KEYENCE

96M12528

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Safety Laser Scanner

SZ Series Ver.2

Instruction Manual

Introduction

This instruction manual describes handling, operation, and precautionary information for the SZ Series Safety Laser Scanner (“SZ”).
Read this instruction manual thoroughly before operating the SZ in order to understand the device features, and keep this manual readily available for reference. Ensure that the end user of this product receives this instruction manual.
This manual is the original instruction manual.

Safety headings

This instruction manual uses the following headings to display important safety information.
Strict adherence to the instructions next to these heading is required at all times.

Danger Failure to follow the instruction results in significant harm to the machine operators including serious injury or death.

Caution Failure to follow the instruction may result in damage to the SZ or to the machine on which the SZ is installed.

NOTE Provides additional information for proper operation.

Reference Provides advanced and useful information for operation.

Indicates reference pages in this manual.

Safety Precautions

General precautions

- SZ is an active opto-electronic protective device responsive to diffuse reflection (AOPDDR). It is a device, whose sensing function is performed by opto-electronic emitting and receiving elements, that detects the diffuse reflection of optical radiations generated within the device by an object present in a protection zone specified in two dimensions.
- You must verify that the SZ is operating correctly in terms of functionality and performance before the start of machine and the operation of the SZ.
- KEYENCE does not guarantee the function or performance of the SZ if it is used in a manner that differs from the SZ specifications contained in this instruction manual or if the SZ is modified by the customer.
- When using the SZ to protect machine operators against a hazard or hazardous zone or when using the SZ as a safety component for any purpose, always follow the applicable requirements of the laws, rules, regulations and standards in the country or region where the SZ is used. For such regulations, you should directly contact the regulatory agency responsible for occupational safety and health in your country or region.
- Depending on the type of machine on which the SZ is to be installed, there may be special safety regulations related to the use, installation, maintenance, and operation of the safety component. In such a case, you must fulfill such safety regulations. The responsible personnel must install the SZ in strict compliance with such safety regulations.
- The responsible personnel must do the training to the assigned personnel for the correct use, installation, maintenance, and operation of the SZ.
- "Machine operators" refers to personnel who have received appropriate training from the responsible personnel and are qualified to operate the machine correctly.
  Machine operators must have specialized training for the SZ, and they must understand and fulfill the safety regulations in the country or region in which they are using the SZ.
- If the SZ fails to operate, machine operators must immediately stop the use of the machine and the SZ and report this fact to the responsible personnel.
- The SZ is designed with the assumption that it would be correctly installed in accordance with the installation procedures described in this instruction manual and correctly operated according to the instructions in this instruction manual. You must perform an appropriate installation of the SZ after performing a sufficient risk assessment for the target machine.
- The SZ should be processed as an industrial waste product when being disposed.

Warning

■ Operators

Danger

- In order to operate the SZ correctly, the responsible personnel and machine operators must fulfill all of the procedures described in this instruction manual.
- No person other than the responsible personnel and machine operators should be allowed to install or test the SZ.
- When performing electrical wiring, always fulfill the electrical standards and regulations for the country or region in which the SZ is used.

■ Usage environment

Danger

- Do not use the SZ in an environment (temperature, humidity, interfering light, etc.) that does not conform to the specifications contained in this instruction manual.
- Do not use wireless devices such as cellular phones or transceivers in the vicinity of the SZ.
- The SZ is not designed to be explosion-proof. Never use it in the presence of flammable or explosive gases or elements.
- Do not use the SZ in the presence of substances, such as heavy smoke, particulate matter, or corrosive chemical agents, that may induce deterioration in product quality.
- Install the SZ in such a way so that no direct or indirect light from inverter-type fluorescent lights (rapid-start type lights, high-frequency operation type lights, etc.) enters the optical window.
- Be sure to absolutely confirm that there is nobody in the hazardous zone, before the interlock is released (i.e. the machine system restarts) by the interlock reset mechanism. Failure to follow this warning may result in a significant harm to the machine operators, including serious injury or death.
- Be sure to confirm that there is nobody in the hazardous zone, before the override is activated. Failure to follow this warning may result in a significant harm to the machine operators, including serious injury or death.

■ Target machine

Danger

- The SZ has not undergone the model certification examination in accordance with Article 44-2 of the Japanese Industrial Safety and Health Law. The SZ, therefore, cannot be used in Japan as a “Safety Device for Press and Shearing machines“ as established in Article 42 of that law.
- The machine on which the SZ is to be installed must be susceptible to an emergency stop at all operating points during its operation cycle. Do not use the SZ for machines with irregular stop times.
- Do not use the SZ for power presses equipped with full-revolution clutches.
- The SZ cannot be used as a PSDI because it does not fulfill the requirements of OSHA 1910.217(h). Refer to OSHA 1910.217 for the PSDI mode.
- Do not use the SZ to control (stop forward motion, etc.) trains, cars and other transportation vehicles, aircraft, equipment for use in space, medical devices, or nuclear power generation systems.
- The SZ is designed to protect the people or objects approaching into the specified protection zone against a machine's hazard or hazardous zone. It cannot provide a protection against objects or materials that are expelled from the machine's hazard or hazardous zone, so you must establish additional safety measures such as installing safeguards when there is the possibility of such projectiles.

■ Installation

Danger

- SZ must be installed in such a way that the screws do not loose due to vibration and/or shock. The screw loosen may cause the displacement of detection plane and SZ can not make a protection as intended. Failure to follow this warning may result in a significant harm to the machine operators, including serious injury or death.
- The installation of the SZ must ensure the required safety distance in compliance with the requirements of laws, rules, regulations and standards in the country or region in which the SZ is installed.
- When changing the minimum detectable object size and response time for SZ, the minimum safety distance must be recalculated, and the SZ must be reinstalled based on the result of recalculation to keep the required minimum safety distance.
- The SZ must be installed so that the machine operator is able to go into or approach the hazardous zone or hazards only by passing through the protection zone of the SZ. Strictly avoid installation that allows the machine operator or a part of the machine operator's body to go into or approach the hazardous zone or hazards without passing through the protection zone of the SZ or to remain in a position between the protection zone of the SZ and the hazardous zone or hazard.
- You must always perform the pre-check tests after installing the SZ in accordance with the pre-check test procedures, such as the item specified in this instruction manual, in order to verify that the test pieces can be detected in all of the protection zones.
- The interlock reset mechanisms (such as switches) must be installed so that the whole hazardous zone can be checked by the responsible personnel and that operations of the interlock reset mechanisms are not possible within the hazardous zone.
- Reference points monitoring function must be applied when the SZ is used for the access protection specified in IEC61496-3:2008 Annex A.12 and A.13 (the application where the angle of the approach exceeds ±30° to the detection plane). The SZ-16V and the SZ-16D cannot be used for this application because the SZ-16V and the SZ-16D do not have the reference points monitoring function.
- The muting is a function to allow a temporary automatic suspension of the safety function while the SZ receives a signal from one or more muting devices (such as sensors or switches). Therefore, additional safety measures are required for the whole machine on which the SZ is installed in order to ensure safety while the muting is activated.
- The muting devices, the installation of those devices and the procedure to activate the muting must fulfill the conditions specified in this instruction manual and the requirements of the laws, rules, regulations, and standards in the country or region in which the SZ and those devices are used. Failure to follow this warning may result in a significant harm to the machine operators, including serious injury or death.
- When you install the muting devices (such as sensors or switches), the following conditions must be fulfilled.
  (1) Muting devices must be installed so that the muting cannot be activated if the hazard is still existing during machine cycle.
  (2) Muting devices must be installed so that the muting cannot be activated if someone approaches into the protection zone of the SZ.
- The muting device must be installed such that only responsible personnel have access to that device to change its installation or orientation. Special tools must be required to ensure that only responsible personnel are capable of installation, orientation or change of muting device.
- Only the responsible personnel may be allowed to install or wire the devices to activate the muting function, suspension in teaching mode, or override function.
- The installation of muting lamp may be required by the laws, rules, regulations, and standards in the country or region in which the SZ is used. It depends on the machine application or the result of your risk assessment. If it is necessary for you to provide the muting lamp, you must fulfill the requirements because you are fully responsible for installing the muting lamp. (Precautions on the suspension in teaching mode)
- The suspension in teaching mode is a function to allow a temporary manual suspension of the safety function. Therefore, additional safety measures are required for the whole machine system on which the SZ is installed in order to ensure safety while the suspension in teaching mode is activated.

- The installation of the indication for the suspension in teaching mode may be required by the laws, rules, regulations, and standards in the country or region in which the SZ is used. It depends on the machine application or the result of your risk assessment. If it is necessary for you to provide such an indication, you must fulfill the requirements because you are fully responsible for installing such an indication.
- The override is a function to allow a temporary manual suspension of the SZ safety functions. Therefore, additional safety measures are required for the whole machine system on which the SZ is installed in order to ensure safety while the override is activated.
- The override devices, the installation of those devices, and the procedures to activate the override must fulfill the conditions specified in this instruction manual as well as the requirements of the laws, rules, regulations, and standards in the country or region in which the SZ and those devices are used. Failure to follow this warning may result in significant harm to the machine operators, including serious injury or death.
- The override devices, which are used for activation of override, must be manual operating devices. When installing the devices to activate the override (override device), those devices must be installed so that the whole hazardous zone can be checked by responsible personnel and so that it is not possible for the device operators to operate those device in the hazardous zone.
- The installation of the indication for override may be required by the laws, rules, regulations and standards in the country or region where the SZ is used. It depends on the machine application or the result of your risk assessment. If it is necessary for you to provide the indication for override, you must fulfill the requirements because you are fully responsible for installing the indication for override.
- The customer is fully responsible for complying with the requirements for the muting, suspension in teaching mode, and the override. KEYENCE accepts NO responsibility or NO liability for any damage or any injury due to the unauthorized installation, usage, or maintenance, which are not specified in this instruction manual, and/or due to noncompliance with the laws, rules, regulations and standards in the country or region in which the SZ is used.
- Securely tighten mounting brackets and cable connectors used for the installation of the SZ in accordance with the torque values specified in this instruction manual.
- Do not put the additional housing, such as glass covers or clear polymeric covers, in front of the window of the SZ. This may lead to the loss of the detection capability of the SZ.
- Do not put the SZ into additional housing for any purpose. This may lead to the loss of the detection capability of the SZ.

■ Circuit design and wiring

⚠ Danger

- Always turn off the power to the SZ when performing electrical wiring.
- You must fulfill the electrical standards and regulations in the country or region in which the SZ is being used when you perform the electrical wiring.
- To avoid the risk of electric shock, do not connect any of the SZ inputs to DC power sources outside of the range of 24 V DC +20% or to any AC power source.
- To avoid the risk of electric shock, the hazardous voltage must be isolated from all wiring of the SZ with the reinforced insulation or double insulation.
- If the power supply for the SZ is the converting type, the power supply for the SZ must meet the conditions listed below in order to meet the requirements specified in IEC61496-1, UL61496-1, and EN61496-1.
  (a) A rated output voltage of 24 V DC (SELV circuit, Overvoltage Category II) within ±10%.
  (b) Double insulation or reinforced insulation between the primary and secondary circuits.
  (c) Output holding time of 20 ms or more.
  (d) A power supply must meet the requirements of the electrical safety and electromagnetic compatibility (EMC) regulations or standards in all countries and/or regions where the SZ is used.
- Do not install the electric wiring of the SZ together with or in parallel with the high-voltage electrical or power lines.
- For the wiring between SZ and a safety-related machine control system, both OSSD 1 and OSSD 2 must be always wired to a safety-related machine control system in order to ensure the safety. Similarly, both OSSD 3 and OSSD 4 must be always wired to a safety-related control system if you assign a function for OSSD 3/4. If one OSSD is only wired to a safety-related machine control system, it results in a significant harm to the machine operators, including serious injury or death, due to OSSD mulfunction.
- When using PNP output type cable, do not cause short-circuit between the OSSD and +24 V. Otherwise, OSSDs keep staying at the ON-state and it causes a dangerous situation.
- When using PNP output type cable, be sure to connect the load between the OSSD and 0 V to avoid a dangerous situation. If the load is incorrectly connected between the OSSD and +24 V, the logic of OSSD operation will be reversed, and then OSSD will turn to the ON-state when the SZ detects an object in the specified protection zone. This is a dangerous situation.
- When using NPN output type cable, do not cause short-circuit between the OSSD and 0 V. Otherwise, OSSDs keep staying at the ON-state and it causes a dangerous situation.
- When using NPN output type cable, be sure to connect the load between the OSSD and +24 V to avoid dangerous situation. If the load is incorrectly connected between the OSSD and 0 V, the logic of OSSD operation will be reversed, and then OSSD will turn to the ON-state when the SZ detects an object in the specified protection zone. This is a dangerous situation.
- In case of wiring, regardless of PNP output type cable and NPN output type cable, you must fulfill the requirements of Clause 9.4.3 in IEC60204-1: 2005 in order for the protection against maloperation due to earth fault.
- The AUX output is not allowed to be used as a safety output for safety-related control systems. Usage of these functions as safety output may result in a significant harm to the machine operators, including serious injury or death.
- The check input is not allowed to be connected to the safety output provided from the safety-related control system. If the check input is connected to the safety output, it may result in significant harm to the machine operators, including serious injury or death.
- The connector cable must have a length less than or equal to the specification in this instruction manual. Usage of connector cables longer than the specified length may cause the improper operation of safety functions and may cause a dangerous situation.

Safety Precautions on Laser Product

This product employs a semiconductor laser for its light source. Follow the instructions mentioned in this manual. Otherwise, injury to the human body (eyes and skin) may result.

⚠ Danger

- Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.
- Precautions on Class 1 Laser Product
  - Do not disassemble this product. Laser emission from this product is not automatically stopped when it is disassembled.

Testing and maintenance

- You must always perform the pre-check test in accordance with the pre-check test procedures, after maintenance, adjustment or alignment of the target machine or the SZ and before the machine startup.
- If the SZ does not operate properly when you perform pre-check test in accordance with the pre-check test procedures specified in this instruction manual, do not operate the machine.
- You must periodically examine the machine to verify that all brakes, other stop mechanisms, and control devices operate reliably and correctly in addition to checking the SZ.
- The responsible personnel must perform maintenance procedures as specified in this instruction manual at least once every six months to ensure safety to the machine and SZ.

Precautions on Regulations and Standards

■ CE and UKCA Markings

KEYENCE Corporation has confirmed that this product complies with the essential requirements of the applicable EU Directive and UK regulations, based on the following specifications. Be sure to consider the following specifications when using this product in the Member State of European Union and in the United Kingdom.

- **Machinery Directive (CE) and Supply of Machinery (Safety) Regulations (UKCA)**
  SZ is a safety component defined in the EU Machinery Directive Annex V and Supply of Machinery (Safety) Regulations.
  The SZ complies with the following EN Standards and has been certified by TÜV SÜD Product Service GmbH and TUV SUD BABT UNLIMITED.
  - (BS)EN61496-1 Type 3 ESPE
  - (BS)EN61496-3 Type 3 AOPDDR
  - (BS)EN61508 SIL2
  - (BS)EN ISO13849-1 Category 3, PLd
  - (BS)EN60825-1 Class 1 Laser Product

- **EMC Directive (CE) and Electromagnetic Compatibility Regulations (UKCA)**
  - (BS)EN55011 Group1, Class A

  These specifications do not give any guarantee that the end-product with this product incorporated complies with the essential requirements of EMC Directive and Electromagnetic Compatibility Regulations. The manufacturer of the end-product is solely responsible for the compliance on the end-product itself according to EMC Directive and Electromagnetic Compatibility Regulations.

■ UL Certification and North American Regulations

SZ complies with the following UL, CSA, and North American standards and regulations, and has received UL certification and C-UL certification (CCN: NIPM/NIPM7, File No: E322137)

- UL61496-1 Type 3 ESPE
- IEC61496-3 Type 3 AOPDDR
- UL508
- UL1998
- CAN/CSA 22.2 No.14

SZ also complies with the following North American regulations.

- CDRH Part 1040.10 (Laser Notice No.50), Class 1 Laser Product
- FCC Part15 Subpart B, Class A Digital Device
- ICES-003, Class A Digital Apparatus

Checking the package contents

SZ x 1
Label for setting cover x1 (except the SZ-16D)
Instruction manual (English) x 1
Instruction manual (Japanese) x 1
Instruction manual (Chinese) x 1

Options

■ Connector cable

Model of SZ	Model	Output type of OSSD	Length	No. of internal wires
SZ-01S	SZ-P5PS	PNP	5 m	8
	SZ-P10PS		10 m	
	SZ-P20PS		20 m	
	SZ-P30PS		30 m	
	SZ-P5NS	NPN	5 m	
	SZ-P10NS		10 m	
	SZ-P20NS		20 m	
	SZ-P30NS		30 m	
SZ-04M SZ-16V SZ-16D	SZ-P5PM	PNP	5 m	18
	SZ-P10PM		10 m	
	SZ-P20PM		20 m	
	SZ-P30PM		30 m	
	SZ-P5NM	NPN	5 m	
	SZ-P10NM		10 m	
	SZ-P20NM		20 m	
	SZ-P30NM		30 m	

■ Other

For more information about mounting brackets or SZ Configurator (SZ-H1S), see the "User's Manual".

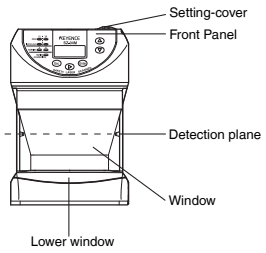
Parameter for IEC61508

T1 (Proof test interval)	20 years
PFHD (average frequency of a dangerous failure per hour) *1	1.4×10^{-7} or less
Hardware fault tolerance	1
Type of element	Type B
Failure response time	Within a response time
Safe state	OSSDs are in OFF-state

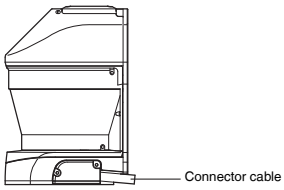
*1 For PFHD of each SZ, contact your nearest KEYENCE office.

Part description

Front view

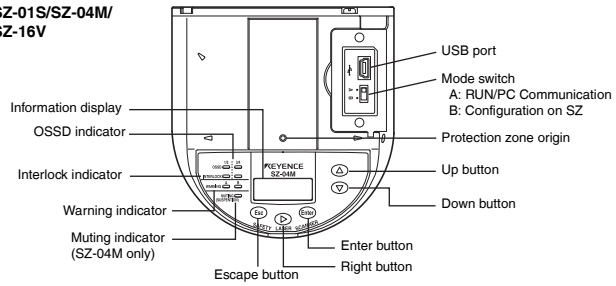


Side view

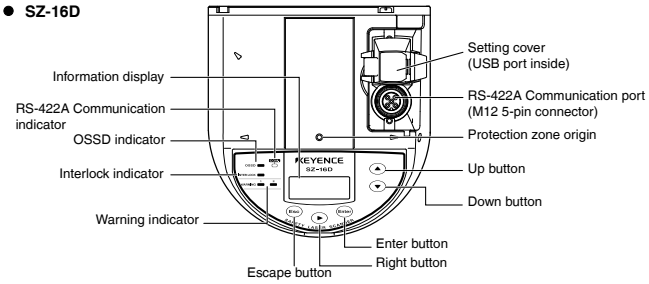


Details

● **SZ-01S/SZ-04M/ SZ-16V**

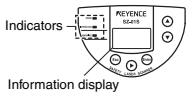


● **SZ-16D**

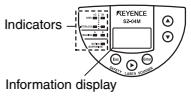


■ Indicator

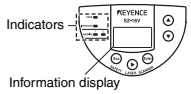
□ **SZ-01S**



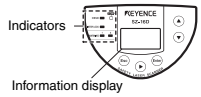
□ **SZ-04M**



□ **SZ-16V**



□ **SZ-16D**



■ SZ-01S (S)

Description on label	Assigned function	Description	Reference page
OSSD1/2	OSSD indicator	Light in green: OSSD1/2 is in the ON-state Light in red: OSSD1/2 is in the OFF-state	"OSSD" (page 4)
INTERLOCK	Interlock indicator	Light in yellow: Interlock condition Light OFF: Other than above	"Interlock" (page 4)
WARNING	Warning zone indicator	Light in orange: Detected in the warning zone Light OFF: Other than above	"User's Manual"

■ SZ-04M (M)

Description on label	Assigned function	Description	Reference page
OSSD 1/2	OSSD1/2 indicator	Light in green: OSSD1/2 is in the ON-state Light in red: OSSD1/2 is in the OFF-state	"OSSD" (page 4)
OSSD 3/4	OSSD3/4 indicator	Light in green: OSSD3/4 is in the ON-state Light in red: OSSD3/4 is in the OFF-state	"Multi-OSSD function" (page 5)
INTERLOCK 1/2	Interlock indicator	Light in yellow: OSSD1/2 is in the Interlock condition Light OFF: Other than above	"Interlock" (page 4)
INTERLOCK 3/4	Interlock indicator	Light in yellow: OSSD3/4 is in the Interlock condition Light OFF: Other than above	
WARNING A	Warning zone A indicator	Light in orange: Detected in warning zone A Light OFF: Other than above	"User's Manual"
WARNING B	Warning zone B indicator	Light in orange: Detected in warning zone B Light OFF: Other than above	
MUTING	Muting indicator	Light in orange: In the state (1) or (2) below: (1) Muting function works. (2) Suspension in teaching mode works. Blinking in orange: Override function works. Light OFF: Other than above	"Temporary Suspension of Safety Function (Muting function)" (page 6)

■ SZ-16V (V)

Description on label	Assigned function	Description	Reference page
OSSD (1/2)	OSSD indicator	Light in green: OSSD1/2 is in the ON-state Light in red: OSSD1/2 is in the OFF-state	"OSSD" (page 4)
INTERLOCK	Interlock indicator	Light in yellow: Interlock condition Light OFF: Other than above	"Interlock" (page 4)
WARNING A	Warning zone A indicator	Light in orange: Detected in warning zone A Light OFF: Other than above	"User's Manual"
WARNING B	Warning zone B indicator	Light in orange: Detected in warning zone B Light OFF: Other than above	

■ SZ-16D (D)

Description on label	Assigned function	Description	Reference page
OSSD	OSSD indicator	Light in green: OSSD1/2 is in the ON-state Light in red: OSSD1/2 is in the OFF-state	"OSSD" (page 4)
COM.	RS-422A Communication indicator	Blinking in green: RS-422A communicates Light OFF: Other than above	"SZ-16D Communication Manual"
INTERLOCK	Interlock indicator	Light in yellow: Interlock condition Light OFF: Other than above	"Interlock" (page 4)
WARNING 1	Warning zone 1 indicator	Light in orange: Detected in warning zone 1 Light OFF: Other than above	"User's Manual"
WARNING 2	Warning zone 2 indicator	Light in orange: Detected in warning zone 2 Light OFF: Other than above	

Functions and features

<List of functions for each model> ✓: Available -: Not available

Function	SZ-01S	SZ-04M	SZ-16V/SZ-16D
Detection in protection zone	✓ 1 zone	✓ 1 zone *1	✓ 1 zone
Detection in warning zone	✓ 1 zone	✓ 1 zone *1	✓ 2 zones
Bank switching	-	✓ 4 Banks *1	✓ 16 Banks
Minimum detectable object size	✓ 30 / 40 / 50 / 70 / 150 mm		
Response time	✓ 60 - 480 ms (Scan cycle A) 66 - 528 ms (Scan cycle B)		
Interlock	✓		
EDM	✓		
Reference points monitoring	✓	✓	-
Multi-OSSD	-	✓	-
Muting	-	✓	-
Suspension in teaching mode	-	✓	-
Override	-	✓	-
AUX output	✓ 2 outputs	✓ 6 outputs	✓ 4 outputs
Muting lamp output	-	✓	-
Check input	✓	✓	-
RS-422A Communication	-	-	✓ SZ-16D only

*1. The number of the selectable zones (protection zone and warning zone) varies depending on the configuration on the Multi-OSSD function.
The number of the banks also varies depending on the configuration on the Multi-OSSD function.
"Multi-OSSD function" (page 5)

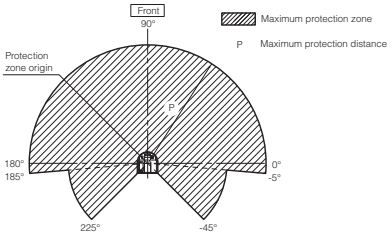
■ Protection zone

When the SZ detects an object (someone or something) in the protection zone, the OSSD goes to the OFF-state.

⚠ Danger

- The protection zone must be configured so as to ensure the minimum safety distance, which has been calculated according to the laws, regulations, and standards of the country and region in which the SZ is installed. "Safety distances" (page 7)
- When either multi-OSSD function or bank switching function is enabled, every protection zone must be configured so as to ensure the minimum safety distance, which has been calculated according to the laws, regulations, and standards of the country and region in which the SZ is installed.
- SZ cannot monitor anything behind the object that the SZ detects in the protection zone. (This is a blind area for the SZ.) The responsible personnel must perform the risk assessment with taking into account this factor in case of installation of the SZ. If necessary, the additional countermeasure must be taken by the responsible personnel.

■ Protection zone (top view)



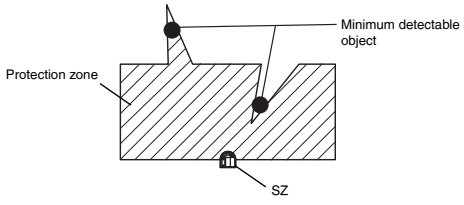
■ Minimum detectable object size and maximum protection distance

As shown in the following table, the maximum protection distance varies depending on the minimum detectable object size.

Minimum detectable object size (mm)		ϕ30	ϕ40	ϕ50	ϕ70	ϕ150
Maximum distance (m)	-5° to 185°	1.8	2.4	3.0	4.2	
	-45° to -5° 185° to 225°	1.2	1.6	2.0	2.8	

⚠ Danger

As shown in the following figure, the detection may not be performed if the whole of minimum detectable object is not included in the protection zone. You must configure the protection zone so as to ensure that the whole of minimum detectable object is included everywhere in that protection zone.



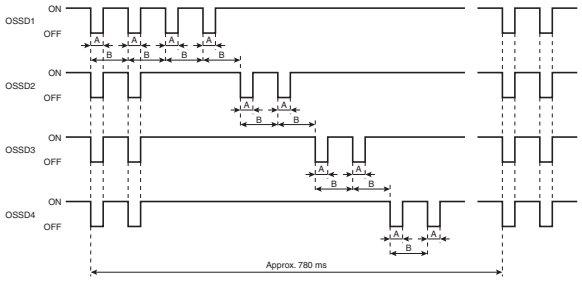
NOTE Even if the object is smaller than the minimum detectable object size, it may be detected. But this is not guaranteed.

■ OSSD

When the SZ detects an object (someone or something) in the protection zone, the OSSD goes to the OFF-state. "Protection zone" (page 3)
The OSSD is a safety output for safety-related part of a machine control system.
OSSD 1/2 is a pair of safety outputs that performs the output of same state. Similarly, OSSD 3/4 is also a pair of safety outputs that performs the output of same state.
The SZ generates self-diagnosis signals on its internal control circuit to perform diagnostics on the OSSD. These signals periodically force the OSSD into a temporary OFF-state when the OSSD is in the ON-state (when the SZ detects no object in the protection zone.).
The internal control circuit receives a feed-back signal (OFF-signal) based on the self-diagnosis, the SZ determines that its OSSD is in the normal operation. If the OFF-signal is not returned to the internal control circuit, the SZ determines that there is a problem in its OSSD or wiring and goes to the error state.

Reference
- For the simple function type (SZ-01S), multi-bank type (SZ-16V), and communication type (SZ-16D), they have OSSD1 and OSSD2, which are a pair of safety outputs that perform the output of same state.
- For the SZ-04M, it has OSSD1/2 and OSSD3/4. OSSD 1/2 are a pair of safety outputs that perform the output of same state. Similarly, OSSD 3/4 are also a pair of safety outputs that perform the output of same state. For more information about the OSSD3/4, see "Multi-OSSD function" (page 5).
- The SZ has a function to monitor the state of external devices (EDM function) that are connected to the OSSD. The OSSD can go to the OFF-state due to the error state of external devices if the SZ detects the error on external devices in case of the enabling the EDM function. For more information about the external device monitoring function, see "External device monitoring function (EDM)" (page 4).

Time chart for self-diagnosis pulse



A : approx. 20 µs (If a capacitive load is connected, max. 200 µs can apply.)
B : approx. 30 ms

NOTE
The devices connected to the OSSD, such as safety relay or contactor, should not respond to these temporary, self-diagnostic OFF-signals.

Reference OSSD 3/4 is only available for SZ-04M.

■ Response time and scan cycle

The response time of SZ is the time from when an object (someone or something) goes into the protection zone to when the OSSD goes to the OFF-state due to the detection of object. There are several options for response time. (The response time is selectable for user.)

Advantage of a fast response time: The safety distance can be shortened.
"Safety distances" (page 7)
Advantage of a slow response time: You can reduce problems that the OSSD goes to the OFF-state due to light interference or instantaneous detection of dust passing through the protection zone, because of the increasing the number of scans.

⚠ Danger
- The necessary safety distance varies depending on the response time you specify. The protection zone must be configured so as to ensure the minimum safety distance, which has been calculated according to the laws, regulations, and standards of the country and region in which the SZ is installed. "Safety distances" (page 7)
- The response time must be 90 ms or less when the SZ is used for the detection for access protection (trip device using whole-body detection with normal approach). The SZ may not detect the person in the protection zone if the specified response time is more than 90 ms.

SZ has two different scan cycles. You can select either one. You can reduce the possibility of mutual interference between the SZs if you set the different scan cycle individually, even if two SZs are installed facing each other. The selectable response time varies depending on the scan cycle you specify.

Scan cycle and available response time

	Response time (ms)														
Scan cycle A	60	90	120	150	180	210	240	270	300	330	360	390	420	450	480
Scan cycle B	66	99	132	165	198	231	264	297	330	363	396	429	462	495	528

Reference
- Scan cycle A is 30 ms, while scan cycle B is 33 ms. (Response time = Scan cycle x the number of scan)
- You can select the response time from a pull-down menu through the SZ Configurator, or from a selectable menu through manual configuration on SZ.
See "User's Manual" or "Configuring settings" (page 11).

NOTE
- For more information about preventing mutual interference, also see "User's Manual".
- The response time and scan cycle is always the same for all banks when 2 or more banks are set with the bank switching function.
- When the Mode C or D is applied as the operation mode for OSSD3/4, the response time for OSSD1/2 can be different from that for OSSD 3/4. However, the can cycle for OSSD3/4 is always the same as that for OSSD1/2.
- Scan cycle A can only be set in case of the manual configuration on the SZ.
"Configuring settings" (page 11)

■ Interlock

Interlock is a function to prevent that the OSSD automatically goes to the ON-state from the OFF-state. You can prevent the unintended start-up and/or the unintended restart of the machine if the interlock is applied to the SZ.
It is necessary for to perform the reset operation in order that the SZ goes back to the normal operation from the interlock condition. The configuration for interlock is necessary through the manual configuration on the SZ or SZ Configurator. Furthermore, the reset switch must be connected to the reset input terminal on the SZ.
For more information about the configuration, see "User's Manual".

Reference When the Mode D is applied as the operation mode for OSSD3/4, you can configure the interlock function to both OSSD 1/2 and OSSD 3/4. "Multi-OSSD function" (page 5)

■ Start/restart mode

You can determine whether the interlock function is enabled at start-up or at restart based on the setting of start/restart mode.
In this manual, start-up and restart refer to the following.
Start-up: 1) when the power is supplied (after SZ loading),
2) when the SZ is restored from error state thorough reset input,
3) when the configuration is completed through the SZ Configurator or the manual configuration on the SZ.
Restart: 1) When the OSSD goes back to the ON-state from OFF-state, except for the start-up

Start mode
Automatic:
Interlock function does not work. The SZ starts operation automatically without the reset operation. The OSSD goes to the ON-state automatically if the SZ detects no object in the protection zone at startup. This mode can be used for machines where nobody can go into or approach the hazardous area by only passing through the protection zone, or if the safety-related part of a control system other than the SZ, such as a safety relay unit, can ensure the safety with other means.
Manual:
Interlock function works. The SZ starts operation if the SZ receive the reset operation.
The OSSD keeps the OFF-state at start-up (Interlock condition). It is necessary to perform the reset operation when the SZ detects no object in the protection zone, in order that the machine starts operation. Because of reset operation, the OSSD goes to the ON-state, and then interlock condition is terminated. Unexpected/Unintended start-up of the machine or machinery can be prevented.

Restart mode
Automatic:
Interlock function does not work. The SZ starts operation automatically without the reset operation. The OSSD goes to the ON-state automatically at restart if the object detected by the SZ is removed from the protection zone.
This mode can be used for machines where nobody can go into or approach the hazardous area by only passing through the protection zone, or if the safety-related part of a control system other than the SZ, such as a safety relay unit, can ensure the safety with other means.
Manual:
Interlock function works. The SZ starts operation if the SZ receive the reset operation.
The OSSD keeps the OFF-state even if the object detected by the SZ is removed from the protection zone. (Interlock condition).
It is necessary to perform the reset operation when the SZ detects no object in the protection zone, in order that the machine starts operation. Because of reset operation, the OSSD goes to the ON-state, and then interlock condition is terminated.

Reference
- There are three options on the configuration of start/restart through the SZ Configurator: Automatic/Automatic, Manual/Automatic, Manual/Manual. "User's Manual"
- There are two options on the configuration of start/restart through the manual configuration on the SZ: Automatic/Automatic and Manual/Manual. "Configuring settings" (page 11)

⚠ Danger
- Be sure to absolutely confirm that there is nobody in the hazardous zone before the interlock condition is terminated (i.e. the machine system restarts) by the interlock reset mechanism. Failure to follow this warning may result in a significant harm to the machine operators, including serious injury or death.
- In case of "Automatic/Automatic" on the configuration of start/restart, the SZ cannot go to the interlock condition. You must prevent the unintended start-up/restart and ensure the safety with machine control system except for the SZ.

NOTE
- It is necessary to provide 20 ms or more between the timing of reset input and the timing of other inputs.
- The OSSD keeps the OFF-state during error state regardless of the configuration of interlock function. "Troubleshooting" (page 14)
- In case of "Manual/Automatic" or "Manual/Manual" on the configuration of start/restart, you have no chance to apply the check input function. "User's Manual"

■ Restart Delay (ON-delay)

In case of "Automatic" on the configuration of restart mode, restart delay (ON-delay) can be applied to the SZ.
You can change the time from when the object detected by the SZ is removed from the protection zone to when the OSSD goes back to the ON-state.
This is a delay time, which can be set from 2 seconds to 60 seconds on the second time scale.
On the other hand, the OSSD goes back to the ON-state after passing the response time (ON to OFF) if the restart delay (ON-delay) is not applied. "Response time and scan cycle" (page 4)

■ External device monitoring function (EDM)

The SZ can monitor the state of external device, such as safety relay or contactor, that is connected to the OSSD in order to detect the failure on that external device. This function is the external device monitoring function (EDM function).

■ Reference points monitoring function

Reference points monitoring is a safety-related function where the SZ monitors the position change of the structure (such as protective guarding or door) located at the specified reference point.
As well as the SZ detects an object in the protection zone, the OSSD goes to the OFF-state if the position of the structure (such as protective guarding or door) varies exceeding the specified tolerance.

Reference
- SZ configurator must be used to apply the reference points monitoring to the SZ.
- Maximum 30 reference points can be set.

⚠ Danger
Reference points monitoring function must be applied when the SZ is used for the access protection specified in IEC61496-3:2008 Annex A.12 and A.13 (the application where the angle of the approach exceeds ±30° to the detection plane.). In this case, the tolerance for reference points must be ±100 mm or less and the response time must be 90 ms or less. Additional countermeasures for protection must be provided if there is the unprotected space between the protection zone and the protective structure that the minimum detectable object is not detected by the SZ.

■ Multi-OSSD function

The SZ-04M has an OSSD 3/4.
The following functions (four modes: mode A to mode D) can be assigned to the OSSD 3/4.

NOTE

- When the Mode D is applied as the operation mode for OSSD3/4, you have no chance to apply the temporary suspension of the safety function to the SZ. "Temporary Suspension of Safety Function (Muting function)" (page 6)
- Bank switching function can be applied to the SZ if you apply the multi-OSSD function, but the number of settable banks varies depending on the mode of OSSD 3/4.
  For Mode A: 3 banks
  For Mode B: 3 banks
  For Mode C: 3 banks
  For Mode D: 2 banks

⚠ Danger

If you realize the safety-related control to the two hazards independently under the Mode D, you must take into full account the positioning and orientation of SZ in case of installation. If there is unprotected space where the operator can approach into the hazardous area, you must take additional countermeasure against the hazard.

Reference SZ configurator must be used to assign the function to OSSD 3/4.

- **Mode A:**
  OSSD 3/4 performs completely the same operation for the detection as OSSD 1/2.
  You can establish the same control to the two machines through one SZ if you use the OSSD 1/2 and OSSD 3/4.

- **Mode B:**
  OSSD 3/4 performs the same operation for the detection as OSSD 1/2. As well as mode A, you can establish the same control to the two machines through one SZ if you use the OSSD 1/2 and OSSD 3/4.
  But, the interlock and temporary suspension of safety function does not work for the OSSD 3/4 under mode B.
  "Interlock" (page 4)
  "Temporary Suspension of Safety Function (Muting function)" (page 6)
  More specifically, the following functions are not enabled for the OSSD 3/4.
  - Start interlock
  - Restart interlock
  - Restart delay (ON-delay)
  - Muting
  - Suspension in teaching mode
  - Override

- **Mode C:**
  OSSD 3/4 performs different operation for the detection from OSSD 1/2, especially the minimum detectable object size and response time, but the protection zone is completely the same as OSSD 1/2.
  The minimum detectable object size and response time for OSSD 3/4 are to be less than or equal to those for OSSD 1/2.
  In this mode, OSSD 3/4 always goes to the OFF-state if the OSSD 1/2 goes to the OFF-state.
  If you assign a faster response time to the OSSD 3/4 than OSSD 1/2, it becomes possible that only OSSD 3/4 goes to the OFF-state even if the OSSD 1/2 does not go to the OFF-state.
  When you use the OSSD 3/4 for the purpose of reducing speed of machine and use the OSSD 1/2 for the purpose of stopping the machine, the machine can stop only if the SZ detects a person in the protection zone (in case of hazardous situation), while the machine just reduces the speed if the SZ detects a dust or spatter in the protection zone. Mode C is useful for such an application because you can prevent the unnecessary stop of machine.

- **Mode D:**
  OSSD 3/4 performs the non-related (independent) operation from OSSD1/2. Therefore, all of parameters related to OSSDs, including the protection zone, can be different from OSSD 1/2. Additionally, two warning zones can also be set.
  It is possible to configure two protection zones, such as protection zone A and protection zone B. Furthermore, it is also possible to configure two warning zones, such as warning zone A and warning zone B.
  The OSSD 1/2 goes to the OFF-state if the SZ detects an object in the protection zone A. On the other hand, the OSSD 3/4 goes to the OFF-state if the SZ detects an object in the protection zone B.
  "Protection zone" (page 3)

- **Not used**
  OSSD3/4 are always in the OFF-state.

■ Bank switching function

You can set the number of zones in the SZ.
Bank switching function is the function to switch a number of zones (Bank) according to the external input (bank input).
The bank refers to the combination with protection zone, warning zone and reference points.
The maximum number of banks and the number of warning zones per one bank varies depending on the model.

	SZ-01S	SZ-04M *1	SZ-16V/SZ-16D
Maximum number of banks	1	4 (2)	16
Number of protection zones per one bank	1	1 (2)	1
Number of warning zones per one bank	1	1 (2)	2

*1. The numbers are as indicated in the parentheses if mode D is selected as the operation mode for OSSD3/4.

You can switch the banks according to the signal combination of bank inputs (ON/OFF state combination).
Appropriate protection zone can be selected if you configure the SZ to switch the banks corresponding to the hazard and/or hazardous area.

NOTE

For the SZ-04M, the maximum number of the selectable banks varies depending on the configuration assigned to OSSD 3/4.
"Multi-OSSD function" (page 5)

Reference SZ configurator must be used to apply the bank switching function to the SZ.
For the information of reference points monitoring, see User's Manual"

⚠ Danger

Someone may be able to approach the hazard and/or hazardous area without passing through the SZ protection zone if the bank switching is performed at unintended timing. Therefore, you must perform the risk assessment on your own responsibility, taking into account the delay time of bank input, in order to establish the appropriate control system for bank switching.

● SZ-04M

For the SZ-04M, you can set the four banks at maximum. As shown in the following table, bank 1 to bank 4 can be switched according to the signal combination of bank inputs (bank input 1 to 4). In other words, SZ-04M switches the banks based on the signal state (ON/OFF) of four bank inputs.

	Bank input 1	Bank input 2	Bank input 3	Bank input 4
Bank 1	ON	OFF	OFF	OFF
Bank 2	OFF	ON	OFF	OFF
Bank 3	OFF	OFF	ON	OFF
Bank 4	OFF	OFF	OFF	ON

Reference Bank switching works only if a certain bank input is in the ON-state and the other bank inputs are in the OFF-state.
Bank No. is the same as the bank input No. that is in the ON-state.

NOTE

- The SZ does not start operation if the signal combination of bank inputs is different from the combination as shown in Table 1 at start-up, because the SZ goes to the state of "Waiting for bank input". The SZ starts operation if the signal combination of bank inputs becomes the same as the combination as shown in Table 1. "Start-up" means 1) when the power is supplied, 2) when the SZ is restored from error state thorough reset input, and 3) when the configuration is completed through the SZ Configurator or the manual configuration on the SZ.
- The SZ goes to the error state of "Bank error" if the signal combination of bank inputs becomes different from the combination as shown in Table 1 after start-up. (Example: All bank inputs go to the OFF-state, or two or more bank inputs go to the ON-state simultaneously.)
- Bank switching must be performed according to the bank transition time you specified through the SZ Configurator. The SZ goes to the error state of "Bank error" if the time does not meet the specified bank transition time. (Example: When the signal combination of bank inputs is different from the combination as shown in Table 1 when the specified bank transition time has been passed.)
- For more information about the error state, see "User's Manual".

● SZ-16V/SZ-16D

For the multi-bank type (SZ-16V) and the communication type (SZ-16D), you can set sixteen banks at maximum. As shown in the following table, bank 0 to bank 15 can be switched according to the signal combination of bank inputs (bank input A to D / bank input a to d). In other word, the SZ-16V and SZ-16D switch the banks based on the signal state (ON/OFF) of eight bank inputs.

	Bank input A	Bank input B	Bank input C	Bank input D	Bank input a	Bank input b	Bank input c	Bank input d
Bank 0	OFF	OFF	OFF	OFF	ON	ON	ON	ON
Bank 1	ON	OFF	OFF	OFF	OFF	ON	ON	ON
Bank 2	OFF	ON	OFF	OFF	ON	OFF	ON	ON
Bank 3	ON	ON	OFF	OFF	OFF	OFF	ON	ON
Bank 4	OFF	OFF	ON	OFF	ON	ON	OFF	ON
Bank 5	ON	OFF	ON	OFF	OFF	ON	OFF	ON
Bank 6	OFF	ON	ON	OFF	ON	OFF	OFF	ON
Bank 7	ON	ON	ON	OFF	OFF	OFF	OFF	ON
Bank 8	OFF	OFF	OFF	ON	ON	ON	ON	OFF
Bank 9	ON	OFF	OFF	ON	OFF	ON	ON	OFF
Bank 10	OFF	ON	OFF	ON	ON	OFF	ON	OFF
Bank 11	ON	ON	OFF	ON	OFF	OFF	ON	OFF
Bank 12	OFF	OFF	ON	ON	ON	ON	OFF	OFF
Bank 13	ON	OFF	ON	ON	OFF	ON	OFF	OFF
Bank 14	OFF	ON	ON	ON	ON	OFF	OFF	OFF
Bank 15	ON	ON	ON	ON	OFF	OFF	OFF	OFF

Reference The logic for bank input a is the opposite of bank input A. The same goes for bank input b to d and bank input B to D.
Bank No. is represented with binary code consisting of the signal combination of bank input A, B, C and D.
For the bank input a, b, c and d, these are inverted signals from bank input A, B, C and D.

NOTE

- The SZ does not start operation if the signal combination of bank inputs is different from the combination as shown in Table 2 at start-up, because the SZ goes to the state of "Waiting for bank input".
  The SZ starts operation if the signal combination of bank inputs becomes the same as the combination as shown in Table 2. "Start-up" means 1) when the power is supplied, 2) when the SZ is restored from error state thorough reset input, and 3) when the configuration is completed through the SZ Configurator or the manual configuration on the SZ.
- The SZ goes to the error state of "Bank error" if the signal combination of bank inputs becomes different from the combination as shown in Table 2 after start-up. (Example: All bank inputs go to the OFF-state. All bank inputs go to the ON-state.)
- Bank switching must be performed according to the bank transition time you specified through the SZ Configurator. The SZ goes to the error state of "Bank error" if the time does not meet the specified bank transition time. (Example: When the signal combination of bank inputs is different from the combination as shown in Table 2 when the specified bank transition time has been passed.)
- If the total number of banks is eight or less (ie. When bank 0 to bank 7 are enabled), the SZ does not check the state of bank input D and bank input d because they are not related to the bank switching.
- If the total number of banks is four or less (ie. When bank 0 to bank 3 are enabled), the SZ does not check the state of bank input C/D and bank input c/d because they are not related to the bank switching.
- If the total number of banks is two or less (ie. When bank 0 to bank 1 are enabled), the SZ does not check the state of bank input B/C/D and bank input b/c/d because they are not related to the bank switching.
- For more information about the error state, see "User's Manual".

● Bank sequence monitoring

The SZ can monitor the sequence of bank switching so that the OSSD may go to the OFF-state due to the error state if the SZ detects the signal combination of bank inputs in the unexpected sequence. You can prevent the machine operation with an unintended protection zone selected because of the bank sequence monitoring.
For each bank, you can assign 3 bank numbers to be followed. The SZ goes to the error state of "Bank error" if the bank number indicated by the signal combination of bank inputs is different from the specified bank number that is to be followed under the bank sequence monitoring function.
Keyence Corporation strongly recommends enabling the bank sequence monitoring function if you can specify the bank sequence in your machine application.

Reference SZ Configurator must be used to apply the bank sequence monitoring function to the SZ.
For more information about the bank error, see "User's Manual".

■ Temporary Suspension of Safety Function (Muting function)

You can configure any muting zone in the protection zone. The SZ goes to the muted condition when the conditions for initiation of muting are fulfilled. The OSSD keeps the ON-state even if the SZ detects an object in the muting zone.
(Even if the conditions for initiation of muting are fulfilled, the OSSD goes to the OFF-state when the SZ detects an object in the protection zone that the muting zone is not configured.)
For example, it is not necessary to stop the machine when the AGV goes into the hazardous area if you configure the muting zone in the protection zone where the AGV would pass through.
The muting input terminals on the SZ must be connected to the muting devices if you want to use the muting function.

● Limitation

- **Muting device**
  - The muting device output must be N.O. (normally open).
  - The muting device is required to be PNP output when using the PNP output type cable, while the muting device is required to be NPN output when using the NPN output type cable.
  - Do not use one muting device with multiple outputs in place of two or more muting devices. (One muting device may only provide one output.)
  - If the muting device has a timer function that can adjust the output timing, do not use that function.

● Conditions for initiation of muting

Muted condition is initiated if all of the following conditions are met.
- Muting inputs go to the ON-state with the specified sequence and within the specified time between them.
- The SZ detects no object in the protection zone.
- The OSSD is in the ON-state.

- **Configuration to the conditions for initiation of muting**

For the sequence of muting inputs (muting input 1 and muting input 2) and the time between muting inputs, you can change them as shown in the following.

For the sequence of muting inputs
- Muting input 1 to Muting input 2 (default)
- Muting input 2 to Muting input 1
- Not specified

For the time between muting inputs (Unit: second)
- 0.04 to 3.0 (default)
- 0.04 to 5.0
- 0.04 to 10.0
- 0.04 to (not specified)

● Conditions for termination of muting

The muted condition is terminated if one of the following conditions is met.
- Either of muting inputs goes to the OFF-state at least for more than 0.03 sec.
- The SZ goes to the error state.
- Check input goes to the ON-state. 🕮 "User's Manual"
- The power supply is interrupted or restored.
- Maximum muting period of time has been passed.

- **Configuration to the conditions for termination of muting**

For the maximum muting period of time, you can change it as shown in the following.
- Approx. 1 minute
- Approx. 5 minutes (Default)
- Approx. 10 minutes
- Not specified

⚠ Danger

The responsible personnel must perform the risk assessment based on the machine application in order to appropriately determine the risk if "Not specified" is selected for the maximum muting period of time. Failure to follow this warning may result in a significant harm to the machine operators, including serious injury or death.

NOTE

Muted condition is terminated approx. 5 minutes later when the time between muting inputs exceeds 3 seconds, even if "Not specified" is selected for both maximum muting period of time and time between muting inputs.

■ Temporary Suspension of Safety Function (Suspension in teaching mode)

Suspension in teaching mode is a temporary suspension of safety function while the industrial robot (hereinafter called as "robot") is in the teaching mode.
Generally, the operation mode of the robot would be switched to the teaching mode in order to configure the robot. After that, the operator or responsible personnel can go into the hazardous area (ie. inside of safety guarding).
The SZ is connected to both the signal from switch to change the operation mode to teaching mode and the signal from the robot indicating that the robot is in the teaching mode.
The safety function is suspended only if the SZ recognizes that the robot is in the teaching mode (manual operation mode for a robot that has sufficiently reduced speed).
The whole of protection zone goes to the suspended condition during the suspension in teaching mode. (It is not possible to suspend the safety function to a part of the protection zone.)

● Conditions for initiation of suspension in teaching mode

Suspended condition (Temporary suspension of safety function) is initiated if all of the following conditions are met.
- Teach ready input goes to the ON-state within the specified time after the teach mode goes to the ON-state.
- The SZ detects no object in the protection zone.
- The OSSD is in the ON-state.

- **Configuration to the conditions for initiation of suspension in teaching mode**

For the time between teach mode input and teach ready input, you can change it as shown in the following.
- 0.04 to 3.0 (default)
- 0.04 to 5.0
- 0.04 to 10.0

● Conditions for termination of suspension in teaching mode

Suspended condition (Temporary suspension of safety function) is terminated if one of the following conditions is met.
- Either of teach mode input or teach ready input goes to the OFF-state at least for more than 0.03 sec.
- The SZ goes to the error state.
- Check input goes to the ON-state.
- The power supply is interrupted or restored.

Reference ☞ There is no specification for maximum suspended period of time in case of suspension in teaching mode.

■ Temporary Suspension of Safety Function (Override function)

Under the temporary suspension of safety function activated, such as muting or suspension in teaching mode, the OSSD goes to the OFF-state if that suspension is interrupted for any reason while an object is still in the protection zone.
In this case, the machine continues to stop because the muting or suspension in teaching mode never works again for the reason that the SZ detects an object in the protection zone.
The override is a helpful function suitable for such a situation.
The SZ goes to the override condition when the conditions for initiation of override are met. Under the override activated, you can easily remove an object in the protection zone.
The whole of protection zone goes to the override condition during override activated. (It is not possible to suspend the safety function to a part of the protection zone.)

● Under the muting function activated

- **Conditions for initiation of override**

Override condition is initiated when the reset input goes to the ON-state*1 within 0.04 to 1 sec. after the override input goes to the ON-state, if all of the following conditions are met.
- Either of muting inputs or both muting inputs go to the ON-state.
- The SZ is not in the error state.
- The SZ detects an object in the protection zone.
- The OSSD is in the OFF-state. (Including interlock condition)

*1 In case of "Manual/Automatic" or "Automatic/Automatic" on the configuration of start/restart, the reset input must be the OFF-state for initiation of override. Additionally, in case of applying the check input function, check input must be the ON-state for initiation of override.

- **Conditions for termination of override**

The override condition is terminated if one of the following conditions is met.
- All muting inputs go to the OFF-state.
- Either override input or reset input goes to the OFF-state.
- The SZ goes to the error state.
- Maximum override period of time has been passed.

Reference ☞ You can select the maximum override period of time.
Option is "1 minute", "5 minutes" and "10 minutes". (Default: 1 minute)

● Under the suspension in teaching mode activated

- **Conditions for initiation of override**

Override condition is initiated when the reset input goes to the ON-state*2 within 0.04 to 1 sec. after the override input goes to the ON-state, if all of the following conditions are met.
- Both teach mode input and teach ready input go to the ON-state.
- The SZ is not in the error state.
- The SZ detects an object in the protection zone.
- The OSSD is in the OFF-state. (Including interlock condition)

* 2 In case of "Manual/Automatic" or "Automatic/Automatic" on the configuration of start/restart, the reset input must be the OFF-state for initiation of override. Additionally, in case of applying the check input function, check input must be the ON-state for initiation of override.

- **Conditions for termination of override**

The override condition is terminated if one of the following conditions is met.
- Either of teach mode input or teach ready input, or both of them go to the OFF-state.
- Either override input or reset input goes to the OFF-state.
- The SZ goes to the error state.
- Maximum override period of time has been passed.

Reference ☞ You can select the maximum override period of time.
Option is "1 minute", "5 minutes" and "10 minutes". (Default: 1 minute)

■ Muting lamp output

The SZ can inform that it is under temporary suspension of safety function through an external indicator, which is called the muting lamp.
Since the SZ can assign the AUX 6 to the output for muting lamp, the SZ itself can control the muting lamp.
The following conditions must be fulfilled if the muting lamp is connected to the AUX 6 assigned to the muting lamp output.
- In case of incandescent lamp: DC 24V, 1.0-5.5 W
- In case of LED indicator: Current consumption 10-230 mA

You can receive alerts about muting lamp failure, such as blowout of the lamp, disconnection or overcurrent, through alert output, error output or state information output. 🕮 "User's Manual"
You can define the performance of SZ under the muting lamp failure as either error (muting lamp error) or alert. The SZ goes to the error state in case of muting lamp failure in accordance with the default configuration.

■ Other functions

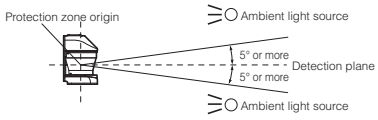
For more information about "Warning zone", "AUX output", "Check input function", "Monitoring function", see the 🕮 "User's Manual".
For more information about "RS-422A Communication", see the 🕮 "SZ-16D Communication Manual".

Light interference

Although there is no object in the protection zone, the OSSD might go to the OFF-state if the ambient light source as shown in below is located at the detection plane, because the SZ performs the false detection.

- Incandescent lamp
- Sunlight
- Fluorescent light
- Strobe light
- Other infrared light sources (infrared photoelectric sensor, infrared laser, etc.)

In order to avoid this situation, the ambient light source should not be located within ±5° of the detection plane.

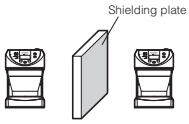


Mutual interference

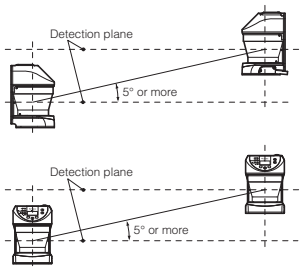
The OSSD might go to the OFF-state due to mutual interference if you install multiple SZ.

The SZ should be installed according to the following countermeasures in order to avoid mutual interference.

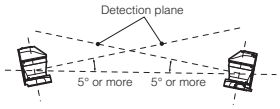
(1) A shielding plate should be installed like below.



(2) The height of installation should be changed like below.



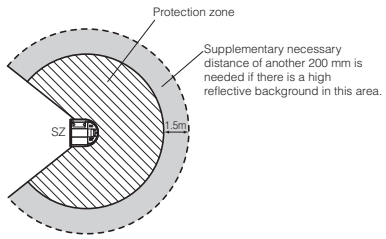
(3) The angle of installation should be changed like below.



High reflective background

The SZ performs false detection for the actual distance to the object if there is a high reflective background at the detection plane. In this case, the SZ falsely recognizes that the object is located farther than the actual distance to the object.

Therefore, if there is a high reflective background within 1.5 m from the boundary of the protection zone, you must take a countermeasure, such as reducing the reflectance or removing the background itself.
However, if you cannot take the above-mentioned countermeasures, another 200 mm must be added as supplementary necessary distance to the protection zone in case of calculation of the minimum safety distance.



⚠ Danger

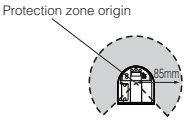
- If there is a high reflective background within 1.5 m from the boundary of the protection zone, you must take a countermeasure, such as reducing the reflectance or removing the background itself. If you cannot take the above-mentioned countermeasures, another 200 mm must be added as supplementary necessary distance to the protection zone in case of calculation of the minimum safety distance.

The SZ goes to the alert state (Alert for high-reflective background) if it detects the high reflective background. For more information about the alert state, see "User's Manual".

Reference
- Examples of high reflective backgrounds
  - Metallic glossy surface
  - Retro-reflective sheet
  - Retro-reflective plate etc...

Zone with limited detection capability

SZ might not detect an object with low reflectance located at the distance of 85 mm or less from the protection zone origin. This is the zone with limited detection capability.



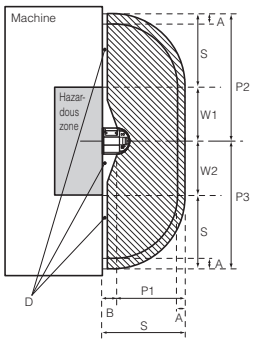
⚠ Danger

In case of installation of the SZ, the responsible personnel must perform the risk assessment with taking into account the possibility that an object might go into the zone with limited detection capability. If it is possible, the additional countermeasure must be taken by the responsible personnel.

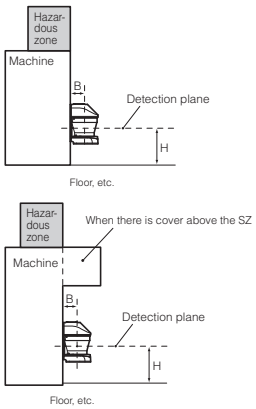
Safety distances

■ Example of area protection (Direction of approach parallel to the protection zone)

Top view of the machine



Side view of the machine



Protection zone

S = K x T + C + A < According to ISO13855 (2010) and IEC61496-3 (2008) >
- S: Safety distance
- K: Approach speed of the body or parts of the body in millimeters per second
- T: Overall Response time in second (t1 + t2)
  - t1: SZ response time in second
  - t2: Max. time in second required to stop the machine after receiving the OSSD signal from SZ
- C: 1200 - 0.4 x H (850 mm or higher)
  - H: Height of detection plane (protection zone) above the reference plane in millimeters, for example the floor. 1000 mm ≥ H ≥ 15 x (d-50)
  - d: SZ minimum detectable object size in millimeters
- A: Supplementary necessary distance for SZ in millimeters

P1, P2, P3: Protection distances to be configured as the protection zones
W1, W2: Width of the hazardous area
B: Distance between the edge of the hazardous area and protection zone origin on the SZ
D: Unprotected space

⚠ Danger

- The unprotected space (D) between the protection zone and the protective structure must be less than the minimum detectable object size when the SZ is installed, in order to prevent the machine operators from approaching into the hazardous area through this space (D). Additional countermeasures for protection must be provided if there is a space (D) between the protection zone and the protective structure that the minimum detectable object is not detected by the SZ.
- There is a risk of inadvertent undetected access beneath the detection plane (protection zone), if the height "H" of detection plane (protection zone) is greater than 300 mm (200 mm for non-industrial application, for example in the presence of children). The responsible personnel must perform the risk assessment with taking into account this factor in case of installation of the SZ. If necessary, the additional countermeasure must be taken by the responsible personnel.
- If you select the minimum detectable object size of 150 mm, "H" (Height of detection plane) exceeds 1,000 mm.
  You must select the minimum detectable object size of 70 mm or less if you want to configure the area protection (direction of approach parallel to the protection zone.).

● **Example of safety distance calculation**

K = 1600 mm/s	Approach speed of the body or parts of the body (Constant)
T = t1+t2 = 0.59 s	Overall response time
t1 = 0.09 seconds	SZ response time (Changeable)
t2 = 0.5 seconds	Max. time required to stop the machine after receiving the OSSD signal from SZ
C = 1200-0.4 x H = 1080 mm	
H = 300 mm	Lowest allowable height of detection plane (protection zone). This must be calculated using the following formula: H ³ 15 (d -50 mm)
d = 70 mm	Minimum detectable object size (Changeable)
A = 100 mm	Supplementary necessary distance for SZ
B = 59 mm	Distance between the edge of the hazardous area and protection zone origin on the SZ
W1 = W2 = 1000 mm	Width of the hazardous area

Safety Distances
S = K x T + C + A
= 1600 x 0.59 + 1080 + 100 = 2124 mm

Protection distances to be configured as the protection zones
P1 = S - B = 2065 mm
P2 = S + W1 = 3124 mm
P3 = S + W2 = 3124 mm

If there is a high reflective background within 1.5 m from the boundary of the protection zone, another 200 mm must be added as supplementary necessary distance to the P1, P2 and P3 respectively.
"High reflective background" (page 7)

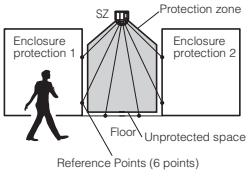
We recommend you should have a marking on the floor for indicating the specified protection zone.

■ Example of access protection (Direction of approach normal to the protection zone)

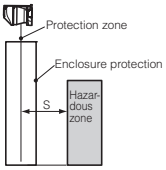
Danger

- Reference points monitoring function must be applied when the SZ is used for the access protection specified in IEC61496-3:2008 Annex A.12 and A.13 (the application where the angle of the approach exceeds ±30° to the detection plane.). In this case, the tolerance for reference points must be ±100 mm or less and the response time must be 90 ms or less. "User's Manual"
- The unprotected space between the protection zone and the protective structure must be less than the minimum detectable object size when the SZ is installed, in order to prevent the machine operators from approaching into the hazardous area through this space. Additional countermeasures for protection must be provided if there is a space between the protection zone and the protective structure that the minimum detectable object is not detected by the SZ.

Front view of the machine



Side view of the machine



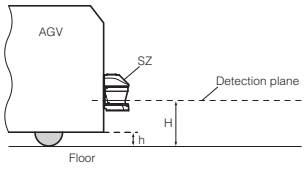
S = (K x T) + C < According to ISO13855 (2010) and IEC61496-3 (2008)>

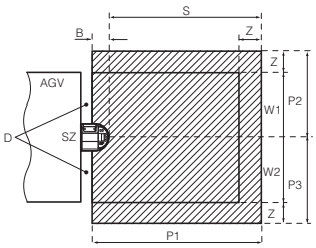
S: Minimum safety distance in millimeters
K: Approach speed of the body or parts of the body in millimeters per second
T: Overall response time in second (t1 + t2)
t1: SZ response time in second
t2: Max. time in second required to stop the machine after receiving the OSSD signal from SZ.
C: Additional distance in millimeters, taking into accounts the intrusion prior to actuation of protective equipment.

● Example of safety distance calculation

K = 1600 mm/s — Approach speed of the body or parts of the body
T = t1+t2 = 0.59 s — Overall response time
t1 = 0.09 seconds — SZ response time (Changeable)
t2 = 0.5 seconds — Max. time required to stop the machine after receiving the OSSD signal from SZ
C = 850 mm
d = 70 mm — Minimum detectable object size
S = K x T + C = 1600 x 0.59 + 850 = 1794 mm

■ Example of installing to an AGV (automated guided vehicle)

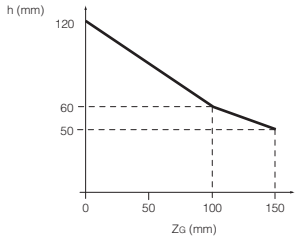




$S = V \times T + S_{brake} \times L + Z$

S: Minimum safety distance in millimeters
V: Maximum approach speed of the AGV in millimeters per second
T: Overall response time in second (t1 + t2)
t1: SZ response time in second
t2: Max. time in second that AGV responds after receiving the OSSD signal from SZ.
S_{brake}: Required distance for braking AGV in millimeters
L: Safety coefficient for required distance based on the wear of braking
Z: Additional distance in millimeters, $Z_{SZ}+Z_G$ (mm)
Z_{SZ}: Supplementary necessary distance for SZ in millimeters
Z_G: Supplementary necessary distance in millimeters, if "h" is not enough.
h: Space between the reference plane (floor) and the bottom of AGV.

If the "h" is not enough ensured, you must take into account the risk that the toe or toe tip is caught between the ground (floor) and the AGV.
The relationship between "h" and "Z_G" is as follows.



P1, P2, P3: Protection distances to be configured as the protection zones
W1, W2: Width of the AGV
B: Distance between the front edge of the SZ and protection zone origin on the SZ
D: Unprotected space
H: Height of detection plane (protection zone) above the reference plane in millimeters, for example the floor. "H" must be less than 200 mm.

Danger

- The unprotected space (D) between the protection zone and the protective structure must be less than the minimum detectable object size when the SZ is installed, in order to prevent the machine operators from approaching into the hazardous area through this space (D) when the AGV stops. Additional countermeasures for protection must be provided if there is a space (D) between the protection zone and the protective structure that the minimum detectable object is not detected by the SZ.
- There is a risk of inadvertent undetected access beneath the detection plane (protection zone), if the height "H" of detection plane (protection zone) is greater than 200 mm. However, the height "H" should be 150 mm or less in order to detect the object with the height of 150 mm. The responsible personnel must perform the risk assessment with taking into account this factor in case of installation of the SZ. If necessary, the additional countermeasure must be taken by the responsible personnel.

● Example of safety distance calculation

V = 1500 mm/s
T = t1+t2 = 0.19 s — Overall response time
t1 = 0.09 seconds — SZ response time (Changeable)
t2 = 0.1 seconds — Max. time in second that AGV responds after receiving the OSSD signal from SZ.
S_{brake} = 1,300 mm — Required distance for braking AGV in millimeters
L = 1.1 — Safety coefficient for required distance based on the wear of braking
Z = $Z_{SZ}+Z_G$ = 100+100 = 200 mm — Additional distance in millimeters (mm)
Z_{SZ} = 100 mm — Supplementary necessary distance for SZ in millimeters
Z_G = 100 mm — Supplementary necessary distance in millimeters, if "h" is not enough
h = 60 mm — Space between the reference plane (floor) and the bottom of AGV
B = 45 mm — Distance between the front edge of the SZ and protection zone origin on the SZ
W1 = W2 = 1,000 mm — Width of AGV

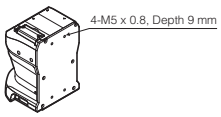
Safety Distances

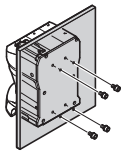
S = V x T + S_{brake} x L + Z = 1,500 x 0.19 + 1,300 x 1.1 + 200 = 1,915 mm
Protection distances to be configured as the protection zones
P1 = S + B = 1,960 mm P2 = W1 + Z = 1,200 mm P3 = W2 + Z = 1,200 mm

If there is a high reflective background within 1.5 m from the boundary of the protection zone, 200 mm must be added as supplementary necessary distance to the P1, P2 and P3 respectively.
"High reflective background" (page 7)

Mounting for installation

You can use four screw holes on the backside of the SZ for installation. Purchase the appropriate screws separately.
(Recommended tightening torque: 3 N·m)





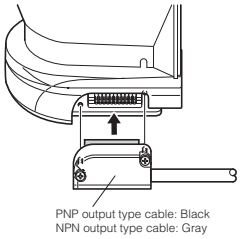
When using an optional mounting bracket, see the "User's Manual".

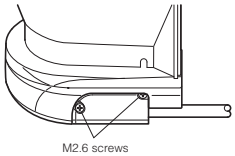
Mounting the connector cable

NOTE Do not remove the gray gasket mounted on the connector. The specification of IP65 cannot be fulfilled without this gasket.

■ How to mount

As shown in the figures below, you can use the M2.6 screws (2 screws) to mount the connector cable, and tighten the screws according to the specified tightening torque.
(Recommended tightening torque: 0.3 N·m)





Power supply

If the power supply for the SZ is the converting type, the power supply for the SZ must meet the conditions listed below in order to meet the requirements specified in IEC61496-1, UL61496-1, and EN61496-1.
A rated output voltage of 24 V DC (SELV circuit, Overvoltage Category II) within ±10%.
Double insulation or reinforced insulation between the primary and secondary circuits.
Output holding time of 20 ms or more.
A power supply must meet the requirements of the electrical safety and electromagnetic compatibility (EMC) regulations or standards in all countries and/or regions where the SZ is used.

NOTE

If the power supply for the SZ is shared with the one for the machine or the other electronic devices, voltage reduction to the SZ or noise influence to the SZ may occur due to the temporary increasing of the current consumption on the machine or the other electronic devices.
Since the SZ may go to the error state in such case, the power supply for the SZ should only be shared with the one for the load and muting devices.
We do not recommend the power supply for the SZ is shared with the one for the machine or the other electronic devices.

Pin assignment for the connector cable

■ SZ-01S

Wire color	Function
Brown	+24V
Blue	0V
Black	OSSD1
White	OSSD2
Yellow	Input 1: Reset input / Check input
Red	Input 2: EDM input
Orange	AUX output 1
Orange/Black	AUX output 2

■ SZ-04M

Wire color	Function
Brown	+24V
Blue	0V
Black	OSSD1
White	OSSD2
Gray	OSSD3
Gray/Black	OSSD4
Yellow	Input 1: Reset input / Check input
Red	Input 2: EDM input (for OSSD1/2)
Light Blue	Input 3: Muting input 1
Light Blue/Black	Input 4: Muting input 2
Yellow/Black	Input 5: Override input
Red/Black	Input 6: EDM input (for OSSD3/4)
Orange	AUX output 1
Orange/Black	AUX output 2
Pink	AUX output 3
Pink/Black	AUX output 4
Green	AUX output 5
Green/Black	AUX output 6

■ SZ-16V/SZ-16D

Wire color	Function
Brown	+24V
Blue	0V
Black	OSSD1
White	OSSD2
Yellow	Input 1: Reset input
Red	Input 2: EDM input
Light Blue	Input 3: Bank input A
Gray	Input 4: Bank input B
Pink	Input 5: Bank input C
Green	Input 6: Bank input D
Light Blue/Black	Input 7: Bank input a
Gray/Black	Input 8: Bank input b
Pink/Black	Input 9: Bank input c
Green/Black	Input 10: Bank input d
Orange	AUX output 1
Orange/Black	AUX output 2
Yellow/Black	AUX output 3
Red/Black	AUX output 4

For information about the wire colors and functions when not using the muting function, see the "User's Manual".

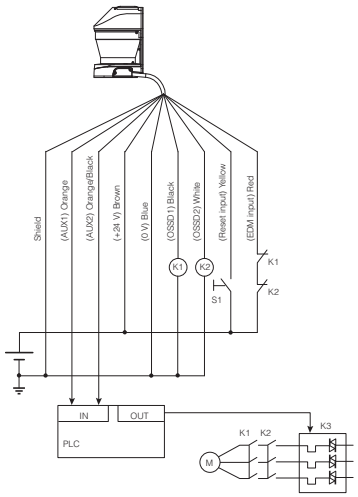
NOTE

- The NPN output cable shield is connected to +24 V inside the SZ. When wiring, do not connect the shield to 0 V.
- The PNP output cable shield is connected to 0 V inside the SZ. When wiring, do not connect the shield to + 24 V.

Example of wiring for simple function type (SZ-01S)

■ Configuration of start/restart mode: Manual/Manual

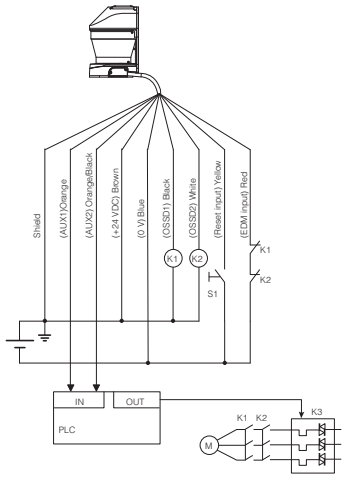
● For the PNP output type cable



K1, K2: External device (Safety relay, magnet contactor, etc.)
K3: Solid state contactor
S1: Switch for reset operation (N.O.)
PLC: Used for monitoring, not for control systems related to safety.

- In case of "Manual/Automatic" on the configuration of start/restart, the switch with N.C. type (S1) should be used for reset operation.
- In case of "Automatic/Automatic" on the configuration of start/restart, the yellow wire should be short-circuited to +24 V.
- In case of NOT applying the EDM function, the red wire must be insulated (open-circuit).
- In case of NOT applying the AUX output, the wire for AUX must be insulated (open-circuit).
- K3 and PLC are NON SAFETY-RELATED systems.

● For the NPN output type cable



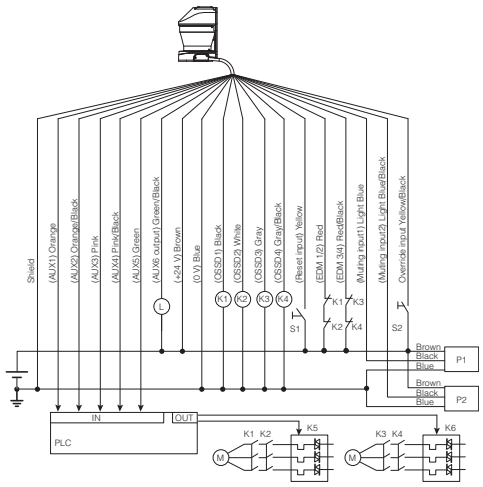
K1, K2: External device (Safety relay, magnet contactor, etc.)
K3: Solid state contactor
S1: Switch for reset operation (N.O.)
PLC: Used for monitoring, not for control systems related to safety.

- In case of "Manual/Automatic" on the configuration of start/restart, the switch with N.C. type (S1) should be used for reset operation.
- In case of "Automatic/Automatic" on the configuration of start/restart, the yellow wire should be short-circuited to 0 V.
- In case of NOT applying the EDM function, the red wire must be insulated (open-circuit).
- In case of NOT applying the AUX output, the wire for AUX must be insulated (open-circuit).
- K3 and PLC are NON SAFETY-RELATED systems.

Example of wiring for multi-function type (SZ-04M)

■ Multi-OSSD function: Mode A, B, C and Not use Configuration of start/restart mode: Manual/Manual In case of applying the muting function

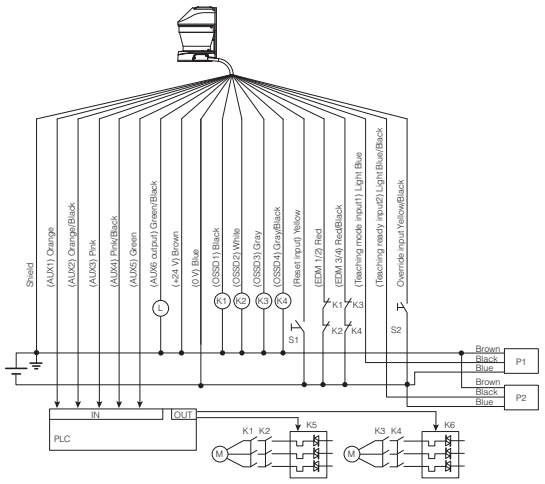
● **For the PNP output type cable**



K1, K2, K3, K4: External device (Safety relay, magnet contactor, etc.)
K5, K6: Solid state contactor
S1: Switch for reset operation (N.O.)
S2: Switch for override (N.O.)
PLC: Used for monitoring, not for control systems related to safety.
P1, P2: Muting devices (ex. PZ series with PNP output, Keyence Corp.)
M: 3-phase motor
L: Muting lamp

- In case of "Manual/Automatic" on the configuration of start/restart, the switch with N.C. type (S1) should be used for reset operation.
- In case of "Automatic/Automatic" on the configuration of start/restart, the yellow wire should be short-circuited to +24 V.
- When "Not use" is applied as the operation mode for OSSD3/4, the gray and gray/black wire must be insulated (open-circuit)
- In case of NOT applying the EDM function, both red wire and red/black must be insulated (open-circuit).
- In case of NOT applying the AUX output, the wire for AUX must be insulated (open-circuit).
- K5, K6 and PLC are NON SAFETY-RELATED systems.

● **For the NPN output type cable**



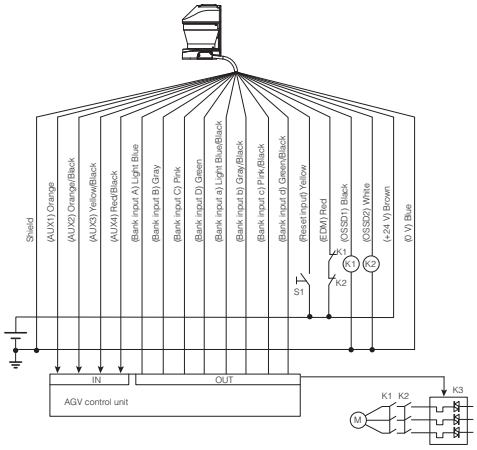
K1, K2, K3, K4: External device (Safety relay, magnet contactor, etc.)
K5, K6: Solid state contactor
S1: Switch for reset operation (N.O.)
S2: Switch for override (N.O.)
PLC: Used for monitoring, not for control systems related to safety.
P1, P2: Muting devices (ex. PZ series with NPN output, Keyence Corp.)
M: 3-phase motor
L: Muting lamp

- In case of "Manual/Automatic" on the configuration of start/restart, the switch with N.C. type (S1) should be used for reset operation.
- In case of "Automatic/Automatic" on the configuration of start/restart, the yellow wire should be short-circuited to 0 V.
- When "Not use" is applied as the operation mode for OSSD3/4, the gray and gray/black wire must be insulated (open-circuit)
- In case of NOT applying the EDM function, both red wire and red/black must be insulated (open-circuit).
- In case of NOT applying the AUX output, the wire for AUX must be insulated (open-circuit).
- K5, K6 and PLC are NON SAFETY-RELATED systems.

Example of wiring for multi-bank type (SZ-16V) and communication type (SZ-16D)

■ Configuration of start/restart mode: Manual/Manual

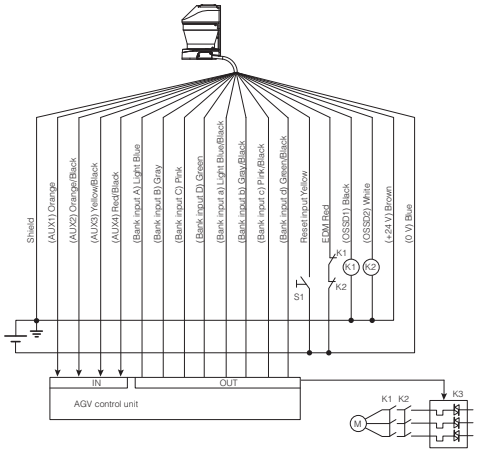
● **For the PNP output type cable**



K1, K2: External device (Safety relay, magnet contactor, etc.)
K3: Solid state contactor
S1: Switch for reset operation (N.O.)

- In case of "Manual/Automatic" on the configuration of start/restart, the switch with N.C. type (S1) should be used for reset operation.
- In case of "Automatic/Automatic" on the configuration of start/restart, the yellow wire should be short-circuited to +24 V.
- In case of NOT applying the EDM function, the red wire must be insulated (open-circuit).
- In case of NOT applying the AUX output, the wire for AUX must be insulated (open-circuit).
- K3 is NON SAFETY-RELATED system.

● **For the NPN output type cable**



K1, K2: External device (Safety relay, magnet contactor, etc.)
K3: Solid state contactor
S1: Switch for reset operation (N.O.)

- In case of "Manual/Automatic" on the configuration of start/restart, the switch with N.C. type (S1) should be used for reset operation.
- In case of "Automatic/Automatic" on the configuration of start/restart, the yellow wire should be short-circuited to 0 V.
- In case of NOT applying the EDM function, the red wire must be insulated (open-circuit).
- In case of NOT applying the AUX output, the wire for AUX must be insulated (open-circuit).
- K3 is NON SAFETY-RELATED system.

⚠ Danger

- The bank switching function is a function for the SZ to select the protection zone according to the signal combination of bank inputs.
  It must be confirmed for the user whether the protection zone selected completely and intentionally corresponds the actual signal combination of bank inputs.
- Additional safety measures are required for the whole machine on which the SZ is installed in order to ensure safety while the bank switching function is activated.

Manual configuration on the SZ

For information about using SZ Configurator (SZ-H1S) to configure settings from the PC, see the "User's Manual".

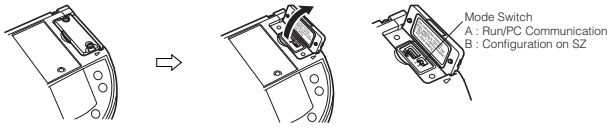
■ Password input

NOTE

The SZ cannot perform the normal operation with factory default. Password input and the configuration are required for start normal operation.
Functions for the multi-bank type (SZ-16V) and the communication type (SZ-16D) must be configured through SZ Configurator because the system does not provide for manual configuration on the SZ.

Reference For information about changing the password, see "User's Manual".

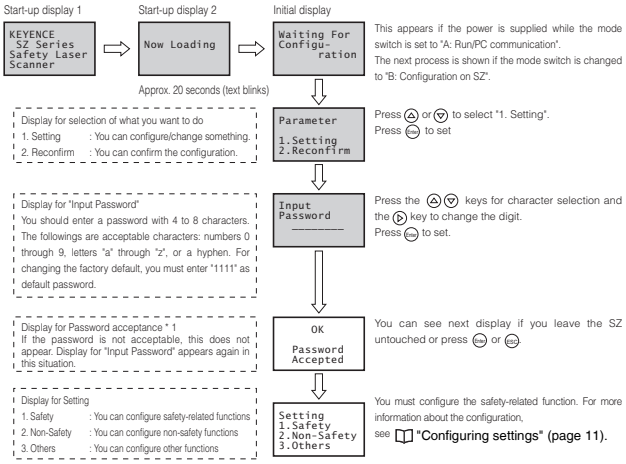
1 Two screws must be loosed to open the setting cover. (The setting cover must be closed after completing the configuration, and then two screws must be tightened. (Recommended tightening torque: 0.3 N·m))



NOTE

The specification of IP65 cannot be fulfilled unless the screw for setting cover is tightened with recom-mended torque.

2 The following is the procedure after power is supplied to the SZ. You can operate this process through the front panel and information display.



*1 If you don't change the default password, the following display appears. You can change the default password to anything you want.
See "User's Manual".

If the password is not acceptable, such as incorrect password, the following display appears. Display for "Input Password" appears again in this situation.

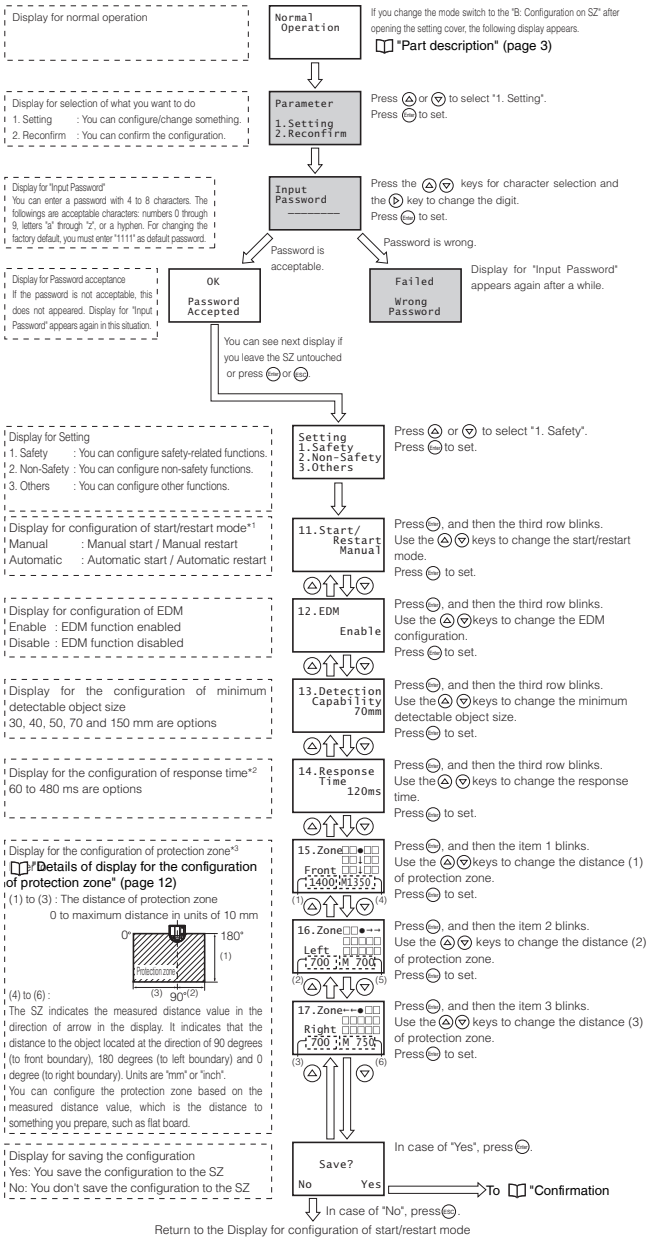
NOTE

The configuration for safety-related functions and the others cannot be performed without the password (ex. when you forget password). Store the password carefully.

■ Configuring settings

In order to use the SZ-16V and the SZ-16D, the safety function must be set with SZ Configurator "SZ-H1S". For more information, see the "SZ Series User's Manual".
For information about configuring settings other than the safety function, see the "SZ Series User's Manual".
The following information describes setting the safety function for SZ-01S or SZ-04M.

You can configure the function and confirm the configured function if you set the mode switch to "B: Configuration on SZ". The mode switch must be set back to the "A: RUN/PC communication" in order to restart the normal operation.



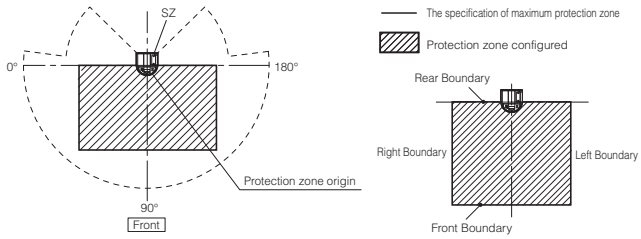
*1 The configuration for restart-delay (ON-delay) function cannot be performed through the manual configuration on the SZ.
*2 The configuration for scan cycle cannot be performed through the manual configuration on the SZ. "Response time and scan cycle" (page 4)
*3 You can only configure the quadrate and rectangular protection zone through the manual configuration on the SZ.

NOTE

When documenting the settings such as detection zone(s) on paper, please print out the settings from the dedicated software, SZ Configurator. Documents includes information such as date, serial number, and responsible person.

● **Details of display for the configuration of protection zone**
"Protection zone" (page 3)

• **Example of Protection zone**



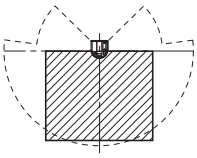
• **Condition for the configuration of protection zone**

You can configure the protection zone on the SZ under the following condition. The following conditions are always applicable.

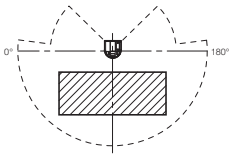
(1) The shape of the protection zone must be the quadrate or rectangular.
(2) The protection zone composed of 3 distances (distance 1, 2 and 3) must be within the specification of maximum protection zone.
(3) The rear boundary of the protection zone must be on the line including the protection zone origin.
(4) The distance from the protection zone origin to the front boundary must be 100 mm or more. The distance from the protection zone origin to the left or right boundary must be also 100 mm or more.

<Example of unconfigurable protection zone>

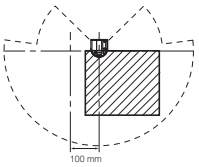
The following protection zone is beyond the specification of maximum protection zone



The rear boundary of protection zone is not on the line including the protection zone origin



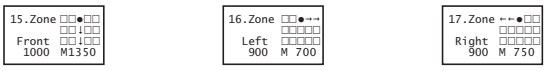
The distance from the protection zone origin to the right boundary is less than 100 mm

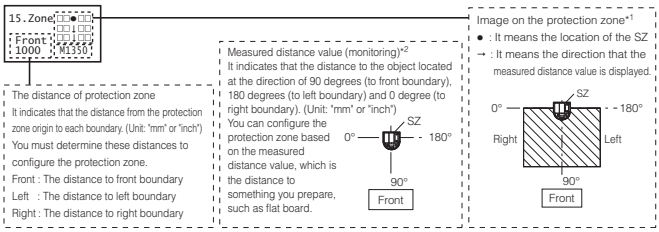


• **Detail procedure for the configuration of protection zone**

In order to configure the protection zone, especially the shape of the protection zone, you must determine the 3 distances from the protection zone origin, 1) to front boundary, 2) to left boundary, and 3) right boundary.

15. Display for Front boundary **16. Display for Left boundary** **17. Display for Right boundary**

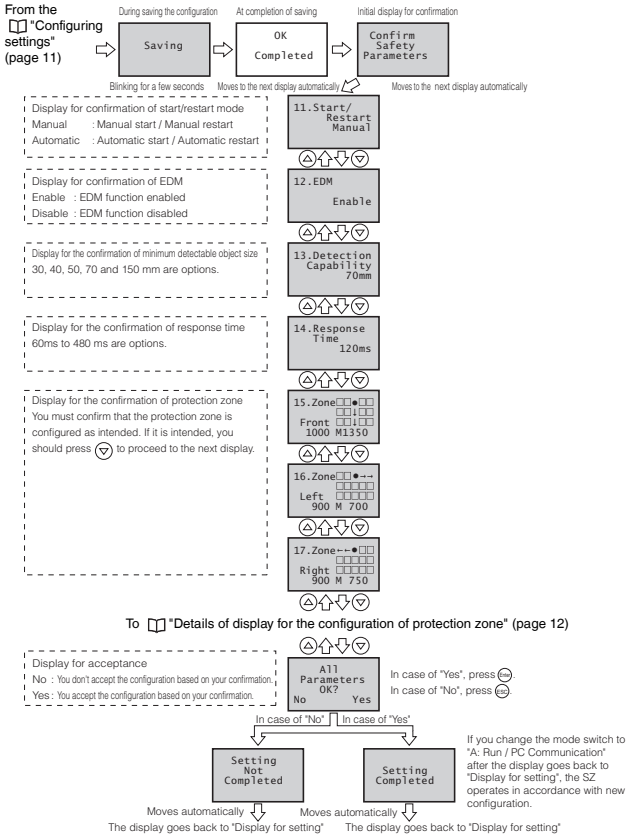




*1 The protection zone image is shown assuming that the front panel is to be seen from the front side of the SZ.
*2 "M****" appears if the measured distance value exeeeds 9,999 mm.

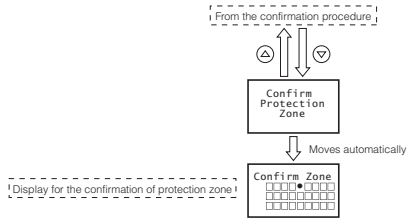
● **Confirmation procedure**

The following confirmation procedure is required to enable the configuration. According to the following procedure, you must confirm whether the configuration is as intended.



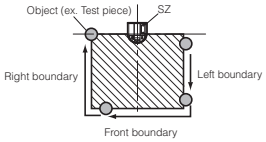
● **Details of display for the confirmation of protection zone**

You must confirm whether the protection zone is configured as intended. You must confirm whether the SZ detects the object, such as test piece, at the boundary of protection zone.

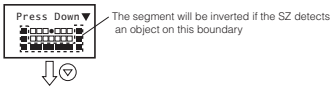


• **The sequence of confirmation**

(1) While you find the display for the confirmation of protection zone, you should move an object, such as test piece, along with the boundary of the protection zone.



(2) The information display lights in red if the SZ detects an object in the protection zone. On the other hand, the information display lights in green if the SZ detects no object in the protection zone. You can easily confirm the boundary of the protection zone because of the changing color on the information display.
(3) The following display appears at the "display for the confirmation of protection zone" if the SZ detects an object all over the boundary of the protection zone. The display changes to the "display for acceptance" if you press ▽ at this moment.



NOTE

You can find that there are some segments that are not inverted on the boundary unless the SZ detects an object all over the boundary of the protection zone. If you press ▽ in this situation, the following display appears, and then the display goes back to the "display for the confirmation of protection zone".

Model

SZ- 01 S

(1) (2) (3)

< Nomenclature >

(1) Basic designation: SZ
(2) Number of banks One-digit or two-digit numbers.
(3) Type identification S : Simple function type
M : Multi-function type
V : Multi-bank type
D : Communication type

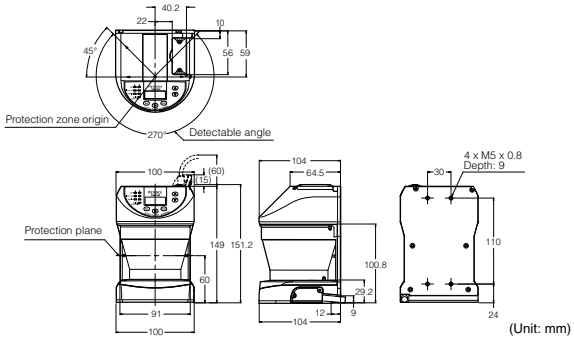
Specifications

Model			SZ-01S	SZ-04M	SZ-16V/SZ-16D
Detection capability	Minimum detectable object size		Diameter 30, 40, 50, 70, 150 mm (depends on the setting) Reflectance 1.8% min., Speed 1.6 m/s max.		
	Detectable angle		270° (-45° to 225°)		
	Response time (ON to OFF)	General scan cycle (Scan cycle A)	60 ms (2 scans) to 480 ms (16 scans)		
		Specific scan cycle (Scan cycle B)	66 ms (2 scans) to 528 ms (16 scans)		
	Response time (OFF to ON)	General scan cycle (Scan cycle A)	Response time (ON to OFF) + 125 ms		
		Specific scan cycle (Scan cycle B)			
	Maximum protection zone	Minimum detectable object size: 70/150 mm	4.2 m (-5° to 185°) 2.8 m (-45° to -5°, 185° to 225°)		
		Minimum detectable object size: 50 mm	3.0 m (-5° to 185°) 2.0 m (-45° to -5°, 185° to 225°)		
		Minimum detectable object size: 40 mm	2.4 m (-5° to 185°) 1.6 m (-45° to -5°, 185° to 225°)		
		Minimum detectable object size: 30 mm	1.8 m (-5° to 185°) 1.2 m (-45° to -5°, 185° to 225°)		
	Maximum warning zone*1 (non safety-related)	Minimum detectable object size: 70/150 mm	10.0 m (-5° to185°) 7.0 m (-45° to -5°, 185° to 225°)		
		Minimum detectable object size: 50 mm	7.5 m (-5° to 185°) 5.0 m (-45° to -5°, 185° to 225°)		
		Minimum detectable object size: 40 mm	6.0 m (-5° to 185°) 4.0 m (-45° to -5°, 185° to 225°)		
		Minimum detectable object size: 30 mm	4.5 m (-5° to 185°) 3.0 m (-45° to -5°, 185° to 225°)		
	Additional safety distance		100 mm*2		
Light source	Type, wavelength		Infrared laser diode, 905 nm		
	Laser class		Class 1 IEC / EN 60825-1 Class 1 CFR 21 1040.10, 1040.11 (Laser Notice No.50) Class 1 JIS C6802		
Rating	Power voltage		24 V DC ±10% (Ripple P-P 10% or less): When using a converter power supply 24 V DC +20%/-30%: When using a battery		
	Power consumption		Max. 9.5 W (without load) Max. 39W (with load)	Max. 9.5 W (without load) Max. 50W (with load)	Max. 10.5 W (without load) Max. 43W (with load)
OSSD output	Output		PNP or NPN (Selectable according to the connector cable)		
			2 outputs	4 outputs	2 outputs
	Max. load current		500 mA*3		
	Residual voltage (during ON)		Max. 2.5 V (with a cable length of 5 m)		
	OFF-state voltage		Max. 2.0 V (with a cable length of 5 m)		
	Leakage current		Max. 1 mA*4		
	Max. capacitive load		2.2 µF (with a load resistance of 100 Ω)		
	Load wiring resistance		Max. 2.5 Ω*5		
Input (safety-related)	Input resistance		4.4 kΩ (for Input 1) 2.2 kΩ (for Input 2)	4.4 kΩ (for Input 1, 3, 4, and 5) 2.2 kΩ (for Input 2 and 6)	4.4 kΩ (for Input 1 and 3 to 10) 2.2 kΩ (for Input 2)
Non safety-related output (AUX output)	Output type		PNP / NPN totem-pole output		
			2 outputs	6 outputs	4 outputs
	Max. load current		50 mA		
	Residual voltage (during ON)		Max. 2.5 V (with a cable length of 5 m)		
Muting lamp output	(AUX6 output can be assigned for the muting lamp output)			Can be connected to the incandescent lamp (24V DC, 1 to 5.5W) and LED lamp (load current 10 to 230 mA)	
RS-422A Communication (SZ-16D only)	Communication method				Full duplex
	Synchronization method				Start-stop
	Baud rate				9600/19200/38400/ 57600/125k/250k bps
	Data bit length				8 bit
	Parity check				None
	Stop bit length				1 bit
	Maximum number of connectable units				4 units (multi-drop link)
	Transmission distance				Max. 30 m
	Data transfer direction				LSB
Environmental resistance	Enclosure protection		IP65 (IEC60529)*6		
	Operating ambient temperature		-10 to +50°C (No freezing)		
	Storage ambient temperature		-25 to +60°C (No freezing)		
	Operating relative humidity		35% to 85% RH (No condensation)		
	Storage relative humidity		35% to 95% RH		
	Surrounding light		incandescent lamp: 1500 lx or less *7		
	Vibration		10 to 55 Hz, 0.7 mm compound amplitude, 20 sweeps each in X, Y, and Z directions		
	Shock		100 m/s^2 (Approx. 10 G) 16 ms pulse, in X, Y, Z directions 1,000 times each axis		
Material	Main unit case		Aluminum die casting, SPHC (Bottom)		
	Window		Polycarbonate		
Cable length			30 m or less*8		
Approved standards	EMC	EMS	IEC61496-1, EN61496-1, UL 61496-1		
		EMI	EN55011 Class A, FCC Part15B Class A		
	Safety		IEC61496-1, EN61496-1, UL 61496-1 (Type 3 ESPE)		
			IEC61496-3, EN61496-3 (Type 3 AOPDDR)		
			IEC61508, EN61508, IEC62061, EN62061 (SIL2)		
			EN ISO13849-1:2015 (PL d, Category 3)		
			UL508, UL1998		

*1 20% or more reflectance is necessary for the minimum detectable object in the warning zone.
*2 If there is a high reflective background within 1.5 m from the boundary of the protection zone, 200 mm must be added as supplementary necessary distance to the protection zone in case of calculation of the minimum safety distance.
*3 For the load current calculation of the OSSD output and the AUX output, make sure it is 1.5 A or less when using converter power supply (or 1.0 A or less when the cable length is 25 m or more), and 1.0A or less when using a battery (or 0.5 A or less when the cable length is 5 m or more).
*4 This also takes into account the situations when power is either off or disconnected.
*5 The wiring resistance between the OSSD output and the connected equipment (excluding the resistance of the cable) must be 2.5 Ω or less to ensure operation. However, it must be 1.0 Ω or less if the load current is 300 mA or more.
*6 The SZ doesn't fulfill the requirements of IP65 degree of protection with the setting cover opened or the connector cable unattached. In addition, the SZ-16D doesn't fulfill the requirements of IP65 degree of protection with the connector cable for the RS-422A communication unattached.
*7 The SZ should not be installed so as to have light interference within ±5° to the detection plane.
*8 It must be 10 m or less if the power is supplied by the battery.

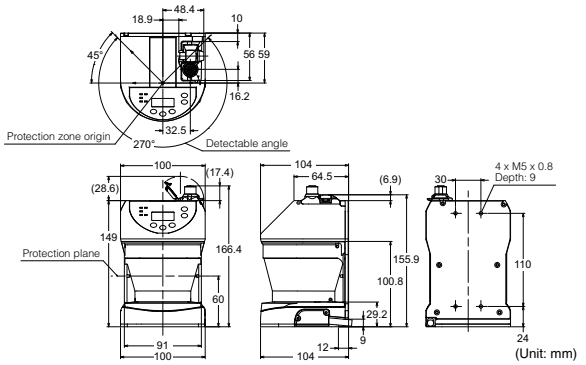
SZ main unit

SZ-01S/SZ-04M/SZ-16V



(Unit: mm)

SZ-16D

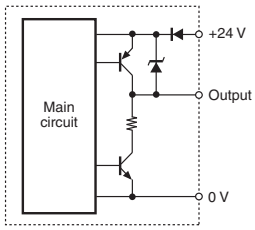


(Unit: mm)

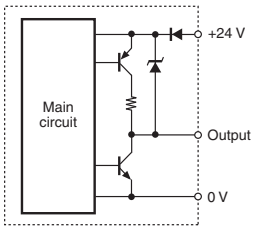
Input / output circuit

■ OSSD output circuit (Safety output)

● **For the PNP output type cable**

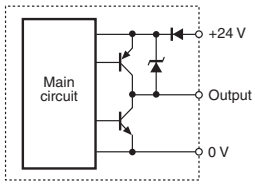


● **For the NPN output type cable**



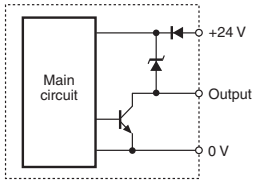
■ AUX output circuit (Non-safety output)

● **Common for the PNP output type cable/NPN output type cable**



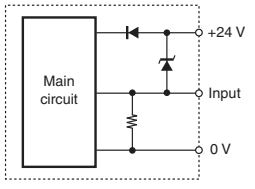
■ Muting lamp output

● **Common for the PNP output type cable/NPN output type cable**

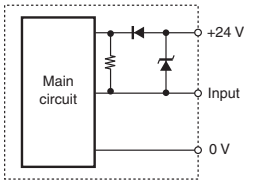


■ Input circuit

● **For the PNP output type cable**



● **For the NPN output type cable**



Troubleshooting

You can confirm the state of the SZ through the information display in case of error or alert. You should resolve the problem with the information on that display if the SZ does not operate as intended.

Information on the display	Description	Countermeasure
Nothing in display	No power supply	You should check the wiring. "Example of wiring" (page 9) You should check the rating of power supply to the SZ. You should check whether the power is enough. "Specifications" (page 13)
	"Turn off backlight" has been configured.	If you want to turn on the backlight, you should change the configuration through the SZ Cofigurator. "User's Manual"
	The SZ may be broken.	You should replace the SZ.
KEYENCE SZ Series Safety Laser Scanner	This is indicated at start-up for a few seconds.	You should wait for normal operation.
	The OSSD keeps the OFF-state due to the detection of an error through the self-diagnosis at start-up unless you see "Now Loading" after this information. The SZ may be broken in this case.	You should replace the SZ unless you see "Now Loading" after this information.
Now Loading	This is indicated for approx. 20 seconds before starting normal operation. The SZ is under loading.	You should wait for starting normal operation.
	The OSSD keeps the OFF-state due to the detection of an error through the self-diagnosis at start-up unless you see "Normal Operation" after this information. In this case, (1) the SZ is in the error state of light interference, (2) the SZ is in the error state due to the strong vibration and shock, or (3) the SZ may be broken in this case.	(1) You should reinstall the SZ so as not to have light interference within ±5° to the detection plane. "Light interference" (page 7), "Mutual interference" (page 7) (2) You should install the SZ so as not to have the vibration and shock exceeding the specification. "Specifications" (page 13) (3) You should replace the SZ.
Waiting For Configu- ration	The configuration is not completed.	You should perform the configuration of safety function through the SZ Configurator or manual configuration on the SZ. "Configuring settings" (page 11)
Under Configu- ration	(1) The configuration through the SZ Configurator is being transferred or initialized. (2) AUX output test is in execution.	(1) You should wait for completing the transferring or initialization. (2) You should complete the AUX output test. "User's Manual"
Normal Operation	The SZ is under normal operation. The OSSD is in the ON-state if the display lights in green, while the OSSD is in the OFF-state if the display lights in red. For the SZ-04M, if either OSSD 1/2 or OSSD 3/4 is in the ON-state and the other OSSD is in the OFF-state, the display lights in orange.	If the OSSD goes to the OFF-state when nothing is present in the protection zone, see "Troubleshooting on the OSSD operation" (page 15).
Normal Operation Bank*	It indicates the bank number in case of enabling the bank switching function. Asterisk (*) is the bank number.	"Bank switching function" (page 5)
Normal Operation Check Input	The OSSD is in the OFF-state due to the check input.	"User's Manual"
Normal Operation ON Delay	The OSSD is in the OFF-state due to restart delay (ON-delay).	The OSSD automatically goes to the ON-state after the configured delay time is passed. "Restart Delay (ON-delay)" (page 4)
Muting	The SZ is under the temporary suspension of safety function due to muting, override, or suspension in teaching mode.	"Temporary Suspension of Safety Function (Muting function)" (page 6)
Muting Detection	The SZ is under the temporary suspension of safety function due to muting, override, or suspension in teaching mode. The OSSD is still in the ON-state even if the SZ detects an object in the protection zone or if the structure moves exceeding the specified tolerance for reference points monitoring function.	"Temporary Suspension of Safety Function (Muting function)" (page 6)
Interlock	The SZ is under interlock condition. The SZ detects an object in the protection zone or that the structure moves exceeding the specified tolerance for reference points monitoring function.	You should perform the reset operation in order to terminate the interlock condition when the SZ detects no object in the protection zone or the structure on the reference points. "Interlock" (page 4)
Interlock Reset Ready	The SZ is under interlock condition. You can perform the reset operation to restart the SZ because the conditions for terminating the interlock are met.	You should perform the reset operation in order to terminate the interlock condition. "Interlock" (page 4) For the SZ-04M, you should perform the reset operation for OSSD 1/2 and/or OSSD 3/4 respectively in order to terminate the interlock condition when the Mode D is applied as the operation mode for OSSD 3/4.
Interlock RST Ready1/2	The OSSD 1/2 is under interlock condition. You can perform the reset operation to restart the SZ because the conditions for terminating the interlock are met.	You should perform the reset operation for OSSD 1/2 in order to terminate the interlock condition. "Interlock" (page 4)
Interlock RST Ready3/4	The OSSD 3/4 is under interlock condition. You can perform the reset operation to restart the SZ because the conditions for terminating the interlock are met.	You should perform the reset operation for OSSD 3/4 in order to terminate the interlock condition. "Interlock" (page 4)
Alert Window Pollution	Alert: Window pollution There is pollution or damage on the window. The OSSD may go to the OFF-state if you leave this situation as it is.	You should perform the cleaning according to "Cleaning the window" (page 16).
Alert Light Interference	Alert: Light interference The SZ has light interference, such as incandescent lamp, fluorescent lamp, stroboscopic light, or photoelectric sensor. Or, the SZ has mutual interference between SZs. The OSSD may go to the OFFstate as unintended.	You should take a countermeasure according to "Light interference" (page 7), "Mutual interference" (page 7).
Alert Muting Lamp	Alert: Muting lamp failure The SZ has a problem on the muting lamp connected to the AUX 6. (Disconnection, broken, or overcurrent.) The OSSD keeps normal operation.	You should check the wiring between the AUX6 and muting lamp, and whether the muting lamp is broken or not. You should also check the rating/ specification of muting lamp. "Muting lamp output" (page 6)
Alert AUX Over current	Alert: AUX Overcurrent The SZ detects an overcurrent on the AUX output. All of AUX outputs go to the OFF-state after the SZ detects this situation. The OSSD keeps normal operation.	You should check the wiring between the AUX and the load, and whether the loads are broken or not. You should also check the current on AUX outputs. "Specifications" (page 13)

Information on the display	Description	Countermeasure
Alert High Reflection	Alert: High-reflective background There is a high reflective background behind the specified protection zone, which has impact to the detection capability.	High reflective background must not be positioned within 1.5 m from the boundary of the protection zone. You must remove the background itself or reduce the reflectance. Unless you can take the above-mentioned countermeasures, 200 mm must be added as supplementary necessary distance to the protection zone in case of calculation of the minimum safety distance. "High reflective background" (page 7)
Waiting For Bank Input	The signal combination of bank inputs does not meet the specification.	You should check the signal combination of bank inputs. The SZ automatically goes back to the normal operation if the signal combination of bank inputs meets the specification. "Bank switching function" (page 5)
Error1 OSSD1 Error	OSSD 1 Error (1) OSSD 1 is short-circuited to the other wire, or the wiring is wrong. (2) OSSD 1 has a surge voltage due to inductive load. (3) OSSD 1 is influenced by the EMC environment. (4) OSSD 1 is broken.	(1) You should check the wiring on OSSD 1. "Example of wiring" (page 9) (2) You should use the load with a surge absorber function, or apply the surge protection to the load. (3) You should check the wiring and EMC environment in the surrounding. (4) You should replace the SZ.
Error2 OSSD2 Error	OSSD 2 Error (1) OSSD 2 is short-circuited to the other wire, or the wiring is wrong. (2) OSSD 2 has a surge voltage due to inductive load. (3) OSSD 2 is influenced by the EMC environment. (4) OSSD 2 is broken.	(1) You should check the wiring on OSSD 1. "Example of wiring" (page 9) (2) You should use the load with a surge absorber function, or apply the surge protection to the load. (3) You should check the wiring and EMC environment in the surrounding. (4) You should replace the SZ.
Error3 OSSD3 Error	OSSD 3 Error (1) OSSD 3 is short-circuited to the other wire, or the wiring is wrong. (2) OSSD 3 has a surge voltage due to inductive load. (3) OSSD 3 is influenced by the EMC environment. (4) OSSD 3 is broken.	(1) You should check the wiring on OSSD 1. "Example of wiring" (page 9) (2) You should use the load with a surge absorber function, or apply the surge protection to the load. (3) You should check the wiring and EMC environment in the surrounding. (4) You should replace the SZ.
Error4 OSSD4 Error	OSSD 4 Error (1) OSSD 4 is short-circuited to the other wire, or the wiring is wrong. (2) OSSD 4 has a surge voltage due to inductive load. (3) OSSD 4 is influenced by the EMC environment. (4) OSSD 4 is broken.	(1) You should check the wiring on OSSD 1. "Example of wiring" (page 9) (2) You should use the load with a surge absorber function, or apply the surge protection to the load. (3) You should check the wiring and EMC environment in the surrounding. (4) You should replace the SZ.
Error5 OSSD Over current	OSSD Overcurrent Error Overcurrent occurs on any of OSSD1 to 4.	You should check the wiring between OSSD and the load, and whether the load is broken or not. "Example of wiring" (page 9) You should also check the rating/specification of the load. "Specifications" (page 13)
	In case of NPN output type cable, the SZ with positive grounding is connected to the PC with negative grounding through the USB cable.	In case of NPN output type cable used, either the SZ or the PC should not be grounded prior to the connection through the USB cable. The brown wire and shielded wire must be grounded in order to start normal operation.
Error6 EDM Error (OSSD1/2)	EDM Error for OSSD 1/2 <In case of EDM function applied> (1) EDM input is not connected to the external device correctly. (2) The external device connected to the OSSD is broken. <In case of EDM function not applied> (3) EDM input is not open-circuited.	(1) You should check the wiring on EDM. "Example of wiring" (page 9) (2) You should check the external device. If it is broken, you should replace it. (3) You should make an open-circuit on EDM input with an insulation, in case of EDM function not applied.
Error7 EDM Error (OSSD3/4)	EDM Error for OSSD 3/4 <In case of EDM function applied> (1) EDM input is not connected to the external device correctly. (2) The external device connected to the OSSD is broken. <In case of EDM function not applied> (3) EDM input is not open-circuited.	(1) You should check the wiring on EDM. "Example of wiring" (page 9) (2) You should check the external device. If it is broken, you should replace it. (3) You should make an open-circuit on EDM input with insulation, in case of EDM function not applied.
Error8 Reset Error (OSSD1/2)	Reset input Error for OSSD 1/2 The reset input is in the OFF-state at start-up even if the configuration of restart mode is "Automatic". Or, the reset input is in the ON-state at start-up if the configuration of restart mode is "Manual".	You should check the wiring of reset input and the configuration on restart mode. "Interlock" (page 4), "Example of wiring" (page 9)
Error9 Reset Error (OSSD3/4)	Reset input Error for OSSD 3/4 The reset input is in the OFF-state at start-up even if the configuration of restart mode is "Automatic". Or, the reset input is in the ON-state at start-up if the configuration of restart mode is "Manual".	You should check the wiring of reset input and the configuration on restart mode. "Interlock" (page 4), "Example of wiring" (page 9)
Error10 Bank Error	Bank Error (1) The signal combination of bank inputs does not meet the specification. (2) The bank switching was not performed during the specified bank transition time. (3) The bank switching was not performed according to the specified bank sequence.	(1) You should check the wiring on the signal combination of bank inputs. (2) The bank switching should be performed during the specified bank transition time. (3) You should check the bank sequence and the configuration of bank sequence monitoring. "Bank switching function" (page 5), "User's Manual"
Error11 Window Error	Window Error Window may be polluted or damaged.	You should perform cleaning according to "Cleaning the window" (page 16). If you experience continuous errors after cleaning, you should replace the window. In this case, you should consult the nearest KEYENCE office.
	Window may be broken. Or it may not be correctly positioned.	You should replace the window. In this case, you should consult the nearest KEYENCE office.
Error12 Check Point Error	Check Point Error The SZ detects no structure on the check points within the specified tolerance when the check input goes to the ON-state.	You should check whether the SZ or the structure on the check points is displaced or not. "User's Manual"
Error13 Muting Lamp Error	Muting Lamp Error (Disconnection) Muting lamp has a failure, such as disconnection or break.	You should check the wiring between the AUX6 and muting lamp, and whether the muting lamp is broken or not. You should also check the rating/ specification of muting lamp. "Muting lamp output" (page 6)
Error14 Muting Lamp Error	Muting Lamp Error (Overcurrent) Muting lamp has an overcurrent exceeding the rated current.	You should check the wiring between the AUX6 and muting lamp, and whether the muting lamp is broken or not. You should also check the rating/ specification of muting lamp. "Muting lamp output" (page 6)
Error15 Calibration Error	Calibration Error	You should consult the nearest KEYENCE office.

Information on the display	Description	Countermeasure
Error16 MI Error	MI Error (1) An object with extremely low reflectance is located close to the SZ. (2) The SZ unit is not detecting any diffuse light reflected from objects or the background. An error is generated if the zone in which no reflection is detected exceeds 60°.	(1) Remove objects with extremely low reflectance that are located close to the SZ. (2) Place a background along the edge of the protection zone or take other measures so that the SZ can detect diffuse light reflected from the background.
Error** SYSTEM Error	System Error The number from 17 to 46 is assigned to the asterisk (**) (1) The SZ is under EMC environment. (2) The SZ has light Interference. (3) The SZ has strong vibration or shock. (4) The power is disconnected during configuration. (5) The SZ is broken.	(1) You should check the wiring and EMC environment in the surrounding. (2) You should take a countermeasure to 📖 "Light interference" (page 7), or 📖 "Mutual interference" (page 7). (3) You should avoid strong vibration or shock. (4) You should perform the configuration again. (5) You should replace the SZ.
Error47 COM Monitor Error	Communication monitoring error (only for the SZ-16D) It will occur only when the communication monitor function of a part of the RS-422A communication function is enabled.	Enact the command communication within the set communication monitoring interval, then clear the timer, or, stop the communication monitor function.

*1 The information display lights in green if the OSSD is in the ON-state. It lights in red if the OSSD is in the OFF-state. For the SZ-04M, if either OSSD 1/2 or OSSD 3/4 is in the ON-state and the other OSSD is in the OFF-state, the information display lights in orange.

Troubleshooting on the OSSD operation

Situation	Description	Countermeasure
The OSSD goes to the OFF-state when nothing is present in the protection zone.	Light interference may occur.	You should take a countermeasure according to the description in 📖 "Light interference" (page 7). You can check the situation of light interference through the SZ Configurator.
	Mutual interference due to another SZ may occur.	You should take a countermeasure according to the description in 📖 "Mutual interference" (page 7).
	The SZ may detect the floor or the surrounding (background) because the SZ is installed with some inclination.	You should adjust the SZ installation angle and position so that the SZ does not detect the floor or the surrounding (background).
	The background is close to the boundary of the specified protection zone.	The SZ detect the surroundings (background). You should move it away from the specified protection zone. 📖 "Protection zone" (page 3) If the surroundings are high reflective background, you should take into account the additional safety distance. 📖 "High reflective background" (page 7)
	The position of the SZ or the surroundings (background) has been changed.	You should restore the position of the SZ or the surroundings (background). You should perform the configuration on the protection zone again.
	The structure on the reference points is not present or is not located within the specified tolerance.	You should check the position of the structure on the reference points and the tolerance. You should change the configuration on the reference points, if necessary.
	Laser shutdown function is activated.	You should switch the bank. 📖 "User's Manual"
	The SZ has a pollution on the window.	You should perform the cleaning according to 📖 "Cleaning the window" (page 16).
	The SZ detects particles in the air, such as dust, spatter or moisture.	You should take a countermeasure that the particles in the air do not go into the protection zone.

Troubleshooting on the USB communication

Situation	Description	Countermeasure
The USB cannot be connected to the SZ. (You cannot log-in.)	USB cable is not connected to the SZ, or is disconnected.	You should check the USB cable and USB port on your personal computer.
	The power is not supplied to the SZ.	You should supply the power to the SZ.
	Mode switch is in the "B: Configuration on SZ".	You should change the mode switch to "A: Run / PC Communication".
	USB driver is not installed into your computer.	You should click the "DPInst" file USB driver is installed into your personal computer."DPInst" file is located in the folder that the SZ Configurator is installed. (C:\Program Files\KEYENCE\SZ Configurator\Driver\)
	In case of NPN output type cable, the SZ with positive grounding is connected to the PC with negative grounding through the USB cable.	In case of NPN output type cable used, either the SZ or the PC should not be grounded prior to the connection through the USB cable. The brown wire and shielded wire is necessary to be grounded in order to start normal operation.
You cannot transfer the configuration.	The specified model in the SZ Configurator mismatches the actual SZ model.	You should check the SZ model through the "Property" in the Sub panel. If the model mismatches, you should select "Chage model (M)" on "File (F)" from menu bar in order to select the correct model. When the model cannot be changed, create a new file. From "File (F)" choose "Create New File (N)".
	All configurations are not completed.	You should check the configuration.
	The specified protection zone or warning zone is configured beyond the specification.	You should check the configuration on the protection zone, warning zone, and minimum detectable object size.
	The power is not supplied to the SZ.	You should supply the power to the SZ.
You cannot perform the monitoring on the SZ.	The specified model in the SZ Configurator mismatches the actual SZ model.	You should match the models between the specified one in the SZ Configurator and the actual one before starting the monitoring. You should transfer the configuration if you want to monitor the SZ operation according to the configuration through the SZ Configurator. On the other hand, you should read out the configuration in the SZ if you want to monitor the SZ operation according to the current configuration in the SZ. In this case, all setting under configuration on the SZ Configurator is deleted.
	The configuration is not completed.	You should start monitoring after you transfer the configuration to the SZ.

Inspection and maintenance

■ Inspection

You are fully responsible for performing the risk assessment on your machine application, taking into account performing maintenance and inspections, which are critical factor for appropriate risk assessment. In addition, it is a responsibility for the responsible personnel to train the machine operators regarding inspection and maintenance of the machine and the SZ.
Note that the following inspection items comprise only a bare minimum inspection. KEYENCE Corporation strongly recommends including the necessary checking items into this checklist based on the judgment of the responsible personnel since additional criteria may be necessary depending on both the machine to which the SZ is installed and the laws, rules, regulations and standards in the country or region in which the SZ is used/installed.
You must keep the inspection result along with the machine log.

⚠ Danger Do not use the machine on which the SZ is installed if the SZ does not operate according to any of the inspection items as listed below. Failure to follow this warning results in a significant harm to the machine operators, including serious injury or death.

■ Initial inspection

When the installation of the SZ is completed, the responsible personnel must check the operation of the SZ in accordance with the checklist shown below.

(1) Pre-check for installation conditions

- ❑ The SZ is installed without loose fixture screws, in accordance with the specification of tightening torque in this manual.
- ❑ The machine under SZ control can stop running when the OSSD is in the OFF-state.
- ❑ The SZ is installed so that the machine operator cannot go into or approach the hazardous area or hazards without passing through the protection zone of the SZ.
- ❑ The SZ is installed so that the machine operator cannot go into or approach the hazardous area or hazards without passing through any of the protection zone of the SZ belonging to the bank switching function.
- ❑ The interlock reset mechanism is installed so that it cannot be operated if there are any personnel within the hazardous area.
- ❑ The device to activate the override is installed so that it cannot be operated if there are any personnel within the hazardous area.
- ❑ Minimum safety distance is ensured, which has been calculated according to the laws, regulations, and standards of the country and region in which the SZ is installed.
- ❑ The SZ is installed at a location free from light interference, for example an incandescent lamp or a halogen lamp. 📖 "Light interference" (page 7)
- ❑ When two or more SZ are installed nearby, the countermeasures against mutual interference are taken based on the description of 📖 "Mutual interference" (page 7).
- ❑ The muting devices fulfill the conditions specified in this manual and the requirements of the laws, rules, regulations and standards in the country or region in which the SZ and those devices are used. 📖 "Mutual interference" (page 7)
- ❑ The devices used to activate the override fulfill the conditions specified in this manual and the requirements of the laws, rules, regulations and standards in the country or region in which the SZ and those devices are used. 📖 "Temporary Suspension of Safety Function (Override function)" (page 6)
- ❑ All conditions specified in this manual are fulfilled when enabling the suspension in teaching mode. 📖 "Temporary Suspension of Safety Function (Suspension in teaching mode)" (page 6)
- ❑ The reference points monitoring function is enabled in case of access protection. Additionally, two or more reference points are set on one structure so as to ensure the detection of its position change.

(2) Pre-check for wiring

- ❑ The SZ power supply is 24 V DC, fulfilling the conditions for the power supply as specified in this manual. See 📖 "Power supply" (page 9).
- ❑ For the wiring between the SZ and a safety-related part of a machine control system, both OSSD 1 and OSSD 2 is wired to a safety-related part of a machine control system. Similarly, both OSSD 3 and OSSD 4 is also wired to a safety-related part of a machine control system if you assign a function for OSSD 3/4.
- ❑ The polarity of the power supply is not reversed.
- ❑ The shielded wire is grounded. (0 V line is grounded in case of PNP output type cable, while +24 V line is grounded in case of NPN output type cable.)
- ❑ In case of using PNP output type cable, the OSSD is not short-circuited to +24 V, and the load is between the OSSD and 0 V.
- ❑ In case of using NPN output type cable, the OSSD is not short-circuited to 0 V, and the load is between the OSSD and +24 V.
- ❑ All of the AUX outputs are not used as a safety output for safety-related part of a control system.
- ❑ There is no damage to the cable insulation.
  Additionally, the protection against the disconnection or short-circuit of cable, which might be caused by crushing or being caught in a machine, is taken into account.
- ❑ Any non-safety related functions described in this manual should not be used as a safety related machine control.

(3) Pre-check test while the machine is stopped

You should perform the following pre-check test with the test piece in order to make sure the operation of the SZ while the machine is stopped. In this case, you should supply the power only to the SZ.
Test piece should match the minimum detectable object size you chose.

- ❑ The OSSD indicator lights in red when the test piece is present in the specified protection zone. This test must be performed for the whole specified protection zone. If the bank switching function is applied to the SZ, this test must be performed for the whole and every specified protection zone. If the muting function is applied to a part of the protection zone, this test must be performed during muted condition for the whole specified protection zone, except for muting zone.
- ❑ The OSSD indicator lights in red when the SZ detects the test piece at the intended detection plane (height) while the test piece vertical to the detection plane moves in the protection zone.
- ❑ The OSSD indicator lights in red due to an error caused by the open-circuit of the EDM input while the test piece is present in the protection zone. This is only applicable if the EDM function is applied.
- ❑ The OSSD indicator lights in green when the SZ starts normal operation after power on (when "Now Loading" is changed to "Normal Operation" on the information display) and detects no object in the protection zone with "Automatic/Automatic" for the configuration of start/restart mode.
- ❑ The OSSD indicator continues to light in red and the interlock indicator lights in yellow, when the SZ starts normal operation after power on (when "Now Loading" is changed to "Normal Operation" on the information display) with either "Manual/Manual" or "Manual/Automatic" for the configuration of start/restart mode. Continuously, the OSSD indicator lights in green and the interlock indicator lights off in the event of reset operation, if the SZ detects no object in the protection zone at that time.
- ❑ The OSSD indicator lights in red and the interlock indicator lights in yellow when the SZ detects the test piece in the protection zone with "Manual/Manual" for the configuration of start/restart mode. Continuously, the OSSD indicator continues to light in red and the interlock indicator lights off when the test piece is removed from the protection zone.
- ❑ The OSSD indicator lights in green after the specified delay time has been passed if the restart delay (ON-delay) function is applied to the SZ.
- ❑ The SZ does not go to the muted condition even if the muting inputs are activated in accordance with the specified sequence and time difference, when the SZ detects an object in the protection zone other than muting zone. This is only applicable if the muting function is applied.
- ❑ The SZ does not go to the muted condition if the muting inputs are activated with different sequence from the specified one. The SZ does not also go to the muted condition if the muting inputs are activated exceeding the specified time difference. These are only applicable if the muting function is applied.
- ❑ The muted condition is terminated if the specified muting period of time has been passed. This is only applicable if the muting function is applied.
- ❑ The SZ does not go to the suspension in teaching mode even if the teach input and teach ready input are activated in accordance with the specified sequence and time difference, when the SZ detects an object in the protection zone. This is only applicable if the suspension in teaching mode is applied.
- ❑ The SZ does not go to the suspension in teaching mode if the teach input is activated after the activation of teach ready input. The SZ also does not go to the suspension in teaching mode if the teach input and teach ready input are activated exceeding the specified time difference. This is only applicable if the suspension in teaching mode is applied.

- The override condition is terminated if the specified override period of time has been passed. This is only applicable if the override function is applied.
- The protection zone can be switched according to the signal combination of bank inputs in case of bank switching function.
- "Bank error" occurs if the protection zone is switched according to the unspecified sequence. This is only applicable if the bank sequence monitoring function is applied.
- If there is an unprotected space between the protection zone and the protective structure, test piece is always detected by the SZ when it goes through that space. This is only applicable if the SZ is used for the access protection (the application where the angle of the approach exceeds ±30° to the detection plane).
- The OSSD indicator lights in red when the protective structure moves exceeding the tolerance of reference point. This is only applicable if the SZ is used for the access protection (the application where the angle of the approach exceeds ±30° to the detection plane).

(4) Pre-check test while the machine operates

The purpose of this pre-check test is to make sure that the machine (hazards) stops its operation. This test must be performed after you completely make sure that there is nobody in the hazardous zone.

- Machine (hazard) stops its operation if the test piece is present in the specified protection zone. If the bank switching function is applied to the SZ, this test must be performed for the whole and every specified protection zone.
- The machine (hazard) still stops its operation as long as the test piece is present in the specified protection zone. If the bank switching function is applied to the SZ, this test must be performed for the whole and every specified protection zone.
- The machine (hazard) stops its operation when the power for the SZ is disconnected.
- The machine (hazard) stops its operation when the interlock indicator lights in yellow.
- The response time for overall safety-related control system (from the intrusion of test piece in the protection zone to the machine stop) is less than overall response time (T) used for the calculation of safety distance.

■ Daily inspection

The daily inspection for the SZ operation and the machine operation should be performed based on the following check items.

(1) Pre-check for installation conditions

- The SZ is installed so that the machine operator cannot go into or approach the hazardous area or hazards without passing through the protection zone of the SZ.
- The SZ is installed so that the machine operator cannot go into or approach the hazardous area or hazards without passing through any of the protection zone of the SZ belonging to the bank switching function.
- The SZ is installed at a location free from light interference, for example an incandescent lamp and a halogen lamp.
- There is no damage to the cable insulation.
  Additionally, the protection against the disconnection or short-circuit of cable, which might be caused by crushing or being caught in a machine, is taken into account.

(2) Pre-check test while the machine is stopped

You should do the following pre-check test with the test piece in order to make sure the operation of the SZ while the machine is stopped. In this case, you should supply the power only to the SZ. Test piece should match the minimum detectable object size you chose.

- The OSSD indicator lights in red when the test piece is present in the specified protection zone. This test must be performed for the whole specified protection zone. If the bank switching function is applied to the SZ, this test must be performed for the whole and every specified protection zone. If the muting function is applied to a part of the protection zone, this test must be performed during muted condition for the whole specified protection zone, except for muting zone.
- The OSSD indicator lights in red when the SZ detects the test piece at the intended detection plane (height) while the test piece vertical to the detection plane moves in the protection zone.
- The OSSD indicator lights in green when the SZ starts normal operation after power on (when "Now Loading" is changed to "Normal Operation" on the information display) and detects no object in the protection zone with "Automatic/Automatic" for the configuration of start/restart mode.
- The OSSD indicator continues to light in red and the interlock indicator lights in yellow, when the SZ starts normal operation after power on (when "Now Loading" is changed to "Normal Operation" on the information display) with either "Manual/Manual" or "Manual/Automatic" for the configuration of start/restart mode. Continuously, the OSSD indicator lights in green and the interlock indicator lights off in the event of reset operation, if the SZ detects no object in the protection zone at that time.
- The OSSD indicator lights in red and the interlock indicator lights in yellow when the SZ detects the test piece in the protection zone with "Manual/Manual" for the configuration of start/restart mode. Continuously, the OSSD indicator continues to light in red and the interlock indicator lights off when the test piece is removed from the protection zone.
- The OSSD indicator lights in green after the specified delay time has been passed if the restart delay (ON-delay) function is applied to the SZ.
- The SZ does not go to the muted condition even if the muting inputs are activated in accordance with the specified sequence and time difference, when the SZ detects an object in the protection zone other than the muting zone. This is only applicable if the muting function is applied.
- The SZ does not go to the muted condition if the muting inputs are activated with different sequence from the specified one. The SZ does not also go to the muted condition if the muting inputs are activated exceeding the specified time difference.
- The SZ does not go to the suspension in teaching mode even if the teach input and teach ready input are activated in accordance with the specified sequence and time difference, when the SZ detects an object in the protection zone. This is only applicable if the suspension in teaching mode is applied.
- The protection zone can be switched according to the signal combination of bank inputs.
- If there is an unprotected space between the protection zone and the protective structure, test piece is always detected by the SZ when it goes through that space. This is only applicable if the SZ is used for the access protection (the application where the angle of the approach exceeds ±30° to the detection plane).
- The OSSD indicator lights in red when the protective structure moves exceeding the tolerance of reference point. This is only applicable if the SZ is used for the access protection (the application where the angle of the approach exceeds ±30° to the detection plane).

(3) Pre-check test while the machine operates

The purpose of this pre-check test is to make sure that the machine (hazards) stops its operation. This test must be performed after you completely make sure that there is nobody in the hazardous zone.

- Machine (hazard) stops its operation if the test piece is present in the specified protection zone. If the bank switching function is applied to the SZ, this test must be performed for the whole and every specified protection zone.
- The machine (hazard) still stops its operation as long as the test piece is present in the specified protection zone. If the bank switching function is applied to the SZ, this test must be performed for the whole and every specified protection zone.
- The machine (hazard) stops its operation when the power for the SZ is disconnected.
- The machine (hazard) stops its operation when the interlock indicator lights in yellow.
- The response time for overall safety-related control system (from the intrusion of test piece in the protection zone to the machine stop) is less than overall response time (T) used for the calculation of safety distance.

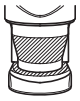
■ Regular (periodical) inspection

The responsible personnel must perform a regular inspection at least once every six months. Additionally, you should perform the regular inspection if you make any change to the configuration on the SZ and on the machine on which the SZ is installed.
Regular (periodical) inspection items include the following, in addition to the "Daily inspection" (page 16).

(1) Additional inspection items

- The SZ is installed without loosing the screws for fixture, in accordance with the specification of tightening torque in this manual.
- The screw on the connector cable is fastened tightly to the SZ.
- The SZ does not have any change on its position. (Safety distance is ensured, and the detection-plane is not changed.)
- The shielded wire is securely grounded.
- All of wires are correctly connected to external device, and the connection is securely performed.
- There is sufficient life left in terms of how many times the safety relay has been opened and closed.
- There is no damage to the SZ that may impair the performance of its protective IP65 structure.
- The surface of the window is not dirty or damaged.
- The OSSD indicator lights in red due to an error caused by the open-circuit of the EDM input while the test piece is present in the protection zone. This is only applicable if the EDM function is applied.
- The muted condition is terminated if the specified maximum muting period of time has been passed.
- The override condition is terminated if the specified maximum override period of time has been passed.
- The bank error occurs if the bank is switched according to unspecified sequence in case where the bank sequence monitoring is applied to the SZ.

■ Cleaning the window



The SZ window is a critical part of the detection system. You must clean the window whenever there is dust or pollution on it.
You should wipe off the pollution in the area indicated by the diagonal lines with a soft cloth moistened with a mild detergent that will not corrode polycarbonate.

NOTE

- OSSD might go to the OFF-state if the window has a scratch, because the SZ falsely detects that scratch as the object approaching into the protection zone. Be sure to take care that the window has no scratch on it.
- Be careful static electricity while cleaning because of avoiding dust collection. You should use a cloth that will be hard to generate static electricity when rubbed on polycarbonate.

Reference

Detection capability might be decreased due to the attenuation of light if the window has a pollution. OSSD goes to the OFF-state before the pollution on the window leads to loss of detection capability because the SZ has a function to monitor the pollution on the window. Furthermore, OSSD might go to the OFF-state if the window has a pollution because the SZ detects that pollution as the object approaching into the protection zone. Be sure to keep clean on the window to avoid unnecessary OFF-state of OSSD.

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