

SE1L Safety Laser Scanner

Smallest in its Class
Ideal for use in limited spaces



SE1L Safety Laser Scanner

Compact and Lightweight



PLd
SIL2

Protection
Degree
IP65

Adjustable
Response
Time

Muting
Function

Override
Function



48
areas
maximum

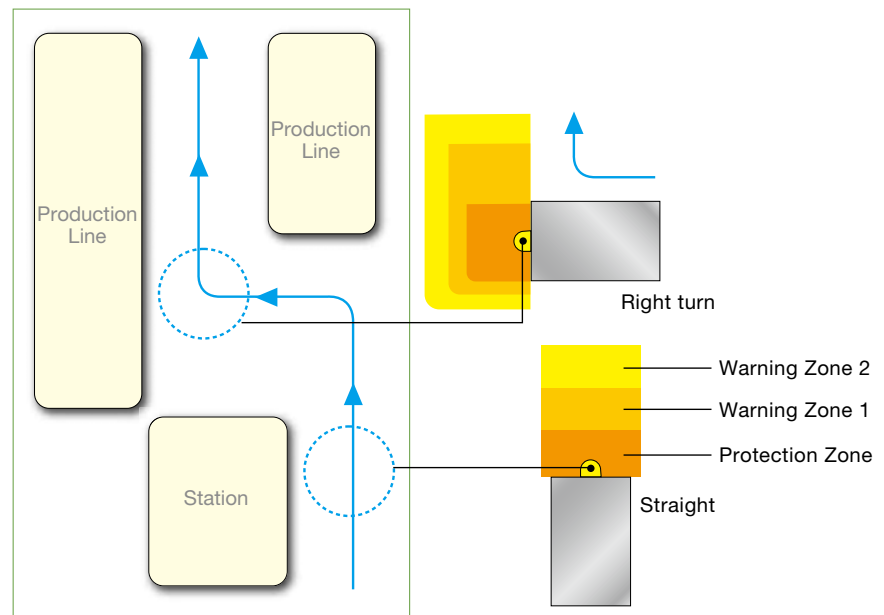
Stores 16 area patterns × 3 zones

Total of 3 zones – 1 protection zone and 2 warning zones, can be set for 1 area. Up to 16 area patterns can be configured depending on speed, direction, and surrounding conditions from external signals.

Protection
Zone
2m
max

Warning
Zone
10m
max

AGV traveling route example



**Easily
Visible**

Find out operational status at a glance

The selected area number or error number is displayed on the 7-segment display on the front of the safety laser scanner. The operation status is easy to monitor.

OSSD
ON LED (green)
ON when the
OSSD signal is ON

7-Segment
Display

OSSD
OFF LED (red)
ON when the
OSSD signal is OFF

INTERLOCK
LED (orange)
ON during
an interlock status

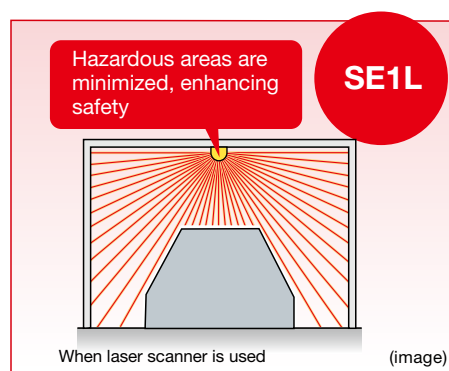
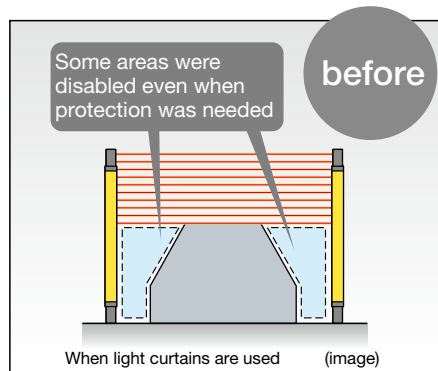




Muting Function

Muting function enables flexible setting of protection zones

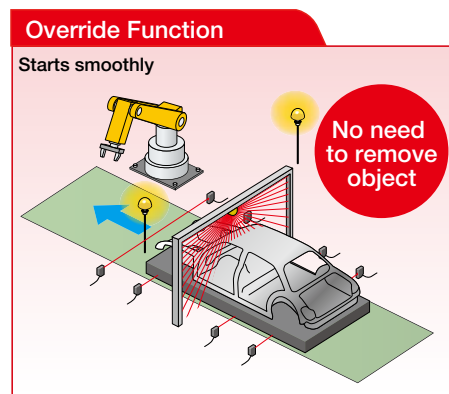
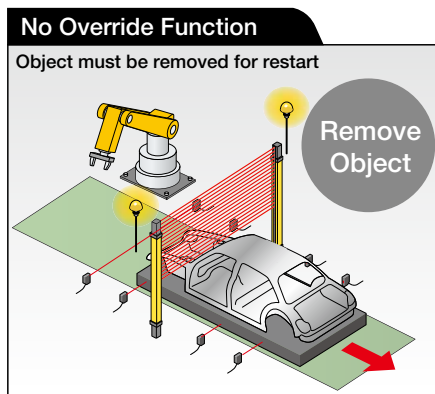
Specific areas of the protection zone can be disabled by the muting sensor. Complicated protection zones can be configured easily.



Override Function

Override function enables safe restart of factory lines

With the override function, when a light curtain is interrupted by an object or when a line stops before muting conditions are established (when only one muting sensor is interrupted), the object interrupting the light does not have to be removed. Therefore, the line can be started smoothly and safely.

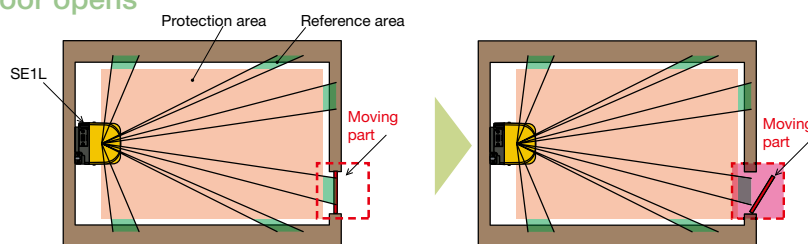


Reference monitor function detects misalignment

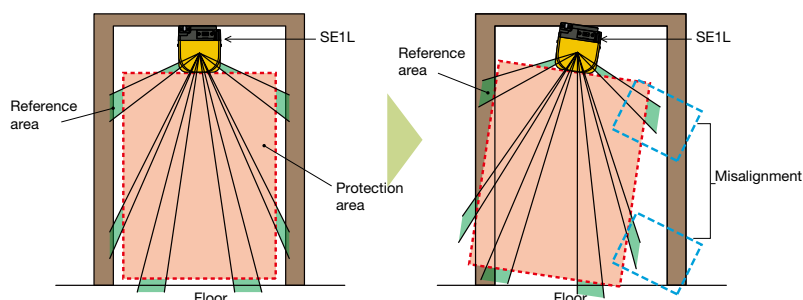
By configuring a reference point, moving parts such as doors can be detected when SE1L is not correctly positioned, and turns off the safety output (OSSD). Because the misalignment of the SE1L can be detected, hazardous areas can be avoided, enhancing safety.

① Output OFF when door opens

When a moving part is set as a reference point, the output turns OFF when the door is opened.



② Output OFF when mounting SE1L is misaligned

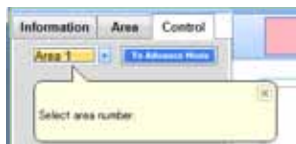


Beginner mode for simple and comfortable operation

Simple layout and easy-to-use configuration screen. With beginner mode, setting is easy. Automatic setting is ideal for configuring complicated protection zones, and for users not having time for configuration.

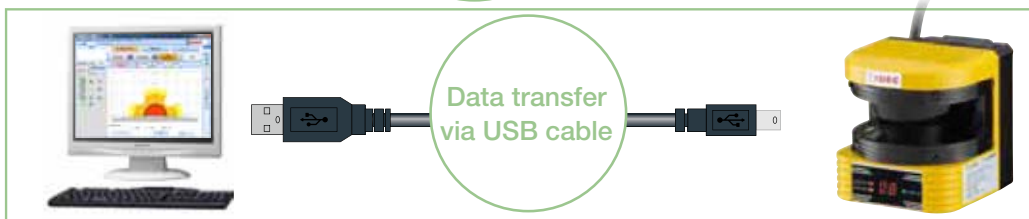
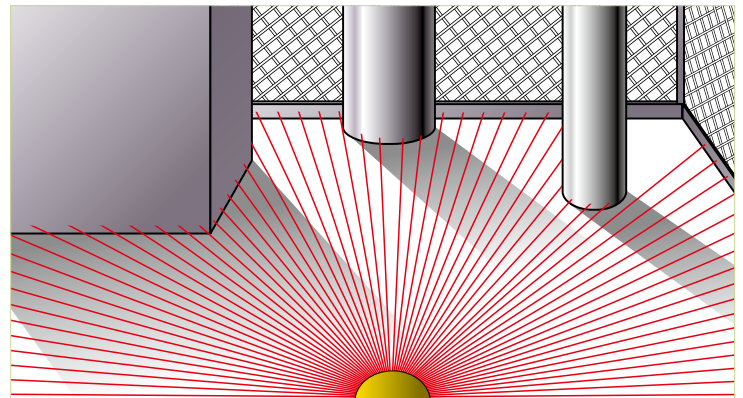


Beginner mode



Each item
can be set

Auto configuration



Data transfer
via USB cable

Ideal for various applications

For presence detection

Mat
Sensor

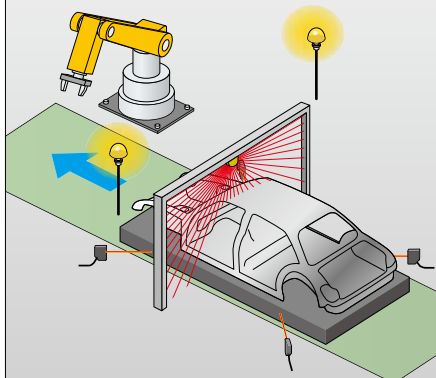
- Mat sensors may be damaged if objects are dropped on the mat.
- Cannot be used if the layout is changed.
- Protection zone is rectangular.

SE1L

- No damage is caused by falling objects.
- Layout can be changed easily.
- The shape of the protection zones can be changed.

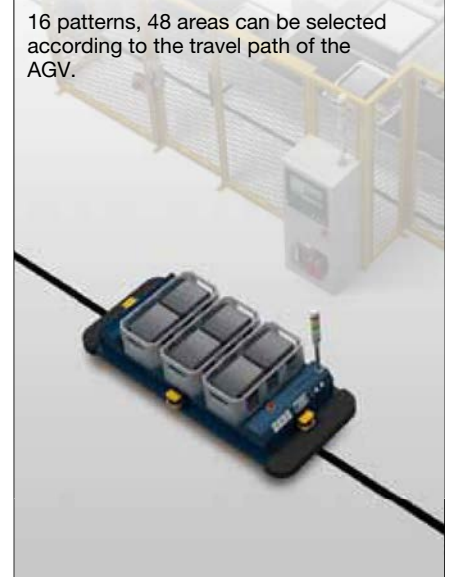
For sites that require muting function

Specific areas of the protection zone can be disabled, as with a light curtain.



To prevent collision of AGVs (Automatic Guided Vehicles)

16 patterns, 48 areas can be selected according to the travel path of the AGV.



SE1L Safety Laser Scanner

Smallest in its class. Ideal for installation in small spaces.


- Each area consists of 1 protection zone and 2 warning zones. Up to 16 area patterns are available.
- Operation status is easily visible with a 7-segment display.
- Muting function enables flexible configuration of areas needing protection.
- Override function enables safe restart of factory lines.
- Misalignment can be detected.
- Drawing methods can be selected from configuration, numerical input, and auto setting. Beginner mode is available to support inexperienced users.
- Degree of protection: IP65 (IEC 60529)



SE1L

Safety Laser Scanner

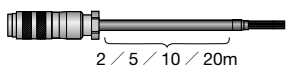

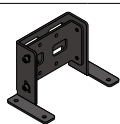

Package Quantity: 1

Shape	Part No.	Remarks
	SE1L-H02LP	Includes: SLS Configurator (configuration CD software (manual), English/Japanese) Applicable OS: Windows XP Professional edition Windows Vista Business edition Windows 7 Professional edition Windows 7 Ultimate edition

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Accessories

Package Quantity: 1

Name and Shape		Part No.	Remarks
Connector Cable 	2m	SE9Z-HS1-C002	• One cable is needed for each safety laser scanner.
	5m	SE9Z-HS1-C005	
	10m	SE9Z-HS1-C010	
	20m	SE9Z-HS1-C020	
USB Maintenance Cable 		HG9Z-XCM42	• Used to connect the safety laser scanner and PC. • Cable length: 2m
L-shaped Bracket 		SE9Z-HS1-BK01	• Used to change the horizontal angle alignment of the SE1L. • Adjustable by 15 degrees total (7.5 degrees each direction) (See page 7 for dimensions) • Material: iron • Attachment: bracket + M5 mounting screws (4 pcs)
Vertical Mount Bracket 		SE9Z-HS1-BK02	• Used to change the horizontal and vertical angle alignment of the SE1L. • Adjustable by 15 degrees total (7.5 degrees up and down, left and right in each direction) (See page 7 for dimensions) • Material: iron • Attachment: bracket + M5 mounting screws (4 pcs)

Abbreviation

The abbreviations used in this catalog are as shown in the table below.

Abbreviation	Description
OSSD	Output signal switching device
AGV	Automated guided vehicle
EMD	External monitoring device
AOPDDR	Active opto-electronic protective device responsive to diffuse reflection
MSCE	Machine secondary control element



SE1L Safety Laser Scanner

Performance Specifications

Part No.		SE1L-H02LP
Applicable Standards		IEC/EN 61496-1 (TÜV SÜD), IEC 61496-3 (TÜV SÜD), IEC 61508 Part 1-7 (TÜV SÜD, UL listed), IEC 62061 (TÜV SÜD), EN ISO 13849-1 (TÜV SÜD), ISO 13849-1 (UL listed), IEC 60825-1 (TÜV SÜD), EN 50178 (TÜV SÜD), EN 55011 (TÜV SÜD), UL 508 (UL listed), ANSI/UL 1998 (UL listed), UL 61496-1 (UL listed), CSA C22.2 No. 14-10 (c-UL listed)
Safety Performance	Type	Type 3 (IEC 61496-1, IEC 61496-3, UL 61496-1)
	Safety Integrity Level	SIL 2 (IEC 61508, IEC 62061)
	Performance Level	PL d (EN ISO 13849-1, ISO 13849-1)
	Category	Category 3 (EN ISO 13849-1, ISO 13849-1)
Sensing Characteristics	Protection Zone	2.0m maximum
	Warning Zone	10m maximum (non-safety)
	Additional Safety Distance (Note 1)	+100 mm
	Sensing Characteristics	Black reflector sheet (1.85%) to retro-reflector sheet Speed: 1.6 m/s max.
	Sensing Angle	190°
	Minimum Sensing Width	ø30 mm (maximum distance: 1.0m) ø50 mm (maximum distance: 1.5m) ø70 mm (maximum distance: 2.0m)
	Scan Cycle	30 ms (rotating speed 2,000 rpm)
	Area	16 patterns
	Response Time	OSSD output ON→OFF: 60 to 510 ms OSSD output OFF→ON: 270 to 510 ms
Power Voltage		24V DC ±10%: power from converter 24V DC -30%/+20%: power from battery
Power Consumption	Normal (without output load)	11W (Typ.)
	Maximum (without output load)	19W
	Maximum (with output load)	58W
PFHd (Note 2)		7.5×10 ⁻⁸
Output	OSSD1/2 (safety)	Output type (High side SW)
		Output current (maximum: 500 mA)
		Leakage current (maximum: 1 mA)
		Cable (length: 20m AWG 26)
		Allowable load (L/R=25 ms C=1μF)
	WARNING1 (non-safety)	Output type (PNP transistor output)
		Output current (maximum: 100 mA)
		Leakage current (maximum: 1 mA)
		Cable (length: 20m AWG 28)
	WARNING2/ERR/MUT_OUT (non-safety)	Output type (PNP transistor output)
		Output current (maximum: 100 mA)
		Leakage current (maximum: 1 mA)
		Cable (length: 20m AWG 28)
	READY/RES_REQ (non-safety)	Output type (PNP transistor output)
		Output current (maximum: 100 mA)
		Leakage current (maximum: 1 mA)
		Cable (length: 20m AWG 28)
Input	Number of Inputs	16 area switching (4 inputs × 2 channels) EDM (external device monitoring) / RESET / MUTING1 / MUTING2 / OVERRIDE (1 input × 1 channel)
	Input Resistance	4.7kΩ
	Cable	Cable length: 20m AWG 28
Light Source		Pulse laser diode (wavelength: 905 nm) Laser class 1 (IEC 60825-1, 21 CFR Part 1040.10 and 1040.11)
Operating Conditions		Operating temperature: -10 to +55°C (no freezing) Storage temperature: -25 to +70°C (no freezing) Operating humidity: max. 95% RH (no condensation) Storage humidity: No freezing and condensation
Surrounding Light Intensity (Note 3)		3000 lx maximum
Vibration Resistance		Frequency: 10 to 55 Hz Sweep: 1 octave/minute Amplitude: 0.35 mm ±0.05 mm
Shock Resistance		Acceleration: 98 m/s ² (10G) Pulse duration : 16 ms
Dimensions		97.0H × 90.0W × 99.8D (mm)
Weight (approx.)		1.0 kg
Degree of Protection		IP65 (IEC 60529)
Material		Body: Aluminum diecast / Optical window: Polycarbonate
Cable		Flying cable and waterproof connector / cable 300 mm / M16-19p
Interface	Structure	USB2.0 (USB mini B type connector)
Cable Length		Cable length: 20m maximum AWG 22, 26, 28

Note 1: Additional distance of 200 mm is needed when the SE1L operates under high reflective background.

Note 2: Probability of failure per hour

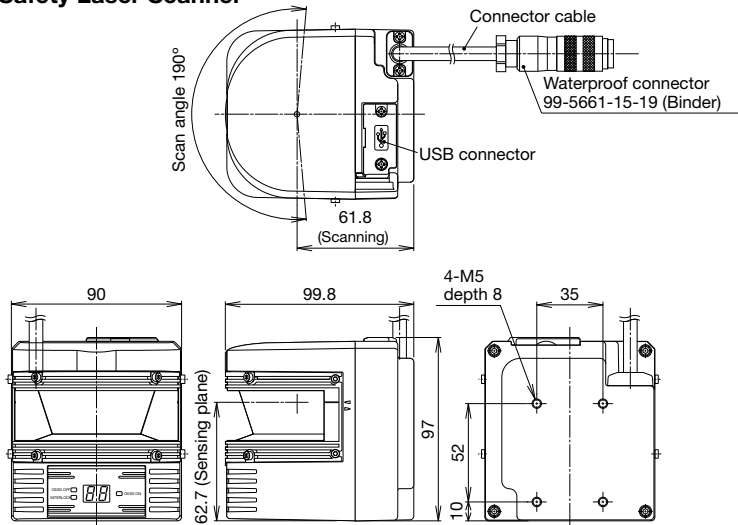
Note 3: The angle between the sensing plane and the light source should be more than 5 degrees.

SE1L Safety Laser Scanner

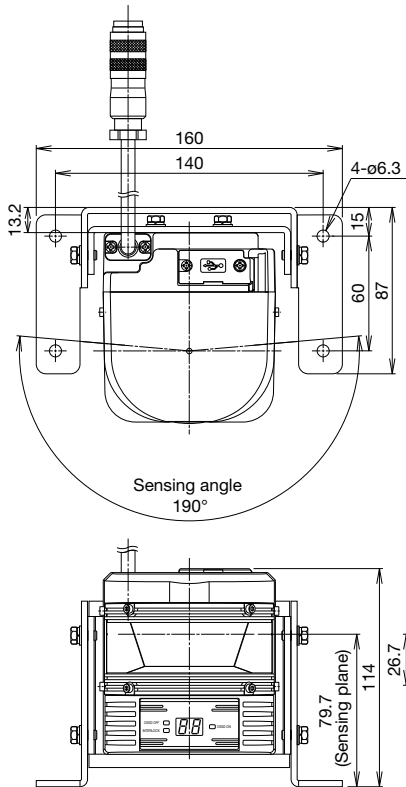
Dimensions

All dimensions in mm.

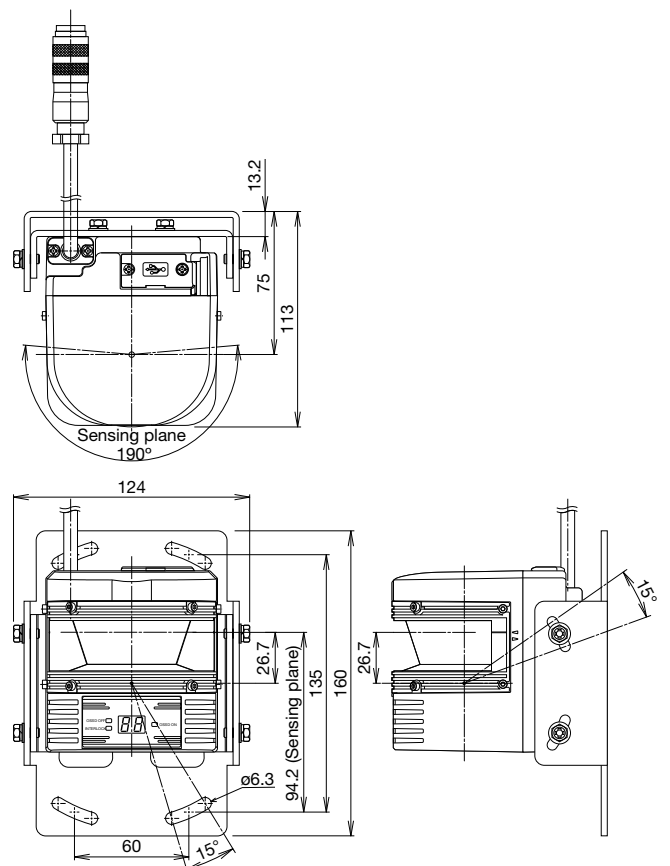
Safety Laser Scanner



L-shaped Bracket



Vertical Mount Bracket

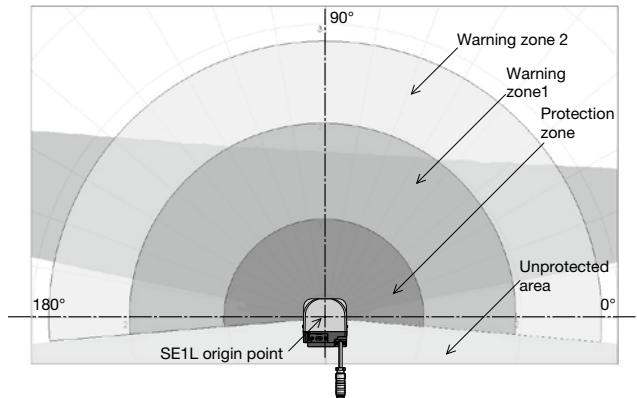


SE1L Safety Laser Scanner

Operating Principle

Scanning Range

The figure below shows the scanning range of the SE1L. Protection zone and warning zones 1 and 2 are configured using the SLS Configurator. When an object enters the protection zone, the OSSD signal will turn from ON to OFF.

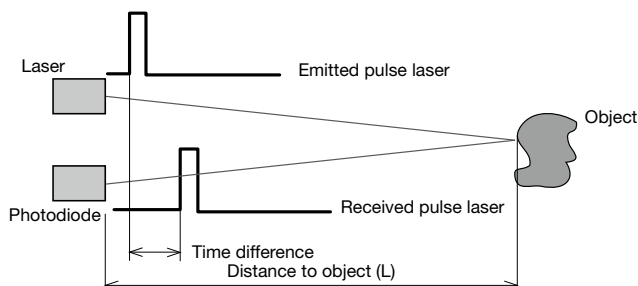


Similarly, when an object is detected in a warning zone, the WARNING signal will turn OFF. The distance is measured by the Time of Flight (TOF) principle. When the motor rotates, the pulse laser beam is emitted within the scanning range of 190° and is reflected back from an object within the range. The distance can be calculated as follows:

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

L = Distance to the object
C = Speed of light
T = Time difference

TOF Operating Principle



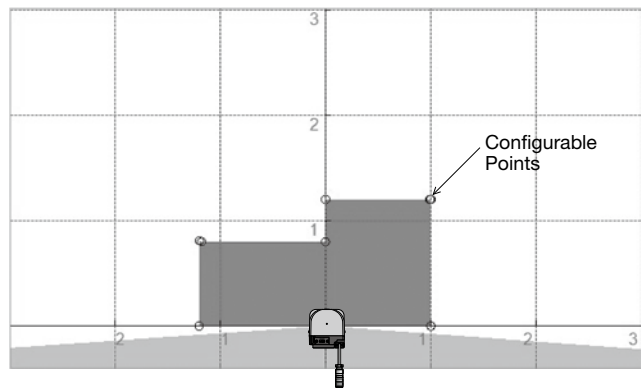
Scanning Area

The scanning area of the SE1L consists of a protection zone and two warning zones. A protection zone is an area that is directly connected to an OSSD signal. When an object is detected in the protection zone, the SE1L switches the OSSD signal to OFF (triggers the switch that stops the machine or the AGV). For moving applications, the OSSD signal is used as an emergency stop signal.

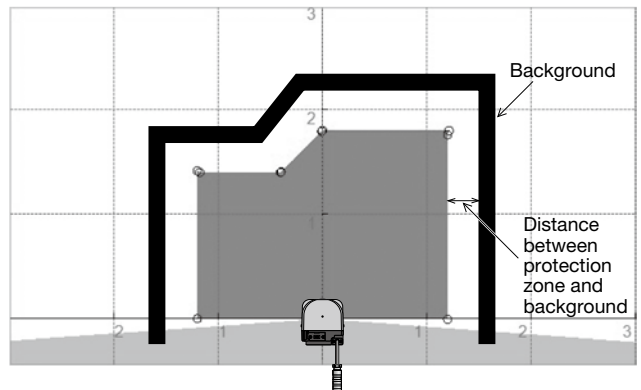
Protection Zone

Below are examples of protection zones configured by manual mode and auto mode with the SLS Configurator. The operator must configure the software so that the hazardous areas are fully protected.

Manual configuration of protection zone



Auto configuration of protection zone



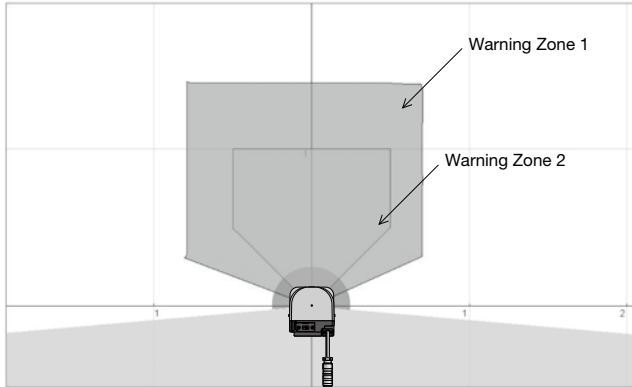
- The operator must test to make sure that the protection zone is properly configured before operation.
- The configured protection zone must have a minimum safety distance.
- The minimum sensing width varies with distance.
- When setting the protection zone, take into consideration additional safety distances.

Note:

- Before operation, evaluate detection capability by using the actual object.
- For details on SLS Configurator, see user's manual.

Warning Zone

The warning zone is a non-safety area and is connected to WARNING 1 and 2 outputs. When an object is detected within this zone, the WARNING signal turns from ON to OFF. The warning signal can be used as an alert signal to prevent humans or objects approaching the protection zone. For moving applications, warning zones can be used to reduce the speed of the AGV to avoid collision.



- A non-safety signal is the output from the warning zone.
- Do not use the warning zone output signal to control machines or AGVs for safety purposes.

Note:

- WARNING signal is a non-safety signal.
- Warning signals 1 and 2 are not related to the OSSD signal.

Area Switching

The SE1L can store up to 16 area patterns. Each area consists of a protection zone, warning zone 1, and warning zone 2. To switch areas, an external input signal is required. Table below shows the combinations of input signals for switching areas.

The number of the current area is displayed on the 7-segment display of the SE1L. The switching time of areas can be configured.

Area switching combinations

Area Pattern	IN_A	IN_B	IN_C	IN_D	IN_Ā	IN_B̄	IN_C̄	IN_D̄
1	ON	ON	ON	ON	OFF	OFF	OFF	OFF
2	OFF	ON	ON	ON	ON	OFF	OFF	OFF
3	ON	OFF	ON	ON	OFF	ON	OFF	OFF
4	OFF	OFF	ON	ON	ON	ON	OFF	OFF
5	ON	ON	OFF	ON	OFF	OFF	ON	OFF
6	OFF	ON	OFF	ON	ON	OFF	ON	OFF
7	ON	OFF	OFF	ON	OFF	ON	ON	OFF
8	OFF	OFF	OFF	ON	ON	ON	ON	OFF
9	ON	ON	ON	OFF	OFF	OFF	OFF	ON
10	OFF	ON	ON	OFF	ON	OFF	OFF	ON
11	ON	OFF	ON	OFF	OFF	ON	OFF	ON
12	OFF	OFF	ON	OFF	ON	ON	OFF	ON
13	ON	ON	OFF	OFF	OFF	OFF	ON	ON
14	OFF	ON	OFF	OFF	ON	OFF	ON	ON
15	ON	OFF	OFF	OFF	OFF	ON	ON	ON
16	OFF	OFF	OFF	OFF	ON	ON	ON	ON

- See the user's manual for details.

OSSD

The OSSD signal is a safety signal. When humans are detected inside the protection zone, the OSSD signal turns from ON to OFF. Also the OSSD signal has a self-diagnosis function that tests the signal periodically to detect malfunction. The OSSD signal will turn OFF when a error is detected due to the self-diagnosis function.



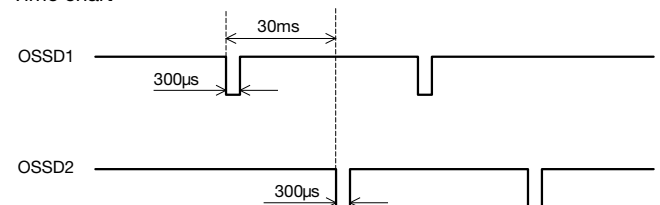
- The OSSD is a safety signal and should be connected directly to a force guided relay or a device that controls the machine or AGV.
- When setting the response time of the OSSD signal, provide sufficient time to stop operation of the machine or AGV.
- The operator must test to make sure the settings are properly configured before operation.

Note: The signal is 24V when the OSSD signal is ON and 0V when OFF.

Self-Diagnosis Function of the OSSD

The self-diagnosis function of the OSSD detects abnormality by switching OSSD 1 to OSSD 2 at intervals of 300 μs maximum. Therefore, a safety relay or converter must not respond to this self-diagnosis function.

Time chart



OSSD Signal and Condition of SE1L

The OSSD signal will switch to OFF (0V) when an object enters a protection zone or when a error is detected by the self-diagnosis function. By observing the READY signal and ERR signal with OSSD signal, the operator is able to recognize the condition of the SE1L. Below shows the start-up status and operating status between the OSSD, READY, and ERR signals.

Relationship between OSSD, READY, and ERR signals

Item Status	Self-Diagnosis Function	Object	Interlock Configuration	Signal		
				OSSD	READY*2	ERR*3
Start-up Status	OK	–	–	OFF	OFF	OFF
	FAIL	–	–	OFF	OFF	OFF
Operating Status	OK	YES	Disabled	OFF	ON	ON
			Enabled	OFF	OFF	ON
		NO	Disabled	ON	ON	ON
			Enabled	OFF/ON*4	ON/OFF*4	ON
	FAIL*1	YES	Disabled	OFF	ON	OFF
			Enabled	OFF	OFF	OFF
		NO	Disabled	OFF	ON	OFF
			Enabled	OFF	OFF	OFF
Lockout	FAIL	–	Disabled	OFF	OFF	OFF
		–	Enabled	OFF	OFF	OFF

*1: The SE1L will switch to a lockout state when a failure occurs during self-diagnosis.

*2: When the interlock is enabled, the READY signal will change to a lockout state.

*3: When the ERR signal is configured.

*4: When the configuration of start/restart is set to manual/manual, the OSSD is OFF and READY is ON. When set to manual/auto, OSSD is ON, and READY is OFF.

SE1L Safety Laser Scanner

Lockout

When an error is detected by the self-diagnosis function normal operation cannot be performed, and SE1L will change to a lockout state. In this condition, the OSSD1, 2 and WARNING 1, 2 signals turn OFF. Only when the cause of the error is removed and the power is reset, the lockout state can be cleared.

Relations between OSSD output and ERR output

Cause	OSSD	ERR
Object detection	OFF	ON
Device error	OFF	OFF

OSSD Interlock

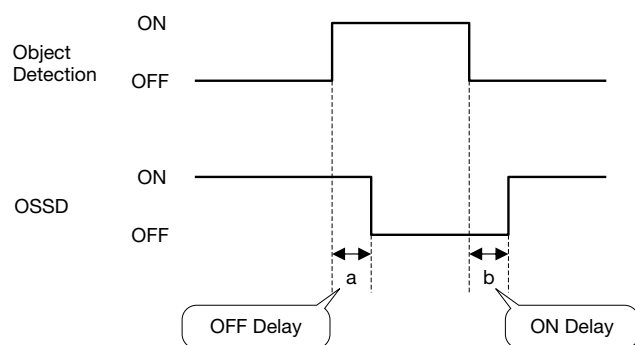
Interlock is a function to prevent the OSSD signal restarting automatically from OFF to ON. The following functions can be set using the SLS Configurator.

Automatic restart

When the interlock function is disabled or restart interlock is set to automatic mode, the SE1L will operate in automatic restart mode. When the objects in the protection zone are removed, the OSSD signal will automatically turn from OFF to ON.

In the figure below, “a” is the OFF delay and “b” is the ON delay. However, if the OSSD signal changes due to lockout of the sensor, the OSSD signal will remain OFF even when the interlock function is disabled.

Time chart (automatic restart)



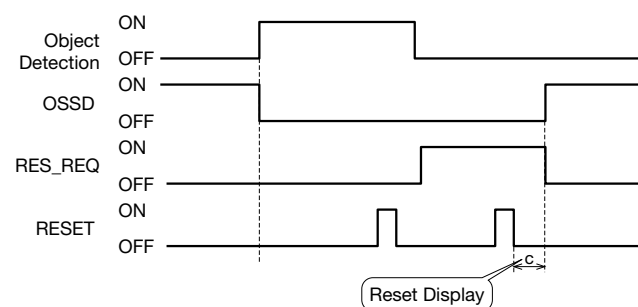
Note:

- When using automatic restart, because the OSSD automatically turns ON when the object is removed, take appropriate safety precautions.
- When using the delay function, make sure that the delay time is sufficient to stop the machine or AGV.

Manual Restart

When the restart interlock is set to manual, the OSSD signal will remain OFF even when the object in the protection zone is removed or when an error is cleared. For the SE1L to return to normal operation, an external reset input signal is required to clear the interlock. The SE1L will resume normal operation when there is a reset signal. The time for the reset signal should be 0.5s minimum. When the reset delay is set to “c” as shown in the figure below, the OSSD signal will turn ON when the OSSD signal reaches the delay time. However, if the OSSD signal turns OFF due to internal failure, the OSSD signal remains OFF regardless of the set delay time. The reset delay can be set from 1 second to 6 seconds.

Time chart



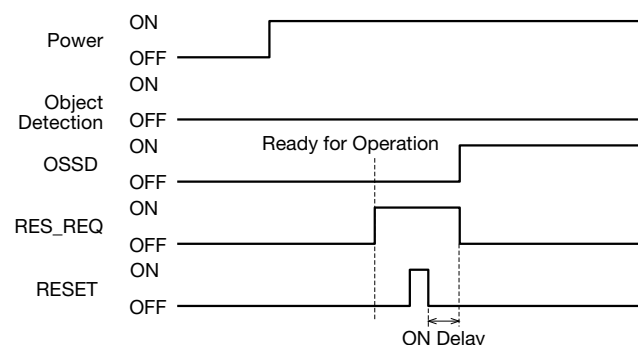
- The operator must check that the object is removed before resetting the SE1L.
- When using the manual restart to restart the machine, the reset switch must be installed far away from the protection zone.
- If the above measures are not taken, critical injury or death may result.

Note: If the OSSD signal remains OFF even when the object is removed from the protection zone, check the error code and troubleshooting. For details, see the user's manual.

Manual Start

The configuration for start interlock can only be configured manually. This function is used to maintain the OSSD in an OFF state until the external reset signal is input at start-up. The RES_REQ signal turns ON after start-up preparation and ready to receive the reset signal. When the reset signal is input, if there is no object in the protection zone, the OSSD signal will turn ON. The input time of the reset signal must be more than 0.5 seconds.

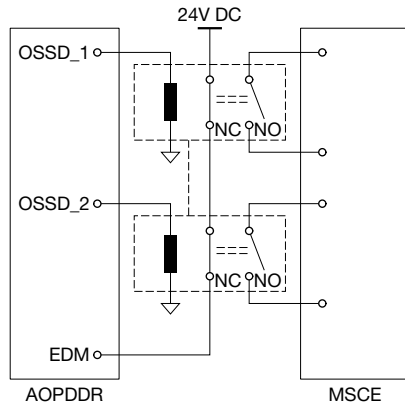
Time chart (manual start)



External Device Monitoring (EDM) Function

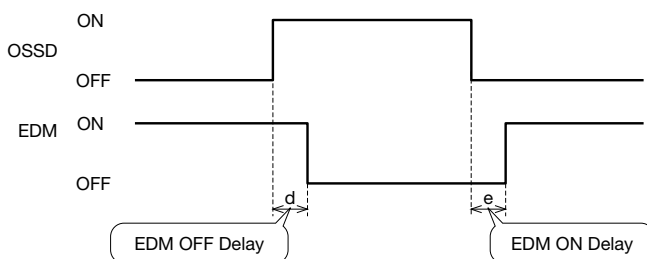
EDM function monitors the input signal status of a machine or AGV. The SLS Configurator is used to configure the EDM. When an EDM signal detects an error, the OSSD signal turns OFF. The EDM input signal is always the inverse of the OSSD signal. The EDM input signal ON/OFF delay can be configured. Do not connect the EDM when the EDM function is not used.

EDM Circuit



Note: When the EDM function is disabled, do not connect the EDM as an error will occur.

Time chart



Muting Function

Muting function is a function to temporarily stop the safety function in the protection zone. During muting, the OSSD signal will remain ON even when an object is detected in the muting area. The muting function can be started and stopped using two signals that are independently wired. Muting areas can be configured using the SLS Configurator. When the muting input satisfies the starting conditions, the SE1L stops the safety function within 60 ms. (For details, see the user's manual)

Muting Start

Muting function starts when the following conditions are satisfied:

- 1) When OSSD is ON and there are no objects within the protection zone.
- 2) 2 muting input signals which are independently wired are switched to the preset input order or switched within the time interval of T1.

To start muting, see the configuration below. The SLS Configurator can be used for the configuration below. (For details, see the user's manual)

● Muting input order

- Muting 1 → Muting 2
- Muting 2 → Muting 1

● Input time difference (T1)

- 1 second
- 3 seconds
- 5 seconds
- 10 seconds

Muting Stop

Muting function stops when the following conditions are satisfied:

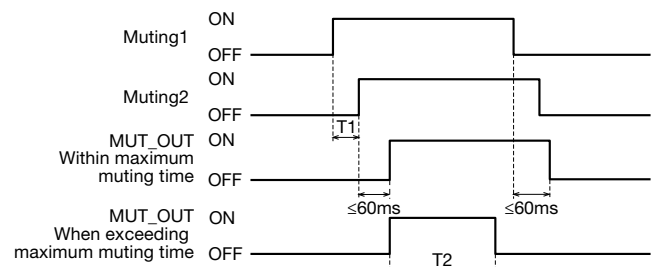
- 1) Either one of the muting input turns OFF.
- 2) When the muting status exceeds the maximum muting time T2.
- 3) When an object is detected in a protection zone that is not covered by a muting area.
- 4) When an error is detected by a self-diagnosis function.
- 5) When the muting area is switched to a different area during muting.

The following shows the necessary configuration to end the muting function.

● Maximum muting time (T2)

- 1 minute
- 6 minutes
- 12 minutes

Muting Sequence



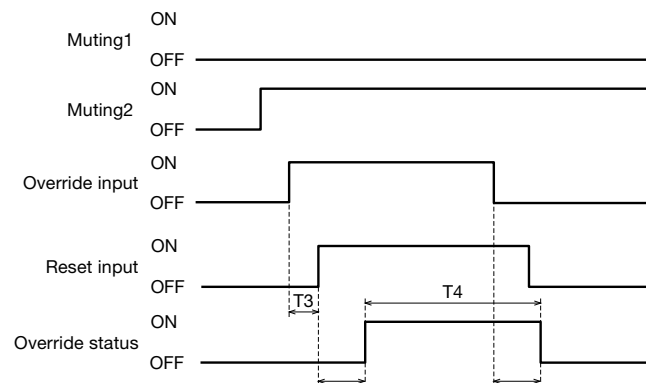
SE1L Safety Laser Scanner

Muting Override Function

Muting override function is used to temporarily stop all safety functions of the entire protection zone when the OSSD turns OFF during muting. The override function is effective when the override input and reset input is switched in the order as shown below. When the SE1L is in a override status, the 7-segment display shows the override code.

- Override start condition
 - ▶Either one of the muting input is ON.
 - ▶When an object exists in the protection zone.
 - ▶When the time interval of the override input and reset input is between 0.03 and 1 second (T3)
- Override stop condition
 - ▶Both of the muting inputs are OFF.
 - ▶Either the override input or reset input is OFF.
 - ▶When the override state exceeds the maximum override time T4.
 - ▶When an error is detected by the self-diagnosis function of the SE1L.
 - ▶When the muting area switched to a different area during muting.
- Maximum override time (T4)
 - ▶1 minute
 - ▶6 minute
 - ▶12 minute

Override Sequence



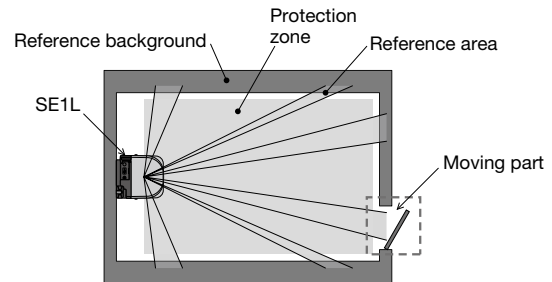
- When the muting function is effective, the user must ensure the safety of the protection zone.
- Before using the muting function, make sure to perform a risk assessment.
- If the above procedures are not followed, critical injury or death may result.

Reference Monitor Function

The reference monitor function is a function to monitor the displacement of the SE1L or the structure in the background used as a reference.

Existence Detection Application Examples

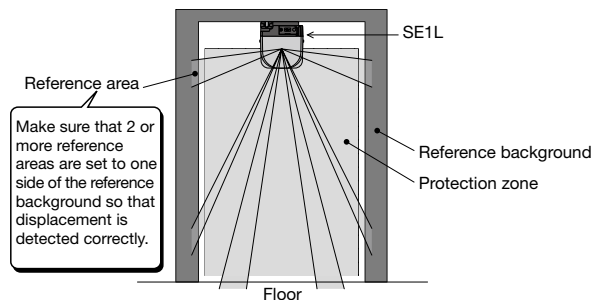
When the reference area is set to a moving part such as a door, the OSSD will turn OFF if the position of the door changes.



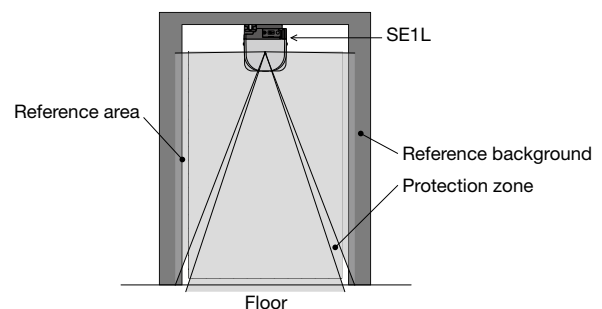
Access Detection Application Example

The user must configure the reference area for monitoring. To detect the displacement, set a reference area on each side. The OSSD will turn OFF when the distance between the reference background has changed or when an access is detected. This function must be used when the SE1L is installed vertically.

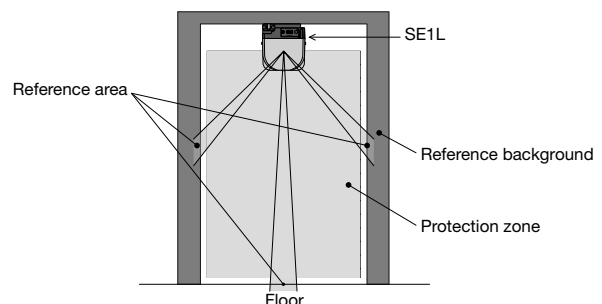
(1) Application Example 1 (front view)



(2) Application Example 2 (front view)



(Caution) Incorrect reference area configuration (front view)



Response Time

The response time for the OSSD signal can be configured by the SLS Configurator. The response time for WARNING 1, 2 is the same as the response time for OSSD. The stability of the SE1L can be increased by setting a long response time, but a long safety distance is required. (See Calculating the Safety Distance on page 13 to 15.) Before setting the response time, the user must perform a risk assessment. The configurable response time is shown in the table below. Be sure to add the time taken to switch areas (30 ms)

SE1L Response Time

	Response Time (ms)						
ON→OFF	60	90	120	180	210	240	270
OFF→ON	270						

	Response Time (ms)							
ON→OFF	300	330	360	390	420	450	480	510
OFF→ON	300	330	360	390	420	450	480	510

Other Inputs

SE1L has 3 non-safety outputs such as WARNING1, WARNING2/ERR/MUT_OUT, and READY/RES_REQ. WARNING2/ERR/MUT_OUT (WARNING2 at default) and READY/RES_REQ (READY at default) use the same output terminal and can be configured using the SLS Configurator.

Warning Output (WARNING1)

This signal turns OFF when an object is detected in protection area 1.

Warning Output (WARNING 2)

This signal turns OFF when an object is detected in protection area 2.

Error Output (ERR)

ERR output shows the operating status of the SE1L. This signal turns OFF when an error is detected by the self-diagnosis function of the SE1L.

Muting Output (MUT_OUT)

MUT_OUT indicates the MUTING/OVERRIDE status of the SE1L. When muting is activated, MUT_OUT turns ON. In a muting status, the 7-segment display shows "18". In an override status, the display shows "19". Use this signal to indicate whether the SE1L is in a muting status.

Ready Output (READY)

This signal turns ON when the SE1L is ready for operation.

Reset Request (RES_REQ)

This signal turns ON when the SE1L is ready to receive the reset signal.

Calculating Safety Distance

To use the SE1L as a safety equipment, take into consideration the guidelines mentioned below.

- 1) The hazard must be identified before performing a risk assessment.
- 2) Do not use the SE1L for finger protection.
- 3) Use under an operating environment within the specifications of the SE1L.
- 4) The safety distance must be determined in accordance to ISO 13855 and IEC 61496-3.

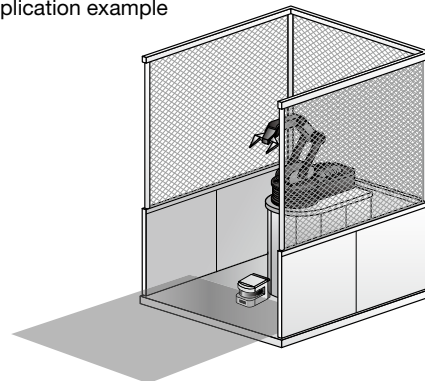


• Using sensors that exceed specifications may lead to critical injury or death.

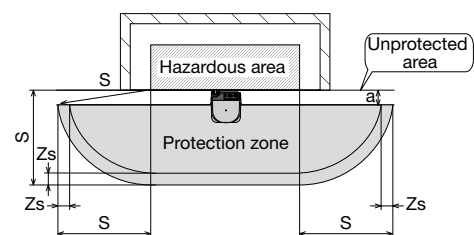
Hazardous Area Protection (Stationary)

In this application, the SE1L is horizontally installed to protect the hazardous area. The protection zone is set around the hazardous area to prevent humans or objects from entering the hazardous area. Warning zones 1 and 2 are configured to surround the protection zone. The warning zones prevent the machine from stopping unnecessarily and can be used as a warning to humans or objects that approach the protection zone. By detecting humans or objects in the protection zone, the OSSD signal switches from ON to OFF. Also, when humans or objects are detected in the warning zone, the warning zone output (WARNING signal) switches from ON to OFF.

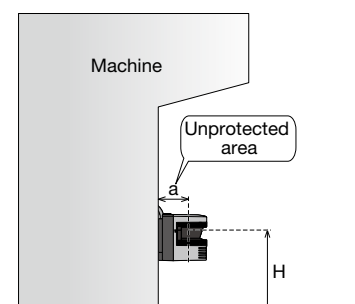
Application example



Safety distance (upper view)



Safety distance (side view)



SE1L Safety Laser Scanner

Calculation

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

S = Safety distance (mm)

K = Human approach speed 1,600 (mm/s)

T_m = Maximum stop speed of machine or system (s)

T_s = Response time of SE1L (s)

$C = 1200 - 0.4 \times H \geq 850$

H = height from the floor to the sensing plane (mm)

$1000 \geq H \geq 15 \times (d - 50)$

d = Minimum sensing width of object (mm)

Z_s = Additional safety distance of SE1L (mm)



- Install the SE1L so that the distance between the end of the hazardous area and the origin of the protection zone "a" is shorter than the minimum sensing width. If the distance of "a" is longer than the minimum sensing width, additional protection measures must be taken so that objects cannot enter the unprotected area.
- Do not install the SE1L higher than 300 mm to prevent obstacles entering beneath the sensing plane. If there is a need to install the SE1L higher than 300 mm, take measures to prevent obstacles entering beneath the detecting surface.
- To install the SE1L in a public area, make sure that the height from the floor to the sensing plane is within 200 mm or install according to local height regulations.
- To use the SE1L for presence detection (when an object enters the protection area horizontally), make sure to set the minimum sensing width to less than 70 mm.

Note:

- It is recommended that markings be placed on the floor so that the protection zone is clearly defined.
- To configure the safety distance, the additional safety distance must be taken into consideration.
- When operating the SE1L in a high reflective background environment, additional distance must be added.
- Make sure that protective measures or background are not detected in the protection zone. If they are detected as an object, the OSSD remains OFF.

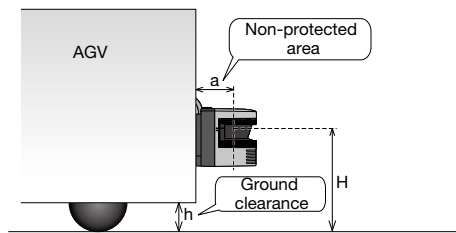
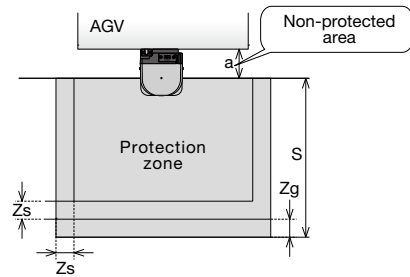
Hazardous Area Protection (Movable)

The SE1L can be used for movable applications. In an application using an AGV, the SE1L on the AGV detects humans or objects while traveling on the fixed route. The warning zone signal is used to slow down the AGV and the OSSD signal can be used to stop the AGV when required. By using the area switching function of the SE1L, the AGV can use 16 different area patterns based on its traveling route. When using the SE1L on an AGV, take into consideration the time needed for the AGV to stop completely when configuring protection zones and warning zones.

Application Example



Safety distance (top view)



Calculation

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

S = Safety distance (mm)

V = Maximum approach speed of the AGV (mm/s)

T_m = Maximum stopping time of the machine or system (s)

T_s = Response time of SE1L (s)

Z_b = Distance required for the AGV to stop (mm)

L = Brake friction coefficient

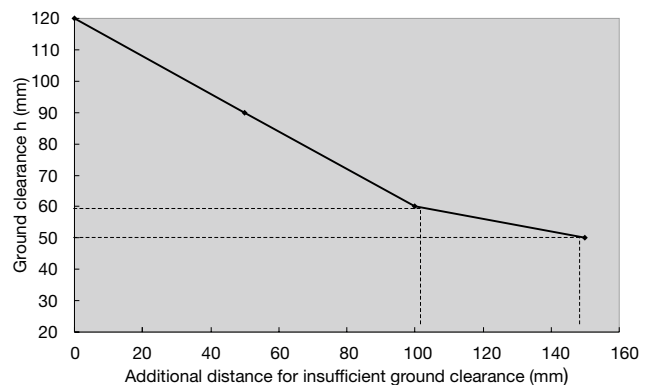
Z_s = Additional safety distance of SE1L (mm)

Z_g = Additional safety distance due to insufficient ground clearance

h = ground clearance (mm)

To prevent damages to fingers, provide sufficient ground clearance.

The graph below shows the relation between h and Z_g .



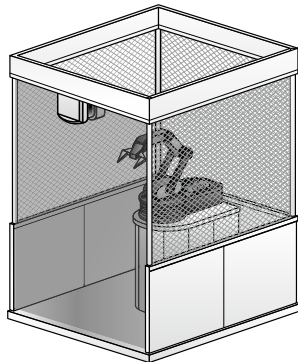
- Install the SE1L so that the distance between the end of the hazardous area and the origin of the protection zone "a" is shorter than the minimum sensing width. If the distance of "a" is longer than the minimum sensing width, additional protection measures must be taken so that objects cannot enter the unprotected area.
- Do not install the SE1L higher than 200 mm to prevent objects entering beneath the sensing plane.

Note: Make sure that protective measures or background are not detected in the protection zone. If they are detected as an object, the OSSD remains OFF.

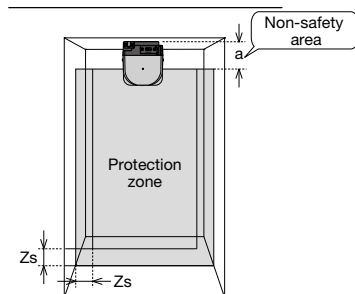
Access Detection (Detecting the Entire Body)

When constructing a protective shield, the SE1L can be installed vertically. In the application below, it is used to prevent access into hazardous areas. When an object or human enters the hazardous area, the OSSD signal switches from ON to OFF. When the SE1L is installed vertically, an object or human is detected by the vertical sensing plane. The front and rear of the sensing plane cannot detect objects or humans. Therefore, the distance between the approach and hazardous area must be carefully determined. The reference monitor function must be used for this kind of application. If a displacement occurs within the reference background, the OSSD signal turns OFF.

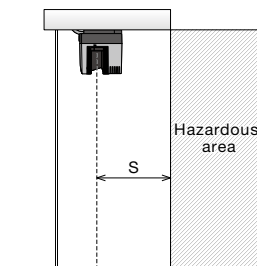
Application example



Safety distance (front view)



Safety distance (side view)



Calculation

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

S = Safety distance (mm)

K = Approach speed 1600 (mm/s)

T_m = Maximum stopping time of the machine or system (s)

T_s = Response time of SE1L (s)

C = Additional distance for entry of fingers 850 (mm)



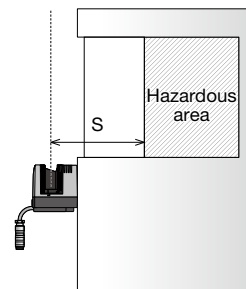
- Install the SE1L so that the distance between the end of the hazardous area and the origin of the protection zone "a" is shorter than the minimum sensing width. If the distance of "a" is longer than the minimum sensing width, additional protection measures must be taken so that objects cannot enter the unprotected area.
- For access detection applications, if the approach angle exceeds $\pm 30^\circ$ be sure to use the "reference monitor function". The response time must be 90 ms maximum for access detection applications. Set the tolerance range of the reference area to 100 mm.
- In order to detect displacement, make sure to set a reference area on each side.
- Make sure that the SE1L is installed in a way that access to hazardous points is impossible. Take additional protection measures if necessary.
- Before setting the reference area, take into consideration the tolerance range.

Note: When setting the minimum sensing width to 30 mm, the value C can be replaced by 0.

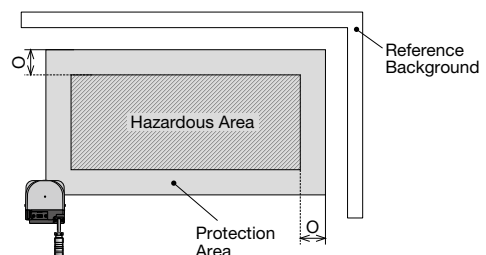
Access Detection (Detecting Parts of a Body)

When constructing a protective shield, the SE1L can be installed vertically. It is used to prevent a part of a body from reaching a hazardous area. When an object or a part of a body enters the hazardous area, the OSSD signal switches from ON to OFF. When the SE1L is installed vertically, the vertical side of the object or human is detected. The front and rear of the sensing plane cannot detect objects or humans. Therefore, the distance between the approach and hazardous area must be carefully determined. The width of the protection zone must be configured to fully cover the hazardous area. The reference monitor function must be used for this kind of application. If a displacement occurs with the reference background, the OSSD signal turns OFF. For details, see the user's manual.

Safety distance (side view)



Safety distance (front view)



SE1L Safety Laser Scanner

Calculation

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

S = Safety distance (mm)

K = Approach speed 2000 (mm/s)

T_m = Maximum stopping time of the machine or system (s)

T_s = Response time of SE1L (s)

C = Additional distance

$$= 8 \times (d - 14)$$

d = minimum sensing width (mm)

O = Additional width from the end of the hazardous source
 $\geq (2 \times Z_s) - d$

d = Minimum sensing width (mm)

Z_s = Additional safety distance of SE1L (mm)



- For access detection applications, if the approach angle exceeds $\pm 30^\circ$ be sure to use the "reference monitor function"
- Configure the reference area to each side so that displacement can be detected.
- Set the tolerance range of the reference area to 100 mm.
- In order to detect displacement, make sure to set a reference area on each side.
- Make sure that the SE1L is installed in a way that access to hazardous points is impossible. Take additional protection measures if necessary.
- Before setting the reference area, take into consideration the tolerance range.

Note: When $S > 500$ mm, value K can be replaced by 1600 mm/s instead of 2000 mm/s. In this case, S must be larger than 500 mm.

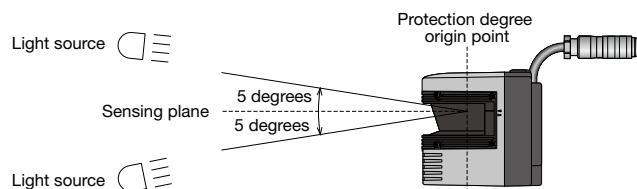
Installation

Light Interference

SE1L is a sensor that transmits pulsed laser for obstacle detection. Interfering light sources may lead to false detection. Before using the SE1L, examine the surrounding environment. Be sure to avoid the following light sources.

- 1) Incandescent light
- 2) Florescent light
- 3) Strobe light
- 4) Flashing beacon
- 5) Sunlight
- 6) Infrared light source

However, if the SE1L must be used under the above environment, install the SE1L so that the light source is located more than ± 5 degrees from the sensing plane to prevent light interference.



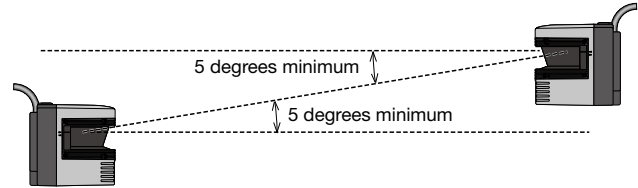
- Be sure to perform a risk assessment for light interference in the operating environment before installing the SE1L.
- Avoid using direct interference light such as fluorescent light, flashing beacons, or strobe light.
- If the above precautions are not followed, critical injury or death may result.

Mutual Interference

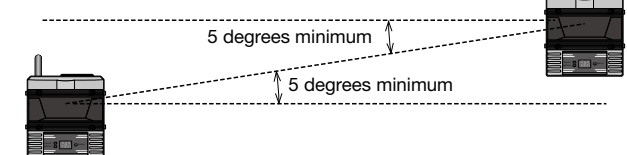
When using several SE1Ls of the same model, pulse laser signals from different SE1Ls may be falsely detected. To prevent mutual interference, see the installation methods shown below.

1) Changing the installation height

① Face to face installation

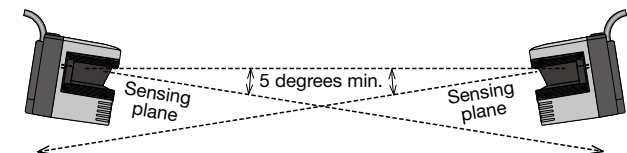


② Parallel installation

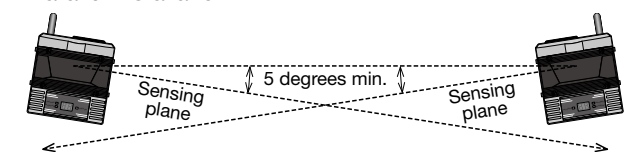


2) Changing the installation angle

① Face to face installation

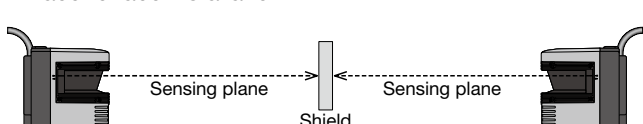


② Parallel installation

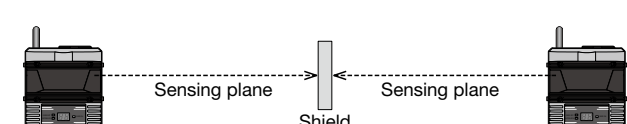


3) Using shields

① Face to face installation



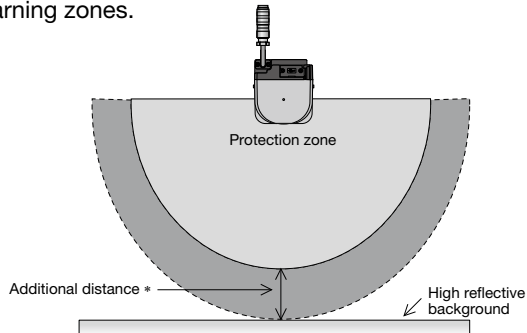
② Parallel installation



Note: Use a solid and non-transparent material for shields.

Highly Reflective Background

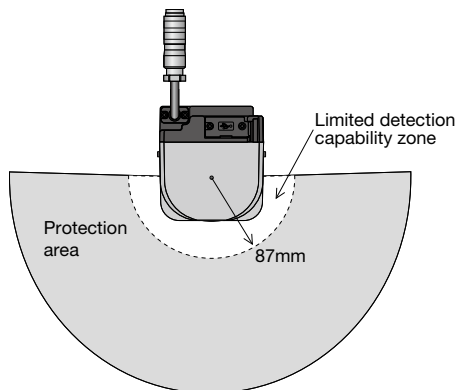
Highly reflective backgrounds may cause false detection causing the SE1L to detect a longer distance than the actual distance. If an operating environment with a highly reflective background cannot be avoided, an additional distance of 200 mm is needed when configuring protection or warning zones.



- When the background is highly reflective, the detected distance may be longer than the actual distance.
- When setting the protection zone, an additional distance must be added.
- Avoid using a highly reflective background (such as mirror, corner cube reflector, reflective safety jacket, road reflector). Otherwise, false detection may occur in the protection zone.
- Perform tests to make sure the area is properly configured before operation.
- Failure to follow the above precautions may lead to critical injury or death.

Limited Detection Capability Area

The limited detection capability area is the area between the optical window and the beginning of the detection zone. The area from the origin point of the SE1L to 87 mm from the origin point is the limited detection capability area. In this area, a low reflective object is difficult to detect.



- The user must perform a safety assessment for the possibility of objects entering the limited detection capability zone.

Wiring

- Make sure that power is disconnected or turned off during wiring.
- Do not use cables that are longer than the length described in the specification of the SE1L. If cables longer than the length described in the specification are used, the safety function may not operate correctly and may cause critical injury or death.
- Make sure that the power supply is within 24V DC \pm 10%. When using a battery, make sure that the power voltage is within 24V DC $-30\%/+20\%$. Excessive power may damage the SE1L.



- Do not use cables longer than the length described in the specification.

Note: For safety, turn off the power during wiring.

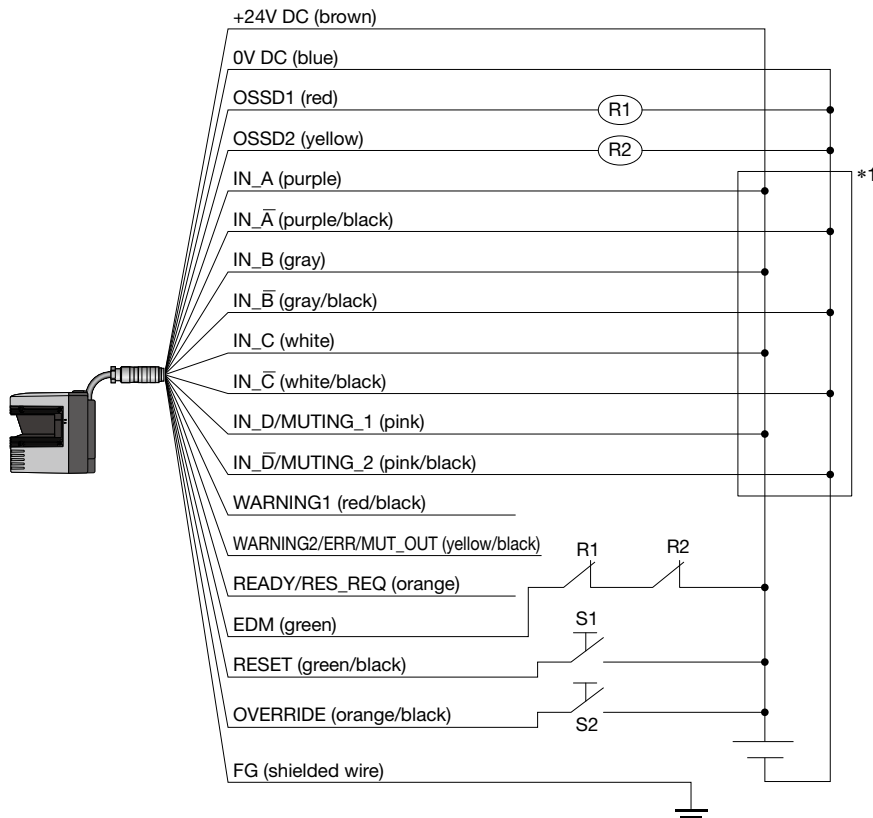
Wire Color and Functions

The table below shows the functions of each wire. Use of a shielded wire is recommended.

Color	Signal	Function	Description	AWG
Brown	+24V DC	Power	Power: 24V DC	22
Blue	0V DC		Power: 0V	22
Red	OSSD 1	Output	Protection zone output 1	26
Yellow	OSSD 2		Protection zone output 2	26
Purple	IN_A	Input	Area switching input A	28
Gray	IN_B		Area switching input B	28
White	IN_C		Area switching input C	28
Pink	IN_D/ MUTING1		Area switching input D/ Muting input 1	28
Purple/ Black	IN_A̅		Area switching input A̅	28
Gray/ Black	IN_B̅		Area switching input B̅	28
White/ Black	IN_C̅		Area switching input C̅	28
Pink/ Black	IN_D̅/ MUTING2		Area switching input D̅/ Muting input 2	28
Green	EDM		External device monitor	28
Red/ Black	WARNING1	Output	Warning zone output 1	28
Yellow/ Black	WARNING2/ ERR/MUT_ OUT		WARNING2: Warning zone output 2 ERR: OFF when error is detected MUT_OUT: Output during muting	28
Orange	READY/ RES_REQ		READY: ON during normal operation RES_REQ: ON when external reset is required	28
Green/ Black	RESET	Input	Reset input	28
Orange/ Black	OVERRIDE		Override input	28
Shield	FG	—	Frame ground	—

SE1L Safety Laser Scanner

Wiring Example



R1, R2: External device (safety relay, magnet contactor, etc.)

S1: Interlock reset switch

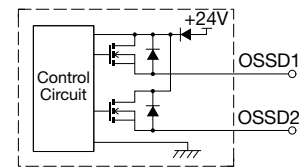
*1: See page 9 for area switching.

• For details on the wire colors and function, see page 17.

Input/Output Circuit

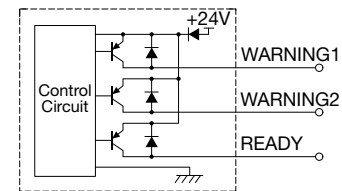
OSSD Output Circuit

OSSD outputs are N channel MOSFET outputs.



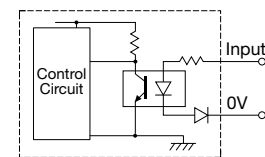
Other Output Circuit

WARNING1, WARNING2, READY outputs are PNP outputs.



Input Circuit

Available for area input, EDM, RESET, MUTING1, MUTING2, and OVERRIDE.



Safety Precautions

For correct use of the SE1L, take note of the following precautions.

- SE1L is a AOPDDR (Active Optoelectronic Protective Device responsive to Diffuse Reflection) that detects diffused emitted light within the protection zone. The emitted light is irradiated within the protection zone by the rotating motor and reflects back from the objects as diffused reflective light and is detected by the receiving unit of the SE1L.
- Perform tests before operation to check the function and performance of the SE1L.
- Use the SE1L within the specification range described in the manual. To prevent degradation of detection characteristics, make sure that maintenance is carried out.
- To maintain the degree of protection, do not modify or disassemble the SE1L.
- The operator must be a person qualified to operate the SE1L. The operator must be trained and be able to operate the SE1L correctly.
- The administrator must provide continuous training to the operator for correct use of the SE1L.
- When using the SE1L in a safety-related system, the administrator must be responsible for following safety requirements, standards, rules, regulations, and laws of each country, state, or district.
- The administrator must understand the manual and be responsible for ensuring appropriate operating conditions for SE1L.

- To examine the object detecting performance, use a test piece the size equivalent to the minimum detectable object.
- Error occurs when detection capability is below 30% due to homogenous dirt on the optical window. The operator must keep the windows clean
- While SE1L is removed, a protective measure must be taken to ensure safety within the protection zone. To prevent entry into the danger zone, use protective materials such as a safety guard or light curtain.
- Dispose the SE1L as industrial waste or in accordance with the local regulations.
- Do not perform withstand voltage tests or insulation resistance tests. Varistors that are used in power circuits may be damaged.

Operating Environment

- Make sure that the operating environment is within the range of the specifications (temperature, humidity, vibration, light interference).
- Do not use the SE1L near a machine that may generate strong radio waves. It may interfere with the operation of the SE1L.
- Do not use or install the SE1L where dust, smoke, or corrosive chemical substances exist. Using the SE1L under these environments may lead to degradation of detection performance.
- When the interlock function is active, make sure that the surrounding environment, especially within the protection zone, is safe before resetting the interlock.

Safety Precautions

Installation

- Install the SE1L on a stable surface or structure to prevent displacement of the sensor.
- Install the SE1L securely so that screws do not loosen due to shock or vibration. (Recommended tightening torque 3N·m). Displacement may degrade protection performance.
- Determine the safety distance before installing the SE1L. After installing the SE1L, use a test piece for all protection zones to check the sensing functions. (Calculating safety distance : see page 13)
- After installing the SE1L, to prevent entry into the protective zone, use protective materials such as safety guards and light curtains.
- The reset switch to reset the interlock function should be installed far from the protection zone.
- If several SE1Ls are installed on the same sensing plane, mutual interference may occur. For countermeasures on mutual interference, see page 16.
- Provide enough space for installation and maintenance of the SE1L.
- Do not cover the front of the optical window with glass or transparent cover, otherwise detection characteristics of the SE1L may be impaired.
- SE1L will not operate without initial configuration.
- Minimum sensing width differs according to the distance. For details on performance specifications see page 6.
- The stability of the SE1L increases by delaying the response time of the OSSD signal but the sensing performance decreases for moving objects. Before using this function, be sure to carry out risk assessment.

Wiring

- Be sure to turn off all the power before wiring.
- When using converter power, make sure to use power that satisfy the following requirements.
 - 1) The rated output voltage is within 24V DC \pm 10% (SELV circuit, overvoltage category II)
 - 2) The circuit between primary circuit and secondary circuit is reinforced insulation or double insulation.
 - 3) The output holding time is 20 ms.
 - 4) The power supply must comply with electrical safety and electromagnetic compatibility (EMC) regulations requirements of each country, state, and district.

- All input/output cables must be located away from power cables and high voltage cables.
- To control safety-related machine or system, use OSSD output. Because warning zone output (warning signal) is a non-safety signal, do not use for safety purposes.
- Only use cables made for the SE1L. (For details see page 17.)
- Use an exclusive cable for connecting OSSD output wire cable and safety-related machine or system.

Installation

- A password is used for configuring the safety function. Only an administrator or operator should be able to use the password.
- Perform test operation and check the configuration before using the SE1L.
- The operator must record the changes made in the configuration. SLS Configurator report function is available. For details, see the user's manual.

Testing and Maintenance

- The operator should perform the following tests or maintenance based on the checklist.
 - 1) Pre-operation inspection
 - 2) Operation inspection
 - 3) Daily inspection
 - 4) Periodic inspectionThis checklist is a basic guideline for performing tests and maintenance. The operator should perform additional tests and maintenance if necessary.
- Stop the machine if failure occurs during tests.
- Clean the optical window if any dirt is found, ask for repair if damaged.



• Do not drop the SE1L. Otherwise damage or failure may occur and performance cannot be guaranteed. Also, injury may occur.

• SE1L cannot be sold, imported, or used in the Federal Republic of Germany until December 2013.

Die technischen Daten und sonstigen Beschreibungen dieser Druckschrift können ohne vorherige Ankündigung geändert werden.

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