Date：2025/5/7

Safety Laser Scanner
UAM-05LECA-T301
Specification

RoHS

1							
Symbol	Amended Reason				Pages	Date	Amended by	Number
Approved by	Checked by	Drawn by	Designed by		Safety Laser Scanner UAM-05LECA-T301 Specification		
Hino	Higashi	Kobayashi	Kobayashi	Drawing No	C-62-00057		1／29

1. Applicable directives and standards

UAM 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).

Table1-1 Applicable directives and standards

Certification authority	Directives/Standard	Details	
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
		CSAC22.2No.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)

1.1 Registered trademarks

- 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. Specification

Table2-1 UAM-05LECA 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	ϕ 30mm(Max:1.8m) ϕ 40mm(Max:2.5m) ϕ 50mm(Max:3.0m) ϕ 70mm(Max:5.0m)
	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 settable 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
	Connector Unit※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. 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 two types, back facing and down facing connectors available for UAM.
Connector units are sold separately.

Table2-1 UAM-05LECA specification(continued)

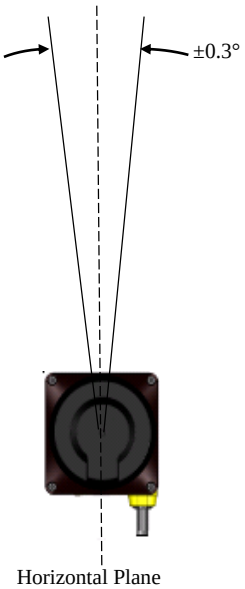
Subject	Specifications	
Output	RES_REQ1/RES_REQ2 MUT_OUT1/ MUT_OUT2	Output types (PNP Transistor)
		Output current (Max: 200mA)
		Leak current (Max: 1mA)
		AWG26
Input	P1_MUT_IN1/P1_MUT_IN2/ P2_MUT_IN1/P1_MUT_IN2/ OVERRIDE1/OVERRIDE2/ RESET1/RESET2/ ENC1_A/ENC1_B/ ENC2_A/ENC2_B	Input Impedance 2.2kΩ 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/Os 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

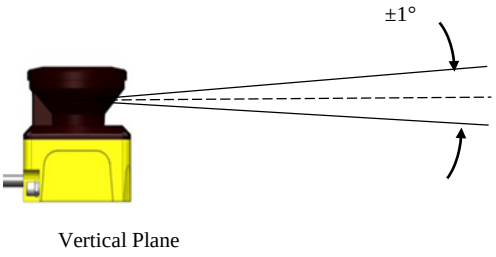
※5. Reference data measured at the manufacturer's facility.

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

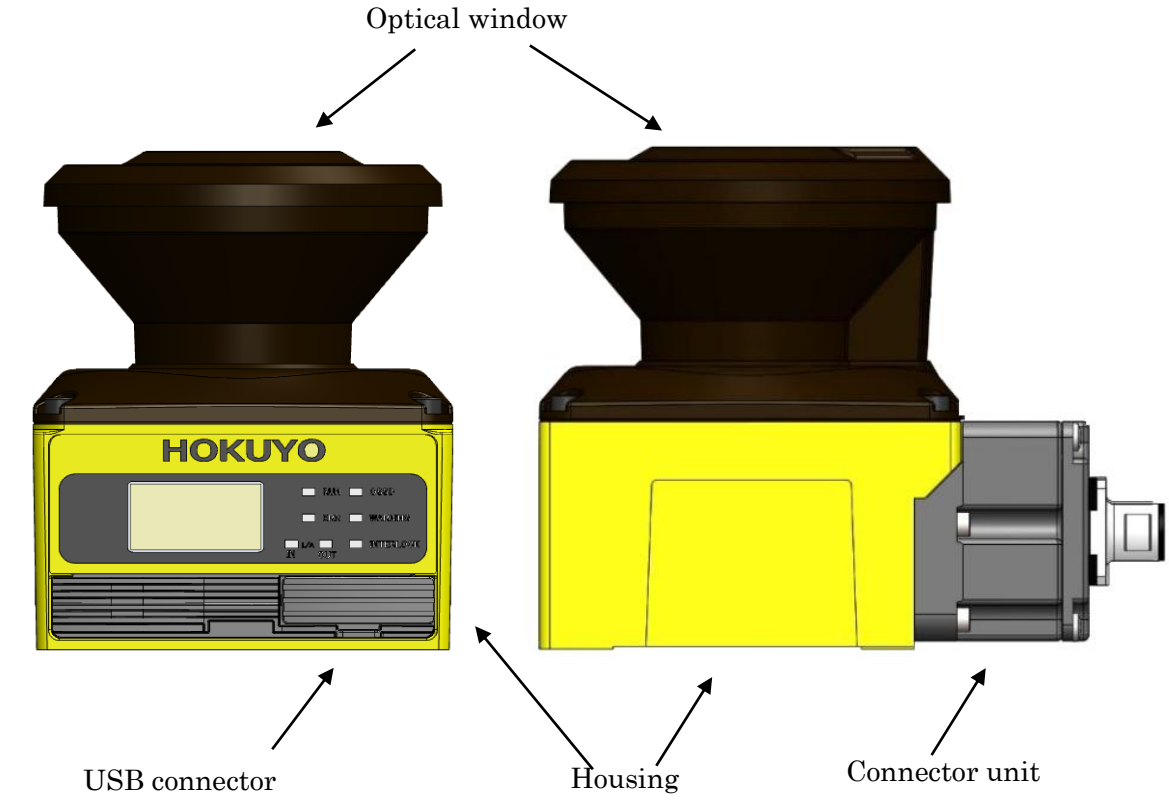
Scan Angle Error (Reference data)

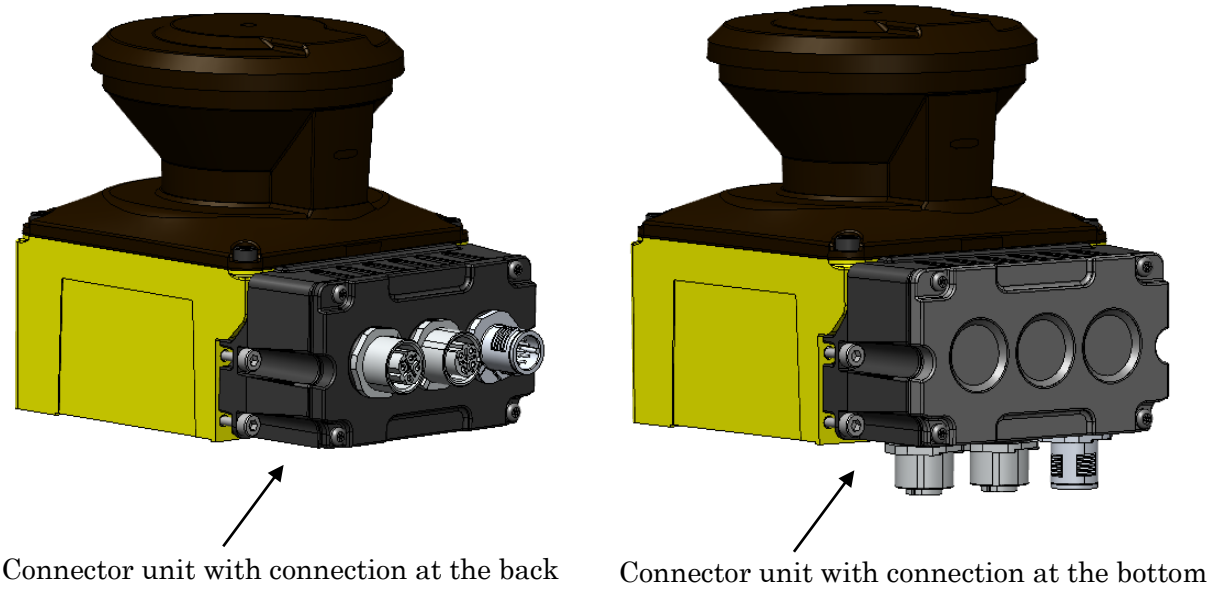
Horizontal and vertical angular error of the optics with reference to the UAM's mechanical axes are ±0.3° and ±1° respectively (figure below). Mount the device appropriately if it is necessary to strictly limit the detection range.





3. Components of UAM-05LECA-T301





Model	
UAM-05LECA-T301	Main body
UAM-5CUBA	Back facing Connector Unit
UAM-5CUBO	Down facing Connector Unit

Figure 3-1: UAM-05LECA components

4. Function

4.1 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.

4.1.1 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 4-1 and 4-2 show 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.

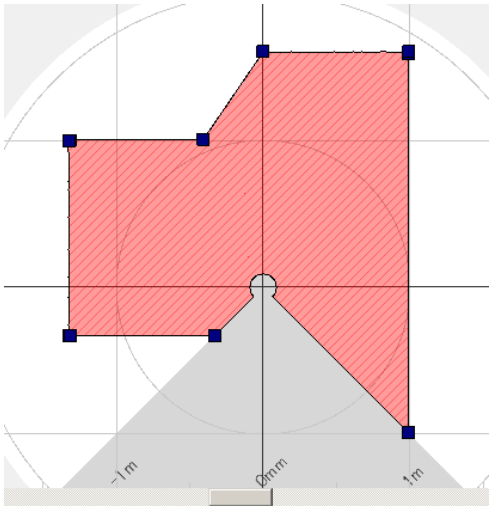


Figure 4-1 Protection zone configured using manual mode

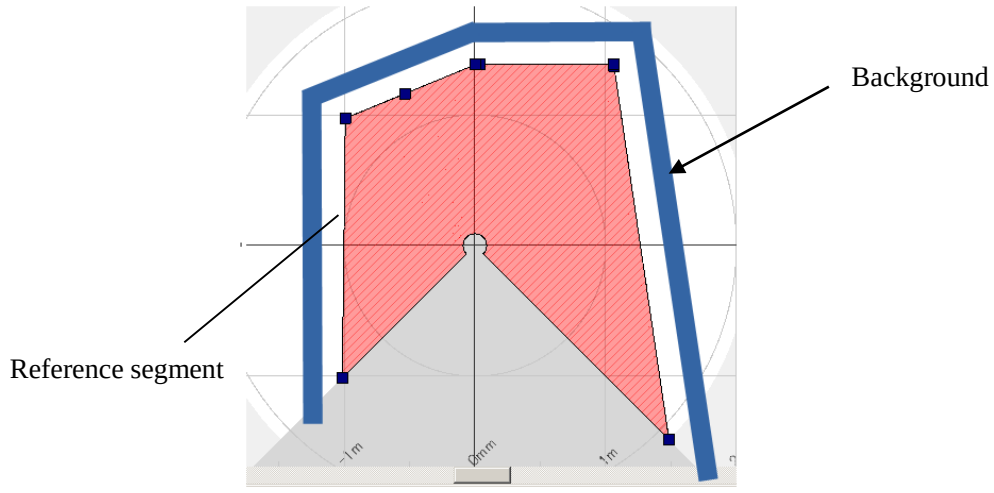


Figure 4-2 Protection zone configured using teaching mode

4.1.2 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 4-3).

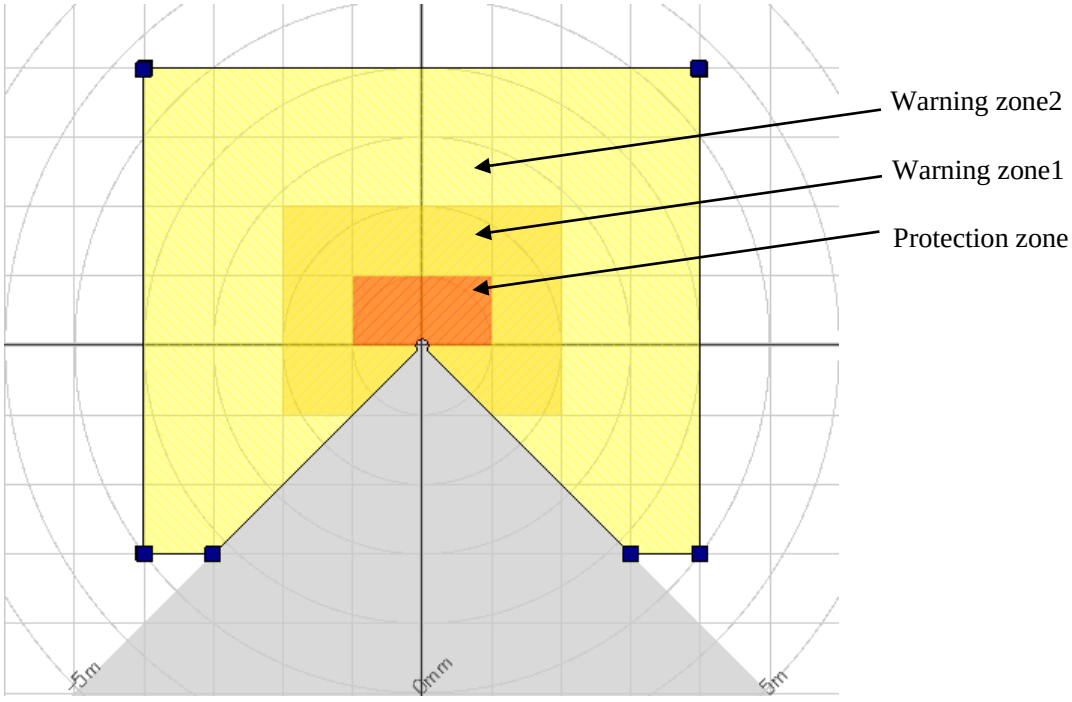


Figure 4-3 Warning zones

4.2 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 (section 4.3.1 to 4.3.3). 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.

4.2.1 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 signals 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.

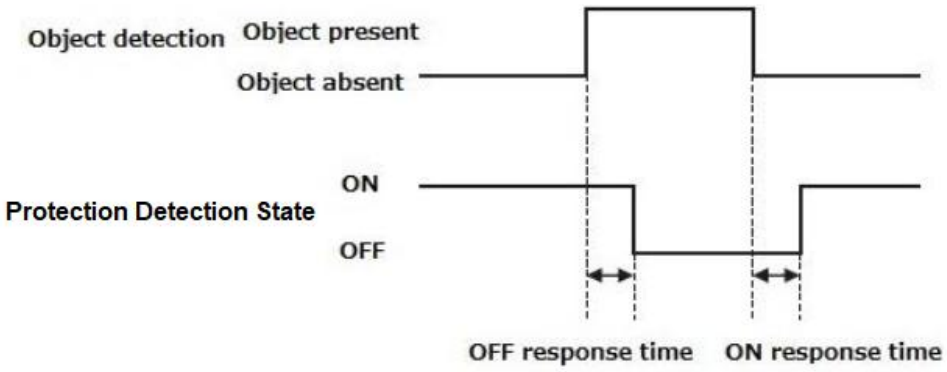


Figure 4-4 Timing chart of automatic restart

4.2.2 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 4-5 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.

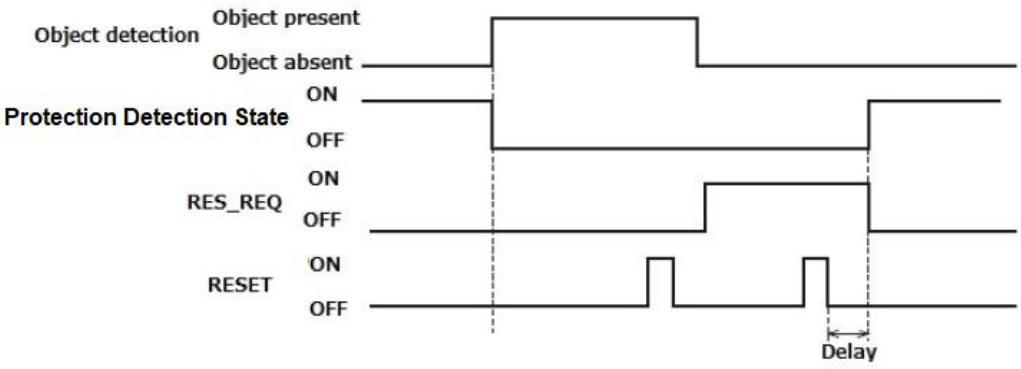


Figure 4-5 Timing chart of manual restart

4.2.3 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 4-6 shows the sequence of start interlock. Delay can be configured in the range of 1s to 6s.

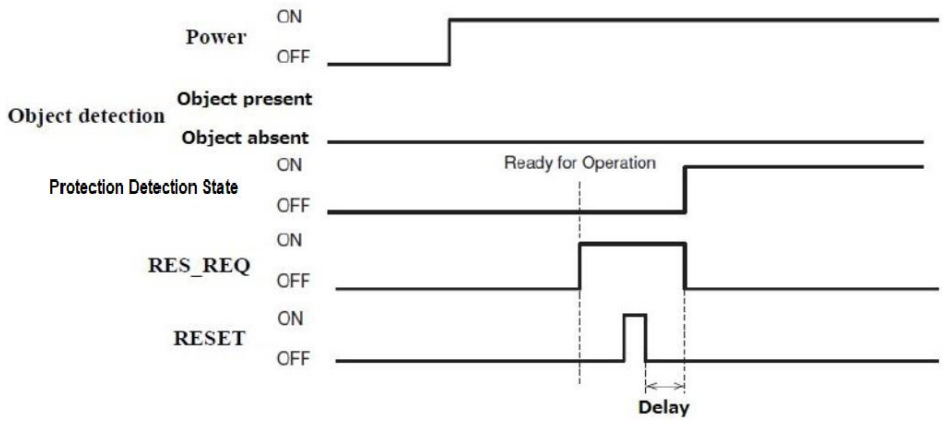


Figure 4-6 Manual start sequence

4.3 Muting

Muting function temporarily 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 60ms and resume the safety function if they fulfill the muting stop conditions. 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 4-1.

Table 4-1: 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

4.3.1 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 1 ⇒Muting 2
- ▸ Muting 2 ⇒Muting 1

●Time interval between two inputs (T1)

- ▸ 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.

4.3.2 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 4-7).
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.

Figure 4-7 shows the muting sequence.

●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.

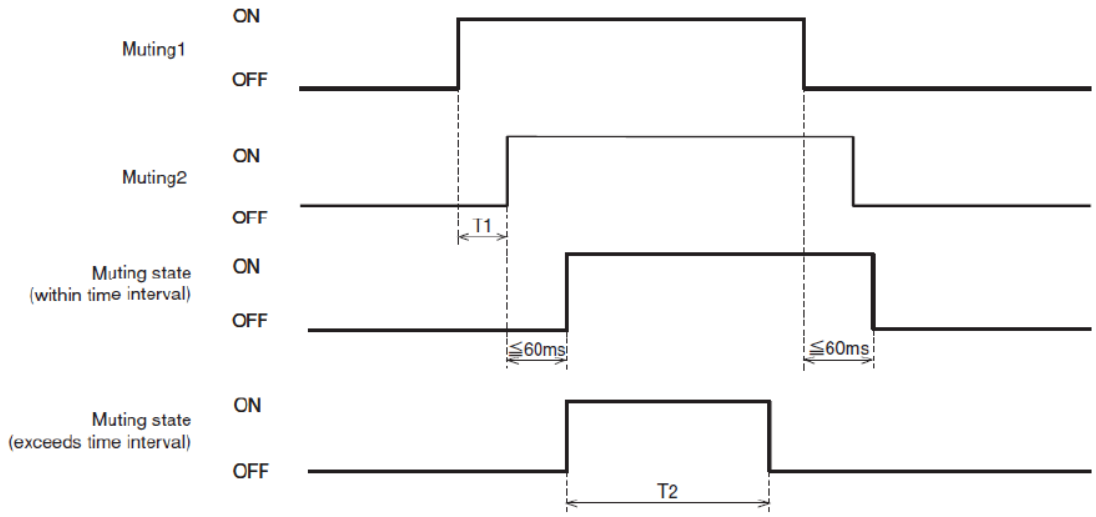


Figure 4-7 Muting sequence

4.3.3 Muting override function

Muting override is a function to recover UAM by temporarily 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 4-8 shows the override sequence.

●Override start conditions

- ▸ At least one of the muting inputs is in ON-state.
- ▸ Object is present in the protection zone.
- ▸ Time interval between override input and reset input is within 0.03s to 1s (T3).

●Override stop conditions

- ▸ Both muting inputs are in OFF-state.
- ▸ Override input or reset input is in OFF-state.
- ▸ When predefined maximum override time T4 exceeds.
- ▸ Error is detected by self-diagnostic function of the UAM.
- ▸ 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

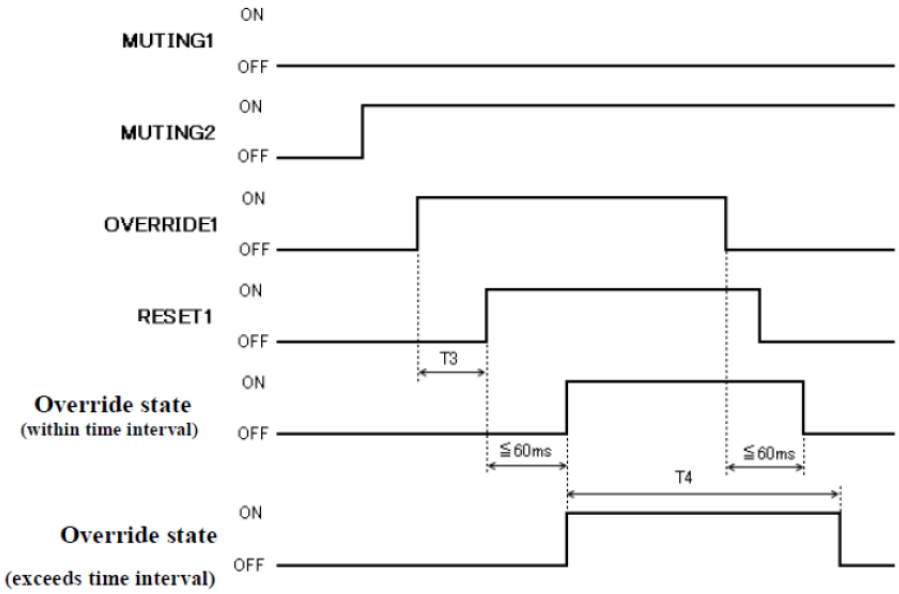


Figure 4-8 Override Sequence

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

4.4 Reference monitoring function

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

4.4.1 Area protection

An example of reference monitor function used for area protection is shown in figure 4-13. If reference segments are configured on moveable objects (example: door) the Protection detection state will switch OFF when the door position is changed.

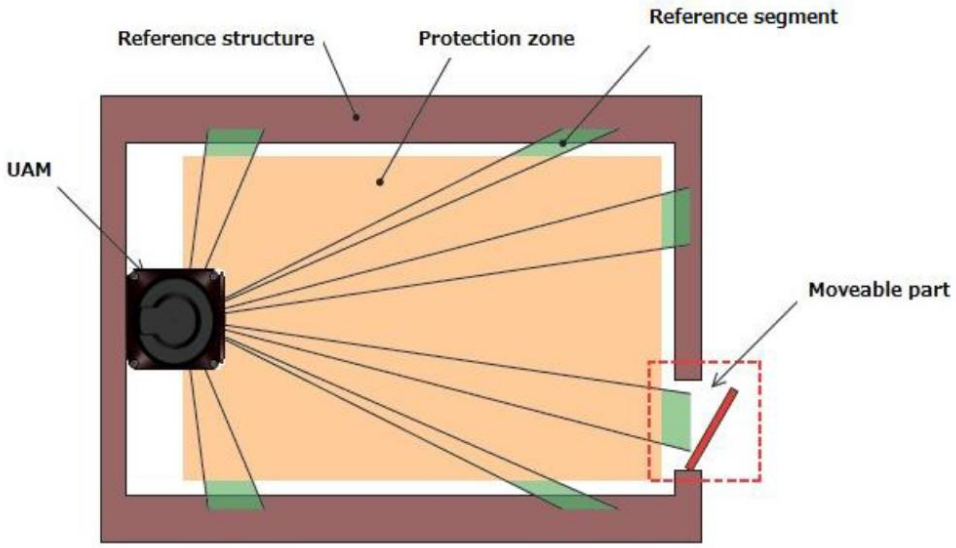


Figure 4-9 Top view of the area protection using reference monitor function

4.4.2 Access protection

An example of reference monitor function used for access protection is shown in figure 4-10(a), (b). Reference segments should be configured on each surface for displacement detection. Reference segments should be configured such that displacement can be easily detected. 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 compulsory for applications which require vertical mounting of UAM.

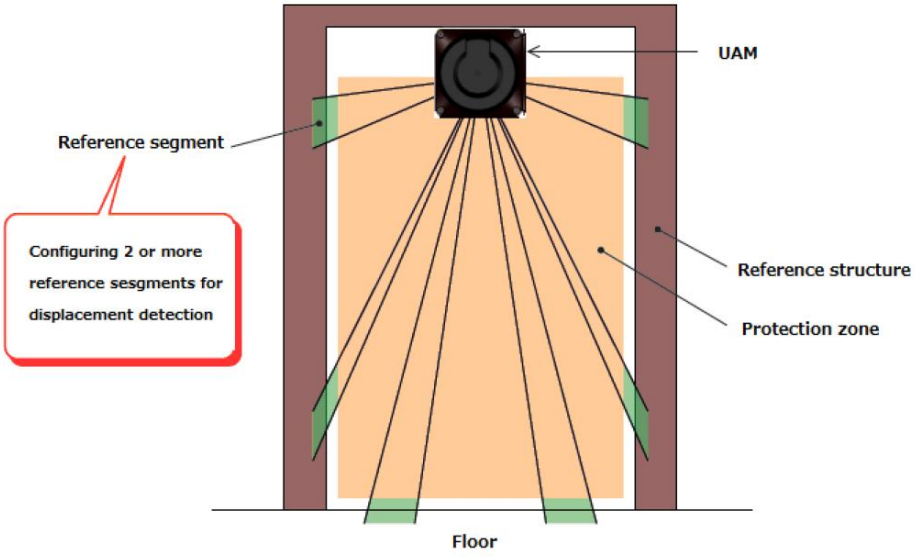


Figure 4-10(a) Front view of the access detection using reference monitor function

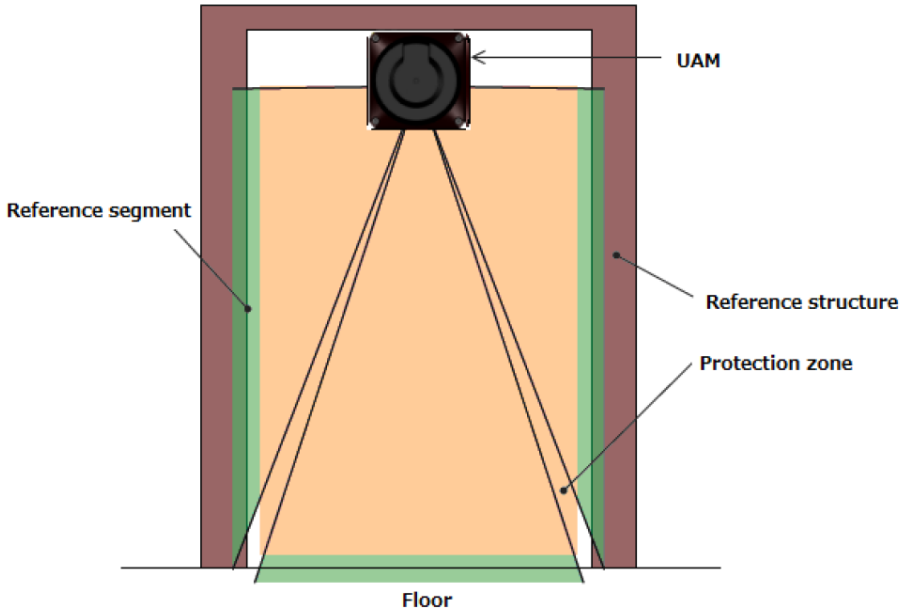


Figure 4-10(b) Front view of the access detection using reference monitor function

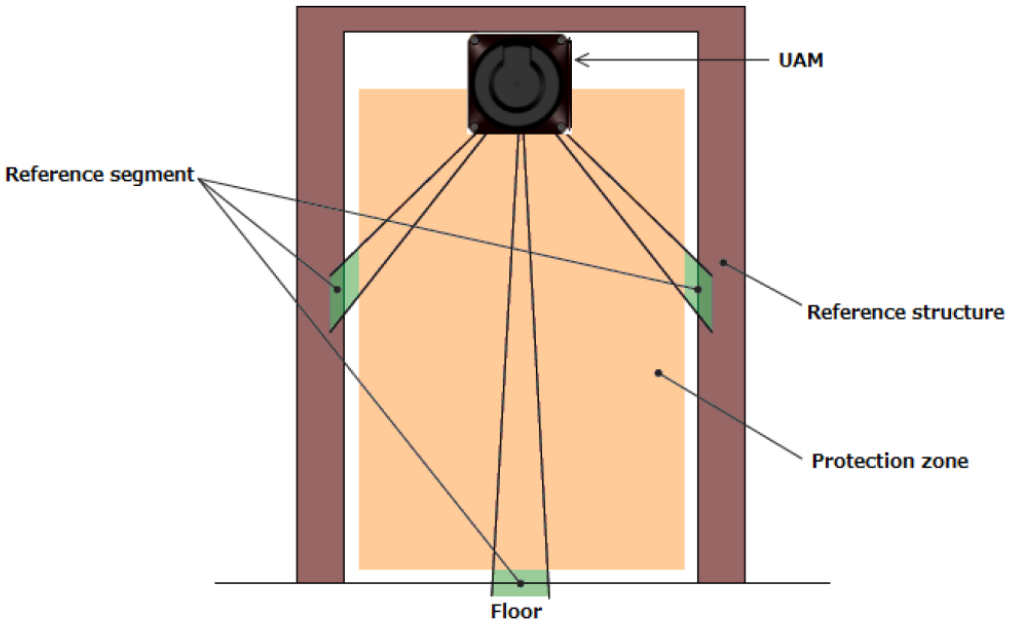


Figure 4-10(c) Incorrect configuration of reference segment

4.5 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 error.

Area switching sequence

When area sequence is disabled, UAM can switch from an area to any other areas (Figure 4-11(a) whereas it can only switch to specified areas if area sequence is enabled. (Figure 4-11(b)). Area sequence function is recommended for control systems where area switching sequences are known beforehand.

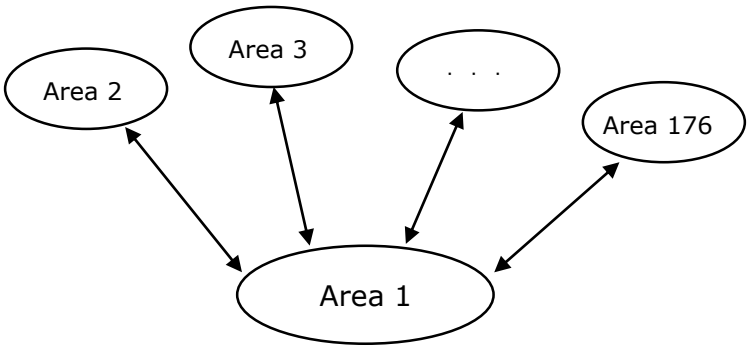


Figure 4-11(a) Operation without area sequence

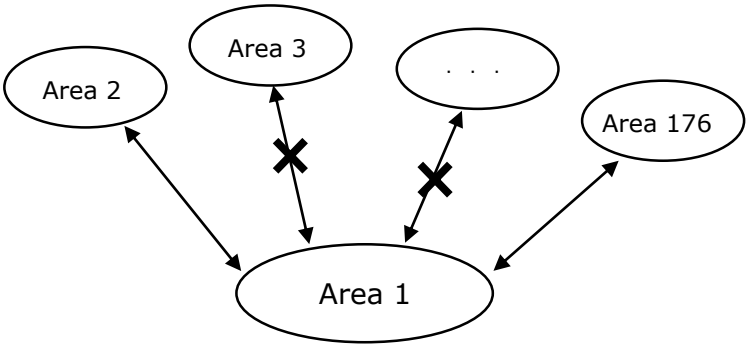


Figure4-11(b) Operation with area sequence

4.6 Response time

Response ON and OFF time for the protection detection state (Figure 4-12) can be configured for each protection zones using UAM Project Designer. Table 4-2 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) has to be taken into account for the area switching.

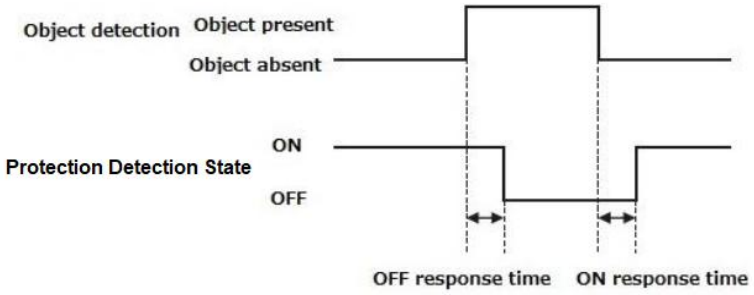


Figure 4-12 Response time

Table 4-2 Response time 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						

	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						

※ Default value

※Default value of OFF response time varies depending on the selected application when creating a “New” project. Refer to User's Manual for details.

4.7 Incremental encoder

In UAM there are 4 pairs of encoder input terminals for connecting 4 units of dual channel incremental encoder signals. Area will be switched depending on the encoder speed. Direction of travel is detected by encoder's phase A and phase B signals having the phase difference of 90°. Speed and rotating direction of both encoders are constantly monitored to detect abnormal travel and stop the AGV.

Incremental encoder output signals should be connected to the respective input terminals of UAM. There are two patterns of signals generated by the combination of Phase A and Phase B of encoders depending on the direction of travel (Figure 4-13). In the first pattern, Phase B is 90 degrees ahead of Phase A wherein, at the rising edge of Phase A, state of Phase B is “H”. This pattern is considered as positive direction (forward motion). In the second pattern, Phase B lags behind Phase A by 90 degrees and the state of Phase B at the rising edge of Phase A is “L”. This is considered as negative direction (backward motion).

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.

Further, encoder speed and direction can be also supplied by EtherCAT communication (FSoE).

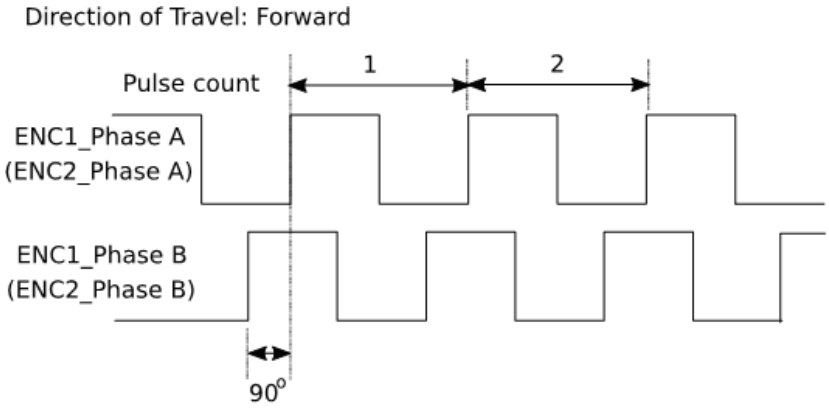


Figure 4-13 Input signal through Incremental encoder

4.7.1 Pulse per cm travel generated by incremental encoders

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

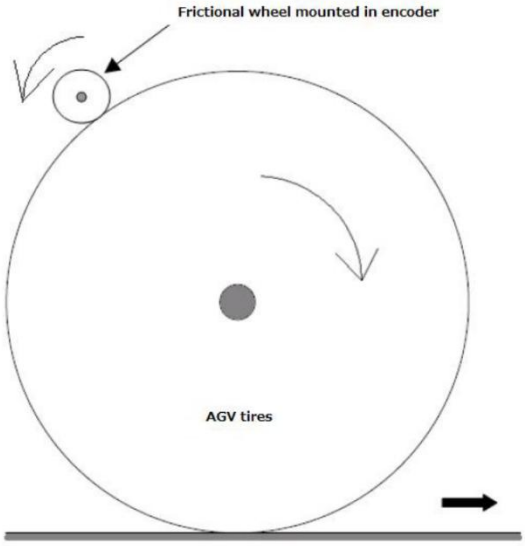


Figure 4-14 Calculation of pulse count per centimeter travel

● Calculation of pulse generated for 1cm travel is given below.
・AGV tire diameter：40 cm
・Frictional wheel diameter mounted in incremental encoder：5 cm
・Incremental encoder pulse number per revolution：1000 pulse

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.

4.7.2 Area switching by encoder input

Enable the encoder input function in UAM Project Designer to configure the encoder settings.
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 must be provided during the configuration.
- 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 configurations 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 4-4.

Table 4-3 Maximum Speed Division

Number of Patterns	Maximum Speed Division
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 4-4(a), 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.

From velocity [cm/sec]	To velocity [cm/sec]	Select area
-1000	100	Area 1
101	300	Area 2
301	500	Area 3

Figure 4-4(a) Example of encoder setting

Figure 4-4(b) 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 report error if such velocities are detected during the operation and Protection and Warning detection signals will be switched off.

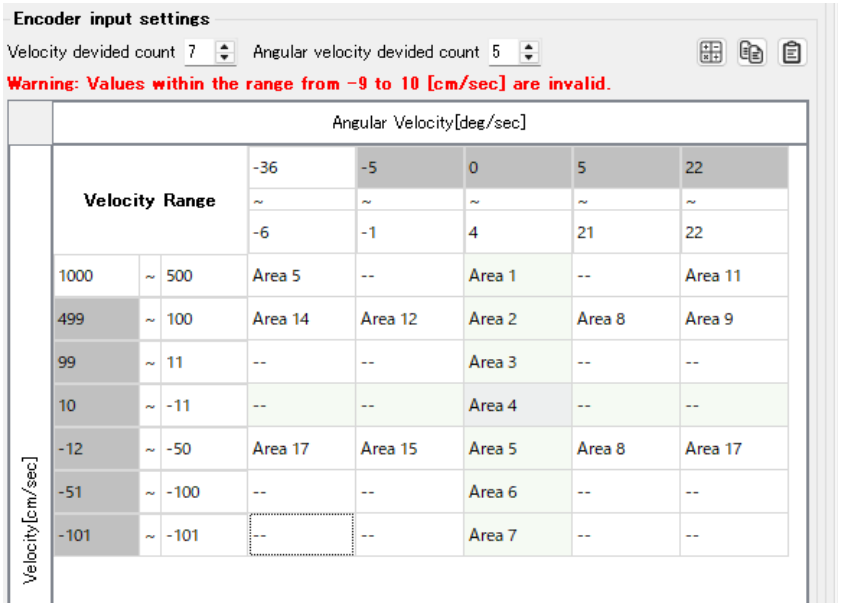


Figure4-4(b) Example of encoder input setting

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

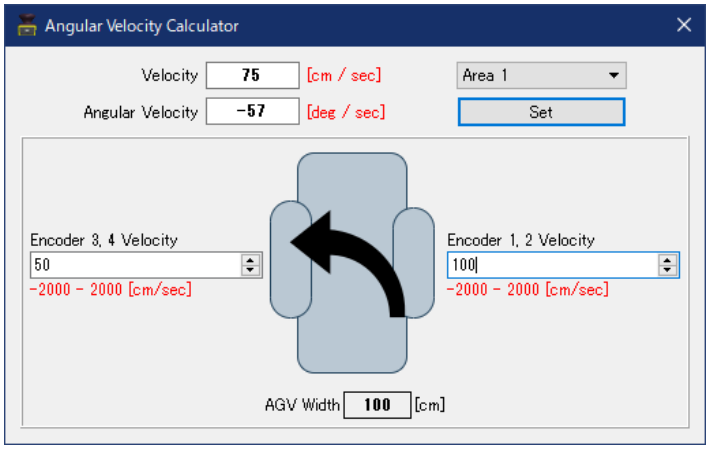


Figure 4-4(c)　Angular velocity calculation tool

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 4-4(c), 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 left turn (negative angular velocity).

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

Velocity: $V = \dfrac{V_L + V_R}{2}$ [cm/s]　V_R : Velocity of the encoder on the right side

V_L : Velocity of the encoder on the left side

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

For patterns configured with “Static Input”, it is required to assign an area to each pattern. The velocity and angular velocity monitoring function can also be individually enabled or disabled for each pattern. It is also required to define the velocity and angular monitoring ranges if the corresponding function is enabled.

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

Additionally, enabling the individual monitoring option allows monitoring of each encoder velocity independently.

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

・Speed internally calculated by UAM
- Calculated from pulse signals received via external input lines
- Calculated based on encoder speeds received via EtherCAT communication

・Speed 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 speed and angular velocity monitoring to support area switching and safety control functions.

4.8 EtherCAT Communication Profile

4.8.1 FSoE 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.

4.8.2 CoE Compatibility

Device configuration stored in the UAM can be obtained by CoE communication. Refer UAM-05LEC_Communication Protocol Specification (C-64-00087) for the details.

4.8.3 EoE 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. Refer UAM-05LEC_Communication Protocol Specification (C-64-00220) for the details.

4.8.4 FoE 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.

4.9 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.

4.9.1 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.

4.9.2 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.

4.9.3 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.

4.10 Other Functions

4.10.1 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).

4.10.2 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 4-14 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 4-4.

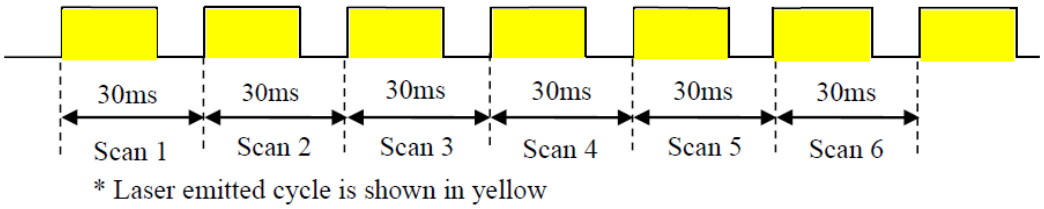


Figure 4-14 Operation of UAM when scan skip count is 0

Figure 4-15 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.

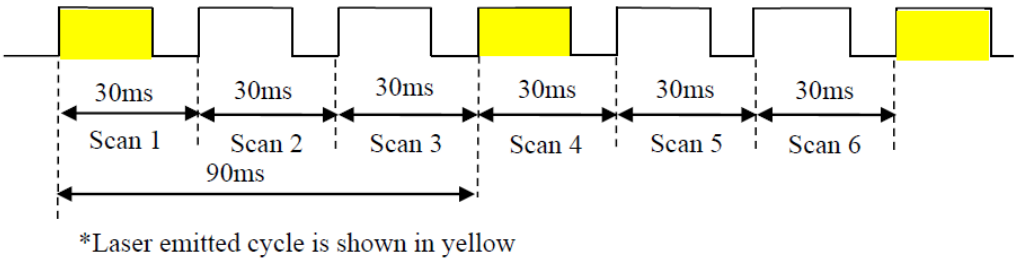


Figure 4-15 Operation of UAM when scan skip

Table 4-4 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

4.10.3 Optical Window Contamination Warning Function

This is a function to inform the optical window contamination when it reaches the warning level. There is no setting required to activate this function and the information is displayed on the LCD panel.

Use this information to clean the optical window before contamination reaches the error level switching the protection detection state to OFF and stopping the system.

4.10.4 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.

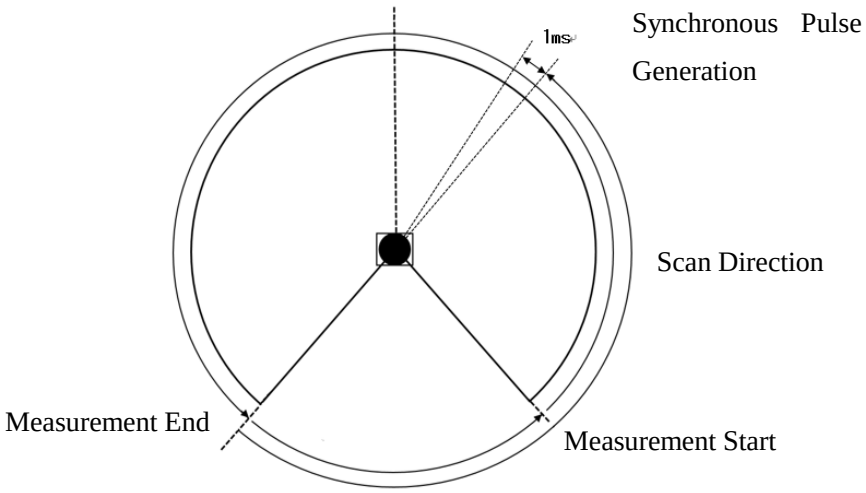
Further, check the box beside "Use the OSSD outputs of this device" to activate the slave's OSSDs when configuring the master-slave function

Output	Details
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.

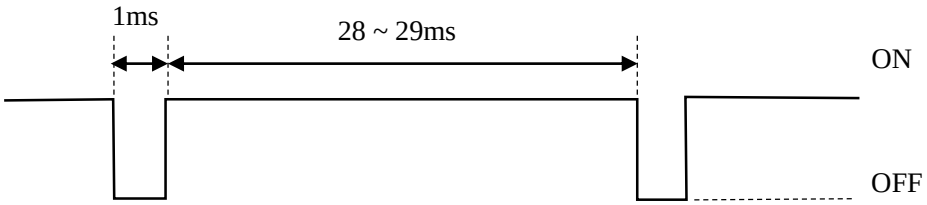
.

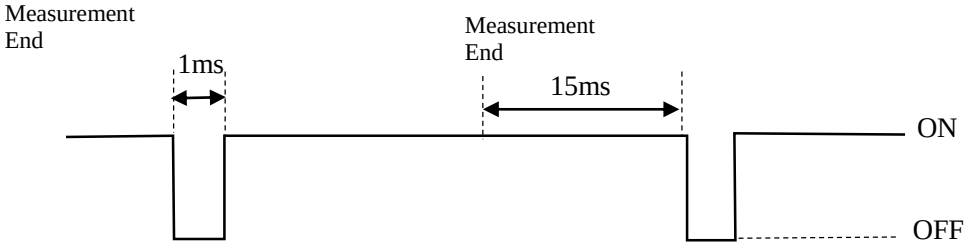
<Synchronous signal timing chart>

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



Synchronous Pulse Frequency





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

5. Wiring

5.1 Input / Output cable and function

Table 5-1 shows the signal name of each lead wire and function. It is recommended to use the shielded cable for wiring.

Table 5-1 Wire function

No	Signal	Function	Description
1	+24VDC	Power	Power supply：DC24V
2	0VDC	Power	Power supply：0V
3	P1_MUT_IN1/ENC1_A	Input	Muting input 1 / Encoder input 1_A
4	P1_MUT_IN2/ENC1_B	Input	Muting input 2 / Encoder input 1_B
5	P2_MUT_IN1/ENC2_A	Input	Muting input 1 / Encoder input 2_A
6	P2_MUT_IN2/ENC2_B	Input	Muting input 2 / Encoder input 2_B
7	RESET1/ENC3_A	Input	Reset input 1/ Encoder input 3_A
8	RESET2/ENC3_B	Input	Reset input 2/ Encoder input 3_B
9	OVERRIDE1/ENC4_A	Input	Override 1/ Encoder input 4_A
10	OVERRIDE2/ENC4_B	Input	Override 2/ Encoder input 4_B
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
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

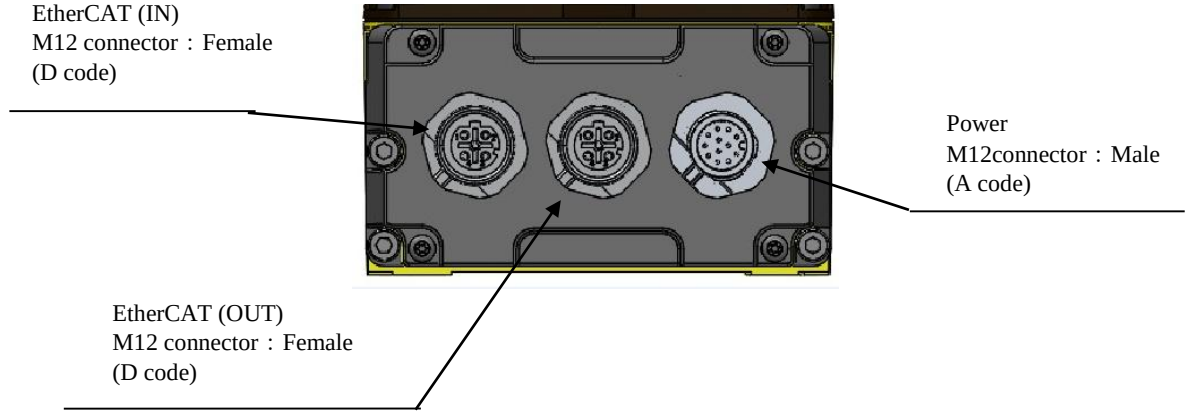
Table 5-2: EtherCAT (IN)

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

Table 5-3: 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-

5.2 Wiring example



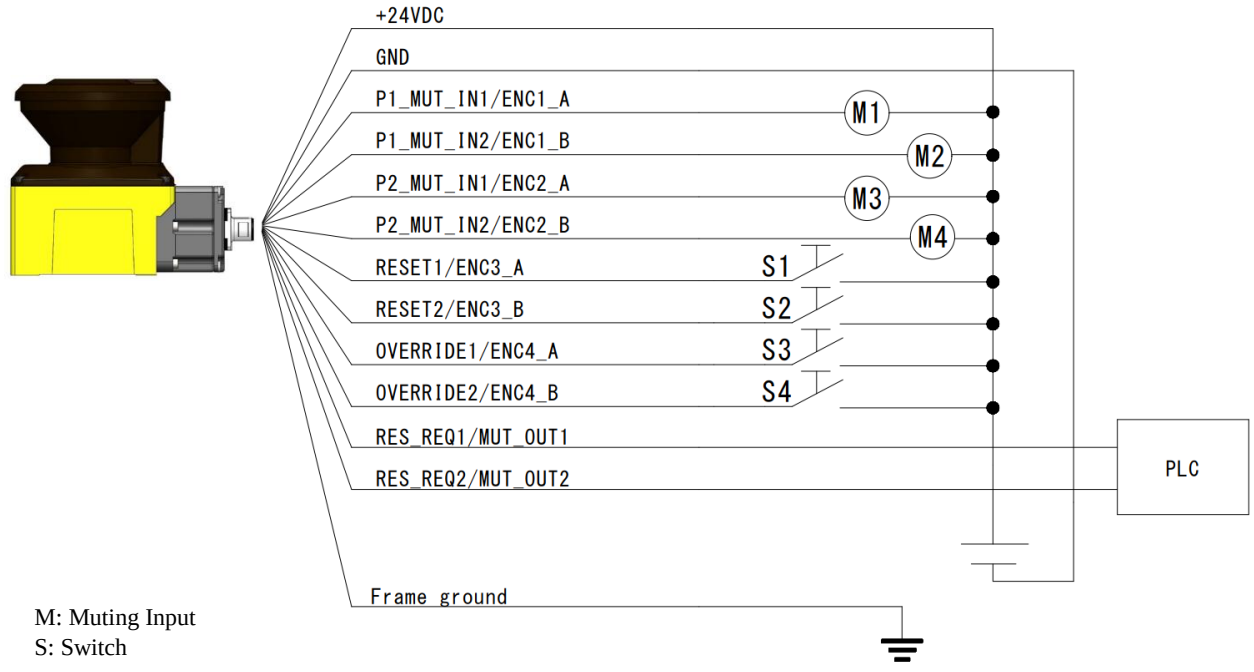


Figure 5-1 Wiring Example(Muting and override functions used)

6. Input / Output circuit

6.1 Output circuit

RES_REQ1, RES_REQ2, MUT_OUT1, MUT_OUT2, AUX_OUT1, AUX_OUT2 outputs are PNP type.

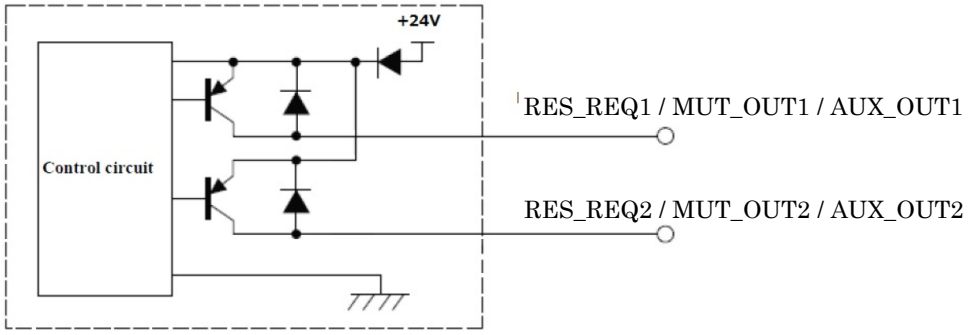


Figure 6-1 Output circuit

6.2 Input circuit

Figure 6-2 shows input circuit for RESET1, RESET2, MUTING 1, MUTING 2, MUTING 3, MUTING 4, OVERRIDE 1, and OVERRIDE 2 signals.

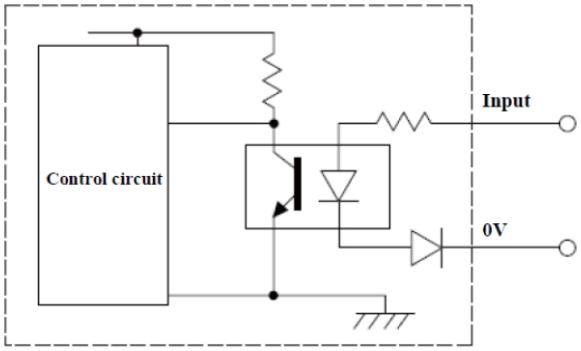


Figure 6-2 Input circuit

8. Revision history

Amended No	Revision date	Details
-	2025/7	Released