Document No: C-41-02543-2

Scanning Laser Range Finder

UST-10LN

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 UST sensor (UST-10LN).

1.1 About this document/manual

The UST'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 UST is prohibited. Modifications will affect sensor performance and detection capability that could lead to critical injury and death.
- Any modifications or disassembly of the UST 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 products

This document is for the following sensor models.

- UST-10LN

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 UST 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 document as they are used for explanatory purposes only.

2. Safety precautions

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

2.1 General precautions

- The UST is not a safety device. Do not use this sensor for the purpose of protecting humans.
- The UST uses laser radiation for detecting objects within configured area.
- Perform pre-operation tests in order to verify the performance of the UST.
- 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 UST within the specifications described in this user's manual. Perform necessary maintenance to prevent deterioration of UST's detection capability (refer to chapter 8)
- Do not modify or disassemble the UST. This could compromise the IP65 housing rating. Such modifications will void the warranty.
- The detection capability of the UST will decrease if dust covers the optical window. Regular cleaning of the optical window is necessary while working under dusty environment. (Refer to section 8.5)
- The UST should be disposed as industrial waste or in accordance with the local disposal directives.

2.2 Operating environment

- This product is for indoor use only.
- Make sure that the UST's operating environment is within the stated specification (temperature, humidity, vibration, ambient light, etc.)
- Do not use or mount the UST near devices that could generate strong electromagnetic waves as it could affect the operation of the sensor.
- Do not use or mount the UST in dusty, smoky, or misty environments, or where corrosive substances are present. Working under such environments may decrease the detection capacity of the sensor.

2.3 Installation of UST

- Install the UST on a firm surface or structure to avoid displacement.
- 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 UST sensors are mounted at the same detection plane. Refer to chapter 5 (mutual interference and synchronous operation) for details.
- The UST should be mounted with a provision of sufficient space for maintenance.
- The UST should be mounted where indicator lamps are easily visible.
- Do not put any object in the detection area of the UST. It is not possible for the sensor to detect objects that lie behind the obstacle.
- Do not add any protective materials such as glass, transparent cover, etc. in the front of the optical window. This may lead to loss of detection capability of the UST.

- Avoid direct sunlight as it may cause sensor malfunction. Refer to chapter 5 (light interference) for details.
- Increasing the response time will also increase the stability of the UST. 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 (above 1A)
  - 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 UST.
- 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 8)
  - Pre-operation inspection
  - Operation inspection
  - Daily inspection
  - Periodical inspection
  - Cleaning the optical window

Checklists in this document are provided as 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 so contact the nearest distributor or sales representative.

3. Product overview

This chapter describes the features and properties of the UST-10LN.

3.1 Features of UST-10LN

- Detection range **:** Maximum 10m
- Detection angle **:** 270°
- Angular resolution **:** 0.25°
- 31 set of areas (configurable)
- LED indicates UST's status
- Easy configuration using PC installed with UST configuration application software (Area Designer)
- Teaching function
  For detail refer to Area Designer instruction manual
- Minimum response time of 66ms (configurable)
- Malfunction output: Activates malfunction output according to self-diagnosis function.
- Synchronize function**:** A maximum of 3 sensors for master/slave operation is possible
- Hysteresis function of detection area
- ON delay and OFF delay function
- Minimum detectable size set function
- Scan skip function
- High sensitivity mode
- Detachable area setting function

UST can be used for the following applications:

- Security monitoring of a building and locations (entrances, passages, etc.)
- In detecting the collapse of cargo at an automatic warehouse, detection of protruding objects from shelves.
- In automated guided vehicles (AGV), overhead transportation (OHT), robots, cranes, etc.
- For automation process (detection of transported object)
- Object detection
- Other similar applications

3.2 Components of UST-10LN

Figure 3-1 shows the components of UST-10LN

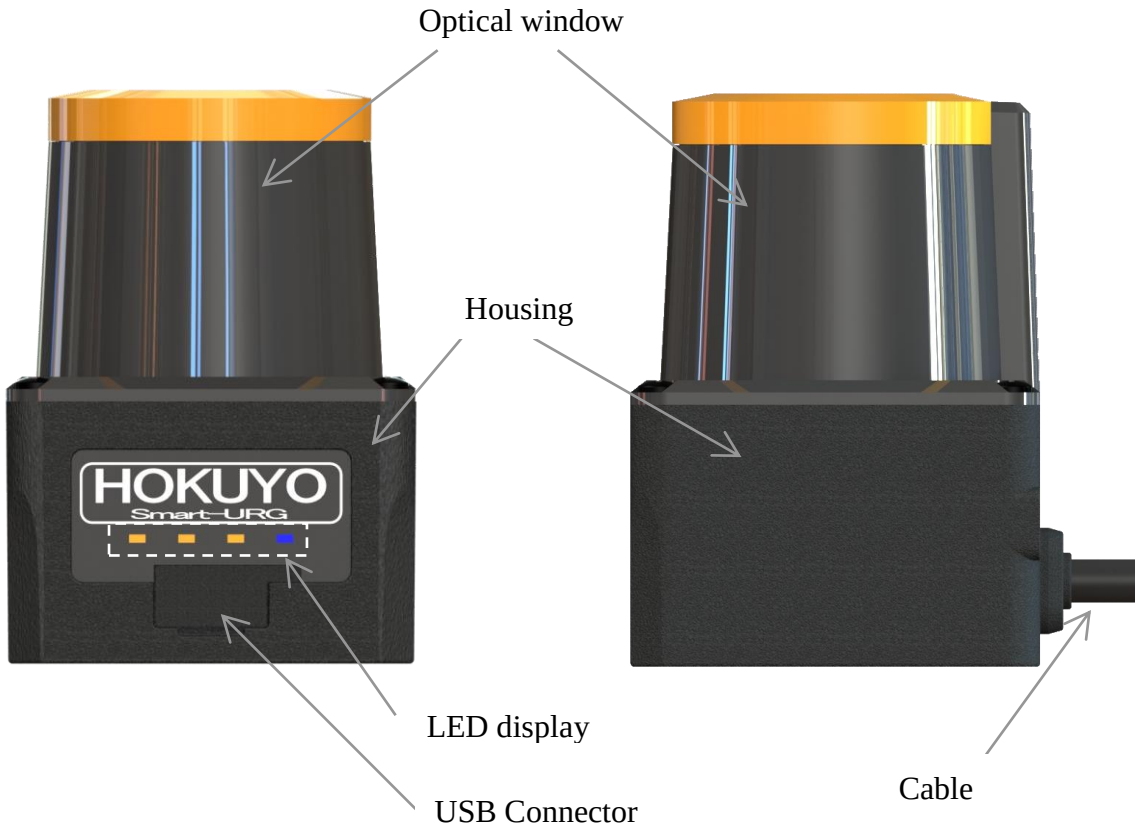


Figure 3-1 UST-10LN components

Figure 3-2 shows the scanning range and detection zone origin of the UST, while figure 3-3 shows its detection plane.

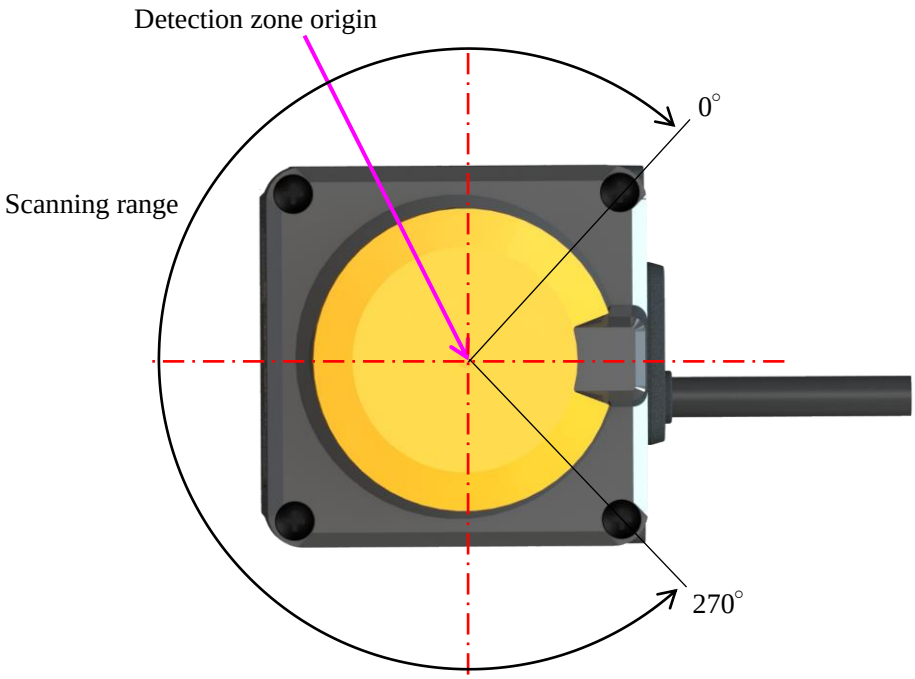


Figure 3-2 Scanning range and detection zone origin (Top view)

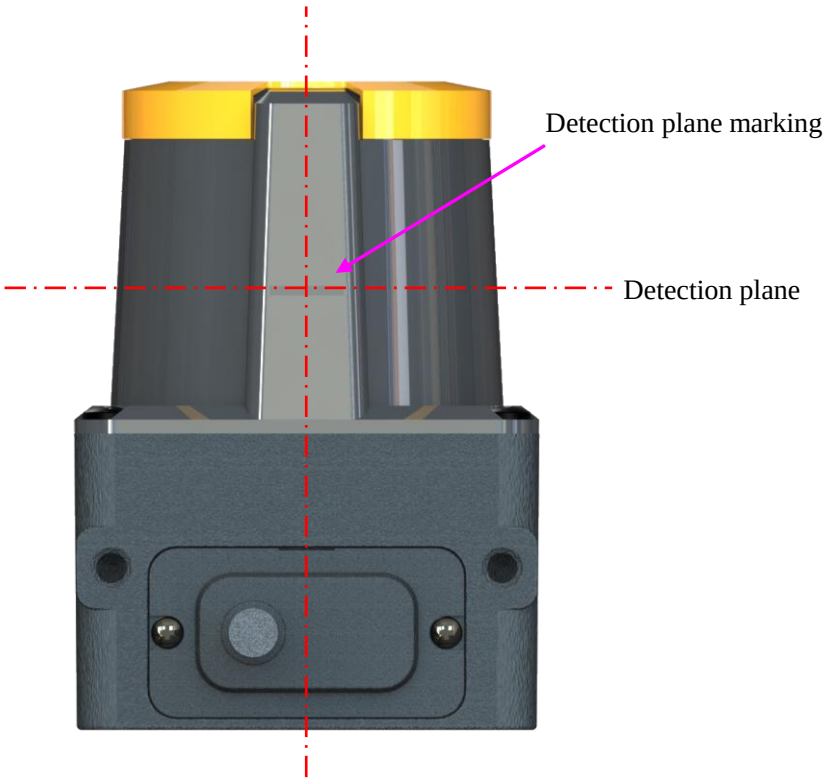


Figure 3-3 Detection plane of UST (Back view)

3.3 Operation principle

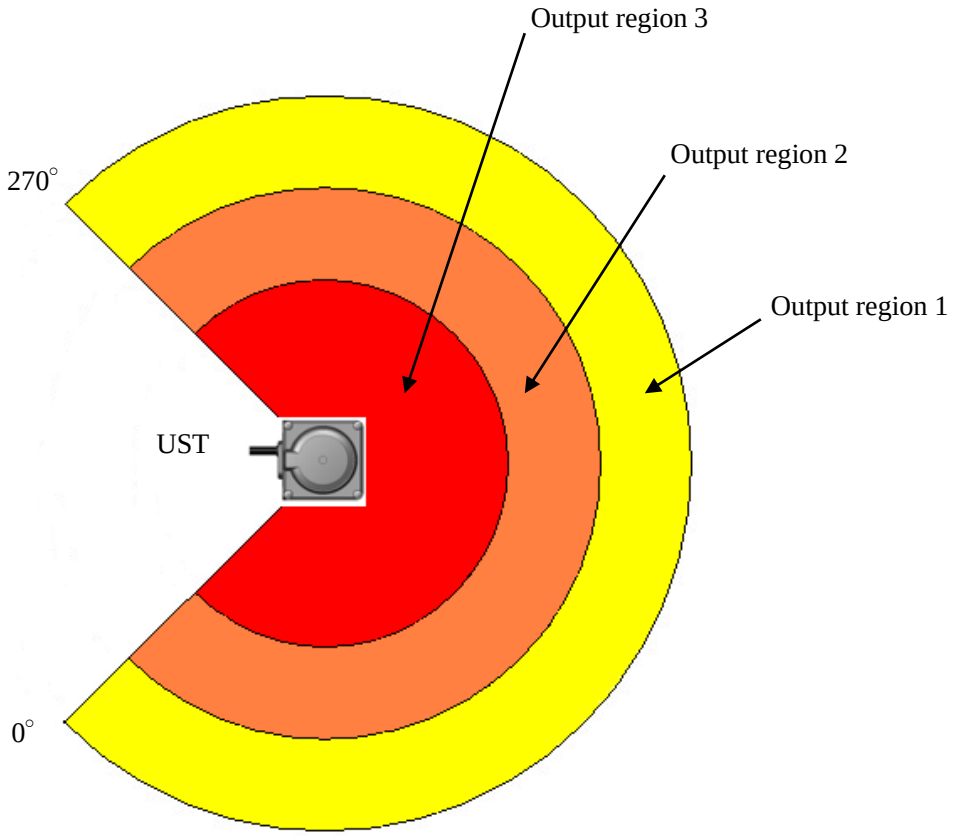


Figure 3-4 Scanning range

Figure 3-4 shows the scanning range of the UST. The sensor emits pulsed laser beams which reflect on a rotating mirror forming a fan-like scanning pattern over 270 ° field.

Maximum detection range is 10m for white Kent sheet. Detection range for objects of 10% diffused reflectance is 4m.

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 outputs are switched to OFF state.

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

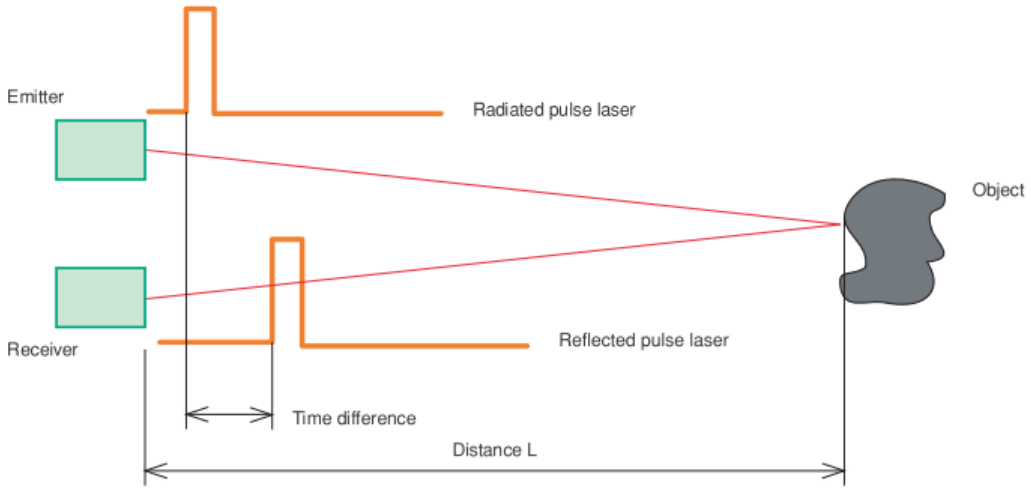
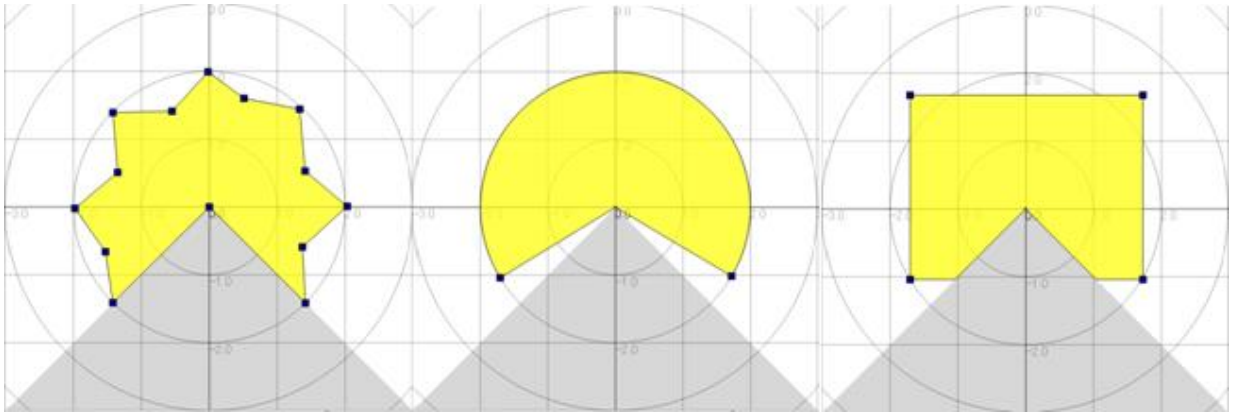


Figure 3-5 TOF operation principle

3.4 Area configuration

The detection area of the UST 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 a USB cable. Area configuration methods can be Independent and Dependent. A maximum of 31 sets of areas can be configured.

For the Independent method the following shapes are supported: Polygon, Arc and Rectangle (numerical input is also available)

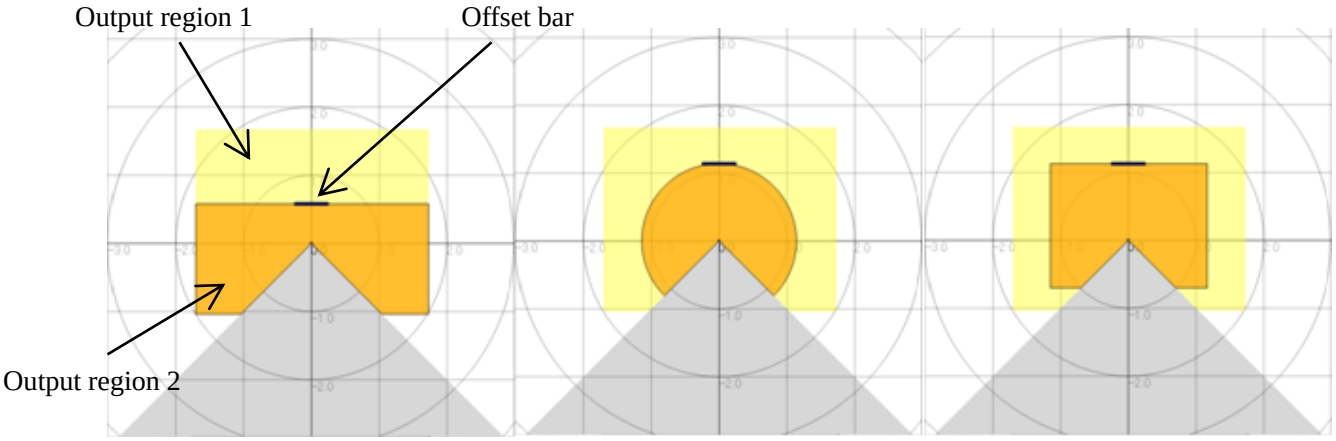


a) Polygon b) Arc c) Rectangle

Figure 3-6 Area configurations (Independent method)

For the Dependent method, the following shapes are defined: Straight line, Fan, and Ratio (numerical input is also available).

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.

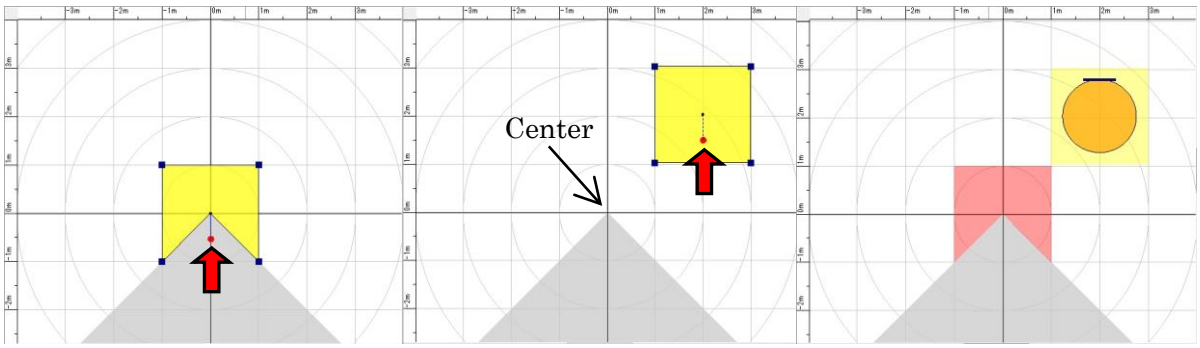


a) Straight line b) Fan c) Ratio

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 for region 2.

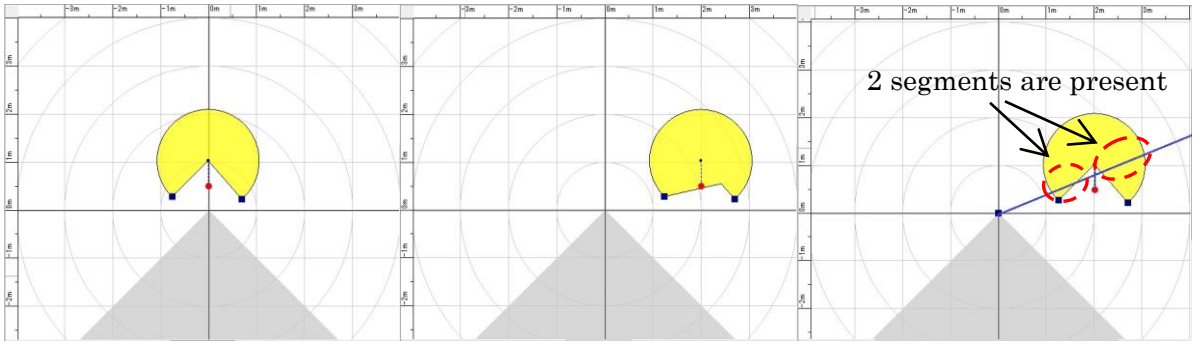
As shown in figure 3-8 a) and b), a red point near the center is present. If it is moved away from the center, a detached region is created. Is possible to use any shape region (Polygon, Arc and Rectangle) as a detached output. When an object enters the detached region, a detection get signaled by switching the corresponding output. However, if the object is present between the center and the detached region, no detection is signaled. As shown in figure 3-8 c), it is possible to configure an area with attached and detached regions.



a) Attached b) Detached c) Attached and Detached

Figure 3-8 Detached area configurations

As shown in figure 3-9 a) and b), depending on the shape of the detached region, changing the position of the red point location may involve some adjustments to the shape of the region. In figure 3-9 c), along a laser beam corresponding to 1 step (blue line), 2 or more segments may exist. In this case, the configuration is not possible. Therefore, an automatic adjustment to fill the gap is introduced.



a) Normal detached region b) Automatic shape adjustment c) Abnormal detached region

Figure 3-9 Notes when configuring detached region

For details on area configuration methods, refer to the Area Designer UST Series 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.
- While an object stands before the beginning of a detached area, the object creates a blind spot so that the detached area becomes not operational.

Note

- To reset the detached region to the center, right click with the mouse over the red point, press the Backspace key or press the Delete key.
- It is not possible to configure a detached region with more than 30 points.

3.5 Area switching

A maximum of 31 sets of areas can be configured. For area switching, input signals 1 to 5 are required. Table 3-1 below shows the combination of input signal to switch the area. Laser is switched off when all the inputs 1 to 5 are switched ON.

Note

- Laser is switched ON only in the selected area.

Table 3-1 Input states and corresponding area number

Area Number	Input1	Input2	Input3	Input4	Input5
Laser off	ON	ON	ON	ON	ON
Area1	OFF	ON	ON	ON	ON
Area2	ON	OFF	ON	ON	ON
Area3	OFF	OFF	ON	ON	ON
Area4	ON	ON	OFF	ON	ON
Area5	OFF	ON	OFF	ON	ON
Area6	ON	OFF	OFF	ON	ON
Area7	OFF	OFF	OFF	ON	ON
Area8	ON	ON	ON	OFF	ON
Area9	OFF	ON	ON	OFF	ON
Area10	ON	OFF	ON	OFF	ON
Area11	OFF	OFF	ON	OFF	ON
Area12	ON	ON	OFF	OFF	ON
Area13	OFF	ON	OFF	OFF	ON
Area14	ON	OFF	OFF	OFF	ON
Area15	OFF	OFF	OFF	OFF	ON
Area16	ON	ON	ON	ON	OFF
Area17	OFF	ON	ON	ON	OFF
Area18	ON	OFF	ON	ON	OFF
Area19	OFF	OFF	ON	ON	OFF
Area20	ON	ON	OFF	ON	OFF
Area21	OFF	ON	OFF	ON	OFF
Area22	ON	OFF	OFF	ON	OFF
Area23	OFF	OFF	OFF	ON	OFF
Area24	ON	ON	ON	OFF	OFF
Area25	OFF	ON	ON	OFF	OFF
Area26	ON	OFF	ON	OFF	OFF
Area27	OFF	OFF	ON	OFF	OFF
Area28	ON	ON	OFF	OFF	OFF
Area29	OFF	ON	OFF	OFF	OFF
Area30	ON	OFF	OFF	OFF	OFF
Area31	OFF	OFF	OFF	OFF	OFF

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 3-10.

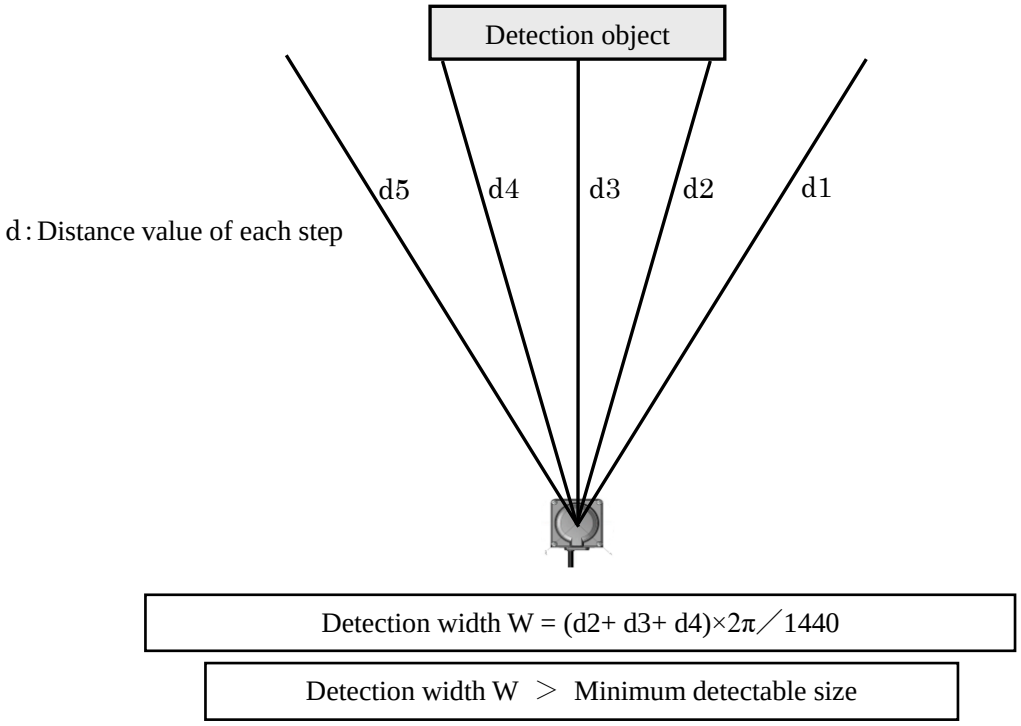


Figure 3-10 Schematic diagrams for the calculation of detection width

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 3-11.

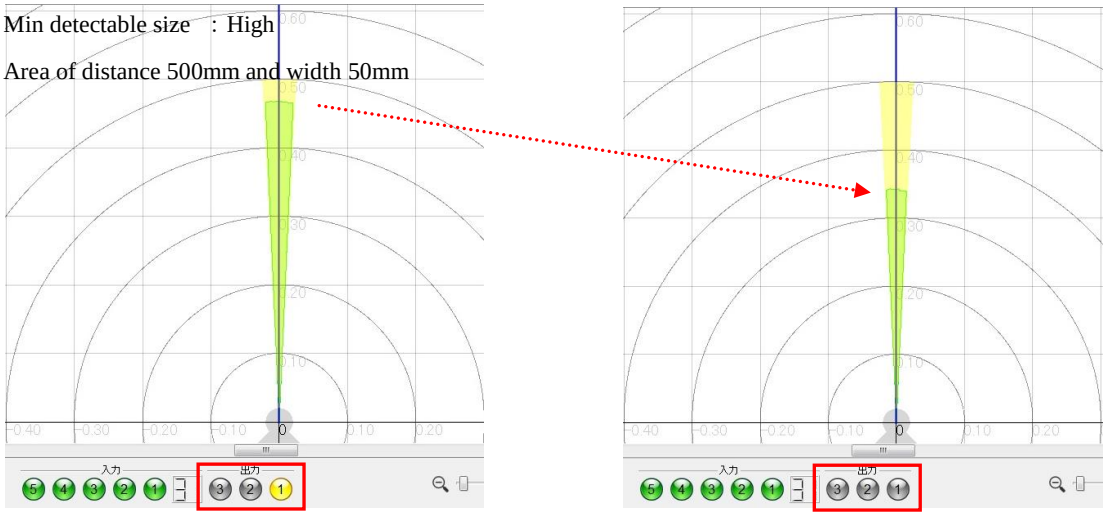


Figure 3-11 Caution of area configurations when minimum detectable size

Caution

- Depending upon the laser spot, environment and detection object, the actual width of detected objects may differ from the width measured.
- User should verify detection capability before using 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 1scan (66ms) to 128 scan (3241ms) (default is 1scan(66ms))

ON delay is the response time changing from OFF state to ON state. OFF delay is the response time changing from ON state to OFF state.

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

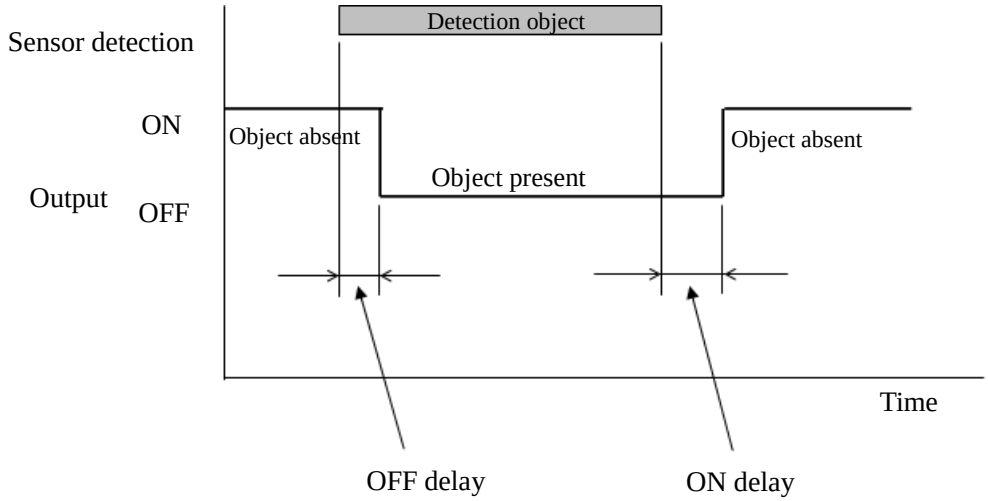


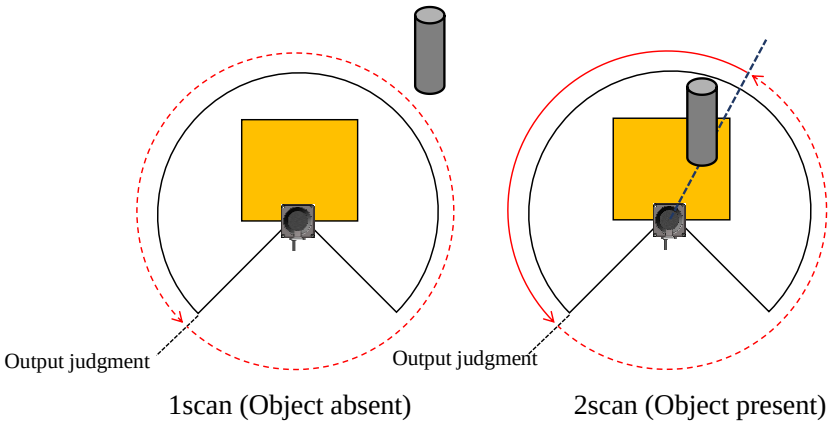
Figure 3-12 ON delay /OFF delay

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

1. Schematic diagram without OFF delay setting

: Object absent

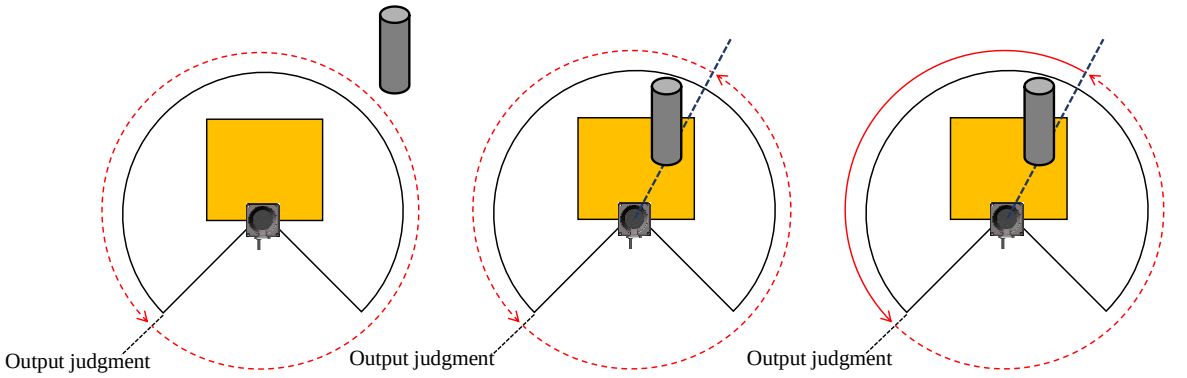
: Object present



2. Schematic diagram when 2 scan OFF delay setting

: Object absent

: Object present

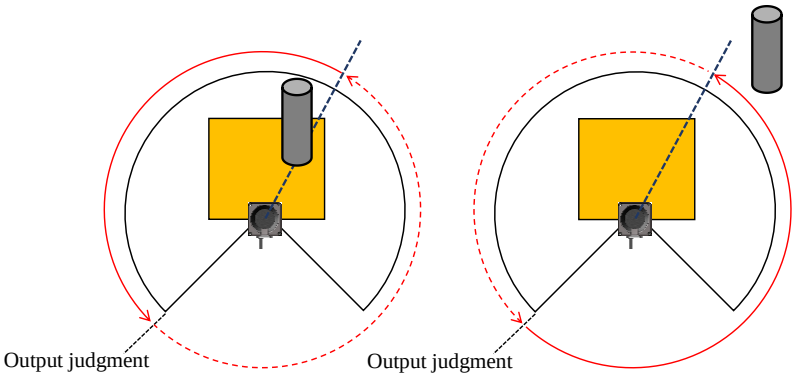


1scan (Object absent) 2scan (Object absent) 3scan (Object present)

3. Schematic diagram without ON delay setting

: Object absent

: Object present

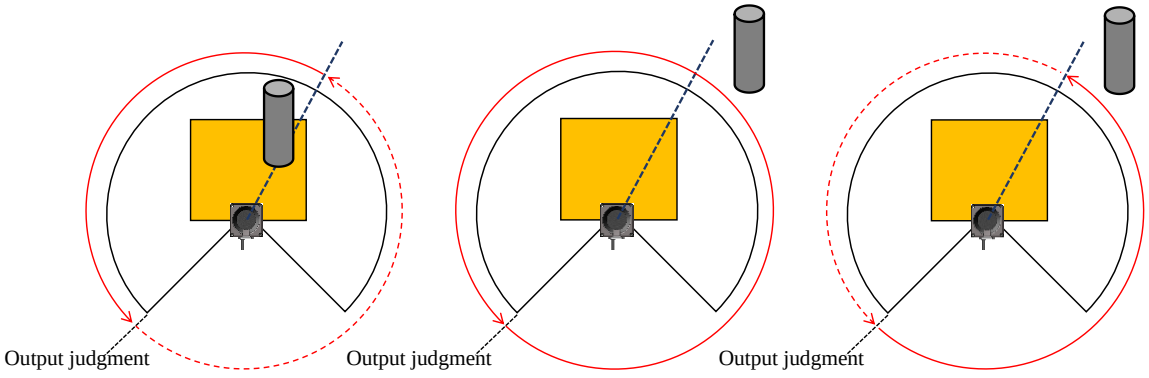


1scan (Object present) 2scan (Object absent)

4. Schematic diagram when 2 scan ON delay setting

: Object absent

: Object present



1scan (Object present) 2scan (Object present) 3scan (Object absent)

3.8 Hysteresis function of detection area

When a sensor detects an object near the boundary of the detection area, outputs 1 to 3 may oscillate (changing to ON/OFF state) repeatedly. To prevent such oscillation, sensor has a hysteresis function that temporarily increases the area size. When an object is detected, the area increase in size with the specified ratio. If the object moves out of the area, the area is restored to its original size. Ratio of increase can be specified using the Area Designer application software. Hysteresis setting has 3 options: None (0%), Low (3.125%) and High (6.25%).

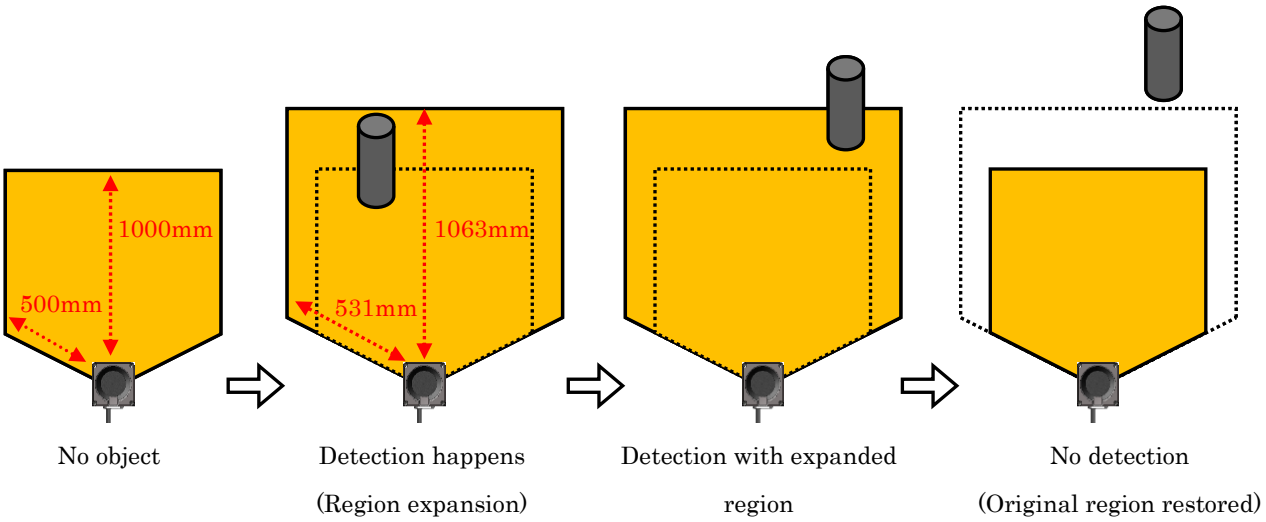


Figure 3-13 Example of a detection behavior with High (6.25%) value

In case of a detached region, both sides of the region get expanded. A detached region with an applied hysteresis is shown in figure 3-14.

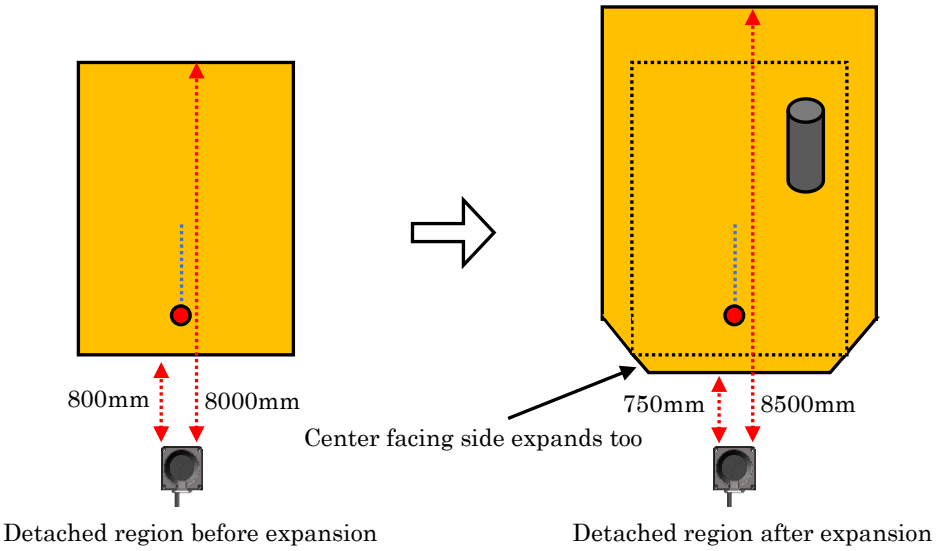


Figure 3-14 Example of a detection behavior with High (6.25%) value

3.9 Setting of UST

Setting of operating parameter of UST by Area Designer.

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

Table 3-2 Parameter setting

<table>
<tr><th>Parameter</th><th>Description</th></tr>
<tr><td>Serial baud rate</td><td>When connecting with RS422 can set serial baud rate. Select from below setting.
<table>
<tr><th>Setting</th></tr>
<tr><td>115.2kbps － Default</td></tr>
<tr><td>230.4kbps</td></tr>
<tr><td>460.8kbps</td></tr>
<tr><td>921.6kbps</td></tr>
</table></td></tr>
<tr><td>Output logic</td><td>Inverting area output can be set. (Other outputs will not be inverted) Select from below setting.
<table>
<tr><th>Setting</th><th>Description</th></tr>
<tr><td>Active High</td><td>Refer to section 3.10.</td></tr>
<tr><td>Active Low</td><td>Invert outputs</td></tr>
</table></td></tr>
<tr><td>Scan skip count
(For details, refer to section 3.15.)</td><td>Scan skip count can be set. Select from below setting.
<table>
<tr><th>Setting</th><th>Description</th></tr>
<tr><td>0</td><td>No scan skip.</td></tr>
<tr><td>1</td><td>1 scan skip.</td></tr>
<tr><td>2</td><td>2 scan skip.</td></tr>
<tr><td>3</td><td>3 scan skip.</td></tr>
<tr><td>4</td><td>4 scan skip.</td></tr>
<tr><td>5</td><td>5 scan skip.</td></tr>
</table></td></tr>
<tr><td>Motor speed</td><td>Motor speed ratio of UST can be set. Select from below setting.
* Can select only when motor sync mode is independent.
<table>
<tr><th>Setting</th><th>Description</th></tr>
<tr><td>2400rpm (100%)</td><td>Normal motor speed</td></tr>
<tr><td>2160rpm (90%)</td><td>90% of motor speed</td></tr>
</table></td></tr>
</table>

Table 3-2 Parameter setting

<table>
<tr><th>Parameter</th><th>Description</th></tr>
<tr><td>Motor sync angle</td><td>To prevent mutual interference when Master/Slave is in operation In Slave mode motor synchronization angle can be set.
<table>
<tr><th colspan="2">Setting</th></tr>
<tr><td>0 deg</td><td>180 deg</td></tr>
<tr><td>90 deg</td><td>270 deg</td></tr>
</table></td></tr>
<tr><td>Motor sync mode
(For wiring refer to section 5.3)</td><td>Master/Slave function can be set. Select Independent/Master when Master/Slave is not in operation.
<table>
<tr><th>Setting</th><th>Description</th></tr>
<tr><td>Master</td><td>Set the sensor as master.</td></tr>
<tr><td>Slave</td><td>Set the sensor as slave.</td></tr>
<tr><td>Slave
(Redundant mode)</td><td>Set the sensor as slave. Even if the master fails, the slave continues its operation.</td></tr>
<tr><td>Independent</td><td>Motor speed can be set.</td></tr>
</table></td></tr>
<tr><td>High sensitivity mode
(For detail refer to section 3.16)</td><td>Detection sensitivity of the sensor can be increased. Select from below setting.
<table>
<tr><th>Setting</th><th>Description</th></tr>
<tr><td>OFF</td><td>Normal detection sensitivity.</td></tr>
<tr><td>ON</td><td>Increases detection sensitivity.</td></tr>
</table></td></tr>
<tr><td>Minimum detectable size
(For detail refer to section 3.6)</td><td>Width of minimum detectable size can be set.
<table>
<tr><th>Setting</th><th>Description</th></tr>
<tr><td>High</td><td>Detect the object of width 50mm or more if present for 3 continuous steps.</td></tr>
<tr><td>Middle</td><td>Detect the object of width 30mm or more if present for 3 continuous steps.</td></tr>
<tr><td>Low</td><td>Detect the object of width 20mm or more if present for 3 continuous steps.</td></tr>
<tr><td>OFF</td><td>Detect the object if present for 3 continuous steps.</td></tr>
</table></td></tr>
</table>

3.10 Output

The UST has 3 types of outputs as below.

3.10.1 Output 1 to Output 3

Output 1**:** When the object is detected in the output region 1, output 1 will switch to OFF state.

Output 2**:** When the object is detected in the output region 2, output 2 will switch to OFF state.

Output 3**:** When the object is detected in the output region 3, output 3 will switch to OFF state.

3.10.2 Malfunction output

Sensor has self-diagnosis function as shown in table 3-3; switch from ON state to OFF state.

(*During malfunction state, output 1 to 3 will be in object present state.)

Table 3-3 Malfunction description

Malfunction mode	Malfunction condition
Motor malfunction	Motor is not operating or rotary detection part of motor is damaged.
Laser malfunction	Laser is not emitting or laser is not able to receive the light.
FPGA malfunction	FPGA is not operating.
Synchronization malfunction	When slave sensor could not recognize the signal of master sensor for 2min. *In case of Slave (Redundant mode), no malfunction is reported
Simulation malfunction	When malfunction simulation is operated in “Area Designer”.

3.10.3 Synchronization output

When operating Master/Slave sensors, the synchronization signal is output from master sensor to slave sensor(s).

3.11 Input

The UST has 2 types of inputs as below.

3.11.1 Input 1 to Input 5

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 (Synchronization operation)

3.12 Indicator lamp

4 LED display indicates the UST status. This LED display is located in the front of the UST as shown in Figure 3-15. Table 3-4 shows the description of the LEDs.

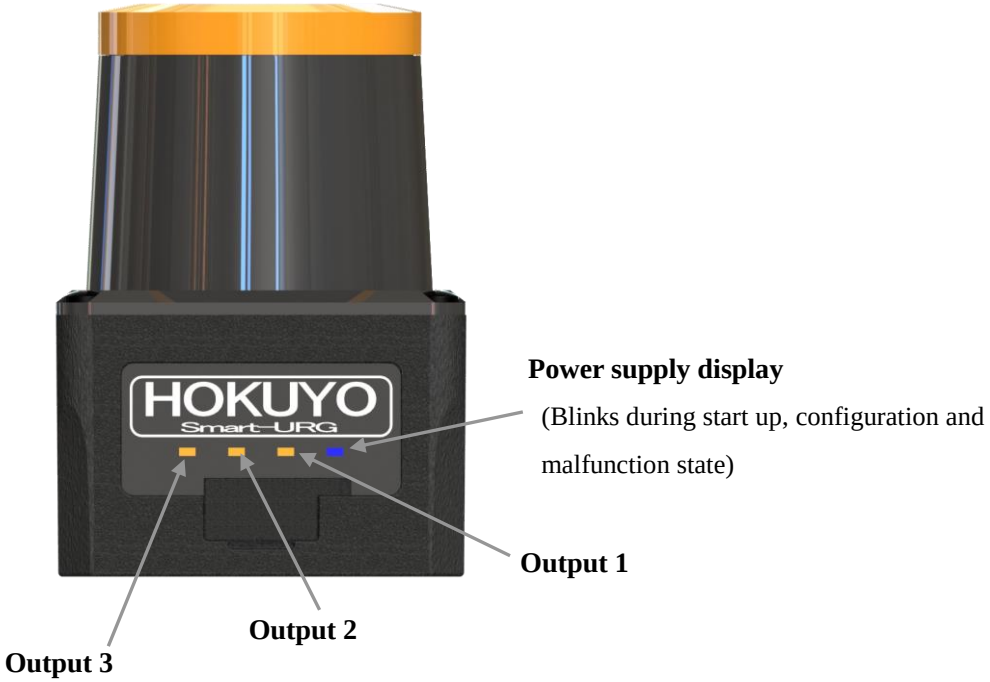


Figure 3-15 Indicator lamp

Table 3-4 Description of Indicator lamp

Indicator Lamp (LED)	Description
Blue display **:** Power supply	ON during normal operation, blinks during start up, configuration and malfunction state.
Orange display **:** Output 1	ON during the object detection in the region of output 1.
Orange display **:** Output 2	ON during the object detection in the region of output 2
Orange display **:** Output 3	ON during the object detection in the region of output 3.

3.13 Laser spot

The laser spot of the UST is as shown in figure 3-16. The spread of laser spot differs on the front and side of the unit.

* The size value is for reference only.

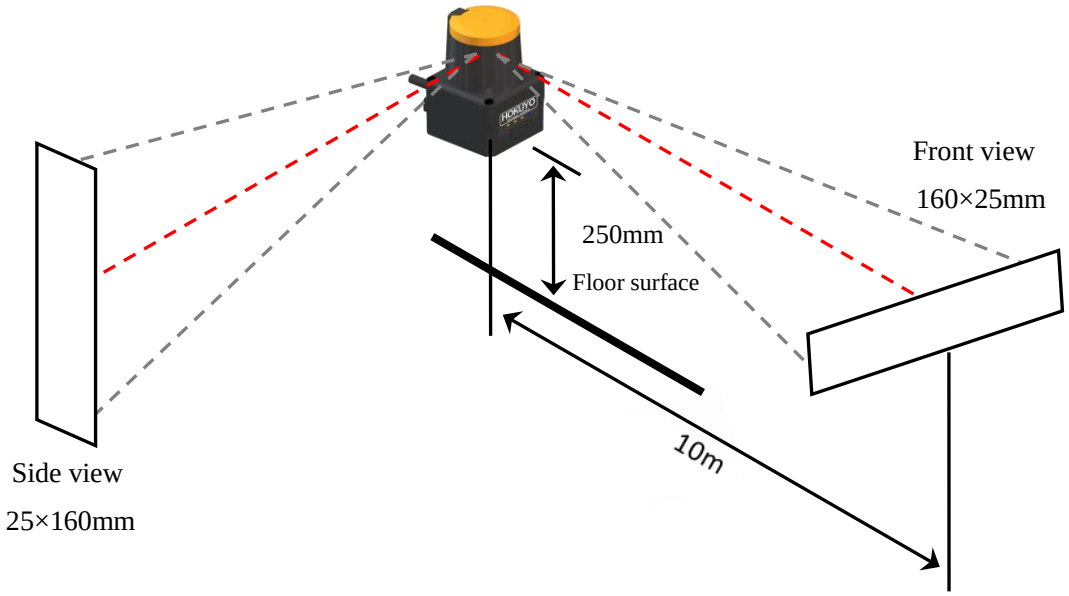


Figure 3-16 Size of laser spot

3.14 Data logging

By connecting the UST with the Area Designer software for data logging (the log includes: distance, intensity, output states, recording time), it is possible to record and play of log data. The operating steps are as follows.

3.14.1 Record of log data

Follow the steps below for data recording.

① Connect UST with Area Designer.

② Click record button as shown in Figure 3-17.

Figure 3-17 Record buttons

③ When data logging window is displayed as in figure 3-18, enter the number of scans you want to record in the scan limit box (if the scan limit is 0, records until stop button is clicked)

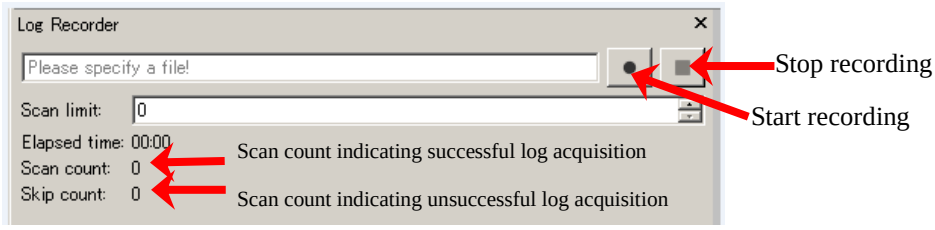


Figure 3-18 Data logging window

④ After entering the number of scans, click start recording button as show in figure 3-18.
Select the location and enter the file name. Click save button and it starts recording.

Note

- In case you want to confirm the detection judgment of the area when playing log data, it is necessary to open the original project file used while recording the log data. Please make sure to save the project file.
- Make sure that you record the data in Monitor mode. If you record in Edit mode, output status will not be recorded in log data.
- Record to “ubh” files extension. Cannot play log data in other extensions and formats.
- When “Prioritize recording (continuous mode)” is selected in application setting of Area Designer, then it will reduce the “Skip count”. Although “Prioritize recording (continuous mode)” is selected, skips the log data. In that case select “Distance only support” also. (Depending upon the specification of computer, the data cannot be recorded in real time.)

3.14.2 Playing log data

Follow the steps below for playing log data.

① Click play button as shown in figure 3-19.

(Cannot play the log data until measurement display button is OFF)

Figure 3-19 Play log data button

② Log player is displayed as shown in figure 3-20.

Click “Open” and select the log data file which you want play.

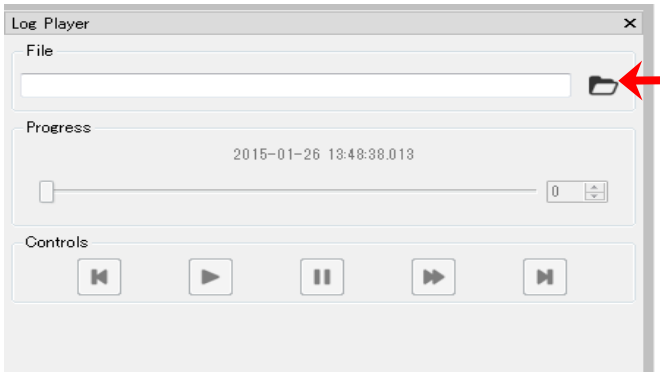


Figure 3-20 Log player windows

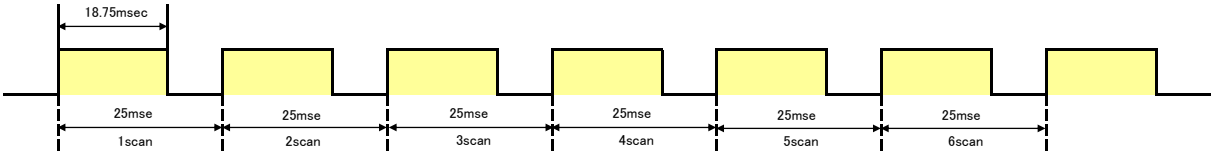
③ Use control buttons as required as shown in figure 3-20.

Note

- In case you want to confirm the detection judgment of the area when playing log data, it is necessary to open the original project file used while recording the log data. The area displayed for the current project might differ from the original project.
- Play log data in the Monitor mode. If you play log data in Edit mode, output status will not be displayed.
- By using this icon  automatically takes/moves up to the position where output changes.

3.15 Scan skip function

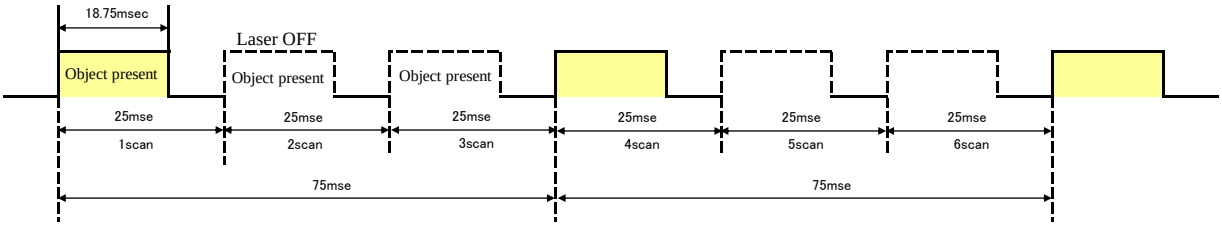
When scan skip function is activated, it stops laser emission of the set scan number during rotation. Through sensor setting, it is possible to stop laser emission from 0 scan to 5 scan. Figure 3-21 shows the schematic diagram, when scan skip count “0”is set. When “0” is set, scan skip function will become inactive and performs normal operation.



*The yellow part indicates that laser is ON

Figure 3-21 Schematic diagram when scan skip count “0” is set

Figure 3-22 shows the schematic diagram, when scan skip count “2” is set. When “2” is set, stops laser emission of 2 scans. During scan skip, the output state will remain in the same state as in laser emission period.



*The yellow part indicates that laser is ON

Figure 3-22 Schematic diagram when scan skip count “2” is set

The maximum response time can be calculated “66ms ＋(25ms × Scan skip count)”.In the case of 2 scan skip, calculation will be “66ms + (25ms × 2) = 116ms”

Caution

- When scan skip function is activated, ON/OFF delay function will become inactive and operates with default setting (1 scan (66ms))

* In Area Designer, ON delay/ OFF delay display will not be changed.

Note

- In case when the laser of the UST affects the other products operation (causes light interference in other products), activate scan skip function to reduce affects on other products.

3.16 High sensitivity mode

When high sensitivity mode is activated, it increases the detection sensitivity of UST. Table 3.5 shows about the detection sensitivity when high sensitivity mode is ON or OFF.

Table 3-5 Difference in detection sensitivity due to high sensitivity mode

High sensitivity mode	OFF[*1]	ON
Maximum detection distance of object with black 10% reflectance (mm)	4000	5000
Minimum detection object at the distance of 10m [*2]	175	130

[*1] Value during normal operation

[*2] Value while using white Kent paper

- During high sensitivity mode, the detection sensitivity increases and therefore the sensor becomes more susceptible to ambient light noise and optical interference. Please evaluate the actual operation environment before deploying the sensor in this mode.

4. Application examples of the UST

In this chapter will explain giving some application examples that can be used.
Before installing, the user has to decide the main purpose for using the UST. 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, how area switching will takes place.

Note

- UST is not a safety device. It cannot be used for human protection purpose.
- Before setting UST read the whole manual thoroughly.

4.1 Access protection (Horizontal application Stationary）

UST can be installed for security at an entrance or a passage way and can be used for monitoring. For example, in order to monitor a restricted area UST is installed horizontally as one example is shown in figure 4-1. In order to monitor the entrance when the object enters, output region 1 to 3 are configured.

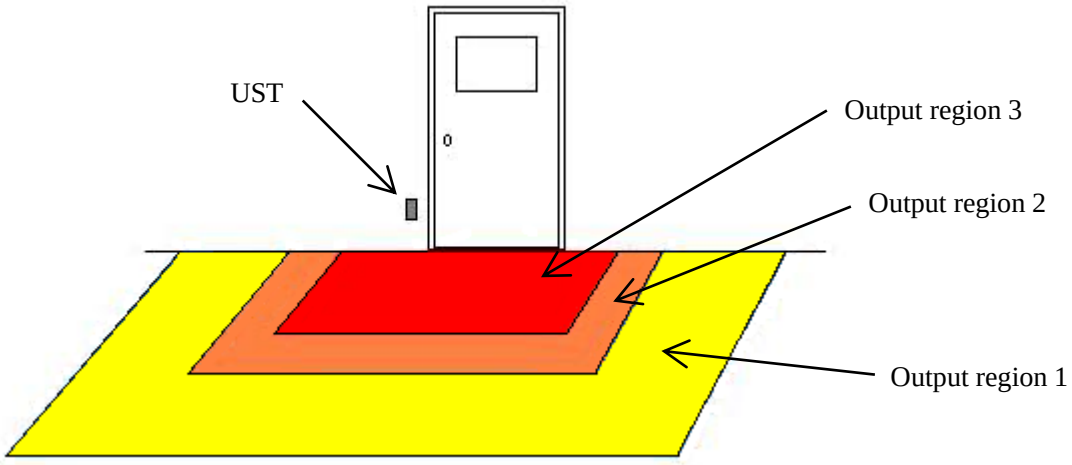


Figure 4-1 Example of access protection

For example, if access penetration is detected in output region 1 and 2 then a warning is displayed, and when access penetration is detected in output region 3 an alarm can be configured.

Note

- UST might detect the floor. Mount it at height 250mm above the floor.

4.2 Protrusion detection (vertical placement)

The UST can be installed vertically. Figure 4.2 shows the application of protrusion detection.

For the protrusion detection of cargo from the shelf of an automatic warehouse, install the sensor vertically on the back side so that the detection surface covers the back side of the shelf. If cargo enters the detection surface a warning signal can be triggered, and equipment for position adjustment of cargo can be operated.

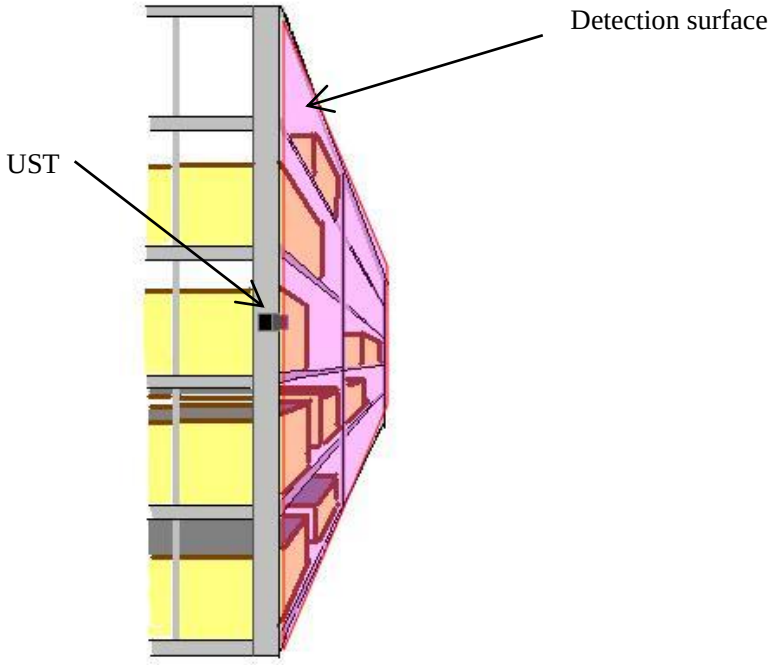


Figure 4-1 Example of protrusion detection

Similarly, vertical applications can be used in warehouse detection of cargo collapse, and detection of cargo from the conveyors line.

4.3 Area protection (Mobile)

The UST can be used for mobile applications. Figure 4-3 shows an example of an AGV (Automatic Guided Vehicle). The UST is installed on an AGV and detects the objects while travelling along a fixed route. Output signals 1 to 3 can be used in order to reduce the speed and to stop the AGV.

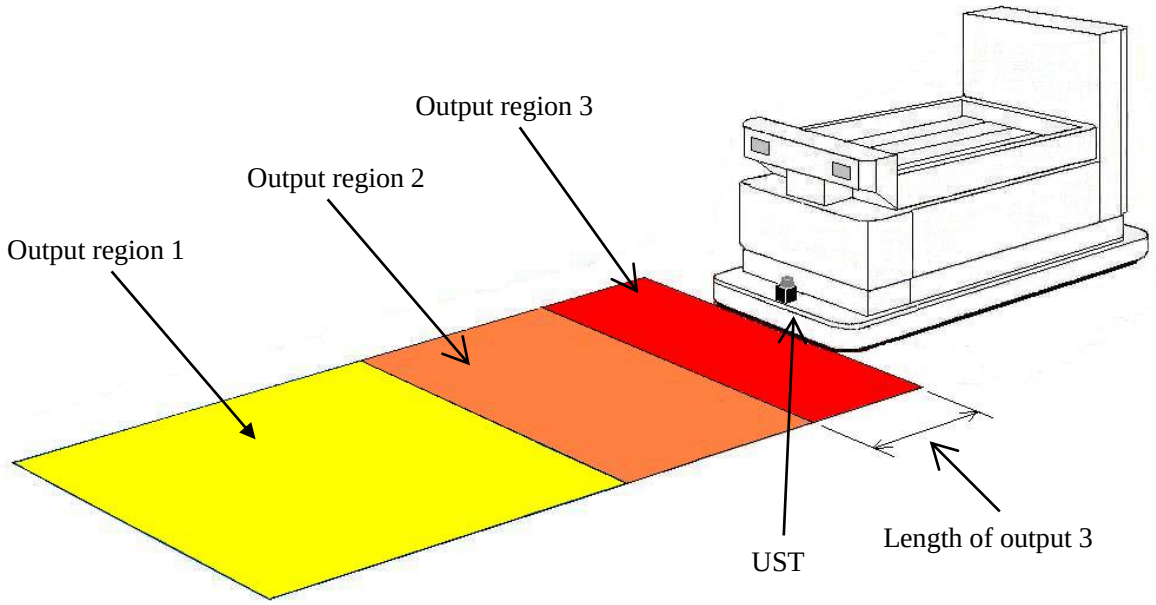


Figure 4-3 Example of AGV application

For example, if an object is detected in the output region 1 and/or output region 2, the AGV will slow down and warns that an object is approaching nearer, and if an object is detected in the output region 3 then AGV stops.

By area switching function of the UST, a maximum 31 area sets can be used according to the travel route of the AGV. For example, while traveling in a forward direction, it monitors the front portion mainly. While turning right, the area switches in a way that the region of the right side becomes larger (refer to figure 4-4). Make adjustments to the detection area according to the speed of the AGV. When using the UST on an AGV, the user needs to confirm the time and distance required for the AGV to stop completely when configuring the output regions 1 to 3.

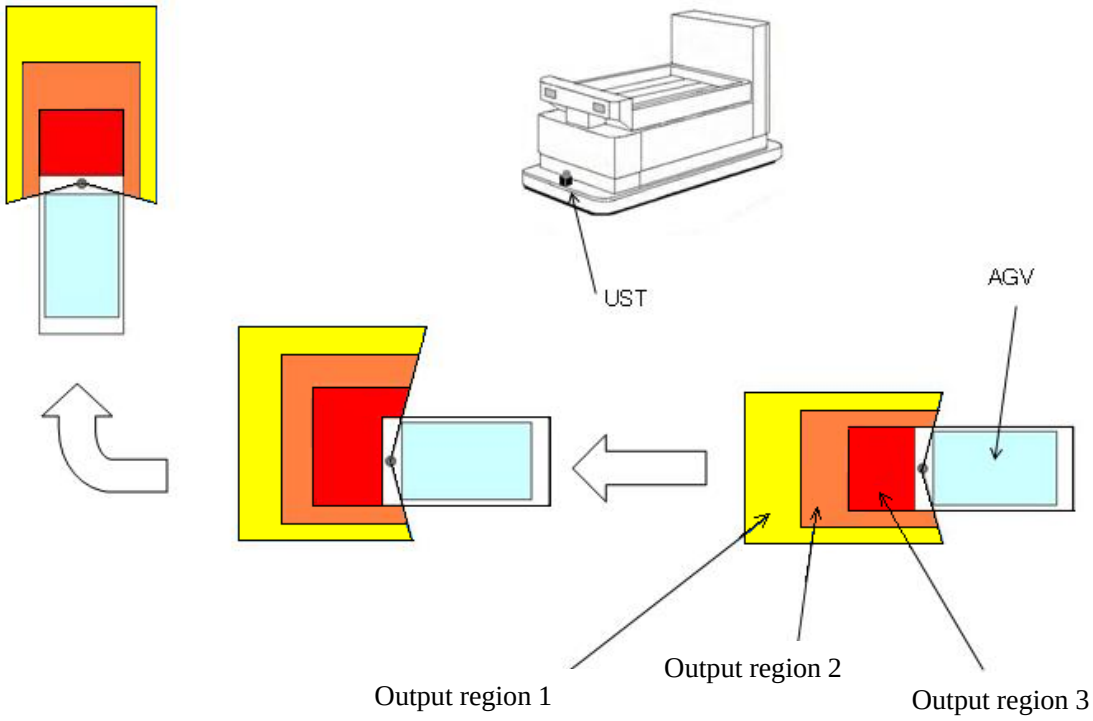


Figure 4-4 Example of area switching of AGV while turning right

Note

- Check that there is no object or background in the configured area. If any object is detected then output 1 to 3 will remain in OFF state.

5. Installation

This chapter describes precautions during sensor installation.

The UST can be fixed to a surface using either the back mounting plate or the bottom mounting plate and each plate provided with two screw holes. This mounting plate is used as a frame ground (FG). Mount the sensor on a stable structure.

In the case of using the back mounting plate. 2 M4 screw holes are available (screw depth 6mm).
In the case of using the bottom mounting plate, 2 M3 screw holes are available (screw depth 6mm)

5.1 Light interference

The UST uses a pulsed laser for object detection. Light interference sources could lead to false detection. User should examine the surrounding environments before installation the sensor.
If the light source cannot be avoided during operation, the UST should be installed with the light source located at ±5 degrees or more from the detection plane in order to prevent interference as shown in figure 5.1.

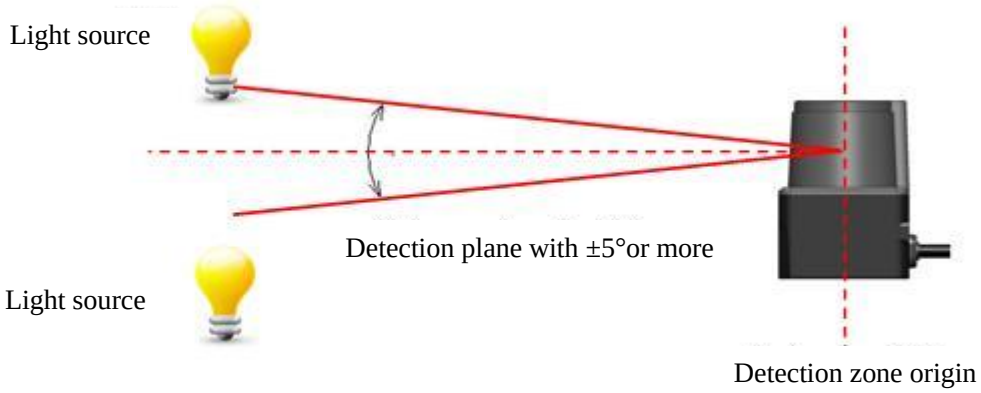


Figure 5-1 Installation under light interference

Danger

- User must perform risk assessment for interference lights in the working environment before installation.

5.2 Mutual interference

Extra precautions are required while using two or more identical UST sensors because pulsed laser signals from identical UST 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 UST should be separated 5 degrees or more from detection plane.

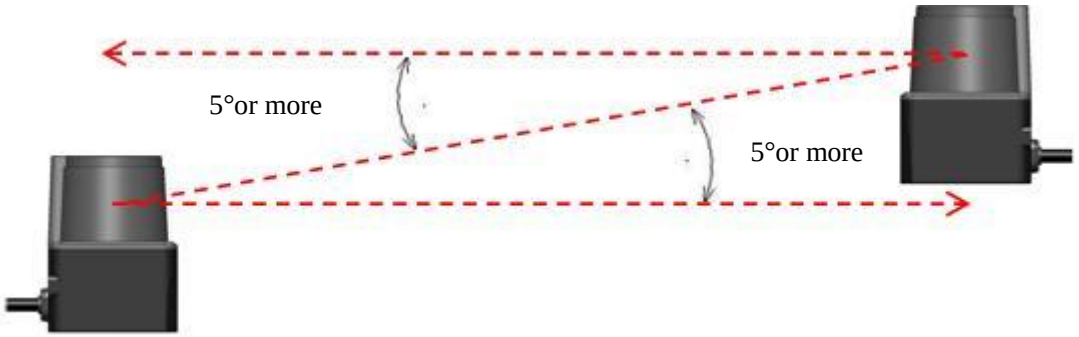


Figure 5-2 Opposite facing installation

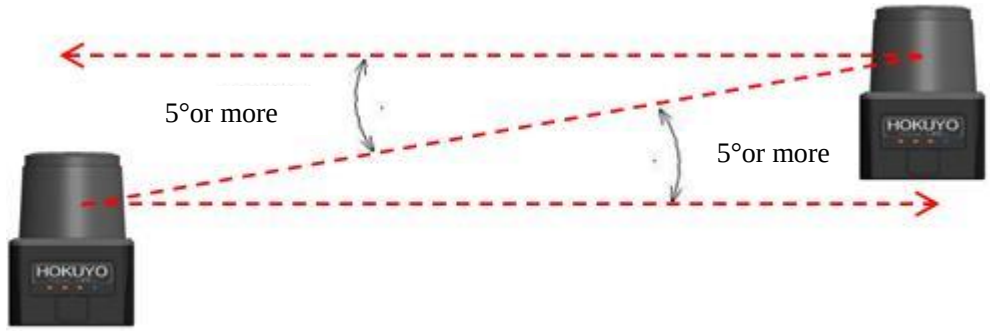


Figure 5-3 Parallel installation

b) Changing the angle of installation

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

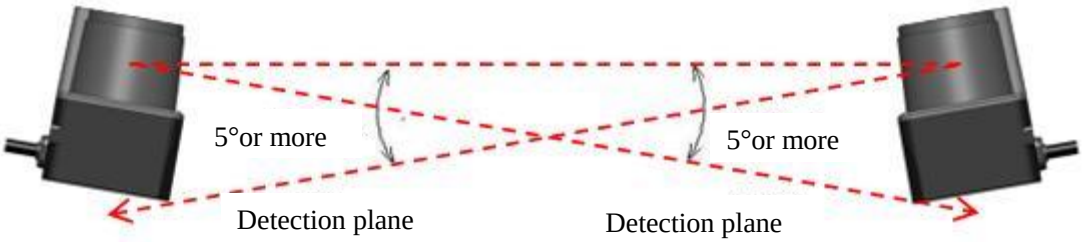


Figure 5-4 Opposite facing installation

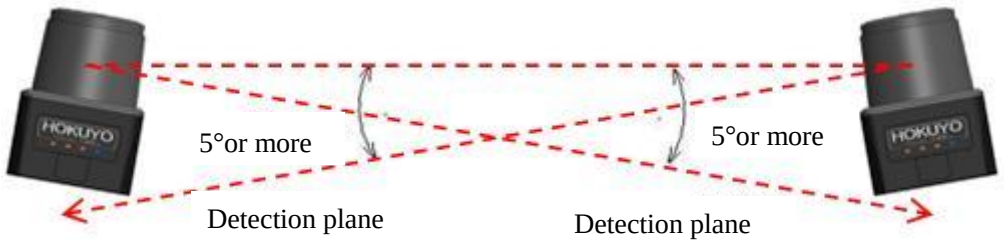


Figure 5-5 Parallel installation

C) Adding shield in between UST

By adding a shield in between the UST units, laser beam cannot reach the opposite sensor so this will avoid possible mutual interference

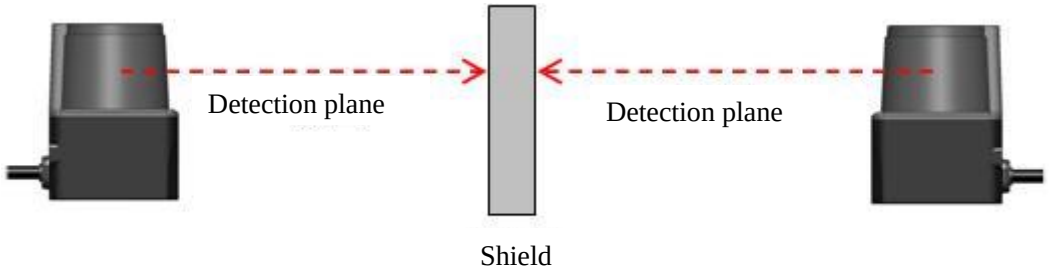


Figure 5-6 Opposite facing installation

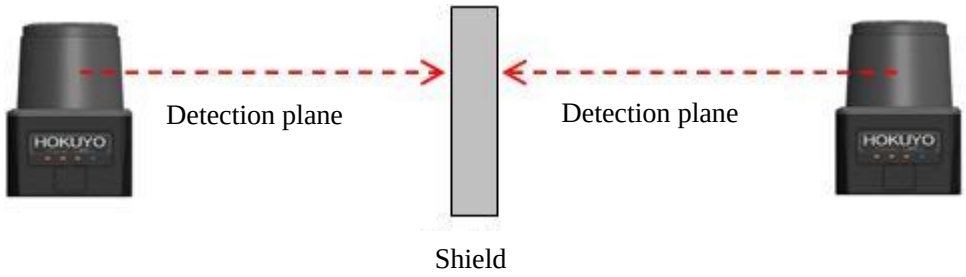


Figure 5-7 Parallel installation

Note

- Material must be of solid opaque non-transparent material.

5.3 Synchronous operation

When operating two or more UST units within a short distance mutual interference may occur. To prevent mutual interference between them, the rotation of the USTs can be synchronized. A maximum of 3 UST units can be operated by delaying the rotation by 90 degrees (however, this cannot guarantee 100% prevention of mutual interference, depending upon the installation condition, background condition, etc., of each UST. If interference cannot be avoided verify before operation) during this operation, one master and a maximum of two slaves can be set.

During initial shipment the UST is set as master, so it is necessary to configure a sensor as slave. Configuration of each UST is done through the Area Designer.

Example of connection is shown in figure 5-8.

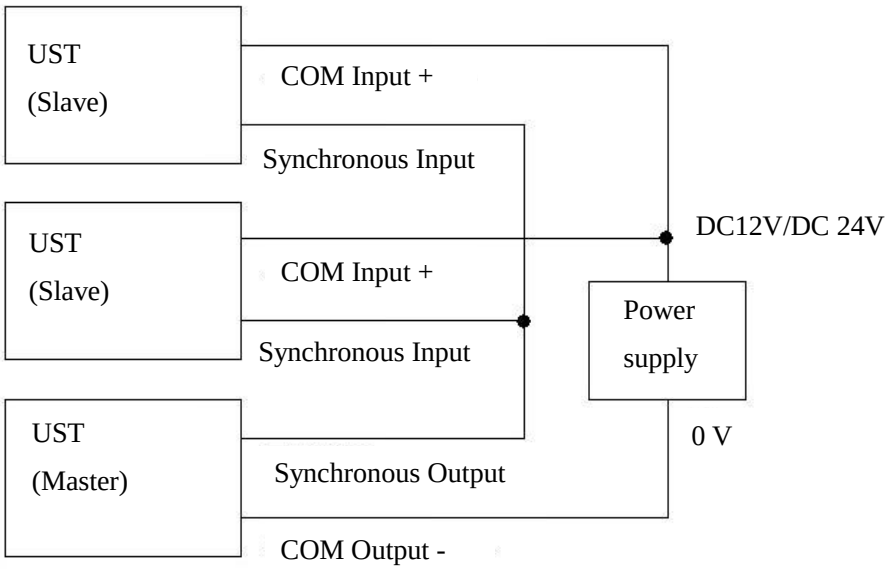


Figure 5-8 Example of Synchronization wiring (in case of 3 UST)

6 Wiring

This chapter describes precaution to take during wiring.

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, UST 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 (more than 1A)
- The power supply must comply with the requirements of electromagnetic compatibility (EMC) regulations of the respective country, states and district.

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

- If there is an electric potential difference between the UST and ground of other connected devices, 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.

Table 6-1 Wire color and function

Color	Signal	Function	Description	AWG
Brown	+VIN	Power	Power Supply: DC 12V or DC 24V	28
Blue	-VIN	Power	Power Supply : 0V	28
Black	Output 1	Output	When an object is detected in the output region 1 it is turned OFF	28
White	Output 2	Output	When an object is detected in the output region 2 it is turned OFF	28
White (Blue)	Output 3	Output	When an object is detected in the output region 3 it is turned OFF	28
Orange	Malfunction Output	Output	Turns OFF when malfunction output is detected by self-diagnostic function.	28
Light green	Synchronous Output	Output	Synchronous output for Master/Slave operation	28
Gray	COM Output -	Input	COM Output -	28
Red	COM Input +	Input	COM Input +	28
Green	Input 1	Input	Area switching Input 1	28
Yellow	Input 2	Input	Area switching Input 2	28
Purple	Input 3	Input	Area switching Input 3	28
White(Black)	Input 4	Input	Area switching Input 4	28
White (Red)	Input 5	Input	Area switching Input 5	28
Light Blue	Synchronous Input	Input	Synchronous Input for Master/Slave operation	28
Pink	RS422 GND	Communication	RS422 GND	28
Yellow(Red)	RS422 TXD+	Communication	RS422 TXD+	28
Yellow (Black)	RS422 TXD-	Communication	RS422 TXD-	28
Light Blue (Red)	RS422 RXD+	Communication	RS422 RXD+	28
Light Blue (Black)	RS422 RXD-	Communication	RS422 RXD-	28

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- (gray) if not in use.

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

Attachment connector SHR-14V-S,SHR-06V-S(JST Mfg. Company) is for test purpose only.

6.4 Input/Output circuit

6.4.1 Input circuit

Photo coupler input circuit (anode COM, Input ON current 4mA)

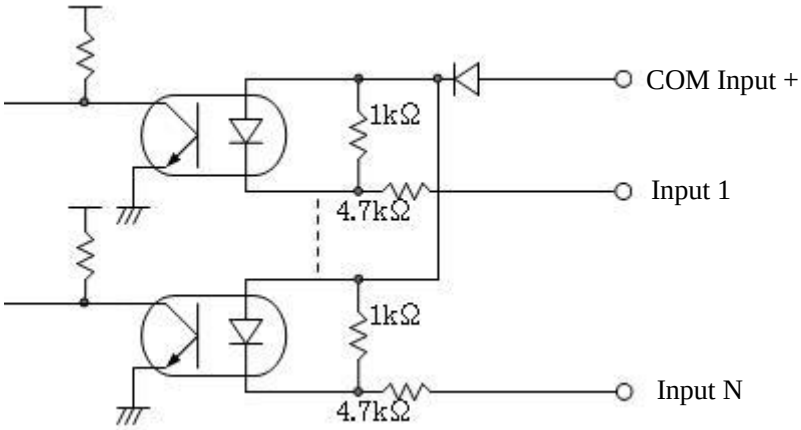


Figure 6-1 Input circuit

6.4.2 Output circuit

NPN open collector output circuit (maximum DC 30V, 50mA)

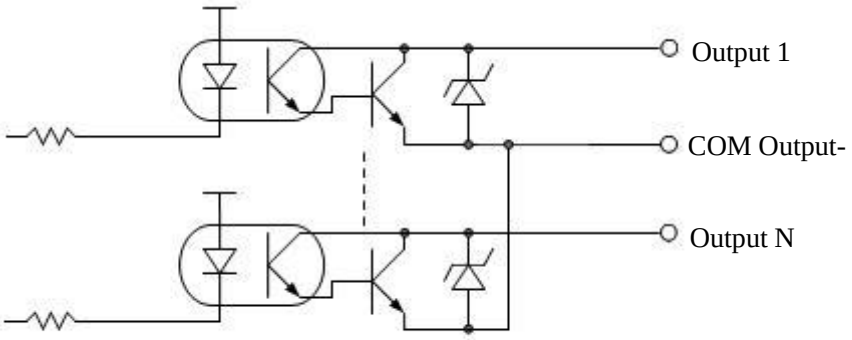
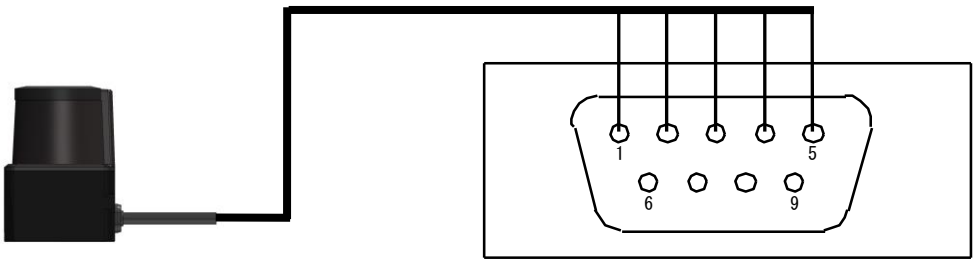


Figure 6-2 Output circuit

6.5 RS422

Figure 6-3 shows the example of connection of RS422



UST D-SUB 9pin male

UST	
Wire color	Signal
Pink	RS422 GND
Yellow (Red)	RS422 TXD+
Yellow (Black)	RS422 TXD-
Light Blue (Red)	RS422 RXD+
Light Blue (Black)	RS422 RXD-

D-SUB 9pin	
Signal	Pin No.
GND	5
RX+	3
RX-	4
TX+	2
TX-	1

Figure 6-3 Example of RS422 Connection

The serial baud rates can be selected from 115.2kbps (default), 230.4kbps, 460.8kbps, and 921.6kbps and can be set by using the Area Designer.

7. UST Area Designer application software

Install application software (Area Designer) in a supported operating system and connect UST using a USB cable. Area Designer has the following functions:

- Configuration of detection area
- Configuration of various UST 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 UST Series sensor configuration tool Instruction manual.

7.2 System requirements

Table 7-1 Minimum system required for Area Designer

PC	CPU	Pentium® Ⅳ processor 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 (16bit color) or above , 800×600 dot or above	

(Note) 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 made 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 UST. Instruction manual can be loaded from the help menu of Area Designer.
- Cover the sensor's USB connector with the protection cap while using UST. Make sure that mist and dust does not enter.
- You cannot use the USB cable of mobile chargers. We recommend using a standard USB cable, not a winding type.

8. 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 UST is switched OFF
- The surrounding of the working environment is safe

Danger

- Do not modify or dissemble the UST 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.
- All inspections should be performed during initial commission of the UST.

8.1 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 8-1 shows an example of pre-operation inspection items list.

Table 8-1 Pre-operation inspection list

No.	Check item	Condition		Remark
		Yes	No	
1	UST 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.

8.2 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, the system can get damaged. Table 8-2 is an example of operation inspection list.

Table 8-2 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.

8.3 Daily inspection

Below Table 8-3 shows an example of the items that should be checked during daily inspection.

Table 8-3 Daily inspection list

No.	Check item	Condition		Remark
		Yes	No	
1	UST 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.

8.4 Periodical inspection

Periodical inspection should be performed to ensure the detection capability of the UST. Table 8-4 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 8-4 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 UST			
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	Predetermined 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.

8.5 Cleaning the optical window

Dust covering the optical windows affects the detection capability of the UST. When you install the UST in 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.

- 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.

- Do not use organic solvents (such as thinner, benzene and acetone) for cleaning. Plastics parts and paint might be affected.

9. Troubleshooting

Table 9-1 Troubleshooting list

Situation	Possible reason	Solution suggestion
UST 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
UST does not connect with Area Designer	Configuration is incomplete	Reconfigure UST
	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
	USB cable is not connected to USB port	Make sure the USB is connected to both PC and UST
	Driver is not installed	Install the driver
Obstacles are not detected inside the selected detection area	Power supply is OFF	Voltage is within the specification
	UST is in malfunction state	Make sure that power supply LED is in normal state Restart UST if it is blinking.
	Minimum detectable size configuration	Make sure that object width in detection area is more than minimum detectable size configuration (Refer to section 3.9)
Output remains OFF even if no object in the detection area	Light interference	Mount UST 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)

10. Specification

Table 10-1 Specification of UST-10LN

Product name	Scanning laser range finder	
Model	UST-10LN	
Supply voltage	DC12V/DC24V (operation range 10 to 30V, ripple within ±10%)	
Supply current	150mA or less (when using DC24V) During start up about 450mA is necessary	
Light source	Laser semiconductor (905nm), Laser class 1	
Detection range and object	60mm to 10000mm (white Kent sheet) 60mm to 4000mm (diffuse reflectance 10%) * Minimum detectable size 175mm (changes according to distance) *1	
Accuracy	60mm to 10000mm ±40mm *2	
Repeat accuracy	σ < 20mm *2	
Scan angle	270°	
Scan speed	25ms (motor speed 2400rpm)	
Angular resolution	0.25°	
Start up time	Within 10 sec (start up time differs if malfunction is detected during start up)	
Outputs	Photo-coupler, open collector output Max DC 30V 50mA Output 1: Output 1 OFF during object detection Output 2: Output 2 OFF during object detection Output 3: Output 3 OFF during object detection Malfunction output: ON during normal operation, OFF during malfunction Synchronization output: Synchronization signal during Master/Slave operation. Note: Output 1 to 3 are switched OFF during malfunction state	
Inputs	Photo-coupler, common anode, power supply is 4mA when input is ON Input 1 to 5: Area switching inputs Synchronization input: Input synchronization signal during Slave operation.	
Response time *3	OFF	66msec to 3241msec
	ON	66msec to 3241msec
Hysteresis	Hysteresis high (Increases 6.25%) Hysteresis low (Increases 3.125%) No Hysteresis (Default)	
Interface	USB / RS422	

LED display	Blue LED: ON during normal operation, blink during the start up, configuration and malfunction state Orange LED 1: Output 1 ON during object detection Orange LED 2: Output 2 ON during object detection Orange LED 3: Output 3 ON during object detection
Synchronization function	Synchronization Master/Slave operation mode (can set by using Area Designer) *4 Synchronization slave mode (0°) Synchronization slave mode (90°) Synchronization slave mode (180°) Synchronization slave mode (270°)
Surrounding intensity	Less than 80,000 lx Note : Avoid direct sunlight or other illumination sources as it may cause sensor malfunction
Ambient temperature, humidity	-10°C to +50°C below 85%RH (without dew, frost)
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 98m / 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	IP65
Weight	130g (without cable)
Operation life	5 years under normal temperature (motor life)
Material	Optical window : Polycarbonate Body : Aluminum
Dimensions (W×D×H)	50×50×70(mm) (Sensor only)

*1 In the case installing the sensor parallel to the Emitter/Receiver surface. Minimum detectable size of the object can be set by Area Designer.

*2Under the factory standard testing condition using white Kent sheet.

*3Initial setting is 66msec. ON/OFF delay function switching is possible by Area Designer. Response time can be further delayed by a maximum of 1scan during the area switching.

*4Initial setting is synchronization master. When using synchronization operation, refer to section 5.3 for details about synchronization wiring. Synchronization slave setting is possible using Area Designer.

*5The recorded distance data, level data, etc., can be confirmed using Area Designer application. For detail refer to Area Designer UST series sensor configuration instruction manual.

11. Applicable directives and standards

Table 11-1 shows the conformant EU directives and EN standards

Table 11-1 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 EN61000-4-8:2010

- About the laser safety

The UST laser safety standard is class 1.

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

Average laser power・・・・3.19mW or less

Beam size・・・・・160mm×25mm (distance 10000mm at the sensor's front) (For detail refer to 3.13 sections)

Standard・・・・・・・・IEC60825-1 (2007)

Accession number・・・・・1420210-001

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.

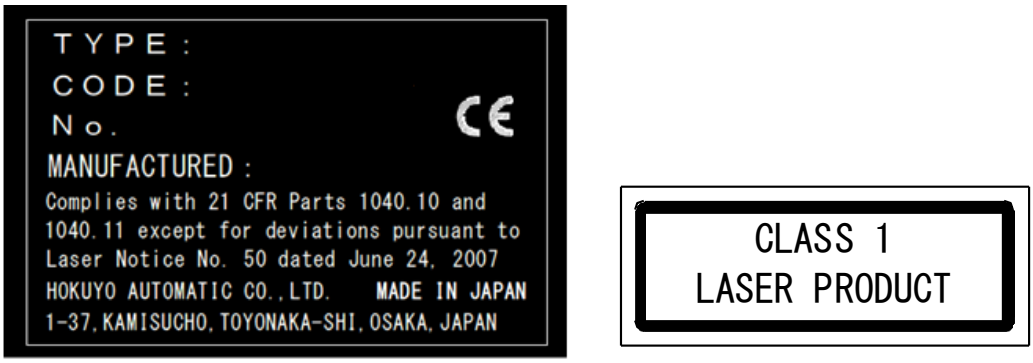


Figure 11-1 FDA Certified labels

Caution

- Do not look directly into a laser beam.

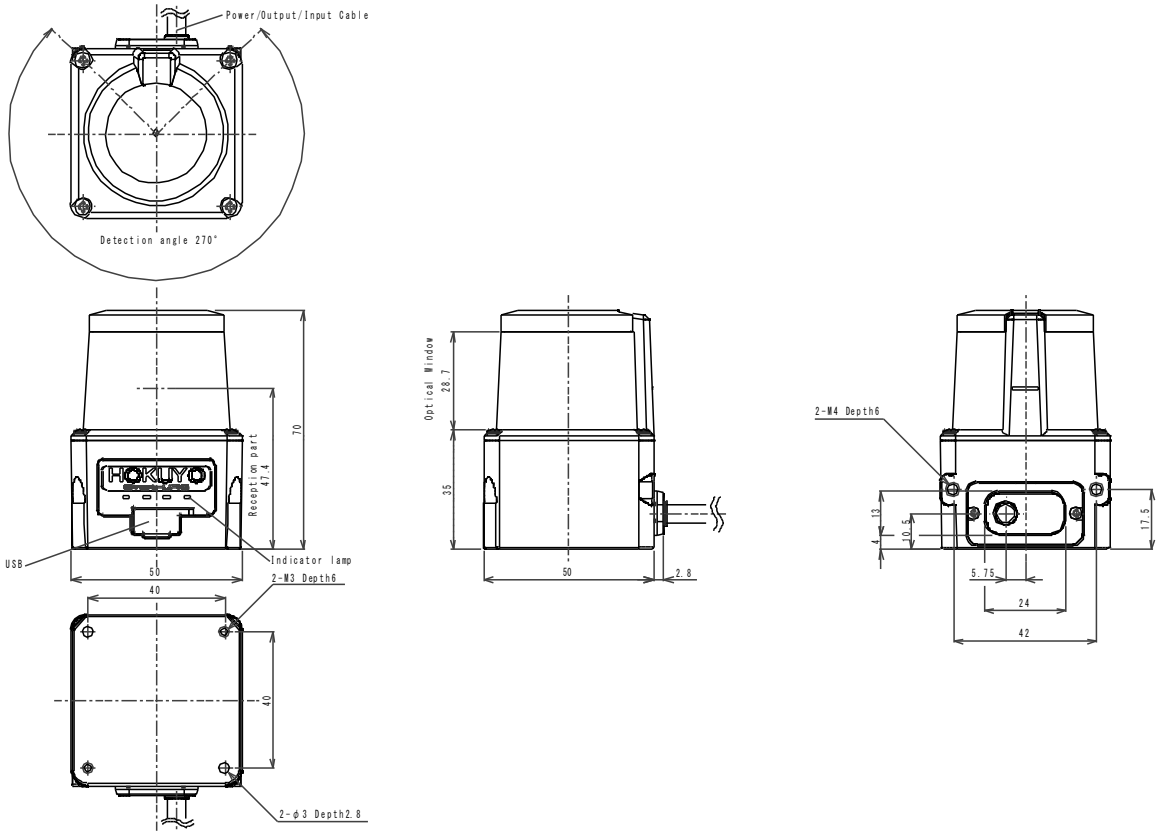
12. Package contents

The following items are included in the package:

a) UST ×1

b) User's Manual ×1

13. External Dimensions



14. Revision history

Document No.	Amended No.	Revision date	Details
C-41-02543	---	March 2016	First Release
C-41-02543-1	RS-00684	June 2016	Partial Revision:P13,40
C-41-02543-2	RS-01575	Dec. 2020	Specification changed : P49