Safety Laser Scanner
UAM-05LECA

User's Manual

HOKUYO AUTOMATIC CO.,LTD.

C-61-00009

Table of contents

1 Introduction

This user's manual is designed with the purpose of providing guidelines and instructions for the machine operator or system designer while operating, installing, wiring and servicing the safety laser scanner UAM-05LECA.

1.1 About this manual

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

- Read this document carefully before installation, wiring, operation, inspection and maintenance.
- User should have a copy of this document at an easy-to-access place for quick reference.
- Information provided in this document is subject to change without prior notice. For the latest information visit the company's website http://www.hokuyo-aut.jp
- Actual product may differ from the illustrations and figures in this document as they are used for explanatory purpose only.

1.2 Applicable products

This document is for the following sensor model.

- UAM-05LECA-T301

1.3 Abbreviations

The list below shows abbreviations used in this document.

Table 1-1 Abbreviations

Abbreviation	Meaning
AGV	Automated guided vehicle
AOPDDR	Active optoelectronic protective device responsive to diffuse reflection
AWG	American wire gage
EMC	Electromagnetic compatibility
MSCE	Machine secondary control element
SELV	Safety extra low voltage

1.4 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.

Table 1-2 Special markings and symbols

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.

1.5 Applicable directives and standards

UAM (UAM-05LECA) is certified by TUV SUD Product Service GmbH and UL/c-UL, FDA (CDRH), ETG (ETC) as a safety sensor defined in EU Machine Directive (2006/42/EC).

Table 1-3 Applicable directives and standards

Certifying Organization	Directives/Standard	Detail	
TUV SUD	EU directives	Machinery Directive: Directive 2006/42/EC	
		EMC Directive: Directive 2014/30/EU	
		RoHS Directive：Directive 2011/65/EU	
	EN standard IEC standard ISO standard	IEC 61496-1:2020 EN 61496-1:2020	Type 3
		IEC 61496-3:2018	Type 3
		IEC 61508 Part1-7:2010	SIL2
		EN62061:2021	SIL2
		EN ISO13849-1:2023	Category 3, PLd
		IEC60825-1:2014	Safety of laser products Class 1
UL/c-UL	UL standard IEC standard ISO standard CSA standard	UL 508:2010	-
		ANSI/UL 1998:2013	-
		IEC 61496-1:2020	Type 3
		IEC 61496-3:2018	Type 3
		IEC 61508 Part1-7:2010	SIL2
		ISO13849-1:2023	Category 3, PLd
		CSAC22.2 No.14-13:2013	-
FDA (CDRH)		21 CFR Part 1040.10 and 1040.11	Safety of laser products Class 1
ETG (ETC)	EtherCAT	ETG.1000 ETG.5100	Safety over EtherCAT (FSoE)

1.6 Registered trademarks

- Microsoft®, Windows® are the registered trademarks of Microsoft Corporation USA.
- Intel® is the registered trademark of Intel Corporation.
- EtherCAT® and Safety over EtherCAT® are registered trademarks and patented technologies licensed by Beckhoff Automation GmbH, Germany.
- Other products mentioned in the document are trademarks or registered trademarks of the respective companies.

2 Safety precautions

Caution

- Read the following guidelines for correct use of the UAM. Proper handling and usage will ensure the UAM to operate accordingly.

2.1 General precautions

- UAM is designed to protect human begins or systems by monitoring the hazardous area. It is not designed for the protection from high-speed objects or the electromagnetic radiation.
- Perform pre-operation tests in order to verify the performance of UAM.
- Do not modify or disassemble UAM. Such modifications will affect the detection capability leading to injuries or death.
- Do not modify or disassemble UAM to maintain its housing rating. Such modifications will void the warranty.
- The person-in-charge should be qualified to operate UAM. The person must be trained, on safety requirements with necessary cautions for handling the device.
- The person-in-charge should train the user with correct installation, operation, inspection and maintenance procedures.
- The person-in-charge is responsible to ensure the proper working environment for UAM.
- The person-in-charge is responsible for the compliance with the local safety requirements, standards, rules and regulations, laws of respective nations, states or districts when UAM is used in a safety-related system.
- UAM has been manufactured and shipped under the strict quality control. If you find any defect in the product, contact the nearest distributor or sales representative. (☞Last page)
- Hokuyo cannot be held responsible for the damages or failure due to misuse of the product.
- User should prepare test pieces for detection capability verification. The test piece should emulate the smallest object that is intended to be detected during the operation.
- Maximum level of homogeneous pollution for UAM to operate normally is under 30%. UAM will report error if the pollution exceeds the stated limit. Always keep the optical window in clean condition to avoid the error.
- Before resetting the interlock of UAM, user must ensure the surrounding is safe especially the protected area.
- Apply sufficient measures to ensure safety of the protected area when decommissioning UAM. Protective materials such as guards or light curtain should be used to prevent the passage to the hazardous area.
- UAM including its accessories are subject to change without prior notice for the improvement.
- UAM should be disposed as industrial waste or in accordance with the local disposal directives.

2.2 **Operating environment**

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

2.3 **Installation of UAM**

- Install UAM on a firm surface or structure to avoid displacement.
- UAM should be firmly mounted using the screws (recommended torque for screws is 3N·m). Shock and vibration should not loosen the mounting. Detection may fail if actual protection zone differs from the intended zone due to displacement of UAM.
- Safety distance should be determined before installing UAM. User must verify the function of UAM after installation by placing a test piece at all the positions of protection zone (refer to chapter 4 for the details on the safety distance calculation for various applications).
- When installing the UAM, protective materials such as guards or light curtain should be used to prevent any passage into the hazardous area.
- Reset switch used for interlock, muting and override function should be mounted at a location away from the protection zone.
- Mutual interference can occur when identical UAMs are mounted at the same detection plane. Refer to chapter 5 for countermeasures to avoid mutual interference.
- UAM should be mounted at the location which has sufficient space for maintenance.
- Do not add any protective materials such as, glass and transparent cover, in front of the optical window. This could lead to loss of detection capability of the UAM.
- Minimum detectable width varies with the distance. Refer to chapter 10 for details.

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) A rated output voltage within the range of DC 24V±10% (SELV circuit, Category II).
  b) Reinforced insulation or double insulation for the primary and secondary circuit.
  c) Holding time of the output should be above 20ms.
  d) The power supply complies with the requirements of electromagnetic compatibility regulations (EMC) of the respective country, state and district.
- All the input/output signal cables should be installed away from machines power lines and high- voltage cables.
- Use the protection detection state of UAM to control safety-related machines or control system.
- Do not use warning detection state signals to control safety related machine as these are non-safety signals.

2.5 Configuration

- Configuration of safety functions are password protected. Only authorized users with password can configure UAM.
- UAM does not operate without initial configuration.
- Pre-operation tests should be performed to verify the configurations before operating the UAM.
- Increasing the response time of protection detection will increase the stability of UAM. However, this will reduce the detection capability towards moving objects. User must perform risk assessment before using this function.
- Changes made during the configuration must be recorded and saved. Use the report function in the UAM Project Designer for this purpose. (☞Chapter 7.8.3)

2.6 Inspection and maintenance

- User must perform inspection and maintenance by referring to the checklists provided in this document (☞Chapter 8)
  a) Pre-operation inspection
  b) Operation inspection
  c) Daily inspection
  d) Periodic inspection

- The 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.

⚠ Danger

- For the repair of UAM, contact the nearest distributor or sales representative. User should not repair or disassemble UAM.

Note

- Safety Standard Class 1 Laser of UAM-05LECA: It is guaranteed as safety class laser. Additional measures are not necessary to maintain the laser safety.
- Caution - Use of controls or adjustments or procedures of performed other than those specified herein may result in hazardous radiation exposure.

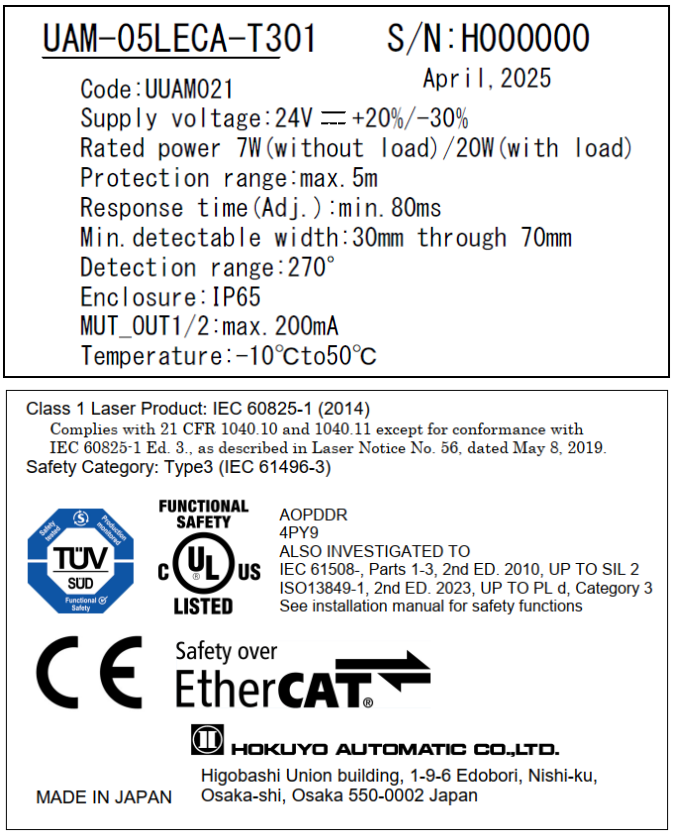


Figure 2-1 Example of product labels

3 Product overview

UAM is an AOPDDR that emits pulsed laser beam to detect an object in the detection zone. Light emitted from the source is transmitted to the protection zone by a rotating mirror inside the device. When these emitted laser beams are reflected from objects in the range, its distance is measured by the reception circuit. This chapter describes the features and properties of UAM.

3.1 Features of UAM-05LECA

- Protection range**:** Maximum 5m (☞Chapter 3.4.1)
- Warning range: Maximum 30m (☞ Chapter 3.4.2)
- Detection angle: 270°(☞Chapter 3.2)
- Minimum response time of 80ms (Configurable) (☞Chapter 3.12)
- 176 set of areas (Configurable) (☞Chapter 3.5)
- 5 independent zone settings in a scanning area (Configurable) (☞Chapter 3.4)
- Scanning area switch through incremental encoder input (Configurable) (☞Chapter 3.6)
- Interlock function (Configurable) (☞Chapter 3.8)
- Muting /Override function (Configurable) (☞Chapter 3.9)
- Reference monitor function (Configurable) (☞Chapter 3.10)
- Area sequence function (Configurable) (☞Chapter 3.11)
- LED indicator for UAMs status (☞Chapter 3.14.1)
- LCD indicator for UAMs status (☞Chapter 3.14.2)
- Easy configuration with UAM configuration application software installed in PC (☞ Chapter 7)

3.2 Components of UAM-05LECA

UAM-05LECA consists of a body and a connector Unit. There are two types of connector units available, one with the connections at the back (UAM-5CUBA) and the other with the connections at the bottom (UAM-5CUBO) which can be selected to suite the mounting requirement.

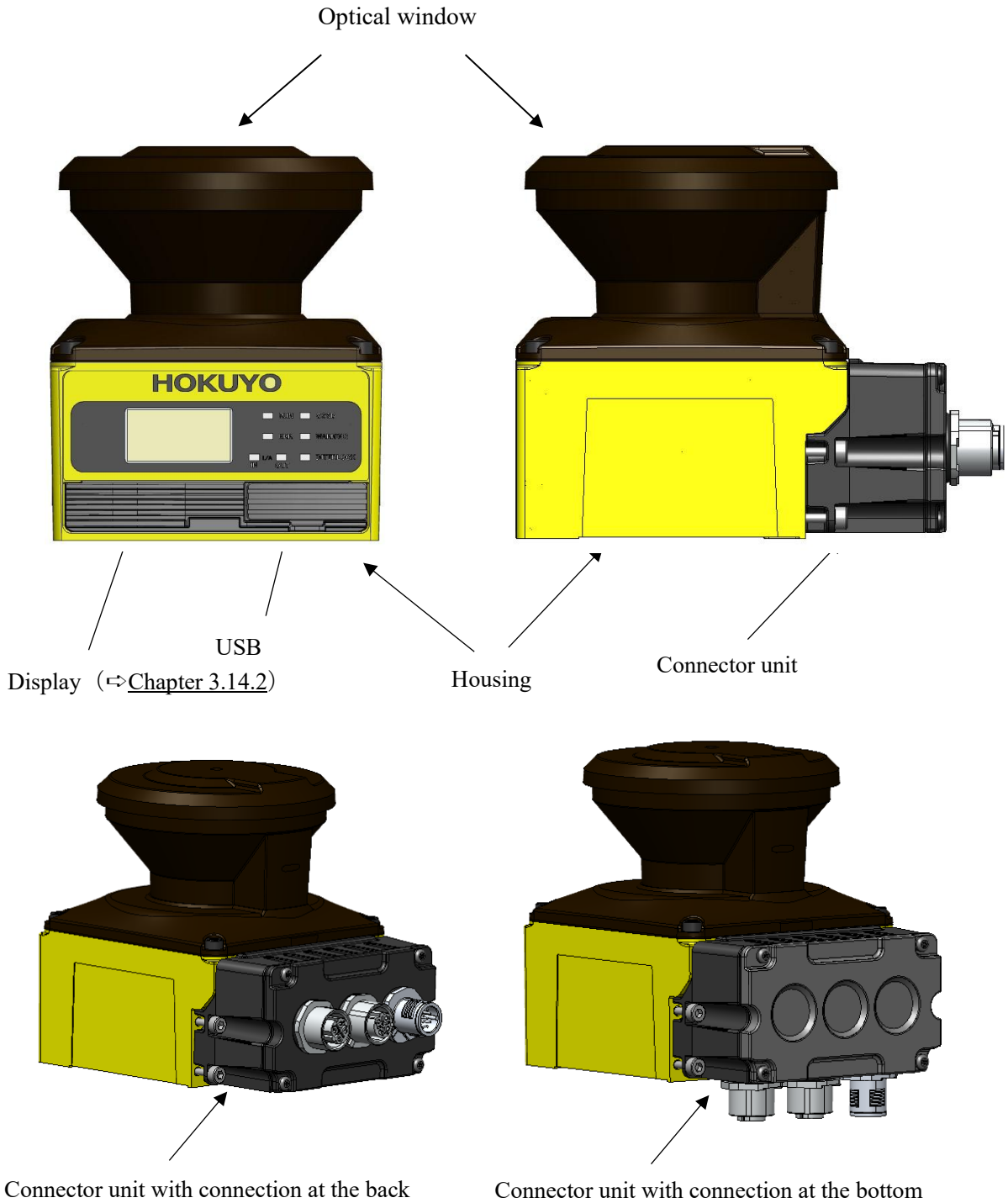


Figure 3-1 UAM-05LECA components

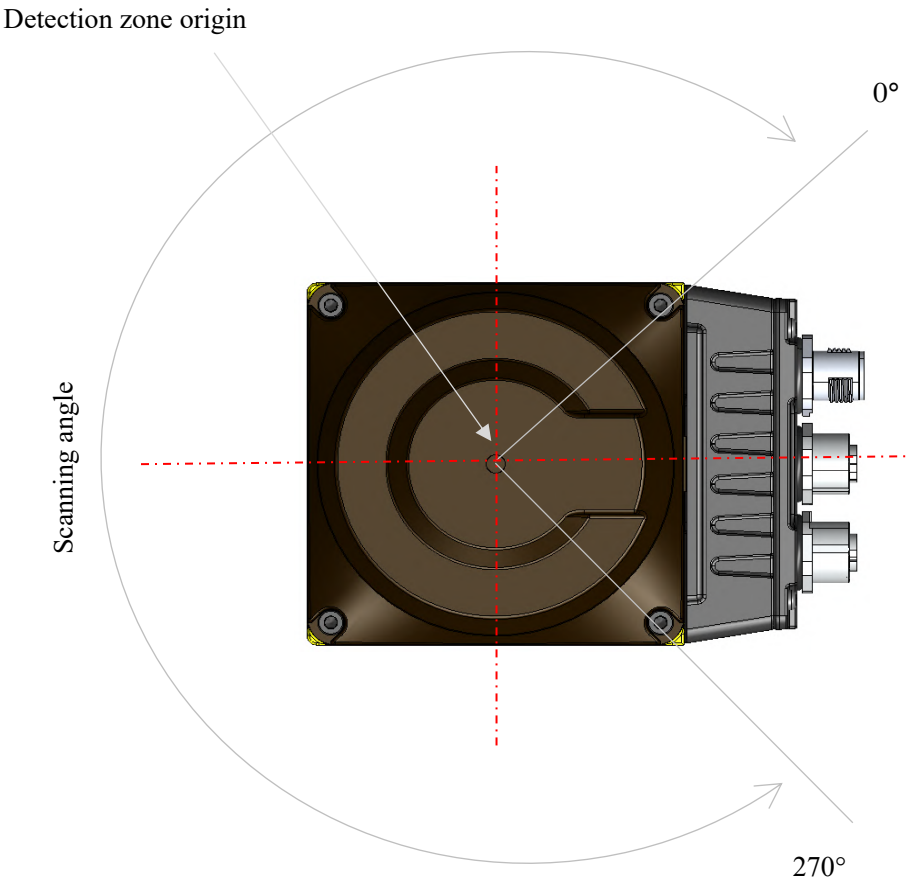


Figure 3-2 Scanning range and detection zone origin (Top view)

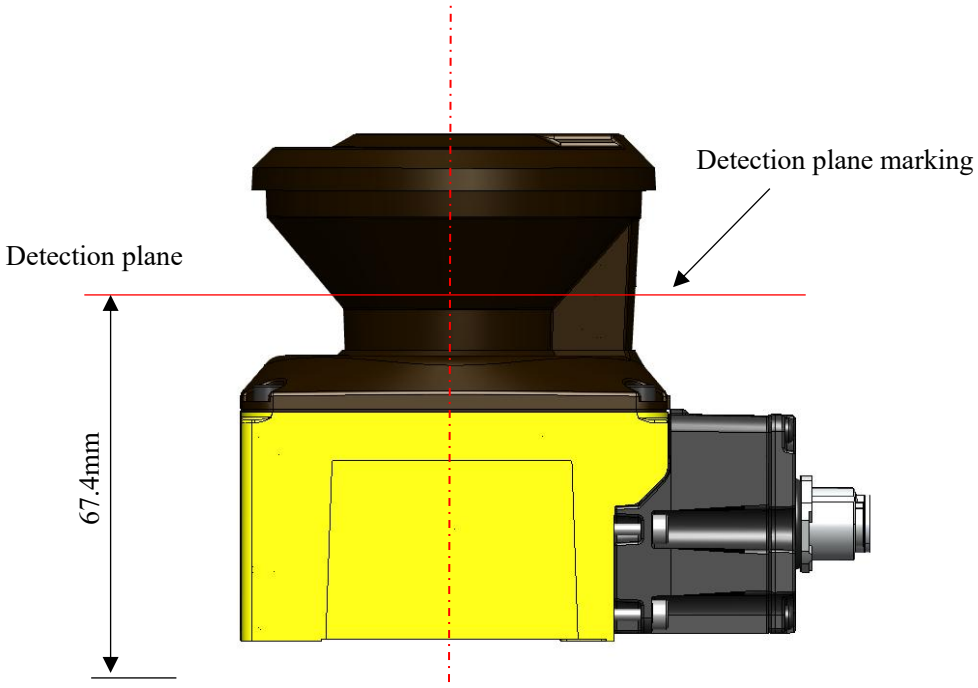


Figure 3-3 Detection plane of UAM-05LECA (Side view)

3.3 Operation principle

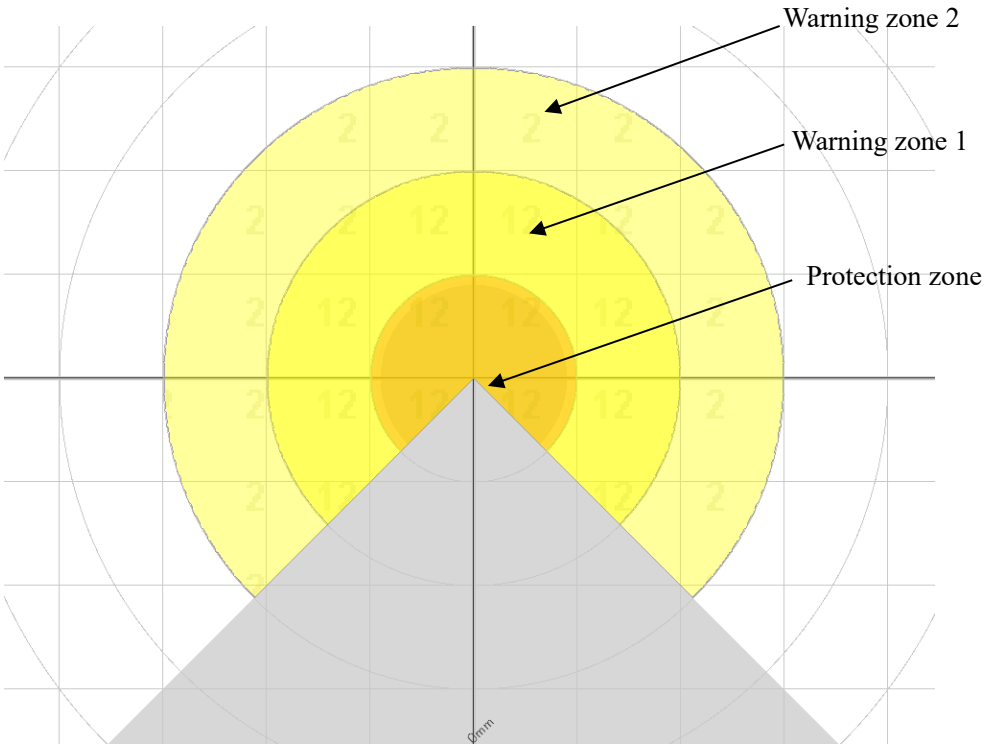


Figure 3-4 Scanning range

Figure 3-4 shows the scanning range of UAM. Protection zone and warning zones are configured using the UAM Project Designer application software. Any object or human beings entering the protection zone will lead the protection detection state to change from ON-state to OFF-state. Similarly, an object detected in the warning zones will lead the warning detection state to change from ON-state to OFF-state.

Distance to the object is measured using the Time of Flight (TOF) principle. Pulsed laser beams are radiated into the scanning range of 270º by the rotating motor. These pulsed laser beams are reflected by objects inside the scanning range. The duration of reflected beams is used 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 operating principle of TOF is schematically shown in Figure 3-5.

The angular resolution of UAM is 0.125°.

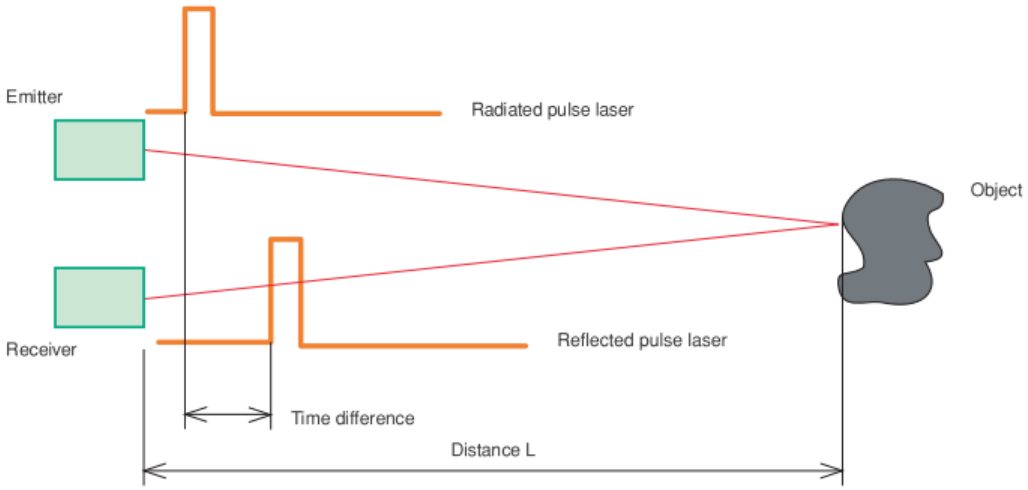


Figure 3-5 TOF operation principle

3.4 Scanning area

Scanning area of UAM consists of protection and warning zones. Maximum 176 sets of area can be configured in the device. Each area can have up to 5 zones for simultaneous monitoring. The number of warning zones and protection zones in each area is free to select however, there must be at least one protection zone in each area. Area count will vary depending on the number of zones used in each area. Use the configuration software tool provided with the device to configure the number of areas and simultaneous monitoring zones in the device.

3.4.1 Protection zone

Protection zone is safety-critical parameter and directly related to the protection detection state. When an obstacle is detected in the protection zone, UAM will switch the protection detection state from ON to OFF. Protection detection state is supplied through EtherCAT communication packet (FSoE). There must be at least one protection zones in each area and maximum can be 5.

Figure 3-6 and Figure 3-7show the examples of protection zone configured manually and by using a teaching mode respectively. User should configure these zones to ensure hazardous area is completely protected.

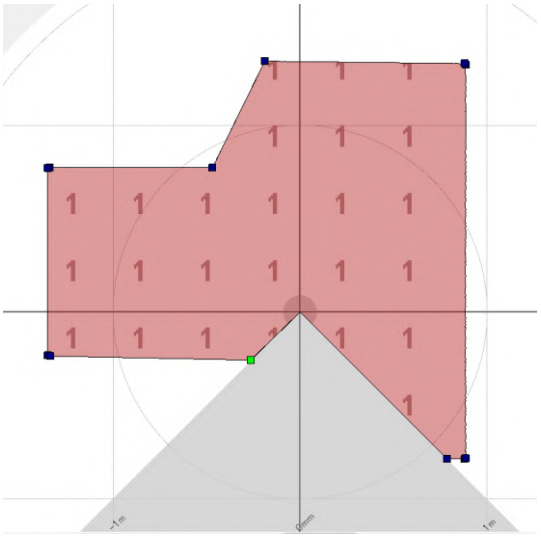


Figure 3-6 Protection zone configured using manual mode

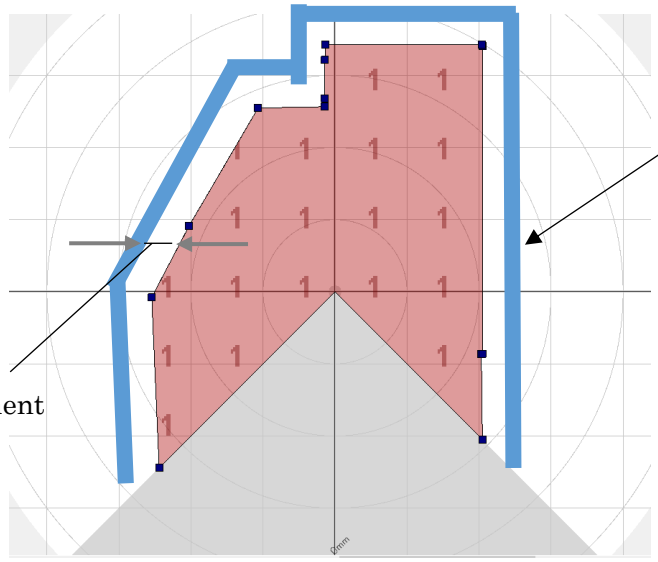


Figure 3-7 Protection zone configured using teaching mode

Danger

- User should verify the configuration before actual operation.
- The configured zone should be of minimum safety distance or more.
- Minimum possible detectable width changes according to the distance.
- Additional distance must be taken into account while configuring the protection zone.

Caution

- User should verify the detection capability using an actual object.

3.4.2 Warning zone

Warning zone is non-safety zones that is related to warning detection state. When an obstacle is detected in the warning zone, UAM will switch the warning detection state from ON to OFF. Warning signals can be used as an alert signal to avoid humans or objects before approaching the protection zone. In mobile applications, warning signals can be used for reducing the speed of automatic guided vehicle (AGV) to avoid collision. Warning detection state is supplied through EtherCAT communication packet (FSoE). There can be 0 warning zones in each area and maximum can be 4 (Figure 3-8).

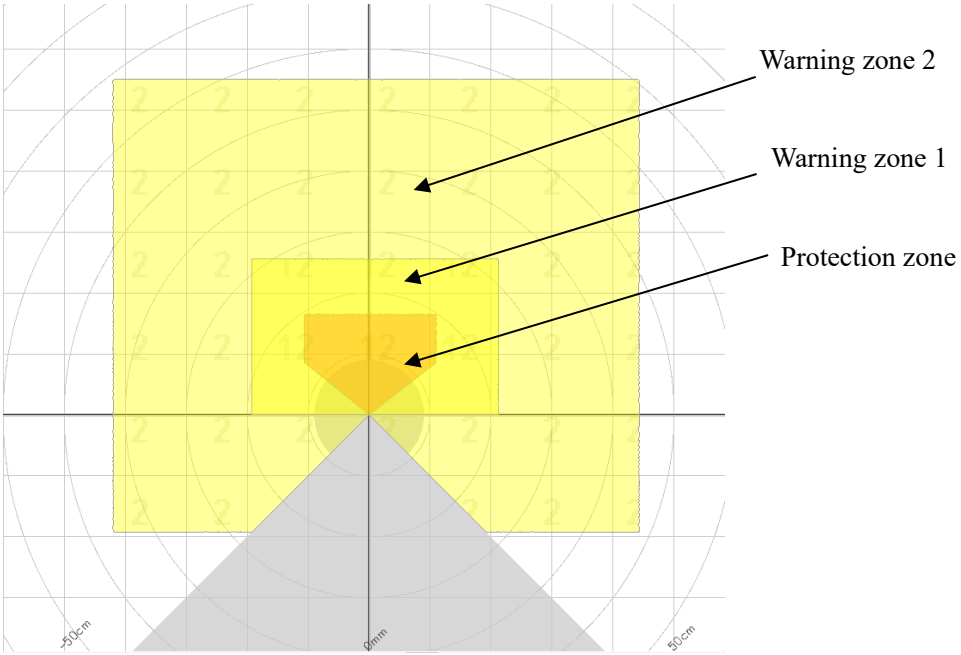


Figure 3-8 Warning zones

Danger

- Warning zones are non-safety zones.
- Warning signals should not be used for controlling any machine or vehicle for the safety-related purposes.

Caution

- Warning detection state are non-safety signal.
- Warning detection state and protection detection state is not inter-related.

3.5 Area switching

It is possible to configure and save up to 176 areas in UAM. Area number is provided in the EtherCAT communication packet (FSoE) to switch between these areas.

Table 3-1 Operating Area Number Address

Index	Sub Index	Name	Data Type	Description
0x1600	2	SafeData_0_Bit_0	BOOL	Area Input 1
	3	SafeData_0_Bit_1	BOOL	Area Input 2
	4	SafeData_0_Bit_2	BOOL	Area Input 3
	5	SafeData_0_Bit_3	BOOL	Area Input 4
	6	SafeData_0_Bit_4	BOOL	Area Input 5
	7	SafeData_0_Bit_5	BOOL	Area Input 6
	8	SafeData_0_Bit_6	BOOL	Area Input 7
	9	SafeData_0_Bit_7	BOOL	Area Input 8

3.6 Incremental encoder

In UAM there are 4 pairs of encoder input terminals for connecting 4 units of dual channel incremental encoders. They can be used in 2 encoders-1 pair or 4 encoders-2 pairs combination. In 2-encoder combination the area switching is performed by the velocity calculated from the encoder signals whereas, both the velocity and angular velocity calculated form the encoder signals are used for area switching in 4 encoder combination.

Direction of travel is detected by encoder's phase A and phase B signals having the phase difference of 90°. If the phase of signal B is ahead of signal A by 90°, and the state of signal B is high at the rising edge of the signal A, the direction of travel is considered as forward. If the phase of signal B is lagging the phase of signal A by 90° and the state of signal B is low at the rising edge of signal A, the direction of travel is considered as reverse. Area will be switched depending on the encoder speed and direction.

By duplicating the incremental encoders, the system can detect abnormalities in the AGV’s motion, such as differences in speed or discrepancies in rotational direction, and stop the AGV if necessary. It is also possible to provide the encoder speed and direction to UAM via EtherCAT communication (FSoE).

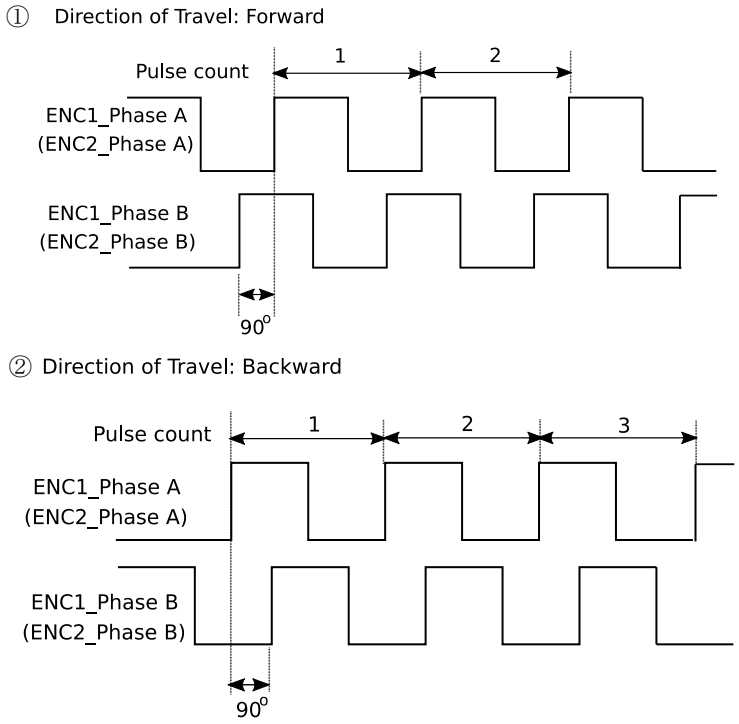
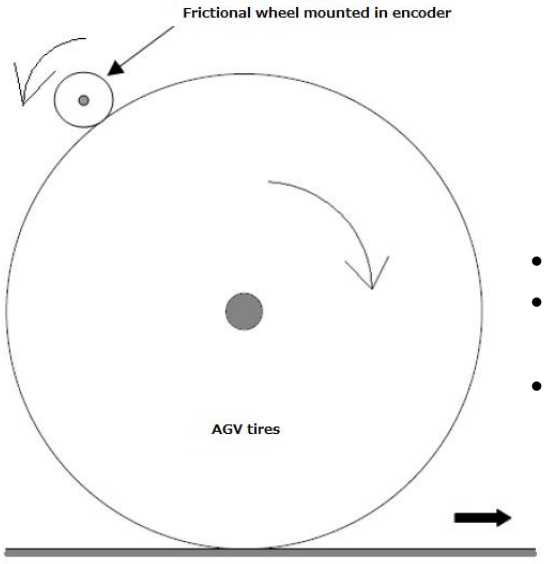


Figure 3-9 Input signals from incremental encoder

3.6.1 Pulse per cm travel generated by incremental encoders

When AGV travels, incremental encoder generates pulses due to the transmission ratio between AVG tires and incremental encoder frictional wheel. Pulse count per cm depends on AGV's speed.



- AGV tire diameter: 40 cm
- Frictional wheel diameter mounted in incremental encoder: 5 cm
- Incremental encoder pulse number per revolution:

Figure 3-10 Calculation of pulse count per centimeter travel

AGV tire circumference = Diameter × Circumference ratio = 40 cm × 3.14 = 125.6 cm

AGV tire's one rotation is equivalent to 8 rotations of frictional wheel. This equals to the 8,000 pulses of incremental encoder.

From above, incremental encoder pulse count per cm is obtained as

8,000/125.6 = 63.7

While setting encoder parameters (Encoder Pulse1 and Encoder Pulse2) in UAM project Designer, set the encoder pulse count after rounding the calculated value to nearest whole number (64 in this case)

In the explanation above, the transfer method of the rotation was based on the frictional wheel. Same method can be applied for other cases to estimate the pulse count generated for one rotation of the wheel.

Caution

- User should verify the proper area switching through encoder inputs.
- Always use 2 units of incremental encoder. It is not possible to detect the failure of incremental encoder or abnormal travel of the vehicle with single unit.
- Use separate sets of cable to connect outputs from incremental encoder 1 and 2 to the respective encoder input terminals of UAM.
- Separate the power supply cables and power source of each incremental encoder. Output pairs of Encoder connection should match the input pair of UAM.
- Do not wire other power lines parallel to encoder and UAM or wire in the same duct. There is a possibility of noise disturbance.

3.6.2 Recommend incremental encoder specification

- Phase setting 90° dual channel rotary encoder
- Power supply: DC 24V
- Output: Complementary output
- Protective class: IP 54 or more
- Output cable: Twist pair/ shield cable
- Maximum pulse frequency: 100 kHz
- Minimum pulse frequency: 50 pulse/cm

3.6.3 Tolerances allowed for encoder

When AGV travels in a straight direction, speed input through the two incremental encoders will be same as the original pulse frequency. However, there are cases when two speed input values may differ, such as while cornering and due to AGV tire exhaustion. The difference between two input speeds should not exceed the error tolerance for more than a fixed period. It is possible to set the error tolerance in the range of 0 to 80% to manage the difference.

Of the two speeds, the higher value will be considered for vehicles speed calculation. When permitted error tolerance exceeds the fixed period, protection detection state will go to OFF state. Tolerance period differs according to the vehicle speed as shown in

Table 3-2.

Table 3-2 Relation between AVG speed and tolerance

AGV speed v (cm/s)	Tolerance
$-9 \leqq V \leqq +9$	Infinity
$-30<v<-9$ or $9<v<30$	60s
$v \leqq -30$ or $+30 \leqq v$	20s
$v < -9$ or $+9 < v$ (Two encoders with different rotating direction)	0.3s

3.6.4 Area switching by encoder input

To switch areas using encoder input signals, the encoder function must be enabled and its details needs to be provided in the UAM Project Designer during the device configuration.

UAM can be configured to receive the encoder signals from one of the following two methods.

- Encoder signals provided directly from the external input lines.
- Encoder information provided via EtherCAT communication.

If the external input lines are selected for calculating the speed, the following information are also required.

- Tolerance
- The number of pulses per 1 cm of travel for the encoder.

The minimum and maximum speeds are automatically calculated based on the pulses per 1 cm of travel and the encoder's maximum pulse frequency (100kHz).

The encoder information provided via EtherCAT communication can be one of the following two types.

- Encoder speed
- Speed of the AGV that the UAM is mounted on.

When UAM is configured to receive the encoder speed via EtherCAT, it will internally calculate the AGV's speed from the information and automatically switches to the area corresponding to that speed.

On the other hand, if it is configured to receive the AGV's speed, the area is switched based on that speed without any internal calculation.

Next is the selection of the number of encoders.

- The 2 Encoder (Encoder 1 and 2) configuration will allow UAM to switch areas based on the AGV's speed.
- The 4 Encoder (Encoder 1, 2, 3 and 4) configuration will allow UAM to switch areas by checking both AGV's speed and rotation (angular speed).

To enable area switching based on AGV's rotation, the following configuration details are also required.

- Encoder numbers mounted on the right side of the AGV.
- The distance between AGV's left and right tires.

There are number of input patterns available in the encoder input mode. Each of these patterns can be assigned to one of the following three area switching modes.

- Static Input
- Encoder Input
- Not Used

Note that at least one of the patterns must be set to encoder input mode. The number of patterns and the maximum number of speed divisions for each pattern are shown in Table 3-3.

Table 3-3 Pattern Count and Maximum number of Speed

Pattern Count	Maximum number of Speed
32	176

An example of configuring encoder input mode using Encoder 1 and 2 is shown below. The number of speed divisions must be less than or equal to the number of areas set in the sensing configuration (maximum 176). In the example shown in Figure 3-11, Pattern 1 is set to "Encoder Input", and the number of speed divisions is set to "5". Finally, the speed range and an area number corresponding to it is assigned.

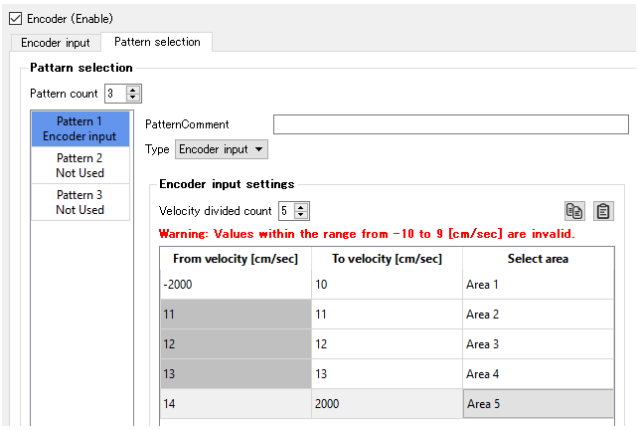


Figure 3-11 Example of Encoder Input Setting1

Figure 3-12 shows the example of encoder input setting for 4 encoders (Encoder 1, 2, 3, 4). Velocity and angular velocity are divided into 7 and 5 ranges respectively and an area is assigned to each range. Cells can be filled with [--] for the unused velocity range. UAM will monitor the velocity and switch the protection detection state to OFF when it is out of the range.

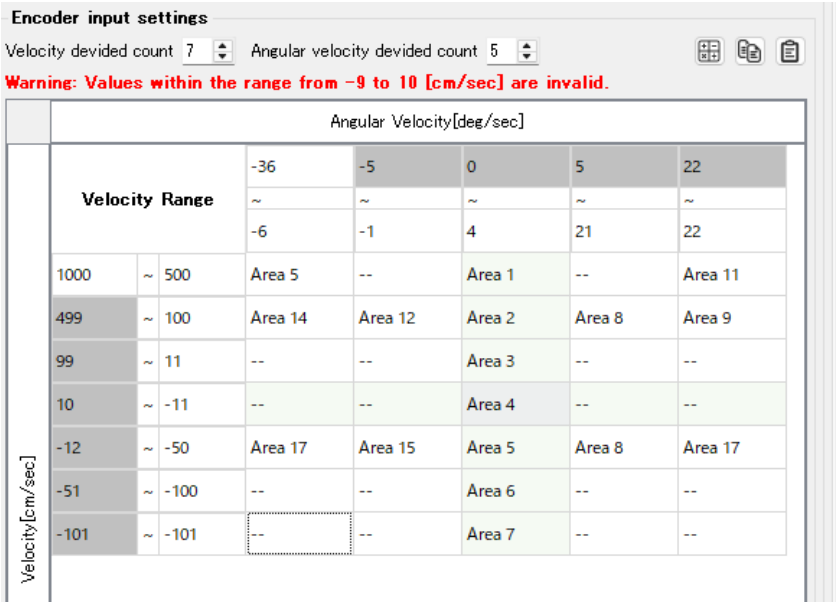


Figure 3-12 Example of Encoder Input Setting2

A calculation tool is provided in the UAM Project Designer to calculate the angular velocity when 4 encoders are used (Figure 3-13). When velocities of right and left side encoders are entered the corresponding angular velocity is automatically calculated and displayed on the tool.

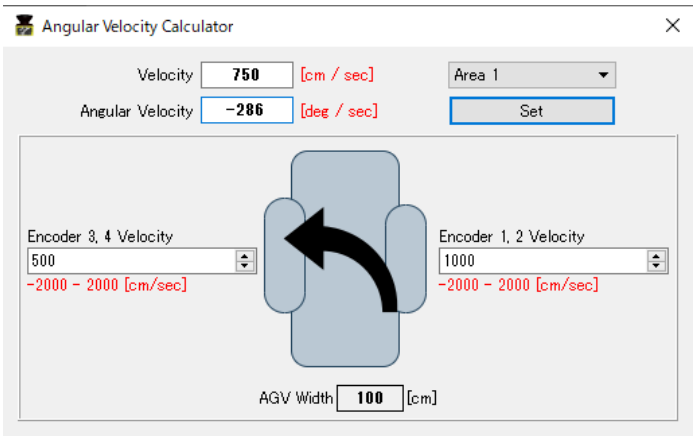


Figure 3-13 Angular velocity calculation tool

The upward direction (positive velocity) in the UAM Project Designer corresponds to the forward direction whereas downward direction (negative velocity) corresponds to the backward direction. Further, positive angular velocity corresponds to clockwise turn and negative angular velocity corresponds to the counter clockwise turn. In Figure 3-13, The encoder velocity of the right-side encoders (Encoder 1, 2) is greater than the left-side encoders (Encoder 3, 4) therefore, the it is considered right turn (negative angular velocity).

Following formula is used for calculating the velocity and angular velocity in the UAM

Velocity: $V = \frac{V_L + V_R}{2}$ [cm/s]

Angular velocity: $W = \frac{180(V_L - V_R)}{\pi D}$ [deg/s]

V_R: Velocity of the encoder on the right side

V_L: Velocity of the encoder on the left side

For patterns configured with “Static Input”, it is required to assign an area to each pattern. UAM will operate with the assigned area for any velocities in this mode. However, the velocity and angular velocity can be monitored by enabling the monitoring function for each pattern. It is required to define the velocity and angular monitoring ranges if the function is enabled. Additionally, enabling the individual monitoring option allows monitoring of each encoder velocity independently (Figure 3-14, Figure 3-15, Figure 3-16)

When velocity or angular velocity monitoring is enabled, the AGV's travel and turning rate are continuously monitored. If any of the monitored values fall outside the specified range, the system will report error and switch the Protection and Warning detection signals to OFF state.

AGV’s velocity and angular velocity can be monitored based on the following two types of encoder data.

・Velocity internally calculated by UAM

- Calculated from pulse signals received via external input lines
- Calculated based on encoder velocity received via EtherCAT communication

・Velocity calculated by the external controller

- The AGV controller calculates and sends velocity and angular velocity data to UAM via EtherCAT communication

Using these two sources, the UAM performs velocity and angular velocity monitoring to support area switching and safety control functions.

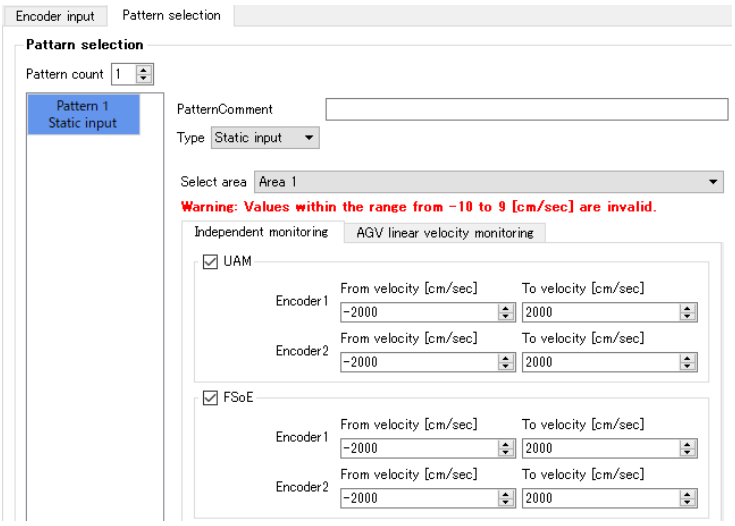


Figure 3-14 Static Input Configuration with Independent Encoder Velocity Monitoring

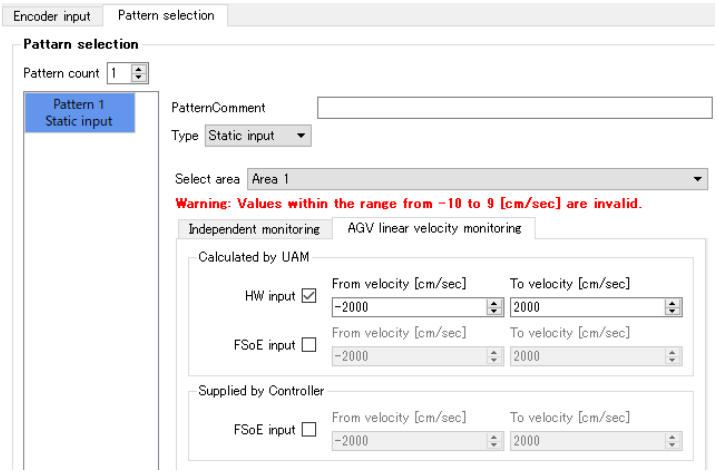


Figure 3-15 Static Input Configuration with AGV Velocity Monitoring

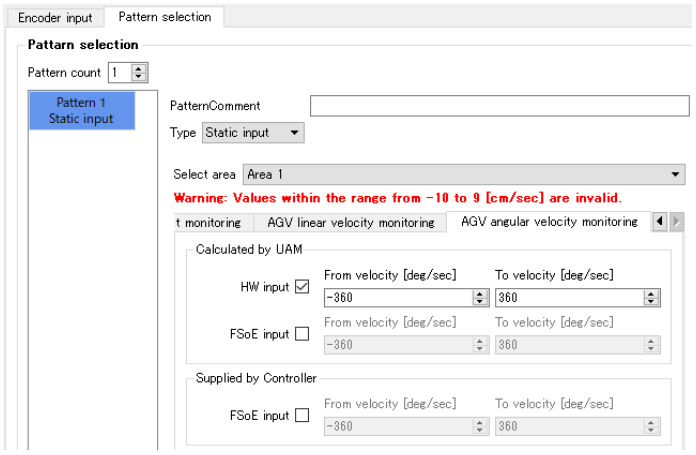


Figure 3-16 Static Input Configuration with AGV Angular Velocity Monitoring

3.7 Lockout state

When an error is detected by the self-diagnostic function and UAM cannot operate normally it will switch to lockout state. Communication with controller will be disconnected in this state. After removing the error, UAM can be reset by restoring the power to release from the lockout state.

3.8 Interlock function

Interlock is a function to prevent automatic switching of the protection detection state from OFF to ON. Different types of interlock can be configured in the device using UAM project designer. RES_REQ1 and RESET1 signals corresponds to interlock for Protection zone1 and RES_REQ2 and RESET2 signals corresponds to interlock for Protection zone2. It is possible to use interlock function for up to 5 protection zones using the corresponding signals (RES_REQ1~RES_REQ5, RESET1~RESET5). In the following section, examples are given using general representation of signals as RES_REQ and RESET. Reset signal from the EtherCAT communication (FSoE) is used for resuming the normal operation of device after protection zone is clear from obstacle and device is free from the error. Further, the device also has hardware terminals for the reset function for Protection zones 1 and 2 only.

3.8.1 Automatic restart

UAM will restart automatically when interlock function is disabled or only the start interlock function is enabled. When obstacle in the protection zone is removed, protection detection state switch from OFF-state to ON-state automatically. However, if UAM is in the lockout state due to error, Protection detection signals will remain in OFF-state even if the interlock function is disabled.

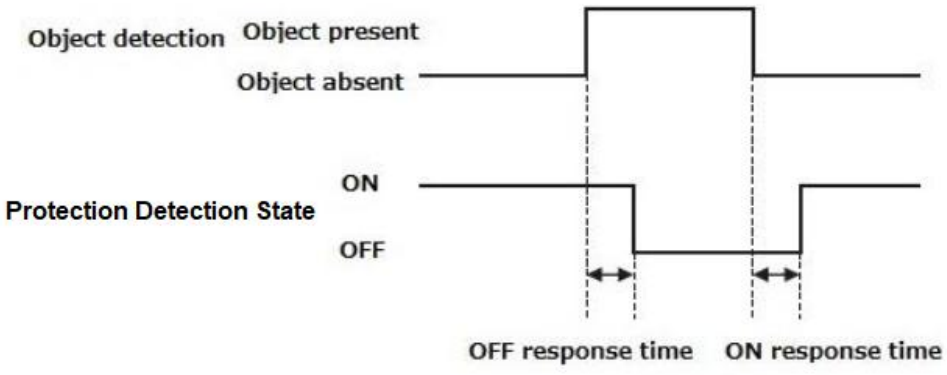


Figure 3-17 Timing chart of automatic restart

Danger

- In automatic restart configuration, protection detection will automatically switch to ON state after the object is removed. Confirm the safety while removing the object.
- Configured response time should be sufficient for the machine or AGV to stop safely.

3.8.2 Manual restart (Interlock enabled)

UAM operates in manual restart mode when interlock function is set to manual mode. The Protection detection state switches from ON to OFF, if UAM detects any obstacle within the protection zone or detects any system error. In this mode, even if the detected obstacles or system error is removed, Protection detection state will remain OFF. An external reset input signal is required to release the interlock which allows the UAM to switch to normal operation.

UAM will resume normal operation only after confirming the reset signal (RESET). The duration of the reset signal should be more than 500ms. Figure 3-18 shows the timing chart of the manual restart. After reset signal is confirmed, the Protection detection state will switch to ON after the lapse of the configured delay time. If Protection detection state is OFF due to an internal fault, it will remain in OFF even when reset signal is provided. Reset delay is configurable in the range of 1s to 6s.

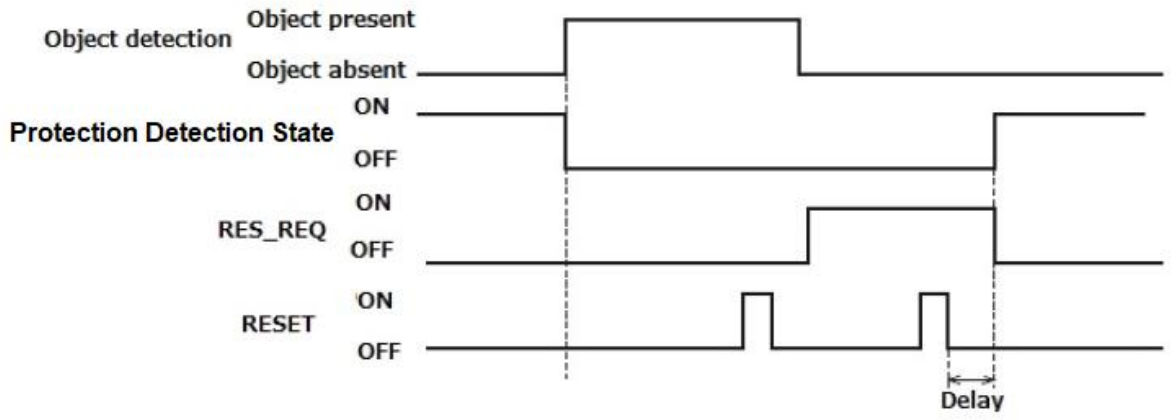


Figure 3-18 Timing chart of manual restart

Danger

- User should verify that the detected obstacle is safely removed before resetting the UAM.
- If restart interlock function is used to restart the machine, the reset switch should be mounted away from the protection zone.
- Falling to comply with the above could lead to critical injury or death.

Note

- Even after the object is removed from the protection zone, if the protection detection state remains in OFF-state, check the error code and suggested solution (Refer to Chapter 9)
- Duration of reset input should not exceed 30s otherwise, it will be detected as hardware malfunction.

3.8.3 Manual start (Interlock enabled)

Start interlock is a function which keeps the protection detection state to OFF during the start-up until an external reset input is supplied. Start interlock setting has only manual mode. The RES_REQ state switches to ON after UAM completes initial routines and ready to accept the RESET input. When RESET input is applied, protection detection state will switch to ON if there are no obstacles in the protection zone. The duration of the reset input should be more than 500ms. Figure 3-19 shows the sequence of start interlock. Delay can be configured in the range of 1s to 6s.

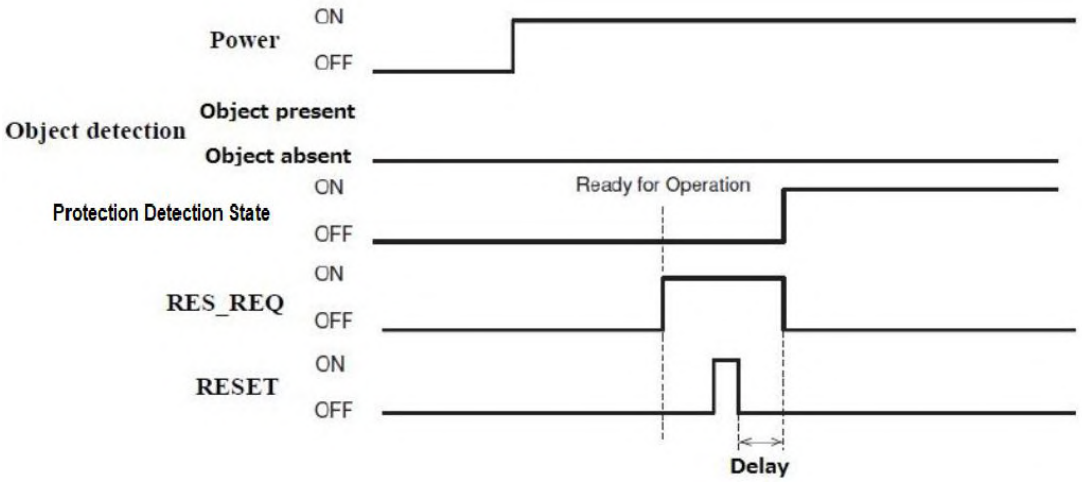


Figure 3-19 Manual start sequence

3.9 Muting function

Muting function suspends the safety function in the configured muting zone of UAM when specified conditions are fulfilled. In the muting state Protection detection state remains ON even when there is an object in the muting zone. Two independent input signals (either hard wired or from EtherCAT communication (FSoE)) are provided to start and end the muting function. Muting zone and related parameters are configured using the UAM project designer. When muting inputs fulfill the muting start conditions, UAM will suspend the safety function within 80ms and resume the safety function if they fulfill the muting stop conditions. Figure 3-20 shows the muting sequence. It is possible to configure muting zone in every protection zone. Maximum number of areas in the device depends on the selection of protection, muting and warning zones which is shown in Table 3-4.

Table 3-4 Maximum area count based on protection, muting and warning zones

Muting	Protection zone	Maximum warning zone	Maximum area count
Disable	n	176 - n	176
Enable	n	176 - 2n	88

3.9.1 Muting start condition

Muting function will start when the following conditions are fulfilled.

a) There are no objects in the protection zone and the Protection detection state is ON.

b) The two independent hard wired muting input signals or FSoE input data are switched to ON state in the predefined sequence within the pre-set time interval.

Note: There should be at least 30ms delay between the signals.

The following configurations are necessary for the muting function. User can configure these by using the UAM project designer.

- Muting inputs sequence
  Muting inputs sequence can be selected from one of these values
  ▶ Muting 1 ⇒ Muting 2
  ▶ Muting 2 ⇒ Muting 1

- Time interval between two inputs (T1)
  T1 can be selected from one of these values
  ▶ 1second
  ▶ 3seconds
  ▶ 5seconds
  ▶ 10seconds

P2_MUT_IN1~P5_MUT_IN2 inputs are configured in similar way when muting function is enabled for protection zone 2 to 5.

3.9.2 Muting stop condition

Muting function will stop when any one of the conditions below is fulfilled:

a) One of the muting inputs switches to OFF-state.
b) When the predefined (preset) maximum muting time T2 exceeds (1 minute and above) (Figure 3-20).
c) Objects are detected in the protection zone which is not covered by the muting zone.
d) Error is detected by the self-diagnostics function.
e) During muting state when the area is switched to other area.

- Maximum muting period (T2)
  Maximum muting period can be selected from one of these values
  ▶ 1 minute
  ▶ 6 minutes
  ▶ 12 minutes
  ▶ Unlimited

P2_MUT_IN1~P5_MUT_IN2 input parameters (input sequence, input delay, maximum muting period etc.) are configured in similar way when muting function is enabled for protection zone 2 to 5.

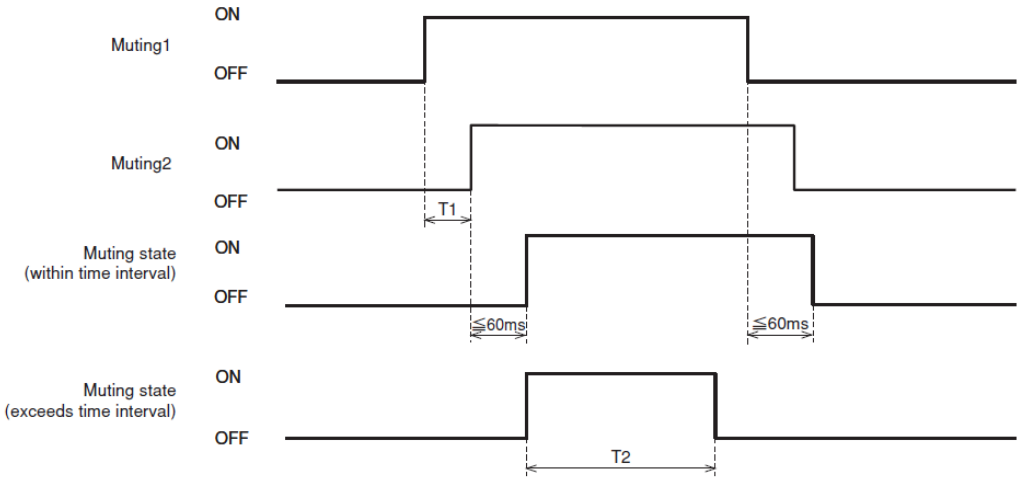


Figure 3-20 Muting sequence

3.9.3 Muting override function

Muting override is a function to recover UAM by suspending the safety function when the Protection detection state is switched OFF due to muting related errors. Override function is active when the override input (OVERRIDE) and the reset input (RESET) are switched in a sequence. Explanation below is given by taking protection zone1 as an example. Figure 3-21 shows the override sequence.

●Override start conditions

a) At least one of the muting inputs is in ON-state.

b) Object is present in the protection zone.

c) Time interval between override input and reset input is within 0.03s to 1s (T3).

●Override stop conditions

a) Both muting inputs are in OFF-state.

b) Override input or reset input is in OFF-state.

c) When predefined maximum override time T4 exceeds.

d) Error is detected by self-diagnostic function of the UAM.

e) During override state when area is switched to the other area.

●Maximum override period (T4)

Maximum override period can be selected from one of these values

▶ 1 minute

▶ 6 minutes

▶ 12 minutes

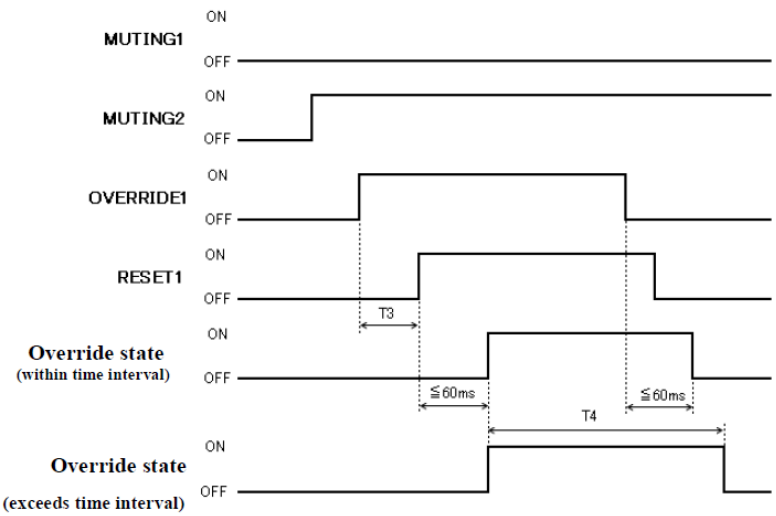


Figure 3-21 Override Sequence

When using override for protection zones 2 ~5, MUTING3 ~ 10, OVERRIDE2 ~ 5 and RESET2 ~ 5 are configured in the similar way.

Danger

- When muting function is enabled, user must ensure the safety of the protection zone.
- Before using the muting function, user must perform risk assessment.
- A qualified person should configure the appropriate muting period according to the requirement of the application. It is the user's responsibility to properly perform the risk assessment when configuring muting period to unlimited.
- Failing to comply with the above could lead to critical injury or death.

3.10 **Reference monitoring function**

Reference monitoring is a function to monitor the displacement of the UAM or the structure used as reference boundary.

3.10.1 Area protection (Horizontal)

An example of reference monitor function used for area protection is shown in Figure 3-22. If reference segments are configured on moveable objects (example: door) the Protection detection state will switch OFF when the door position is changed.

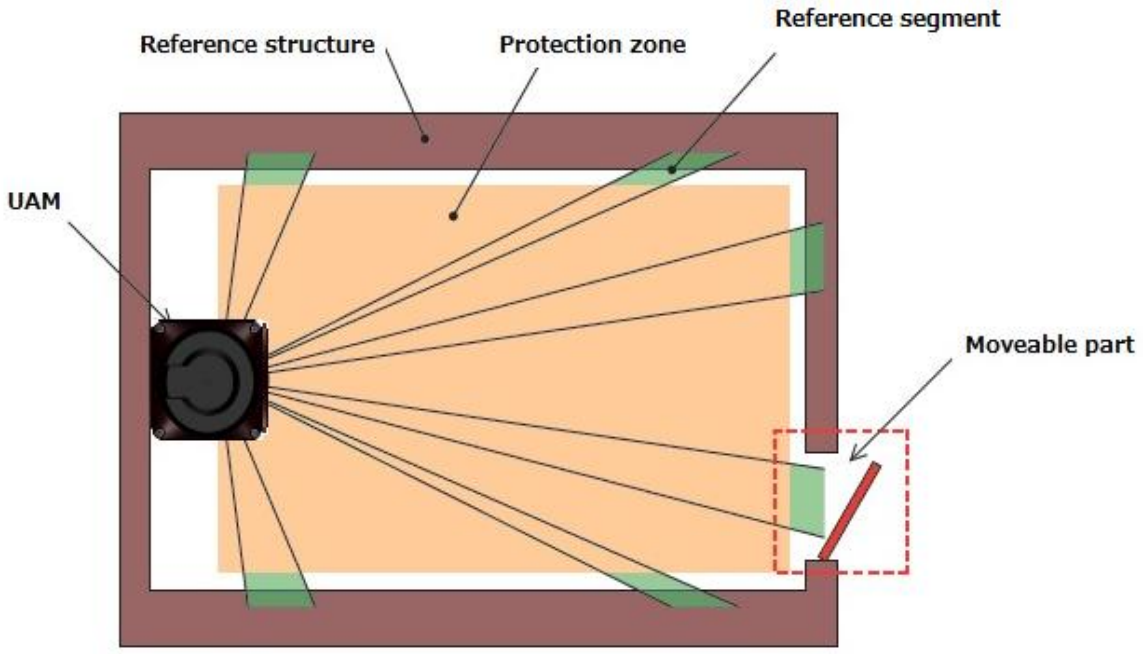


Figure 3-22 Top view of the area protection using reference monitor function

3.10.2 Access protection (Vertical)

An example of reference monitor setting used for access protection is shown in Figure 3-23, Figure 3-24. Reference segments should be configured on each surface for displacement detection. Reference segments should be configured such that displacement can be easily detected. Figure 3-25 shows an example of incorrect reference monitoring setting as there are chances of device displacement to go unnoticed. The Protection detection state will switch to OFF-state when access penetration is detected or if the distance between UAM and the reference structure changes. This function is mandatory for applications which require vertical mounting of UAM.

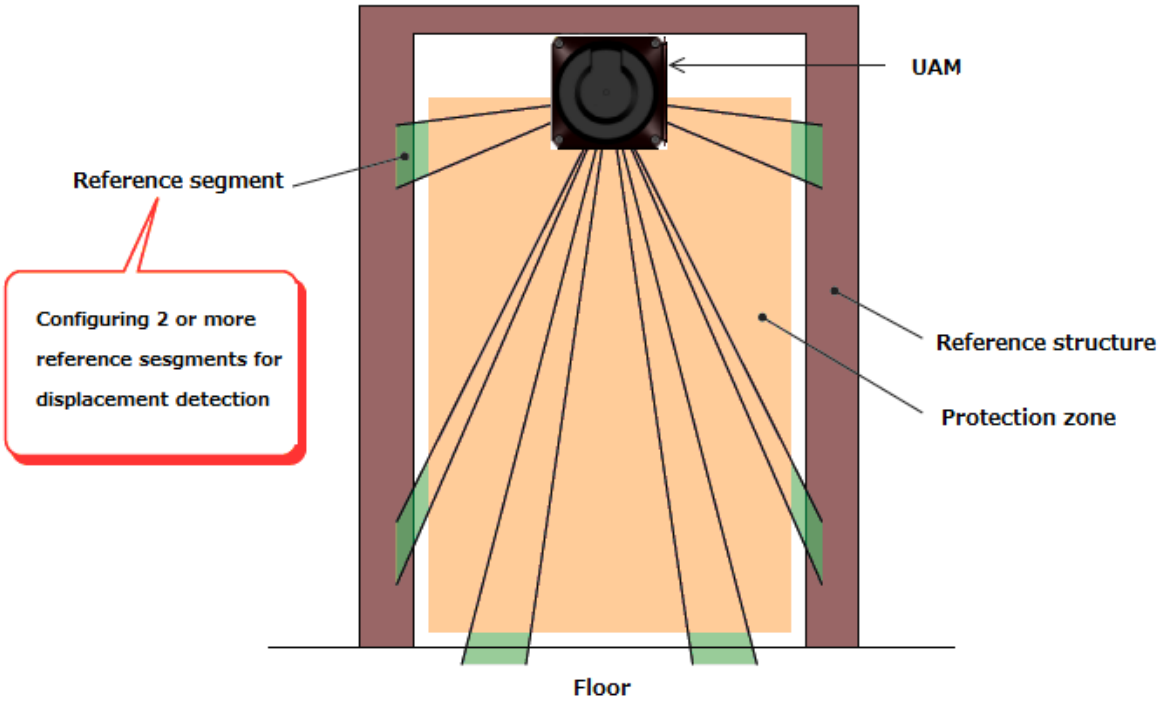


Figure 3-23 Front view of the access detection using reference monitor function

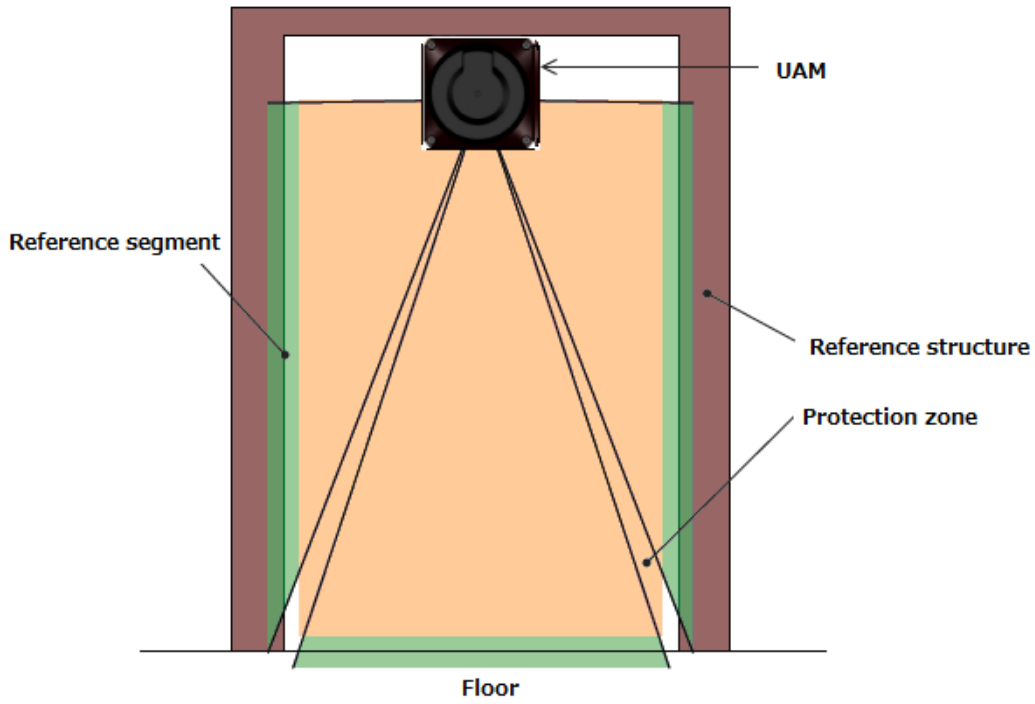


Figure 3-24 Front view of the access detection using reference monitor function

Front view of the access detection using reference monitor function

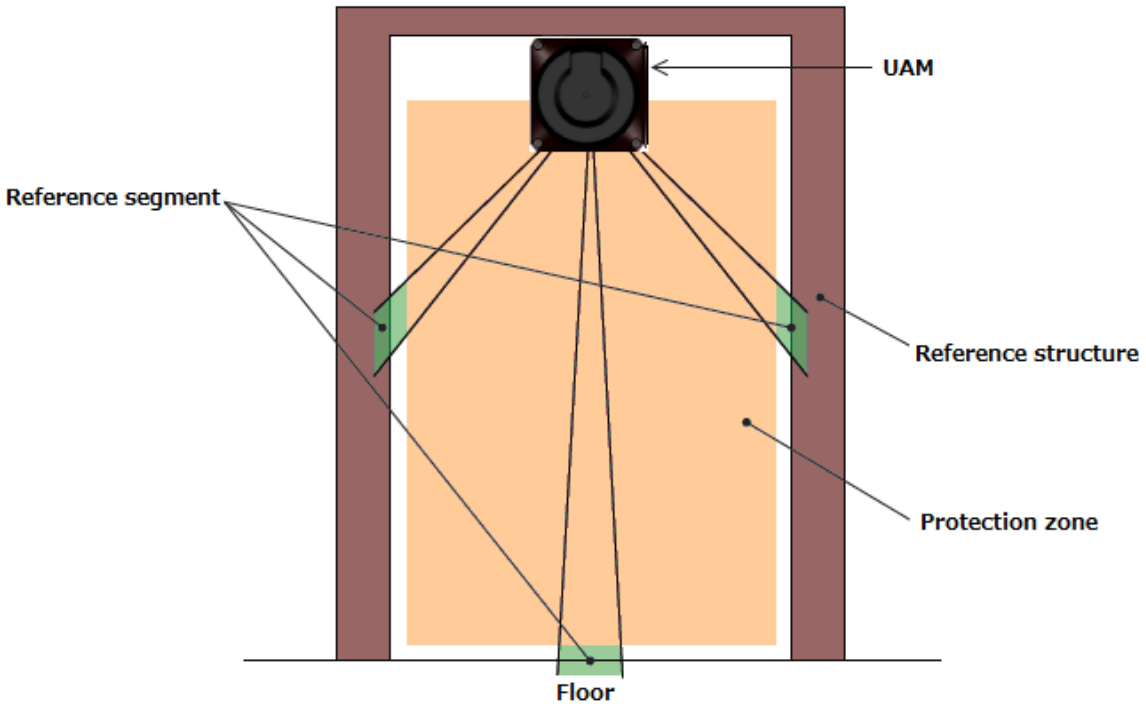


Figure 3-25 Incorrect configuration of reference monitor function

3.11 **Area sequence function**

Area sequence is a function to monitor sequences of area switching. When this function is activated, Protection detection state will switch to OFF-state if switching pattern doesn't match the configured sequence. This function prevents the machine to operate with random protection zone.

From each area, switching selection to maximum 10 other areas are possible when configuring the area sequence. And, it is necessary to specify at least 1 or more areas to avoid deadlock.

<Area switching sequence>

When area sequence is disabled, UAM can switch from an area to any other areas (Figure 3-26) whereas it can only switch to specified areas if area sequence is enabled. (Figure 3-27). Area sequence function is recommended for control systems where area switching sequences are known beforehand.

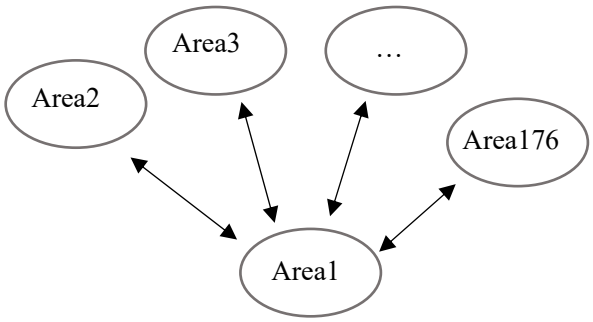


Figure 3-26 Operation without area sequence

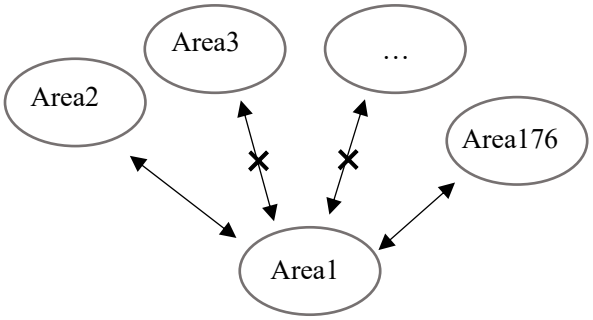


Figure 3-27 Operation with area sequence

3.12 **Response time**

Response ON and OFF time for the protection detection state (Figure 3-28) can be configured for each protection zones using UAM Project Designer.

Table **3-5** and Table 3-6 shows the possible response time configurations in the device.

When longer response time is configured, the stability of UAM can be increased. However, longer response time requires longer safety distance. User must perform risk assessment before configuring the response time. Addition of maximum 1 cycle (30ms) must be taken into account for the area switching.

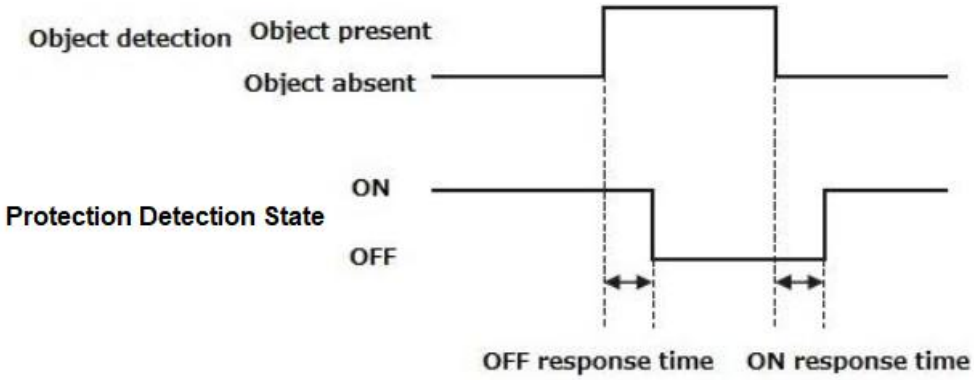


Figure 3-28 Response time

Table 3-5 Response time (OFF) of UAM

	Time (ms)							
OFF	80	110	140	170	200	230	260	290
	320	350	380	410	440	470	500	530
	560	590	620	650	680	710	740	770
	800	830	860	890	920	950	980	1010
	1040	1070	1100	1130	1160	1190	1220	1250
	1280	1310	1340	1370	1400	1430	1460	1490
	1520	1550	1580	1610	1640	1670	1700	1730
	1760	1790	1820	1850	1880	1910	1940	1970
	2000	2030						

Table 3-6 Response time (ON) of UAM

	Time (ms)							
ON								290
	320	350	380	410	440	470	500	530
	560	590	620	650	680	710	740	770
	800	830	860	890	920	950	980	1010
	1040	1070	1100	1130	1160	1190	1220	1250
	1280	1310	1340	1370	1400	1430	1460	1490
	1520	1550	1580	1610	1640	1670	1700	1730
	1760	1790	1820	1850	1880	1910	1940	1970
	2000	2030						

3.13 **Other outputs**

UAM consist of 6 non-safety outputs, MUT_OUT1, MUT_OUT2, RES_REQ1, RES_REQ2, AUX_OUT1 and AUX_OUT2. RES_REQ1/MUT_OUT1/AUX_OUT1 and RES_REQ2/MUT_OUT2/AUX_OUT2 are configurable outputs that share the same terminal. When the functions are selected using UAM project designer, outputs are configured automatically.

3.13.1 Muting output 1/2（MUT_OUT1/2）

MUT_OUT1/2 represents the muting/override state of protection zone1/2. When muting function is enabled, MUT_OUT1/2 will switch to ON state whenever the device initiates muting or override. Use these signals to inform the muting or override state of the device.

3.13.2 Reset Request output 1/2（RES_REQ1/2）

This signal will switch to ON-state when the protection zone 1/2 of the UAM is ready to receive reset signal.

3.13.3 Auxiliary output 1/2（AUX1/2）

AUX1/2 terminals can be independently assigned to one of the following 4 functions.

- ●Synchronous signal: UAM generates 1ms pulse in every scan.
- ●Error: Signal goes to ON state when UAM is in error state.
- ●Window contamination error: Signal goes to ON state when contamination on the optical window reaches the error level.
- ●Window contamination warning: Signal goes to ON state when contamination on the optical window reaches the warning level.

3.14 **Information indicator**

7 LEDs and an LCD indicate the UAM status. These indicators are in front of UAM. Figure 3-29 shows the information indicators of the UAM.

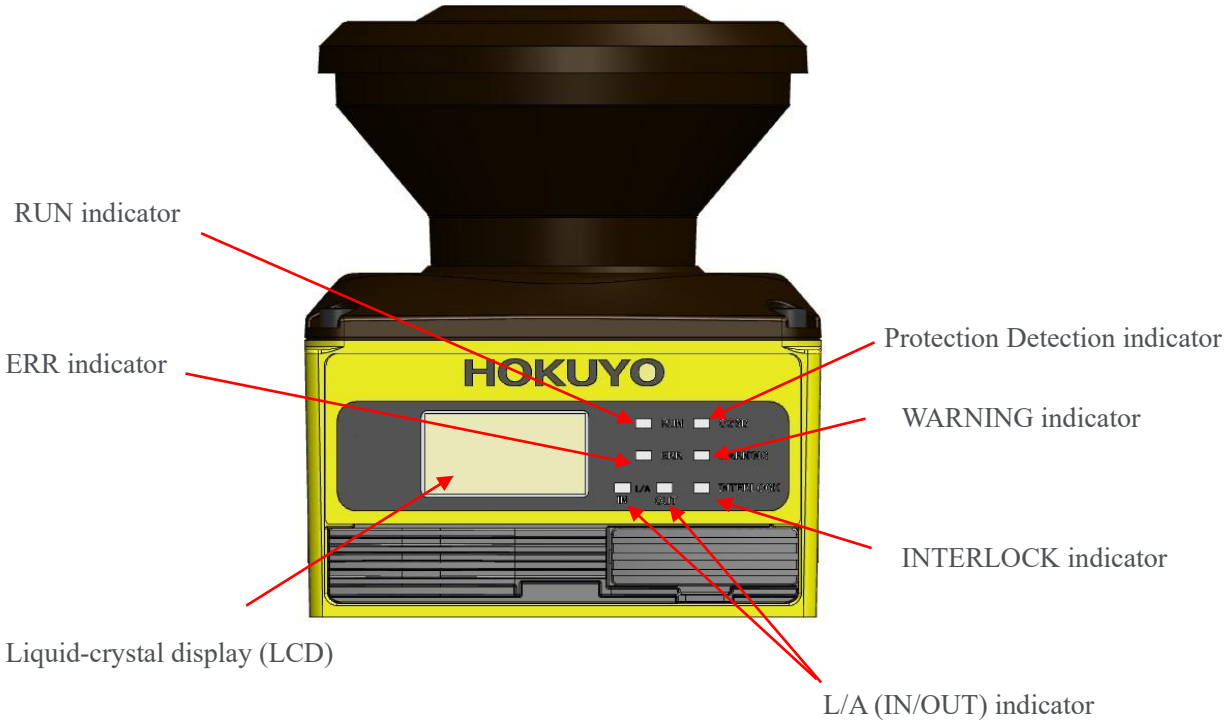


Figure 3-29 Indicator lamp

3.14.1 LED indication

LED indicators and their descriptions are shown in Table 3-7.

Table 3-7 Description of indicator LEDs

LED	Color	LED status	Description
Protection Detection	Green	On	Detection states of all protection zones in the operating area are ON.
	Red	On	Detection state of at least one protection zone in the operating area is OFF.
WARNING	Orange	On	Detection state of at least one warning zone in the operating area is OFF.
		Off	Detection states of all warning zones in the operating area are ON or warning zone is not used.

Table 3-8 Description of indicator LEDs(continued)

LED	Color	LED status	Description
INTERLOCK	Orange	On	At least one protection zone in the operating area is in the interlock state.
		Off	UAM is not in the interlock state.
RUN	Green	Off	Initializing
		Blinking	Before stating the operation.
		Single flash	Performing safety operation, EtherCAT communication is active.
		On	Actively operating.
ERR	Red	Off	No error
		Blinking	Communication setting error.
		Single flash	Synchronization error, Communication data error.
		Double flash	Watchdog timeout.
		On	Communication error with Controller unit
L/A (IN/OUT)	Green	On	Connected with Controller unit
		Off	Disconnected with Controller unit

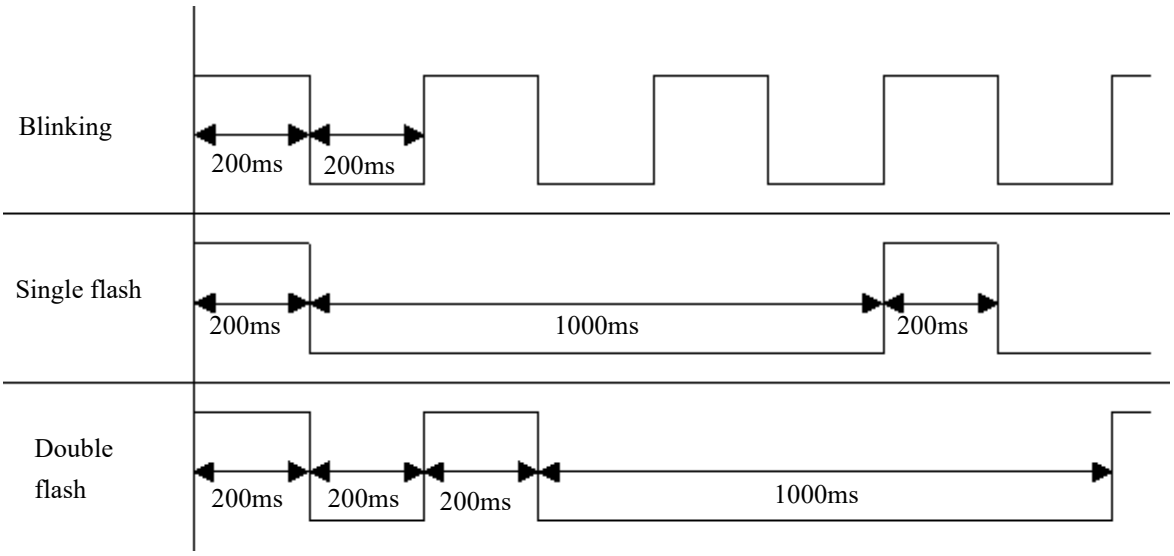


Figure 3-30 LED luminous pattern

3.14.2 Display indication

Table 3-9 shows the information shown on UAM's LCD. Display can be configuration using UAM Project designer to show the information upside down when mounting of UAM is inverted.

Table 3-9 Description of the indications displayed on LCD

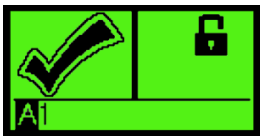
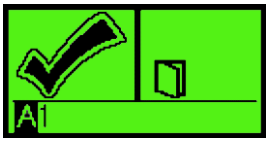
Display	Description
	● No detection (Optional functions disabled) ● Operating area number
	● Detection in protection zone(s) (Optional functions disabled) ● Operating area number, Obstacle detected protection zone number(s).
	● Detection in warning zone(s) (Optional functions disabled) ● Operating area number, Obstacle detected warning zone number(s).
	● Interlock function enabled (No detection) ● Operating area number
	● Muting function enabled (No detection) ● Operating area number
	● Reference monitoring function enabled (No detection) ● Operating area number
	● Area sequence function enabled (No detection) ● Operating area number

Table 3-10 Description of the indications displayed on LCD(continued)

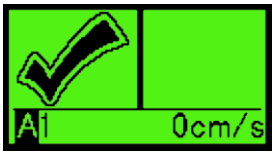
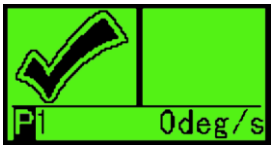
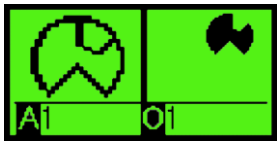
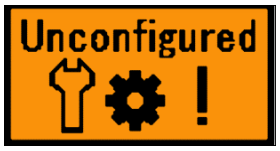
Display	Description
 	● Encoder Input function enabled (No detection) ● Operating area number, encoder speed (2 Encoders Activated) ● Operating area number, encoder speed (4 Encoders Activated)
	● Muting operation active ● Operating area number, muting active zone(s)
	● Override operation active ● Operating area number, override active zone(s)
	● Error detection ● Error number (hexadecimal)
	● Ready to accept reset request to resume from interlock state ● Operating area number, protection zone number(s) ready to accept reset input
	● Laser off mode activated
	● Error due to object near the optical window ● Error number
	● Warning due to optical window contamination ● Operating area number
	● Error due to optical window contamination ● Error number

Table 3-11 Description of the indications displayed on LCD(continued)

Display	Description
	● Error due to object near the optical window ● Error number
	● Initializing
	● Device is in setting mode (UAM project designer/FoE file) ● Calibrating optical window
	● Factory dispatch state/ Settings initialized state

3.15 EtherCAT Communication Profile

See UAM-05LECA_EtherCAT Communication Specification (C-64-00220) for the details on communication profile. UAM-05LECA will operate by switching the data module based on whether the Encoder Input Function is enabled or disabled.

3.15.1 FSoE (FailSafe over EtherCAT) Compatibility

Safety related information such as, Protection detection state, area switching (area number), encoder speed is transmitted between Master controller and UAM via FSoE communication.

3.15.2 CoE (CANopen over EtherCAT) Compatibility

Device configuration stored in the UAM can be obtained by CoE communication.

3.15.3 FoE (File Access over EtherCAT) Compatibility

A FoE compatible setting file can be generated using UAM Project designer. This file is transferred to UAM via FoE communication to configure the device.

3.15.4 EoE (Ethernet over EtherCAT) Compatibility

UAM's Measurement data can be obtained for monitoring via EoE. Use either UAM Project Designer application or EoE compatible user application to obtain the data.

3.16 Laser Off Mode

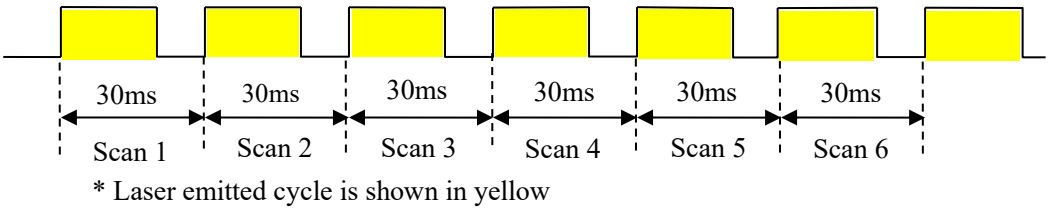
Laser off mode is a function to stop the laser emission in the measurement region in order to prevent the interference to the surrounding equipment. This function is activated by the input supplied in the EtherCAT communication (FSoE).

3.17 **Scan Skip Function**

Scan skip is a function to stop the laser emission for a specified number of scan cycles in the measurement region in order to reduce the interference to the surrounding equipment.

When this function is enabled by specifying the skip count, UAM will operate by skipping the scan for the number of cycles. During the skipping cycle the laser is switched off in the measurement region. Configurable value for skip cycle is 0 ~ 3 count. Figure 3-32 shows the operating concept when the scan skip is 0. In this configuration the scan skip function is disabled and sensor operates normally.

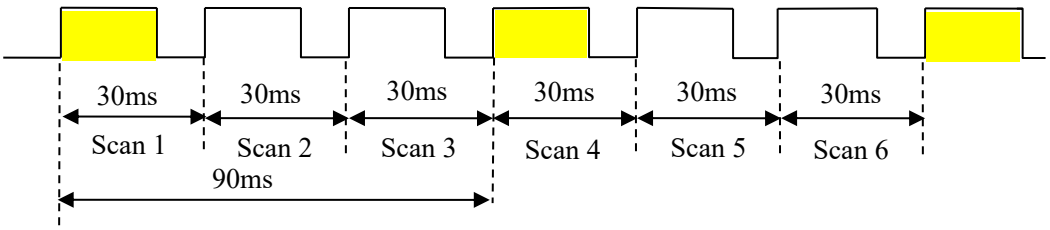
Response time of UAM for the different settings is shown in Table 3-12.



* Laser emitted cycle is shown in yellow

Figure 3-31 Operation of UAM when scan skip count is 0

Figure 3-32 shows the operating concept when the scan skip is set to 2. In this configuration UAM will skip the measurement for every 2 cycles in between the normal measurement cycles. Outputs states just before the skipping cycle are retained during the skipping cycle.



*Laser emitted cycle is shown in yellow

Figure 3-32 Operation of UAM when scan skip count is 2

Table 3-12 Response time for different scan skip settings

Scan Interval	Off Time (ms)							
1	110	170	230	290	350	410	470	530
	590	650	710	770	830	890	950	1010
	1070	1130	1190	1250	1310	1370	1430	1490
	1550	1610	1670	1730	1790	1850	1910	1970
	2030							
2	140	230	320	410	500	590	680	770
	860	950	1040	1130	1220	1310	1400	1490
	1580	1670	1760	1850	1940	2030		
3	170	290	410	530	650	770	890	1010
	1130	1250	1370	1490	1610	1730	1850	1970

Scan Interval	On Time (ms)							
1				290	350	410	470	530
	590	650	710	770	830	890	950	1010
	1070	1130	1190	1250	1310	1370	1430	1490
	1550	1610	1670	1730	1790	1850	1910	1970
	2030							
2			320	410	500	590	680	770
	860	950	1040	1130	1220	1310	1400	1490
	1580	1670	1760	1850	1940	2030		
3		290	410	530	650	770	890	1010
	1130	1250	1370	1490	1610	1730	1850	1970

3.18 Optical Window Contamination Warning Function

This is a function to warn the early stages of optical window contamination on the LCD display before it reaches to the level when the device reports error and switches the protection detection state to OFF. Sensitivity of the warning level can be configured using the UAM Project designer. There are three options available, Low, Medium and High. The low sensitivity setting will trigger the warning when the contamination level reaches the maximum tolerance level whereas, high sensitivity setting will trigger the warning as a result of minimum contamination. By cleaning the optical window at the warning stage, it is possible to reduce the error related to optical window contamination which causes the protection detection state going to OFF state. No specific configuration is necessary to activate this function.

3.19 **Auxiliary Output Function**

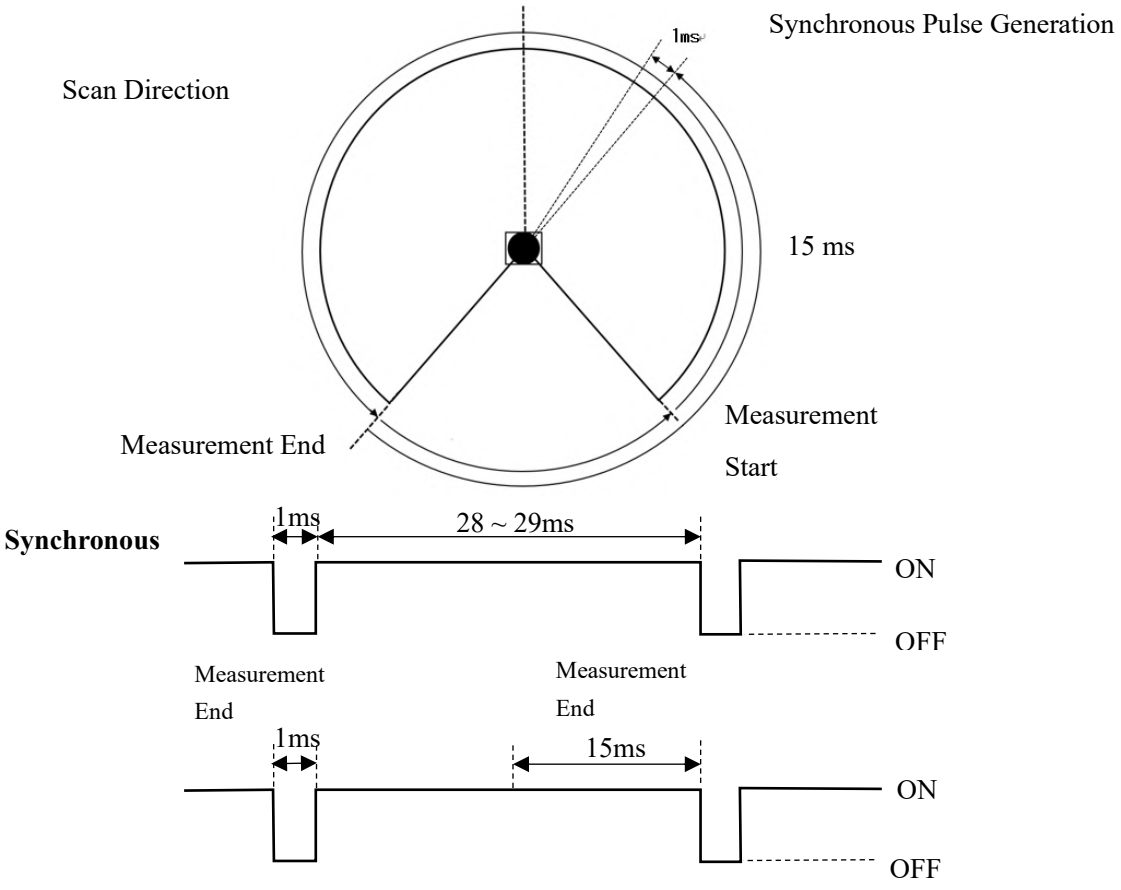
Auxiliary output signals, AUX_OUT1 and AUX_OUT2 can be assigned to one of the following functions shown on the table below. However, it will be automatically assigned to Reset Request signal if the interlock function is enabled or Muting output signal if the muting function is enabled.

Table 3-13 Auxiliary output functions

Output	Description
Synchronous signal	UAM generates 1ms pulse is in every scan.
Error	Signal goes to ON state when UAM is in error state.
Window contamination error	Signal goes to ON state when contamination on the optical window reaches the error level.
Window contamination warning	Signal goes to ON state when contamination on the optical window reaches the warning level.

<Synchronous signal timing chart>

UAM outputs a signal synchronized with its scan at the time shown in the figure below.



Note: Signal will be OFF when the device is in lockout state due to malfunction.

Figure 3-33 Synchronous signal timing chart

Danger

- Auxiliary output signals should not be used for the safety function. Failing to comply will lead to critical injury or death.

4 Application examples of UAM

The section describes some application examples of UAM and safety distance calculation in the respective application. When using the UAM as protective equipment, guidelines below should be taken into account.

a) Hazard should be identified and risk assessment should be carried out.

b) UAM should not be used for finger protection

c) Working environment should be within the specification of UAM

d) Safety distance must be determined in accordance to ISO 13855 and IEC 61496-3.

Danger

- Operating the UAM beyond its specification could lead to critical injury and death.

4.1 Access protection (Stationary, Horizontal, Protection zone 1)

In the access protection application, UAM is mounted horizontally to protect the hazardous area (Figure 4-1). The protection zone is configured around the hazardous area to prevent the entry of human beings or object. Warning zone 1 and Warning zone 2 are configured surrounding the protection zone. Warning zones are used for alerting human beings or object from approaching the protection zone and preventing unnecessary stops of the protected machine. Any objects or human beings detected in the protection zone will cause the protection detection state to switch to OFF-state from ON-state. Any objects and/or human beings detected in the warning zones will cause the warning detection state to switch from ON-state to OFF-state. The safety distance for this application is shown in Figure 4-2 and Figure 4-3.

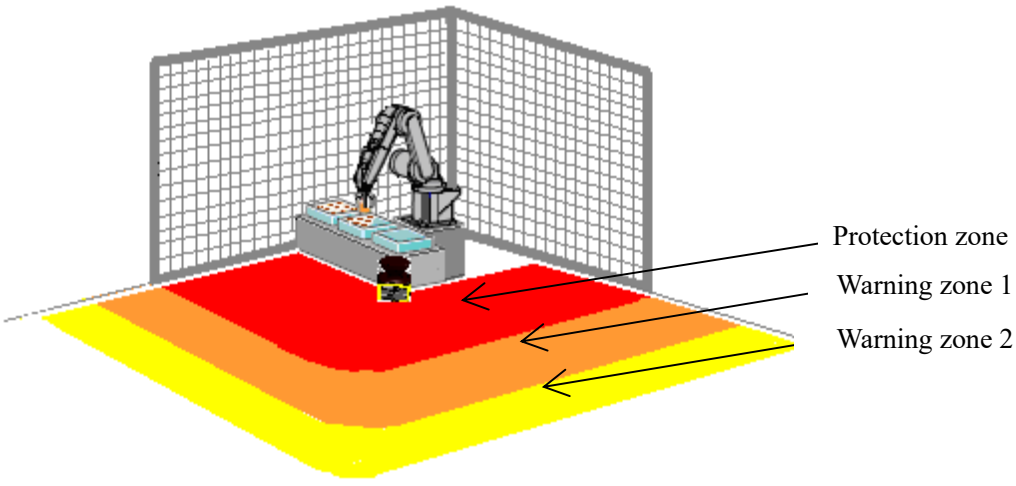


Figure 4-1 Example of access protection (stationary type, protection zone1)

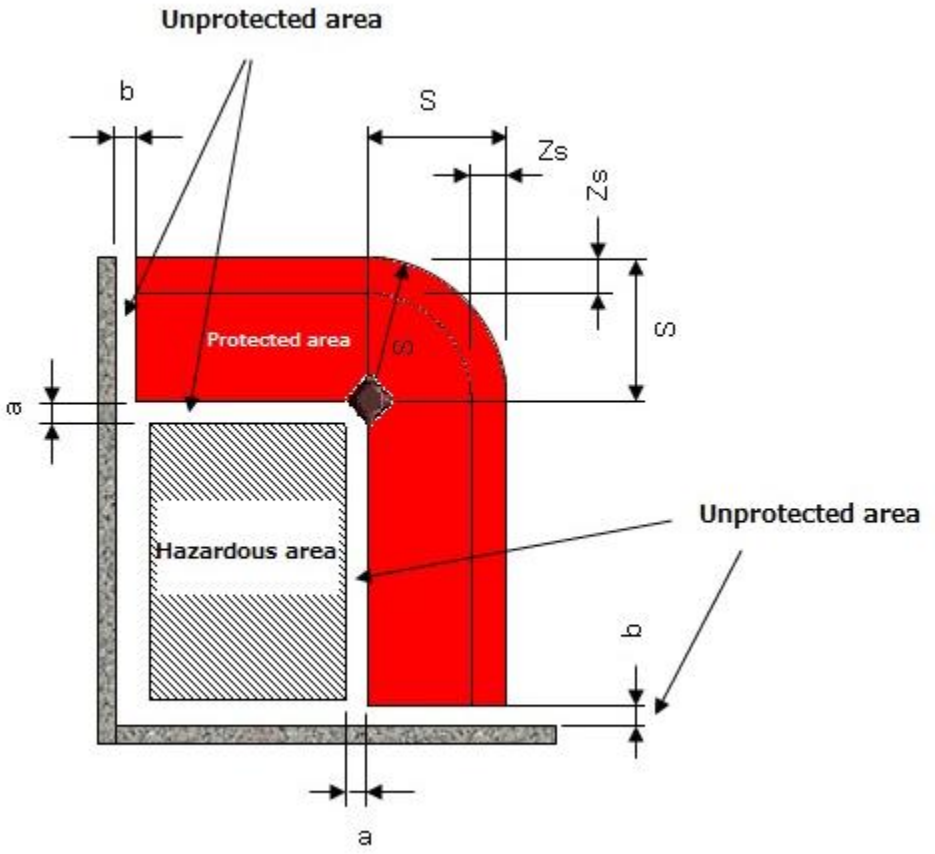


Figure 4-2 Top view of access protection (stationary type)

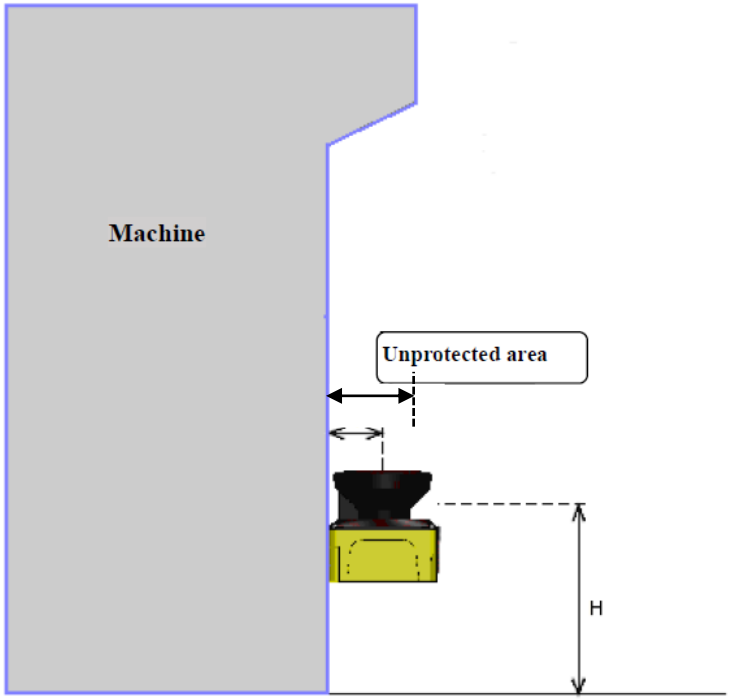


Figure 4-3 Side view of access protection (stationary type)

For safety distance calculation:

$$S=(K\times(T_m+T_s))+C+Z_s$$

where:

S = Safety distance (mm)

K = Approach speed 1600 (mm/s)

T_m = Maximum stopping/run-down time of the machine or system (s)

T_s = Response time of UAM (s)

C = 1200-0.4×H≧850

H = the height at which the protective field is mounted (mm)

1000≧H≧15× (d−50)

d = Minimum detectable object width (mm)

Z_s= UAM tolerance distance (mm)

Danger

- User must ensure the distance between the hazard zone edge and origin of the protection zone “a” must be less than the minimum detectable width. In application where the value of “a” is greater than the minimum detectable width, additional protective measures should be taken to prevent penetration through this unprotected area.
- UAM should not be mounted higher than 300mm to prevent the possibility of crawling beneath the detection plane.
- For applications which require the UAM to be mounted higher than 300mm, additional measures should be taken to prevent intrusion beneath the detection plane.
- If UAM is mounted in a public area, the height of the detection plane should be reduced to 200mm or to the height required by regulations of the local authority.

Note

- It is recommended to mark the floor of the protection zone.
- Distance tolerance should be taken into account when configuring the safety distance.
- Additional tolerance should be applied when UAM is used in the presence of high reflective background.
- User should ensure that boundary or protective measures used are not included inside the protected zone. They will be detected as obstacles causing protection detection to remain in OFF-state.
- User should ensure the gap of 100mm between the protection zone and the distance of the wall “b” to prevent the detection by the sensor.

4.2 Access protection (Stationary, Horizontal, Protection zone 2)

In the access protection application, UAM is mounted horizontally to simultaneously protect two hazardous areas(Figure4-4). Protection zones are configured around the hazardous area to prevent the entry of human beings or object. Any objects or human beings detected in the protection zones will switch the respective protection detection state to OFF state from ON-state. In this configuration it is possible to protect two equipment using a single UAM. The safety distance for this application should be considered in the same way as described in Section 4.1.

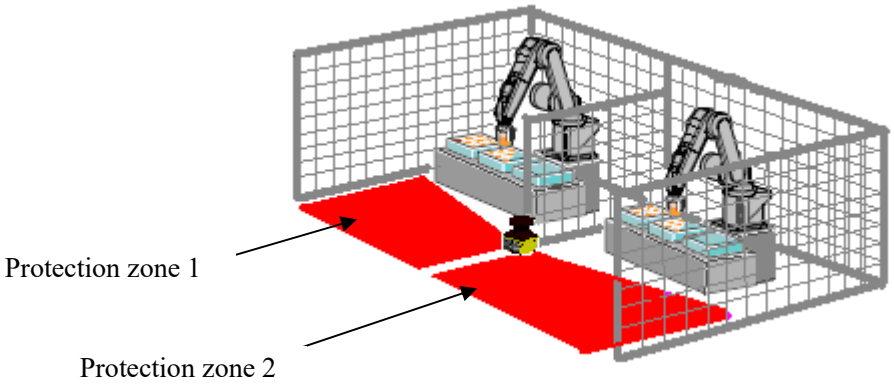


Figure 4-4 Example of access protection (stationary type, protection zone2)

4.3 Access protection (Stationary, Vertical, Whole body detection)

UAM can be used as a protective shield by mounting it vertically (Figure 4-5). Application shown in the figure is generally used in preventing the access to hazardous area. When an object or human enter the passage, protection detection state will switch from ON-state to OFF-state.

In this configuration, UAM detects objects or human beings in vertical plane. It is not possible to detect an object or human being at the front or back side of the detection plane. Therefore, caution should be taken while setting the distance between the detection plane and hazardous area. Configure the shortest response time of UAM not exceeding 80ms. Always use reference monitoring function in such applications to detect the displacement of fences and UAM which may expose the hazardous area. Protection detection state will switch to OFF state when the position of reference is changed. The safety distance for this application is shown in Figure 4-6 and Figure 4-7.

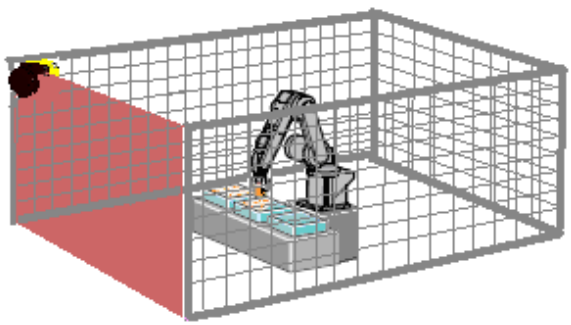


Figure 4-5 Example of access protection (Whole body detection)

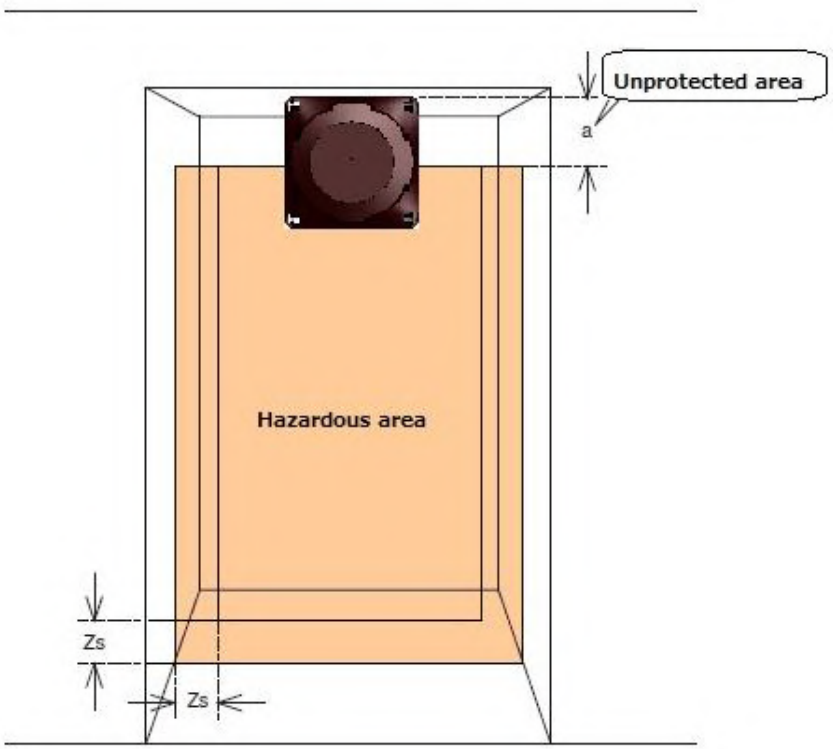


Figure 4-6 Top view of access protection (Whole body detection)

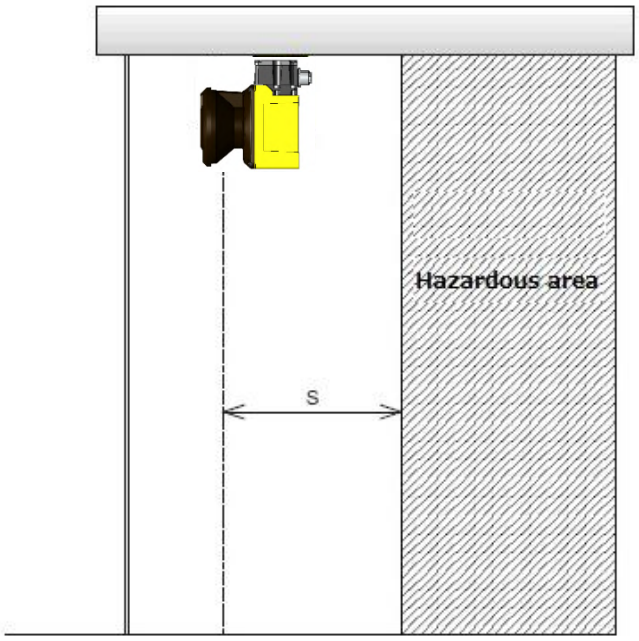


Figure 4-7 Side view of access protection (Whole body detection)

For Safety distance calculation:

$$S=(K\times(T_m+T_s))+C$$

where:

S = Safety distance (mm)

K = Approach speed 1600 (mm/s)

$\mathbf{T_m}$ = Maximum stopping/run-down time of the machine or system (s)

$\mathbf{T_s}$ = Response time of UAM (s)

C = Additional distance of 850mm by considering arm intrusion (mm)

Danger

- User should ensure that the width of unprotected zone "a" is smaller than the minimum detectable width. If the value of "a" is greater than minimum detectable width, additional protective measures should be taken to prevent the penetration through this unprotected zone.
- In the access protection application where the angle of approach exceeds ±30º, "Reference monitoring" function should be used with 100mm tolerance range for the reference zone. Response time should be configured below 80ms in such application.
- Reference segments should be configured on each side of reference boundary.
- UAM should be mounted in such a way that accessibility towards hazardous point is impossible. Use additional protective measures if necessary.
- Tolerance should be taken in account when configuring the reference segments.

4.4 Access protection (Stationary, Vertical, Parts of body detection)

Figure 4-8 shows an example to prevent the access when part of the body is approached near the hazardous area. If objects or part of body enters such area, protection detection state switches to OFF state from ON-state. UAM detects an object or human being in vertical plane in such configuration. It is not possible to detect an object or human being at the front or back side of the detection plane. Therefore, caution should be taken while deciding the distance between approaching point and hazardous area. The width of protection zone should be sufficient to protect the hazardous area. Always use reference monitor function in such applications to detect the displacement of fences and UAM which may expose the hazardous area. Protection detection state will switch to OFF state when the position of reference is changed. The safety distance for this application is shown in Figure 4-8 and Figure 4-9. Refer to section 7.14for configuring the protection zone.

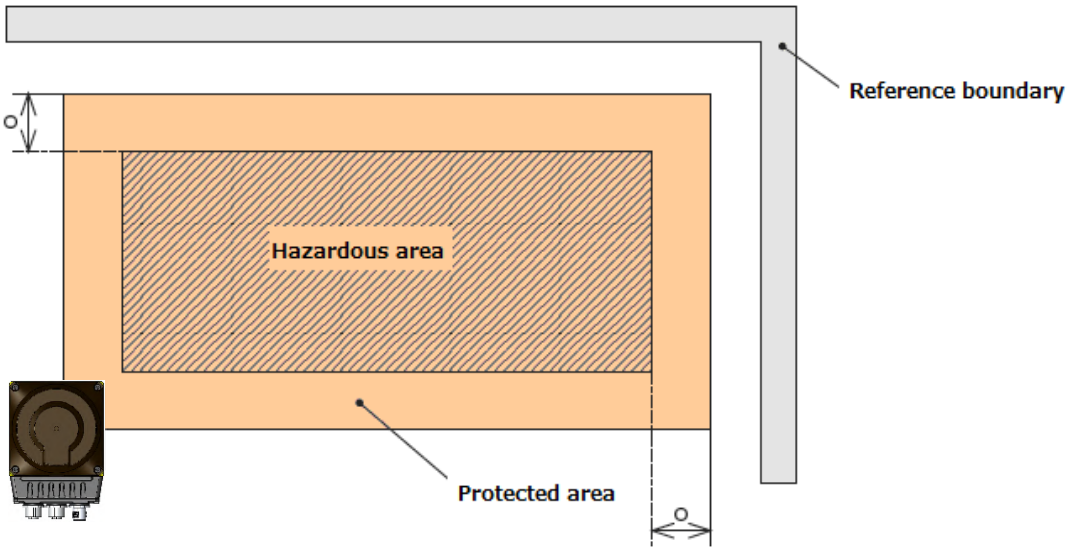


Figure 4-8 Front view of access protection (For detection of body parts)

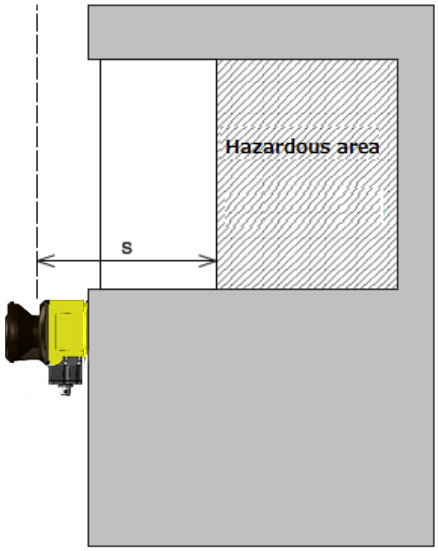


Figure 4-9 Side view of access protection (For detection of body parts)

For Safety distance calculation

S= (K×(Tm+Ts)) + C

where:

S = Safety distance (mm)

K = Approach speed 2000mm/s

$\mathbf{T_m}$ = Maximum stopping/run-down time of the machine or system (s)

$\mathbf{T_s}$ = Response time of UAM (s)

C = Additional distance

$= 8 \times (d - 14)$

d = Minimum detectable object width (mm)

O = Additional width from edge of hazard source

$\geq (2 \times Z_s) - d$

d = Minimum detectable object width (mm)

$\mathbf{Z_s}$= UAM's tolerance distance (mm)

Danger

- In the access protection application, where the angle of the approach exceeds ±30º, "Reference boundary monitoring" function should be used.
- Reference segments should be configured on each side of reference boundary.
- Tolerance of the reference segment should be less than 100mm.
- For detection of body parts, minimum detectable width should be configured as 30mm or 40mm
- UAM should be mounted in such a way that it is impossible to access the hazardous point. Use additional protective measures if necessary.

Note

- When the S > 500mm, value for K can be replace with 1600mm/s instead of 2000mm/s. However, minimum value of S will be 500mm in such cases.

4.5 Area protection (Mobile, Horizontal, Protection zone 1, Fixed area)

UAM can be used for mobile applications such as AGV (Figure 4-10). It is installed on an AGV to detect objects while travelling along a fixed route. Warning signals in such application can be used for reducing the speed and protection detection state can be used for stop the AGV. A maximum 176 area sets can be used to match the travel route of the AGV. Confirm the time and distance required for the AGV to stop completely when configuring the protection and warning zones. The safety distance for this application is shown in Figure 4-11 and Figure 4-12 .

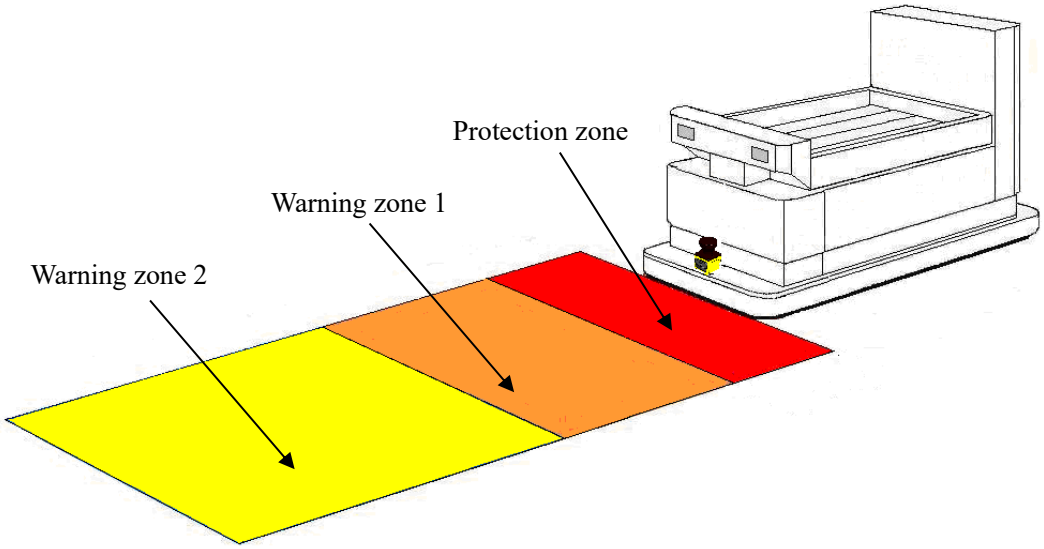


Figure 4-10 Example of area protection (Mobile)

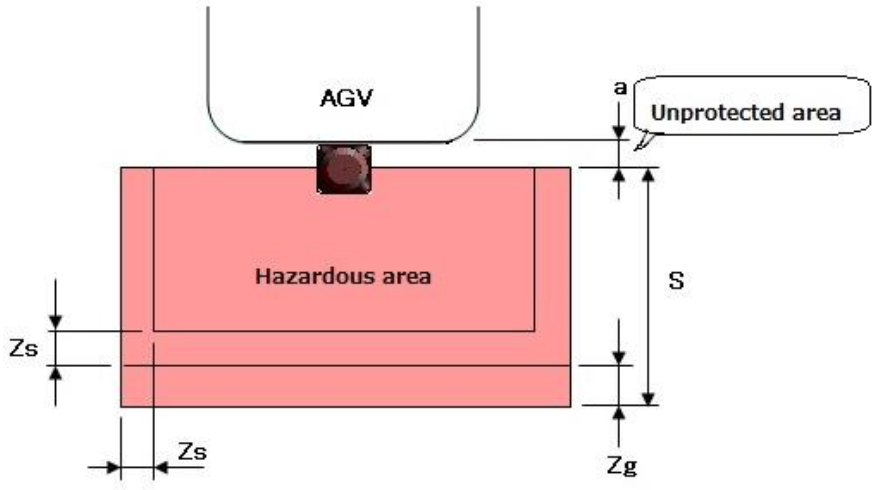


Figure 4-11 Top view of area protection (Mobile)

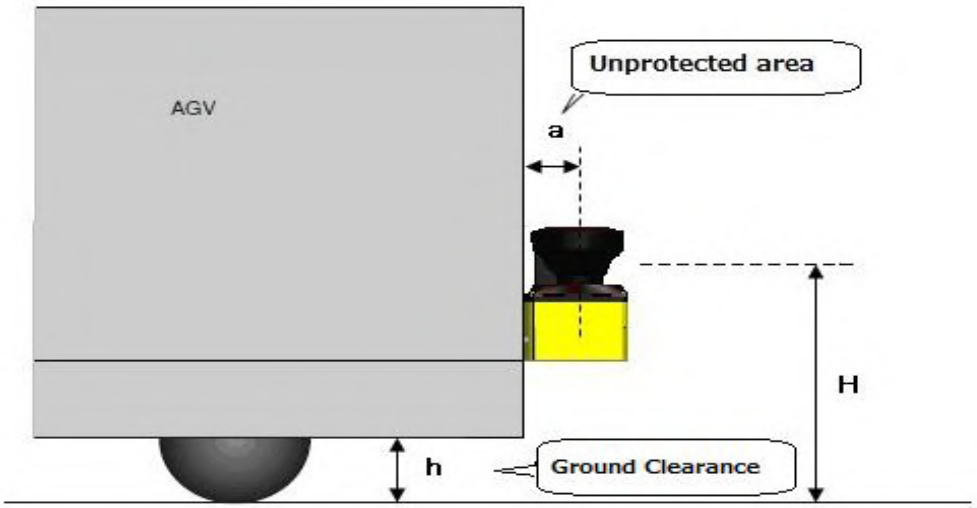


Figure 4-12 Side view of area protection (Mobile)

For Safety distance calculation:

$$S = V \times (T_m + T_s) + Z_b \times L + Z_s + Z_g$$

where:

S = Safety distance (mm)

V = Maximum approaching speed of AGV (mm/s)

$\mathbf{T_m}$ = Maximum stopping/run-down time of the machine or system (s)

$\mathbf{T_s}$ = Response time of UAM (s)

$\mathbf{Z_b}$ = Distance required for AGV to stop (mm)

L= Brake wear coefficient

$\mathbf{Z_s}$ = UAM tolerance distance (mm)

$\mathbf{Z_g}$ **=** Additional of distance with the lack of ground clearance (mm)

h **=** Ground clearance (mm)

When using the UAM on an AGV, user should confirm the time and distance required for the AGV to stop completely as it will move forward during the response time of UAM. It is important to note that distance required to stop is not proportional to the speed, but proportional to the square of the speed.

Further, sufficient ground clearance should be provided to prevent injuries, such as, hitting the toes. Figure 4-13 shows the relationship between ground clearance h and Z_g.

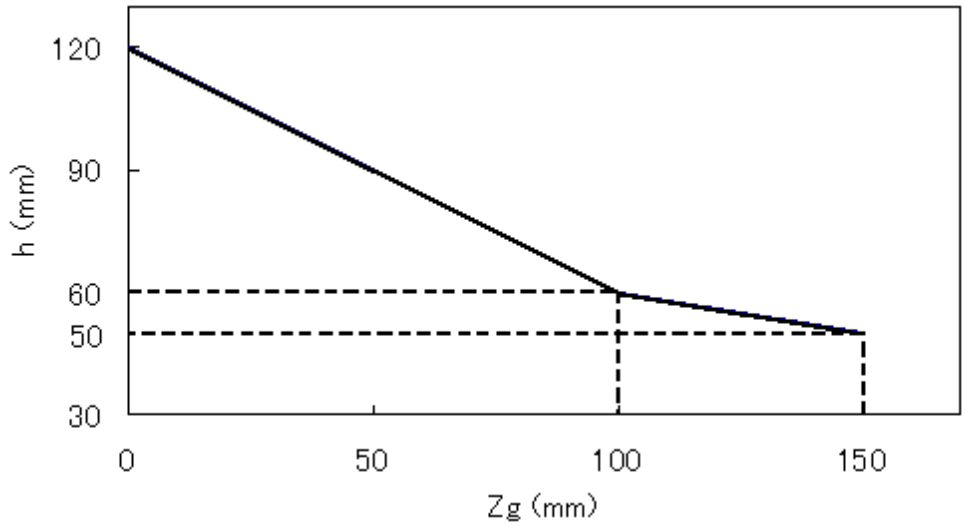


Figure 4-13 The relationship between Z_g and h

Danger

- User should ensure that the width of unprotected area "a" is smaller than the minimum detectable width. When the distance "a" is greater than minimum detectable width, additional protective measures should be taken to prevent the penetration through this unprotected area.
- UAM should not be mounted higher than 200mm to prevent the possibility of crawling beneath the detection plane.
- Detection plane should not be inclined as this could lead to the failure of UAM to detect an object with a diameter of 200mm.

Note

- User should ensure that boundary or protective measures used are not inside the configured protected zone. It will be detected as obstacles causing protection detection to remain in OFF-state.

4.6 Area protection (Mobile, Horizontal, Protection zone 1, Variable Area)

For applications where AGV travels in a single direction, it is possible to switch to different areas at corners for effectively monitoring the obstacles at front (Figure 4-14).

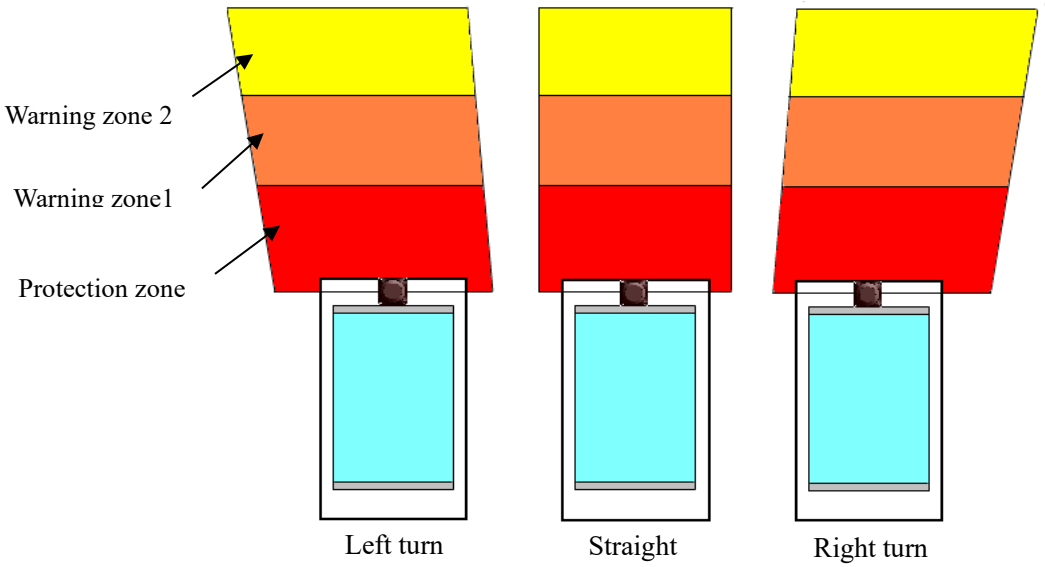


Figure 4-14 one example of AGV scanning area at curve (Top view)

4.7 Area protection (Mobile, Horizontal, Protection zone 1, Encoder Input)

When incremental encoder is used, area can be switched depending on the speed of AGV (Figure4-15).

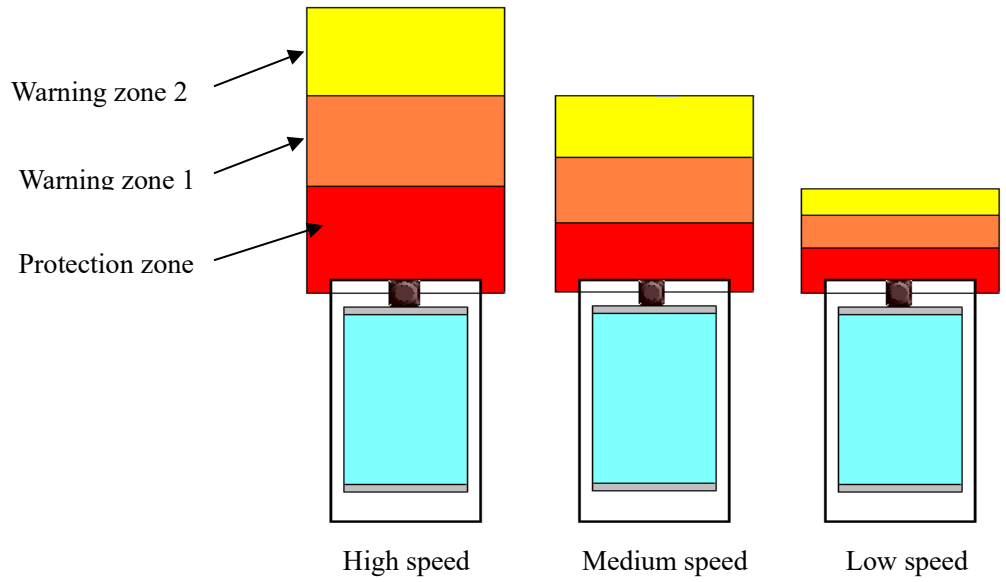


Figure 4-15 Example of AGV's scanning area depending on the speed (Top view)

4.8 Area protection (Mobile, Horizontal, 2 Units Interconnected, Variable Area)

For AGVs travelling in both directions, it is possible to use 2 interconnected units of UAM, each mounted at front and back. Safety can be improved by switching each unit to monitor the area with appropriate size and shape based on the speed and direction of travel. Further, it is also possible to use incremental encoder in such systems for area switching.

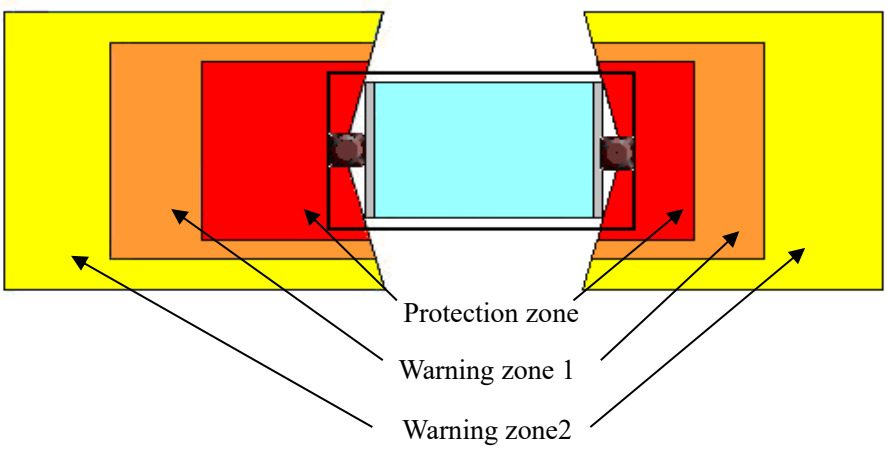


Figure 4-16 Example of AGV's scanning area which can travel in both the direction (Top view)

4.9 Area protection (Mobile, Horizontal, 4 Units Interconnected, Variable Area)

For AGVs travelling in all directions it is possible to use 4 interconnected units of UAMs mounted on each side of AGV. Safety can be improved by switching each unit to the area with appropriate size and shape based on the speed and direction of travel. Further, it is also possible to use incremental encoder in such systems for area switching.

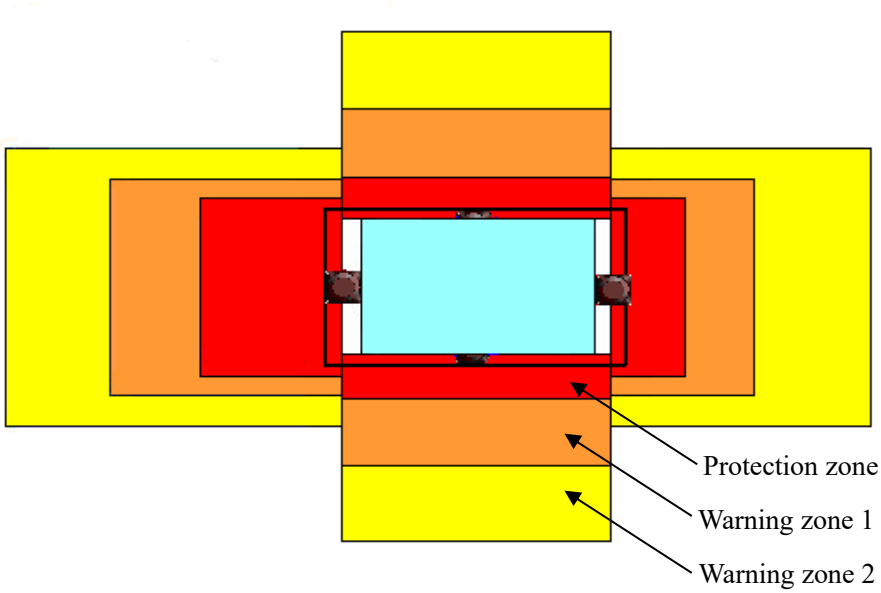


Figure 4-17 Example of AGV's scanning area which can travel in all the direction (Top view)

4.10 **Area protection (Mobile, Horizontal, Autonomous Navigation)**

UAM monitors both protection and warning zones and simultaneously transfers the measured data of the surrounding through the Ethernet to the main control unit of AGV. Supplied data can be used for autonomous route selection. For such systems, there is no need to install guidance means such as optical beacons or electromagnetic tapes on the floor. Refer to UAM-05LECA_Communication_specification (C-64-00220) for the Ethernet communication protocol.

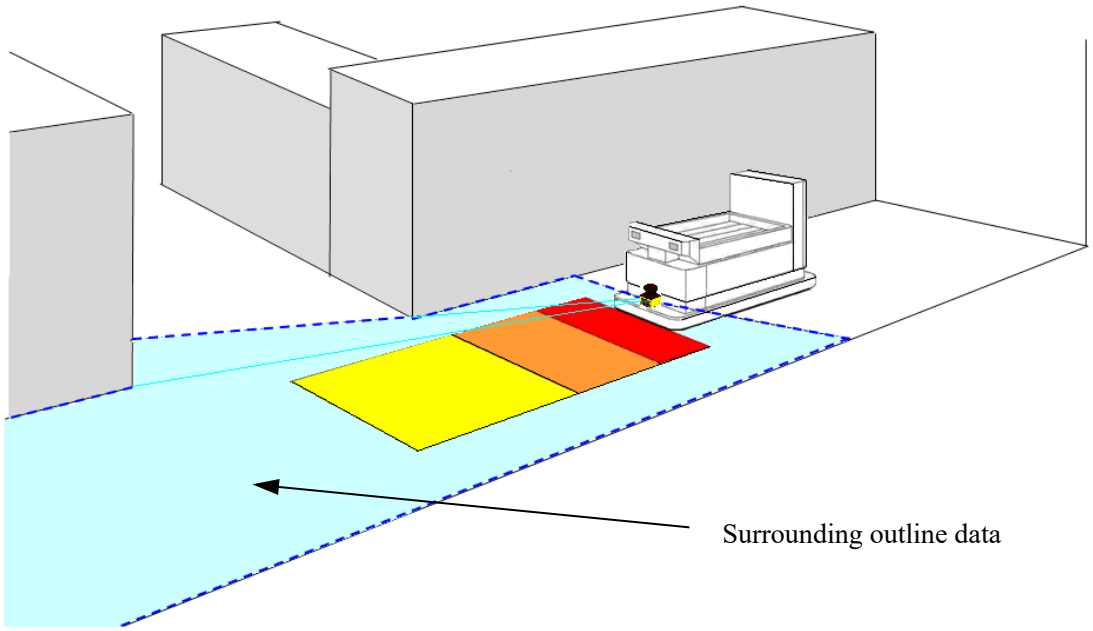


Figure 4-18 Image of automatically operated AGV

4.11 Default Values

When configuring the device, default settings will be set is depending on the type of application selected on the configuration software, UAM Project Designer. Table 4-1 shows the selected values.

Area will not be configured to any default value when selecting the applications. Configure the appropriate area by calculating the safety distance or based on the risk assessment performed on the system. Perform pre-operation tests on UAM to verify the correctness of the selected parameters.

Table 4-1 Default values for selected applications

Applications	Sensing		Interlock		Reference Monitoring (Tolerance)	Off response time (Common to all areas)
	Minimum detection width	Active areas	Start/Restart Setting	Delay		
General	70mm	1	-	-	-	170ms
Access protection (Horizontal application Stationary)	70mm	1	Manual/Auto	1s	-	170ms
Access protection (Vertical application- whole body detection)	70mm	1	Manual/Auto	1s	Used(100mm)	110ms
Access protection (Vertical application Stationary)	30mm	1	Manual/Auto	1s	Used(100mm)	110ms
AGV	70mm	32	-	-	-	140ms

5 Installation

Cautions during the installation of UAM are explained in this chapter.

5.1 Light interference

UAM uses pulsed laser for object detection. Light sources in the surrounding could interfere with its operation leading to false detection. User should examine the surroundings environments before installing the UAM. Some of the light sources that could interfere with UAM are as below.

a) Incandescent light
b) Fluorescent light
c) Stroboscopic light
d) Flashing beacon
e) Sunlight
f) Infrared light sources

In case the light source cannot be avoided during the operation, UAM should be installed with the light source located at ±5 degrees or more from the detection plane to prevent the interference (Figure 5-1).

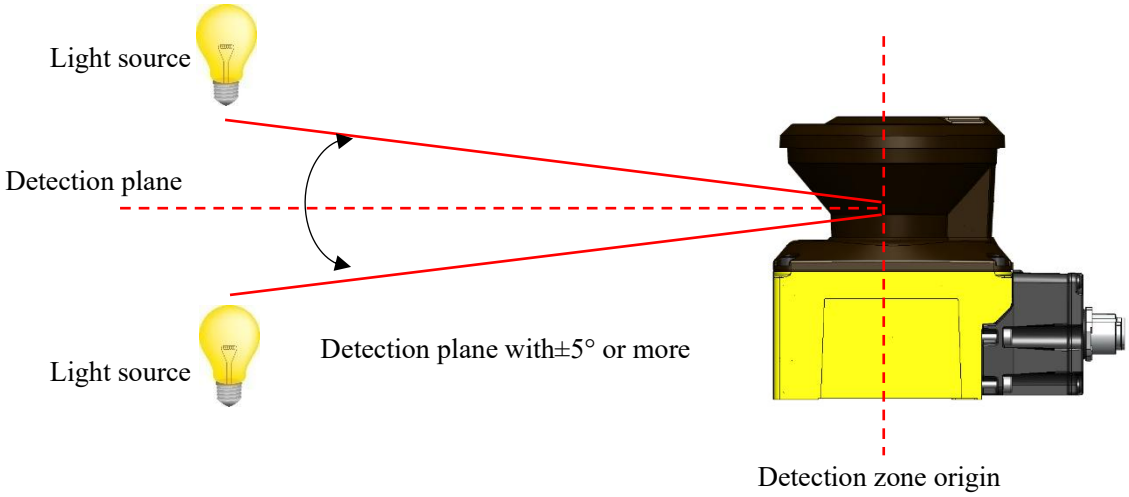


Figure 5-1 Installation to avoid light interference

Danger

- User should perform risk assessment for light interference in the working environment before the installation.
- Avoid direct light such as stroboscopic, flashing beacon, fluorescent.
- Failing to comply with the above could lead to critical injury or death.

Caution

- User should verify detection capability before actual operation.

5.2 Mutual interference

Cautions are required while using two or more units of UAM or identical products as pulsed laser signal from one another could lead to false detection. Figures below show the installation method for avoiding the mutual interference.

a) Changing the height of installation

Install at different heights to separate the mutual detection plane by 5 degrees or more.

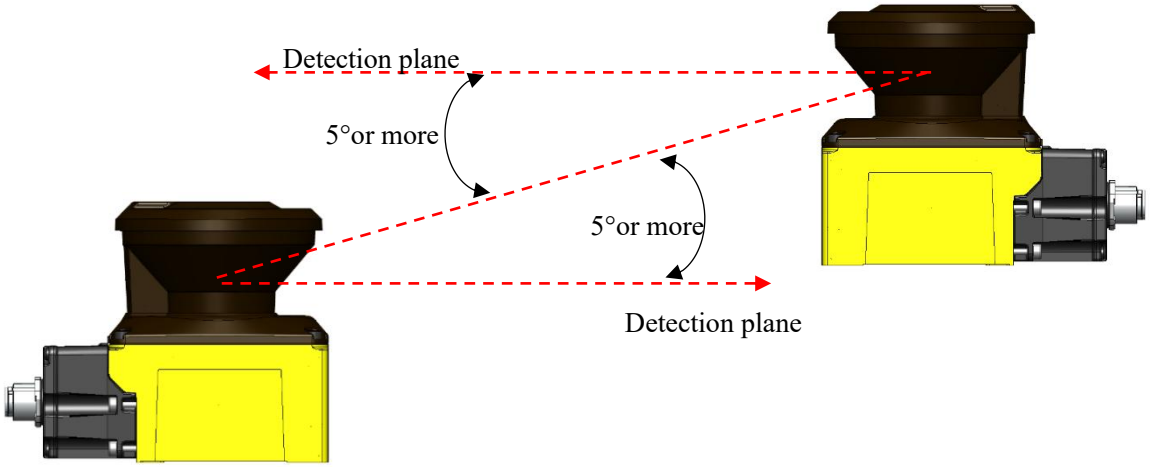


Figure 5-2 Opposite facing installation

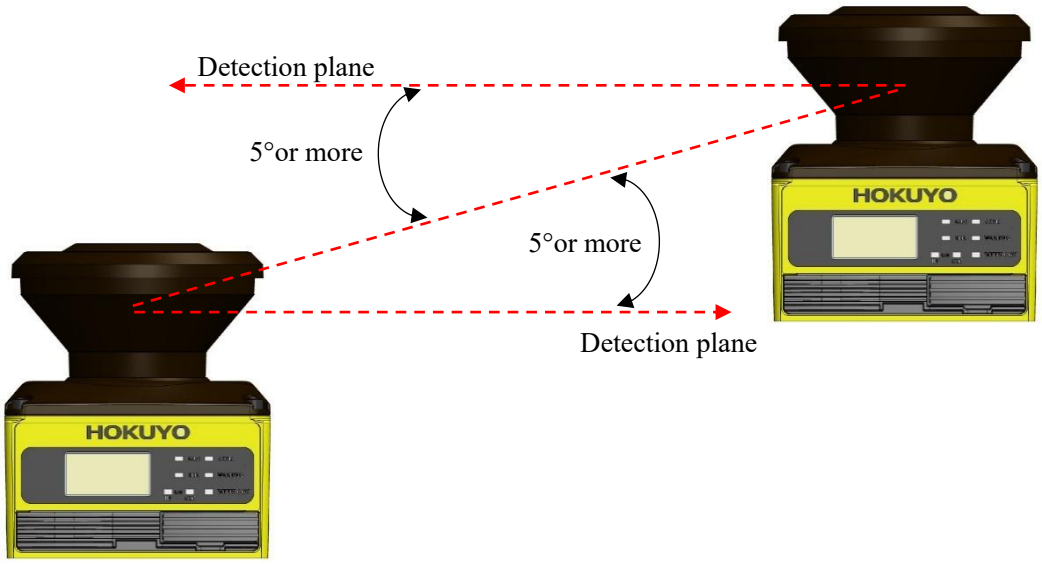


Figure 5-3 Parallel installation

b) Changing the angle of installation

Change the installation angle of UAM by 5 degrees or more from the mutual detection plane.

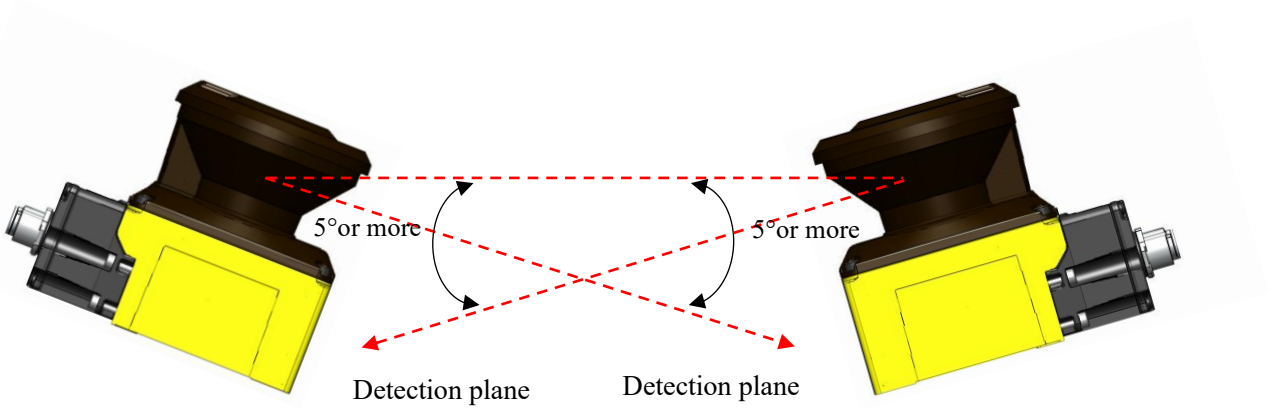


Figure 5-4 opposite facing installation

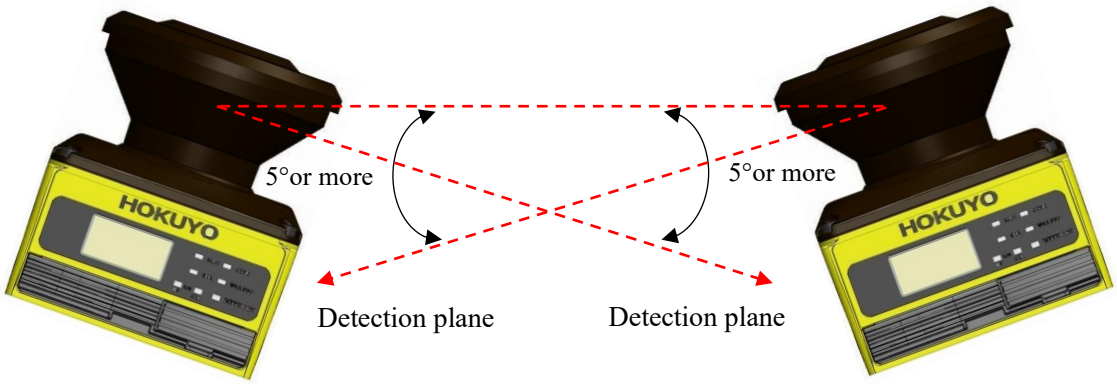


Figure 5-5 Parallel installation

C) Adding a shield between UAMs

Add a shield between UAMs such that laser beam of one unit cannot reach the other to avoid the possible mutual interference.

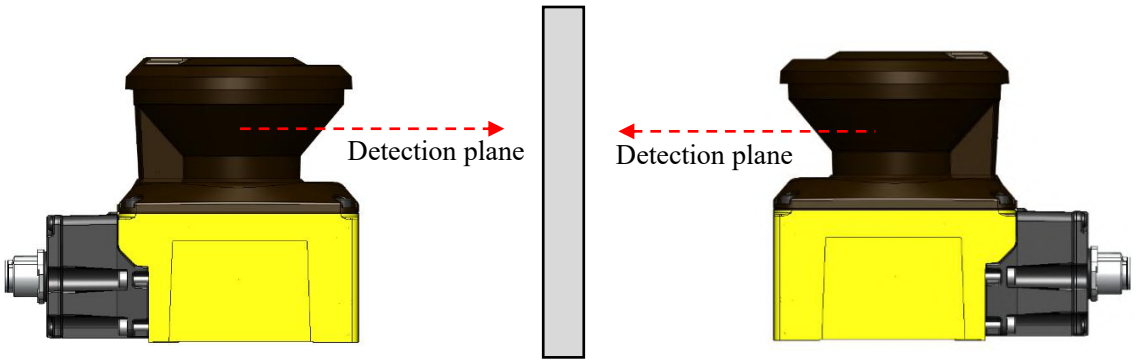


Figure 5-6 opposite facing installation

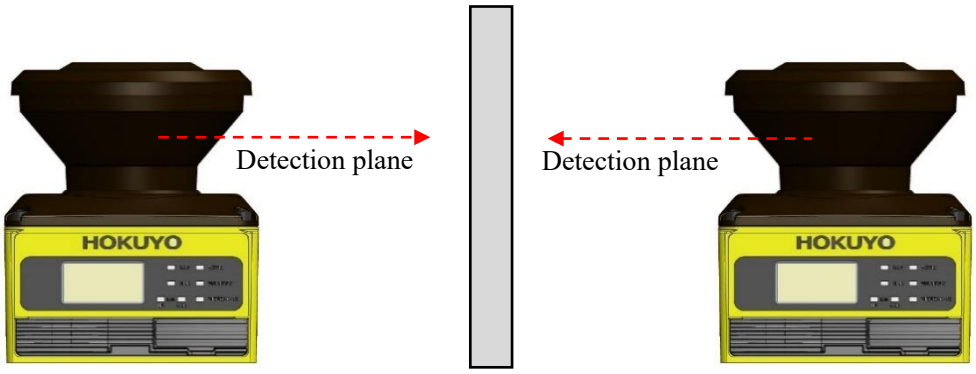


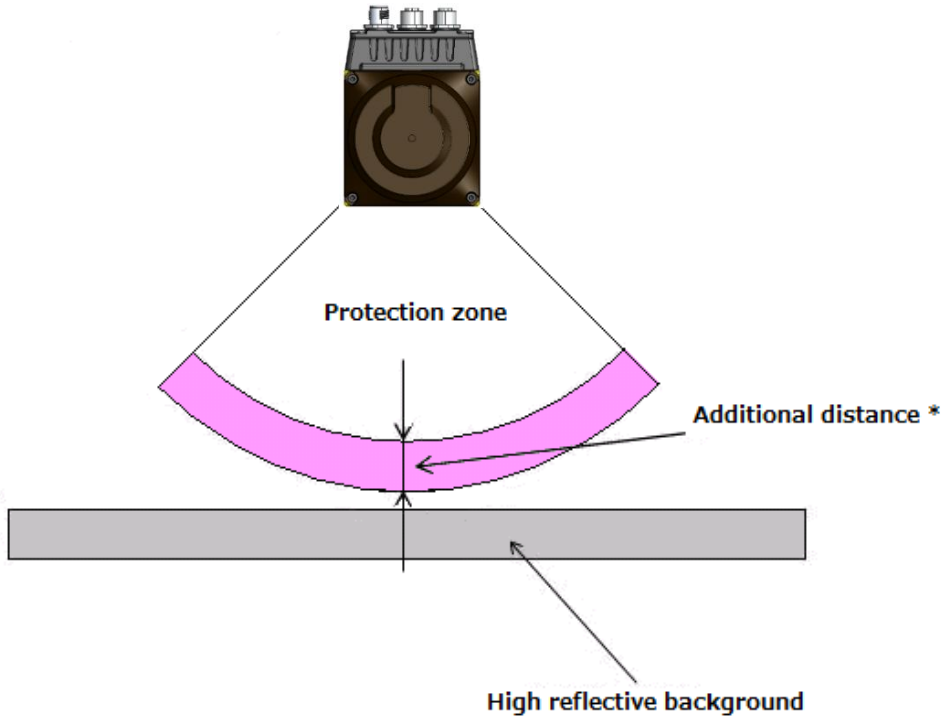
Figure 5-7 Parallel installation

Note

- Shielding material should be opaque.

5.3 High reflective background

Measured value will be longer than the actual distance of the object due to highly reflective background leading to wrong detection result. When high reflective background cannot be avoided in the operating environment, additional distance of 200mm is necessary while configuring the protection and warning zones (Figure 5-8).



* Additional distance : Required additional distance when operating UAM under high reflective background

Figure 5-8 Additional distance in high reflective background

Danger

- Measured value will be longer than actual distance of the object if the background is highly reflective. Additional distance should be included when configuring the protection zone.
- High reflective background (Ex.: Mirror, corner cube reflector, reflective safety jacket, road reflector) should be avoided. Reflectance caused by these materials could lead to false detection in the protection zone.
- Verify the configured areas before actual operation.
- Failing to comply with the above could lead to critical injury or death.

5.4 **Limited detection capability zone**

The limited detection capability zone is defined as a region between the optical window and start of the detection zone. The limited detection capability zone of the UAM is 90mm from the origin of UAM (Figure 5-9). Presence of object with low reflectance may not be detected in this zone.

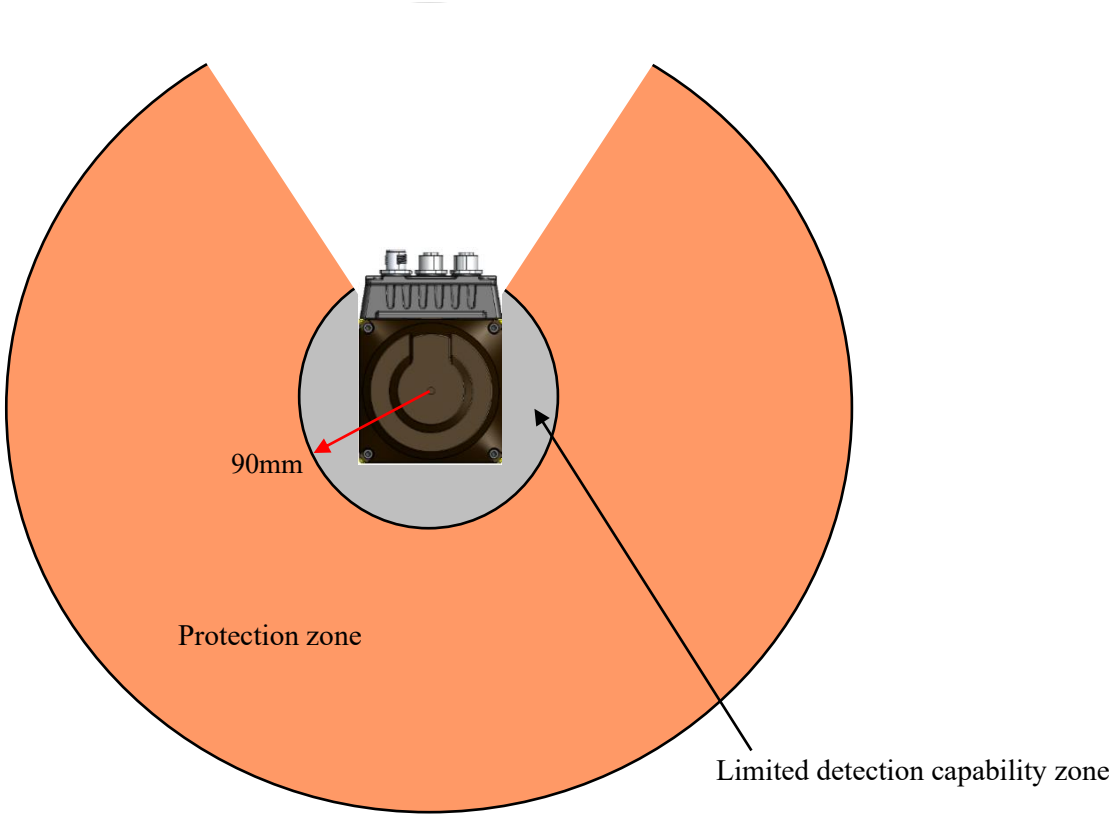


Figure 5-9 Limited detection capability zone

Danger

- User should perform risk assessment for possibility of object penetration into the limited detection capability zone.

6 Wiring

This chapter describes safety precaution when wiring the UAM.

6.1 Precautions

1) During electric wiring make sure that all devices are disconnected from power supply. Switch off all the power supply during wiring. Confirm that power supply is OFF.

2) Do not exceed cable length stated in the specification of UAM.

6.2 Power supply

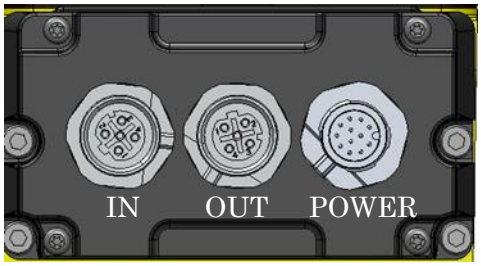
Make sure that power supply is within the range of DC 24V±10%. For battery operation, power supply should be within the range of DC 24V -30% / +20%. UAM could be damaged if rated output voltage exceeds this range.

Danger

- For safety, switch OFF the power supply during electrical wiring.
- Do not use cables longer than those mentioned in the specification of UAM.

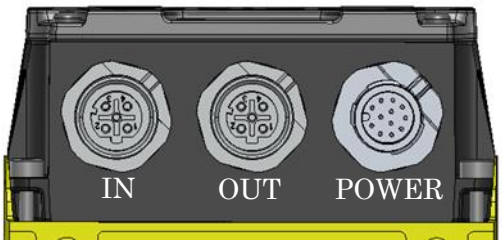
6.3 Input / Output cable and function

Table 6-1 shows the signal name of each lead wire and function. It is recommended to use the shielded cable for wiring.



Back connection type

(Model: UAM-5CUBA)



Bottom connection type

(Model: UAM-5CUBO)

Figure 6-1 Layout of connectors

< Specification of Power and I/O connector >

M12 connector　12core　A code　Plug (Male)

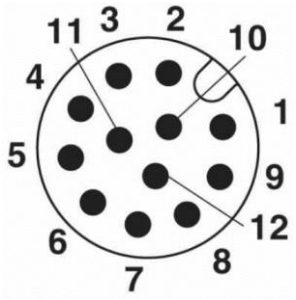


Figure 6-2 Layout of power and IO connector pins

Table 6-1 Wire function

No	Signal	Function	Description	Color*
1	+24VDC	Power	Power supply: DC24V	Brown
2	0VDC	Power	Power supply: 0V	Blue
3	P1_MUT_IN1 / ENC1_A	Input	Protection zone1/ Muting input 1 / Encoder input 1_A	White
4	P1_MUT_IN2 / ENC1_B	Input	Protection zone1/ Muting input 2 / Encoder input 1_B	Green
5	P2_MUT_IN1 / ENC2_A	Input	Protection zone2/Muting input 1 / Encoder input 2_A	Pink
6	P2_MUT_IN2 / ENC2_B	Input	Protection zone2/ Muting input 2 / Encoder input 2_B	Yellow
7	RESET1 / ENC3_A	Input	Reset input 1 / Encoder input 3_A	Black
8	RESET2 / ENC3_B	Input	Reset input 2 / Encoder input 3_B	Gray
9	OVERRIDE1 / ENC4_A	Input	Override 1 / Encoder input 4_A	Red
10	OVERRIDE2 / ENC4_B	Input	Override 2 / Encoder input 4_B	Violet
11	RES_REQ1/MUT_OUT1 AUX_OUT1	Output	RES_REQ1: ON when ready to accept reset input for protection zone1 (when hardware input is used). MUT_OUT1: ON when protection zone1 is in muting state (when hardware input is used) AUX_OUT1: Default OFF ・Synchronous signal (1ms pulse) ・Error ・Window contamination error ・Window contamination warning	Gray/Pink

Table 6-2 Wire function(continued)

No	Signal	Function	Description	Color*
12	RES_REQ2/MUT_OUT2 AUX_OUT2	Output	RES_REQ2: ON when ready to accept reset input for protection zone2 (when hardware input is used). MUT_OUT2: ON when protection zone2 is in muting state (when hardware input is used) AUX_OUT2: Default OFF ・Synchronous signal (1ms pulse) ・Error ・Window contamination error ・Window contamination warning	Red/Blue

*Applicable to optional cables.

< Specification of EtherCAT connectors (IN/OUT) >

M12connector 4core D code Plug (Female)

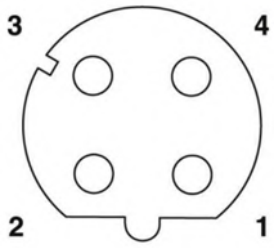


Figure 6-3 Layout of EtherCAT connector pins

Table 6-3 Connector functions of EtherCAT (IN)

No	Signal	Function
1	TD+	EtherCAT_IN TD+
2	RD+	EtherCAT_IN RD+
3	TD-	EtherCAT_IN TD-
4	RD-	EtherCAT_IN RD-

Table 6-4 Connector functions of EtherCAT (OUT)

No	Signal	Function
1	TD+	EtherCAT_OUT TD+
2	RD+	EtherCAT_OUT RD+
3	TD-	EtherCAT_OUT TD-
4	RD-	EtherCAT_OUT RD-

6.4 **Wiring example**

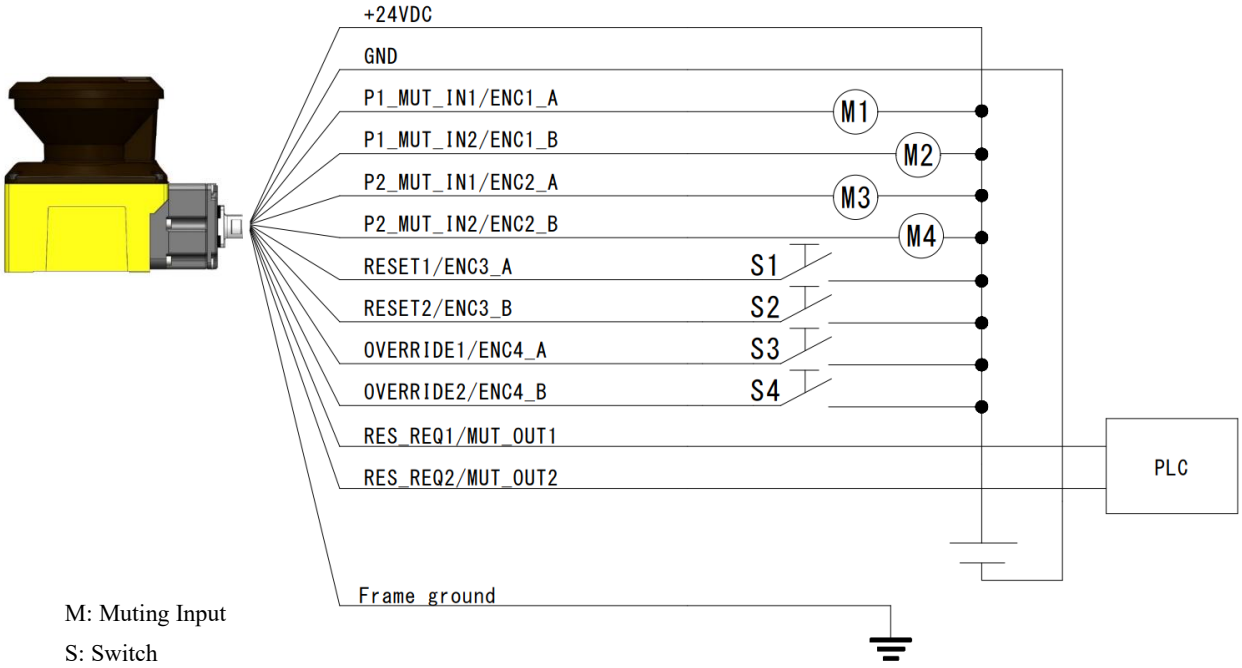


Figure 6-4 Wiring Example

6.5 Input/ Output circuit

6.5.1 Output circuit

RES_REQ1/2, MUT_OUT1/2, AUX_OUT1/2 outputs are PNP type.

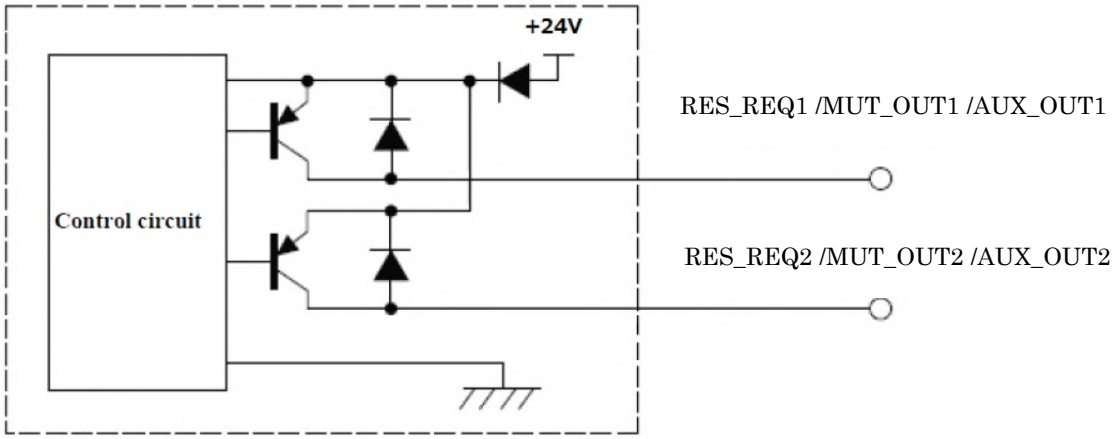


Figure 6-5 Output circuit

6.5.2 Input circuit

Figure 6-6 shows input circuit for RESET1/2, MUTING 1/2/3/4, OVERRIDE 1/2, and ENC1/2/3/4 signals.

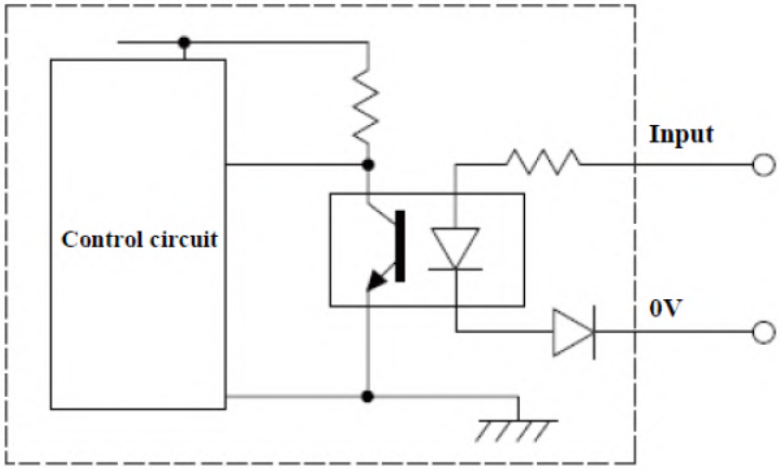


Figure 6-6 Input circuit

7 Function configuration of UAM

7.1 About UAM Project Designer

UAM Project Designer is the application software for UAM that is developed for the following functions.

a) Protection and warning zone configuration
b) Function configuration
c) Displaying the measurement data
d) Record and playback of measurement data
e) Project data management (saving and opening the project data).
f) Generate FoE file

Note

- Figures, illustrations, displays and indications in this manual may differ depending on user's system or environment settings.

7.2 System requirements

Table 7-1 Minimum system required for UAM Project Designer

Item	Explanation	
Interface	USB 1.1/2.0/3.0	
	Ethernet over EtherCAT (EoE)	
PC	CPU	Intel®Core™i3 or above
	RAM	4GB or more
	Hard disk	512MB minimum free space
	Microsoft® Windows® 10 64bit	
	Microsoft® Windows® 11 64bit	
Display	FWXGA (1366×768) or more	

Operation cannot be guaranteed for the following system environment.

- OS other than mentioned above.
- NEC PC98 series and its compatible device.
- Self-assembled PC
- Multi boot environment
- Multi monitor environment
- Upgraded OS from the standard OS

Note

- Even if the system requirements are fulfilled, operation is not guaranteed in all PCs.
- Read the UAM user's manual before configuration. User's manual can be opened from the help menu of UAM Project Designer.
- Cover the USB connector and SD card slot with protective cap when UAM is operating. Make sure that mist or dust does not enter the device.
- Do not use the USB cable of mobile chargers. It is recommended to use a standard USB cable and avoid the winding type.

7.3 Installation of UAM Project Designer

a) Download the configuration application, UAM Project Designer from the company web site, https://www.hokuyo-aut.jp

b) Run the "UAM Project Designer_*.*_installer.exe" file.

c) Follow the instructions to complete the installation.

Note

- Log in as "Administrator" to authorize the installation of the UAM Project Designer. Installation cannot proceed if PC is not running in "Administrator" mode.
- UAM project designer is installed at "C:\Program Files\UAM Project Designer" by default. To install in a different folder, assign the location during the installation process.

7.3.1 Uninstallation UAM Project Designer

Process to uninstall the UAM Project Designer is as shown below.

a) Select all programs from the start menu.

b) Select "Uninstall UAM Project Designer" in the "UAM Project Designer" folder.

c) When "Are you sure you want to completely remove UAM Project Designer and all of its related components?" message appears, click [Yes] to uninstall the program from the PC.

d) Click [OK] when uninstalling process is complete. Restarting the PC is recommended.

Following is the alternative method to uninstall the application,

a) Select the "Control Panel" in the start menu.

b) Click the "Uninstall Programs".

c) Select "UAM Project Designer" and click [Delete].

d) When "Ready to uninstall UAM Project Designer" appears, click [Yes] to uninstall the program from the PC.

e) Click [OK] when uninstalling process is complete. Restarting the PC is recommended.

7.4 Starting the UAM Project Designer

Explanation on this section is based on Microsoft Windows 10. Although the display may differ slightly in the other OS, same method can be applied.

a) Supply the Power to the sensor. Connect USB cable of the sensor to the computer.

b) Double click on the shortcut icon on the desktop created during the UAM Project Designer installation or select the UAM Project Designer application located at [Start] → [All Programs] → [UAM Project Designer] folder.

c) "UAM Project Designer" application will be activated.

7.4.1 Startup Main window

a) Main window as shown in Figure 7-1 will be displayed when UAM project designer starts.

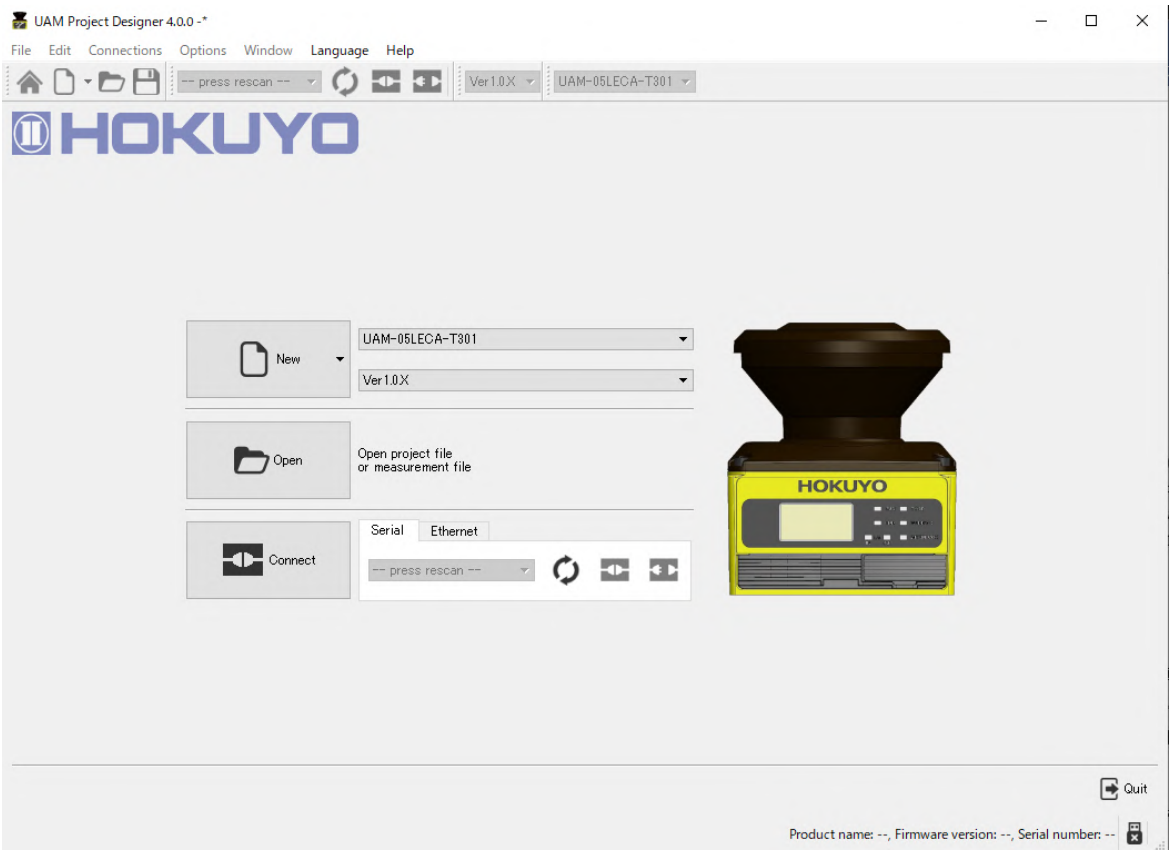


Figure 7-1 Main window

b) Select the method to operate UAM.

Table 7-2 Operating Method

Method	Description
New	Checks the firmware version and creates a new project file for UAM.
Open	Opens an existing project file or the measurement data file
Connect	Establish communication between PC and sensor.

7.4.2 Create new configuration

When “New” is selected, a window as shown in Figure 7-2 will appear.

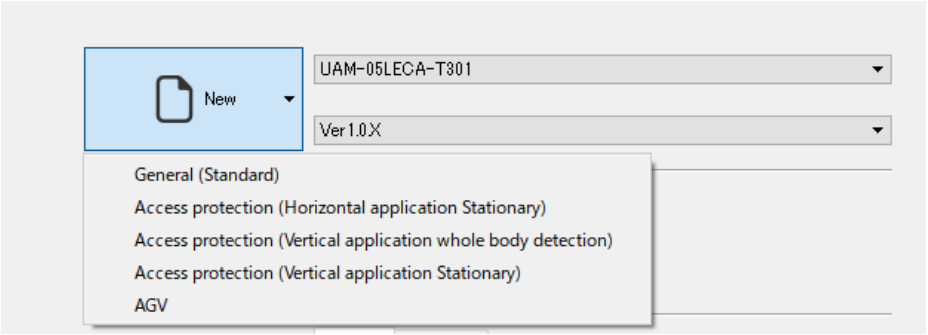


Figure 7-2 Application selection window

A window shown in Figure 7-3 will appear when clicked on “General (Standard)”.

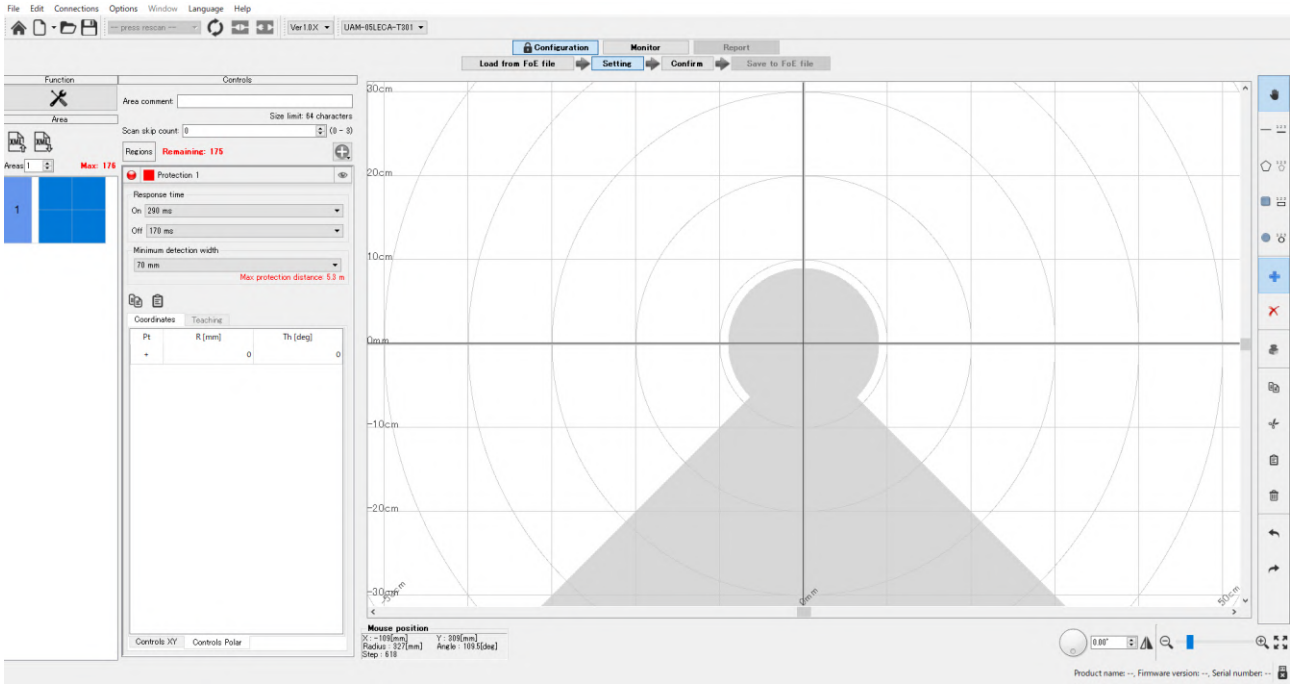


Figure 7-3 New configuration window

7.4.3 Open configuration file or measurement data file

When the “Open” is selected, a window as shown in Figure 7-4 will be displayed. Select the previously saved project（*.hux, *.hucx）, click open to read the settings. Modify the settings if required. Confirm all the settings and proceed to transmit to transfer the configuration to UAM.

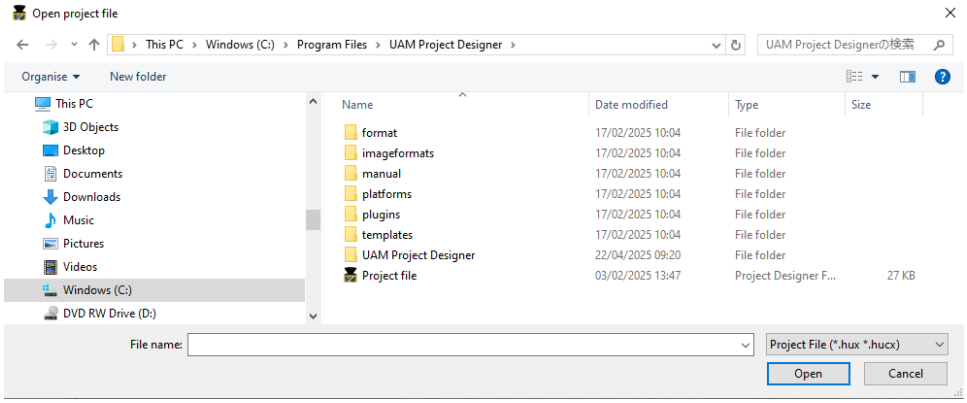


Figure 7-4 Selection of project file

7.4.4 Connect to UAM

When “Connect” button is clicked, a window as shown in Figure 7-5 is displayed indicating the information are being read from UAM. When the settings are successfully transferred, UAM project designer will switch to monitor mode.

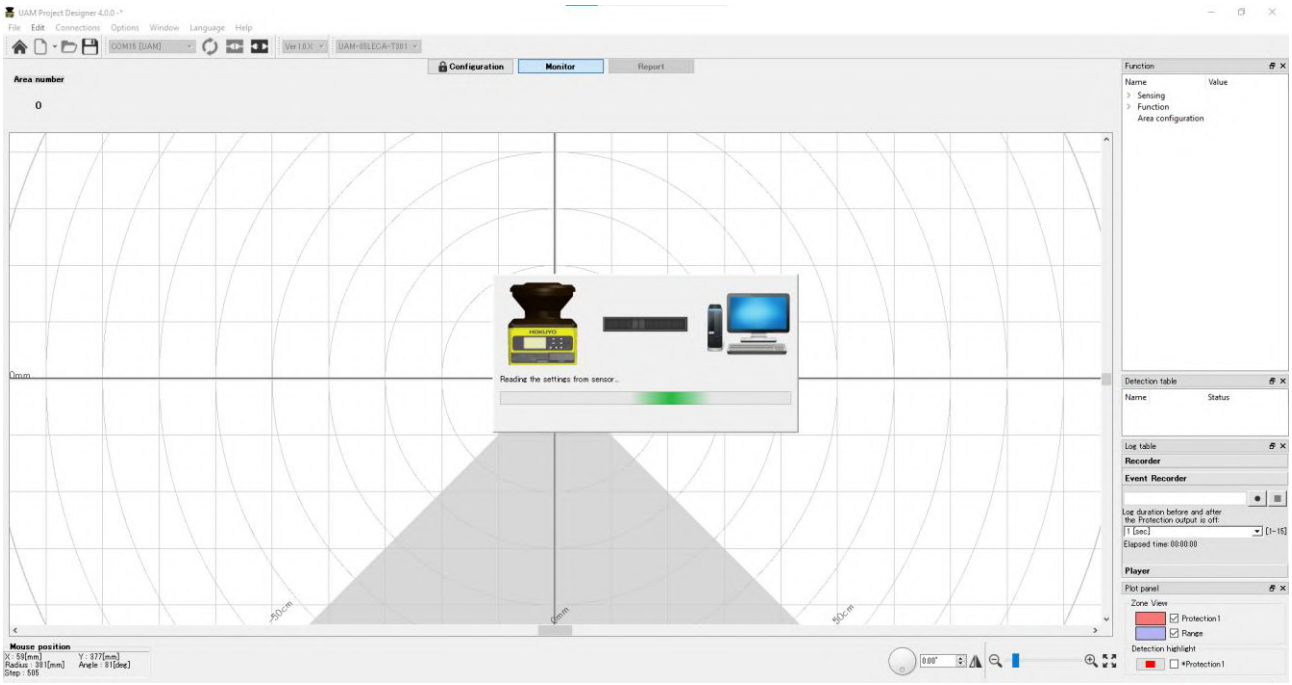


Figure 7-5 Connecting with UAM

7.5 Components of UAM Project Designer

Figure 7-6 shows the name of each component on the main window.

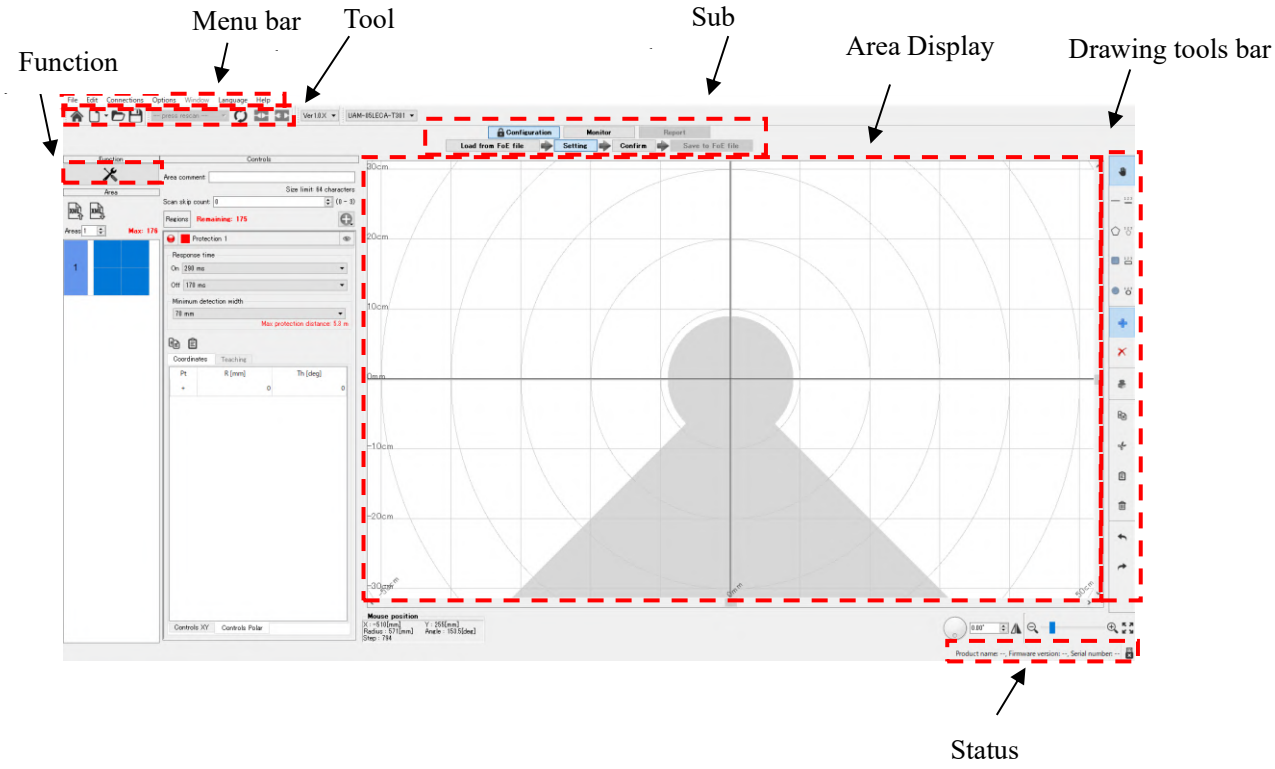


Figure 7-6 UAM Project Designer components

7.6 Menu bar

This section explains the functions of all items in the menu bar. Each function can be executed by either clicking the respective items or by the short-cut key. When UAM is not connected, some items will be in gray and cannot be used.

7.6.1 File

This menu is used for creating and saving the project file and closing the application. When file is clicked, items as shown in the Figure 7-7 will be displayed. Table 7-3 shows the details of each item.

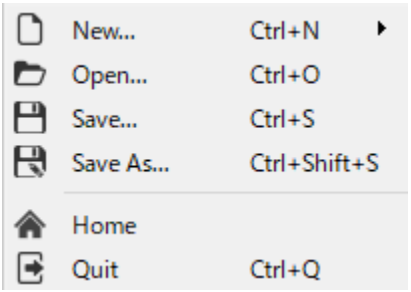


Figure 7-7 File menu

Table 7-3 File menu

Item	Short-cut Key	Function
New	Ctrl + N	Create a new configuration file for UAM
Open	Ctrl + O	Open an existing configurations file
Save	Ctrl + S	Save the current project file
Save As	Ctrl + Shift + S	Save the current project file after naming
Home	-	Returns to start up window.
Quit	Ctrl + Q	Close the UAM Project Designer

7.6.2 Edit

This menu is used for editing the area. When edit is clicked, items as shown in the Figure 7-8 will be displayed. Table 7-4 shows the details of each item.

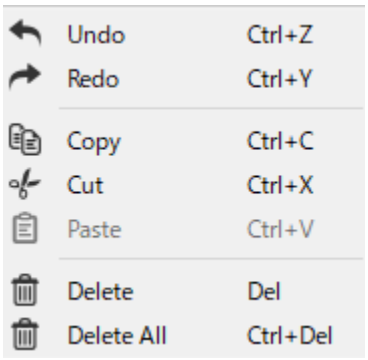


Figure 7-8 Edit

Table 7-4 Edit

Item	Short-cut Key	Function
Undo	Ctrl + Z	It will undo the previous operation.
Redo	Ctrl + Y	It will redo the last operation.
Copy	Ctrl + C	Copy single area.
Cut	Ctrl + X	Cut single selected area. Delete the original area.
Paste	Ctrl + V	Paste the selected area in other area.
Delete	Del	Delete the single selected zone.
Delete all	Ctrl + Del	Delete all the selected area.

7.6.3 Connection

When connection is clicked, items as shown in the Figure 7-9 will be displayed. Table 7-5 shows the details of each item.

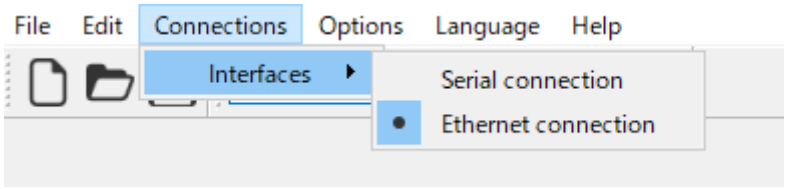


Figure 7-9 Connection

Table 7-5 Connection

Item	Function
Serial connection	UAM connected by USB interface.
Ethernet connection	UAM is connected by Ethernet via master controller unit

7.6.4 Option

When option is clicked, items as shown in the Figure 7-10 will be displayed. Table 7-6 shows the details of each item. When UAM is not connected some items will be in gray and cannot be selected.

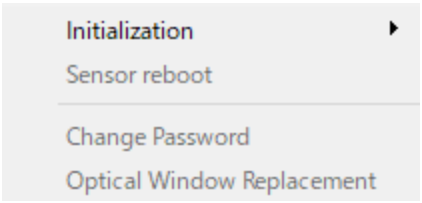


Figure 7-10 Option

Table 7-6 Option

Item	Function
Initialization	Clear UAM'S configurations to default
Sensor reboot	Restart UAM to recover from the error state
Change Password	Change to new 8-digit numeric password
Optical Window Replacement	Open optical window replacement tool (Optical Window Replacement)

7.6.5 Window

Window menu will be active in monitor mode. Items shown in Figure 7-11 will be displayed when it is clicked. Table 7-7 shows the details of each item.

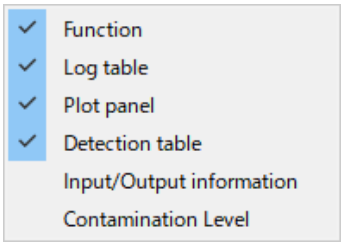


Figure 7-11 Window

Table 7-7 Window

Item	Function
Function	Shows the Function panel on the Monitor window which displays UAM's operating parameters.
Log table	Shows the Log table panel on the Monitor window which records and playback the UAM's data.
Plot Panel	Shows the Plot panel on the Monitor window which allows selection of protection and warning zone display as well as highlight the detection points.
Detection table	Shows the Detection Table on the monitor window to view obstacle detection state.
Input /Output table	Shows the Input /Output Table on the monitor window to view hardware, safety input and output state.
Contamination Level	Shows the Contamination window on the monitor window to see the location of contamination.

7.6.6 Language

This menu is used for changing the application language to English, Japanese. Chinese or German. Items in the menu are shown in the Figure 7-12. Table 7-8 shows the details of each item.

Figure 7-12 Language

Table 7-8 Language

Item	Function
English	Language switches to English
中文（簡体）	Language switches to Chinese
日本語	Language switches to Japanese
Deutsch	Language switches to German

7.6.7 Help

When help is clicked, items as shown in the Figure 7-13 will be displayed. Table 7-9 shows the details of each item.

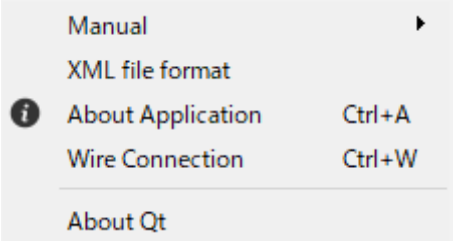


Figure 7-13 Help

Table 7-9 Help

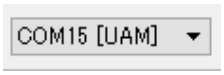
Item	Short-cut key	Function
Manual	-	Shows the manual of compatible UAM models
XML file format	-	Displays format details of XML file
About the application	Ctrl + A	Displays the version details of UAM Project Designer
Wire Connection	Ctrl + W	Displays the wire color and their function allocation
About Qt	-	Displays the information related to Qt

7.7 Tool bar

Frequently used functions are listed on the tool bar. Details of the item are shown in Table 7-10. When UAM is not connected some items will be in gray and cannot be selected

Figure 7-14 Tool bar

Table 7-10 Tool bar

Icon	Function
	Returns to application's startup window.
	Creates a new configuration file for UAM
	Opens a saved file.
	Saves the project file.
	Displays the port number connected to UAM.
	Rescan the USB port
	Establish connection between the sensor and UAM Project Designer.
	Disconnect sensor with UAM Project Designer.
	Selection of UAM's software version when writing the Project.
	Selection of UAM's model when writing the Project.

7.8 Subpanel

Subpanel is used for switching the UAM modes (Configuration, Monitor and Report). Items are displayed in grey when they cannot be used.

Figure 7-15 Subpanels when the sensor is not connected

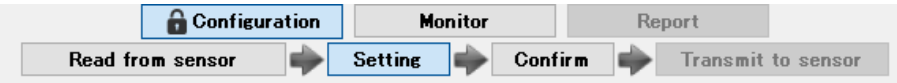


Figure 7-16 Subpanels when sensor is connected

7.8.1 Configuration tab

Configuration tab consists of Functional setting and Area configuration windows. There are 4 subpanels in the configuration tab which will differ depending on the UAM's connection state. When the sensor is connected the displayed panels are; "Read from sensor", "Setting", "Confirm" and "Transmit to Sensor". When the sensor is not connected the panels switches to; "Load from FoE File", "Setting", "Confirm" and "Save to FoE File". Users can configure UAM by sequentially selecting these tabs.

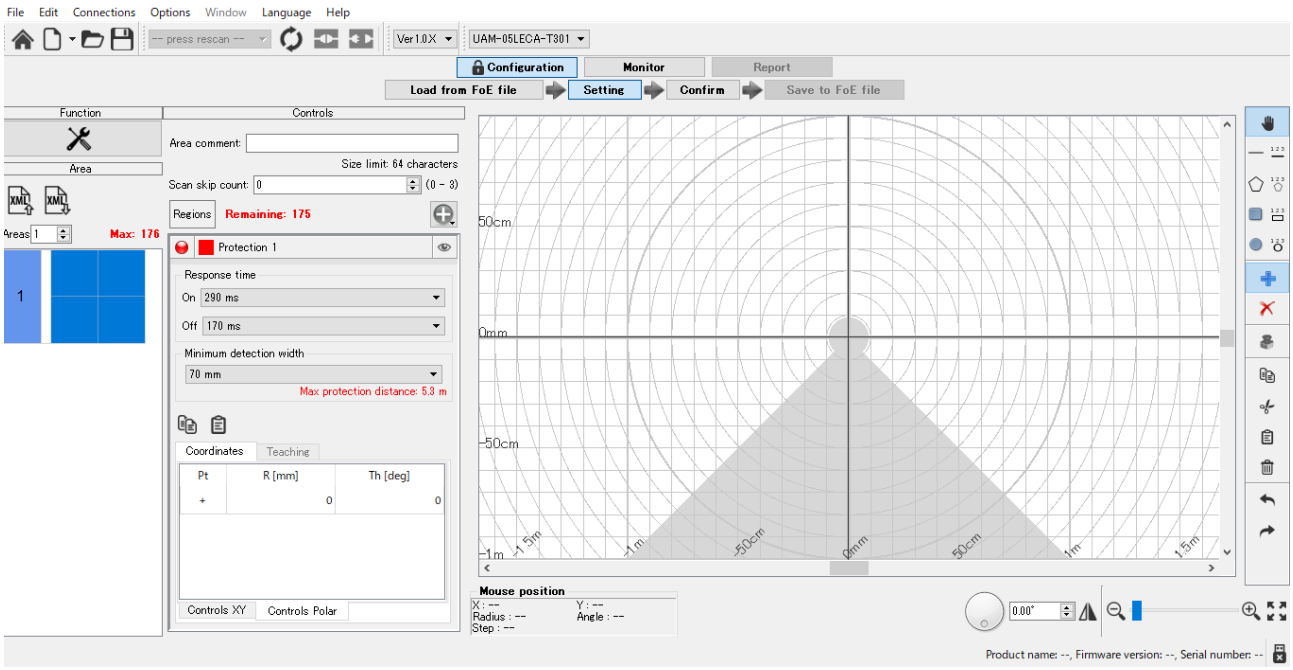


Figure 7-17 Configuration tab

a) Read from sensor or Load from FoE file

When application is connected to UAM, the application will show "Read from sensor" button. Clicking on this button will load the setting from the device to the application. If application is not connected to UAM, it will show "Load from FoE file" button. Clicking on this button will open the folder selection dialog. Application will load the settings from FoE file or project file when the corresponding file is selected and "Open" button is clicked.

b) Function

Figure 7-18 Function setting button

Clicking on the function button will display a panel to configure the following functions.

i. Sensing
ii. Interlock
iii. Muting
iv. Reference Monitor
v. Area Sequence
vi. Encoder Input

See section 7.13 for the details on each function's parameters.

c) Area

User can configure and edit area shapes on this section of configuration tab. Details of each component are explained below.

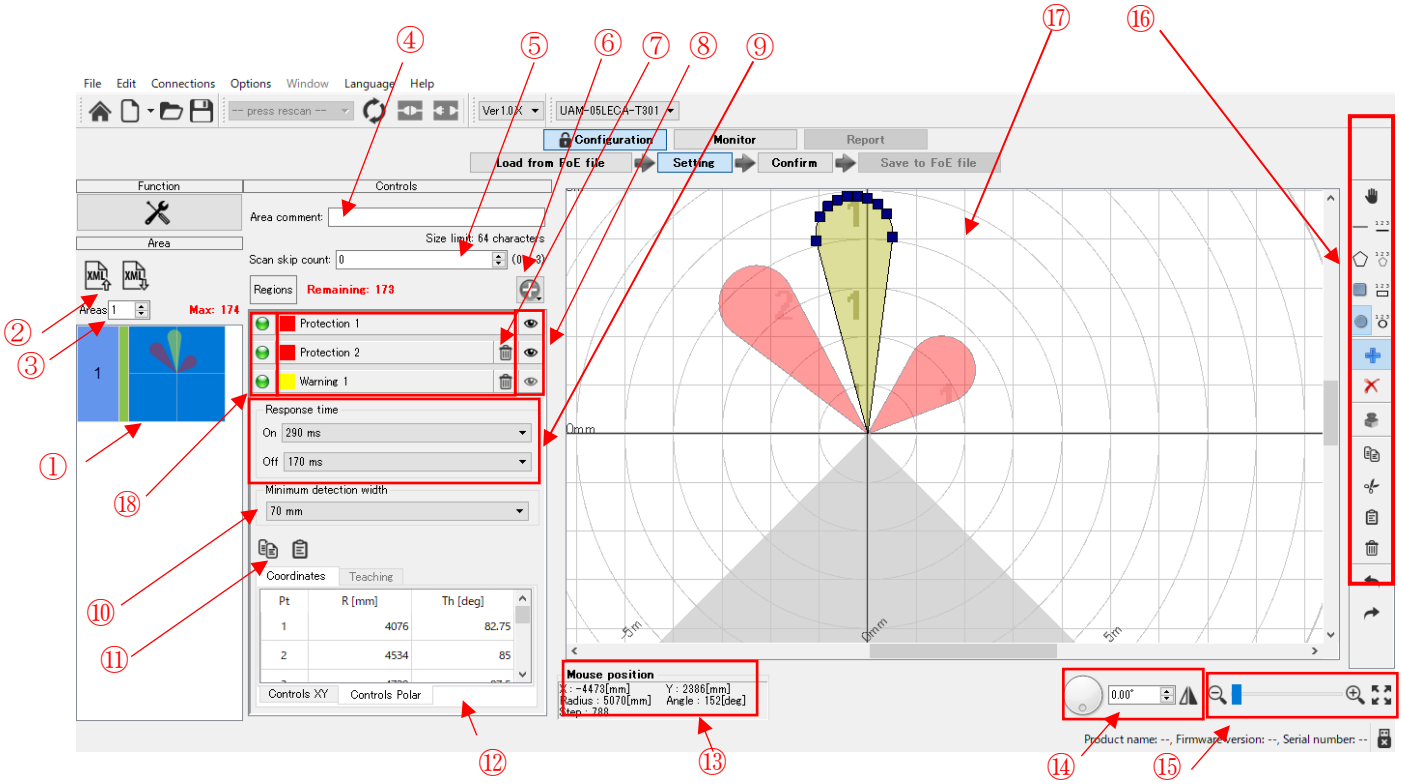


Figure 7-19 Area

①Area Preview

Shows the shape of configured area. It is possible to edit the area when the background of the area preview is blue. The corresponding area can be edited in the area display⑰. Number on the left of area preview represents the area number. The line in the area preview will change from gray to green color when a valid area is configured.

② XML File Tool

Icons to import and export the XML file containing the area information. Icon details are explained in Table 7-11.

③Area

Area count Selector. Area count will vary depending on the number of zones assigned to each area.

④Area Comment

Brief explanation of each area can be entered in the text box (size limit is 64 characters).

⑤ Scan skip count

Scan skip count can be individually set for each area. (Refer to section 3.17 Scan Skip Function)

⑥Zone add button

It is used for adding protection and warning zones in an area.

⑦Zone Selection

Configuration of respective zone is possible when it is selected.

⑧Zone Visibility Selection

Tool to show or hide the corresponding zone.

⑨Response Time (ON/OFF)

Response time of each area can be set.

⑩Minimum detection width

The minimum width of detectable objects. Detection is not possible if configured width is more than the object intended to be detected.

⑪ Copy and Paste

Copy and paste the coordinate data of the area

⑫ Point coordinate

Displays the coordinates of configured points in the zone. They can be also edited directly.

⑬ Mouse position

If the cursor is placed on the configured area, sensor coordinate represented by the mouse pointer is displayed. Table 7-12 explains in detail.

⑭ Tool for rotating and reversing the display

Tool icon to rotate and reverse the area and measurement data. Table 7-13 explains in detail.

⑮Zoom In, Zoom Out tool

Adjust the area display screen ratio. Table 7-14 explains each icon.

⑯ Drawing tools bar

Tool icons for configuring the area shape. Table 7-15 explains each icon.

⑰ Area Display

Shapes of all the areas are displayed.

⑱ Zone Judgement Lamp

When valid zones are configured the corresponding zone judgement lamp turns from red to green. Check whether the zone is configured and it has sufficient width if the lamp remains red.

Table 7-11 XML file icon

Icon	Function
	Imports area details from XML file (Check the help menu for details on XML file format)
	Exports area details to XML file.

Table 7-12 Display of mouse information

Display	Description
X	Displays the mouse position of x -coordinates (mm).
Y	Displays the mouse position of y –coordinates (mm).
Radius	Displays the distance from the origin to the position of the mouse (mm).
Angle	Displays the distance from the smallest angle to the position of mouse (deg.
Step	Displays the step value of mouse position.

Table 7-13 Rotate and reverse icon

Icon	Function
	It will undo the previous operation
	It will redo the last operation
	Rotate the graphical display. Rotate the dial or enter the rotation angle in the box to specify the display angle.
	Reverse the area and measurement data display (left to right or right to left)

Table 7-14 Display adjust icons

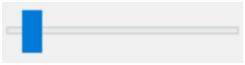
Icon	Function
	Zoom out the main view screen. Same operation can be done by scrolling mouse down.
	Move the cursor left for zoom out and right for zoom in.
	Zoom in the main view screen. Same operation can be done by scrolling mouse up.
	Reset the view to fit the window.

Table 7-15 Drawing assistance icons

Icon	Function
	Move the configured area
	When line segment is drawn by moving the mouse, a triangular shape is drawn by connecting the two points of the line and the origin.
	When coordinates of start and end points of a line are specified numerically, a triangular shape is drawn by connecting these points with the origin.
	When multiple points are selected with mouse click, a polygon is generated by connecting these lines and the origin
	When coordinates of multiple points are specified, a polygon is generated by connecting these lines and the origin.
	When square shape is drawn by moving the mouse, a shape connecting its four edges and the origin is drawn.
	When four coordinates of square shape are numerically specified, a shape connecting these points and the origin is drawn
	When circular shape is drawn by moving the mouse, a shape connecting the arc of the circle with the origin is drawn.
	When center, radius and starting and end point of the arc are numerically specified, a shape connecting the arc of the circle with the origin is drawn.
	Specified shape is added to the area.
	Specified shape is removed from the area.
	Configure the zone by automatic teaching function
	Copy the selected area
	Cut the selected area
	Paste the area previously copied or cut.
	Delete the selected area.

d) Confirm

After completing all the configurations, review the settings by clicking the confirm button followed by the steps shown in Figure 7-20 to Figure 7-22. After verifying the settings, check if UAM is connected to the application. If it is not connected, configuration can be saved as a FoE file by clicking on the “Save to FoE file” button. Return to the respective tab if correction is necessary.

Further, the configuration data can be saved in the pdf format by clicking on the “Output PDF” button. See Table 7-17 for the details on the generated pdf report file. (Note: Sensor information will not be shown in the report if the pdf file is generated without connecting to the UAM).

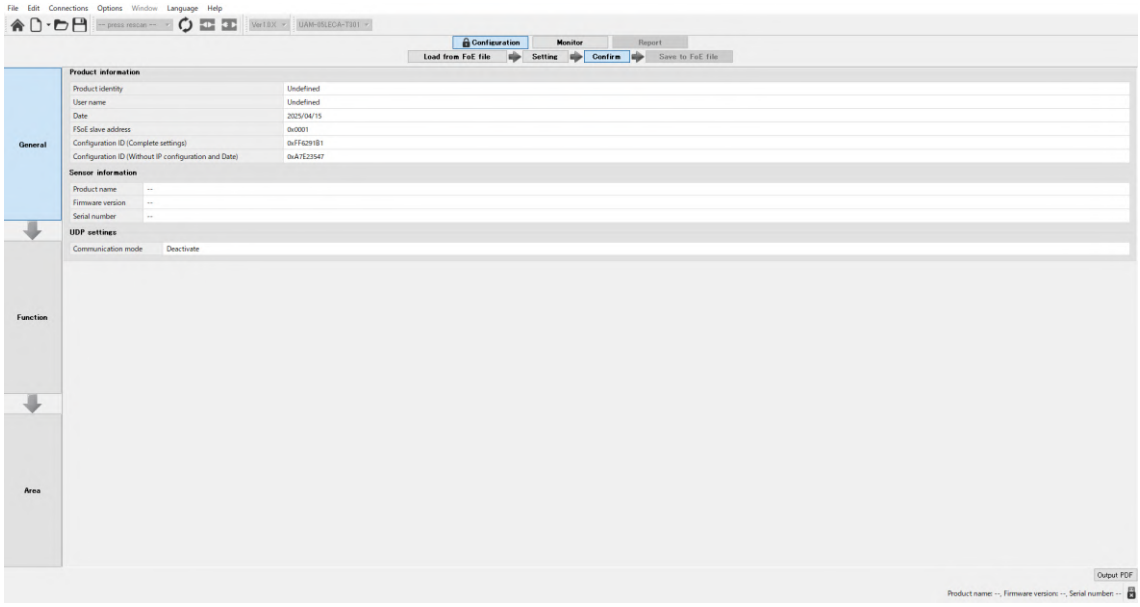


Figure 7-20 General

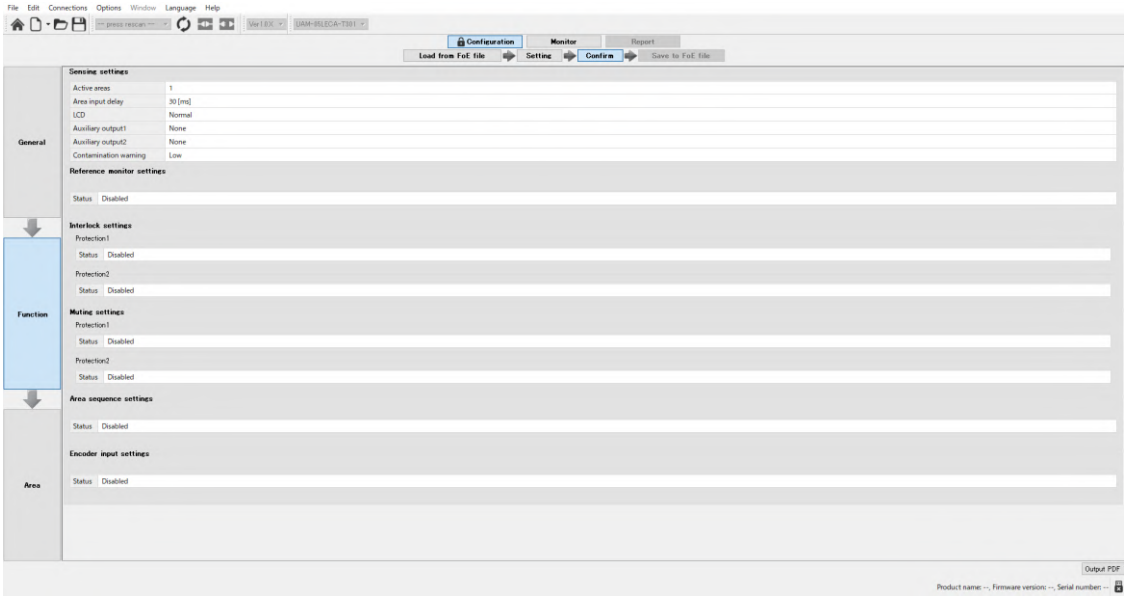


Figure 7-21 Function

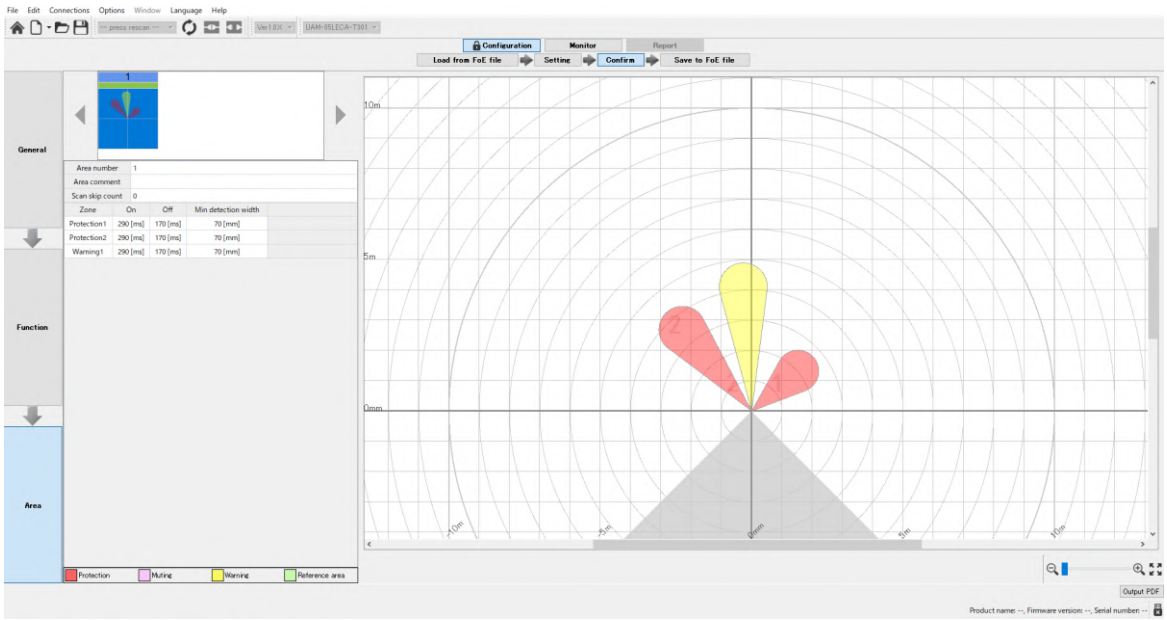


Figure 7-22 Area

e) Transmit to sensor/ Save to FoE file

If application is connected to UAM, “Transmit to sensor” button is visible. A dialog box will appear to confirm the transmission if this button is pressed and data from the application is transmitted to UAM if “Yes” button is pressed. When UAM is not connected to the application, “Save to FoE file” button will be visible which enables the setting to be saved in a FoE file (see section 7.21for the details).

Depending upon the computer’s performance it may take few minutes to transfer the configuration. When transferring process is completed, UAM will restart automatically.

7.8.2 Monitor tab

User can monitor the detection state of the UAM by selecting the monitor tab.

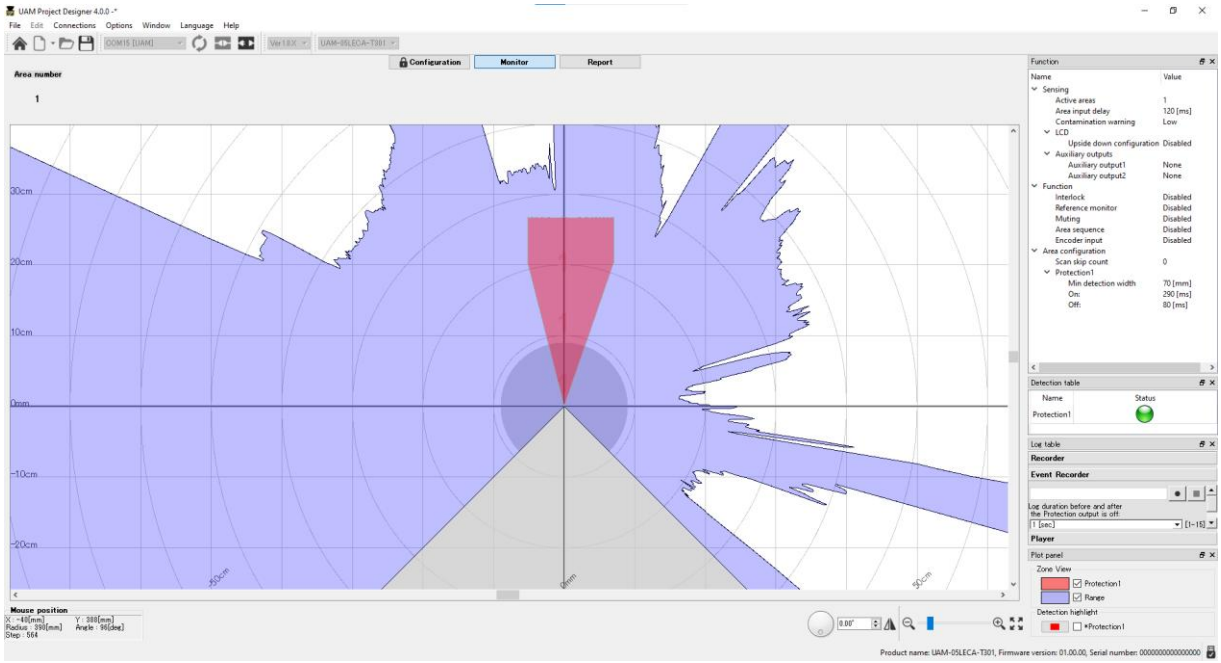


Figure 7-23 Monitor tab

Following icons appear in the monitor window

Table 7-16 Monitor icon

Icon	Function
	Indicates the states of protection detection state. Green: ON (No detection) Red: OFF (Detection)
Area number 1	Indicates the operating area number
Error number 55	Indicates the error number when error is detected. (See section 9 for the details)

7.8.3 Report tab

Report tab is only functional when the UAM is connected to the application. There are 3 types of reports: Project report, Error report and Detection Log report. Project report includes the UAM's configurations. Error report includes error recorded during the operation and past errors. Detection Log report displays the history of object detected in the protection zone. For detail on report tab items refer to7.18. User can save reports in PDF format by clicking the [Output PDF] button. When clear button is clicked all the records are deleted from the sensor. When refresh button is clicked latest information are updated from the sensor.

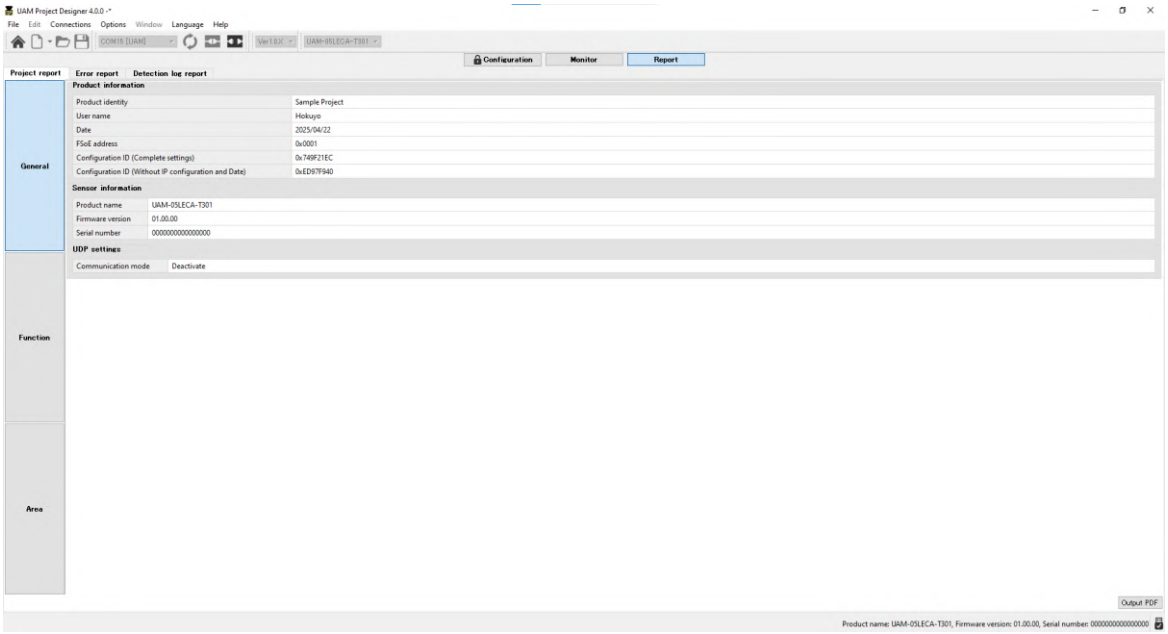


Figure 7-24 Project report tab

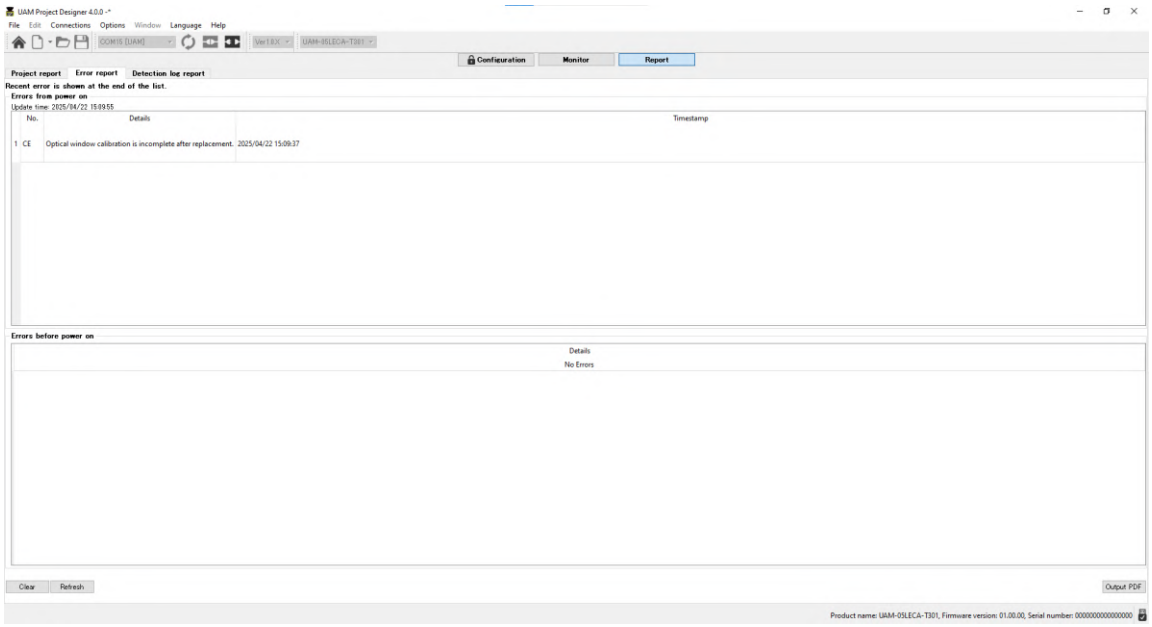


Figure 7-25 Error report tab

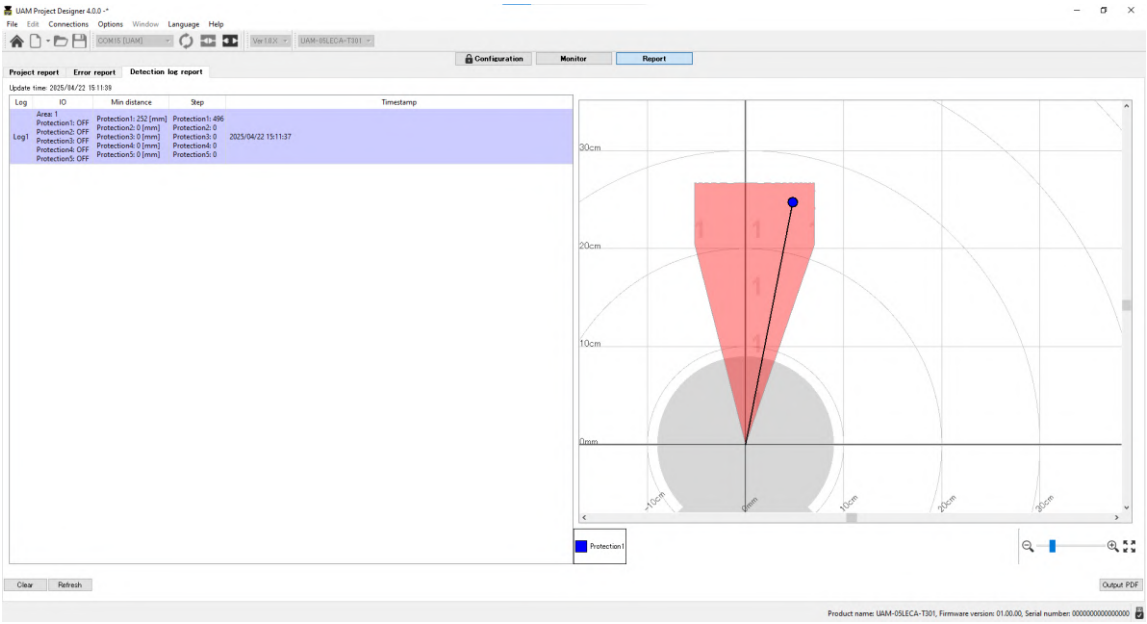


Figure 7-26 Detection log report tab

Table 7-17 Report display items

Frame	Items Shown on the Report
Application information	■ Application name ■ Application version ■ Interfaces
General settings	【Product information】 ■ Product identity ■ User name ■ Date ■ FSoE slave address ■ Configuration ID（Complete setting and Without IP configuration and Date） 【Sensor information】 ■ Product name ■ Firmware version ■ Serial number
Function settings	【Sensing settings】 ■ Min detection width ■ Active areas ■ Area input delay ■ LCD ■ Auxiliary output1/2 ■ Contamination warning

Table 7-18 Report display items (continued)

Frame	Items Shown on the Report
Function settings	【UDP settings】 ■ Communication mode ■ IP address ■ Port number ■ Cycle ■ Data type 【Function settings】 ■ Interlock settings ■ Muting settings ■ Area sequence settings ■ Encoder input settings ■ Reference monitor settings
Muting (When activated)	【Muting settings】 ■ Status ■ MUTING/OVERRIDE signal ■ Muting input sequence ■ Time interval between inputs ■ Maximum muting period ■ Maximum override period
Interlock (When activated)	【Interlock settings】 ■ Status ■ Reset/RES_REQ signal ■ Start / Restart setting ■ Delay
Encoder input (When activated)	【Encoder input settings】 ■ Status ■ Area switching velocity ■ Use hardware IO ■ Pattern count ■ Encoder 3/4 use ■ AGV Width ■ Right side encoder 【UAM settings】 ■ Encoder 1/2 Tolerance ■ Encoder 1/2 pulse count / cm ■ Encoder 3/4 Tolerance ■ Encoder 3/4 pulse count / cm 【FSoE settings】 ■ Encoder 1/2 Tolerance ■ Encoder 3/4 Tolerance ■ Encoder Pattern Setting

Table 7-19 Report display items (continued)

Frame	Items Shown on the Report
Reference monitor settings (When activated)	【Reference area】 ■ Tolerance ■ Response time
Area	■ Area number ■ Area comment ■ Scan skip count ■ Zone Configuration ■ Protection response time[ms]（ON/OFF） ■ Protection minimum detection width
Error logs	【Errors from power on】 ■ Error detected after device is switched on 【Errors before power on】 ■ Error detected in the past and stored in the log
Detection logs	■ Timestamp ■ I/O state ■ Minimum distance of the detected obstacle ■ Step number of the detected obstacle

7.9 Status bar

Figure 7-27 Status bar

This section displays the model, serial number, firmware version of the connected sensor. Icons on the right show connection state. Table 7-20 explains the meaning of each icon.

Table 7-20 Status bar icon

Icon	Description
	Indicates the connected state with UAM.
	Indicates the disconnected state with UAM.

7.10 Connecting UAM with PC

a) Supply the power to UAM and connect with PC through USB cable.
b) When connection is established, application will automatically detect the UAM and displays its COM port. If it is not displayed, click rescan  icon on the toolbar to refresh the COM port.
c) Click connect device  icon on the tool bar and enter the password when dialog appears.
d) Connection status is shown on the information tab. When UAM is successfully connected, icon changes to connected  state.
e) When the UAM is disconnected, icon changes to disconnected  state.

Note

- Do not use the USB hub.
- When UAM is not detected even if it is connected to the PC, click the port refresh button.
- When an additional UAM is connected on the same PC, click the port refresh button.
- Use the IP address obtained from the master controller to connect the UAM Project designer with UAM.
- Do not use USB and Ethernet communication simultaneously.

7.11 **Password**

Configuration of UAM is password protected for preventing unauthorized access. User should enter the password before proceeding to configuration screen. When the window as shown in the Figure 7-28 is displayed, enter the password and click ok. Default password is 12345678.

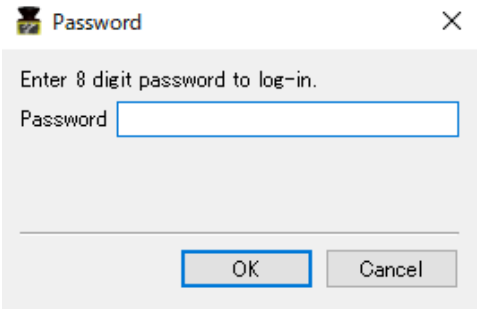


Figure 7-28 Password

7.11.1 Changing the password

User can change the password by performing the following steps:

a) Click the Options on the menu bar.

b) Click the Change Password.

c) Window as shown in figure 7-29 will be displayed.

d) Enter the new password and retype the new password for confirmation. The new password should consist of 8 numerical digits.

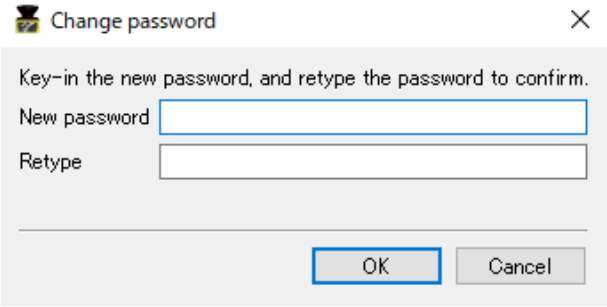


Figure 7-29 Password change

7.11.2 Reclaim the forgotten password

When the password is forgotten, follow the steps below to reclaim the password.

a) Click the File of the menu bar.

b) Click the Save As or press Ctrl + S and save the project at a preferred location. Project will be saved in the file [******.hux].

c) Send this file [****.hux] file to the nearest office or representative listed on this manual to reclaim the forgotten password.

7.12 **Configuration mode**

Click on the configuration tab to configure the setting of UAM. The configuration of UAM is password protected to prevent the unauthorized access. User is required to log-in with the password to proceed with the configuration. Refer to chapter 7.11 for details on password. Follow the steps below for configuration.

a) Confirm that UAM and PC is connected (refer to section 7.10). Connect it if it is not. Even if UAM is not connected, user can configure the settings but cannot the transfer them to UAM.

b) Click the “Configuration” tab or on the menu click “Mode” and select “Configuration”

c) Click the “Function” button  to display the function setting window.

Note ● All output signals remains in OFF state when UAM is in configuration mode

7.13 **Function configuration**

User can configure various functions of the UAM through UAM project designer (Figure 7-30). Function selection window as shown in Figure 7-46 will appear when clicked on the “Function” button.

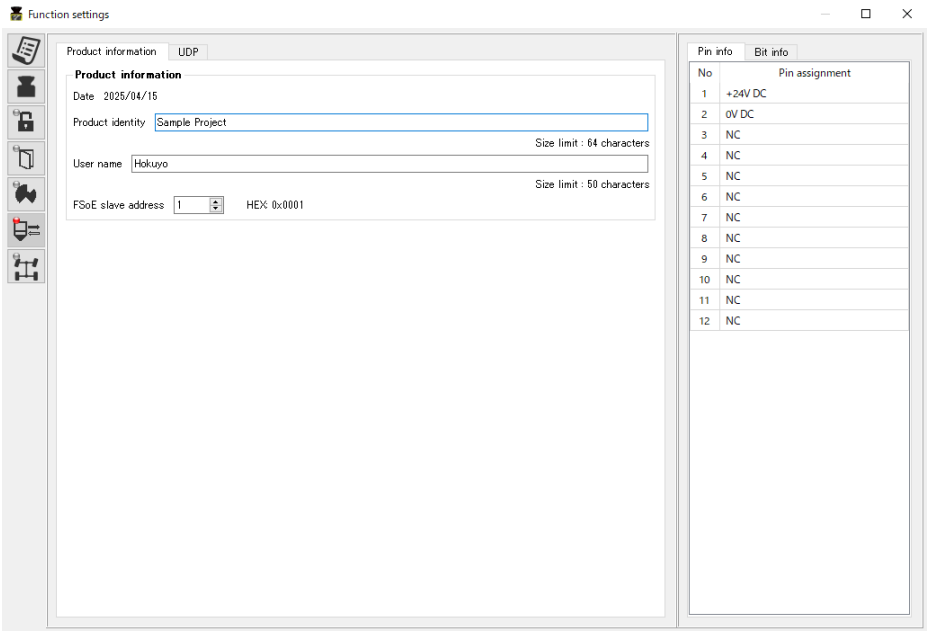


Figure 7-30 Product information

Put a check mark to activate the corresponding function. There are some functions which cannot be used simultaneously *. In such cases, selecting one function will disable the other and its indicator turns red. Also, maximum configurable area will change depending on the selected function. Functions of the connector pin also change automatically depending on the setting. Verify the functions during wiring.

* Muting and encoder, Muting and Interlock functions cannot be configured simultaneously.

List of configurable functions are shown below.

Table 7-21 Detailed Function

Tab	Item	Discerption
General 	Product information	・Product identity: Identification number or name assigned to UAM (max. 64 characters). ・User name: Name or number of the authorized user (max 50 characters). ・FSoE address: Address number assigned to the slave unit (1 ~ 65535).
	UDP	Check mark the UDP Setting box to enable the UDP function and configure its parameters. ● On request ・ Cycle (0 ~ 255) ● Target mode ・ IP address ・ Port number ・ Cycle ● Data type ・ Status only (XR00) ・ Status + Distance (AR02) ・ Status + Distance + Intensity (AR04) ・ Status + Full step distance (AR07) ・ Status + Distance in multiple packets (UR00) ・ Status + Distance + Intensity in multiple packets (UR01) ・ Status + Full step distance in multiple packets (UR02)
Sensing 	Sensing settings	Area input delay (ms): 30, 120, 270, 1000, 2000
	LCD	Check mark the Upside down Configuration box to invert the message displayed on LCD.
	Auxiliary outputs	Assign the function for auxiliary output terminals. ・None ・Error ・Window contamination error ・Window contamination warning ・Synchronous signal
	Contamination warning	Select the sensitivity level to warn the optical window contamination. ・Low ・Medium ・High

Table 7-22 Detailed Function (continued)

Tab	Item	Discerption
Interlock 	Protection1～5	Check mark the Interlock box to enable the Interlock function and configure its parameters. ● Reset/RES-REQ signal: Check mark the Use hardware IO box to use hardware terminals for this function[*1]. ● Start/Restart mode: ・ Manual / Automatic (Default) ・ Manual/ Manual ● Delay (s): 1 (Default) to 6:
Reference monitor 	-	Check mark the Reference monitor box to enable the reference monitor function and configure its parameters. ● Tolerance (mm): 100 (Default) to 10000 ● Response time (ms): Off response time (Default),80 to 2030
Muting 	Protection1～5	Check mark the Muting box to enable the muting function and configure its parameters. ● MUTING/OVERRIDE signal: Check mark the Use hardware IO box to use hardware terminals for this function[*2]. ● Muting input sequence: ・ Muting 1→Muting 2(Default), ・ Muting 2→Muting 1 ● Time interval between two inputs (sec): 1(Default), 3, 5, 10 ● Max. muting period (min): 1(Default), 6, 12, Unlimited ● Max. override period (min): 1(Default), 6, 12
Area sequence *3 	-	Check mark the Area sequence box to enable the area sequence function and configure its parameters. ● Check mark the valid area number(s) that can be switched from the corresponding area. ● Check mark Select all box to allow switching to all area from the corresponding area.

Table 7-23 Detailed Function (continued)

Tab	Item	Discerption
Encoder 	Encoder Input	Check mark the Encoder input box to enable the encoder function and configure its parameters ● Area switching velocity: ・ HW input [Calculated by UAM] ・ FSoE input [Calculated by UAM] ・ FSoE input [Calculated by Controller] ● Check mark the Use hardware IO box to use hardware terminals for this function. ● 4 Encoder configuration: Configuration to enable area switching based on the velocity and angular velocity of the AGV. ● AGV Width: Distance between the right and left AGV wheels when using 4 encoders. ● Right side encoder: Encoder pair mounted on the right side of the AGV when using 4 encoders. Additional configuration parameters will be shown on UAM/FSoE tab when the device is configured to calculate the velocity from the HW input or FSoE input ● Tolerance: 0 to 80% Velocity tolerance between an encoder pair. Difference in velocity of the 2 controllers must remain within the configured tolerance as it is monitored by UAM. ● Pulse setting: 50 to 1000 (count/cm) Number of encoder pulse generated when AGV travels 1cm*4.
	Pattern selection	● Pattern Comment: Identification number or name assigned the pattern ● Pattern count: Number of patterns in use. ● Type ・ Not Used ・ Static input ・ Encoder input Additional configuration in static input. ・ Area: Operating area number corresponding to the input pattern. ・ Independent monitoring: Enable/Disable velocity monitoring of HW encoders or FSoE input. ・ AGV linear velocity monitoring: Enable/Disable AGV velocity monitoring. ・ AGV angular velocity monitoring (only when 4 encoders are used): Enable/Disable angular velocity monitoring of HW encoders or FSoE input. ・ Velocity range: Monitoring velocity range of each encoder or FSoE input if monitoring function is enabled.

*1: For protection zones 1 and 2, reset input can be supplied either through hardware signal or FSoE communication which can be selected during device configuration (for protection zones 3 ~ 5, reset input can be supplied only through FSoE communication).

*2: For protection zones 1 and 2, Muting input can be supplied either through hardware signal or FSoE communication which can be selected during device configuration (for protection zones 3 ~ 5, reset input can be supplied only through FSoE communication).

Auxiliary output terminals will be automatically assigned to Muting Output signal when hardware signal is used for muting function.

*3: Check mark the box such that it should be possible to switch from every area to at least one other area.

*4: Only required when using the HW inputs.

7.14 **Area configuration**

When Configuration tab is clicked, area configuration screen will be displayed as shown in Figure 7-31

There are two types of regions, one where configuration of protection and warning zones are possible and the other where it is not. Range shown in the white represents the region where it is possible to configure the protection zone. Range shown in the light gray is the region where configuration of warning zone is possible. Range shown in the dark gray (beyond 30m from the origin) shows the region where both protection and warning zones cannot be configured. It is possible to configure warning zone inside the protection zone configurable region. Range of protection zone depends on the minimum detection width and changes automatically when it is selected on the sensing setting panel. It is necessary to configure all the activated protection zones.

a) Click “Configuration” tab to switch to area configuration panel.

b) Select the area number from area preview panel and click the indented zone among Warning1, Warnign2 and Protection for configuration. Buttons for configuring the Muting and Reference monitoring zone will be displayed when the corresponding functions are enabled. Reference area preview marked by “REF” is visible when reference function is enabled.

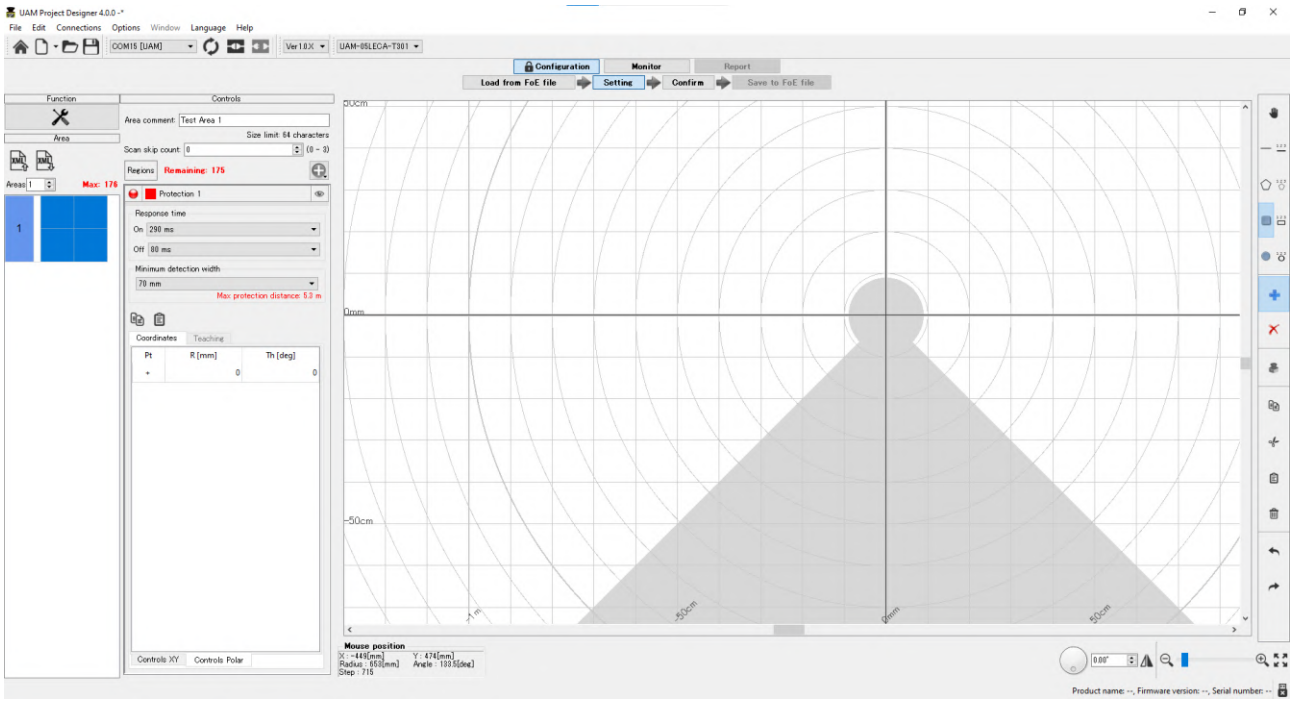


Figure 7-31 Area configuration widow

c) Configure zones on all the activated areas. After completion, click on the “Confirm” button to verify the settings.

Details on area configuration methods are explained in the sections below.

7.14.1 Area configuration by drawing tools

Zones can be configured using the drawing tools on the UAM project designer. Refer to Table 7-15 for the details.

a) Click on the Add button.

b) Select the drawing shape.

c) Move the cursor inside the setting possible region and draw the shape by drag and drop operation. While drawing it is possible to switch the shapes to draw areas with combination of shapes.

Figure 7-32 shows an example of protection zone set by the selecting the line —

Figure 7-33 shows an example of warning zone1 set by the selecting the circle

[Zone configuration example 1]

When a straight line is drawn from point 1→ point 2, a triangular shape is formed by connecting these two lines with origin. Coordinates of point 1 and point 2 are also displayed.

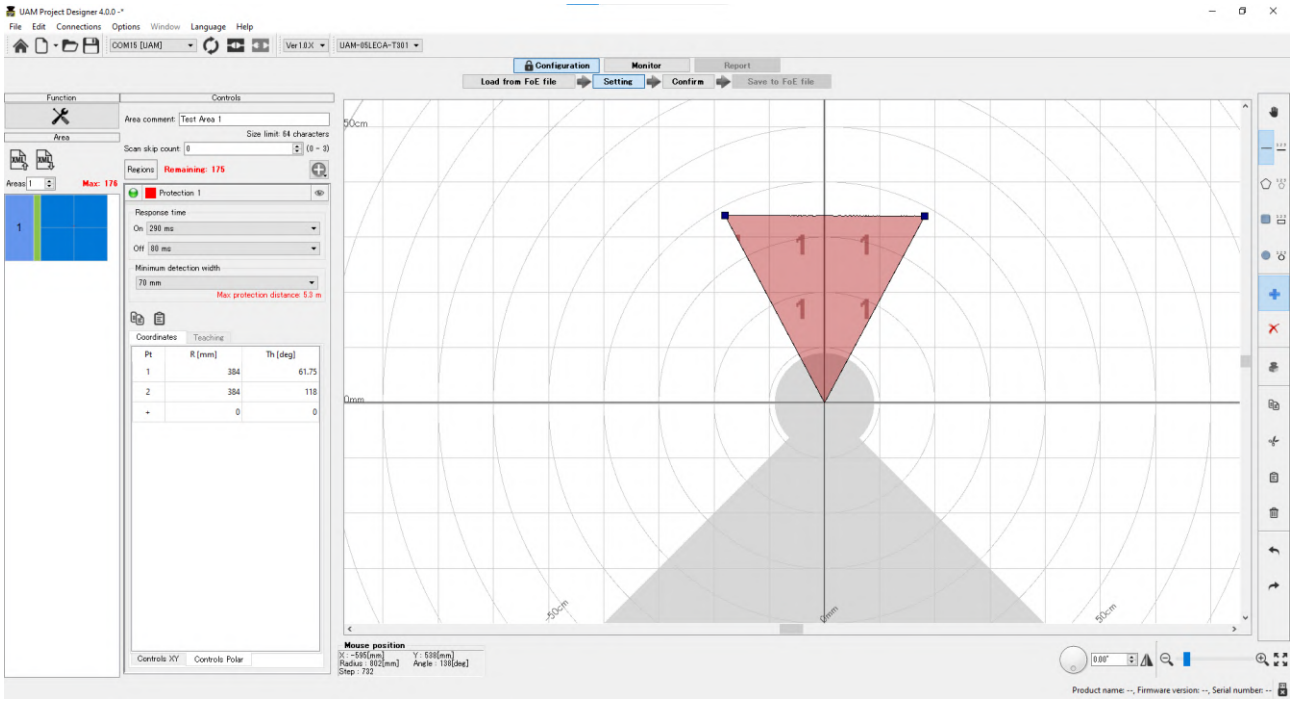


Figure 7-32 Zone configuration example 1

[Zone configuration example 2]

When mouse is dragged from point 1 → point 2, a circular shape with origin at point1 is generated. Circular shape cannot be formed if point is dragged beyond the allowed region. Coordinates of each point are also displayed on the coordinate panel. Points are displayed at every 2.5°.

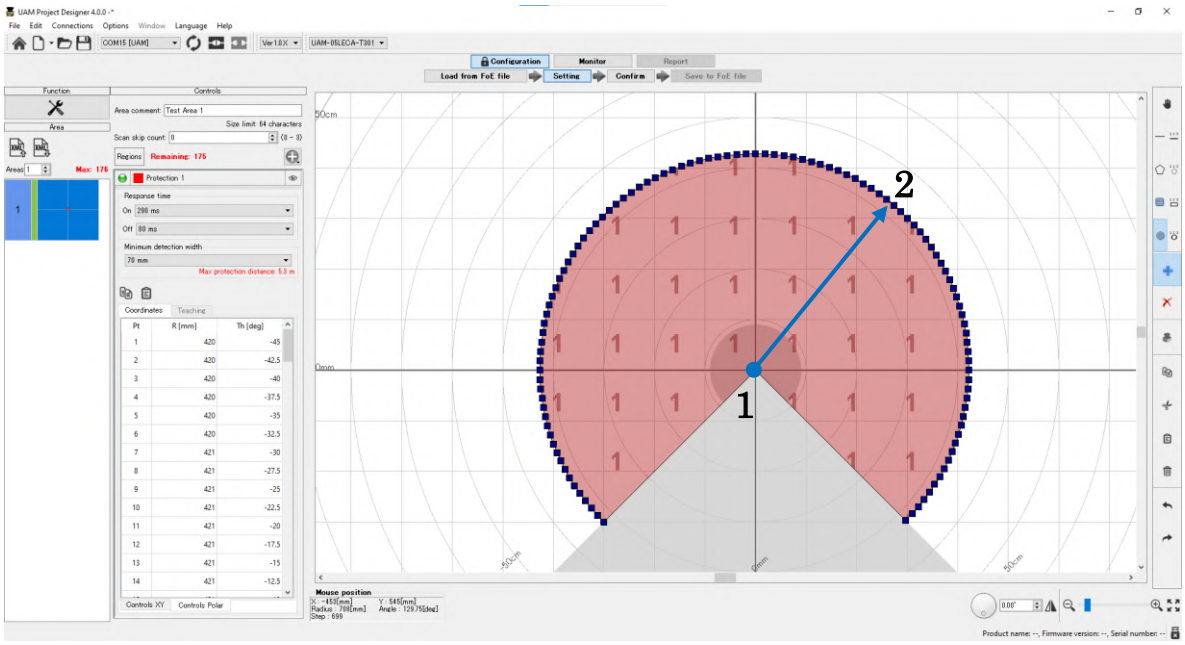
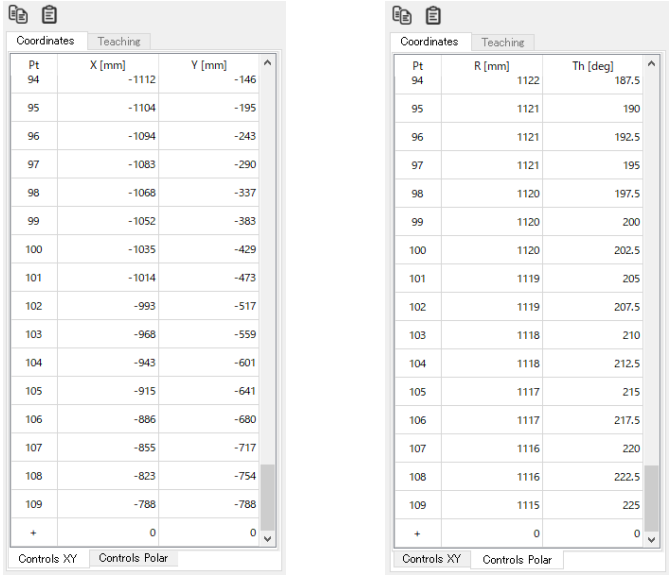


Figure 7-33 Zone configuration example 2

Coordinates of configured points where the numeric values are shown can be edited directly by double clicking on the cell (Figure 7-34). It is also possible to switch between XY coordinates and polar coordinates.



XY coordinates Polar coordinates

Figure 7-34 Coordinate example

Press the “+” on the Pt column to add the coordinate points.

* It is possible to copy the 2-column and n-rows data from a text file and paste it in the coordinate table by using buttons.

* Use backspace key to delete a single coordinate point on the display panel.

d) To delete the parts of the configured zone, click the delete button, then drag-drop the cursor to specify the zone to delete.

e) For configuring the other zones, select the respective zone and repeat the above steps.

f) Confirm that each zone is configured correctly.

If overlapping of shapes disturbs in creating or confirming the zone, visibility can be toggled by clicking the button. However, zone being currently configured cannot be switched to invisible.

Figure 7-35 Switching between visible and invisible mode

7.14.2 Area configuration by teaching function

Automatic zone configuration by referring the boundary can be done by using the UAM's Teaching function. This function is useful when user needs to configure complex zone or would like to reduce the time for zone configuration. Steps below show the configuration procedures using the teaching function.

a) Ensure the UAM is connected with the PC.
b) Click on the Teaching button.
c) Set the desired offset distance from the background and press "Start" button (Figure 7-36) (Max offset can be up to maximum measurement distance).
Further, to use all sensor measurement points for the teaching function, check the [Show all points] and press [Start] button.

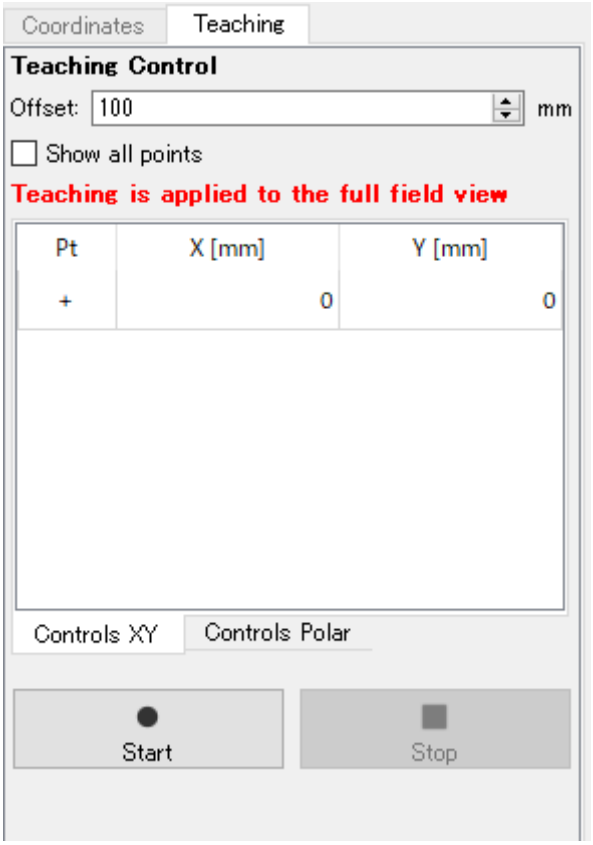


Figure 7-36 Teaching setting

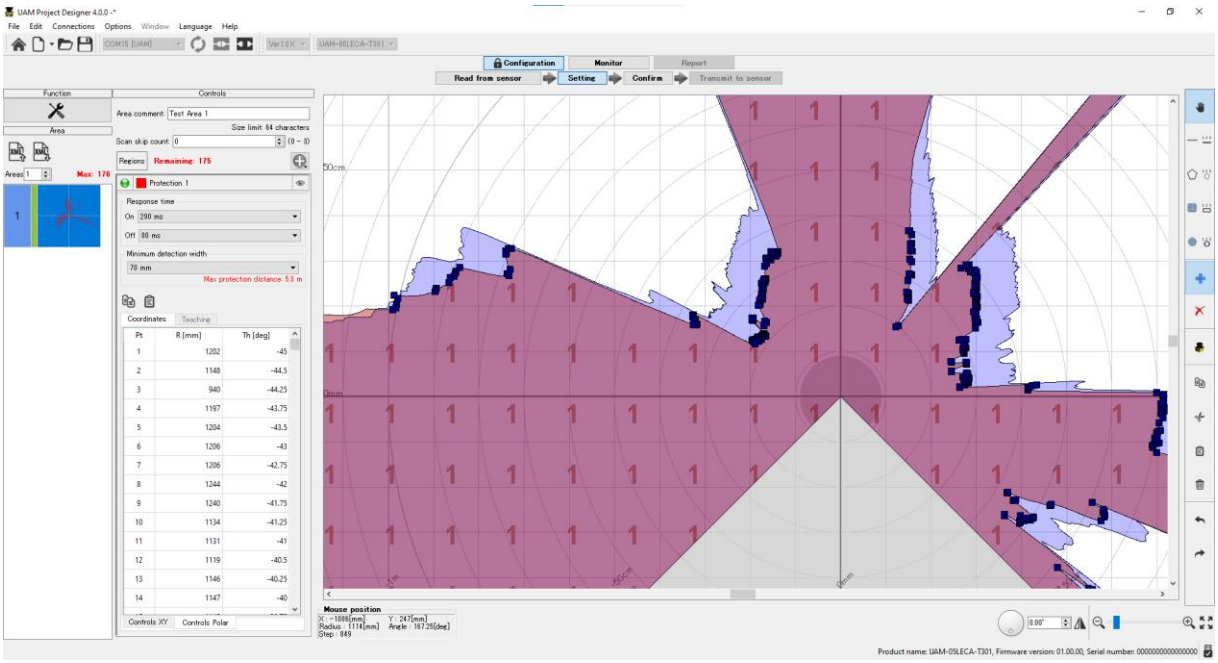


Figure 7-37 Area configured by teaching

d) Click the “Start” button to start recording the background data. Recording will continue until the stop button is clicked.

e) When the stop button is clicked, an area is generated by the shortest distance recorded. Configured area will resemble the UAM’s background. (Figure 7-37). When configuring the protection zone, if the background is not within the maximum detection distance it is set to maximum detection distance of UAM. In case of warning area, if there is no background within 30m from UAM it will be set to 30m.

f) After the area is created automatically it can be edited using the drawing tools.

g) It is also possible to specify the region for generating the area by teaching function. Use the area tools for this purpose. If specified region does not have any background, area will be generated at the maximum distance of the specified region.

Danger

- While using the teaching function, user should confirm that the configured zone meets the safety requirement.
- Distance from area to the background should be in the range of 100mm to 700mm.
- If the distance exceeds the above mentioned range, there may be unprotected hazardous area that could lead to critical injury or death.

7.14.3 Muting configuration

Muting function temporary suspends the safety functions of UAM when required conditions are fulfilled. Follow the steps below to configure muting function.

< Configuration Steps >

a) Confirm that muting function is enabled in the function tab. “Muting” button will be visible on the Area tab.

b) Before configuring the muting zone, it is necessary to configure the protection zone. Configure the protection zone if it is not yet configured.

c) When muting button is clicked, muting configuration screen is displayed. Drag and drop the mouse over the protection zone to configure the muting region inside it. Protection zone is displayed in red and the muting region is displayed in pink. Section covered by the perimeter of the protection zone and the configured shape corresponds to the muting zone.

d) Figure 7-38 and Figure 7-39 shows an example of the muting zone configuration. Region in pink represents the muting zone.

[Muting zone configuration example 1]

Muting zone configuration example as straight line is drawn from point 1 to point 2

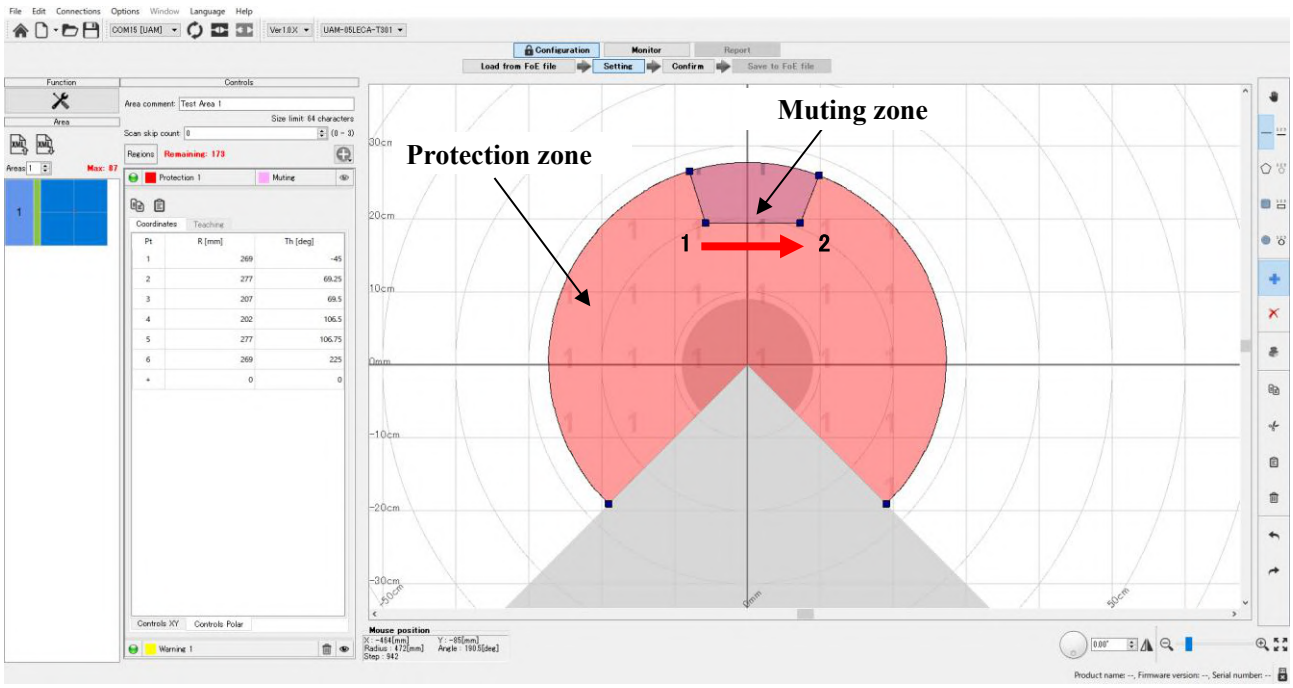


Figure 7-38 Muting zone configuration example 1

[Muting zone configuration example 2]

Muting zone configuration example as square is drawn from point 1 to point 2

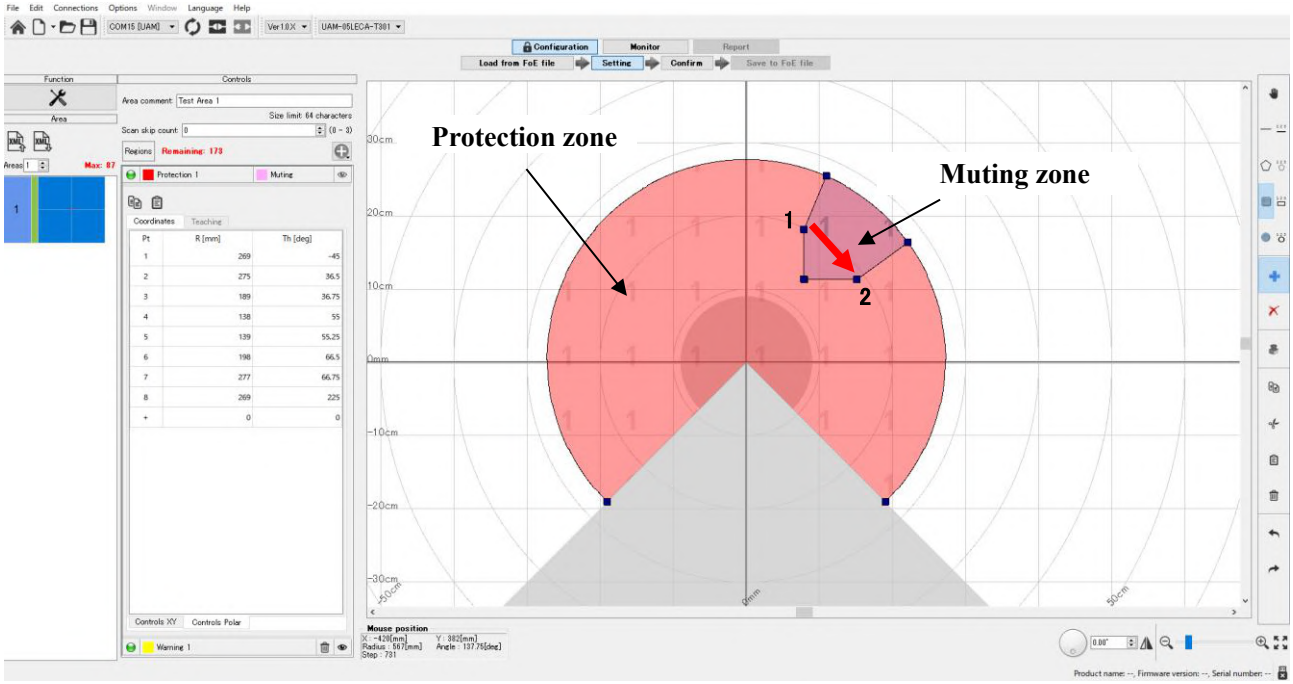


Figure 7-39 Muting zone configuration example 2

e) Confirm that the muting configuration is correct.

7.14.4 Reference region configuration

Follow the steps below to configure reference region.

< Steps for setting >

a) Ensure the UAM is firmly mounted at its location.
b) Ensure the connection between the UAM and PC.
c) Click the Function tab and enable the Reference Monitor function and enter the required tolerance distance (default 100mm).
d) Click the Area tab.
e) Main screen displays the configuration for reference region (Figure 7-40). First area on the preview indicated by “REF” represents the reference area.
g) Configure the reference region by using the drawing tools. Move the cursor on the drawing panel and drag and drop to configure the reference. Monitoring region is displayed in green

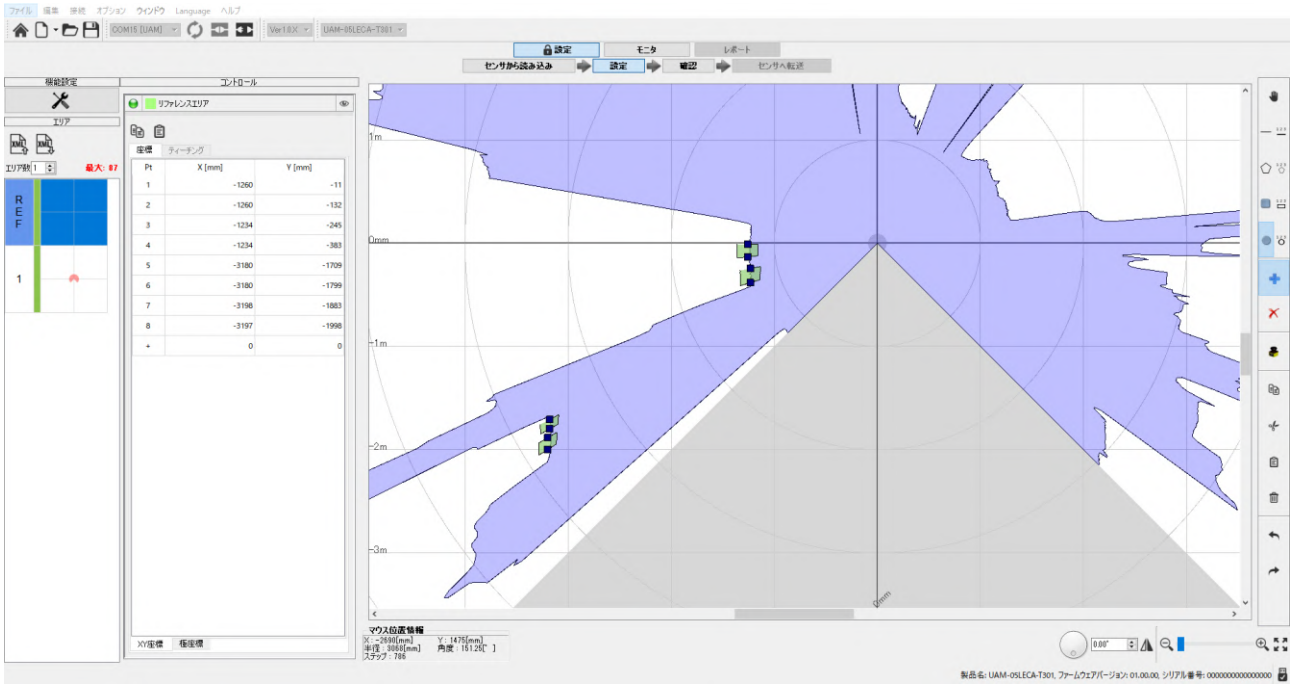


Figure 7-40 Reference region configuration example

For example, to monitor the sensor’s displacement by referring the background, choose the line drawing tool and draw a line segment over the background by mouse drag and drop. Reference region with the ±tolerance is generated on that location.

7.15 **Transmit configurations to UAM**

When all the configurations are complete, click “Confirm” button to verify the configuration. Connect the UAM with the UAM project designer if it is not already connected. Settings can be saved in a FoE file by pressing the “Save to FoE file” butting when the UAM is not connected to UAM project designer.

On the confirm screen, check general, function and area settings in order. If any correction is required, return to related tab and reconfigure the setting.

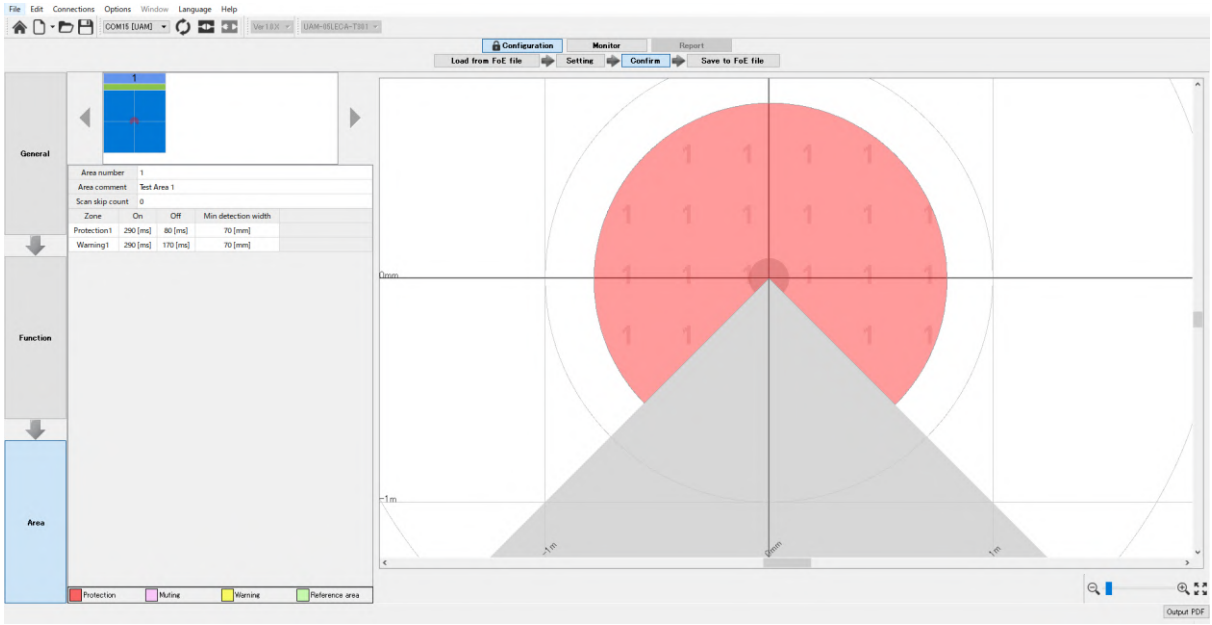


Figure 7-41 Confirm monitor example

When transmit button is clicked verification window appears (Figure 7-42). Click yes to transfer the configuration to UAM

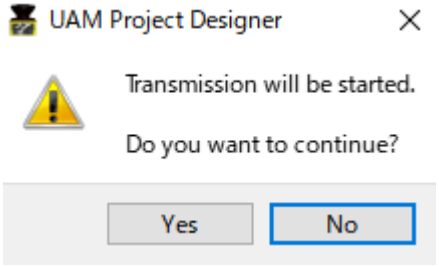


Figure 7-42 Reference monitor configuration example

It may take few minutes to transfer the settings to UAM. When transfer is completed UAM will restart automatically. UAM Project Designer will return to start up panel. Click connect button to run the UAM in monitor mode and verify the operation.

7.16 **Save project file**

Configured functions and area can be saved into a file as a project. Follow the steps below to save the project file.

a) Click File from the menu bar.

b) Click Save As. (Figure 7-43)

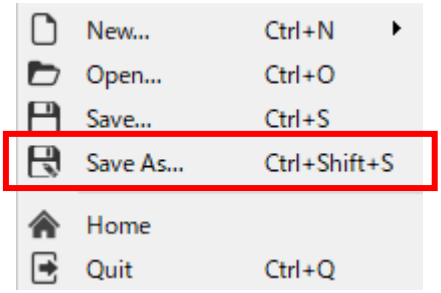


Figure 7-43 Save project file

c) Enter a file name and click Save button. Change the location of the file if necessary. (Figure 7-44)

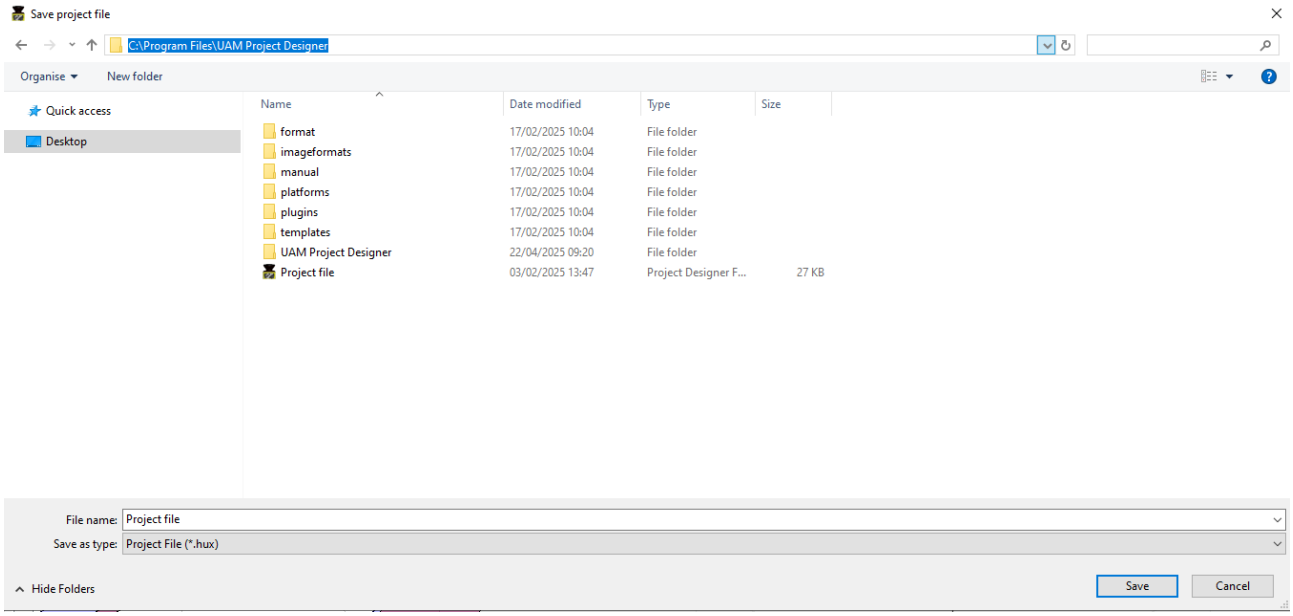


Figure 7-44 Save project file

7.17 **Read configuration from UAM**

User can check the current settings or confirm the configurations of the UAM by performing the following steps.

a) Confirm the UAM and UAM Project Designer is connected. Connect the UAM with the UAM project designer if it is not already connected by pressing the “Connect” button.

b) Select Load settings on the sub panel window. Progress panel will appear (Figure 7-45) showing the state. If Load from FoE file button is clicked without connecting the UAM a dialog box will appear to read settings from the FoE file (refer to section 7.8.1).

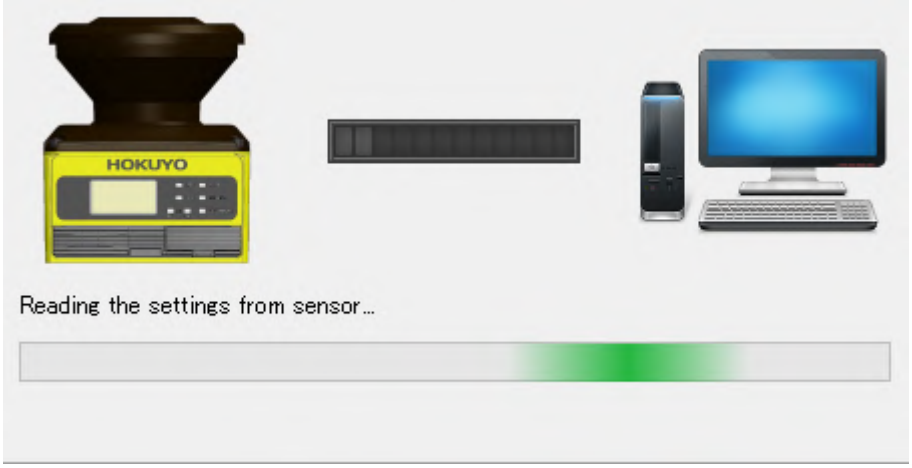


Figure 7-45 Reading the configuration of UAM

c) When reading is complete panel will disappear.

d) Confirm the General, Function and Area settings. Modify the settings if necessary and click transmit to write the configuration to UAM.

7.18 **Open project file**

User can open UAM project file by performing the following steps.

a) Click File from the menu bar.
b) Click Open
c) Dialog box will appear (Figure 7-46). Select the project file [*****.hux/hucx] or SD/FoE file [*****.uam/foe] to open.

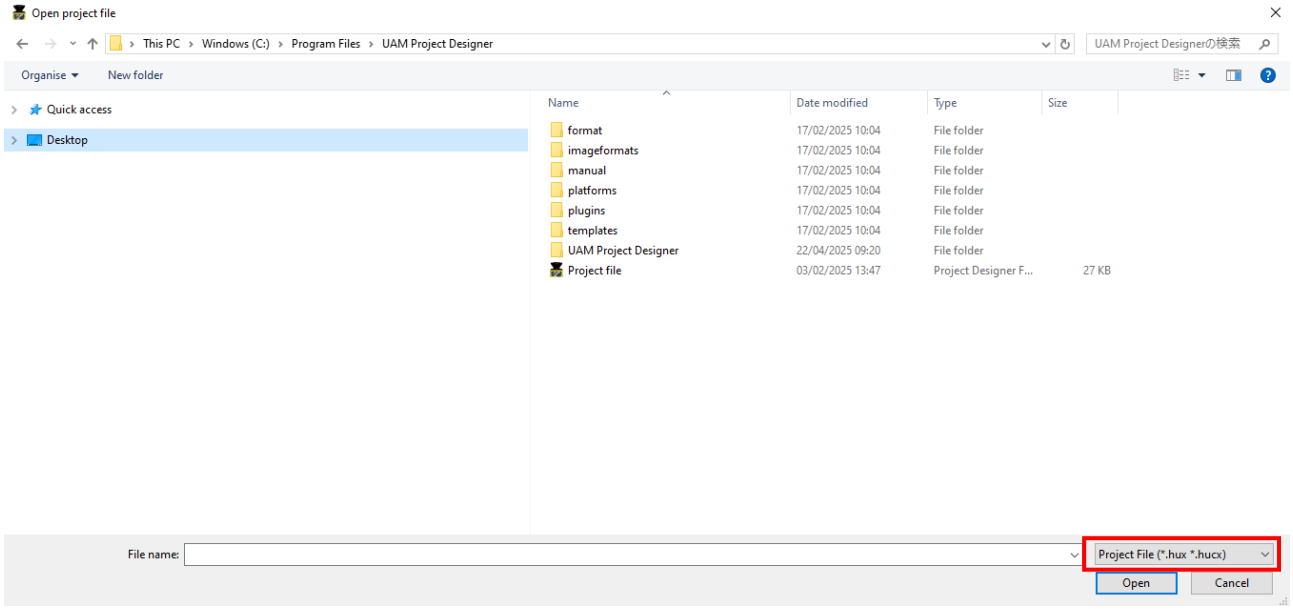


Figure 7-46 Project File Selection

d) Application reads the contents of project. Confirm the General, Function and Area settings. Modify the settings if necessary and click transmit button to write the configuration to UAM.

7.19 **Recording the UAM data**

Follow the steps below for data recording.

a) Connect UAM with UAM Project Designer.
b) Click the monitor button on sub panel. Application will switch to monitor mode.
c) Click the recorder button.
d) Data recording window will appear.

Enter the number of scans in the scan limit field (Figure 7-47)and click the record button. Application will automatically create the file click save. Change the file name and folder if necessary. Data recording will start and stops automatically when the specified scan count is completed. Click the stop button to terminate the recording before reaching the scan count.

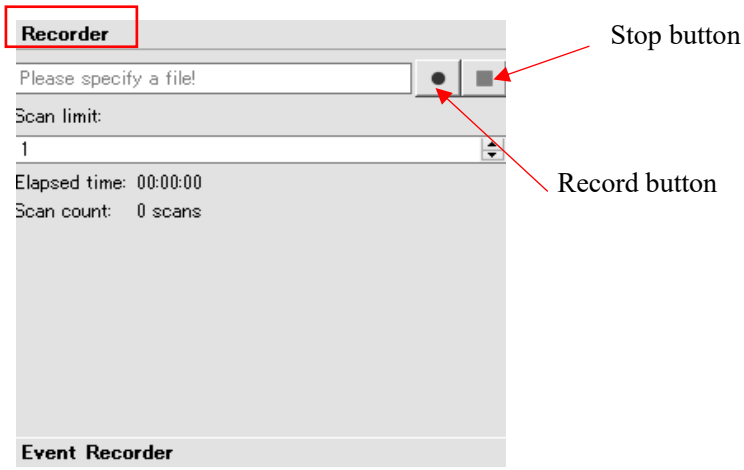


Figure 7-47 Recording the UAM data

e) Click “Event Recorder” to record the data just before and after protection detection state is triggered to OFF state (Figure 7-48).

Recording duration can be selected from 1 to 15 seconds before and after protection detection state switches to off state. When the data log button is pressed, a window will appear to select the folder for saving the data (create the folder to save the data beforehand). Data logging will begin soon after the folder is selected. Wherever protection detection state switches to OFF state, a log data of the specified duration will be saved in the folder. Data logging will continue until the logging stop button is pressed. File name is automatically generated.

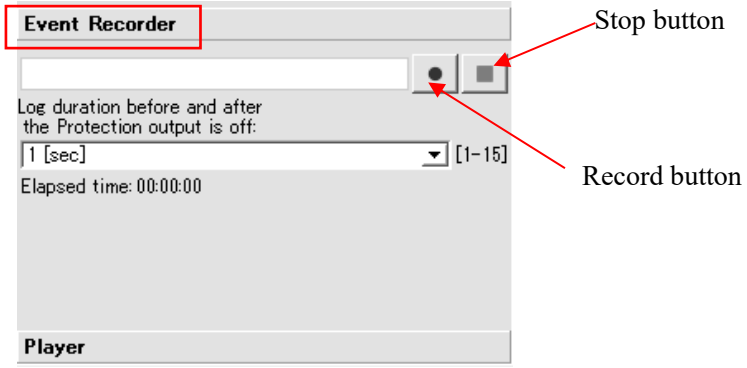


Figure 7-48 Event recording window

7.20 **Replay the log data**

Follow the steps below for re-playing the log data.

a) Confirm that UAM is disconnected with UAM Project Designer. Check disconnect button if is connected.
b) Click “Monitor” button of sub panel and switch to monitor mode.
c) Click player button.
d) Select the log data file for re-playing (Figure 7-49).

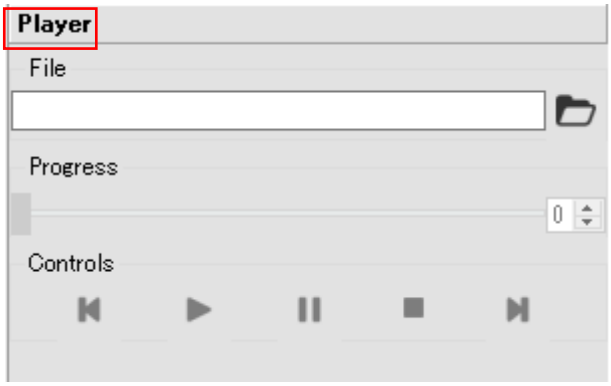


Figure 7-49 Log player window

Click the open icon to choose the file for re-playing and click the play icon to start viewing the log data. Drag the progress bar control to start position and press play button to repeat the viewing. Control icons are explained in Table 7-24.

Table 7-24 Control button

Icon	Description
	Open and select the log data which you want to play.
	Moves to the initial position of log data.
	Starts playing the log data.
	Pause/ Stops the log data for a while.
	Stops the log data.
	Moves to the end of log data.

7.21 **Save settings to FoE file**

Settings saved on the FoE File can be transmitted to UAM via master controller unit without using the UAM project designer application.

< Steps to save >

a) Configure a project in the UAM Project Designer and click confirm button when it is complete.

b) In the confirmation tab, check the general, function and area settings in order.

c) Disconnect UAM if it is connected with the application

d) Click the “Save to FoE file” button to save the settings on FoE file.

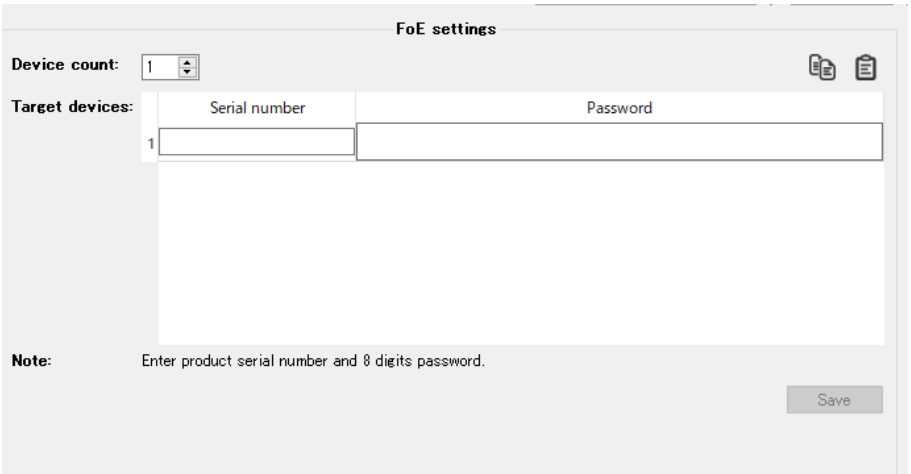


Figure 7-50 FoE setting screen

Figure 7-50 shows the FoE setting screen. Enter the serial number and 8-digit password of the UAM to be configured. To configure the multiple devices with the same settings, increase the device count and enter the serial numbers and passwords of individual units respectively.

* It is possible to copy and paste the serial numbers with n-rows and 2 columns from a text file.

* By default, the first letter is the serial number is assigned as “H”. Enter the correct letter shown on the device if it is other than “H”.

e) Press the “Save” button and select the folder to save the FoE file when a folder save dialog appears.

Note: Following 2 files are generated by the application. Do not rename the FoE file.

- foe_config.foe

“Transmission complete” message will appear when the files are generated successfully. Press the “OK” button to return to the start window.

8 Inspection and maintenance

Inspection and maintenance are necessary for safety operation. User must ensure the inspection and maintenance are carried out as specified in the user's manual.

Before performing inspection and maintenance, confirm the following items.

1) The machine or AGV monitored by UAM is switched OFF.
2) The surrounding of working environment is safe.

8.1 Pre-operation inspection

After configuring the UAM the authorized user should perform pre-operation inspection using a test piece. It should be performed without connecting the sensor to the system.

Table 8-1 Pre-operation inspection list example

No.	Check item	Condition		Remark
		Yes	No	
1	UAM is correctly mounted at the intended location and screws are firmly fastened			
2	All the wirings are correct			
3	Protection detection state switches from ON state to OFF state when the test piece is placed inside the protection zone			
4	Protection detection state signal remains in the OFF state when the test piece is moved inside the protection zone			
5	Protection detection state signal switches from OFF state to ON state when the test piece is removed from the protection zone			
6	Area is switched and correctly displayed on UAM when the input signals are changed according to the area switching table			
7	If UAM is in automatic restart mode, protection detection state switches from ON-state to OFF-state when the test piece is placed inside the protection zone and switches from OFF-state to ON-state when the test piece is removed			
8	If UAM is in manual restart mode, protection detection state switches from ON-state to OFF-state when the test piece is placed inside the protection zone and remains in OFF-state when the test piece is removed			
9	If the start interlock function is configured, starting the UAM without placing the test piece in protection zone causes protection detection state to remain in OFF-state until the RESET signal is provided			

Table 8-1 Pre-operation inspection list example(continued)

No.	Check item	Condition		Remark
		Yes	No	
10	If the muting function is configured, UAM terminates the muting (protection detection state switches to OFF-state) when the test piece is placed inside the protection zone other than the muting area even though the muting conditions are fulfilled.			
11	If the muting function is configured, UAM does not switch to mute state when the muting input sequence is different than the specified sequence.			
12	If the muting function is configured, UAM does not switch to mute state when the time interval between two muting inputs exceeded the specified time interval			
13	If the muting function is configured, the override function is terminated when the override period exceeds the specified override period			
14	If the reference monitoring function is configured, displacement of the reference boundary structures or UAM should cause protection detection state to switch to OFF-state when displacement exceeds the allowable tolerance. This is applicable especially if the angle of approach exceeds ±30º from the detection plane			
15	If the area sequence function is configured, protection detection state switches to OFF-state if area switching sequence is different than the configured sequence.			

Note: Stop using the UAM when any check item is marked NO.

Danger

- Do not modify or dissemble UAM during inspection as this will affect its detection capability leading to critical injury or death.

Note

- For the traceability, it is recommended to retain and store the maintenance and inspection records.

8.2 Operation inspection

This test should be performed after completing the pre-operation inspection. It must be performed by taking the sufficient safety measures. Performing this inspection before pre-operation inspection may damage the system leading to critical injury or death.

Table 8-2 Operation inspection list example

No.	Check item	Condition		Remark
		Yes	No	
1	Protection detection state switches from ON-state to OFF-state and the machine or vehicle stops when the test piece is placed inside the protection zone			
2	Protection detection state remains in OFF-state and the machine or vehicle stops when the test piece is moved inside the protection zone especially at the border			
3	If the UAM is in manual restart mode, protection detection state signal switches from ON-state to OFF-state and the machine or vehicle stops when the test piece is placed inside the protection zone and remains in OFF-state when the test piece is removed			
4	If the UAM is in manual restart mode, protection detection state remains in OFF-state when UAM is restarted			
5	If the UAM is in automatic restart mode, protection detection state signal switches from ON-state to OFF-state when the test piece is placed inside the protection zone and switches from OFF state to ON state when the test piece is removed			
6	If the UAM is in automatic restart mode, protection detection state remains in OFF-state when UAM is restarted with obstacle inside the protection zone			
7	If the start interlock function is configured, starting the UAM without placing the test piece in protection zone causes the protection detection state to remain in OFF-state until the RESET signal is provided			
8	If the muting function is configured, UAM terminates the muting (protection detection state switches to OFF-state) when the test piece is placed inside the protection zone other than the muting area even though the muting conditions are fulfilled.			
9	If the muting function is configured, UAM does not switch to mute state when the muting input sequence is different than the specified sequence.			

Table 8-2 Operation inspection list example(continued)

No.	Check item	Condition		Remark
		Yes	No	
10	If the muting function is configured, UAM does not switch to mute state when the time interval between two muting inputs exceeds the specified time interval			
11	If the muting function is configured, the override function is terminated when the override period exceeds the specified override period			
12	If the reference monitoring function is configured, displacement of the reference boundary structures or UAM should cause protection detection state to switch to OFF-state when displacement exceeds the allowable tolerance. This is applicable especially if the angle of approach exceeds ±30º from the detection plane			
13	If the area sequence function is configured, protection detection state switches to OFF-state if area switching sequence is different than the configured sequence.			

Note: Stop using the UAM when any check item is marked NO.

8.3 Daily inspection

hecked during daily inspection.

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

Table 8-3 Daily inspection list example

No.	Check item	Condition		Remark
		Yes	No	
1	Protection detection state switches from ON state to OFF state when test piece is placed inside the protection zone			
2	Protection detection state remains in OFF state when the test piece is moved inside the protection zone			
3	Protection detection state switches from OFF state to ON state when the test piece is removed from the protection zone			
4	If the UAM is in automatic restart mode, protection detection state switches from ON-state to OFF-state when the test piece is placed inside the protection zone and switches from OFF-state to ON-state when the test piece is removed			
5	If the UAM is in manual restart mode, protection detection state switches from ON-state to OFF-state when the test piece is placed inside the protection zone and remains in OFF-state when the test piece is removed			
6	If the start interlock function is configured, starting the UAM without placing the test piece in protection zone causes protection detection state to remain in OFF-state until the RESET signal is provided			
7	If the muting function is configured, UAM terminates the muting (protection detection state switches to OFF-state) when the test piece is placed inside the protection zone other than the muting area even though the muting conditions are fulfilled.			
8	If the muting function is configured, UAM does not switch to mute state when the muting input sequence is different than the specified sequence.			
9	If the muting function is configured, UAM does not switch to mute state when the time interval between two muting inputs exceeds the specified time interval			
10	If the muting function is configured, the override function is terminated when the override period exceeds the specified override period			

Table 8-3 Daily inspection list example(continued)

No.	Check item	Condition		Remark
		Yes	No	
11	If the reference monitoring function is configured, displacement of the reference boundary structures or UAM should cause protection detection state to switch to OFF-state when displacement exceeds the allowable tolerance. This is applicable especially if the angle of approach exceeds ±30º from the detection plane			
12	If the muting function is configured, UAM terminates the muting if muting period exceeds the specified maximum period			
13	If the area sequence function is configured, protection detection state switches to OFF-state if area switching sequence is different than the configured sequence.			

8.4 Periodical inspection

Periodical inspection should be performed to ensure the detection capability of UAM. Table 8-4 below shows an example of periodical inspection items. It is recommended to perform this inspection at every six months' interval. This inspection should be performed together with the daily inspection.

Table 8-4 Periodical inspection list example

No.	Check item	Condition		Remark
		Yes	No	
1	Screws 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 UAM			
7	Cable connector is in good condition and tightly fastened			
8	Area is switched and correctly displayed on UAM when the input signals are changed according to the area switching table			
9	Protection detection state switches from ON state to OFF state when the test piece is placed inside the protection zone			
10	Protection detection state remains in OFF state when the test piece is moved inside the protection zone			
11	Protection detection state switches from OFF state to ON state when the test piece is removed from the protection zone			
12	If the UAM is in automatic restart mode, protection detection state switches from ON-state to OFF-state when the test piece is placed inside the protection zone and switches from OFF-state to ON-state when the test piece is removed			
13	If UAM is in manual restart mode, protection detection state switches from ON-state to OFF-state when the test piece is placed inside the protection zone and remains in OFF-state when the test piece is removed			
14	If the start interlock function is configured, starting the UAM without placing the test piece in protection zone causes protection detection state to remain in OFF-state until the RESET signal is provided			
15	If the muting function is configured, UAM terminates the muting (protection detection state switches to OFF-state) when the test piece is placed inside the protection zone other than the muting area even though the muting conditions are fulfilled.			

Table 8-4 Periodical inspection list example(continued)

No.	Check item	Condition		Remark
		Yes	No	
16	If the muting function is configured, UAM does not switch to mute state when the muting input sequence is different than the specified sequence			
17	If the muting function is configured, UAM does not switch to mute state when the time interval between two muting inputs exceeded the specified time interval			
18	If the muting function is configured, the override function is terminated when the override period exceeds the specified override period			
19	If the muting function is configured, the muting is terminated when muting period exceeds the specified maximum muting period			
20	If the reference monitoring function is configured, displacement of the reference boundary structures or UAM should cause protection detection state to switch to OFF-state when displacement exceeds the allowable tolerance. This is applicable especially if the angle of approach exceeds ±30º from the detection plane			
21	Safety relay life span is still valid			
22	If the area sequence function is configured, protection detection state switches to OFF-state if area switching sequence is different than the configured sequence.			

Caution

- This manual only suggests the basic steps for the inspection and maintenance. User should perform additional inspection and maintenance if necessary.
- User should follow necessary steps in accordance to the working environment.
- Perform all the inspections mentioned in this manual when using the UAM for the first time.

8.5 Cleaning the optical window

Dust covering the optical window could affect the UAM's detection capability If UAM is installed in dusty environment, regular cleaning of optical window is necessary.

Depending on the level of contamination follow the cleaning method mentioned below.

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

Danger

- Disconnect the system when cleaning the optical window.
- Falling to comply with above could damage the machine leading to critical injury or death.

Caution

- Do not use organic solvents, such as, thinner, benzene and acetone for cleaning the UAM. Plastics parts and paint might be affected.
- Do not use abrasive cleaner. It might scratch the optical window resulting in the loss of detection capability.

Note

- Contamination on the optical window switches protection detection state to OFF state.

8.6 Replacing the optical window

Replacement of the optical window is needed in the following circumstances:

- Crack or scratch on the optical window.
- The surface of optical window remains contaminated even after cleaning.
- Deterioration of the optical window.

Order the replacement optical window at the nearest distributor or to UAM sales representative.

8.6.1 Method of replacing the optical window

Necessary tools

- Hexagonal wrench
- Torque wrench

a) Stop using the system and disconnect the UAM. Remove the UAM from its mounting location.

b) Take the UAM to dust free environment. Remove the dust on UAM if it is present. During the

c) Use wrench to remove screws ①to ④ fixing the optical window.

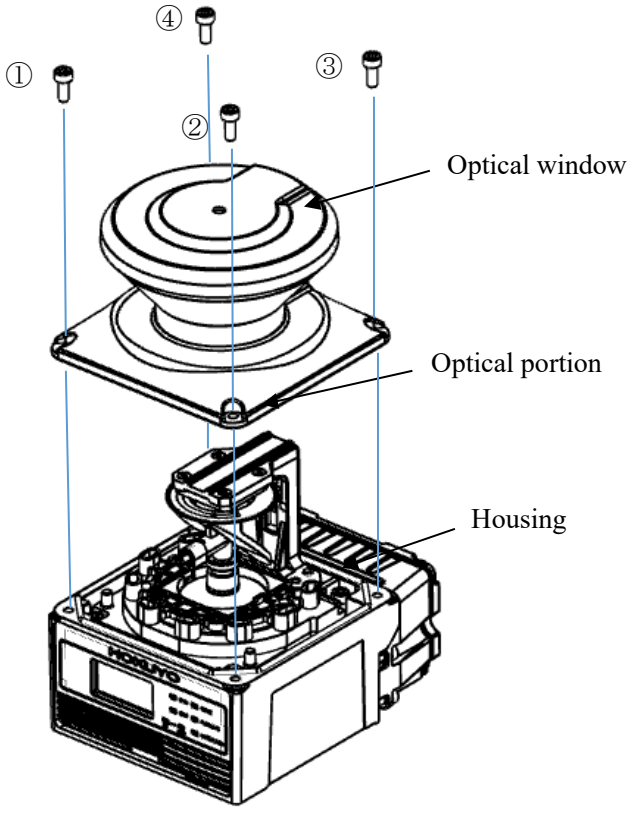


Figure 8-1 Remove the optical window

d) To remove the optical window, lift it slowly. Refrain from touching the optical components of UAM. Avoid applying the force while removing as it could damage the optical component affecting the detection capability of UAM.

e) If there is contamination around the case, remove it with a clean cloth without touching the optical part.

f) If there is contamination on the optical mirror remove it with an air blower.

g) Set a torque wrench to 0.63Nm.

h) Do not touch the new optical window with bare hands. It is recommended to wear clean thin gloves to unpack the new optical window.

i) Check if seal is attached on the surface of the optical window.

j) Check the direction to insert the optical window and cover slowly from above. Avoid shaking the optical components.

k) Confirm that optical window is correctly attached to the body without any inclination.

l) Use torque wrench to tight the 4 screws ①to ④.

m) Confirm that appearance of the UAM is not abnormal before installing it back to original system.

n) After installing in the system, adjust the optical window as explained in section 8.6.2.

Caution

- Optical window is a critical part of UAM therefore it should not be contaminated or scratched during the replacement.
- Replace the optical window at clean environment to avoid dust particles from entering the device affecting the detection capability.
- Do not hold the optical window with bare hands. Finger prints on the inner surface may affect the detection capability.
- Avoid touching or bumping on to the mechanical parts inside the UAM while replacing the optical window. Damage can affect the detection capability.
- After replacing the optical window, it is necessary to apply the adjustment. UAM is ready to use only after completing the adjustment.

8.6.2 Adjustment of the optical window

During the operation UAM constantly monitors the transmittance of optical window. When it decreases due to contamination UAM reports an error. Therefore, it is necessary to measure the initial transmittance of the new optical window and save it into the device. Contamination should not be present while performing this adjustment.

<Adjustment steps>

a) Connect UAM with UAM Project Designer. Click the [Option] menu and select [Optical Window Replacement] in the list. Optical window replacement tool will be displayed in separate window as shown in Figure 8-2.

b) Select the location to save the backup file.

c) Click the [Start Calibration] button to calibrate the new optical window. It will take approximately 6 minutes to complete the calibration of 8 contamination channels. LCD will show “Setting up” message during the process.

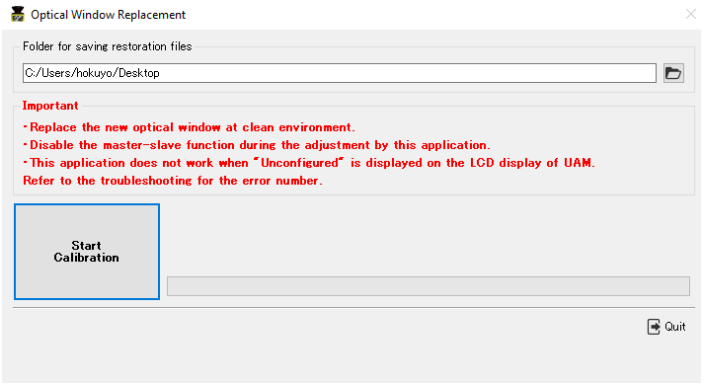


Figure 8-2 Adjustment

d) When the adjustment is complete, dialog box as shown in Figure 8-3 will appear. Click the OK button. USB will be disconnected automatically and UAM will switch to normal operation. Retry the adjustment after checking the optical window and USB connection if an error occurs during the process. If adjustment fails even after repeated trial contact the nearest distributor or sales representative for support. Send the log file and calibration data file for investigating the cause of failure in such case.

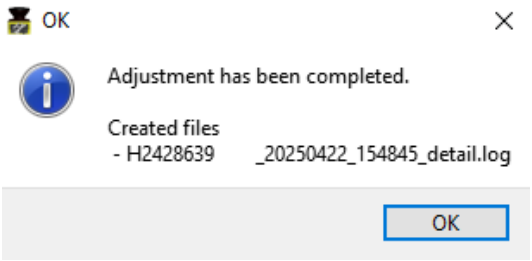


Figure 8-3 completed

9 Troubleshooting

This chapter describes troubleshooting methods while operating the UAM. Table 9-1 below shows the troubleshooting list.

Table 9-1 Troubleshooting List

Situation	Possible reason	Solution suggestion
UAM is not operating	Power supply is OFF /Over voltage/ Under voltage	Make sure power supply is ON
		Check the supplied voltage.
		Check the condition of the power supply cable.
	Cable is damaged	Replace with a new cable
	Configuration is incomplete	Reconfigure UAM
UAM can not connect with the UAM Project Designer	PC trouble	Check the PC's specification. Make sure the specification is compatible.
		Close the other unrelated applications and reconnect
	Power supply is OFF	Make sure the power supply is ON
		Check the supplied voltage.
		Check the condition of the power supply cable.
	USB cable is not connected to USB port	Make sure the USB is connected to both PC and UAM
UAM can not connect with master unit	Fault on the master unit	Check the master unit's specification
	Communication cable is not connected	Check the condition of the communication cable.
		Check for any mistakes in IN/OUT connection of the communication cable.
Measurement data is not displayed	Power supply is OFF	Make sure the power supply is ON
	UAM is in error/lockout state	Check the supplied voltage.
		Check the condition of the power supply cable.
		Check the error codes shown on the LCD or UAM project designer and restart the device after removing the cause of error.
Protection detection state remains OFF even though the protection zone is free from obstacle	Light interference	Mount UAM at a location free from light interference Refer to chapter 5.1 for light interference counter measures
	Mutual interference	Refer to chapter 5.2 for mutual interference counter measures
	Contaminated optical window	Check for any contamination or damage on the optical window

Table 9-2 Troubleshooting List (continued)

Situation	Possible reason	Solution suggestion
Protection detection state remains OFF even though the protection zone is free from obstacle	Floor is detected	Change the mounting position such that the floor is not detected. Reconfigure the detection area.
	Background is detected	Reconfigure the detection area such that background is not detected.
	Lockout state due to self-diagnostic function	Check the description of the error number and perform the possible solution as suggested
	UAM is interlocked	Check the configuration of the interlock function. If RES_REQ is ON, supply UAM with RESET signal

Table 9-3 shows the error number of the UAM. These numbers are displayed on the LCD of UAM. If UAM is unable to resume the normal operation, contact the nearest distributor or sales representative (included in last page of the manual) for support.

Table 9-3 Error number list

Error number	Details	Possible reason	Solution suggestion
4F	Encoder signal (direction change) error	Make sure the encoder is properly mounted and there are no sources of electrical noises around.	Restart the power supply
50	Encoder speed difference error. (When HW signals are used)	Make sure the difference in speed between encoder3 and encoder4 are well within the configured tolerance value.	Automatic recovery or Input reset (During Interlock setting)
55	Encoder speed error (When HW signals are used)	Make sure the encoder speed is correctly configured	Automatic recovery or Input reset (During Interlock setting)
56	Invalid area error	Confirm the input status during area switching.	Automatic recovery or Input reset (During Interlock setting)
57	Unused pattern error	Make sure the pattern number provided is configured for use.	Automatic recovery or Input reset (During Interlock setting)
59	Area sequence error	Confirm area switching sequence.	Automatic recovery or Input reset (During Interlock setting)
5B	Encoder speed error (When HW signals are used)	Make sure the encoder speed is correctly configured	Automatic recovery or Input reset (During Interlock setting)
5C	Encoder speed difference error. (When HW signals are used)	Make sure the difference in speed between encoder1 and encoder2 are well within the configured tolerance value.	Automatic recovery or Input reset (During Interlock setting)

Table 9-4 Error number list(continued)

Error number	Details	Possible reason	Solution suggestion
5D	Encoder speed error	Make sure the encoder speed is correctly configured	Restart the power supply
5E	Error due to invalid input pattern number.	Confirm the supplied input pattern is within the valid limit.	Automatic recovery or Input reset (During Interlock setting)
5F	Encoder speed error (When HW signals are used)	Make sure the encoder speed is correctly configured	Automatic recovery or Input reset (During Interlock setting)
60～63	Motor error	Mount the sensor in a way that the vibration, bump stated in the specification does not exceed.	Automatic recovery or Input reset (During Interlock setting)
70	Optical interference/High reflective background	Mount UAM at a location free from light interference. Refer to chapter 5.1 for light interference counter measures.	Automatic recovery or Input reset (During Interlock setting)
72	Operating temperature error	Make sure that operating temperature is within specification.	Restart the power supply
74	Power supply error	Make sure that voltage is within the specification.	Restart the power supply
7E	UAM reset input error	Make sure the ON state of reset input supplied to UAM does not exceed 30 sec.	Automatic recovery or Input reset (During Interlock setting)
84～85	Object in limited detection zone or contamination on the optical window.	Clean the optical window (refer to chapter 8.5 for cleaning the optical window). Further, remove any objects present inside the zone with limited detection capability (refer to chapter 5.4) of UAM.	Automatic recovery or Input reset (During Interlock setting)
86	Mutual interference error	Mount UAM at a location free from mutual interference. Refer to chapter 5.2 mutual interference for counter measures.	Automatic recovery or Input reset (During Interlock setting)
95	Encoder speed error (When speed is provided by FSoE communication)	Make sure the encoder speed is correctly configured	Automatic recovery or Input reset (During Interlock setting)
96	Encoder speed error (When speed is provided by FSoE communication)	Make sure the encoder speed is correctly configured	Automatic recovery or Input reset (During Interlock setting)

Table 9-5 Error number list(continued)

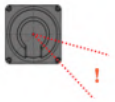
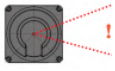
Error number	Details	Possible reason	Solution suggestion
97	Encoder angular velocity error (When speed is provided by FSoE communication)	Make sure the encoder speed is correctly configured	Automatic recovery or Input reset (During Interlock setting)
98	Encoder speed error (When speed is provided by FSoE communication)	Make sure the encoder speed is correctly configured	Automatic recovery or Input reset (During Interlock setting)
99	Encoder angular velocity error (When speed is provided by FSoE communication)	Make sure the encoder speed is correctly configured	Automatic recovery or Input reset (During Interlock setting)
9A	Encoder speed difference error. (When speed is provided by FSoE communication)	Make sure the difference in speed between encoder1 and encoder2 are well within the configured tolerance value.	Automatic recovery or Input reset (During Interlock setting)
9B	Encoder speed difference error. (When speed is provided by FSoE communication)	Make sure the difference in speed between encoder3 and encoder4 are well within the configured tolerance value.	Automatic recovery or Input reset (During Interlock setting)
A7	Communication error with master unit	Confirm the communication between UAM and master unit is established.	Automatic recovery or Input reset (During Interlock setting)
A9	Reset input error	Check the RESET connection.	Automatic recovery or Input reset (During Interlock setting)
AA	Reference monitor error	Check for the displacement of reference structure or UAM position	Automatic recovery or Input reset (During Interlock setting)
AB～AD	Communication error with master unit	Confirm the communication between UAM and master unit is established.	Automatic recovery or Input reset (During Interlock setting)
B9	Optical window is contaminated 	Refer to chapter 8.5 for cleaning the optical window	Automatic recovery or Input reset (During Interlock setting)
BA	Optical window is contaminated 		

Table 9-6 Error number list(continued)

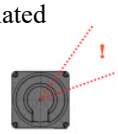
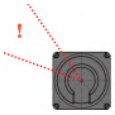
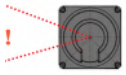
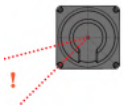
Error number	Details	Possible reason	Solution suggestion
BB	Optical window is contaminated 	Refer to chapter 8.5 for cleaning the optical window	Automatic recovery or Input reset (During Interlock setting)
BC	Optical window is contaminated 		
BD	Optical window is contaminated 		
BE	Optical window is contaminated 		
BF	Optical window is contaminated 		
C0	Optical window is contaminated 		
C1	Optical window is removed or contaminated	Replace or clean the optical window	Restart the power supply
CE	Adjustment of the optical window is incomplete after replacement. (Displays CE during the adjustment of the optical window.)	Adjust the optical window	Automatic recovery or Input reset (During Interlock setting)
CF	UAM is not configured	Configure UAM	Restart the power supply
D3～E8	Configuration is incomplete	Reconfigure UAM	Restart the power supply

Table 9-7 Error number list(continued)

Error number	Details	Possible reason	Solution suggestion
Other Error (41-D0)	Device Error	Make sure that FG wire is correctly to the ground. Also check the surrounding disturbance of the operating environment. Mount the sensor within the stated vibration, bump in the specification. Replace UAM if it does not recover even after restoring the power supply. Contact the nearest distributor or sales representative for the repair.	Restart the power supply

* Error numbers are represented by: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, and F.

* Error number is displayed on the center of LCD.

Note

- When adjusting the optical window using Optical Window Adjuster tool, “Setting up” message will be displayed on the liquid crystal display of UAM. On successful completion of the adjustment, UAM will resume to normal operation displaying the area number.

10 Specification

Specification of UAM-05LECA is shown in Table 10-1.

Table 10-1 UAM-05LECA-T301 specification

Subject	Specifications	
Model	UAM-05LECA-T301	
Detection property	Protection range	Max 5.0m
	Warning range	Max 30m (Non-safety)*1
	Distance tolerance*2	~3000mm: +60mm 3001mm~: +100mm
	Detection capability	From Black-Reflector Sheet (1.8%) to Retro-Reflector Sheet
	Angular Range	270°
	Minimum Detectable Width	φ30 mm (Max: 1.8m) φ40 mm (Max: 2.5m) φ50 mm (Max: 3.0 m) φ70 mm/150mm (Max: 5.0 m)
	Scan Frequency	30ms (Rotational Speed: 2000 rpm)
	Protection zone per area*3	Max 5
	Warning zone per area*3	Max 4
	Area pattern	Max 176 patterns
	Simultaneous configurable zone	Max 6 (Protection zone: 5 + Reference monitor: 1)
	Response time	OFF: 80 ~ 2030ms ON: 290 ~ 2030ms
Optics	Element	Pulse Laser Diode
	Wave Length	905nm
	Safety class	Laser Class 1
Type	Type3 (IEC61496-1, IEC61496-3)	
Functional Safety	SIL2 (Type B, HFT = 1) (IEC61508)	
PFHd	9.4×10^{-8} (T1=20year)	
Housing	Size	80mm(W)×104mm(D)×95mm(H)
	Weight	0.4kg
	Protection	IP65
	Case Material	Body: Aluminum Connector unit: Aluminum Optical Window: Polycarbonate
	Connection Cable*4	Power: M12 connector Male (A code) Communication: M12connector Female (D code)×2
Power supply	DC24V ±10%: When operation using converter power supply DC24V -30%/+20%: When operation using battery	
Supply current	Normal without load	7W
	Maximum with load	20W
Startup time	Less than 30s	

*1: Distance when reflectance of the object is 90% or above.

*2: An additional distance of 200mm is needed when the UAM is working under high reflective background

*3: The zone that can be set for each area is 5 in total, including the protection zone and warning zone.

*4: There are 2 types of connectors, back facing type and down facing type (see section 13). Connector unit is not included in the standard product and sold separately.

Table 10-2 UAM-05LECA-T301 specification(continued)

Subject	Specifications	
Output	RES_REQ1/RES_REQ2 MUT_OUT1/ MUT_OUT2 AUX_OUT1/ AUX_OUT2	Output types (PNP Transistor)
		Output current (Max: 200mA)
		Leak current (Max: 1mA)
		AWG26
Input	P1_MUT_IN1/P1_MUT_IN2/ P2_MUT_IN1/P1_MUT_IN2/ OVERRIDE1/OVERRIDE2/ RESET1/RESET2/ ENC1_A/ENC1_B/ ENC2_A/ENC2_B/ENC3_A /ENC3_B/ENC4_A/ENC4_B	Input Impedance 2.2kΩ AWG26
Interface	Body	USB2.0 (USB micro type-B connector)
	Connector unit	Ethernet 100BASE-TX (EtherCAT IN)
		Ethernet 100BASE-TX (EtherCAT OUT)
FieldBus/Industrial Network	Type	EtherCAT
	Connector	M12 female connector, 4-pin, D-coded
	Profiles	FSoE: Safety I/O CoE: Read only setting data EoE: Measurement data and configuration FoE: Offline generated file-based configuration
Communication Data	Measurement Error (Distance) *5	±20mm (TYP)
	Max Range (Distance)	40m
	Angular resolution	0.125°, 0.25°
Angular Error*5	Vertical Plane	±1° (Beam divergence is excluded)
	Horizontal Plane	±0.3° (Beam divergence is excluded)
Environmental resistance	Temperature	-10ºC to +50ºC (No freezing)
	Storage Temperature	-25ºC to +70ºC (No freezing)
	Humidity	95% RH with no condensation
	Storage Humidity	95% RH with no condensation
	Surrounding Intensity*6	Less than 1500 lx
	Vibration	Frequency range: 10~55Hz Sweep rate: 1 octave/min Amplitude: 0.35mm ±0.05mm
	Bump	Acceleration: 100m/s^2 Pulse hold duration: 16ms
	Outdoor Operation	Not permitted
	Altitude	Below 2000m

*5: Reference data measured at the manufacturer's facility.

*6: When the light sources are located at ≥5º from the detection plane of UAM.

<Scan angle error (reference data)>

Margin of scan angle error corresponding to UAM's mechanics are ±0.3° on horizontal plane and ±1° on vertical plane. Mount the device appropriately if it is necessary to strictly limit the detection range.

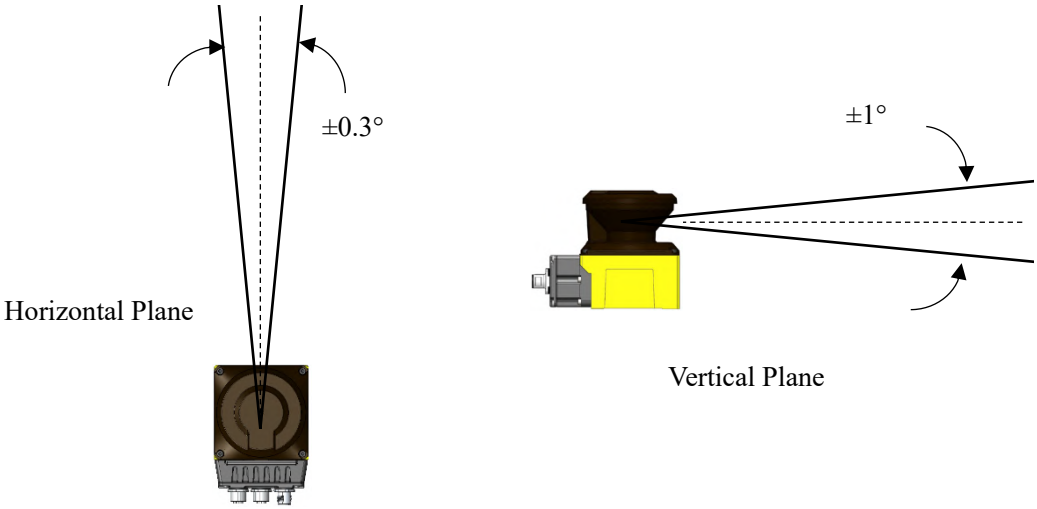


Figure 10-1 Scan angle error

11 Safety object（FSoE）

11.1 Module input data（Input to UAM）

Table 11-1 Module input data for area input mode

Name	Data Type	Description	Value	Category
Area Input 1~8	BOOL	Area number (For switching the operating area)	1~176	Safety
Protection1~5 Reset In	BOOL	Protection zone reset input (For resetting the interlock state or for the override operation)	0: Input OFF state 1: Input ON state	Safety
Protection1~5 Muting1, 2	BOOL	Muting Input1, 2 (For initiating/ terminating the muting function)	0: Input OFF state 1: Input ON state	Safety
Protection1~5 Override	BOOL	Override Input1, 2 (For initiating/ terminating the muting function)	0: Input OFF state 1: Input ON state	Safety
Laser off Mode	BOOL	Laser off mode (To switch off the laser emission)	0: Laser emission 1: Laser emission stop	Safety
Restart Safety Device	BOOL	Restart Safety function (To restart the UAM)	0,1: Invalid Switching with pattern 0-1-0 in 60ms will restart the device.	Safety

Table 11-2 Module input data for encoder input mode

Name	Data Type	Description	Value	Category
Encoder Pattern Input1~6	BOOL	Encoder pattern number (For switching the operating encoder pattern)	1~32	Safety
Protection1~5 Reset In	BOOL	Protection zone reset input	0: Input OFF state 1: Input ON state	Safety
Protection1~5 Muting1, 2	BOOL	Muting Input1, 2 (For initiating/ terminating the muting function)	0: Input OFF state 1: Input ON state	Safety

Table 11-3 Module input data for encoder input mode (continued)

Name	Data Type	Description	Value	Category
Protection1~5 Override	BOOL	Override Input (For initiating/ terminating the muting function)	0: Input OFF state 1: Input ON state	Safety
Laser off Mode	BOOL	Laser off mode (To switch off the laser emission)	0: Laser emission 1: Laser emission stop	Safety
Restart Safety Device	BOOL	Restart Safety function (To restart the UAM)	0,1: Invalid Switching with pattern 0-1-0 in 60ms will restart the device.	Safety
Encoder1~4 Velocity	SINT16	Encoder1~4 speed (For switching the operating area)	-32768 ~ 32767cm/s	Safety
Encoder Linear Velocity	SINT16	AGV velocity calculated by the master	-32768 ~ 32767cm/s	Safety
Encoder Angular Velocity	SINT16	AGV angular velocity calculated by the master	-360 ~ 360deg/s	Safety

11.2 **Module output data (Output from UAM)**

Table 11-4 Module output data for area input mode

Name	Data Type	Description	Value	Category
Protection 1~5 detection	BOOL	Detection state of protection zones	0: Obstacle in protection zone/ Error detection/ Laser off/ Setting mode 1: Obstacle absent in protection zone	Safety
Warning 1~4 detection	BOOL	Detection state of warning zones	0: Obstacle in warning zone/ Error detection/ Laser off/ Setting mode 1: Obstacle absent in warning zone	Non-safety
Protection1~5 Muting/Override	BOOL	Muting or override state of device	0: Device is not in muting or override state 1: Device is in muting or override state.	Non-safety

Table 11-5 Module output data for area input mode (continued)

Name	Data Type	Description	Value	Category
Protection1~5 Reset Request	BOOL	Reset input acceptance state when protection zone is in interlock state	0: Not ready to accept reset input 1: Ready to accept reset input	Non-safety
Operating Mode	BOOL	Operating mode of the UAM	0: Normal operation 1: Setting mode	Non-safety
Laser off State	BOOL	Laser emission state	0: Laser emission 1: Laser emission stop	Non-safety
Lockout State	BOOL	Lockout state of UAM	0: Not in lockout state 1: In lockout state	Non-safety
Error state	BOOL	Error detection	0: No error 1: Error present	Non-safety
Reference Error Status	BOOL	Measurement of reference object	0: No error in reference object measurement 1: Error in reference object measurement	Non-safety
Contamination Error	BOOL	Optical window is contaminated (Clean the optical window of UAM)	0: Contamination error is off 1: Contamination error is on	Non-safety
Contamination Warning	BOOL	Optical window is contaminated (Clean the optical window of UAM)	0: Contamination warning is off 1: Contamination warning is on	Non-safety
Operating area number	UINT8	Operating area number	1 ~ 176	Non-safety
Error code	UINT8	Detected error number (When sensor detects multiple error, error code of the first detected error will be transmitted. However, when the device goes to lockout, error causing the lockout will be transmitted)	65 ~ 255	Non-safety

Table 11-6 Module output data for encoder input mode

Name	Data Type	Description	Value	Category
Protection1~5 detection	BOOL	Detection state of protection zones	0: Obstacle in protection zone/ Error detection/ Laser off/ Setting mode 1: Obstacle absent in protection zone	Safety
Warning 1~4 detection	BOOL	Detection state of warning zones	0: Obstacle in warning zone/ Error detection/ Laser off/ Setting mode 1: Obstacle absent in warning zone	Non-safety
Protection1~5 Muting/Override	BOOL	Muting or override state of device	0: Device is not in muting or override state 1: Device is in muting or override state.	Non-safety
Protection1~5 Reset Request	BOOL	Reset input acceptance state when protection zone is in interlock state	0: Not ready to accept reset input 1: Ready to accept reset input	Non-safety
Operating Mode	BOOL	Operating mode of the UAM	0: Normal operation 1: Setting mode	Non-safety
Laser off State	BOOL	Laser emission state	0: Laser emission 1: Laser emission stop	Non-safety
Lockout State	BOOL	Lockout state of device	0: Device is not in lockout state 1: Device is in lockout state	Non-safety
Error state	BOOL	Error detection	0: No error 1: Error present	Non-safety
Reference Error Status	BOOL	Measurement of reference object	0: No error in reference object measurement 1: Error in reference object measurement	Non-safety
Contamination Error	BOOL	Optical window is contaminated (Clean the optical window of UAM)	0: Contamination error is off 1: Contamination error is on	Non-safety

Table 11-7 Module output data for encoder input mode (continued)

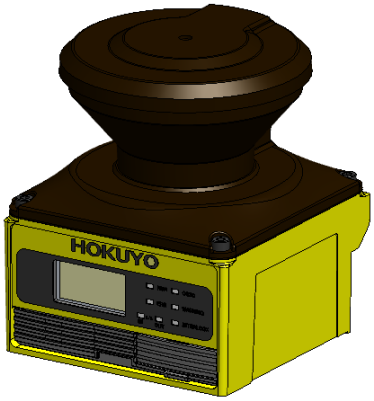
Name	Data Type	Description	Value	Category
Contamination Warning	BOOL	Optical window is contaminated (Clean the optical window of UAM)	0: Contamination warning is off 1: Contamination warning is on	Non-safety
Operating area number	UINT8	Operating area number	1 ~ 176	Non-safety
Error code	UINT8	Detected error number (When sensor detects multiple error, error code of the first detected error will be transmitted. However, when the device goes to lockout, error causing the lockout will be transmitted)	65 ~ 255	Non-safety
HW Encoder 1~4 Velocity	SINT16	Encoder1 ~ 4 velocity calculated from signals on the hardware terminals.	-32768 ~ 32767cm/s 0: In case of unused	Safety
HW Encoder Linear Velocity	SINT16	AGV velocity calculated from signals on the hardware terminals.	-32768 ~ 32767cm/s 0: In case of unused	Safety
HW Encoder Angular Velocity	SINT16	AGV angular velocity calculated from signals on the hardware terminals.	-360 ~ 360deg/s 0: In case of unused	Safety
Area Switching Encoder Linear Velocity	SINT16	Area switching encoder linear velocity	-32768 ~ 32767cm/s	Safety
Area Switching Encoder Angular Velocity	SINT16	Area switching encoder angular velocity	-360 ~ 360deg/s	Safety

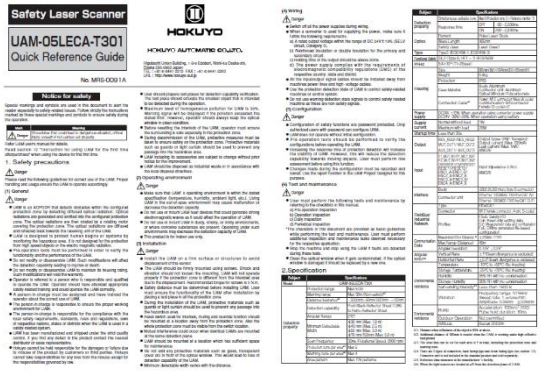
12 Package contents

The following items are included in the package.

a) UAM-05LECA×1

b) Quick Reference ×1





13 Options

13.1 Back facing Connector Unit (Model: UAM-5CUBA)

There are two types, back facing and down facing connectors available for UAM. Selecting the right connector will help to mount the device in a confined space. Back facing Connector unit allows the connection of power and I/O cable from the back of UAM.

*Connector units are sold separately.

13.2 Down facing Connector Unit (Model: UAM-5CUBO)

Down facing Connector unit allows the connection of power and I/O cable from the bottom of UAM.

*Connector units are sold separately.

13.3 Base mounting bracket (Model: UAM-BK08)

This base bracket can be used to change the horizontal alignment of the UAM during installation. This bracket is useful especially in preventing the mutual interference when two or more UAMs are used. (Refer to external dimension)

13.4 Rear mounting bracket (Model: UAM-BK09)

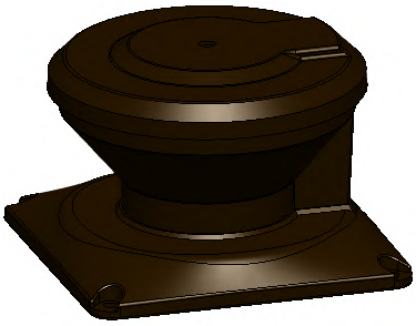
This rear bracket can be used to change the vertical and horizontal alignment of the UAM during installation. This bracket is useful especially in preventing the mutual interference when two or more UAMs are used. (Refer to external dimension)

13.5 USB cable (Model: UAM-MUSB)

This cable is used to connect the UAM and PC. Length of the USB cable is 1m. This cable is used during the configuration of the UAM.

13.6 Optical window for replacement (Model: UAM-W004)

Replacement part when optical window is scratched or damaged.



13.7 Cover Bracket (Model: UAM-BK10)

Cover brackets for optical window protection that can be used in combination with mounting brackets (see section 14.4).

13.8 Power Supply and Input/Output Connector Cable

This is a cable to supply power to UAM and connect the Input/Output terminals.

Model	Cable length
UAM-5EP03C	3m
UAM-5EP05C	5m
UAM-5EP10C	10m

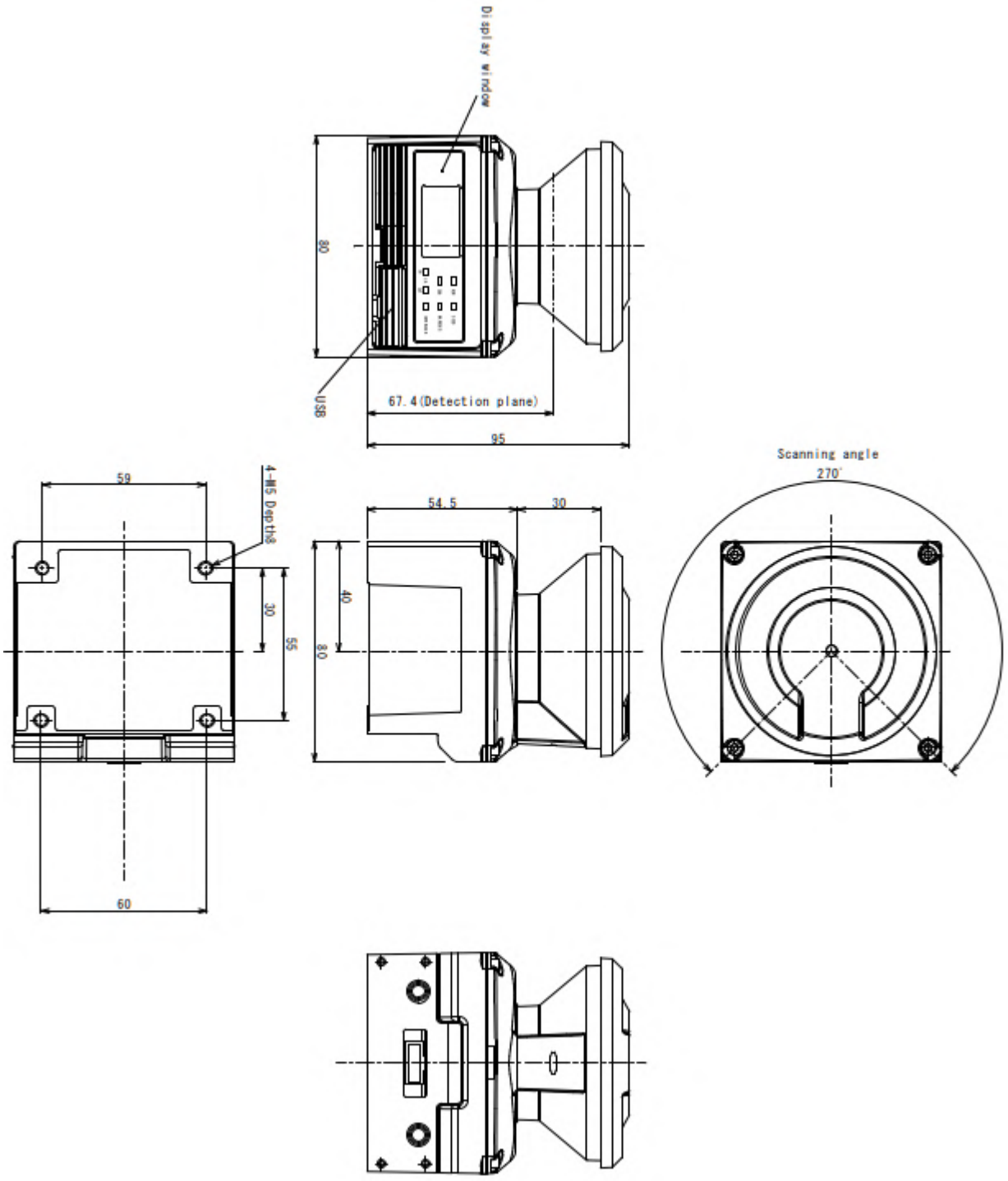
13.9 Communication Connector Cable

This is a communication cable to connect UAM with the master controller unit.

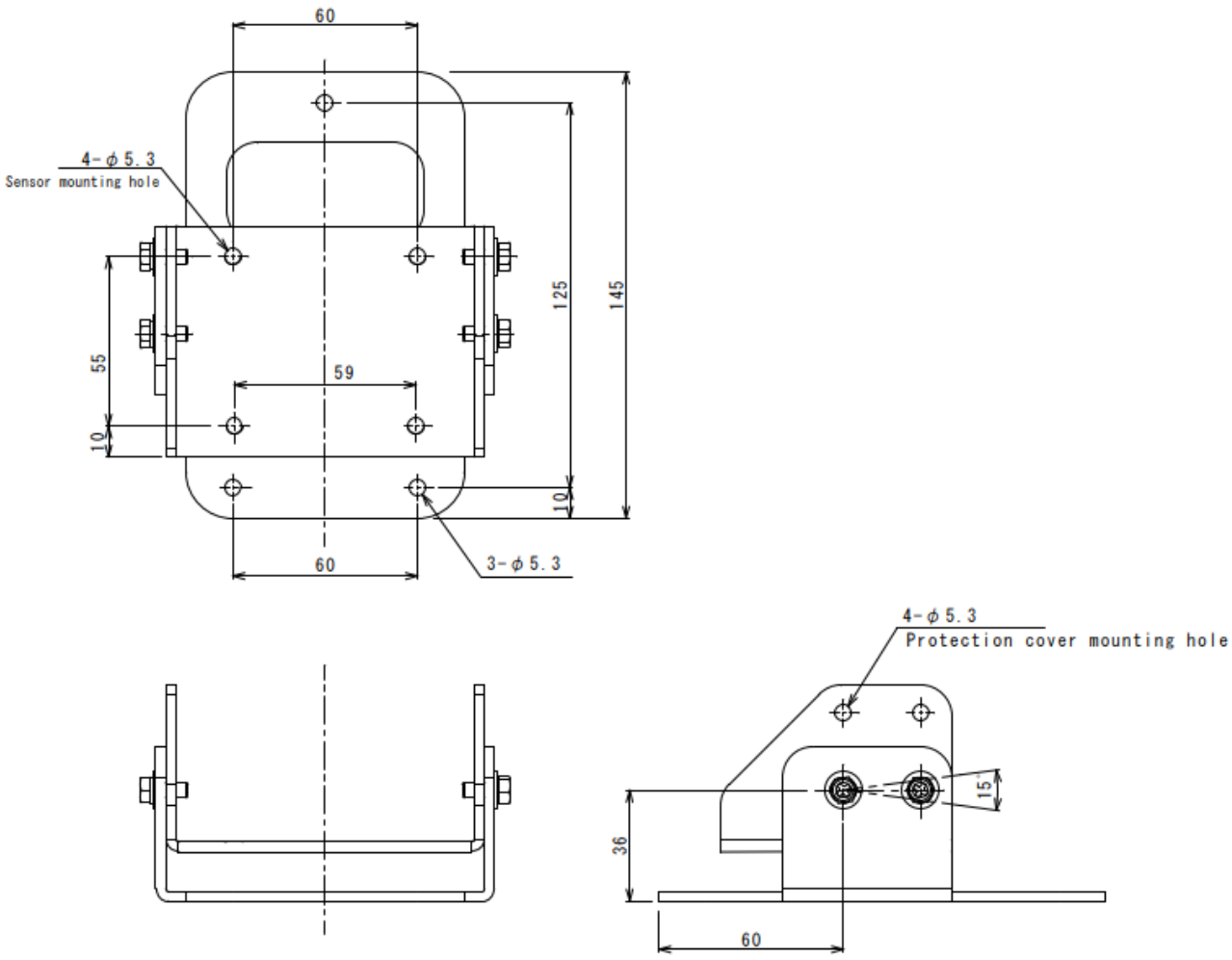
Model	Cable length
UAM-5EC05C	5m
UAM-5EC10C	10m

14 External dimension

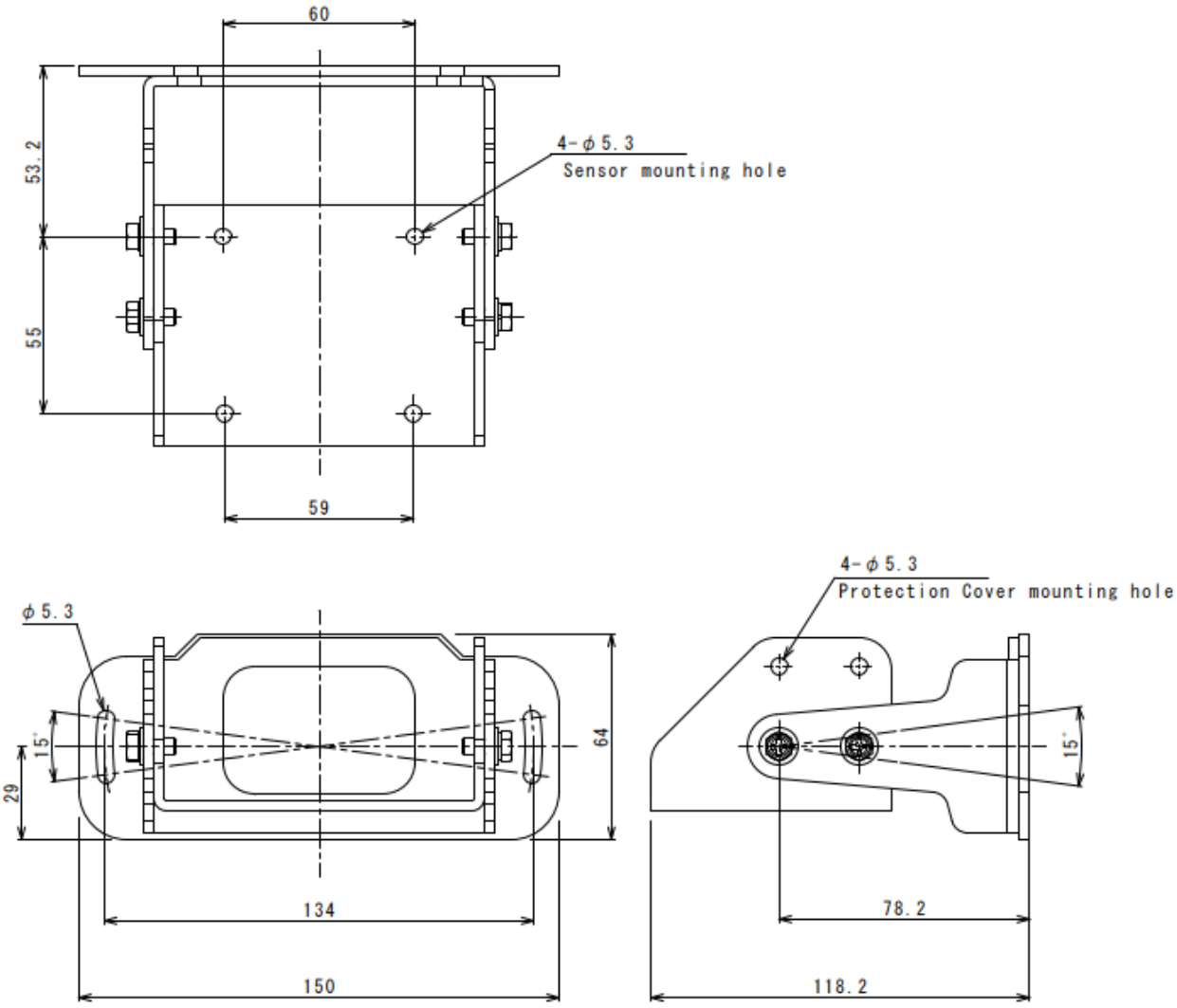
14.1 **UAM-05LECA-T301**



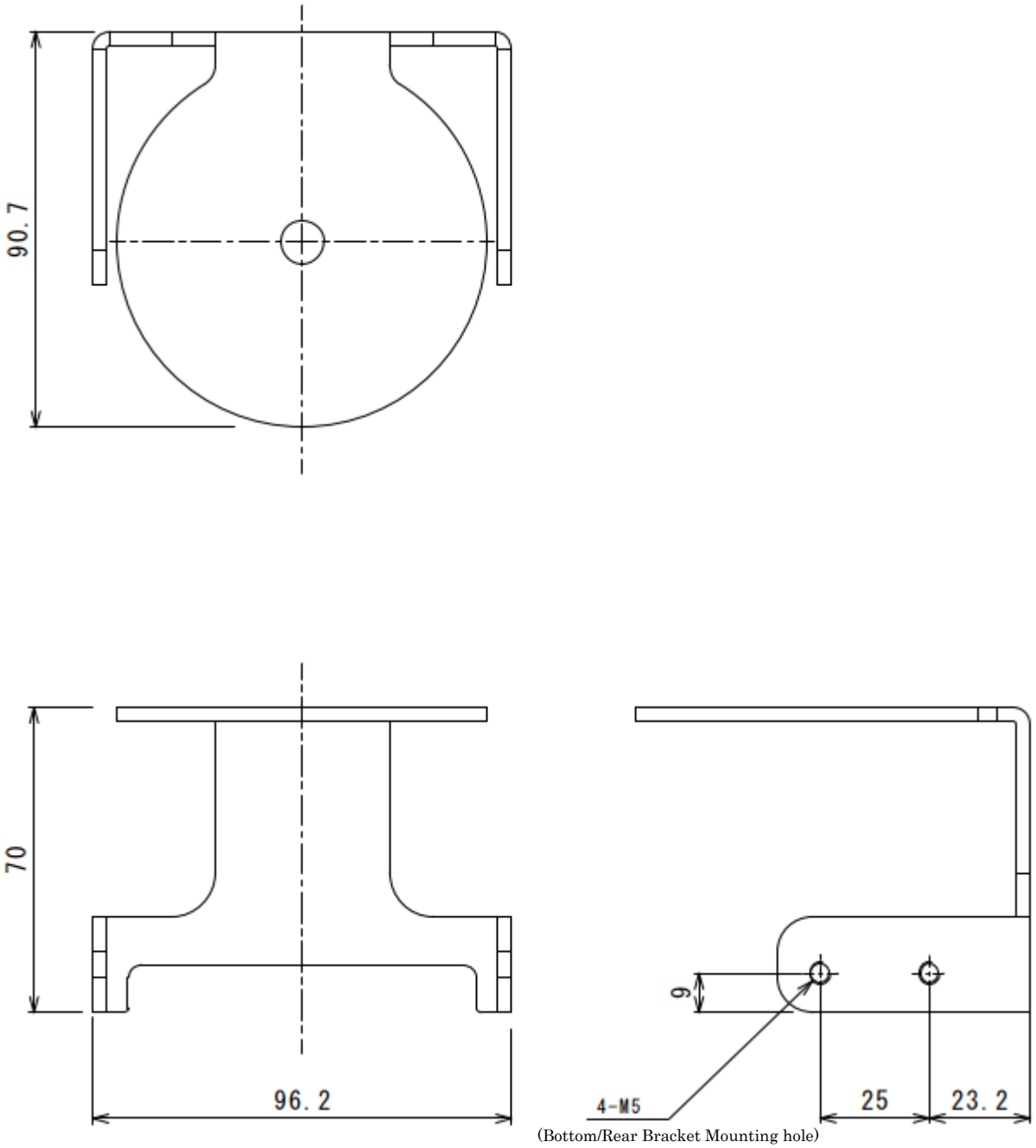
14.2 **Base mounting bracket**



14.3 **Rear mounting bracket**



14.4 **Cover Protection bracket**



(Bottom/Rear Bracket Mounting hole)

15 EC Declaration of conformity

Manufacturer	Name	HOKUYO AUTOMATIC CO., LTD
	Address	Higobashi Union Building, 1-9-6 Edobori, Nishi-ku, Osaka 550 -0002, Japan
Authorized representative in Europe	Name	Hokuyo Automatic Co.,Ltd. Amsterdam Branch
	Address	Prof. J. H. Bavincklaan 2, 1183 AT Amstelveen, The Netherlands
Certify and declare under our solo responsibility that the following apparatus		
Description		Safety Laser Scanner
Manufacturer		HOKUYO AUTOMATIC CO., LTD
Identification		UAM -05 Series
Confirms with the essential requirements of the EMC Directive 2014/30/EU, based on the following specifications applied - EU Harmonized Standards - EN55011: 2016+A1:2017+A11:2020 - EN IEC 61000-6-4: 2019 - EN IEC 61496-1: 2020 (Type3 ESPE) - EN IEC 61000-6-2: 2019 - EN IEC 62061: 2021 (Regarding EMC requirement: refer to EN61326-3-1: 2017 maximum SIL2)		
Confirms with the essential requirements of the Machinery Directive 2006/42/EC, based on the following specifications applied - EU Harmonized Standards - EN IEC 61496-1: 2020 (Type3 ESPE) - IEC61496-3: 2018 (Type3 ESPE) - IEC61508-1: 2010 (SIL1-2) - IEC61508-2: 2010 (SIL1-2) - IEC61508-3: 2010 (SIL1-2) - IEC61508-4: 2010 (SIL1-2) - EN IEC 62061: 2021 (maximum SIL2) - EN ISO13849-1: 2023 (Cat.3, PL d) The following Notified Body has issued a positive Statement of Opinion.		
Confirms with the essential requirements of the RoHS Directive 2011/65/EU, based on the following specifications applied - EU Harmonized Standards - EN IEC63000: 2018		
Notified Body reference		Z10 026630 031
Identification of statement		0123
Name and address of NB		TÜV SÜD Product Service GmbH Ridlerstrasse 65 80039 Muenchen Germany

16 Revision history

Revision Symbol	Revision Date	Revision Details
-	July, 2025	First release

17 Representative contacts

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The contents described in this document are based on the information as of July 2025. The external dimensions, specifications etc. are subject to change without notice.