Scanning Laser Range Finder UXM-30LAH-EWA

User's Manual

HOKUYO AUTOMATIC CO.,LTD.

Table of contents

1. Introduction

This user's manual is designed with the purpose of providing guidelines and instructions for the machine user or system designer while operating, installing, wiring and servicing the UXM-30LAH-EWA sensor.

1.1 About this document/manual

The UXM's features, installation and handling method are described in this document.

- Make sure to read carefully and understand this document before installation, wiring, operation, inspection and maintenance.
- User should have a copy of this document at an easy-to-access place for quick reference.
- Any modifications or disassembly of the UXM is prohibited. Modifications will affect sensor performance and detection capability that could lead to critical injury and death.
- Any modifications or disassembly of the UXM will void the warranty.
- All information in this user's manual is subject to change without prior notice. For the latest information visit our company's website http://www.hokuyo-aut.jp

1.2 Applicable product

This document is for the following sensor model.

- UXM-30LAH-EWA

1.3 Special markings and symbols

Markings and symbols are used in this document to alert the user about safety-related issues. Follow the instructions of these special markings and symbols to ensure safety during the operation.

Mark	Meaning
⚠ Danger	Procedures that could lead to dangerous situation, critical injury or death if not carried out properly.
⚠ Caution	Procedures that could lead to dangerous situation, serious injury or physical damage if not carried out properly.
Note	Points that should be considered for the proper operation.

1.4 Cautions

- The UXM has been shipped upon strict quality control. If you find any defect in the product, contact the nearest distributor or sales representative.

- Hokuyo cannot be held responsible for damages or failure due to misuse of the product.

- The actual product may differ from the illustrations and figures in this documents as they are used for explanatory purpose only.

1.5 Registered trademarks

- Microsoft$^®$, Windows$^®$ are the registered trademarks of Microsoft Corporation USA.

- Pentium$^®$ are the registered trademarks of Intel Corporation or respective country.

- Beside that, other product names, company name mentioned are trademarks or registered trademarks of their respective companies.

2. Safety precautions

Make sure to read the following safety precautions for the correct use and operation of the UXM.

2.1 General precautions

● The UXM uses laser radiation for detecting objects within configured area.

● Perform pre-operation tests in order to verify the performance of the UXM.

● User should prepare test pieces for detection capability verification test. The test piece should emulate the smallest object that is intended to be detected during operation.

● Operate the UXM within the specifications described in this user's manual. Also, perform the necessary maintenance to prevent deterioration of UXM's detection capability. (Refer to chapter 9)

● Do not modify or disassemble the UXM. This could compromise the IP67 housing rating. Such modifications will void the warranty.

● The UXM is not a safety device. Do not use this sensor for the purpose of protecting humans.

● The detection capability of the UXM will decrease if dust covers the optical window. Regular cleaning of the optical window is necessary while working under dusty environment.(Refer to section 9.5)

● The UXM should be disposed as industrial waste or in accordance with the local disposal directives.

2.2 Operating environment

● Make sure that the UXM's operating environment is within the stated specification (temperature, humidity, vibration, ambient light, etc.)

● Do not use or mount the UXM near devices that could generate strong electromagnetic waves as it could affect the operation of the sensor.

● Do not use or mount the UXM in an environment of organic solvents, gas, or where corrosive substances are present. Working under such environments may decrease the detection capacity of the sensor.

2.3 Installation of UXM

● Install the UXM on a firm surface or structure to avoid displacement.

● Mount the sensor firmly to avoid optical axis displacement due to vibration and shock.

● Shock and vibration should not loosen the mounting. Detection result will be different if the sensor is displaced due to such condition.

● Mutual interference can occur when two or more UXM sensors are mounted at the same detection plane. Refer to chapter 5 (mutual interference and synchronous operation) for details.

● When using outdoors add necessary measures to prevent from rain and/or dust accumulation on the optical window.

● When cover is used it should be of highly transparent material that does not influence detection property. (Light wavelength 905nm)

● The UXM should be mounted with a provision of sufficient space for maintenance.

● Do not put any object in the detection area of the UXM. It is not possible for the sensor to detect objects

that lie behind the obstacle.

- Increasing the response time will also increase the stability of the UXM. However, this will reduce the detection capability towards moving objects. User must perform pre-operation tests before using this function.

2.4 Wiring

- Switch off all the power supplies during wiring.
- When a converter is used for supplying the power, make sure it fulfills the following requirements.
  - A rated output voltage within the range of DC 10V to 30V.
  - Use power source with 1A or more (1.5A or more DC 15V or less) current capacity.
    While using the heater additional 1A or more is required.
  - The power supply complies with the requirements of electromagnetic compatibility regulations (EMC) of the respective country, states and district.
- All the input/output signal cables should be installed away from machines, power lines and high-voltage cables.

2.5 Configuration

- Pre-operation test must be performed to verify the configurations before operating the UXM.
- Changes made during the configuration must be recorded and saved.

2.6 Inspection and maintenance

- User must perform inspection and maintenance by referring to the following checklists provided in this document. (Refer to chapter 9)
  - Pre-operation inspection
  - Operation inspection
  - Daily inspection
  - Periodical inspection
  - Cleaning the optical window

Checklists in this document are provided as the basic guidelines while performing the test and maintenance. User must perform additional inspection and maintenance tasks deemed necessary for the respective application.

- Stop the machine and system if faults are detected during these tests.
- Clean the optical window when it gets contaminated. If the optical window is damaged it should be replaced by a new one, therefore contact the nearest distributor or sales representative.

3. Product overview

UXM emits pulsed laser beam which reflect on a rotating mirror within the configured area. When the emitted laser beams are reflected back from an object its distance is measured.

This chapter describes the features and properties of the UXM-30LAH-EWA.

3.1 Features of UXM-30LAH-EWA

- Detection range : Maximum 80m

  (Guarantee detection range: 0.1 to 30m 90% Reflectance white Kent paper 1000mm×1500mm)

- Detection angle :190°

- Angular resolution : 0.125°

- 15 set of areas (Configurable)

- Hysteresis of detection area (☞17 page)

- It is possible to configure area with its origin offset from the center of scanning beam.

- Easy configuration using PC installed with configuration application software (Area Designer)

- Teaching function.

- Minimum response time of 100ms (Configurable)

- Malfunction output: Activates malfunction output according to self-diagnosis function.

- Synchronize function: A maximum of 4 sensors for master/slave operation is possible (☞29 page)

- ON/OFF delay function (☞15 page)

- Filter function (☞19 page)

- Limited detection capacity zone (☞20 page)

- Minimum detection width (☞20 page)

- Heater function (☞19 page)

- SCIP communication protocol

UXM can be used for the following applications:

- For the crane operating application, obstacle detection, position detection of container etc.

- Access protection in the dangerous area, buildings (such as detection of vehicle, persons etc.)

⚠ Danger	• This product is an auxiliary safeguard product only not a safety device. In the event of a product malfunction, it could cause a serious accident so use an additional safeguarding device such as bumpers. Also, take necessary measures such as backup circuit etc.

3.2 UXM-30LAH-EWA components

Figure 3-1 shows the components of UXM-30LAH-EWA

Indicator lamp

Optical window
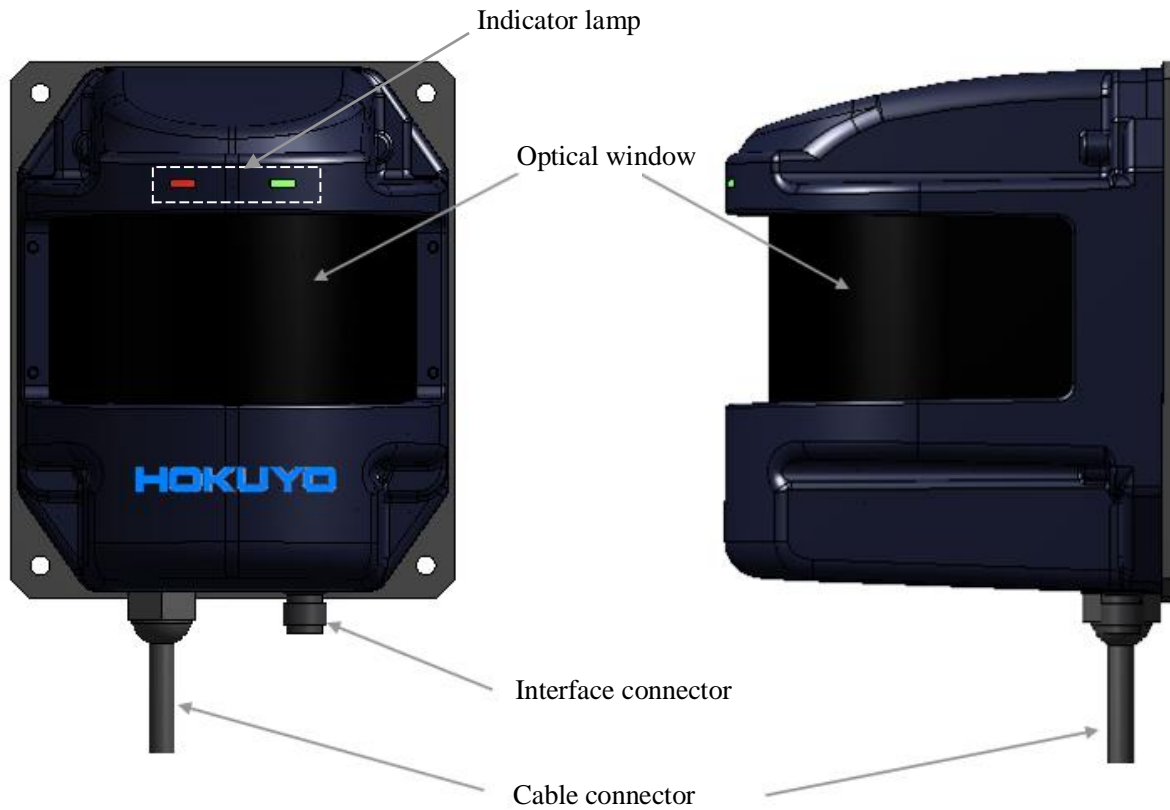
Interface connector

Cable connector

Figure 3-1 UXM-30LAH-EWA components

Figure 3-2 shows the scanning range and detection zone origin of the UXM, while figure 3-3 shows its detection plane.
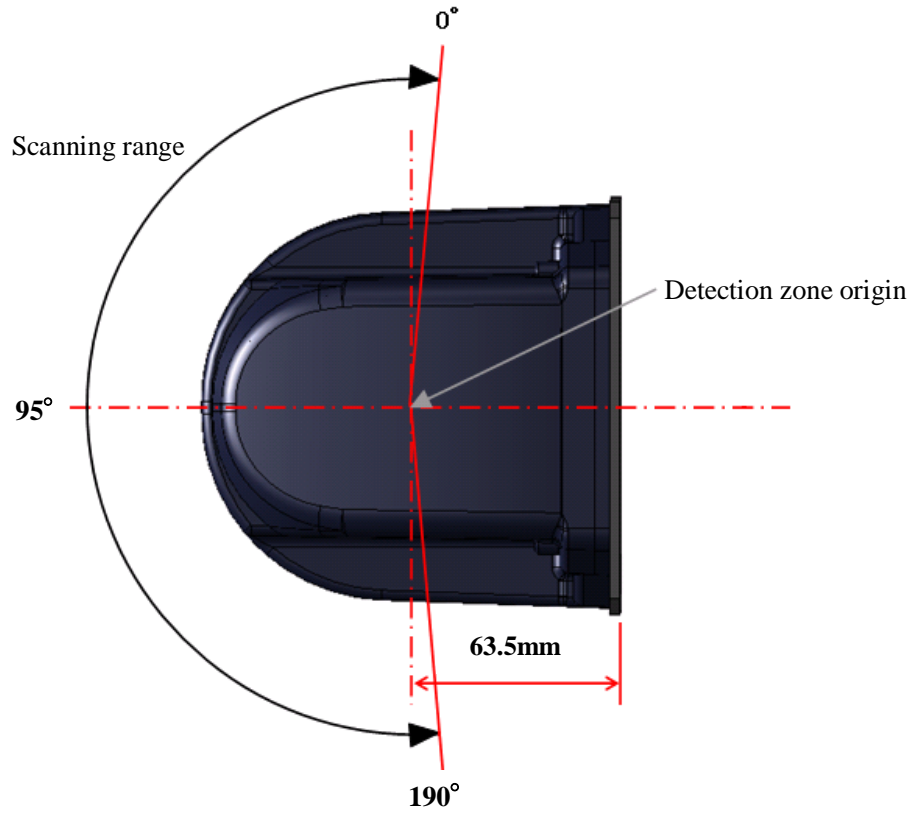
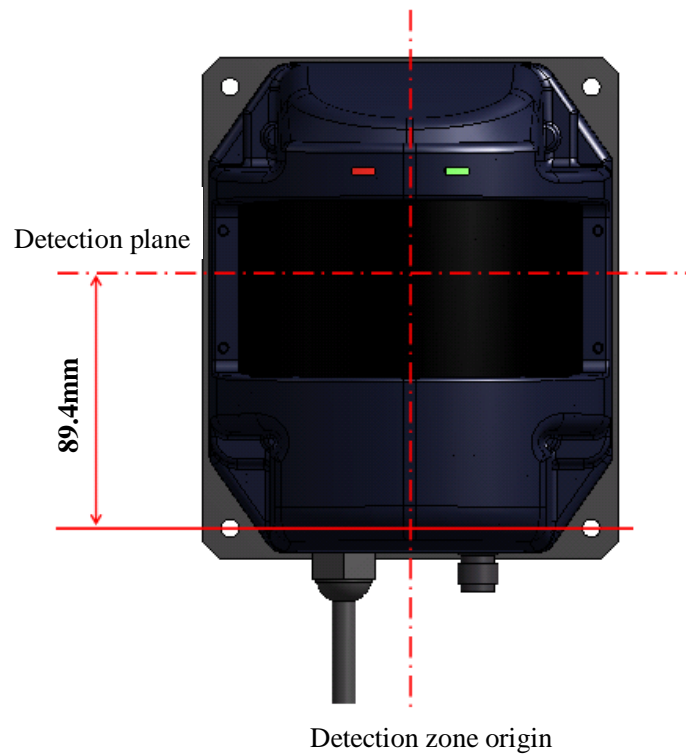Figure 3-2 Scanning range and detection zone origin (Top view)

Figure 3-3 Detection plane of UXM (Front view)

3.3 Operation principle
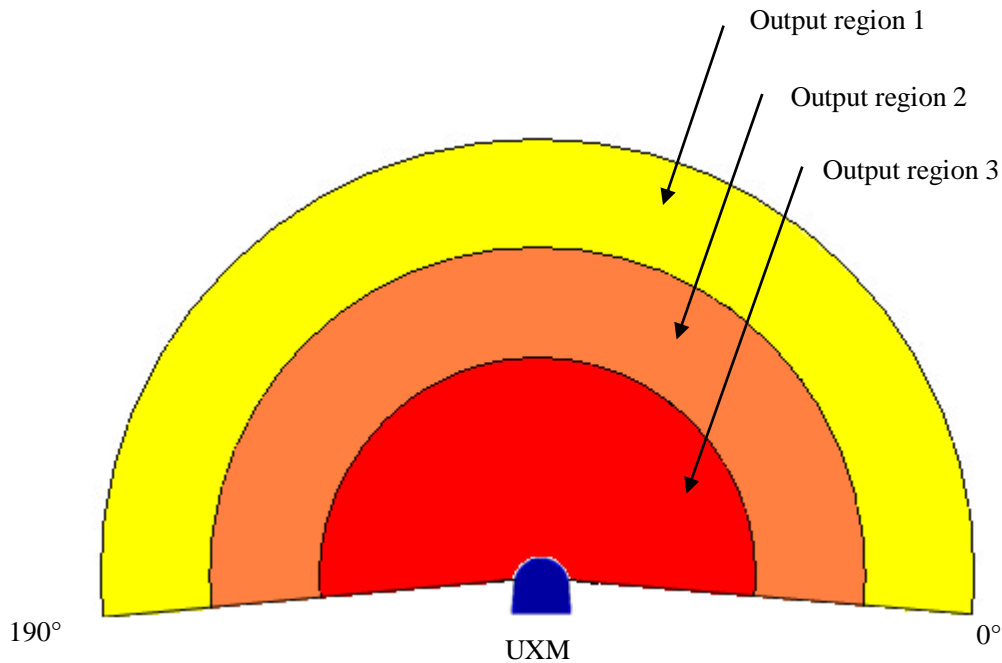
Figure 3-4 Scanning range

Figure 3-4 shows the scanning range of the UXM. The sensor emits pulsed laser beam which reflect on a rotating mirror forming a fan-like scanning pattern over 190 ° field. Maximum detection range is 80m for white Kent sheet. Detection range for objects of 10% diffused reflectance is 30m.

User can configure output regions 1, 2, and 3 by using the Area Designer application. When the sensor detects an object in the configured area, corresponding detection outputs are switched to OFF.

When the emitted laser beams are reflected back from an object, its distance is measured by applying the Time-of-Flight (TOF) principle. The duration of the reflected pulsed laser beam is taken for distance calculation as shown below.

$$L = \frac{1}{2} \times C \times T$$

Where,   L＝Distance of the object

C＝Speed of the light

T＝Time difference

The operation principle of TOF is shown in schematic diagram (Figure 3-5) below

Figure 3-5 TOF operation principle

3.4 Area configuration

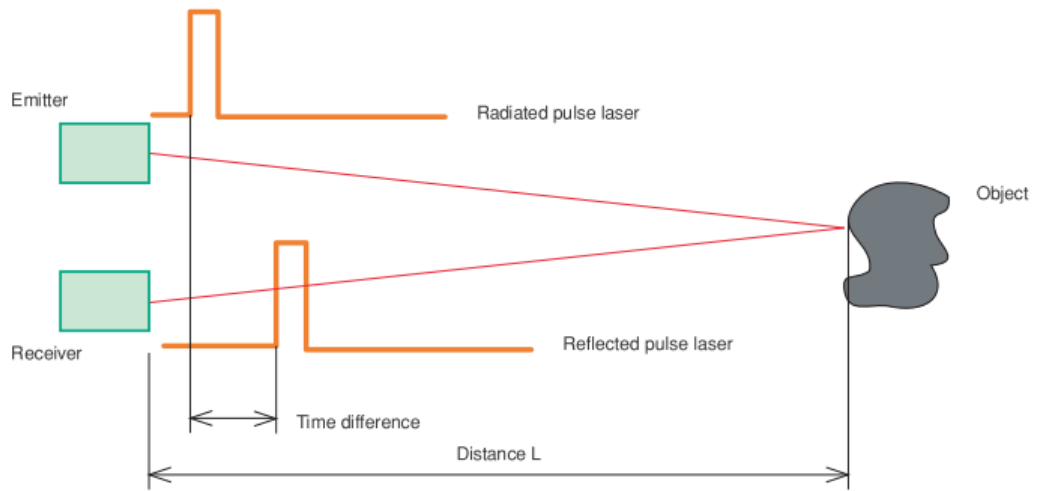The detection area of the UXM consist the output regions 1, 2 and 3 respectively. Output 1 to Output 3 can be configured by using the Area Designer application software through an Ethernet cable. Area configuration methods can be Independent and Dependent. A maximum of 15 sets of areas can be configured.

For the Independent method the following shapes are supported: Polygon, Arc and Rectangle.

a) Polygon   b) Arc   c) Rectangle
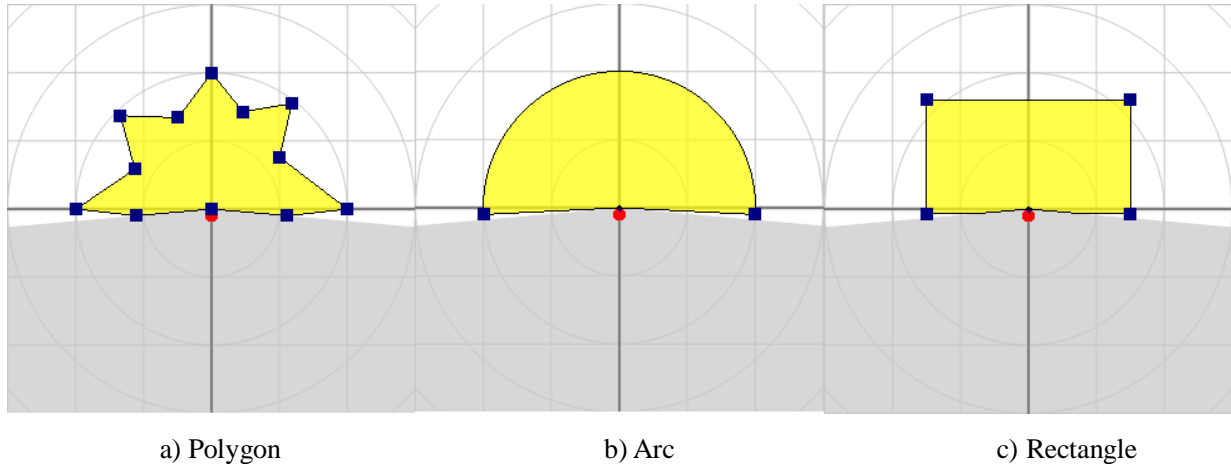
Figure 3-6 Area configurations (Independent method)

For the Dependent method, the following shapes are defined: Straight line, Fan, and Ratio. In the dependent method, output 1 serves as a basis for output 2. Similarly, output 2 can be set as the basis for output 3.

a) Straight line   b) Fan   c) Ratio
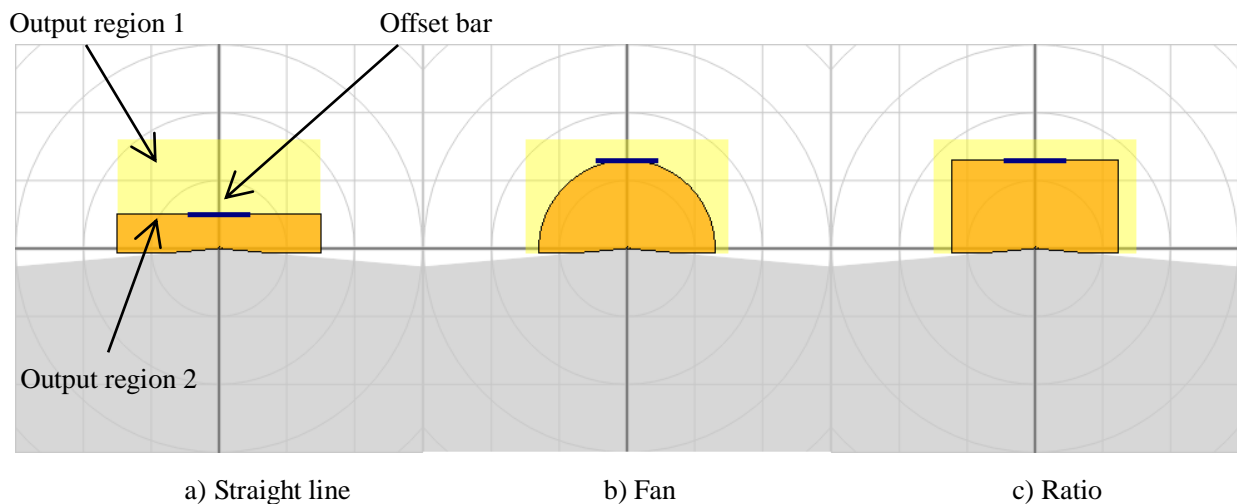
Figure 3-7 Area configurations (Dependent method)

When setting the output region 2 as dependent on output region 1, the following dependent methods can be selected: a) Straight line, b) Fan shape, c) Ratio. By moving the offset bar in the Y-axis, it changes the size of output region 2.The output 2 cannot be made larger than the output 1.Similarly, the output region 3 is used as a basis output region 2.

For details on area configuration methods, refer to the Area Designer sensor configuration tool Instruction manual.

When the sensor detects an object in the configured output region 1 to output region 3, the corresponding outputs signals are switched to OFF state and the corresponding LEDs are also lit.

> ⚠ **Danger** ● User should prepare test pieces for detection capability verification test.

3.5 Area switching

A maximum of 15 sets of areas can be configured. For area switching, input signals 1 to 4 are required. Table 3-1 below shows the combination of input signal to switch the area. Laser is switched off when all the area inputs 1 to 4 are switched ON.

> **Note** ● Laser is switched ON only in the selected area.

Table 3-1 Input states and corresponding area number

Area Number	Area Input 1	Area Input 2	Area Input 3	Area Input 4
Laser off	ON	ON	ON	ON
Area1	OFF	ON	ON	ON
Area2	ON	OFF	ON	ON
Area3	OFF	OFF	ON	ON
Area4	ON	ON	OFF	ON
Area5	OFF	ON	OFF	ON
Area6	ON	OFF	OFF	ON
Area7	OFF	OFF	OFF	ON
Area8	ON	ON	ON	OFF
Area9	OFF	ON	ON	OFF
Area10	ON	OFF	ON	OFF
Area11	OFF	OFF	ON	OFF
Area12	ON	ON	OFF	OFF
Area13	OFF	ON	OFF	OFF
Area14	ON	OFF	OFF	OFF
Area15	OFF	OFF	OFF	OFF

OFF：High level, ON：Low level

Response time：2 Scan (100ms)

3.6 Detection condition

In the configured area, if the detectable size (width) is more than the minimum detectable objects an output signal is displayed (for setting refer to section 3.9).The width of detectable object can be calculated as shown in figure 3-8.

Detection object

d5 d4 d3 d2 d1

d: Distance value of each step

Detection width W = (d2 + d3 + d4) ×2π/ 2880

Detection width W > Minimum detectable size
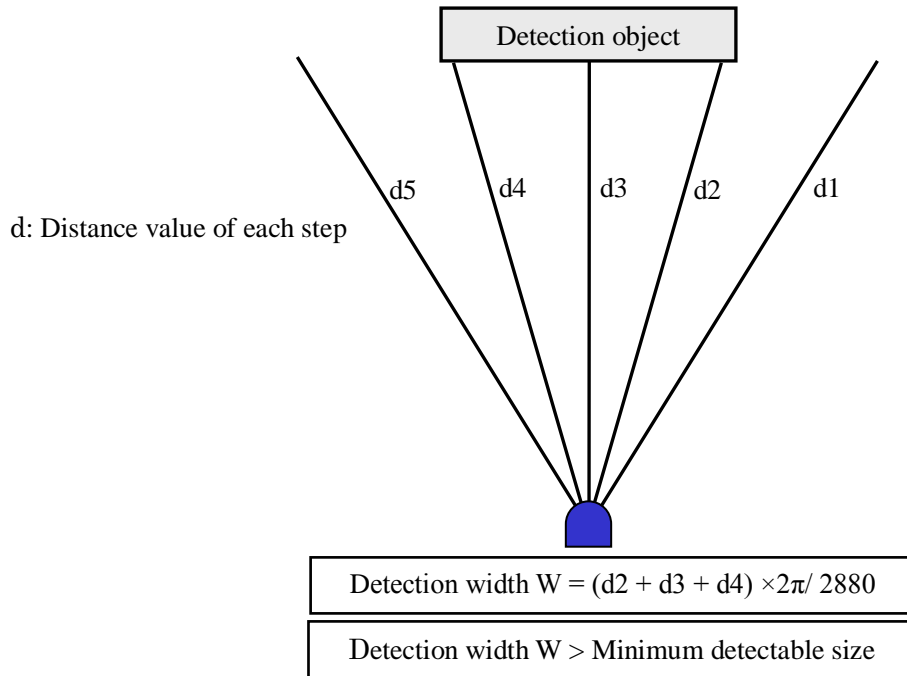
Figure 3-8 Schematic diagrams for the calculation of detection width

If the area is configured with a narrow width below the minimum detectable size, be careful that the output signal may not be displayed for a short distance as shown in figure 3-9.

Min detectable size : 100mm

Area of distance : 1800mm and approx. width 100mm

Figure 3-9 Caution of area configurations when minimum detectable size

| ⚠ Caution | • Depending upon the laser spot, environment and the detection object, the actual width of detected objects may differ from the width measured. |
| | • User should verify detection capability before using the actual object. |

3.7 ON /OFF delay

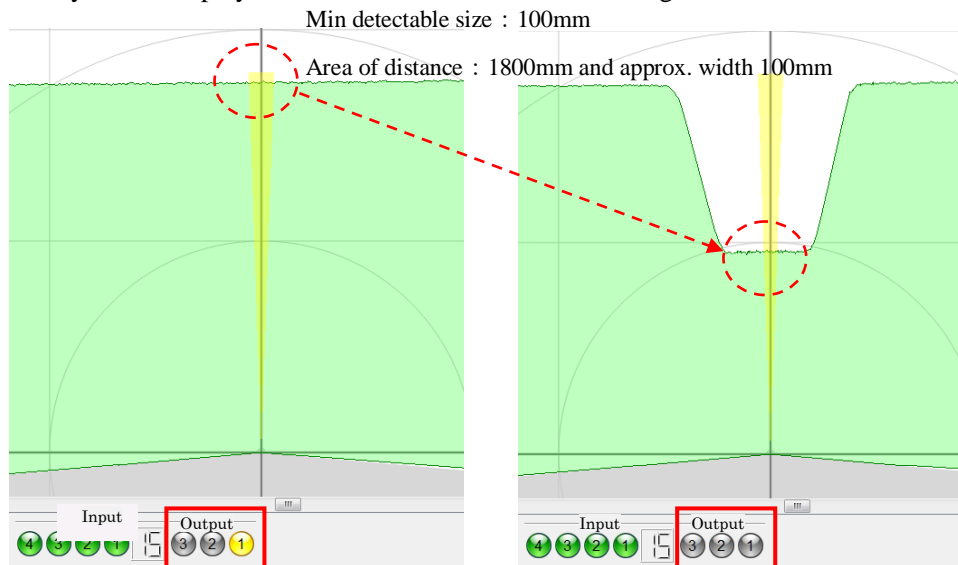ON delay and OFF delay of the output signal can be set by using Area Designer within the range of 50ms to 6400ms with an interval of 50ms. (Default is 50ms)

ON delay is the response time changing from ON state to OFF state after detecting the object. OFF delay is the response time changing from OFF state to ON state while not detecting the object.

Increasing the response time will increase availability of the UXM. However, this will reduce the detection capability towards moving objects. User must perform verification tests before using ON/OFF delay function.
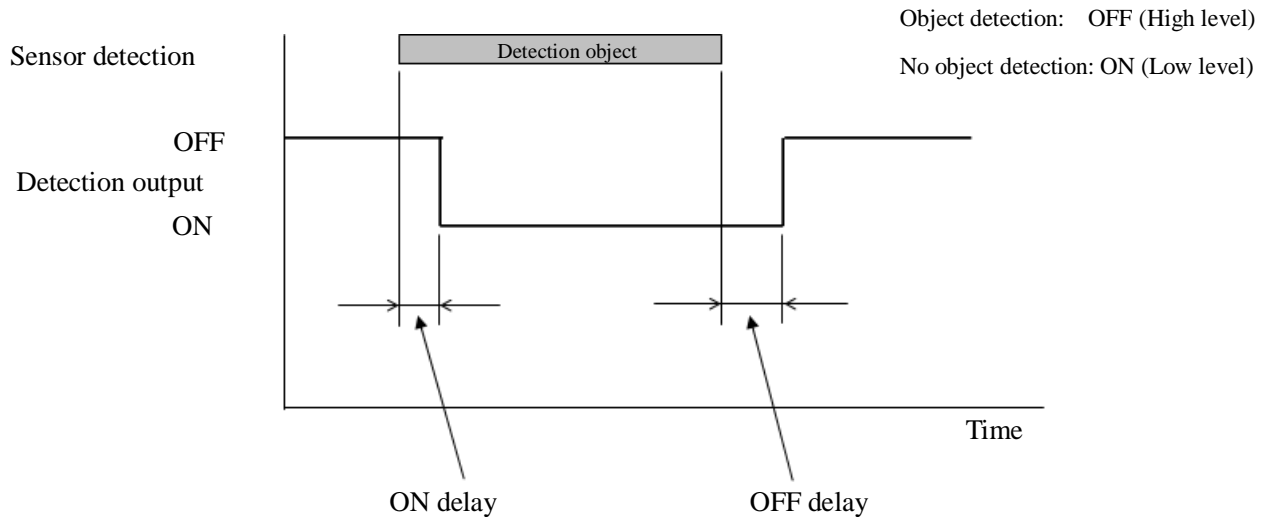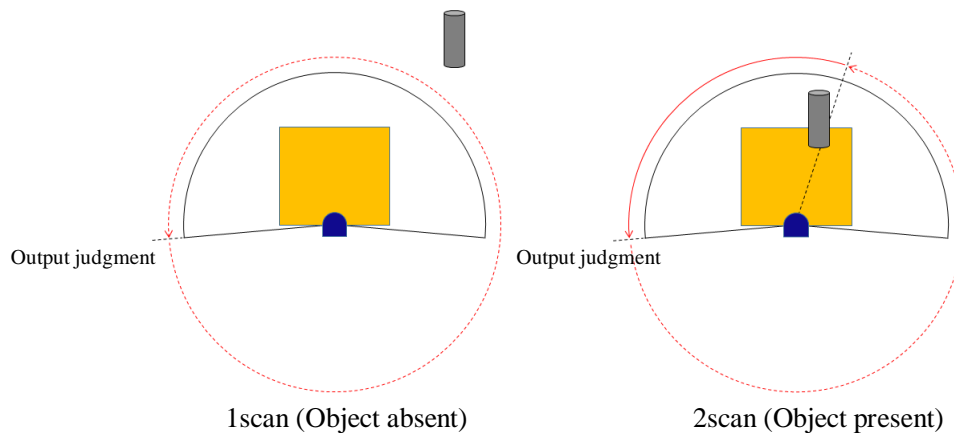

Figure 3-10 ON delay /OFF delay

Schematic diagram for ON delay/OFF delay operation is as shown below.

1. Example of schematic diagram without OFF delay setting

<--···· : Object absent

<--—— : Object present

1scan (Object absent)   2scan (Object present)

2. Example of schematic diagram when 2 scan OFF delay setting

◄······ ：Object absent

◄─── ：Object present

Output judgment

Output judgment

Output judgment

1scan (Object absent)

2scan (Object absent)

3scan (Object present)
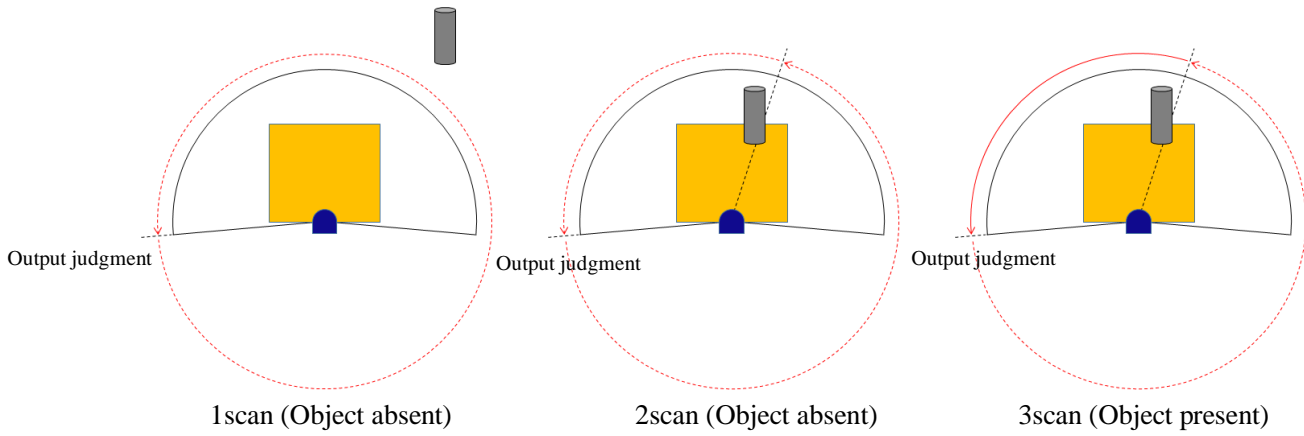
3. Example of schematic diagram without ON delay setting

◄······ ：Object absent

◄─── ：Object present

Output judgment

Output judgment

1scan (Object present)

2scan (Object absent)
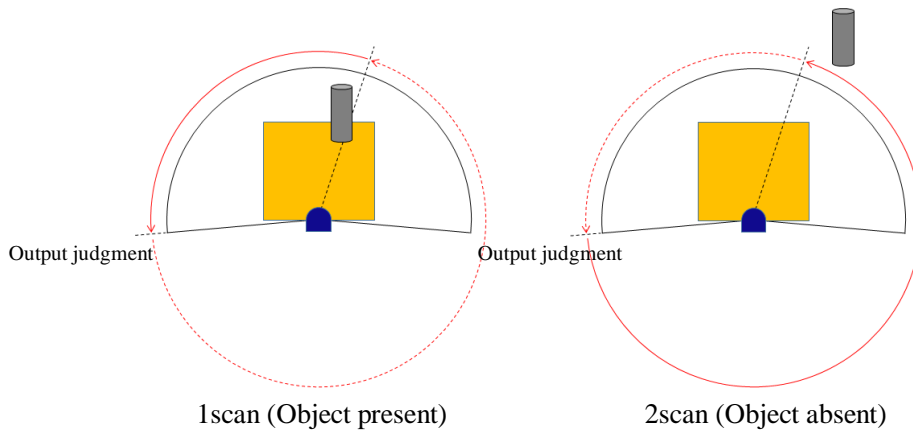
4. Example of schematic diagram when 2 scan ON delay setting

◄······ ：Object absent

◄─── ：Object present

Output judgment

Output judgment

Output judgment

1scan (Object present)

2scan (Object present)

3scan (Object absent)
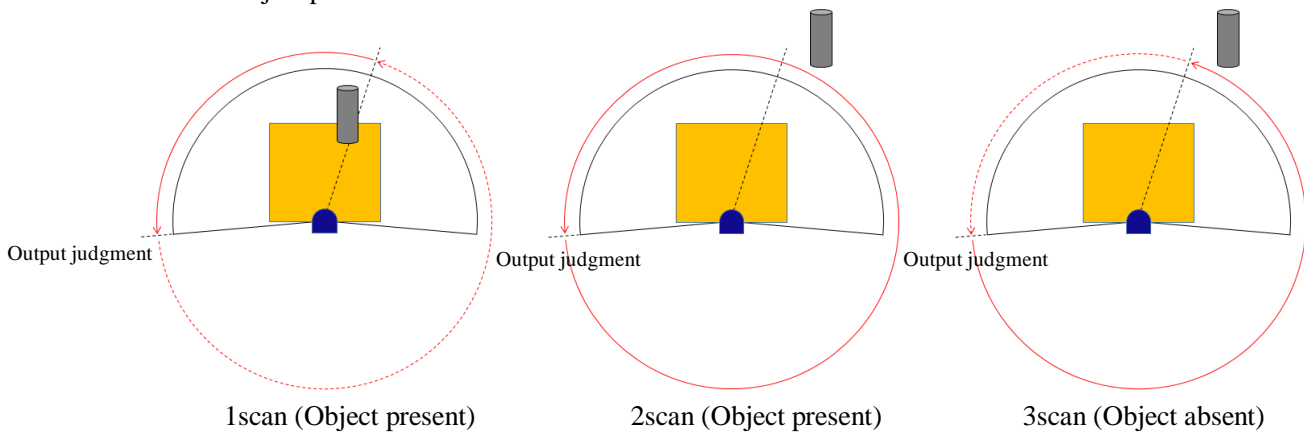
3.8 Hysteresis of detection area

When a sensor detects an object near the boundary of the detection area, outputs 1 to 3 may oscillate (Changing of ON/OFF state) repeatedly. To prevent such oscillation, sensor has a hysteresis function that temporarily increases the area size. If the object is not detected in the temporarily increased area, then it will return to the original detection area.

Hysteresis changes according to the set detection area distance. The minimum and the maximum temporarily increased detection area size can be specified using Area Designer. Minimum detection value will be used if the value is 5000mm or less. Also, maximum detection value will be used if the value is 30000mm or more. For distances between 5000mm to 30000mm; the value is computed using the linear interpolation method from the minimum and maximum values.

Hysteresis = (Max value – Min value) / (25000) × Distance ＋ (6 × Min value －Max value) / 5
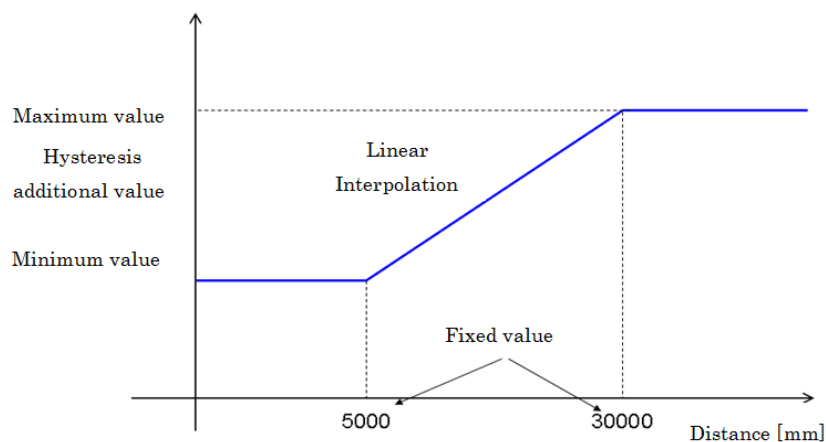
Figure 3-11 Hysteresis additional value

Note

● When you set the detection area close to a wall, set the hysteresis to the minimum value. If the surface of the wall is within the hysteresis detecting area range, then the output will not return to its original state.

· Judgment Area : From object absent to object present

Object

Judgment area

Detection area

Wall
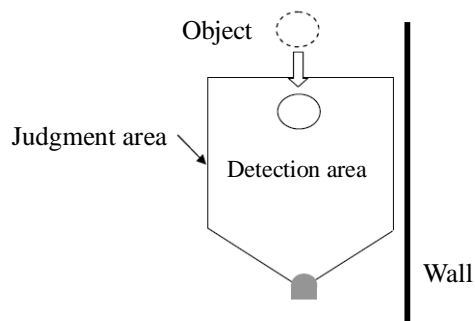
· Judgment Area : From object present to object absent

Object

Judgment area

(Becomes large due to hysteresis)

Detection area

Detects the wall

Wall
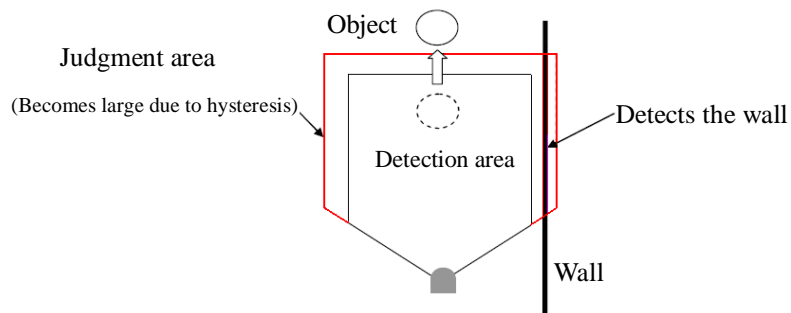
3.9 Setting of UXM

Setting of operating parameter of UXM by Area Designer.

Table 3-2 describes UXM's parameters and settings.

Table 3-2 Parameter settings

Parameter		Description
Motor sync angle		To prevent mutual interference between the sensors, motor synchronize angle can be set by delaying the rotation. For details on synchronization operation, refer to chapter 5.5 <table><tr><td colspan=4>Setting</td></tr><tr><td>0 deg</td><td>90 deg</td><td>180 deg</td><td>270 deg</td></tr></table>
Heater		Heater is internally mounted in the sensor and this function will activate. When the temperature inside the sensor decreases below 0°C.This function stops its operation automatically when the temperature increases more than 10°C. <table><tr><td>Setting</td><td>Description</td></tr><tr><td>OFF</td><td>Cannot use heater function</td></tr><tr><td>ON</td><td>Can use heater function</td></tr></table>
Output logic		Inverting outputs logic of detection output 1 to 3 can be set. Select from below setting. <table><tr><td>Setting</td><td>Description</td></tr><tr><td>Active High</td><td>Normal detection outputs Refer to 3.10.1</td></tr><tr><td>Active Low</td><td>Invert detection outputs</td></tr></table>
Filters	Rain	This filter is used to remove the object if the object is not detected stably at the same place. This filter is effective to remove rain and snow. Select from below setting. <table><tr><td>Setting</td><td>Reference value while using rain filter</td></tr><tr><td>OFF</td><td>Filter not used.</td></tr><tr><td>Low</td><td>Used to remove rain maximum up to approx.100mm/h.</td></tr><tr><td>High</td><td>However, the effect depends upon the installation environment</td></tr></table> Caution: By setting the rain filter, it becomes difficult to detect moving object.
	Fog	This filter is used to remove reflectivity (echoes) from the fog. Select from below setting. <table><tr><td>Setting</td><td>Reference value while using fog filter</td></tr><tr><td>OFF</td><td>Filter not used.</td></tr><tr><td>Low</td><td>Used in fog when the visibility is approx.100m.</td></tr><tr><td>Medium</td><td>However, the effect depends upon the installation</td></tr><tr><td>High</td><td>environment</td></tr></table> Caution: By setting the filter high, it may not also detect the objects with high reflectivity.

Table 3-2 Parameter settings

Parameter		Description
Filters	Sensitivity	Sensitivity filter is used to remove the objects with low reflectivity. This filter is effective to remove light interference and rain. Select from below setting. {{SENSITIVITY_TABLE}} Caution: By using the sensitivity filter, detection capability for objects with low reflectivity will decrease.
	Echo	Echo filter is used in the environment with multiple echoes from the rain, fog, dust, edges of the object or transparent object. Echo filter can be selected first or last. {{ECHO_TABLE}} If using a cover on the front part of the sensor, select last therefore, it does not detect the object. Caution: When last is set, it may not detect the object smaller the laser beam size.
Hysteresis	Upper limit	Hysteresis upper and lower limit can be set in the range of 0 to 250mm. Hysteresis lower limit cannot exceed the upper limit. Refer to section 3.8 for Hysteresis of detection area.
	Lower limit	
Minimum detectable size		Width of minimum detectable size can be set in the range of 10 to 1000mm.It is effective for removing light interference, rain or snow etc.
Limited detection capacity zone		Limited detection capacity zone can be set in the range of 60 to 3000mm.The sensor cannot detect the object which enters at a limited detection capacity zone. This limited detection capacity is used when using a cover on the front part of the sensor.

Sensitivity sub-table:

Setting	Reference value while using sensitivity filter
OFF	Filter not used.
Low	Difficult to detect object with maximum 1.8% reflectivity
Medium	
High	

Echo sub-table:

Setting
First
Last

3.10 Output

The UXM has 4 types of outputs as below.

3.10.1 Detection Output 1 to Output 3

Detection Output 1: When the object is detected in the output region 1, ON (Low level) state will switch to OFF (High level) state.

Detection Output 2: When the object is detected in the output region 2, ON (Low level) state will switch to OFF (High level) state.

Detection Output 3: When the object is detected in the output region 3, ON (Low level) state will switch to OFF (High level) state.

3.10.2 Malfunction output

Sensor has self-diagnosis function and it switches the malfunction output ON state (Low level) to OFF state (High level) when errors are detected in the internal components (malfunction output during laser emission, motor rotation, etc.)

3.10.3 Synchronization output

Sensor outputs a 1ms pulse in every scan which is synchronized with the scanning. The timing of the synchronization signal is shown in the figure 3-12 below. Synchronization output signal in figure 3-13 below.
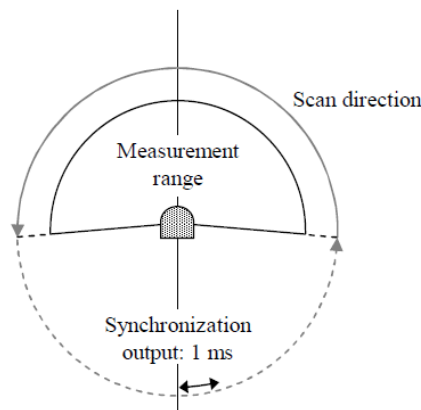
Figure 3-12   The timing of synchronization signal
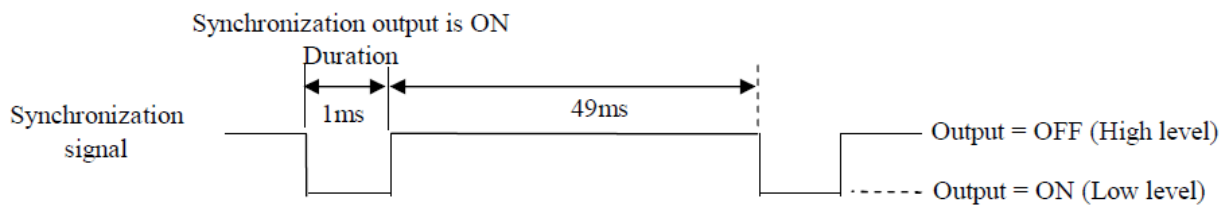
Figure 3-13   Synchronization output signal

3.10.4 Synchronization master output

It is a reference clock signal for synchronizing motor rotation of each sensor. 50ms of cycles and an output ON period (Low level) output the clock signal used as 12.5ms (Duty 25%).Output starts immediately after the power ON, and an output is continued even in the malfunction state.

When operation Master/Slave sensors, the synchronization output signal from the master is used as input for the synchronization input of a Slave. For details on the wiring of synchronization operation, refer to chapter 5.5 (Synchronization operation)

3.11 Input
The UXM has 2 types of inputs as below.

3.11.1 Area Input 1 to Input 4
These inputs are used in order to choose detection area. Table 3-1 shows the relation between input states and corresponding area number.

3.11.2 Synchronization input
When operating Master/Slave sensors, the synchronization output signal from the master is used as input for the synchronization input of a Slave. For details on the wiring of synchronization operation, refer to chapter 5.5 (Synchronization operation)

3.12 Indicator lamp

2 LED display indicates the UXM status. This LED display is located in the front of the UXM as shown in figure 3-14. Table 3-3 shows the description of the LEDs.
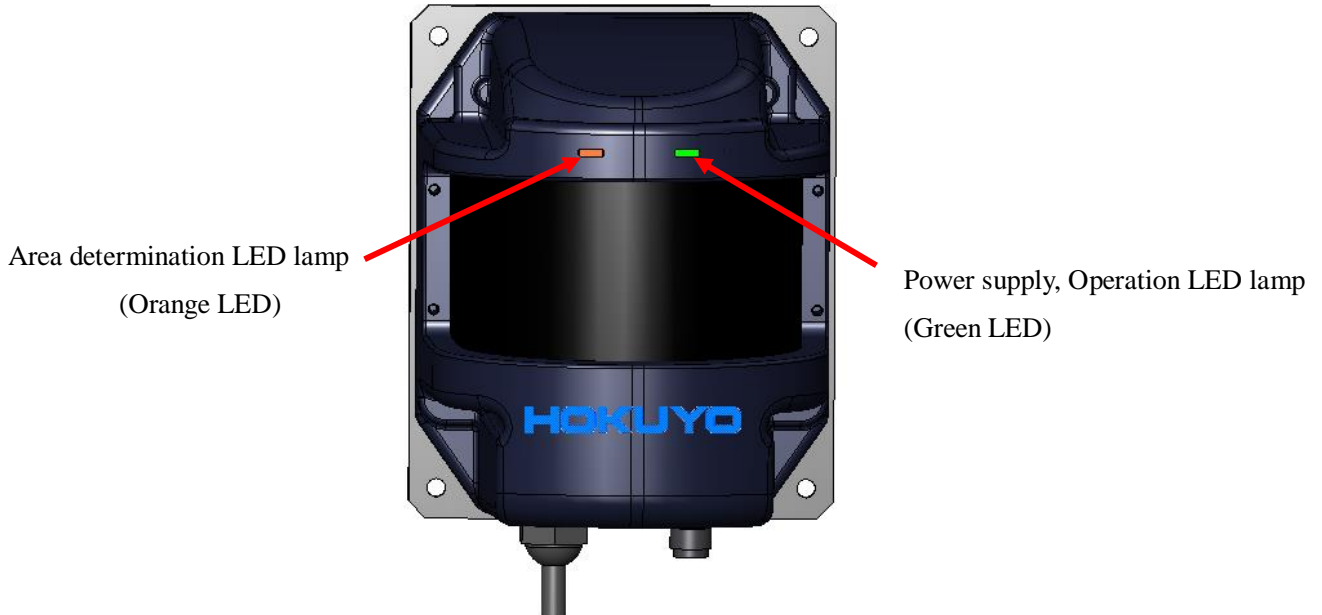
Figure 3-14 Indicator lamp

Table 3-3 Relation table between Indicator lamp (LED) and output signals

State of the sensor	Indication LED for power supply and operation (green)	Indication LED for area determination (orange)	Synchronization master output	Synchronization output	Malfunction output	Area Detection output 1 to 3
At start up	Blinking	ON	Output is always continued after the power supply for the sensor has been turned on [1]	Tr = OFF (Hi) [1]	Tr = OFF (Hi) [1]	Tr = OFF (Hi) [1]
During operation	ON	Detection On / No detection Off		For 1 ms at the cycle of 50 ms / Tr = ON (Low)	Tr = ON (Low)	Detection Tr = OFF (Hi) / No detection Tr=ON (Low)
Malfunction	Blinking (Interval of 1sec)			Tr = OFF (Hi)	Tr = OFF (Hi)	Tr = OFF (Hi)
Initialization of IP	Blinking 2 times after pushing and holding the IP initialization switch ⬇ On (Initialization processing of IP has been completed.) ⬇ Blinking of the LED (green), the LED (orange) is off. (Restart of the sensor begins.) ⬇ On (Restart of the sensor has been completed.)			During initialization of IP Tr = ON (Low) During restart of the sensor Tr = OFF (Hi) [2]	During initialization of IP Tr = ON (Low) During restart of the sensor Tr = OFF (Hi) [2]	Tr = OFF (Hi) [2]

Caution

[1]After power supply is ON approx. 5sec continue unstable state.

[2]The sensor will be in unstable state until sensor restarts after IP initialization process is completed.

4. Application examples of the UXM

In this chapter will explain giving some application examples where the UXM can be used. Before installing, user has to decide the main purpose for using the UXM. Next, decide the suitable installation place as well as required detection area size, etc. In case of area switching, it is necessary to configure in what type of condition and how area switching will takes place.

⚠ **Caution**
- UXM is not a safety device. It cannot be used for human protection purpose.
- Before setting the UXM, read the whole manual thoroughly.

4.1 Obstacle detection

Obstacle detection

Useful to avoid the collision between containers even when they are stationary.
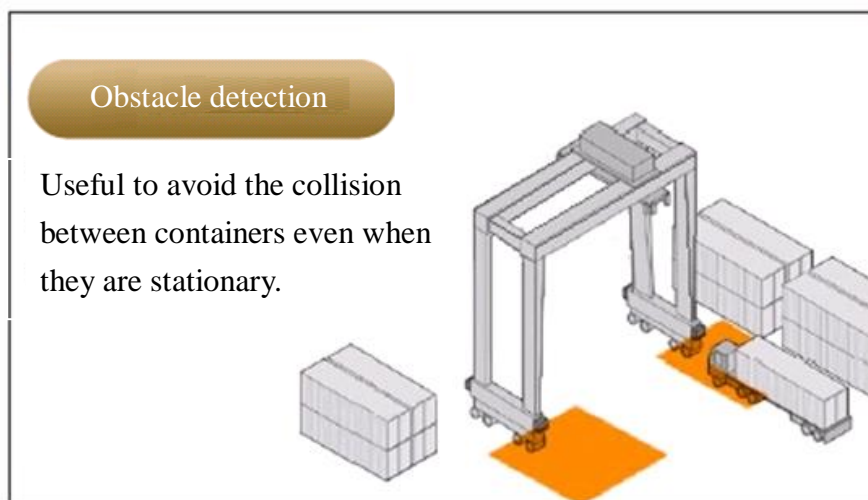
Figure 4-1 Example of obstacle detection

Position detection

Useful to detect the position of the container correctly.
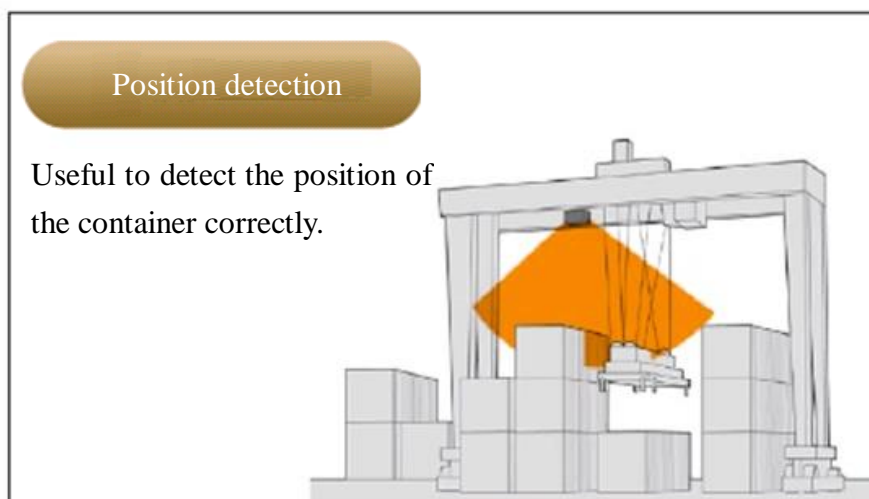
Figure 4-2 Example of obstacle detection

4.2 Access protection
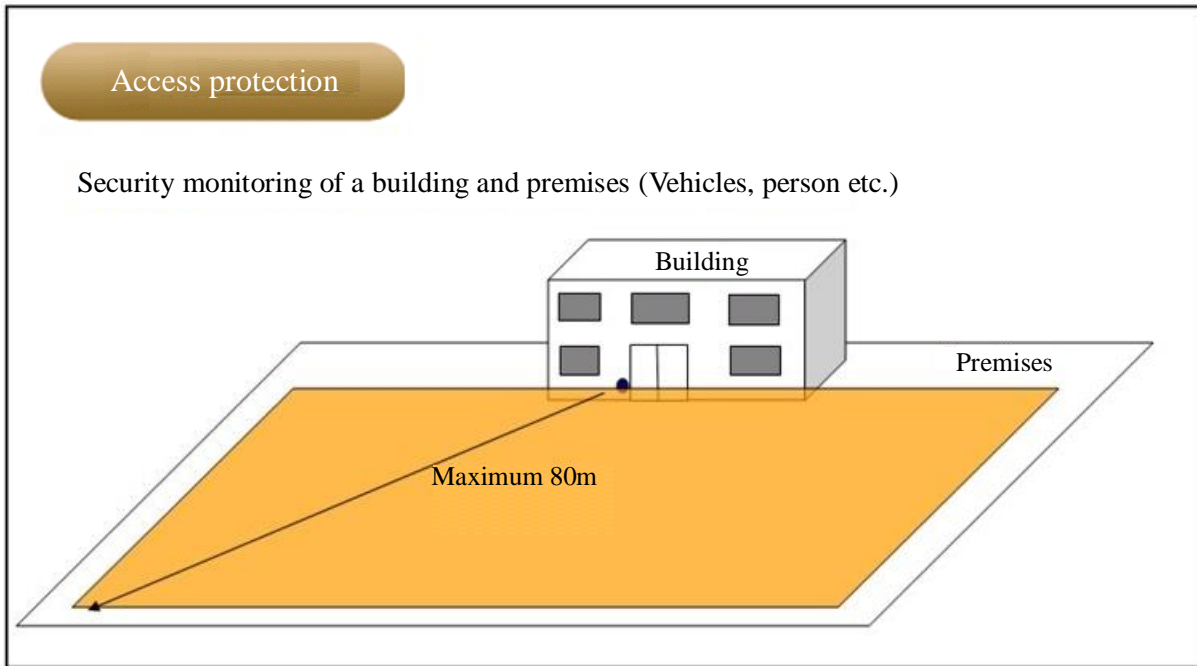
Figure 4-3 Example of access protection

5. Installation

This chapter describes precautions during sensor installation.

5.1 Caution of Installation

The UXM can be fixed to a surface using 4 pieces of M5 screw at back mounting plate. Mount the sensor at a height of 500mm above the floor. When mounting below 500mm, incline 1° in the upward direction. As shown in the below figure 5-1, the spread of the beam differs from front to side.
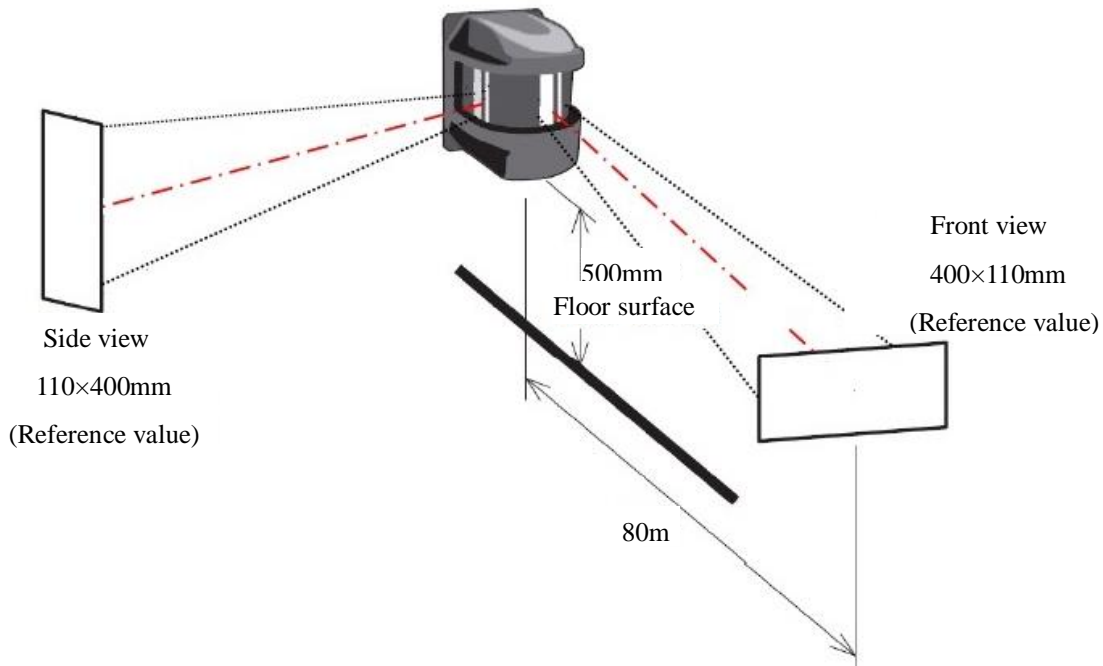
Figure 5-1   Spread of beam of UXM-30LAH-EWA

Table 5-1   Beam size (Reference value)

Distance (m)	Beam size（Reference value）(mm)	
	Front view	**Side view**
10	60×30	30×60
20	110×40	40×110
30	150×50	50×150
50	240×75	75×240
80	400×110	110×400

⚠ **Caution**   ● Fix the sensor firmly so that the optical axis is not displaced by the vibration or resistance.

5.2 Optical axis adjustment

Angular tolerance with respect to structure axis is ±0.2° in the horizontal plane and ±0.5°in the vertical plane. (Figure 5-2) Use the adjustment mechanism for precisely adjusting the detection plane. Detection plane can be checked by Optical-Axis Checker (Model: UES-930, Sold separately)

Horizontal angle
±0.2°

Scan plane
(Top View)

UXM

Scan plane
(Side view)

Vertical angle
±0.5°

UXM
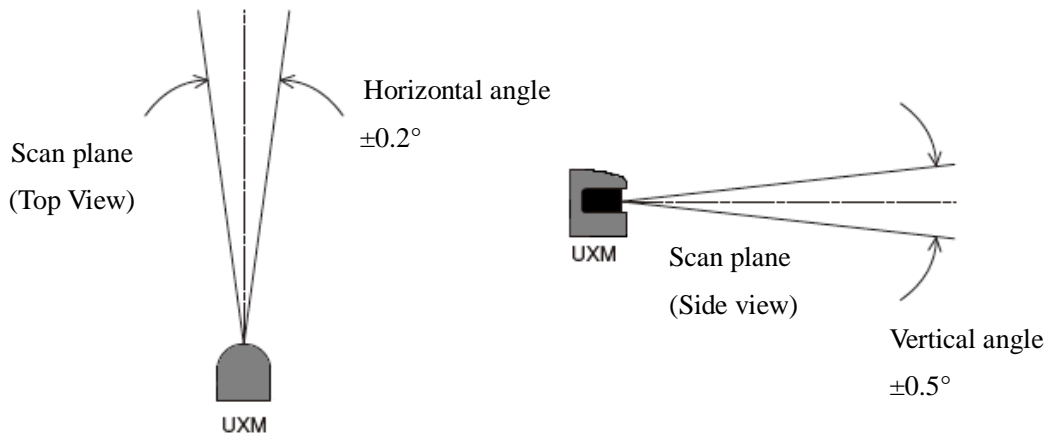
Figure 5-2 Angular Tolerance with Respect to Structure Axis

5.3 Light interference

The UXM uses a pulsed laser for object detection. Light interference sources could lead to false detection. User should examine the surrounding environments before installation the UXM. If the light source cannot be avoided during the operation; then UXM should be installed with the light source located at ±5 degrees or more from the detection plane in order to prevent interference. When sensitive filter is selected it might be effective for light interference.

Light source

Detection plane

Light source

Detection plane with ± 5° or more

Detection zone origin
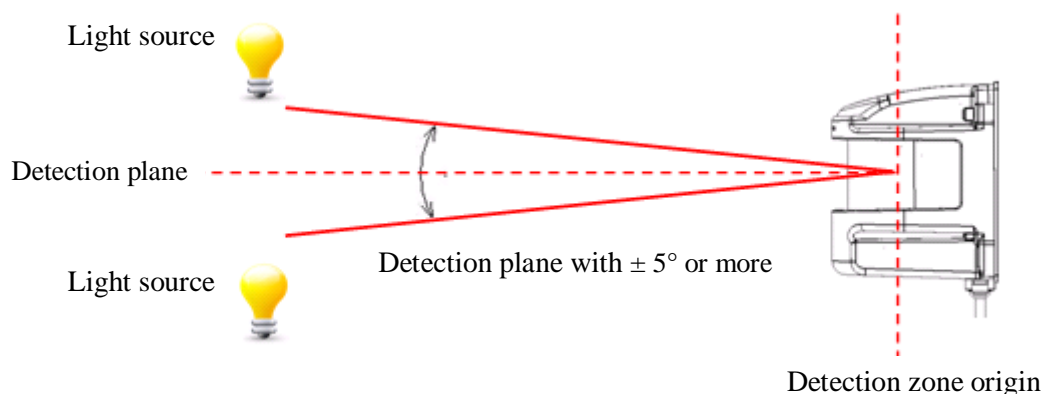
Figure 5-3 Installation under light interference

5.4 Mutual interference

Extra precautions are required while using two or more identical UXM sensors because pulsed laser signals from identical UXM units could lead to false detection. Figures below show the installation method for avoiding mutual interference.

a) Changing the height of installation

Displace the installation position up and down; mutual detection original point of the UXM should be separated 5 degrees or more from detection plane.
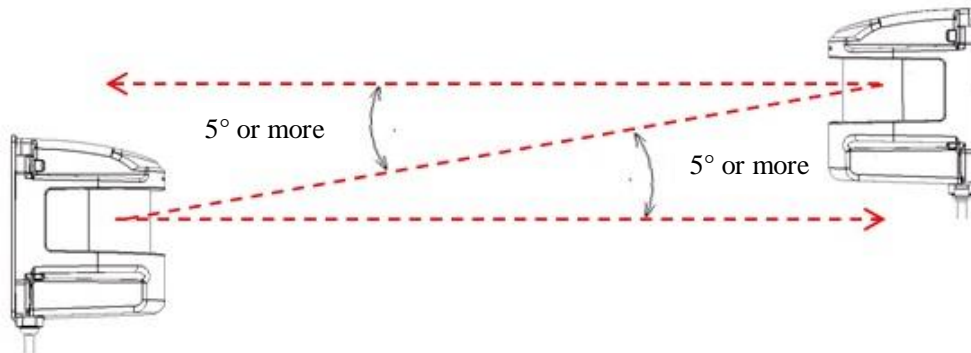
5° or more

5° or more

Figure 5-4 Opposite facing installation
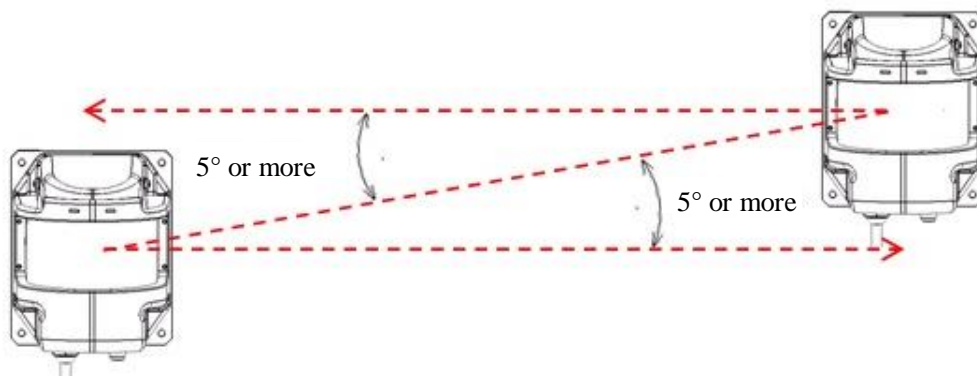
5° or more

5° or more

Figure 5-5 Parallel installation

b) Changing the angle of installation

The installation angle of the UXM is changed; mutual detection original point of the UXM should be separated 5 degrees or more from detection plane.

5° or more

5° or more

Detection plane

Detection plane
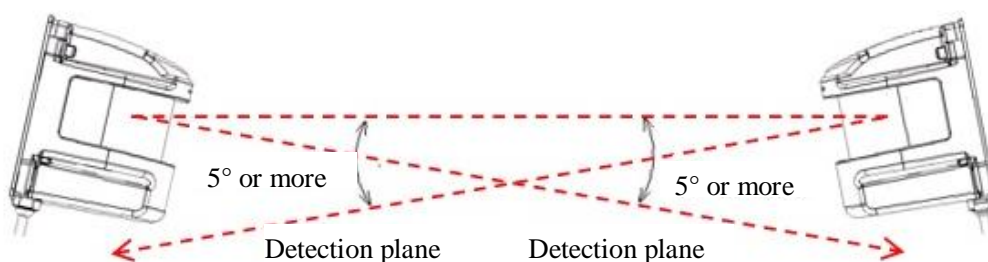
Figure 5-6 Opposite facing installation

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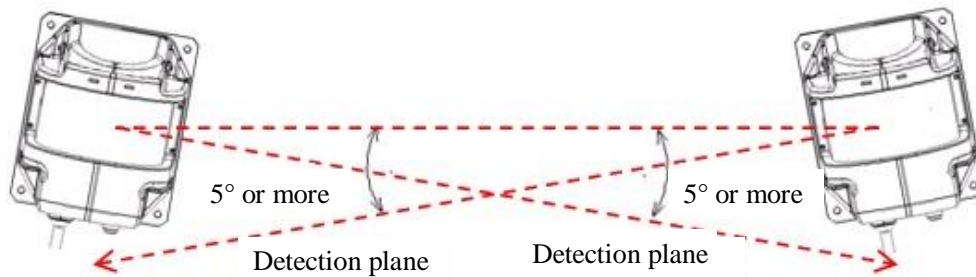
Figure 5-7 Parallel installation

c) Adding shield in between UXM

By adding a shield in between the UXM units, laser beam cannot reach the opposite sensor so this will avoid possible mutual interference.
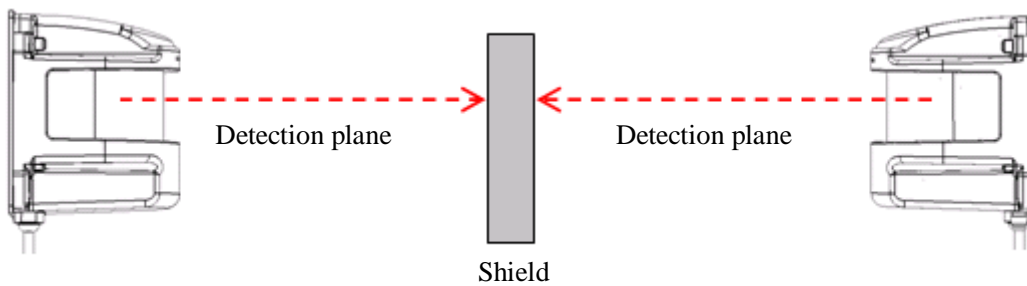
Figure 5-8 Opposite facing installation
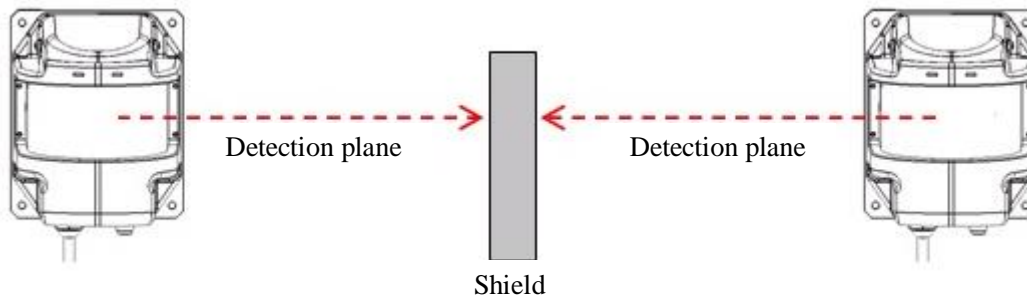
Figure 5-9 Parallel installation

5.5 Synchronous operation

When operating two or more UXM units within a short distance mutual interference may occur. To prevent mutual interference between them, the rotation of maximum 8 UXM units can be synchronized (However, this cannot guarantee 100% prevention of mutual interference, depending upon the installation condition, background condition, etc., of each UXM. If interference cannot be avoided then, verify before the operation).

During 4 UXM units operation, one master and other three slaves can be set. During initial shipment the UXM is set as master, therefore it is necessary to configure a sensor as slave. Configuration of each UXM is done through the Area Designer. Example of connection is shown in figure 5-10.
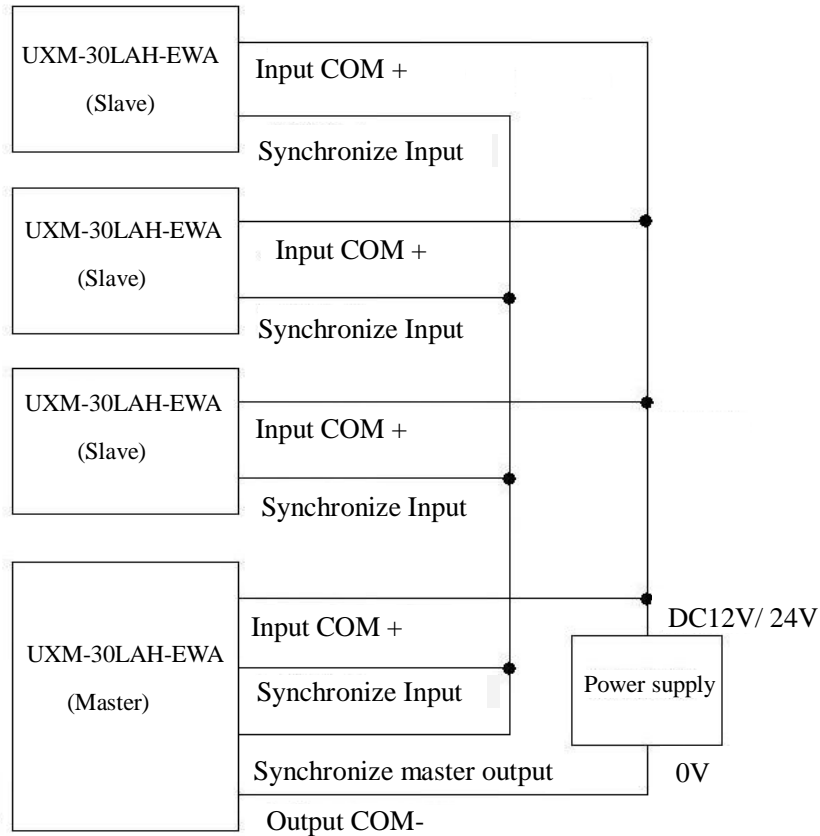
Figure 5-10 Example of synchronization wiring (In case of 4 UXM)

5.5.1 Example of phase setting

In case of installing multiple units of UXM, figure 5-11 to figure 5-13 shows an example of phase setting.

a) Parallel installation

To prevent mutual interference between

2 units of UXM in a parallel installation.

Set Master phase: 0°
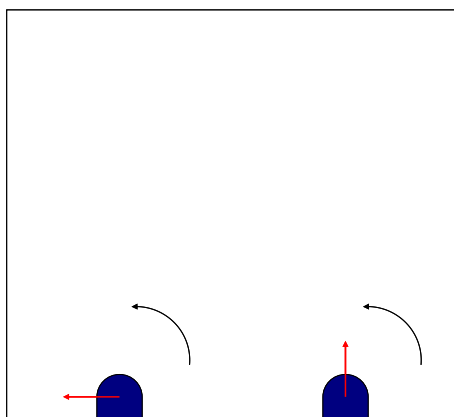
Slave phase: 90°

Master Phase：0°　　Slave　Phase：90°

Figure 5-11 Example of parallel installation

b) Opposite facing installation
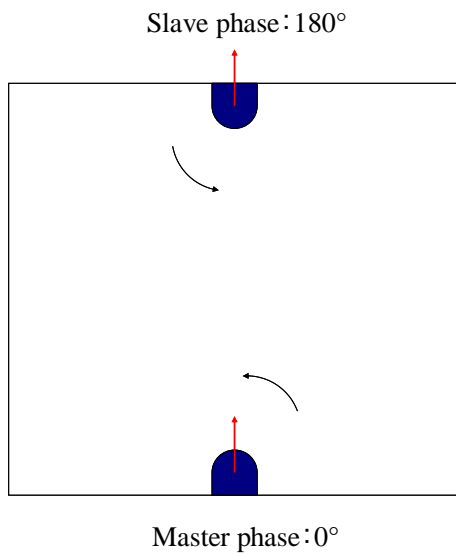
Slave phase：180°

To prevent mutual interference between 2 units of UXM opposite facing installation.
Set Master phase: 0°
Slave phase: 180°

Master phase：0°

Figure 5-12 Example of opposite facing installation

c) Installing 4 units of UXM
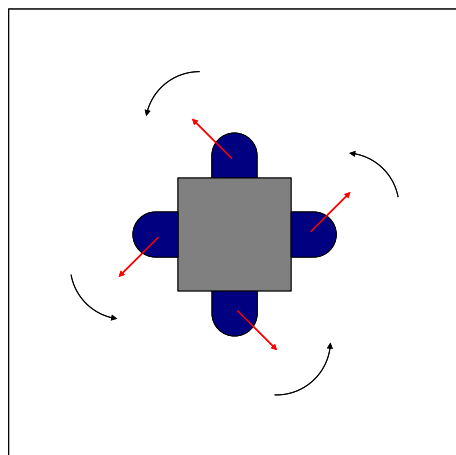
To prevent mutual interference between 4 units of UXM installed facing 4 different directions.
Set Master phase: 0°
Slave phase: 0°

Master/ Slave phase：0°

Figure 5-13 Example of installing 4 units

Mutual interference could occur when multiple identical sensors are mounted on the same detection plane. The sensor cannot differentiate the self emitted laser pulse and the identical pulse from the other device causing the measurement error. Use ON delay setting to prevent such mutual interference.

> ⚠ **Caution**
> - When using a cover in the UXM, it should be of high transparency material that does not influence the detection property. (Wave length 905nm)

6. Wiring

This chapter describes precaution when wiring the UXM.

6.1 Precautions

During electric wiring, make sure that all devices are disconnected from power supply. Switch off all the power supply during wiring.

6.2 Power supply

Make sure that power supply is either DC 12V or DC 24V (operation voltage range 10V to 30V.) In case rated output voltage exceeds this range, UXM could be damaged.

When a converter is used as power supply, make sure it fulfills the following requirements.

- A rated output voltage within range of DC 10V to 30V.
- Use power source with 1A or more (1.5A or more DC15V or less) current capacity.
  While using the heater additional 1A or more is required.
- The power supply must comply with the requirements of electromagnetic compatibility (EMC) regulations of the respective country, states and district.

Danger ● For safety, switch off all the power supply during wiring.

Caution ● If there is an electric potential difference between the UXM and ground of other connected devices, then there is a possibility of malfunction due to noise or of damage. Prevent this by using potential equalization, isolation, etc.

6.3 Wire color and function

Table 6-1 shows the color of each lead wire, signal name, function, etc.

Flying lead cable of length 2 m with 16 shields.

Table 6-1 Wire color and function

Color	Signal	Function	Description	AWG
Brown	+VIN	Power	Power Supply: DC12V or DC24V	22
Blue	-VIN	Power	Power Supply : 0V	22
White/Red	Area Input 1	Input	Area switching Input 1	28
White/Blue	Area Input 2	Input	Area switching Input 2	28
White/Green	Area Input 3	Input	Area switching Input 3	28
White/Black	Area Input 4	Input	Area switching Input 4	28
White	Synchronous Input	Input	Synchronous input for Master/Slave operation	28
Orange	Malfunction Output	Output	Turns OFF when malfunction output is detected by self-diagnostic function.	28
Pink	Detection Output 1	Output	When an object is detected in the output region 1 it is turned OFF	28
Violet	Detection Output 2	Output	When an object is detected in the output region 2 it is turned OFF	28
Yellow(Black)	Detection Output 3	Output	When an object is detected in the output region 3 it is turned OFF	28
Green	Synchronous Output	Output	Synchronized motor rotation output is ON at 1ms pulse in every scan	28
Yellow	Synchronous Master Output	Output	Reference clock signal for synchronizing motor rotation	28
Red	COM Input +	Input	COM Input +	28
Black	COM Input -	Input	COM Input -	28
Gray	NC[1]	----	Non Connect	28
Shield wire	FG	----	Frame ground	----

Note: Color names inside brackets indicate dual color cable.

Keep the input wires open or connected to input Com+ (red) if not in use.

Keep the output wires open or connected to output Com- (black) if not in use.

Input/output direction is defined from the sensor point of view (sensor as reference).

[1] Internally connected. Do not connect as it is not used.

⚠️ **Caution** ● Mounting plate is used as a frame ground (FG).Mount the sensor on as stable structure.

6.4 Input/Output circuit

6.4.1 Input circuit

Photo coupler input circuit (anode COM, Input ON current 2mA, OFF current 0.5mA or less)

6.4.2 Output circuit

NPN Open output collector circuit

Table 6-2 Output circuit specification

Item	Specification
Maximum output current	50mA
Maximum applied voltage	30V
Output residual voltage	1V or less
Power supply range at ＋COM	10 to 30V
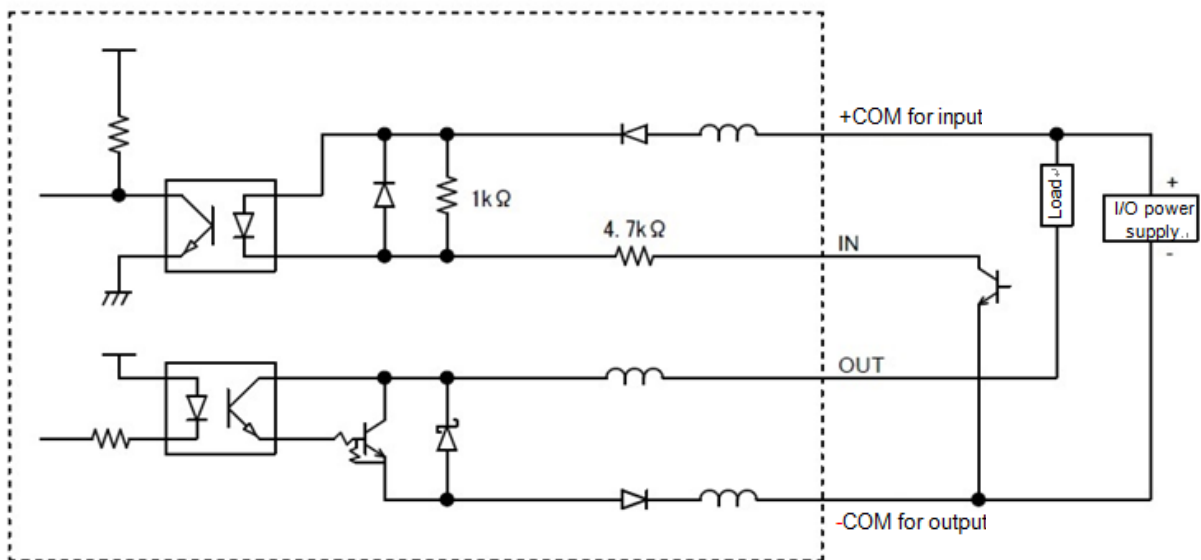
Figure 6-1 Example of connecting input / output circuit

⚠️ Caution
- Input cable should be connected to input common+ or open it when not in use.
- Output cable should be connected to output common- or open it when not in use.
- Output connection requires limit resistors.

6.5 Interface connector

Sensor setting and measurement data can be obtained by Ethernet connection. User should prepare Ethernet cable which connects a sensor with PC. CAT5 (Standard twisted-pair cable) is used which connects between the Ethernet connecting plug (a straight type plug or L type plug) and the RJ-45 modular plug. Pin assignment of each plug is shown in table 6-3 and table 6-4.

Connector

Maker：Binder

Type：09-0431-87-04
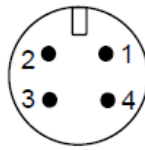
Figure 6-2 Connector (Sensor side)

Ethernet connector plug

Maker：Binder

Straight type plug：99-0430-57-04

L type plug　　：99-0430-69-04

Table 6-3 Connecting plug

PIN No.	Function	Wiring color （T568A）
1	TX+	White/Green
2	TX-	Green
3	RX+	White/Orange
4	RX-	Orange

Table 6-4 Example of RJ-45 Modular wiring

PIN No.	Wiring color	
	Straight	Cross
1	White/Green	White/Orange
2	Green	Orange
3	White/Orange	White/Green
4	Blue	Blue
5	White/Blue	White/Blue
6	Orange	Green
7	White/Brown	White/Brown
8	Brown	Brown

● Ethernet connection plug is as below

Table 6-5　Ethernet connection plug

Code No.	Name	Type
UZ00024	Straight type plug	UXM-CN01
UZ00025	L type plug	UXM-CN02

7. Setting of Area Designer

Install the application software (Area Designer) in a supported operating system and connect UXM using an Ethernet cable. (For details refer to section 6.5).

Area Designer has the following functions:

- Configuration of detection area
- Configuration of various UXM functions
- Display of measurement data
- Record and playback of measurement data
- Project data management (Save and open of project data).

7.1 Area Designer

Application software (Area Designer) can be downloaded from our homepage.

For details of installation and operation please refer to Area Designer sensor configuration tool Instruction manual.

7.2 System requirements

Table 7-1 Minimum system required for Area Designer

PC	CPU	Pentium®Ⅳprocessor of 800MHz or above
	RAM	512MB or more
	Hard disk	150MB minimum free space
Compatible OS	Microsoft® Windows 7 Professional	
	Microsoft® Windows 8.1	
	Microsoft® Windows 10	
Display	High color (16 bit color) or above , 800×600 dot or above	

Microsoft®, Windows® are the registered trademarks of Microsoft Corporation USA.

The operation in the below system environment cannot be guaranteed.

- Other OS that is not mentioned above
- NEC PC98 series and its compatible device
- Self-assembled PC
- Multi boot environment
- Multi monitor environment

Note
- Operation is not guarantee even if the system requirements are fulfilled.
- Read thoroughly the Instruction manual of Area Designer for configuring UXM. Instruction manual can be loaded from the help menu of Area Designer.

8. Communication

8.1 Ethernet setting

8.1.1 Initial value

Initial value of IP: 192.168.0.10

Port No.:   10940

8.1.2 IP Initialization

Remove the rubber cap located at the bottom of the sensor. Press and hold this switch for more than two seconds in order to start the IP initialization process. When the sensor restarts after blinking green and orange LEDs, release the switch. After initialization process is completed, return the cap to its original position. For details on changing the IP address, refer to the manual of IP change tool.
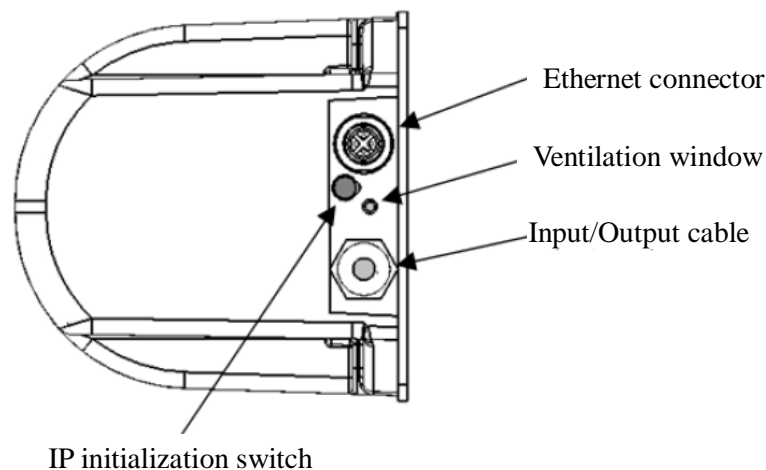
Figure 8-1 UXM-30LAH-EWA (Bottom part)

8.2 Communication protocol

For details on the communication protocol, refer to the UXM series LA type Communication specification (C-42-04041).

8.3 Error code table

The cause of an error can be obtained from STAT line of the "II" Command response, in the SCIP communication protocol. The error codes and solutions from the STAT line are as follows in table 8-1.

Table 8-1 Error code

ID	Message	Meaning	Solution
000	no error.	Normal operation	No action is required
050	internal chip access failed.	Sensor processing system error	Sensor has failed and needs to be repaired.
100	internal chip access failed.	Same as above	
150	internal chip access failed.	Same as above	
151	internal chip initialize failed.	Sensor processing system initialization failure	
200	encoder error.	Encoder fault	
250	motor startup failed.	Motor fault	
251	motor rotation error.	Unstable motor rotation	Reduce the vibration and noise to the sensor
300	laser too high.	Laser fault	Reduce the ambient light and noise to the sensor
301	laser too low.	Same as above	
302	laser no echo.	Same as above	
303	measurement error.	Measuring data processing fault	Reduce the vibration, ambient light and noise to the sensor

8.4 Detail on measurement values

In table 8-2 the details of output value x for each measurement steps.

Table 8-2 Distance value

Distance value "X"	Meaning
x < 23	Measurement error. Distance cannot be measured due to the light influence or noise.
23≤ x < 120000	Measured distance value (mm)
120000 ≤ x	Object does not exist or the object has low reflectivity.

9. Inspection and maintenance

Inspection and maintenance are necessary for safety operation. User must ensure that inspection and maintenance are carried out as specified.

Before performing inspection and maintenance, confirm the following items.

- The machine monitored by the UXM is switched OFF.
- The surrounding of the working environment is safe.

⚠ Danger	• Do not modify or dissemble the UXM during inspection as this will affect the detection capability of the sensor leading to critical injury or death.

⚠ Caution	• This manual only suggests the basic steps for inspection and maintenance. User should perform additional inspection and maintenance if needed. User should follow necessary steps in accordance to the working environment. • Depending upon the operating environment, follow the necessary procedure. • All inspections should be performed during initial commission of the UXM.

9.1 Pre-operation inspection

After configuration is completed, pre-operation inspection test should be performed using a test piece. User should perform this inspection without connecting the sensor to the system. Table 9-1 shows an example of pre-operation inspection items list.

Table 9-1 Pre-operation inspection list

No.	Check item	Condition		Remark
		Yes	No	
1	UXM is correctly mounted at the intended location and screws are firmly fastened			
2	All the wirings are correctly connected			
3	When the test piece is placed in the detection area Output 1 to 3 switch from ON state to OFF state			
4	When the test piece is removed from the detection area Output 1 to 3 switch from OFF state to ON state			
5	Area switching is according to input signal			

* Must check items 3 and 4 for all the areas.

9.2 Operation inspection

This test should be performed when pre-operation inspection is completed. This operation inspection must be performed with sufficient safety measures been taken. If this inspection test is done before pre-operation test, then the system can get damaged. Table 9-2 is an example of operation inspection list.

Table 9-2 Operation inspection list

No.	Check item	Condition		Remark
		Yes	No	
1	When the test piece is placed in the detection area Output 1 to 3 switch from ON state to OFF state			
2	When the test piece is removed from the detection area Output 1 to 3 switch from OFF state to ON state			
3	Area switching is according to input signal			
4	Predetermined system operation is carried out as expected			

* Must check items 1 and 2 for all the areas.

9.3 Daily inspection

Below table 9-3 shows an example of the items that should be checked during daily inspection.

Table 9-3 Daily inspection list

No.	Check item	Condition		Remark
		Yes	No	
1	UXM is correctly mounted at the intended location and screws are firmly fastened			
2	All the wirings are correctly connected			
3	When the test piece is placed in the detection area Output 1 to 3 switch from ON state to OFF state			
4	When the test piece is removed from the detection area Output 1 to 3 switch from OFF state to ON state			
5	Area switching is according to input signal			
6	Predetermined system operation is carried out as expected			

* Must check items 3 and 4 for all the areas.

9.4 Periodical inspection

Periodical inspection should be performed to ensure the detection capability of the UXM. Table 9-4 below shows an example list of periodical inspection items. It is recommended to perform this inspection in six months interval. This inspection should be performed together with daily inspection.

Table 9-4 Periodical inspection list

No.	Check item	Condition		Remark
		Yes	No	
1	Screw are tightly fastened			
2	No displacement from the original mounting position			
3	No scratch or crack on the optical window			
4	Screws of the optical window are tightly fastened			
5	No oil/grease or dirt on the optical window			
6	No visible damage on the UXM			
7	Cable connector is in good condition and tightly fastened			
8	When the test piece is placed in the detection area Output 1 to 3 switch from ON state to OFF state			
9	When the test piece is removed from the detection area Output 1 to 3 switch from OFF state to ON state			
10	Area switching is according to input signal			
11	Pre-determined system operation is carried out as expected			

* Must check items 8 and 9 for all the areas

Note
- For the traceability purposes it is recommended to maintain and store the maintenance and inspection records.

9.5 Cleaning the optical window

Dust covering the optical windows affects the detection capability of the UXM. When you install UXM in the dusty environment, regular cleaning of the optical window is needed.

According to the contamination situation follow the below method:

- Wipe the optical window with a clean soft cloth.
- Clean the optical window with a soft brush.
- Blow off the dust on optical window using air-blower.
- Clean the optical window with mild detergent if it is contaminated with oil/grease particles.

| ⚠ Danger | • Disconnect the system when cleaning the optical window.
• If above-mentioned contents are not followed it could lead to serious damage on the machine, critical injury and death. |

| ⚠ Caution | • Do not use organic solvents (such as thinner, benzene and acetone) for cleaning. Plastics parts and paint might be affected.
• Do not use abrasive cleaner. It might scratches the optical window and result to the loss in the detection efficiency. |

10. Troubleshooting

● While using this sensor, if problem occurs, then refer to the following table.

Table 10-1 Troubleshooting list

Situation	Possible reason	Solution suggestion
UXM is not operating	Power supply is OFF /Over voltage/ Under voltage	Make sure power supply is ON Voltage is within the specification
	Cable is damaged	Power supply cable is in good condition Replace with a new cable
UXM does not connect with Area Designer	Configuration is incomplete	Reconfigure UXM
	PC trouble	Check the PC's specification. Make sure the specification is compatible. Close other unrelated applications and reconnect
	Power supply is OFF	Make sure the power supply is ON Voltage is within the specification Power supply cable is in good condition
	Ethernet cable is not connected to LAN port	Make sure the LAN cable is connected to both PC and UXM
	IP address of PC is not set	Set the IP address of the PC
Obstacles are not detected inside the selected detection area	Power supply is OFF	Voltage is within the specification
	UXM is in malfunction state	Make sure that power supply LED is in normal state Restart UXM if it is blinking.
Output remains OFF even if no object in the detection area	Light interference	Mount UXM at a location free from light interference Refer to chapter 5 light interference for counter measures
	Mutual interference	Refer to chapter 5 Mutual interference and synchronous operation for counter measures
	Contaminated optical window	Check for any contamination or damage on the optical window
	Floor is detected	Make sure floor is not detected. Reconfigure the detection area.
	Background is detected	Make sure that the background is not within the detection area. Reconfigure the detection area.
	Malfunction state due to self-diagnostic function	Make sure power supply LED is not blinking (normal state).
	Hysteresis setting	Reconfirm the hysteresis setting.(Refer to section 3.8)

	• For repairing the UXM, please contact our nearest distributor or sales representative. Do not repair or disassemble the UXM. Such modifications will void the warranty.
⚠ Danger	

11. Specification

Table 11-1 Specification of UXM-30LAH-EWA

Product name	Scanning laser range finder
Model	UXM-30LAH-EWA
Supply voltage	DC12V/DC24V (Operating range DC10V to DC30V, ripple within ±10%)
Supply current	Steady current : 300mA or less Start current: approx.750mA (when using DC24V)
	Steady current : 600mA or less Start current: approx.1500mA (when using DC12V)
	While using the heater (0°or below) : Requires 1A or more in addition
Light source	Laser semiconductor (905nm), Laser class 1
Detection range and object	0.1m to 80 m[*1] (White Kent sheet Reflectance 90%) 0.1m to 30 m[*1] (Black paper Reflectance 10%) Maximum detection distance : 80m Minimum detectable size 33mm (5m), 65mm (10m), 200mm (30m)
Accuracy	10% Reflectance Black paper 0.1 to 15m：±30mm, 15 to 30m：±50mm[*1] 0.1 to 30m：±50mm[*2] Ambient illuminance : 3,000lx or less 0.1 to 20m：±50mm[*2] Ambient illuminance:100,000lx or less
	90% Reflectance white Kent paper 0.1 to 30m：±30mm[*1] 0.1 to 30m：±50mm[*2] Ambient illuminance : 3,000lx or less 0.1 to 30m：±50mm[*2] Ambient illuminance:100,000lx or less
Repeat accuracy	10% Reflectance Black paper 0.1 to 15m：σ<10mm、15～30m：σ<15mm[*1] 0.1 to 30m：σ<20mm[*2] Ambient illuminance: 3,000lx or less 0.1 to 20m：σ<30mm[*2] Ambient illuminance:100,000lx or less
	90% Reflectance white Kent paper 0.1 to 30m：σ<10mm[*1] 0.1 to 30m：σ<15mm[*2] Ambient illuminance: 3,000lx or less 0.1 to 30m：σ<30mm[*2] Ambient illuminance:100,000lx or less
Measurement	1mm
Scan angle	190°
Scan speed	50ms (Motor speed 1200rpm)
Angular resolution	Approx. 0.125°
Start up time	Within 30 sec
Outputs	6 Output: Area detection output 1 to 3, Malfunction output, Synchronization output, Synchronization master output
Inputs	5 Output: Input 1 to 4: Area switching inputs Synchronization input: Input synchronization signal during slave operation.
Response time	OFF	50msec to 6400msec
	ON	50msec to 6400msec
Interface	Ethernet 100Base –TX (Auto-negotiation)

Indicator LED	Green LED　: Power supply and normal operation Orange LED : Area determination (About indicator lamp refer to section 3.12)
Ambient temperature, humidity	-10°C to +50°C　below 85%RH　 (Without dew, frost) -30°C to +50°C　below 85%RH　 (When heater in use) (Without dew, frost)
Environment effect	Measured distance will be shorter than the actual distance under the influence of rain, snow and direct sunlight. *3
Storage temperature, humidity	-30°C to +70°C　below 85%RH　 (Without dew, frost)
Vibration resistance	10 to 55Hz　double amplitude of 1.5mm for 2hrs in each X, Y, and Z direction 55 to 200Hz 19.6m / s^2　sweep of 2min for 1hr in each X,Y and Z direction
Shock resistance	196m /s^2 (20G) X,Y and Z directions each 10 times
Insulation resistance	10MΩ,　DC 500V Megger
Protective structure	IP67
Weight	1200g　(With cable included)
Material	Front face of the case, Optical window : Polycarbonate Back face of the case : Aluminum
Dimensions (W×D×H)	124×126×150 (mm)　(Without connector)

*1Indoor environment (Fluorescent lamp should be 1,000lx or less)
*2Detection cannot be guaranteed when direct light (such as sunlight) enters the device.
*3Depending upon the environment user should verify detection capability before using the actual object.

Table 11-2 Quality Reference Value

Angular Speed	360 deg/s
Angular Acceleration	π/2rad/ s^2
Operation life	5 Years (Varies with operating conditions)

12. Applicable directives and standards

Table 12-1 shows the conformant EU directives and EN standards

Table 12-1 Directives and Standards

Directives/Standard	Details
Directives	EMC Directives
	RoHS Directives
EMC Directives	(EMI)
	EN61326-1：2013
	EN55011：2009 + A1:2010
	(EMS)
	EN61326-1：2013
	EN61000-4-2：2009
	EN61000-4-3：2006 + A1：2008 + A2:2010
	EN61000-4-4：2012
	EN61000-4-6：2009
	EN61000-4-6：2014
	EN61000-4-8：2010

● About the laser safety

The UXM laser safety standard is class 1.

Average laser power‥‥‥3.19mW or less

Wave length‥‥‥‥‥‥905nm (Infrared laser)

Peak Power‥‥‥‥‥‥25W

Pulse cycle‥‥‥‥55.5 KHz

Beam size‥‥‥‥150mm×50mm (Distance: 30m at the sensor's front　(For detail refer to 5.1 sections)[1]

Standard‥‥‥‥‥IEC60825-1 (2007) and (2014)

Accession　number‥1420428-000

About Laser Safety Standard Class 1: under normal operation conditions (operations which can be foreseen rationally) it is guaranteed as safety class laser. Additional measures are not necessary to maintain laser safety.
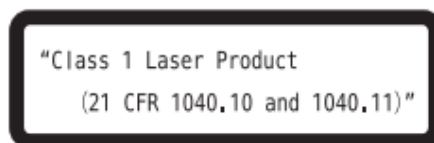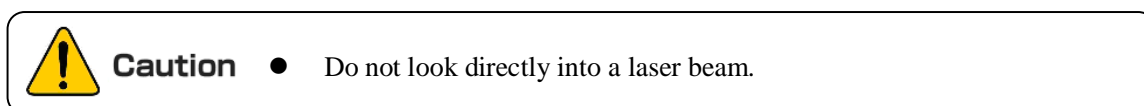
"Class 1 Laser Product
(21 CFR 1040.10 and 1040.11)"

Figure 12-1 FDA Certified labels

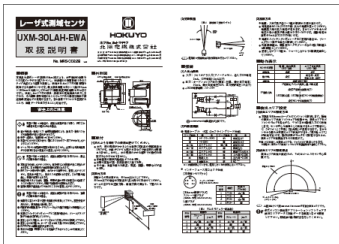⚠ **Caution**　●　Do not look directly into a laser beam.

13. Package contents

The following items are included in the package:

a) UXM-30LAH-EWA ×1

b) User's manual ×1

14. External dimension

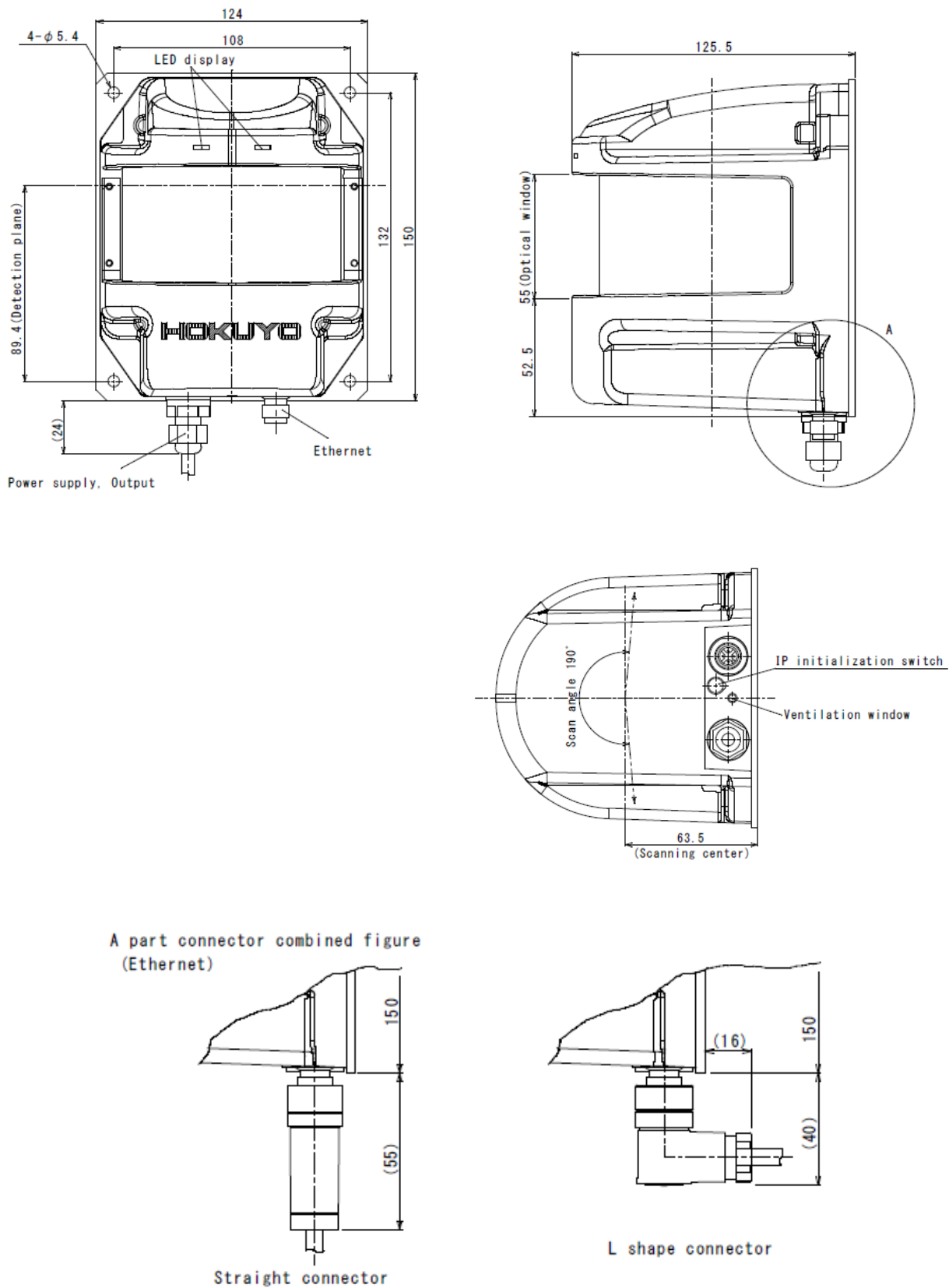

Figure 14-1   External dimension of UXM-30LAH-EWA

15. Revision history

Document No.	Amended No.	Revision date	Details
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16. Representative contacts

● **Asia and others**

Hokuyo Automatic CO., Ltd

540-0028 Osaka HU building, 2-2-5 Tokiwamachi, Chuo-ku, Osaka, Japan

Tel: +81-6-6947-6333

Fax: +81-6-6947-6350
E-mail: overseas-sales@hokuyo-aut.co.jp
URL: http://www.hokuyo-aut.jp

● **Europe**

Hokuyo Automatic Co., Ltd.　Amsterdam Branch

Prof. J.H. Bavincklaan 2, 1183 AT Amstelveen, The Netherlands

Tel: +31 20 240 01 10
E-mail: amsterdam.branch@hokuyo-aut.co.jp
URL: http://www.hokuyo-aut.jp

● **North America**

Hokuyo Automatic USA Corporation
2019 Van Buren Avenue, Suite A, Indian Trail, NC 28079, USA
Tel: +1-704-882-3844　Fax: +1-704-628-0582
E-mail: sales@hokuyo-usa.com
URL: http://www.hokuyo-usa.com

★The contents described in this document are based on the information as of June 2017.The external dimensions; specifications etc. are subject to change without notice.