KEYENCE

D04GB

Safety Interlocking Switch
GS-M
User's Manual



This manual explains items such as the handling, operation, and precautions for the Safety Interlocking Switch GS-M. Read this manual carefully and thoroughly understand its contents to use the GS-M to the full extent of its capabilities.
Also, keep this manual in a safe place for future reference.
Ensure that the end user of this product receives this manual.

Symbols

DANGER	**Indicates a hazardous situation which, if not avoided, will result in death or serious injury.**
CAUTION	**Indicates a situation which, if not avoided, could result in product damage as well as property damage.**
Important	**Indicates cautions and limitations that must be followed during operation.**
Point	**Indicates additional information on proper operation.**
Reference	Indicates tips for better understanding or useful information.

Safety Precautions

■ General precautions

DANGER

- **KEYENCE does not guarantee the function or performance of the GS-M if it is used in a manner that differs from the GS-M specifications contained in this manual or if the GS-M is modified by the customer.**
- **The GS-M can only be used in combination with the dedicated actuators listed in this manual. It cannot be used in combination with other actuators or similar devices.**
- **Do not use a replacement actuator to bypass the GS-M. Store replacement actuators strictly to prevent their easy access.**
- **When using the GS-M to protect machine operators against a hazard or hazardous zone or when using the GS-M 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 GS-M is used. For such regulations, you should directly contact the regulatory agency responsible for occupational safety and health in your country or region.**
- **The responsible personnel must do the training to the assigned personnel for the correct use, installation, maintenance, and operation of the GS-M.**
- **The user of the machine must receive specialized training related to the GS-M and must then understand and adhere to the safety restrictions, laws, and regulations in the country or area in which the GS-M is being used.**
- **The GS-M is designed with the assumption that it would be correctly installed in accordance with the installation procedures described in this manual and correctly operated according to the instructions in this manual. You must perform an appropriate installation of the GS-M after performing a sufficient risk assessment for the target machine.**
- **Machine builder must consider the time the machine with inertia takes to stop.**

■ Environment of use

DANGER

- **Do not use a device that emits strong electromagnetic waves near the GS-M.**
- **This product is not intended for use as an explosion-proof product. Do not use this product in a hazardous location and/or potentially explosive atmosphere.**
- **Do not use the GS-M in the presence of substances, such as heavy smoke, particulate matter, or corrosive chemical agents, that may induce deterioration in product quality.**
- **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.**
- **Indoor use only.**

■ Target machines for installation

DANGER

- **It must be possible to perform an emergency stop on the machine to which GS-M is installed at any and all operation points during the operation cycle. Also, do not use the GS-M on machines that have irregular stop times.**
- **Do not use the GS-M 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.**

■ Circuit design and wiring

DANGER

- **Be sure to turn the power supply off before performing electrical wiring.**
- **Perform electrical wiring according to the electrical standards, regulations and laws in the country or area in which the GS-M will be used.**
- **Use cables with length less than or equal to the specification in this manual. Usage of cables longer than the specified length may cause the improper operation of safety functions.**

Important

- **When disposing the GS-M, always follow the applicable requirements of the laws, rules, regulations and standards in the country or region where the GS-M is used.**
- **Dispose of this product as industrial waste.**

Precautions on Regulations and Standards

■ CE Marking

KEYENCE Corporation has confirmed that this product complies with the essential requirements of the applicable EU Directive(s), based on the following specifications. Be sure to consider the following specifications when using this product in the Member States of European Union.

- Machinery Directive
- RE Directive

The GS-M is a safety component defined in the EU Machinery Directive Annex V and has been certified by TÜV SÜD Product Service GmbH. The GS-M complies with the following EN Standards.

- EN 61508
- EN ISO13849-1
- EN ISO14119
- EN 60947-5-3
- EN300 330
- EN 301 489-1, 3

The power supply that complies with SELV or PELV must be used.
The full text of the EU declaration of conformity is available at the following internet address: http://www.keyence.com/cedoc

- Frequency band of operation 125kHz
- Maximum H-field strength 60 dBμV/m

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

■ UL Certificate

The GS-M is a UL/c-UL certified product.

- UL File No.: E301717
- Category: NRKH/NRKH7
- Enclosure Type 1 (based on UL50)

Be sure to consider the following specifications when using this product as a UL/c-UL certified product.

- Use a power supply with Class 2 output defined in NFPA70 (NEC: National Electrical Code).
- Connect the power supply, external input, and control output to a single power supply with Class 2 output.

■ North American Regulations

The GS-M complies with the following North American regulations.
Applicable regulations:

- FCC Part15 Subpart B, Class A Digital Device
- FCC Part15 Subpart C
- ICES-003, Class A Digital Apparatus
- RSS-210

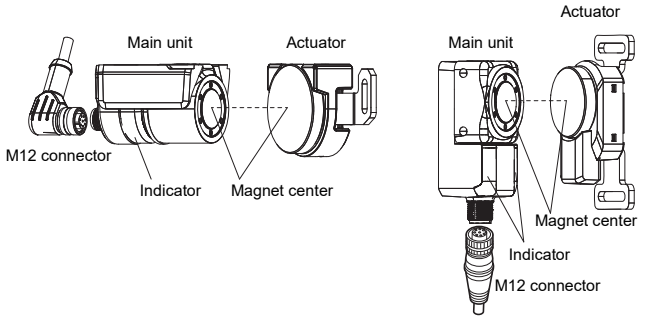
This device complies with part 15 of FCC Rules and Innovation, Science and Economic Development Canada's licence-exempt RSSs. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.
Le présent appareil est conforme à la partie 15 des règles de la FCC et aux normes des CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1)l'appareil ne doit pas produire de brouillage, et (2) l'appareil doit accepter tout brouillage subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.
FCC CAUTION
Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.
Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

1 Before Operation

1-1 Overview

The GS-M is a Type 4 Interlocking Device based on ISO14119. Both the low level coded actuator and the high level coded actuator can be used.
By combining the GS-M with a door or similar movable safety guard and with a safety-related control system, it is possible to stop hazardous machine operations if the door or similar part opens during hazardous machine operations.

■ Names of Each Part



DANGER	Do not use the lock function with a safety-related control system.

1-2 Product List

■ Main unit

GS-M 5 1 P

- P: PNP (OSSD)
  N: NPN (OSSD)
- 1: Standard, M12 connector
  3: Advanced function, M12 connector
- 5: Holding force for locked 500N
  9: Holding force for locked 900N
  L5: Holding force for locked 500N and suitable for sliding door

Model	Holding force	Shape	OSSD	Weight
GS-M51P	Locked: 500N Unlocked: approx. 30N	M12 connector Standard	PNP	approx.250 g
GS-M51N			NPN	
GS-M53P		M12 connector Advanced	PNP	
GS-M91P	Locked: 900N Unlocked: approx. 50N	M12 connector Standard	PNP	approx.480 g
GS-M91N			NPN	
GS-M93P		M12 connector Advanced	PNP	
GS-ML51P	Locked: 500N Unlocked: approx. 30N	M12 connector Standard	PNP	approx.240 g
GS-ML51N			NPN	
GS-ML53P		M12 connector Advanced	PNP	

■ Actuator

Model	Main unit	Coding level	Weight
GS-MA5M	GS-M5	Low	Approx. 160 g
GS-MA5U		High	Approx. 160 g
GS-MA9M	GS-M9	Low	Approx. 250 g
GS-MA9U		High	Approx. 250 g
GS-MAL5M	GS-ML5	Low	Approx. 130 g
GS-MAL5U		High	Approx. 130 g

■ M12 connector type cables

For Standard type, 8 pins

Model	Shape	Length	Weight
GS-P8L3	(Female)	3m	Approx. 160 g
GS-P8C3	(Female)	3m	Approx. 160 g
GS-P8C5		5m	Approx. 230 g
GS-P8C10		10m	Approx. 420 g
GS-P8LC1	(Female) (Male)	1m	Approx. 80 g
GS-P8CC1	(Female) (Male)	1m	Approx. 70 g
GS-P8CC3		3m	Approx. 170 g
GS-P8CC5		5m	Approx. 240 g
GS-P8CC10		10m	Approx. 450 g

For conversion from 8-pin to 5-pin (only GS-M51P/91P/L51P)

Model	Shape	Weight
GS-CC1		Approx. 19 g

When using the GS-CC1, the OSSDs operate as “Open/close link”. “OSSD operation” (page 7)

For Advanced function type, 12 pins

Model	Shape	Length	Weight
GS-P12L3	(Female)	3m	Approx. 170 g
GS-P12C3	(Female)	3m	Approx. 170 g
GS-P12C5		5m	Approx. 250 g
GS-P12C10		10m	Approx. 480 g
GS-P12C20		20m	Approx. 950 g
GS-P12LC1	(Female) (Male)	1m	Approx. 85 g

■ Mounting brackets

Model	Main unit	Detail	Weight
GS-MB11	GS-M5	For 30 to 40mm frames	Approx. 120 g
GS-MB12		For 30 to 40mm frames, Adjustable	Approx. 110 g
GS-MB13		For 40 to 45mm frames	Approx. 130 g
GS-MB21	GS-M9	For 30 to 40mm frames	Approx. 85 g
GS-MB22		For 30 to 40mm frames, Adjustable	Approx. 120 g
GS-MB23		For 40 to 45mm frames	Approx. 95 g
GS-MB31	GS-ML5	For 30 to 40mm frames, Adjustable	Approx. 270 g

1-3 Package Contents

■ Main unit

- Sensor (main unit)
- Instructions Manual
- Assist tool for alignment (Only with the M12 connector type of GS-M5 and GS-M9)

“Actuator” and “M12 connector type cable” have no accessories.

2 Installation

2-1 Installation Conditions

DANGER	• **The sensor’s operating distance may be affected by the presence of metal in the surrounding area. After installation, determine the minimum safety distance based on the actual operating distance and check if it is provided appropriately.** • **To minimize defeat possibilities, refer to ISO 14119 for relevant requirements and precautions.**
CAUTION	**The GS-M should be installed in a position where the main unit cannot be accessed or onto the metal frame which has heat dissipation capacity. Otherwise, accidental contact with the main unit might cause burn injury.**

Important	**Install the actuator and main unit in a manner that ensures the magnet centers are in close contact. If they are not in close contact, the holding force will be reduced.**

■ Alignment tolerance

● Typical Installation

GS-M5 / GS-M9

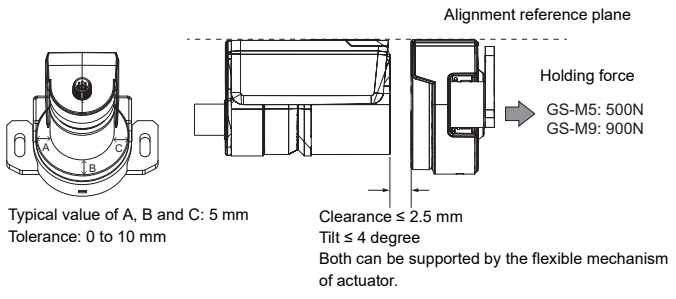
Align the alignment marks and magnet centers. (See Chapter 6, Dimensions).

GS-ML5

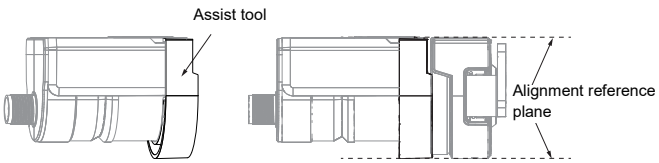
Align the detection centers and the magnet centers. (See Chapter 6, Dimensions).

● Tolerance

GS-M5 / GS-M9

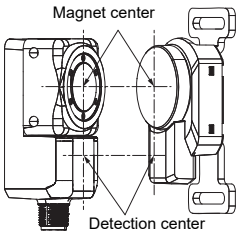


It is recommended to use the assist tool for alignment as it helps make aligning the unit very simple.

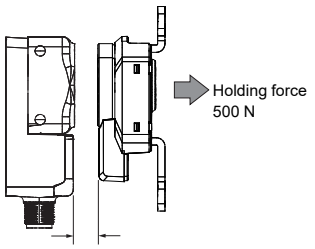


Important **After alignment, remove the assist tool from the main unit.**

GS-M L5



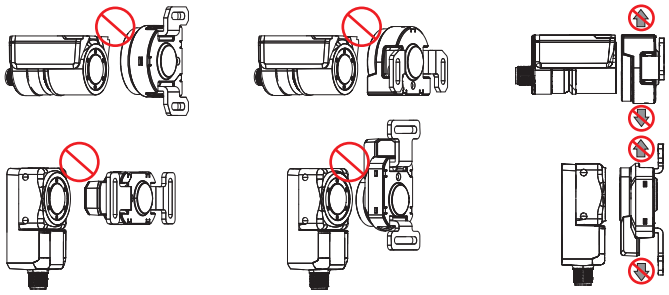
Misalignment between detection centers should be within 5 mm and the magnet centers should be within 5 mm.



Clearance ≤ 2.5 mm
Tilt ≤ 4 degree

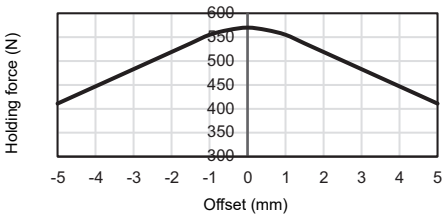
Both can be supported by the flexible mechanism of actuator.

● **Incorrect installation orientations and pulling direction**

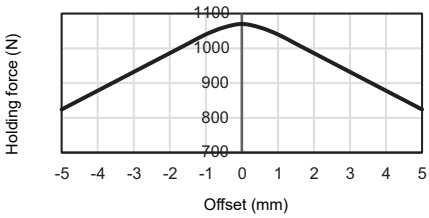


● **Reduction of holding force due to misalignment**

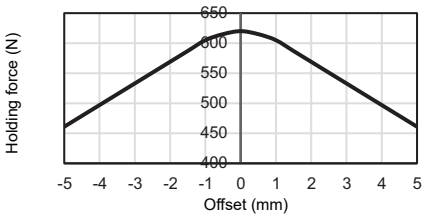
GS-M 5



GS-M 9

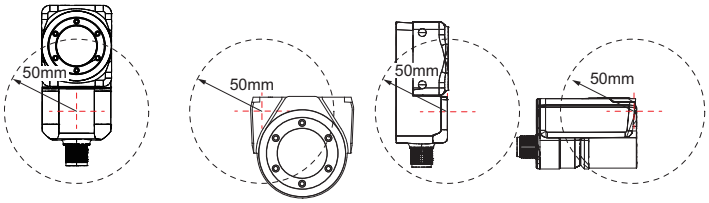


GS-M L5



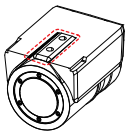
■ Mutual interference

When using multiple GS-M units in close proximity, they may malfunction due to mutual interference. To prevent mutual interference, do not place the detection center of any other main unit within 50mm around the detection center.

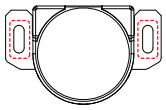


● **GS-M 5**

2 - M5 depth 5 mm
Tightening torque: 3.0 N·m

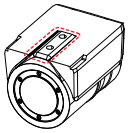


2 - M4
Tightening torque: 1.5 N·m

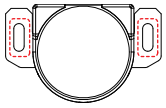


● **GS-M 9**

2 - M5 depth 5 mm
Tightening torque: 3.0 N·m

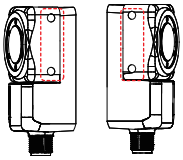


2 - M5
Tightening torque: 3.0 N·m

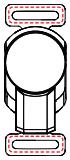


● **GS-M L5**

4 - M5 depth 5 mm
Tightening torque: 3.0 N·m



2 - M4
Tightening torque: 1.5 N·m



* Use 2 or more screw holes

■ Actuator teaching (when using the high coded actuator)

After the power is turned ON, the main unit will memorize the first actuator that has been detected while 3 seconds or more. When the teaching is completed, the indicator will blink green.
After restarting, only the memorized actuators can be detected.

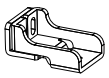
If you need to re-teach the unit to a new actuator, follow the procedure outlined in "4-7 Switching the Coding Level (Low to High)" (page 9).

- Re-teaching with another actuator
- Prohibit re-teaching

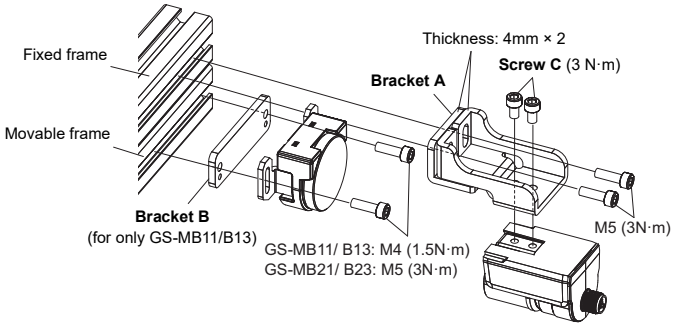
2-2 Installation Method of Mounting Brackets

■ GS-MB11 / B13 / B21 / B23

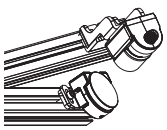
● **Package Contents**

Bracket A × 1	Bracket B × 1 (for only GS-MB11/B13) Thickness: 4mm	Screw C × 2 (M5 hexagon socket head cap screw, across-flats = 4 mm, L = 8 mm)
		

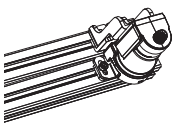
● **Installation**



Opening



Closing



■ GS-MB12 / GS-MB22

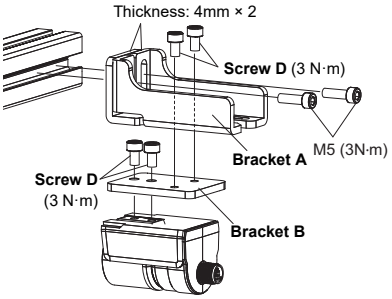
● **Package Contents**

Bracket A × 1	Bracket B × 1 Thickness: 4mm	Bracket C × 1 Thickness: 4mm
		

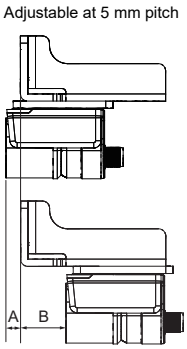
Screw D × 4
M5 hexagon socket head cap screw, across-flats = 4 mm, L = 8 mm

● **Installation**

Main unit

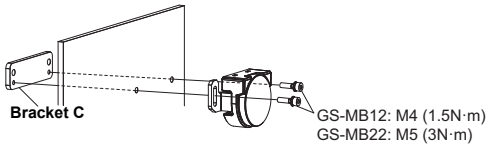


For alignment, bracket A has multiple holes. Use suitable holes.

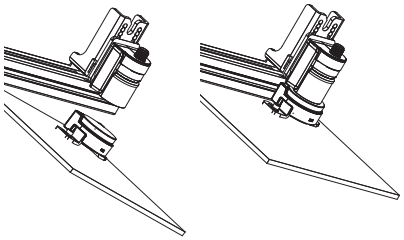


Model	A mm	B mm
GS-MB12	12	28
GS-MB22	10	30

Actuator



Opening Closing



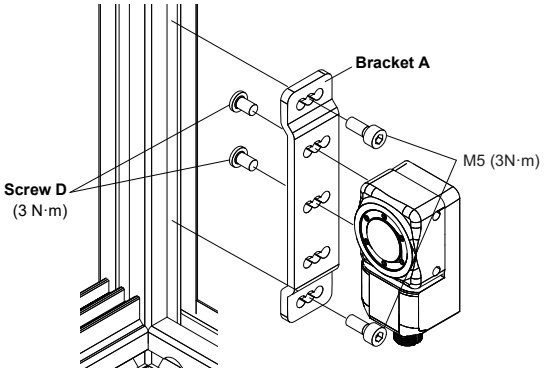
■ GS-MB31

● **Package Contents**

Bracket A × 1 Thickness: 4mm	Bracket B × 1 Thickness: 4.5mm	Bracket C × 1 Thickness: 4mm
Screw D × 2 (For main unit) M5 hexagon socket low head cap screw, across-flats = 4 mm, L = 8 mm	Screw E × 2 (For actuator) M4 hexagon socket head cap screw, across-flats = 3 mm, L = 7 mm	

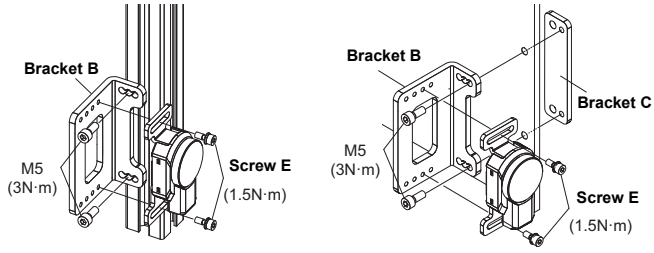
● **Installation**

Main unit



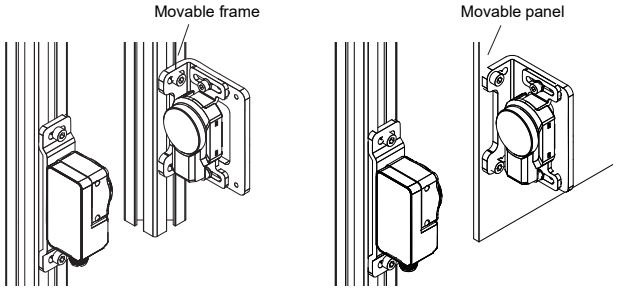
For alignment, there are multiple holes. Use suitable holes.

Actuator



For alignment, there are multiple holes. Use suitable holes.

It is possible to install the left and right sides reversed as shown below.

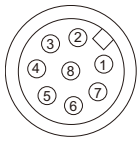


3 Wiring

3-1 Pin Assignment

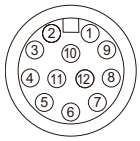
■ Standard type (GS-M51/ GS-M91/ GS-ML51)

Pin number	Wire color	Function
1	Gray	AUX output
2	Brown	+24 V DC
3	Light blue	Lock control input
4	Red/white	Safety input 2
5	Black	OSSD1
6	White	OSSD2
7	Blue	0 V
8	Red/black	Safety input 1



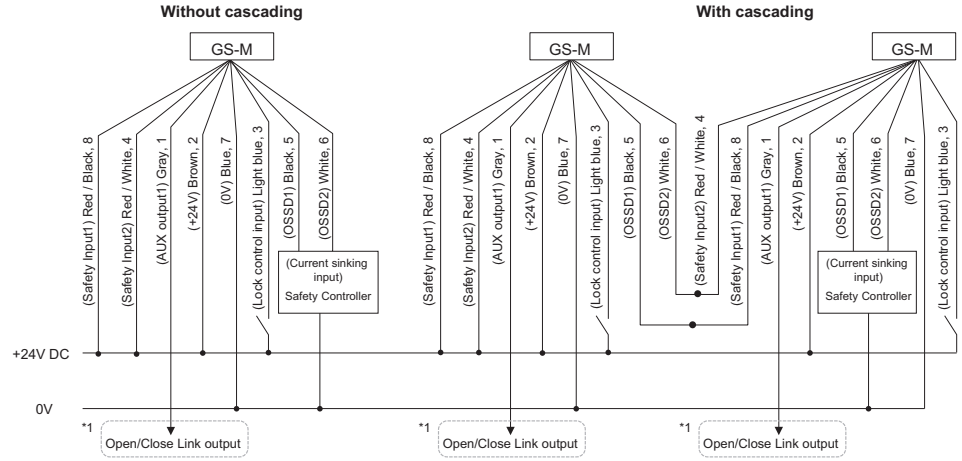
■ Advanced function type (GS-M53/ GS-M93/ GS-ML53)

Pin number	Wire color	Function
1	Brown	+24 V DC
2	Red/black	Safety input 1
3	Blue	0 V
4	Black	OSSD1
5	Gray	AUX output1
6	Red/white	Safety input 2
7	White	OSSD2
8	Pink	EDM selection input
9	Gray/black	AUX output 2
10	Light blue	Lock control input
11	Yellow	Reset/EDM input
12	Light blue/ black	OSSD operation switching input



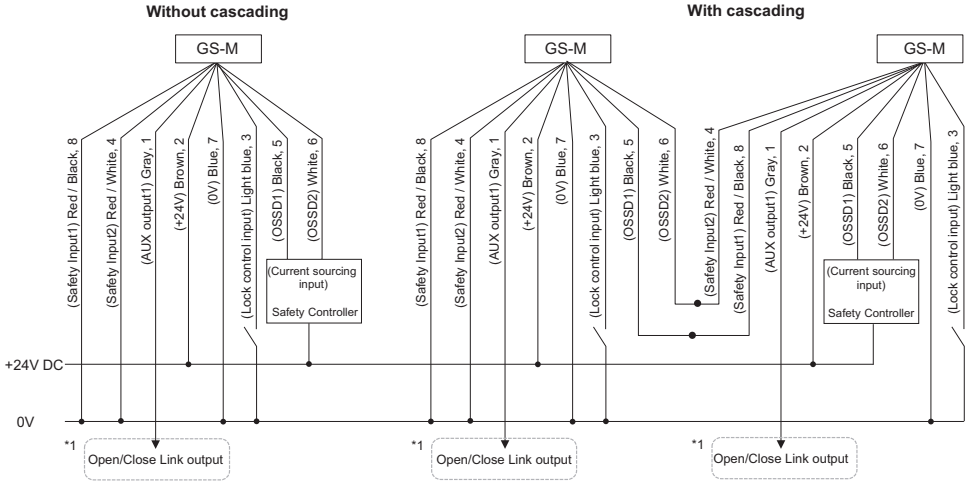
3-2 Wiring Example

■ GS-M51P / 91P / L51P (PNP)



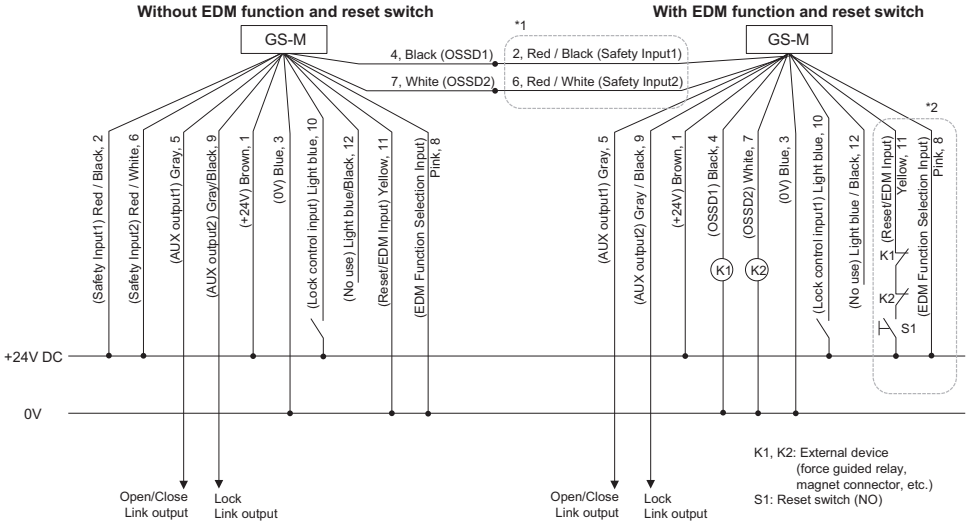
*1 When set the OSSD operation to “Open/close link”, the AUX should be connected to +24V DC.

■ GS-M51N / 91N / L51N (NPN)



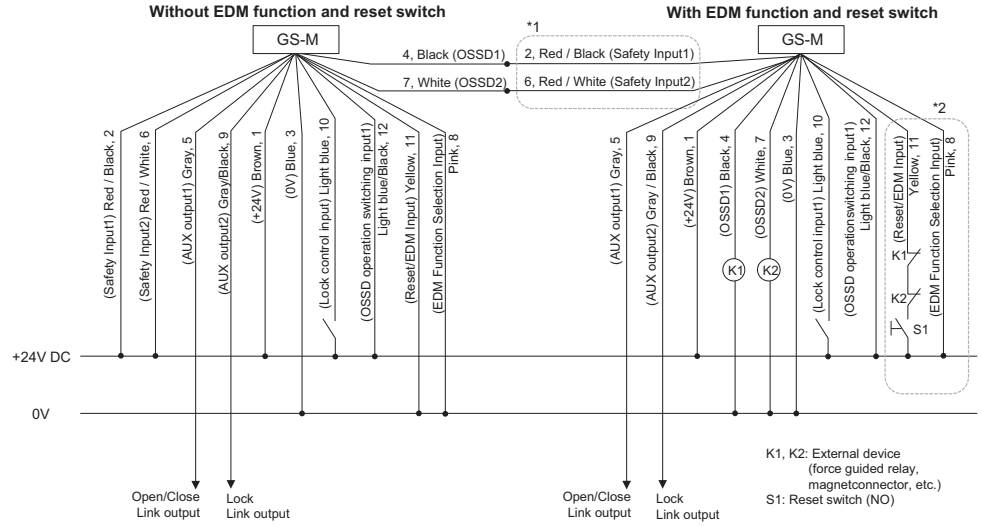
*1 When set the OSSD operation to “Open/close link”, the AUX should be connected to 0V.

■ GS-M53P / 93P / L53P (PNP) (OSSDoperation: Lock link)



*1 When using only 1st unit, the safety input1 and 2 should be connected to +24VDC.
*2 When using only EDM function, the EDM function selection input should be open and insulated.
When not using both EDM function and reset switch, the EDM function selection input and Reset/EDM input should be connected to 0V.

■ GS-M53P / 93P / L53P (PNP) (OSSDoperation: Open/close link)

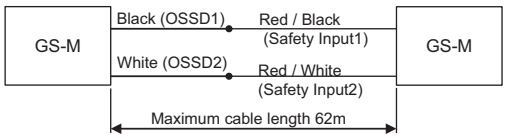


*1 When using only 1st unit, the safety input1 and 2 should be connected to +24VDC.
*2 When using only EDM function, the EDM function selection input should be open and insulated.
When not using both EDM function and reset switch, the EDM function selection input and Reset/EDM input should be connected to 0V.

■ Cable length and number of cascaded units

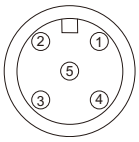
Maximum cable length: 31 m
Maximum number of cascaded units:
20 (for GS-M5 and GS-ML5)
16 (for GS-M9)

● With cascade connection

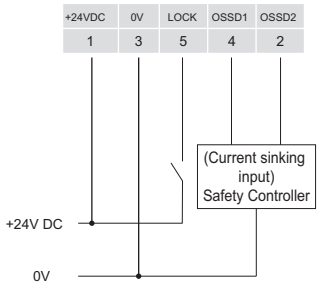


■ When using the GS-CC1

Pin number	Function
1	+24 V DC
2	OSSD2
3	0 V
4	OSSD1
5	Lock control input

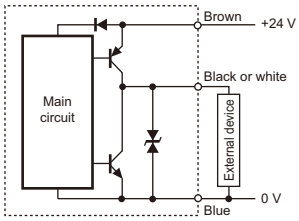


● GS-M51P / 91P / L51P (PNP)

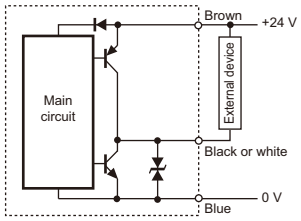


3-3 I/O Circuit Diagrams

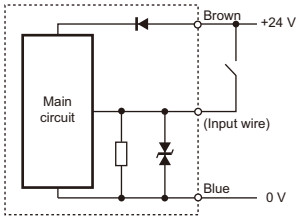
OSSD (PNP)



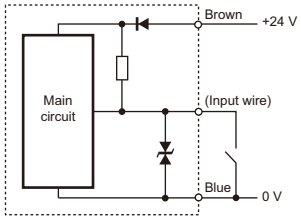
OSSD (NPN)



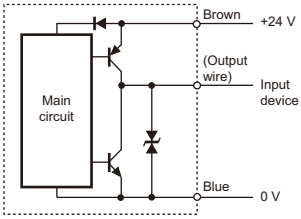
Input circuit (PNP)



Input circuit (NPN)



AUX output (PNP/NPN common)



4 Functions

The functions that can be used with the GS-M vary depending on the model of the main unit (simple function type/standard type/advanced function type).

Function	Standard	Advanced function
OSSD operation	Lock link or Open/close link	Lock link or Open/close link
Safety inputs	✓	✓
Number of AUX	1 *1	2
Interlock function	-	✓
EDM function	-	✓
Wiring saving unit GS-T01 *2	✓	-
GC-Link *3	✓ (For only PNP type)	-

*1 When set the OSSD operation to “Open/close link”, the AUX cannot be used.
*2 See the GS-T01 instruction manual.
*3 See the GC series user’s manual.

4-1 OSSD

An OSSD is a safety output for the safety-related part of a machine control system. The OSSD 1/2 is a pair of safety outputs that are redundant.
The GS-M 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.
If the internal control circuit receives a feed-back signal (OFF-signal) based on the self-diagnosis, the GS-M determines that its OSSD is operating normally. If the OFF-signal is not returned to the internal control circuit, the GS-M determines that there is a problem with the OSSD or wiring and enters into an error state.

■ OSSD operation

The OSSDs go to OFF state during start up and in the error state. When all of the conditions shown below are met during normal operation, the OSSDs go to ON state

● Lock link

- The actuator and main unit are aligned properly and in contact.
- Lock control input is ON.
- Safety inputs are ON.

● Open/close link

- The actuator and main unit are aligned properly and in contact.
- Safety inputs are ON.

Important

- **The starting time of the GS-M is approximately 2.5 seconds. During this time, the OSSDs are in the OFF state.**
- **The OSSDs keep the OFF state in the interlock state.**

■ OSSD operation switching

The OSSDs operation can be switched. The OSSDs operation is determined by the wiring during startup.

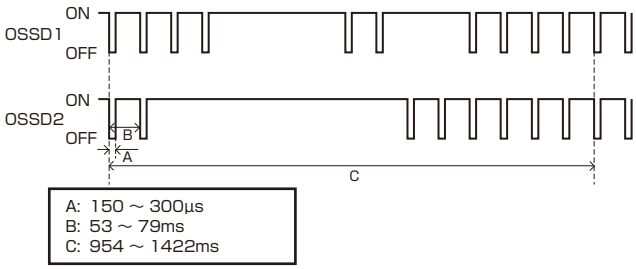
Lock link mode

Type		Pin No.	Wire color	Function	Connection
Standard	PNP	1	Grey	AUX output	Open or connected to input device
	NPN	1	Grey	AUX output	
Advanced	PNP	12	Light blue/ black	OSSD operation switching input	Open

Open/close link

Type		Pin No.	Wire color	Function	Connection
Standard	PNP	1	Grey	AUX output	+24V
	NPN	1	Grey	AUX output	0V
Advanced	PNP	12	Light blue/ black	OSSD operation switching input	+24V

■ OSSD self-diagnosis pulse



DANGER

- **If only one OSSD is used to construct the machine’s control system, an OSSD malfunction will make it impossible to stop the machine.**
- **To prevent malfunctions caused by ground faults on the OSSD wire, perform wiring in a manner such that the requirements specified in IEC 60204-1 are met.**

4-2 Safety Input

This function controls the OSSDs of the GS-M with input signals from sensors or emergency stop switches/buttons connected to the safety inputs.
Safety input 1 and safety input 2 form a safety input pair. If safety input 1 or safety input 2 turns OFF, the OSSDs turn OFF.
Multiple GS-M units can be connected and used in an expanded system (with a cascade connection) by connecting the OSSDs of a different GS-M or other GS models to the safety inputs.
"3-2 Wiring Example" (page 5)

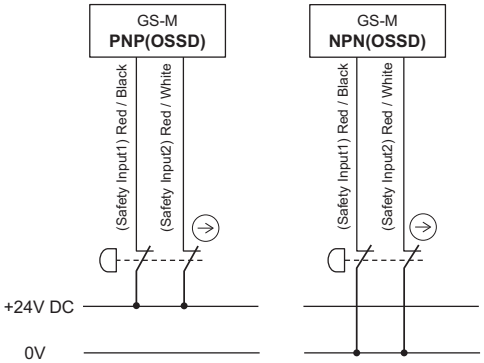
Reference

- Wire the safety inputs as shown below when they are not in use.
  PNP type: Short circuit to 24 V.
  NPN type: Short circuit to 0 V.
- If safety input 1 and safety input 2 are mismatched for 3 seconds or more a Safety Input Error will occur.

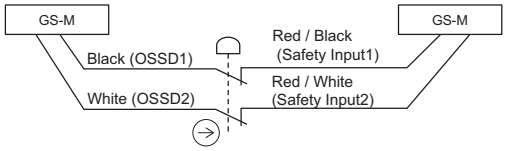
■ Emergency stop switch/button wiring

Wiring an emergency stop switch/button to the safety inputs makes it possible to perform an emergency stop on the machine by pressing the emergency stop switch/button.

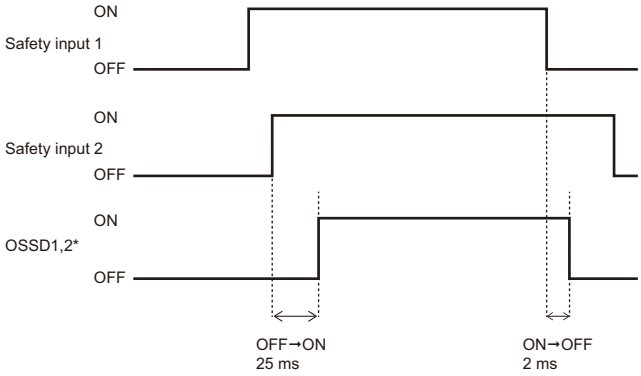
● **Without cascade connection**



● **With cascade connection**



■ Timing chart



* Case in which all the conditions for turning ON the OSSDs are met except for the safety inputs

DANGER	• **Use an emergency stop switch/button that has two or more independent, NC (normally closed) contacts. For the requirements related to emergency stop switches/buttons, see IEC 60204-1, ISO 13850, and all other requirements, regulations, standards, and laws related to occupational safety and health in the country or area where the GS-M will be used. For such regulations, you should directly contact the regulatory agency responsible for occupational safety and health in your country or region.** • **Ensure that the device does not start or restart automatically when the emergency stop switch/button is reset.** • **When using a PNP type, please connect the OSSDs of the PNP type GS-M or GS to the safety inputs.** • **When using a NPN type, please connect the OSSDs of the NPN type GS-M or GS to the safety inputs.**

4-3 Interlock Function

Interlock is a function that prevents the OSSDs from automatically going into the ON-state from the OFF-state. This prevents the unintended start-up and/or the unintended restart of the machine if the interlock is applied to the GS-M. It is necessary to perform the reset operation in order for the GS-M to go back to normal operation from the interlock condition.
On the advanced function type, the interlock function setting can be selected from two types: Automatic and Manual.
Automatic: (The interlock function is not used)
The OSSDs immediately switches to the ON state when the conditions for doing so—such as the unit being in the lock state with the guard closed—are met.
Manual:
Even if the conditions for switching the OSSDs to the ON state are met, the OSSDs maintain the OFF state (interlock state).
<Terminating the interlock state>
To set the OSSDs to the ON state and to start the machine, close the door to which the GS-M has been installed and perform the reset operation after the preparations for starting the machine are complete. This sets the OSSDs to the ON state and terminates the interlock state.

■ Interlock function settings

Use the wiring to configure the settings. The wiring method varies depending on whether the "4-4 EDM Function" (page 9) is used.

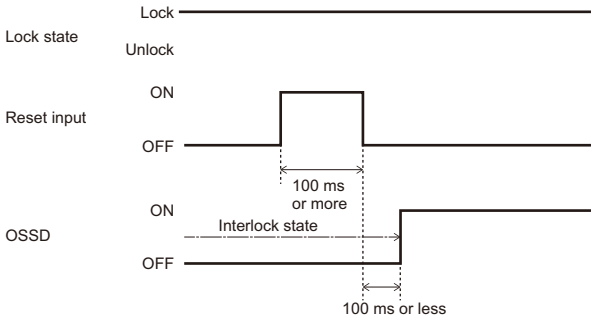
Interlock function	EDM function	Reset/EDM input (yellow)	EDM function selection input (pink)
Automatic	Not used	0 V	0 V
	Used	Connected to +24 V via the NC relay contacts	Open
Manual	Not used	Connected to +24 V via a NO reset switch	+24 V
	Used	Connected to +24 V via a NO reset switch and the NC relay contacts	+24 V

"3-2 Wiring Example" (page 5)

Important

Automatic and Manual can be used for different purposes as described below.
- **Automatic: This can be used on machines that can be started without any problems so long as the door, etc. is closed, or if the safety-related part of the control system other than the GS-M, such as a safety relay unit, can ensure the safety with other means.**
- **Manual: This can prevent unexpected starting of the machine and system when the power supply turns on. It can also prevent automatic restarting of the machine when the guard, etc. to which the actuator of the GS-M is installed closes. In both situations, the machine can be restarted by operating a start/restart switch after finishing a safety check.**

● **Timing chart (Interlock function: Manual)**



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.** • **Install the switch, etc. for releasing the interlock state in a position where it is possible to check the entirety of the hazardous zone and where the switch, etc. cannot be operated from within the hazardous zone.** • **When the interlock function is set to Automatic, it is necessary to ensure the safety of the entire control system in order to prevent unexpected starts from occurring.** • **Exercise caution to prevent the reset/EDM input from forming a short circuit with other inputs or outputs.**

■ Recovering from an error state using reset/EDM input

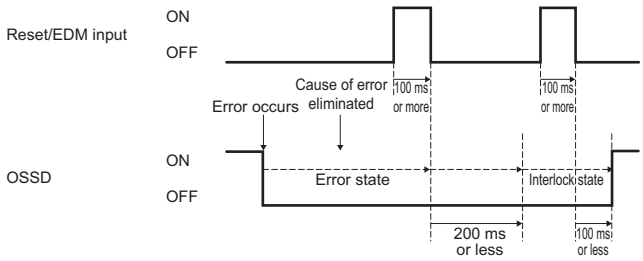
The GS-M returns to normal operation if the cause of the error is removed and the GS-M is reset.

Reference

Some errors cannot be recovered unless the power to the GS-M is turned off and back on again. "6-3 Troubleshooting" (page 11)

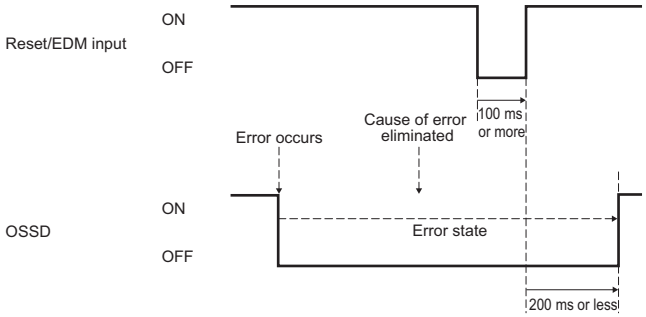
● **When Interlock function is "Manual"**

Use the NO reset switch to recover from an error state.



■ When Interlock function is "Automatic"

Insert an NC reset switch between the GS-M and the power supply and use the switch to recover from an error state.



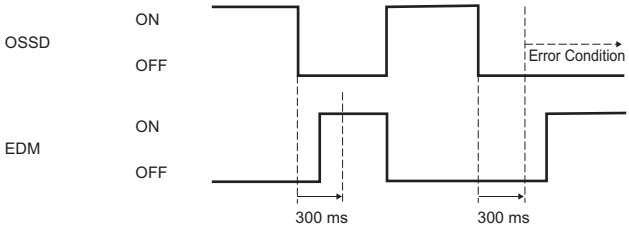
4-4 EDM Function

The GS-M can monitor the state of external devices, such as a force guided relay or magnetic contactor that are connected to the OSSDs, in order to detect the failure of the external device (such as contact welding), thereby enabling start or stop control of the machine's hazard. This monitoring function is called the EDM function.

■ EDM function settings

Use the wiring to configure the settings. The wiring varies depending on whether the interlock function is used.
"4-3 Interlock Function" (page 8).

- **Timing chart (interlock function: Automatic, EDM function: Used)**



Important

Note that there are limitations on the wiring when all of the conditions listed below are met.
- **The EDM function is used.**
- **The interlock function is not used (Automatic).**
- **Units are connected with a cascade connection.**

Only use the EDM function on the first unit in the cascade connection. If the EDM function is used on the second or later units in the cascade connection, EDM errors may occur with unexpected timing.

Point

The EDM function can be used to prevent the hazard from starting when contact welding occurs. However, the following differences are present depending on whether the interlock function is used.
- **The interlock function is not used (Automatic): EDM error**
- **The interlock function is used (Manual): No error occurs**

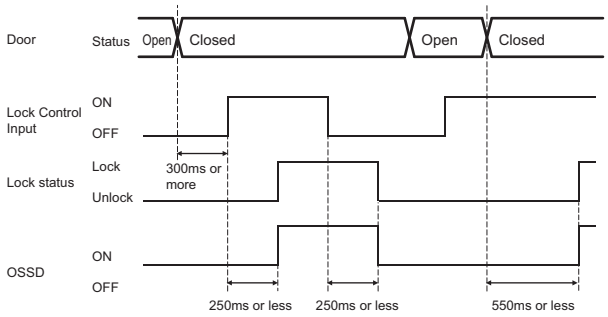
4-5 Lock Function

DANGER **Do not use the lock function with a safety-related control system.**

The lock function makes it possible to keep the guard (e.g. door), to which the GS-M actuator is installed, closed by electromagnetic power.

OSSD type	Power supply	Lock control input	Lock state
PNP	ON	ON (+24V)	Locked
		OFF (Open)	Unlocked
	OFF	-	Unlocked
NPN	ON	ON (0V)	Locked
		OFF (Open)	Unlocked
	OFF	-	Unlocked

- **Timing Chart (lock link mode)**



4-6 AUX Output

DANGER **The AUX outputs cannot be used as the safety outputs to a safety-related control system.**

This is an informational output used to check the operating status of the GS-M. The operation of the AUX output varies depending on the type of the main unit.
If an error occurs, the AUX outputs turn ON.

■ AUX operation

	Standard type	Advanced
AUX output 1	Open/close link	Open/close link
AUX output 2	-	Lock link

■ Open/close link

	Door state	
	Open	Close
AUX output 1	ON	OFF

Response time: "Open to close" is 300 ms, "Close to open" is 20 ms

■ Lock link

	Lock state	
	Unlocked	Locked
AUX output 2	ON	OFF

Response time: "Unlocked to locked" is 250 ms, "Close to open" is 250 ms

Reference

For both the PNP(OSSD) type and NPN(OSSD) type, the AUX outputs can be connected to either the current sinking input (PNP type input) or the current sourcing input (NPN type input). The above explanation pertains to the ON/OFF status of the loads when the AUX outputs are also used as PNP outputs for the PNP(OSSD) type and when the AUX outputs are also used as NPN outputs for the NPN(OSSD) type. Note that the ON/OFF status of the loads is the opposite of that explained above when using a PNP(OSSD) type with the AUX outputs used as NPN outputs and when using an NPN(OSSD) type with the AUX outputs used as PNP outputs.

4-7 Switching the Coding Level (Low to High)

When using the low coded actuator, the coding level of GS-M is "Low". In this case, any actuator is detected by the main unit. If switching the coding level to "High", only the specific actuator that has been taught is detected by the main unit.

■ Teaching/ Re-teaching procedure

(1) Connect the safety input 1 and lock control input without any other connection and start the main unit away from the actuator.
(2) When the indicator turns on and alternates between green and red, wait until it starts blinking orange.
(3) Move the actuator closer to the main unit to detect it.
(4) If (3) is executed correctly, the indicator will change from blinking orange to solid orange.
(5) Wait until the indicator alternates blinking between green and red.
(6) Move the actuator away from the main unit
(7) Execute steps (3) to (4) again. The indicator will change from orange to blinking green.
(8) Turn off the power.
(9) Change the wiring to the proper state and start the main unit. GS-M will be operated in the "High" coding level.

A sensor that is operating with the "High" coding level can be made to operate with a different actuator (up to seven times) by performing the same procedure again.

■ Prohibit Re-teaching

Re-teaching is prohibited by performing the following operations to the GS-M that is coding level "High".
(1) Connect the safety input 1 and lock control input without any other connection and start the main unit away from the actuator.
(2) When the indicator turns on and alternates between green and red, wait until it starts blinking orange.
(3) Move the actuator closer to the main unit to detect it.
(4) If (3) is executed correctly, the indicator will change from blinking orange to solid orange. Wait until it changes to alternating between green and red, orange lighting, and alternating between green and red in sequence. (Wait for approx. 10 seconds.)
(5) Move the actuator away from the main unit.
(6) Wait until the indicator changes from alternating between green and orange to green blinking.
(7) Power OFF.
(8) Change the wiring to the proper state and start the main unit. The GS-M will be operating in the "High" coding level.

Re-teaching has been prohibited, and the unit will not recognize any additional actuators.

5 Specifications

5-1 Specifications

Operating distance *1	**Sao(OFF→ON)**	0.1mm
	Sar(ON→OFF)	15mm
Response time *2	**Lock → Unlock**	250ms
	Unlock → Lock	250ms
	Detect → Not detect	20ms + 2ms × (number of cascaded unit -1)
	Not detect → Detect	300ms + 25ms × (number of cascaded unit -1)
Acceptable operation frequency		1.6Hz (IEC 60947-5-3)
Control output (OSSD output)	**Output**	Transistor outputs × 2
	Max. load current	150 mA
	Residual voltage (during ON)	Max. 2.5V (with a cable length of 5m) Max. 3.5V (with a cable length of 31m)
	OFF state voltage	Max. 2.0V (with a cable length of 5m) Max. 3.0V (with a cable length of 31m)
	Leakage current	Max. 0.5mA
	Max. capacitive load	0.8μF
	Load wiring resistance	Max. 2.5Ω
AUX (Non-safety-related output)	**Output**	Transistor output
	Max. load current	50mA
	Residual voltage (during ON)	Max. 2.5V(with a cable of 5m) Max. 3.5V(with a cable of 31m)
External input (Short circuit current)	**Safety input**	Approx. 1.5mA × 2
	Lock control input	Approx. 2.5mA
	Reset/EDM input	Approx. 5mA (For advanced function type only)
	OSSD operation switchin input	Approx. 2.5mA (For advanced function type only)
Power supply	**Power voltage**	24 V DC ±20% (Ripple P-P 10% or less, Class2)
	Power consumption (without load)	GS-M5 and GS-ML5: 5W, GS-M9: 6W
Protection circuit		Reverse current protection, short-circuit protection and surge protection for each output
Environ-mental resistance	**Enclosure rating**	IP65/67 (IEC60529)
	Operating ambient temperature	-20~55°C (No freezing)
	Storage temperature	-25~70°C (No freezing) *3
	Operating relative humidity	5%~95%RH
	Storage relative humidity	5%~95%RH
	Vibration resistance	10 to 55 Hz, Double amplitude 2.0 mm, 5 minutes in each of the X, Y, and Z directions (IEC 60947-5-3)
	Shock resistance	30 G in X, Y, Z directions 6 times each axis (IEC 60947-5-3)
Applicable Standards (Safety)		EN61508, IEC61508(SIL3), EN ISO13849-1:2015(PL e, Category 4), EN ISO14119(Type4), IEC60947-5-3, EN60947-5-3, UL 60947-5-2
Material	**Main unit**	PBT, PET/PAR, TPC, PC, Nickel-plated steel
	Actuator	GS-MA5 and GS-MAL5: PBT, SUS304, Nickel-plated steel GS-M9: PBT, Steel (Painted and Nickel-plated)
	Mounting brackets	Aluminum (Plate for actuator and screw: Steel)
Weight	**Main unit**	GS-M5: Approx. 250g, GS-ML5: Approx. 240g, GS-M9: Approx. 480g
	Actuator	GS-MA5: Approx. 160g, GS-MAL5: Approx. 130g, GS-MA9: Approx. 250g

*1 Due to the flexible structure of the actuator, the guard can open 3.8 mm larger than the "Sar". The clearance between the actuator and the main unit may be narrowed by a maximum of 2.3 mm due to the magnet power built into the actuator.

*2 Risk time according to IEC60947-5-3 is 150 ms + 2 ms × (number of cascaded units - 1).

*3 When stored for a long period of time, please store it at temperature of 55°C or lower.

■ Holding Force

Type	Locked	Unlocked
GS-M5	500N	Approx. 30N *1
GS-M9	900N	Approx. 50N *1
GS-ML5	500N	Approx. 30N *1

*1 When the actuator changes from the locked condition to the unlocked condition, the residual magnetic force increases the holding force until the actuator is separated from the main unit.

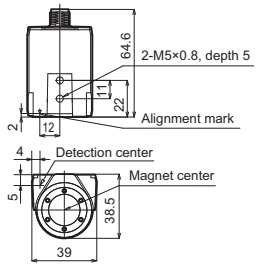
5-2 Safety-related parameters

Mission time	20 years
Hardware fault tolerance	1
Type of element	B
Performance level (ISO13849-1)	e
Category (ISO13849-1)	4
SIL (IEC 61508)	3
PFH (IEC 61508)	4.78×10^{-10}

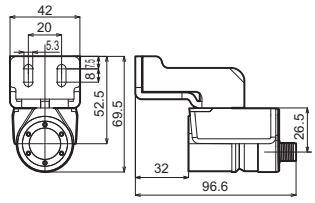
6 Appendix

6-1 Dimensions

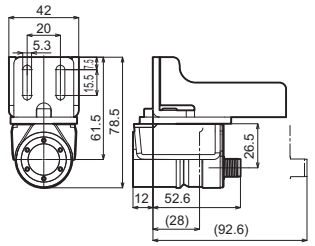
GS-M51/53



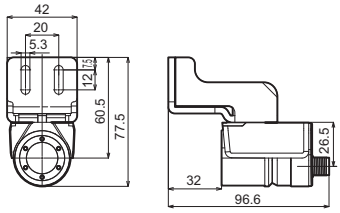
GS-M51/53 + GS-MB11



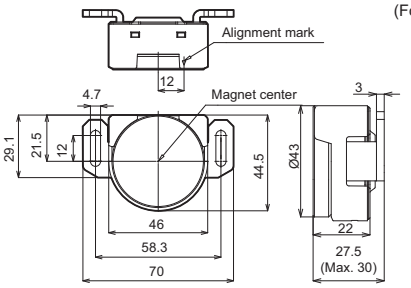
GS-M51/53 + GS-MB12



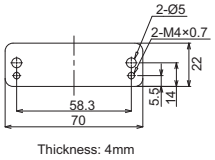
GS-M51/53 + GS-MB13



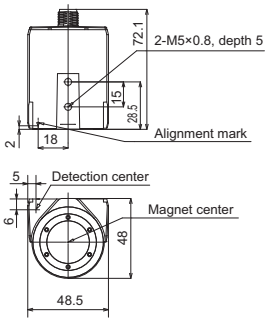
GS-MA5M/U



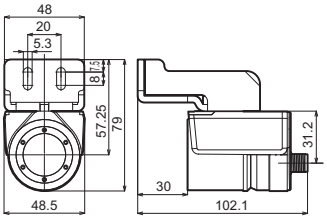
GS-MB11/12/13 Accessory
(For installing the actuator)



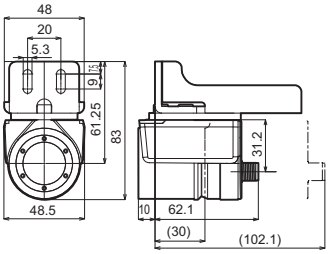
GS-M91/93



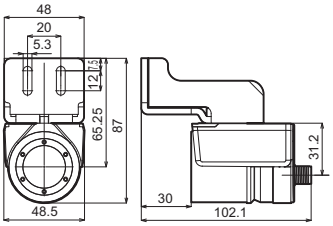
GS-M91/93 + GS-MB21



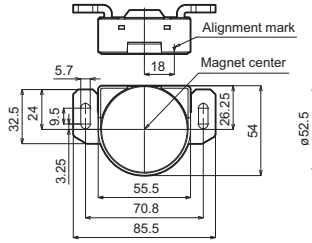
GS-M91/93 + GS-MB22



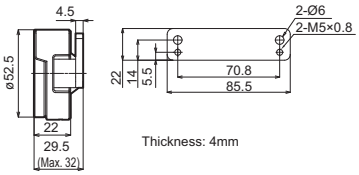
GS-M91/93 + GS-MB23



GS-MA9M/U

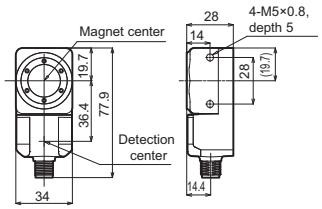


GS-MB22 Accessory
(For installing the actuator)

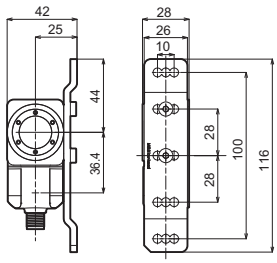


Thickness: 4mm

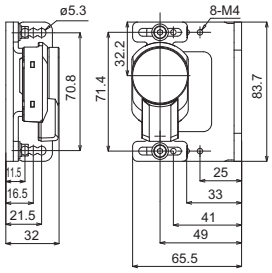
GS-ML51/53



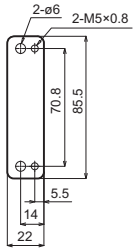
GS-ML51/53 + GS-MB31



GS-MAL5M/U + GS-MB31

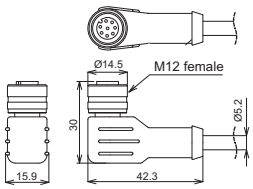


GS-MB31 Accessory
(For installing the actuator)

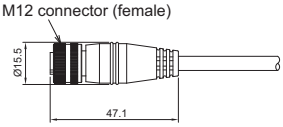


Thickness: 4mm

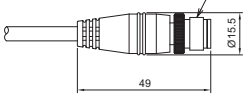
M12 L-shaped connector (female)



M12 connector (female)



M12 connector (male)

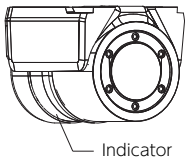


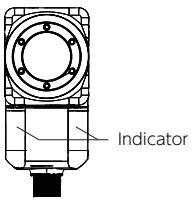
GS-CC1



Cable
Sheath diameter: 5.2 mm
Nominal cross-section area: Brown/Blue 0.22mm^2, Others 0.14 mm^2
Insulator diameter: Brown/Blue 1mm, Others 0.8 mm

6-2 Indicator Descriptions





■ Lock link mode (OSSD Operation)

Indicator	OSSD	Safety inputs	Lock control input	Actuator
Green*1	**ON**	**ON**	**ON**	**Detected**
Red	OFF	ON or OFF	ON or OFF	Not detected
Blinking green	OFF	**ON**	OFF	**Detected**
Orange	OFF	OFF	**ON**	**Detected**
Blinking orange	OFF	OFF	OFF	**Detected**
OFF		Power OFF		
Blinking orange(fast)	OFF	Incorrect actuator is detected. It is different from the high coded actuator memorized by teaching.		
Blinking red	OFF	Error state.		

*1 When the interlock function is set to manual, the indicator will turn orange until the reset/EDM input is operated.

■ Open/close link mode (OSSD Operation)

Indicator	OSSD	Safety inputs	Lock control input	Actuator
Green*1	**ON**	**ON**	ON or OFF	**Detected**
Red	OFF	ON or OFF	ON or OFF	Not detected
Orange	OFF	OFF	ON or OFF	**Detected**
OFF	OFF	Power OFF		
Blinking orange(fast)	OFF	Incorrect actuator is detected. It is different from the high coded actuator memorized by teaching.		
Blinking red	OFF	Error state.		

*1 When the interlock function is set to manual, the indicator will turn orange until the reset/EDM input is operated.

6-3 Troubleshooting

If the GS-M does not operate as intended, read the status from the “indicator”. “6-2 Indicator Descriptions”

■ Examples of indicator colors and causes

Indicator	Causes
OFF	• Wiring is not correct • The power is OFF or the voltage is not enough • The connector cable is disconnected • The main unit is broken • The cable is broken
Red	• The main unit and the actuator are misaligned • The main unit is affected by the surrounding metal. • The actuator is broken
Turn red for a moment	• The actuator or the main unit is affected by vibration or shock • The main unit is affected by mutual interference • Electrical noise is interfering with the detection of the actuator
Blinking orange and green	The main unit and actuator are misaligned, and the actuator cannot be detected correctly.

The holding force while locking is weak

- The surface of the actuator or main unit is dirty.
- The actuator and main unit are not aligned properly.
  “Alignment tolerance”
- The surface of the actuator or main unit is deformed

■ Error state

If an error is found by the self-diagnosis, the GS-M keeps the OSSD in the OFF state and switches to the error state. In the error state, the indicator blinks in red. The number of blinks varies depending on the cause of error.
The GS-M returns to normal operation if the cause of the error is removed and power is turned off and back on again.

Blinks number	Error name	Details	Countermeasures
1	OSSD*1	(1) The OSSD is short-circuited, or the wiring is wrong. (2) The OSSD experienced a surge in voltage due to an inductive load. (3) The OSSD is affected by electrical noise. (4) The OSSD is broken.	(1) Check the wiring for OSSD. (2) Use a load with a surge absorber function or apply surge protection to the load. (3) Check the wiring and the surrounding electrical noise. (4) Replace the main unit.
2	Safety inputs*1	The safety inputs are mismatched, or the wiring is wrong.	Check the wiring for the safety input.
3	Actuator detecting	(1) The main unit is affected by mutual interference. (2) The main unit is affected by electrical noise.	(1) Check the installation. (2) Check the wiring and the surrounding electrical noise.
4	EDM selection Input	EDM selection input or reset / EDM input are wired incorrectly.	Check the wiring for EDM selection input or reset / EDM input.
5	EDM	(1) Reset / EDM input is not connected correctly. (2) There is a welded contact on the external device.	(1) Check the wiring for the Reset / EDM input. (2) Replace the external device.
6	Communication	Unable to communicate with the GC or GS-T01.	Check the number of cascaded units. Check the surrounding electrical noise.
7 or 8	System	(1) The GS-M is affected by electrical noise. (2) The main unit is broken.	(1) Check the wiring and the surrounding electrical noise. (2) Replace the main unit.

*1 When using the advanced function type, it also returns to normal operation if the cause of the error is removed and the Reset / EDM input is operated.

6-4 Inspection and Maintenance

Inspect the safety function of the GS-M on the basis of the results of a risk assessment of the target machine. It is strongly recommended that, at minimum, the following items and periods be met.

⚠ DANGER	• **To prevent danger due to the machine starting, thoroughly ensure that no one is present in the hazardous zone during inspection.** • **If some error is found on the GS-M as a result of the inspection, do not operate the machine.**

■ Initial inspection

Items

- ☐ The main unit and actuator are installed on the basis of the installation conditions, installation methods, and wiring specifications specified in this manual.
- ☐ The safety functions being used (“4-1 OSSD” (page 7), “4-2 Safety Input” (page 8), “4-3 Interlock Function” (page 8) or “4-4 EDM Function” (page 9)) operate as intended.

■ Periodic inspection

Periods

If there is only infrequent action to change the state of OSSD due to open and close the guard or if an emergency stop switch is connected to the safety inputs, the inspection shall be made within the following test intervals in accordance with ISO 14119:

- SIL 3/ PL e: Once per month or more
- SIL 2/ PL d: Once per year or more

Items

- ☐ If an emergency stop switch is connected to the safety input, the safety function acts correctly when the emergency stop switch is pressed.
- ☐ There are no changes in the mounting conditions of the main unit and actuator or in the guard (e.g. door) to which these devices are installed.
- ☐ The guard (e.g. door) is not deformed.
- ☐ There are no changes to the installation status that will affect the results of the risk assessment carried out at the start of the installation.
- ☐ The seals have been applied correctly, in the case that seals have been applied to the mounting screws.
- ☐ No excessive damage or dirt is present.

Especially in the following cases, check the same details as the initial inspection.

- When a change is made to the installation, wiring, or functions
- When the main unit or actuator is replaced
- When the machine is not used for a long period of time
- When a defect occurs

Store the inspection results together with the machine’s records.
Errors found on the main unit or actuator cannot be repaired by the customer.
Replace the product with a new one or contact the nearest KEYENCE office.

6-5 Cleaning

In case metal powder or a similar substance is in contact with the faces of the main unit and actuator, clean the product.

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