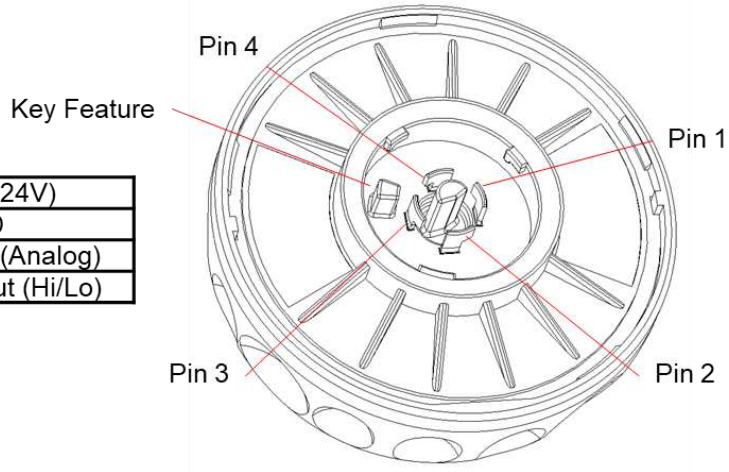


Figure 3 - Interface and Pinout

4.1 Power Supply Connection (Pins 1 and 2)

The LMLO is intended for use with a stable DC power supply, as provided by the installed fixture, control unit, or driver-provided AUX supply. The nominal input voltage range is 10 – 24V DC, with a +/- 10% tolerance accepted. Maximum current consumption is 10mA, with typical consumption during normal operation of 3-5mA depending on input voltage.

Depending on power supply voltage and source impedance, the LMLO may draw a brief inrush current of up to 120mA on power up. Current draw will fall below 10mA within 15ms and reach nominal within 20ms.

NOTE
The LMLO is not a DALI-compatible device and is intended for use in applications where a DC supply is available. However, due to its low power consumption and wide input voltage compatibility, some systems may be able to deploy the LMLO using a DALI bus as the power supply. No warranty is provided for this use case and consultation of IEC 62386 is advised.

4.2 Motion Activity Output (Pin 4)

The LMLO Motion Activity Output (Pin 4) is an active high logic output with high-level equal to V_IN or V_Supply (Pin 1) and low level equal to GND (Pin 2). When a motion event is registered, and as long as motion is active within the sensor field of view, the Motion Activity Output will remain high.

The output electrical configuration is as an open drain with a weak (100KΩ) pull up to V_Supply. When defining controller interface circuitry to monitor the Motion Activity Output, care must be taken to ensure the interface circuit is compatible with these voltage levels or includes appropriate clamping and/or overvoltage protection. A simple resistor divider network should provide a suitable voltage for most systems.

If any external voltage is applied to Pin 4, no more than 5mA of current should be sunk into the Motion Activity Output (Pin 4) by the controller interface circuit. The provided figure shows a representative circuit for the Motion Activity Output pin.

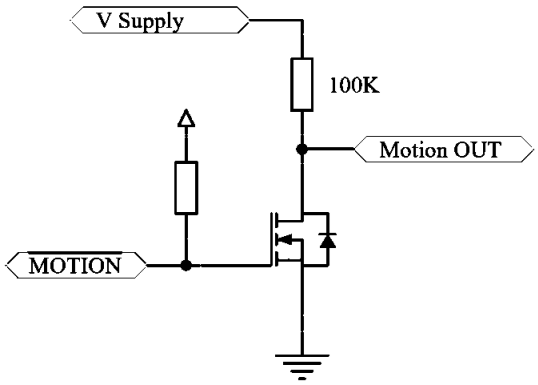


Figure 4 - Representative Motion Activity Output Stage

4.3 Ambient Light Level Output (Pin 3)

The Ambient Light Level Output (Pin 3) provides an analog voltage between 169mV nominal (minimum value at 0 lux) and 3140mV nominal (maximum value at 2000 lux) in proportion to the ambient light level measured by the LMLO internal sensors. For ambient light levels above 2000 lux, the Ambient Light Level Output pin will be set to the maximum value of 3140mV.

The scaling of the voltage output is logarithmic, providing added resolution at lower light levels useful for determining day/night transitions in natural light environments, while still allowing for monitoring higher ambient light conditions up to 2000 lux. The figure below provides a quick reference for output voltage vs ambient lux measurement.

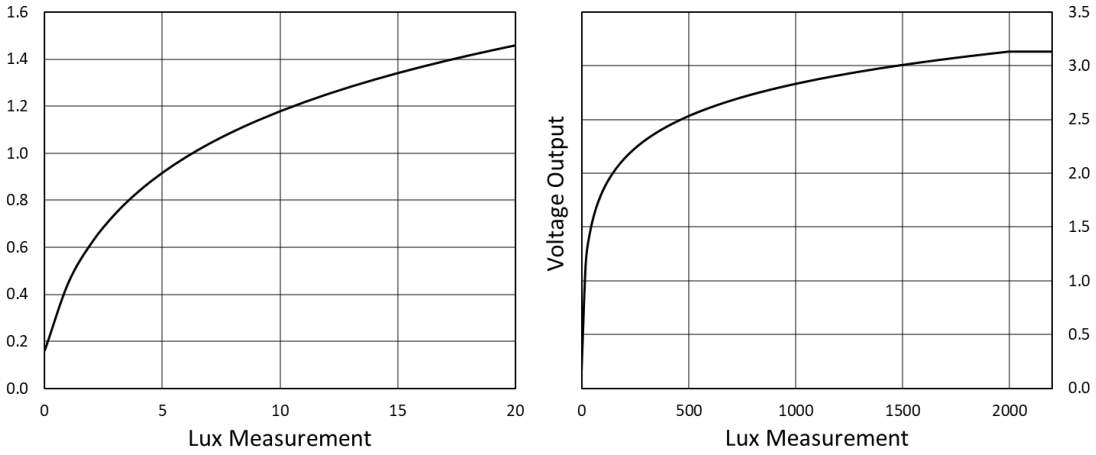


Figure 5 - Output Voltage vs Ambient Lux Measurement for low light levels (left) and full range (right)

The electrical output stage for the Ambient Light Level Output is represented by a rail-to-rail op amp in voltage follower configuration, with 470Ω output impedance. When defining controller interface circuitry to monitor the Ambient Light Level Output, care should be taken that the interface circuit is compatible and will not provide unnecessarily high load on the output. A typical analog-to-digital converter (ADC) should be sufficient for most systems. Since system loading may impact output voltage range for this analog output, it is recommended that connected NLCs take advantage of the power-on sequence defined in the following section to fully calibrate the voltage-to-lux conversion.

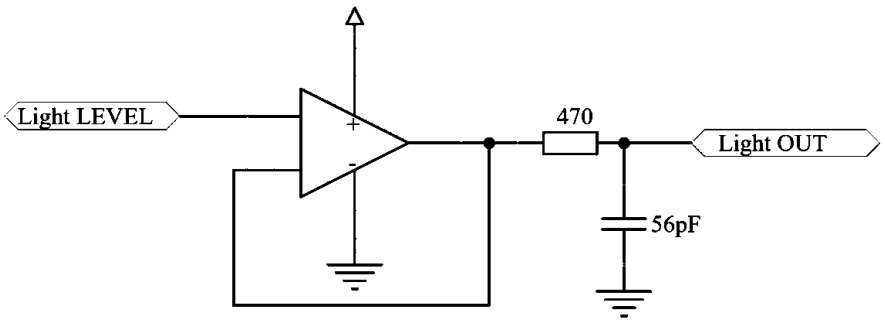


Figure 6 - Representative output stage for Ambient Light Level Output

CAUTION

The Ambient Light Level Output includes a low impedance analog voltage generator with only basic ESD protection. This output should be connected to a high impedance measurement input only. If this output pin is connected to a high external voltage such as 24V, or if more than 10mA is sourced into the output pin, the analog output stage may be damaged rendering it inoperable.

4.4 Power-On Sequence

On any application of power, either initial startup or after a power cycle, the LMLO will execute a standard power-on routine. This power-on sequence exercises both outputs – Motion Activity Output (Pin 4) and Ambient Light Level Output (Pin 3) – and provides useful diagnostic information about the functional health of the LMLO.

Controller systems wishing to actively monitor LMLO system health or calibrate for sensor output performance may make use of the specific timings and features described below.

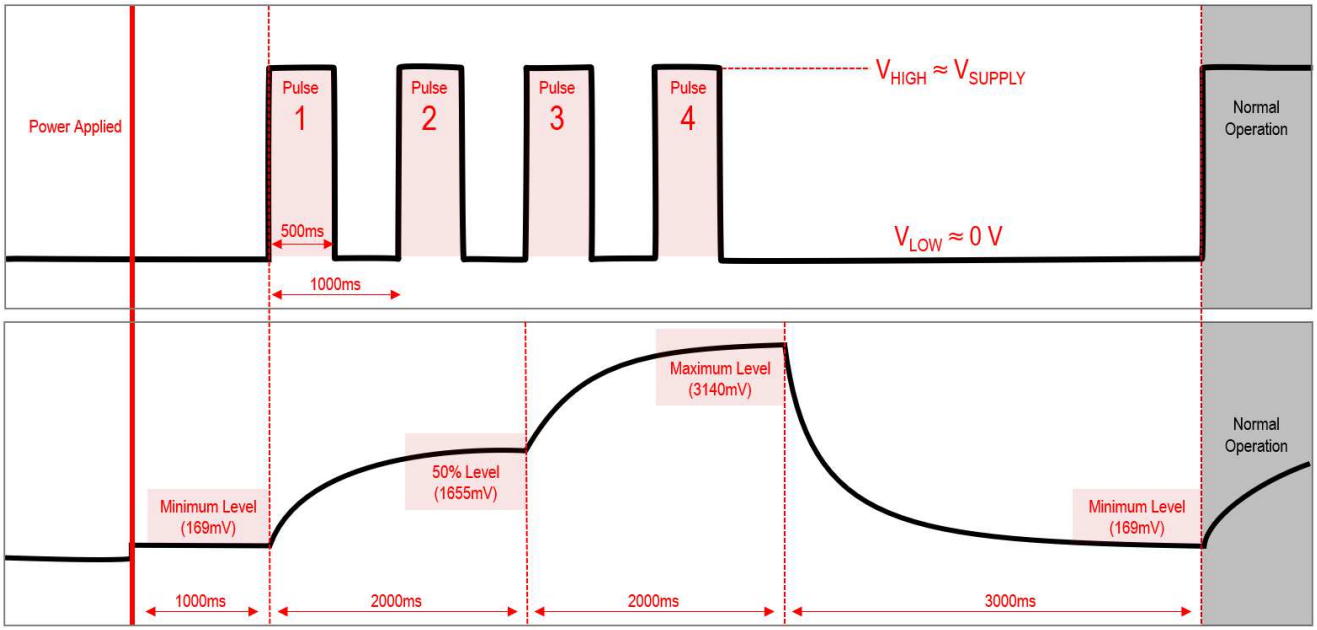


Figure 7 - Startup Health Check Sequence, Motion Activity Output (Top) and Light Level Output (Bottom)

Both Motion Activity Output Health Check and Light Level Output Health Check run concurrently, starting approximately 1000ms after application of power. The total health check / power-on sequence concludes approximately 8000ms after application of power, after which normal operation will begin. Details of each health check are included below.

A. Motion Activity Output Health Check

As shown in the figure above, the Motion Activity Output startup sequence includes 4 pulses, each 500ms wide with 500ms of low time in between. Each pulse indicates the status of an internal system check:

- **Pulse 1:** Confirms operation of Motion Activity Output driver stage
- **Pulse 2:** Confirms internal communication with PIR Sensor 1
- **Pulse 3:** Confirms internal communication with PIR Sensor 2
- **Pulse 4:** Confirms internal communication with Ambient Light Sensor

If any of these pulses are missing from the startup sequence that indicates an internal system failure of the associated function and the sensor unit should be replaced.

B. Light Level Output Health Check

During the power-on sequence the Light Level Output will be set to three distinct, pre-defined levels representing the minimum output value (nominal 169mV), the 50% output level (nominal 1655mV) and the maximum output value (nominal 3140mV). Following the maximum output setting, the Light Level Output will be again set to minimum until the power-on sequence is complete. Since actual output voltages may be impacted by system loading, these pre-defined setpoints may be measured and used to calibrate light sensor calculations in the connected NLC. Recommended sampling times are 900ms, 2900ms, and 4900ms after power-on for minimum, 50%, and maximum levels respectively.

5 MOTION SENSOR OPERATION

The LMLO includes a proprietary PIR and optical lens configuration, specifically tailored for street, area lighting, and pedestrian walkway applications. This section describes the performance and related functionality of the motion sensor system.

5.1 Detection Area: Rectangular Pattern (PN 2445583-1)

The effective motion detection range for the LUMAWISE Motion with the rectangular lens is approximately 30m x 6m when mounted at 5m height above the ground, 30m x 10m when mounted at 8m height above the ground, and 36x12m when mounted 12m above the ground. This motion detection area has been specially designed to meet the needs of pedestrian path and cycleway applications, providing greater range and sensitivity along the illuminated path while ignoring motion in the adjacent areas.

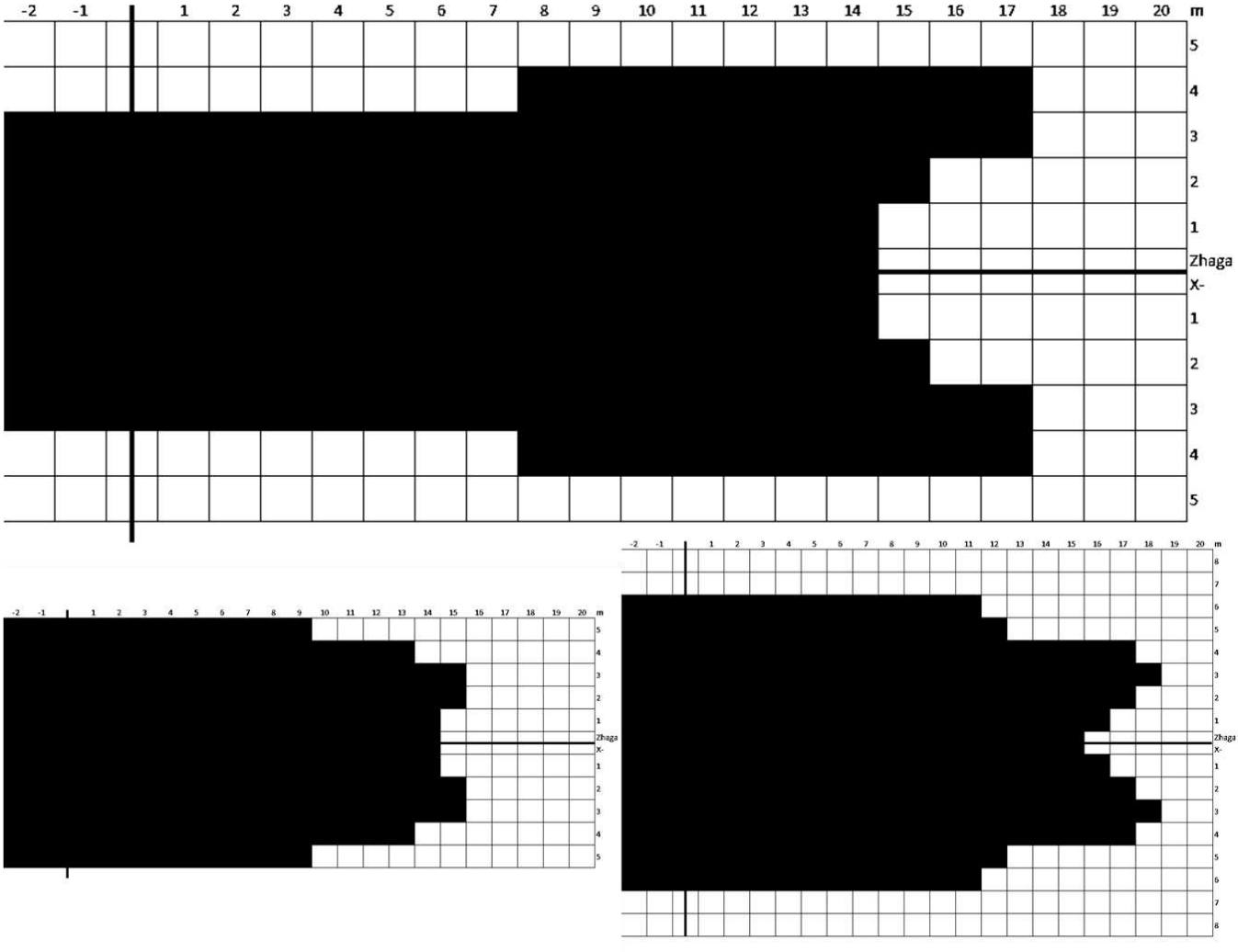


Figure 8 - Representative Motion Detection Performance, Rectangular
Positive X Hemisphere Shown – Symmetrical Performance about Y Axis
5m mounting height (top)
8m mounting height (bottom left),
12m mounting height (bottom right)

5.2 Detection Area: Circular Pattern (PN 1-2445583-1)

The effective motion detection range for the LUMAWISE Motion with the circular lens is approximately 30m x 24m when mounted at 5m height above the ground, 32m x 34m when mounted at 8m height above the ground, and 28x28m when mounted 12m above the ground.

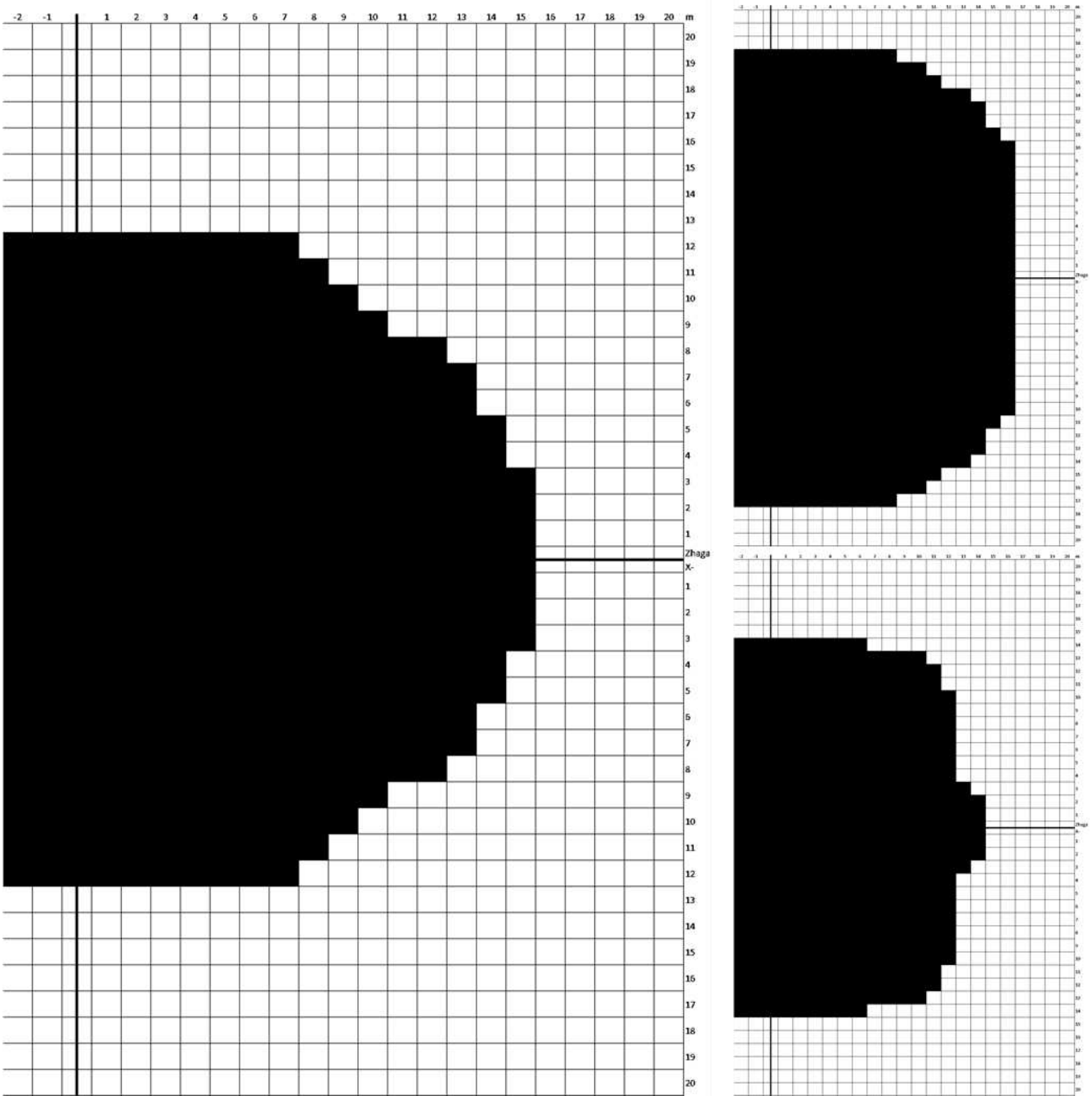


Figure 9 - Representative Motion Detection Performance, Circular
Positive X Hemisphere Shown – Symmetrical Performance about Y Axis
5m mounting height (left)
8m mounting height (top right),
12m mounting height (bottom right)

5.3 Motion Event Timing

Whenever the motion activity observed by the LMLO exceeds the detection threshold, a HIGH output is generated on the Motion Activity Output (Pin 4). The high level is held for the duration of the motion activity, meaning in areas of continuous activity the Motion Activity Output pin may be high for extended periods.

In instances of very short duration motion activity, there is a minimum output pulse width of 1s. This allows for polling-based architectures to ensure no motion event (as indicated by a HIGH signal on the Motion Activity Output) is missed. A minimum polling frequency of 2 Hz (Period <500ms) is recommended to minimize latency of any system actions (e.g., dimming level change) triggered by or resulting from the motion detection.

Polling frequencies less than 1 Hz (Period > 1000ms) may result in missed motion events.

The figure below illustrates Motion Output response as related to motion activity and detection threshold.

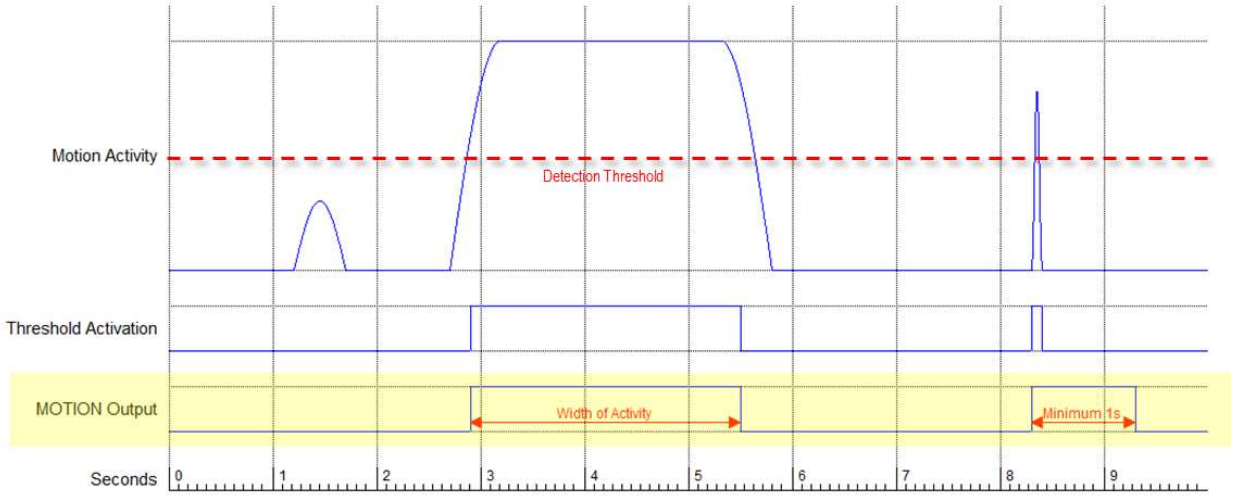


Figure 10 – Example Motion Activity Output state vs motion activity and activation threshold.

5.4 Environmental Considerations (High Ambient Temperature)

Since the motion detection functionality is based on passive infrared (PIR) sensing, the LMLO is subject to the same environmental considerations and limitations inherent to PIR. In environments where the background ambient temperature is very high, the relative differential between motion targets (typically human body temperature) and the background is diminished to the point where the likelihood of missed human body motion events increases.

In order to avoid the situation where a motion event is missed and insufficient illumination is provided to the passerby, the LMLO will enter a High Temperature mode when the onboard temperature sensor measures between 32°C and 40°C. In this mode the Motion Activity Output will be held HIGH, with no change in response to motion events.

At temperatures below 32°C the motion sensor will operate normally as described in the previous sections.

At temperatures above 40°C the motion sensor will generate motion HIGH/LOW signals according to activity as described in previous sections, but with reduced detection sensitivity (increased activation threshold) based on the need to filter increased thermal artifacts resulting from the high temperature environment. In some installations this may result in reduced detection range at temperatures above 40°C ambient.

5.5 Motion System Error Indication

In the unlikely event that an error condition develops internal to the LUMAWISE Motion resulting in a failure of the motion sensing subsystem, a constant HIGH signal will be generated on the Motion Activity Output (Pin 4).

This is the same condition as is generate by a High Ambient Temperature as described in Section 5.4. If a user wishes to determine whether the constant HIGH signal is generated due to High Ambient Temperature or Motion System Error, the device can be powered off and then on again, and the startup pulse sequence observed. A Motion System Error will likely be accompanied by a missing startup pulse, per section 4.4.

5.6 Day / Night Motion Sensing

Using the integral ambient light sensor the LMLO has general day / night awareness in addition to reporting measured light level as described in Section 4.3. The Motion Activity Output on pin 3 reports motion activity regardless of day or night condition. However, the motion detection sensitivity is reduced during daytime to limit false positive detections resulting from solar interference.

Based on ambient light level measured, the LMLO has two primary operation modes: Day Mode and Night mode. Transitions between Day Mode and Night Mode, and subsequent adjustments to detection sensitivity, are described in the figure below.

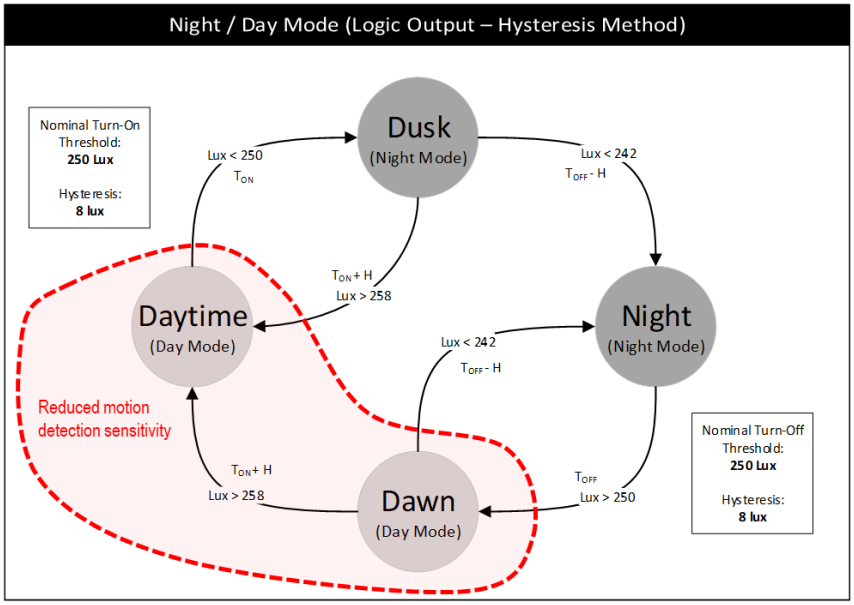


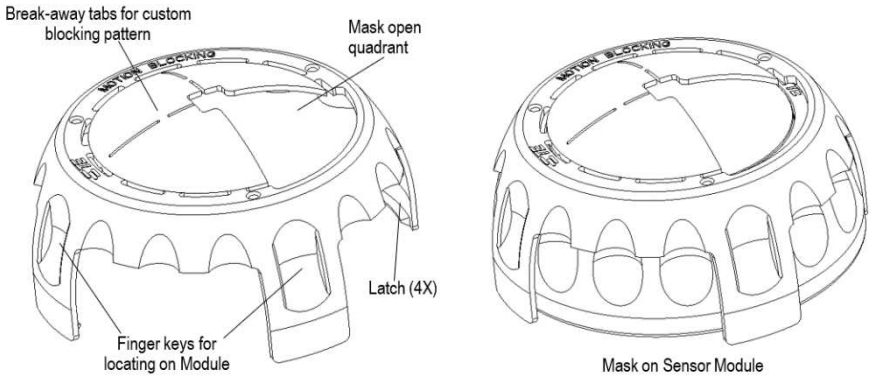
Figure 11 – Day / Night transition thresholds and Hysteresis

Since the LMLO has no feedback as to the on/off/dimming state of the connected luminaire, it cannot account for the luminaire's contribution to the ambient light level observed. Based on this known source of light level measurement contamination, a relatively high day/night transition threshold of 250 lux has been implemented.

5.7 Adjustable Motion Blocking Mask

A Motion Blocking Mask, with one open 90° quadrant, is sold as an accessory. See TE p/n: 2396399-1. Mask can be assembled to the Sensor Module in 90° indexed increments, to block out an area not requiring motion detection. Mask can be snapped onto Sensor Module and retained by latches. If further customization of sensitive area is needed, quadrants of the motion blocking mask can be broken away by the user.

Figure 12 - Motion Blocking Mask



5.8 Influence of a Mask on Light Sensor Readings

The motion blocking mask PN 2396399-1 is opaque to infrared light and therefor disables motion sensing in the blocked regions. The mask is transparent to visible light, and as such should not have a significant impact on the function of the built-in light sensor. There is some risk, however, of minor light attenuation which would manifest as slightly earlier night transitions in the evening and slightly later day transitions in the morning.

6 CUSTOMER SYSTEM TESTING CONSIDERATIONS

LMLO is designed to work reliably in the field, in a variety of installation scenarios and with minimal configuration or commissioning effort required on behalf of the installer or system designer. This is achieved using environmentally reactive operating parameters as described in the sections above, such as reduced motion detection sensitivity during daytime or in high temperature environments.

Laboratory testing of the LMLO, or other artificial installation scenarios, must adequately consider the impact of these features on operation of the device in order to prevent unexpected behavior or incorrect interpretation of experimental results.

6.1 Using the LMLO in an artificially lit environment

As described in Section 5.5, the LMLO will operate with reduced motion detection sensitivity while in day mode. If a user wishes to evaluate motion sensing performance by observing luminaire status (if controlled by an attached NLC) or by monitoring Motion Activity Output signal level, the device must be tested in a low ambient light environment such that the device is operating in Night Mode.

Basic system operation, including motion-based activation of the Motion Activity Output, may be tested in high ambient light environments but detection range will be reduced.

7 ENCLOSURE AND MECHANICAL CONSIDERATIONS

7.1 Material

The base housing and cover are made of UL 94V-0, UV f1 rated thermoplastic. Power contacts are made of brass with tin plating on entire contact.

7.2 Storage

C. Shelf Life

The product should remain in the shipping containers until ready for use to prevent deformation to components. The product should be used on a first in, first out basis to avoid storage contamination that could adversely affect performance.

D. Chemical Exposure

Do not store product near any chemical listed below as they may cause stress corrosion cracking in the material.

Alkalis	Ammonia	Citrates	Phosphates Citrates	Sulfur Compounds
Amines	Carbonates	Nitrites	Sulfur Nitrites	Tartrates

7.3 LMLO Sensor Module Mounting

A. With the LUMAWISE Endurance S/S2 receptacle mounted to the luminaire per TE Connectivity application spec 114-133074 for the LUMAWISE Endurance S/S2 Connector System the LMLO Sensor Module can be mounted.

NOTE
Care must be taken to acknowledge the X-axis directional mark (see figure below) on the final mounted LMLO Sensor Module is in the correct orientation for optimum performance.

B. Align the Module over the mounted receptacle. Based on polarizing features on each, the Module can only be installed in one position. Lightly rotate the Module until you feel the alignment keys and the blades align to the proper location. After alignment, push downward until the Module is bottomed on the receptacles mating face. Then complete mating by rotating Module with downward pressure while twisting in a clockwise direction. The Module or Sealing Cap will lock into position with an audible ‘click’. To un-mate, gently push down and reverse the aforementioned mating process. See Figure 9.

CAUTION
When in field use it is important that a receptacle is mated to the specified a module assembly. The receptacle by itself is not a sealed device and would allow moisture to enter the luminaire.

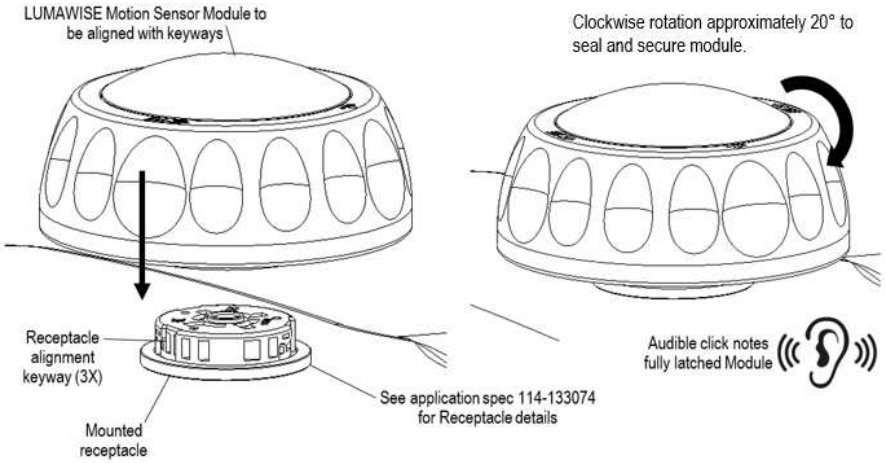


Figure 13 - Mounting the Sensor

7.4 Handling

The LMLO Sensor Module is a self-contained unit with power contacts preinstalled; therefore, take precautions to not bend or damage the contacts prior to mating unit to receptacle. Care must be taken to not damage or deform the lens. Standard ESD precautions should be observed when interacting with exposed metal contacts.

7.5 Replacement and Repair

The contacts and housings are not repairable. DO NOT use a LMLO device with damaged or defective contacts and/or housings. If damaged, replace the module with a new one.

8 QUALIFICATION

LUMAWISE Motion – Logic Output is component listed by Underwriters Laboratories, Inc. in File E66375, Volume 9, and has been investigated to CSA International by UL.

9 TOOLING

No tooling is required for the use of this product.

10 VISUAL AID

The illustration below shows a typical application of LMLO Sensor Module. This illustration should be used by production personnel to ensure a correctly applied product. Applications which DO NOT appear correct should be inspected using the information in the preceding pages of this specification and in the instructional material shipped with the product or tooling.

LMLO Sensor Module

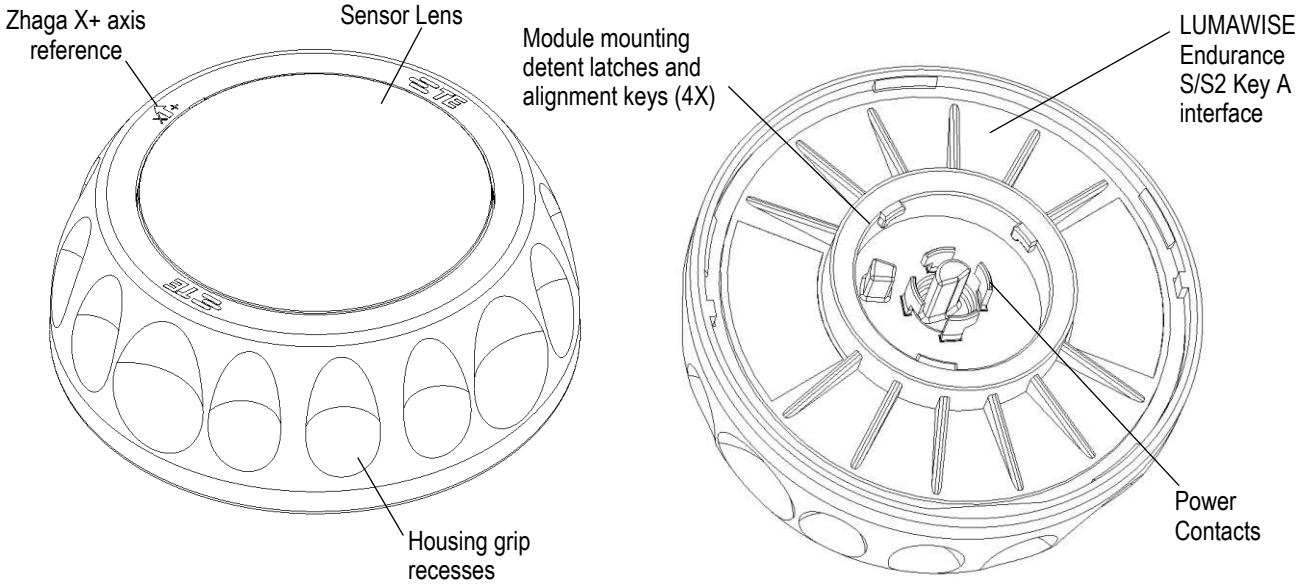


Figure 14 - Visual Aid