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Safety Relay

Safety Relay

XSR Series

User Manual

XSR-MF2C
XSR-MF2S



Safety Instructions

- Read this manual carefully before installing, wiring, operating, servicing or inspecting this equipment.
- Keep this manual within easy reach for quick reference.

LSELECTRIC

Before using the product ...

For your safety and effective operation, please read the safety instructions thoroughly before using the product.

- ▶ Safety Instructions should always be observed in order to prevent accident or risk with the safe and proper use the product.
- ▶ Instructions are separated into “Warning” and “Caution”, and the meaning of the terms is as follows;



This symbol indicates the possibility of serious injury or death if some applicable instruction is violated



This symbol indicates the possibility of slight injury or damage to products if some applicable instruction is violated

- ▶ The marks displayed on the product and in the user’s manual have the following meanings.



Be careful! Danger may be expected.



Be careful! Electric shock may occur.

- ▶ The user’s manual even after reading shall be kept available and accessible to any user of the product.

Safety Instructions when designing

Warning

- ▶ **Please, install protection circuit on the exterior of RELAY to protect the whole control system from any error in external power or RELAY module.** Any abnormal output or operation may cause serious problem in safety of the whole system.
- Install applicable protection unit on the exterior of RELAY to protect the system from physical damage such as emergent stop switch, protection circuit, the upper/lowest limit switch, forward/reverse operation interlock circuit, etc.
- If any system error (watch-dog timer error, module installation error, etc.) is detected during CPU operation in RELAY, the whole output is designed to be turned off and stopped for system safety. However, in case CPU error if caused on output device itself such as relay or TR can not be detected, the output may be kept on, which may cause serious problems. Thus, you are recommended to install an addition circuit to monitor the output status.
- ▶ **Never connect the overload than rated to the output module nor allow the output circuit to have a short circuit,** which may cause a fire.
- ▶ **Never let the external power of the output circuit be designed to be on earlier than RELAY power,** which may cause abnormal output or operation.
- ▶ **In case of data exchange between computer or other external equipment and RELAY through communication or any operation of RELAY (e.g. operation mode change), please install interlock in the sequence program to protect the system from any error.** If not, it may cause abnormal output or operation.

Safety Instructions when designing



Caution

- ▶ **I/O signal line shall be wired at least 100mm away from a high-voltage cable or power line.** If not, it may cause abnormal output or operation.

Safety Instructions when designing



Caution

- ▶ **Use RELAY only in the environment specified in RELAY manual or general standard of data sheet.** If not, electric shock, fire, abnormal operation of the product or flames may be caused.
- ▶ **Before installing the module, be sure RELAY power is off.** If not, electric shock or damage on the product may be caused.
- ▶ **Be sure that each module of RELAY is correctly secured.** If the product is installed loosely or incorrectly, abnormal operation, error or dropping may be caused.
- ▶ **Be sure that I/O or extension connector is correctly secured.** If not, electric shock, fire or abnormal operation may be caused.
- ▶ **If lots of vibration is expected in the installation environment, don't let RELAY directly vibrated.** Electric shock, fire or abnormal operation may be caused.
- ▶ **Don't let any metallic foreign materials inside the product,** which may cause electric shock, fire or abnormal operation.

Safety Instructions when wiring

Warning

- ▶ **Prior to wiring, be sure that power of RELAY and external power is turned off.** If not, electric shock or damage on the product may be caused.
- ▶ **Before RELAY system is powered on, be sure that all the covers of the terminal are securely closed.** If not, electric shock may be caused

Caution

- ▶ **Let the wiring installed correctly after checking the voltage rated of each product and the arrangement of terminals.** If not, fire, electric shock or abnormal operation may be caused.
- ▶ **Secure the screws of terminals tightly with specified torque when wiring.** If the screws of terminals get loose, short circuit, fire or abnormal operation may be caused.
- ▶ **Surely use the ground wire of Class 3 for PE terminals, which is exclusively used for RELAY.** If the terminals not grounded correctly, abnormal operation may be caused.
- ▶ **Don't let any foreign materials such as wiring waste inside the module while wiring,** which may cause fire, damage on the product or abnormal operation.

Safety Instructions for test-operation or repair

Warning

- ▶ **Don't touch the terminal when powered.** Electric shock or abnormal operation may occur.
- ▶ **Prior to cleaning or tightening the terminal screws, let all the external power off including RELAY power.** If not, electric shock or abnormal operation may occur.
- ▶ **Don't let the battery recharged, disassembled, heated, short or soldered.** Heat, explosion or ignition may cause injuries or fire.

Caution

- ▶ **Don't remove PCB from the module case nor remodel the module.** Fire, electric shock or abnormal operation may occur.
- ▶ **Prior to installing or disassembling the module, let all the external power off including RELAY power.** If not, electric shock or abnormal operation may occur.
- ▶ **Keep any wireless installations or cell phone at least 30cm away from RELAY.** If not, abnormal operation may be caused.

Safety Instructions for waste disposal

Caution

- ▶ **Product or battery waste shall be processed as industrial waste.** The waste may discharge toxic materials or explode itself.

Precautions for Building a Safety System

Caution

- ▶ Please ensure that all tasks related to building a safety system (design, installation, operation, maintenance, etc.) are conducted by technicians who have received sufficient education and training on safety standards and the system.
- ▶ For devices and components related to safety functions connecting to safety input/output modules, please use products that meet the required safety level and category specifications.
- ▶ Before the system is operational, conduct a test run to ensure that all safety devices operate correctly according to expected functions, and complete the safety verification.
- ▶ Make sure the system does not operate without the safety verification. There is a risk of severe injury to people if the safety functions are compromised.
- ▶ Confirm that the calculated safety response time meets the required specifications. There is a risk of severe injury to people if the safety functions are compromised.
- ▶ Do not use non-safe signals and data for controlling safety-related functions. There is a risk of severe injury to people if the safety functions are compromised.
- ▶ Do not use the LED of safety modules for controlling safety-related functions. There is a risk of severe injury to people if the safety functions are compromised.
- ▶ The responsibility for compliance of the entire established safety system falls on the customer.



Revision History

Version	Date	Remark	Chapter
V1.0	'25.07	First Edition	-

Thank you for purchasing PLC of LS ELECTRIC Co., Ltd.

Before use, make sure to carefully read and understand the User's Manual about the functions, performances, installation and programming of the product you purchased for correct use and importantly, let the end user and maintenance administrator to be provided with the User's Manual.

The User's Manual describes the product. If necessary, you may refer to the following description and order accordingly. In addition, you may connect to our website (<https://ssq.ls-electric.com/>) and download the information as a PDF file.

TABLE OF CONTENTS

© TABLE OF CONTENTS ©

Chapter 1 Introduction 1-1~1-3

1.1 How to use the User's Manual 1-1
1.2 Features 1-2
1.3 Terminology 1-3

Chapter 2 General Specifications 2-1

2.1 General Specification 2-1

Chapter 3 Safety Relay Module..... 3-1~3-12

3.1 Performance Specifications..... 3-1
3.2 Part Names and Functions..... 3-2
3.3 IO Port Pinout and Functions 3-4
3.4 LED Indicator 3-5
3.5 OPERATING MODES 3-6
 3.5.1 Programming the Safety Relay..... 3-6
 3.1.2 MANUAL MODE..... 3-6
 3.1.3 SIMULTANEITY CHECK..... 3-7
3.6 OPERATING MODES 3-8
 3.6.1 Operating Modes 1A, 1C 3-8
 3.6.2 Operating Modes 2A, 2M, 2C 3-9
 3.6.3 Operating Mode 3A, 3C 3-10
 3.6.4 Operating Modes 4A, 4C 3-12

Chapter 4 IO Port SIGNAL 4-1~4-2

4.1 INPUT..... 4-1
 4.1.1 RESTART command 4-1
 4.1.2 K1K2 FEEDBACK input 4-2
4.2 OUTPUTS..... 4-2
 4.2.1 SYSTEM STATUS output..... 4-2

Chapter 5 Installation and Wiring..... 5-1~5-5

5.1 Installation..... 5-1
 5.1.1 Environment..... 5-1
 5.1.2 Cautions for handling 5-1
 5.1.3 Cautions for wiring 5-1
 5.1.4 Installation and removal of module 5-2
 5.1.5 Cautions for installation 5-2
5.2 Wiring 5-4

5.2.1 Power supply	5-4
5.2.2 Input/Output Device Wiring	5-4
5.2.3 Grounding circuit	5-4
5.2.4 wire specification	5-5
<div>Chapter 6 Maintenance 6-1~6-2</div>	
6.1 Inspection and Maintenance	6-1
6.2 Daily Inspection	6-2
6.3 Regular Inspection.....	6-2
<div>Chapter 7 EMC Compliance..... 7-1~7-3</div>	
7.1 Requirements Complying with EMC Specifications	7-1
7.1.1 EMC specifications	7-1
7.1.2 Panel.....	7-2
7.1.3 Cable.....	7-3
<div>Appendix 1 PFH Value..... A1-1</div>	
<div>Appendix 2 Dimensions..... A2-1</div>	

Chapter 1 Introduction

1.1 How to Use this Users' Manual

This users' manual provides information on the specifications, performance, functions and operation required for using the XSR Series Safety Relay.

The constitution of the user's manual is as follows;

Chapter	Subject	Description
Chapter 1	Introduction	Describes the constitution of the manual, and characteristics and terms used in relation with the product.
Chapter 2	General Specifications	Describes basic specifications of the modules of the XSR.
Chapter 3	Safety Relay Module	Describe the product types available for the XSR configuration.
Chapter 4	IO Port SIGNAL	
Chapter 5	Installation and Wiring	Describes installation and wiring of the system to ensure high reliability.
Chapter 6	Maintenance	Describes manual procedures of the system maintenance to ensure normal operation.
Chapter 7	EMC Compatibility	Describes system configuration to meet EMC requirements.
Appendix 1.	PFH Calculations	Provides information on PFH Calculations
Appendix 2.	Dimensions	Provides information on the outer dimensions of the XSR

1.2 Features

The XSR-MF2 Safety Relay has following features.

The XSR-MF2 Safety Relay can monitor two inputs coming from safety gate, safety guard or similar (two channels electromechanical safety switch)

1) Compatible to international safety standards

A safety control system can be built to satisfy international safety standards.

- SIL 3 (IEC 61508 : 2010)
- maximum SIL 3 (IEC 62061 : 2005 / A2:2015)
- PLe, Category 4 (EN ISO 13849-1 : 2015)

2) Compact size

Innovative compact size compared to the performance – saving expensive space.

3) System configuration

The XSR-MF2 Safety Relay module main features are the following:

- Different safety functions selectable via rotary switch:
 - Safety barrier with fail safe outputs
 - Dual channel Emergency stop button
 - Gate monitoring applications
 - Two-hand control
 - Type 2 safety photocells
- Restart manual or automatic selectable
- 2 N.O. outputs with guided contact safety relays
- 1 system monitor PNP output
- 1 external contactors feedback input
- 1 System test input (for Type 2 light curtains)

1.3 Terminology

For the purpose of this document, the following terms shall have the following definitions:

Term	Definition	Remark
Module	A standardized unit having a specific function, for constituting the entire system, e.g., I/O board.	E.g.) CPU module, Input/Output module
LL0, LL1	Logic Level 0, Logic Level 1	-
PL	Performance Level	-
SIL	Safety Integrity Level	-
PFH (Probability of Failure per Hour)	Indicates per hour failure rate of a system or device. Used to calculate SIL (Safety Integrity Level) of a safety system.	-
Function	An operation unit which outputs result of operation right out, not saving the result in the command, for example, the four arithmetical operations, comparison operation.	-

Chapter 2 General Specifications

2.1 General Specifications

The general specifications of the XSR series are as follows.

No.	Items	Specifications			Related standards		
1	Ambient temperature	0 ~ 55 °C					
2	Storage temperature	-25 ~ +70 °C					
3	Ambient humidity	5 ~ 95%RH (Non-condensing)					
4	Storage humidity	5 ~ 95%RH (Non-condensing)					
5	Vibration resistance	Occasional vibration			-	IEC61131-2	
		Frequency	Acceleration	Amplitude	times		
		5 ≤ f < 8.4Hz	—	3.5mm	10 times each directions (X, Y and Z)		
		8.4 ≤ f ≤ 150Hz	9.8m/s ² (1G)	—			
		Continuous vibration					
		Frequency	Acceleration	Amplitude			
		5 ≤ f < 8.4Hz	—	1.75mm			
		8.4 ≤ f ≤ 150Hz	4.9m/s ² (0.5G)	—			
6	Shock resistance	• Peak acceleration: 147 m/s ² (15G) • Duration: 11ms • Half-sine, 3 times each direction per each axis			IEC61131-2		
		Electrostatic discharge	Voltage: 4kV (Contact discharge)			IEC61131-2 IEC61000-1-2	
		Radiated electromagnetic field noise	80 ~ 500 MHz, 10V/m			IEC61131-2, IEC61000-4-3	
		Fast transient/bust noise	Segment	Power supply module	Digital/analog input/output communication interface		IEC61131-2 IEC61000-1-4
			Voltage	2kV	1kV		
8	Environment	Free from corrosive gasses and excessive dust					
9	Altitude	Up to 2,000 ms					
10	Pollution degree	2 or less					
11	Cooling	Air-cooling					

Note

1) IEC (International Electrotechnical Commission):

An international nongovernmental organization which promotes internationally cooperated standardization in electric/electronic field, publishes international standards and manages applicable estimation system related with.

2) Pollution degree:

An index indicating pollution degree of the operating environment which decides insulation performance of the devices. For instance, Pollution degree 2 indicates the state generally that only non-conductive pollution occurs. However, this state contains temporary conduction due to dew produced.

Chapter 3 Safety Relay Module

3.1 Performance Specifications

The performance specification of the XSR-MF2 is presented in the table below.

Item	Description	Remark
Input number/data (type 3)	4 / according to standard EN61131-2, type 3	Input Data
Input current	Typical 4.3mA	
Input voltage	0VDC...30VDC	
Input number/data (type 2)	1 / according to standard EN61131-2, type 2	
Input current	Typical 10mA	
Input voltage	0VDC...30VDC	
Number of EDM input	1 N.C. contact	
EDM Response time	300ms	
System Test Input	100mA@24VDC; (t>40 msec)	
System Status Output	100mA@24VDC	Output Data
Number of safety output	2 N.O. contacts	
Type	Relays with forced guided contacts	
Max switching voltage	250VAC, 125 VDC, Overvoltage Category III	
Max switching current	6A (AC), 6A (DC)	
Max switching power	1500VA, 180W (85W if load voltage >30Vdc)	
Max Response time	20ms	
Mechanical service life	10 x 10E6	
Electrical service life AC1 at 360 switchings/h	> 10E5	
Operating modes	Automatic, Monitored or Manual selectable via rotary switch	-
Connections	16 Terminal blocks with protection against reversal of polarity	-
Status indicators	Led: Input status – Output status – Fail	-
Applicable specification	SIL 3 (IEC 61508 : 2010) maximum SIL 3 (IEC 62061 : 2005 / A2:2015) PLe, Category 4 (EN ISO 13849-1 : 2015)	-
Power supply	DC +24V (DC +19.2 ~ 28.8V) Extra-Low Voltages with Safe Separation power supply (SELV, PELV)	Safety Extra Low Voltage (SELV) Protective Extra Low Voltage (PELV)
PFH	5,06E-09	-
DCavg	99%	-
H/W Fault Tolerance	1	-
Internal consumption current	250 mA	-
Max length of connections	100M	-
Weight	150g	-

3.2 Part Names and Functions

<Front View>

<Top View>

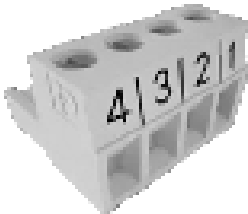
No.	Name	Description
①	IN1 LED	Green ON: Input contact1 ON. Green OFF: Input contact1 OFF
②	IN2/ FAIL LED	Red ON: Fault detected. Green ON: Input 2 ON OFF: Input 2 OFF
③	GUARD/ BREAK LED	Red ON: Output relays opened. Red blinking: The number of blinks show the type of FAIL (only with red FAIL led ON). Green ON: Output relays closed Yellow ON: Input ON Yellow OFF: Output OFF, waiting for Restart
④	Programming rotary switch	Rotary switch for its mode of operation selection.

⑤	IN/Out Connector	DC 24V power supply terminal block for the Safety Relay. (+24V, 24G, PE) In/Out Port terminal block for the Safety Relay. The product model name varies depending on the connector's connection method: C: Clamp type, S: Screw type
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C: Clamp type:



S: Screw type:









- The max Simultaneity check value will be:
 - Mode 3A, 3C: 500 msec
 - Mode 2A, 2M, 2C: 1 sec
- Please refer to the OPRATING MODE EXAMPLE section for a detailed explanation of the simultaneity check.

3.3 IO Port Pinout and Functions

TERMINAL	SIGNAL	TYPE	DESCRIPTION
1	24VDC	-	Power supply 24VDC
2	0VDC	-	Power supply 0VDC
3	PE	-	Ground connection
4	RESTART	Input	Restart command
5	-	-	-
6	SYS TEST	Input	Test for Type 2 photocell application
7	INPUT1	Input	Safety Input 1
8	INPUT2	Input	Safety Input 2
9	OUT TEST1	Output	Test output 1 for mechanical switch
10	OUT TEST2	Output	Test output 2 for mechanical switch
11	K1 K2 FBK	Input	Feedback external contactors K1K2
12	SYS STATUS	Output	Output status
13	B NO1	Output	Safety relay B, contact 1 (N.O.)
14	B NO2	Output	Safety relay B, contact 2 (N.O.)
15	A NO1	Output	Safety relay A, contact 1 (N.O.)
16	A NO2	Output	Safety relay A, contact 2 (N.O.)

3.4 LED Indicator

Diagnostic Operation LED Indicator

LED			MEANING
IN GREEN	IN2/FAIL RED	GUARD/BREAK (RED led pulses)	
OFF	ON	 (2 pulses)	• Possible fault of Microcontroller board
OFF	ON	 (3 pulses)	• Internal relays fault
OFF	ON	 (4 pulses)	• K1K2 external relays fault
OFF	ON	 (5 pulses)	• User configuration failure
OFF	ON	 (6 pulses)	• User configuration changed without system restart
OFF	ON	 (7 pulses)	• Possible overload or • SYSTEM STATUS connection error

3.5 OPERATING MODES

By means of the rotary switch on the relay frontal panel it is possible to select between different operating modes:

Rotary switch position	Operating mode selected	Operating mode description
P	Programming	Programming mode start
1	1A	OSSD double input, automatic restart mode
2	1C	OSSD double input, monitored restart mode
3	2A	Gate monitoring/Emergency stop function, automatic restart mode
4	2M	Gate monitoring/Emergency stop function, manual restart mode (not monitored)
5	2C	Gate monitoring/Emergency stop function, monitored restart mode
6	3A	Two-hands control, automatic restart mode, two N.O. contacts
7	3C	Two-hands control, automatic restart mode, changeover contact
8	4A	Type 2 photocells control, automatic restart mode
9	4C	Type 2 photocells control, monitored restart mode

Table 1 - Operating Modes

3.5.1 Programming the Safety Relay

XSR-MF2 provides on the front panel a rotary switch for its mode of operation selection. The programming sequence is the following:

STEP	OPERATION
1	Set the rotary switch to configuration position P
2	Switch on the power supply of the device
	The led IN1 is flashing green (the device is waiting the programming)
3	Adjust the rotary switch to the needed position (refer to Table 2 - Operating Modes)
	During the rotation the led IN2/FAIL lapse green by every step
4	Wait 5 seconds until led IN1 flashes three times (memorization) and remains on
5	Turn OFF the power (the device is now ready to work)

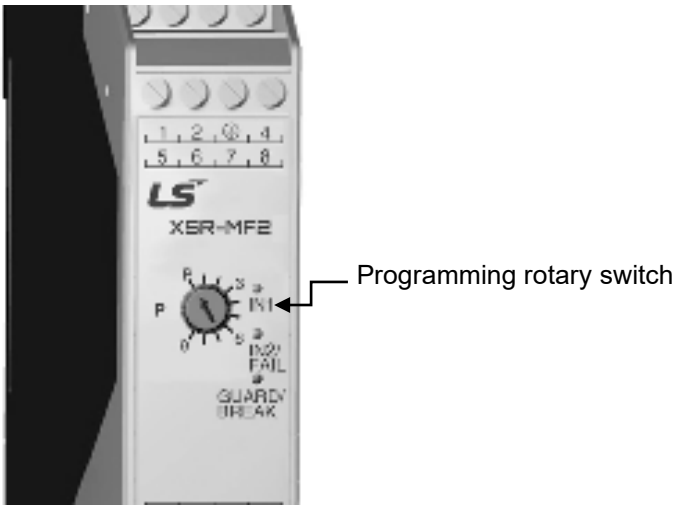


Figure 1

3.6 OPERATING MODES

With **automatic restart modes**, the outputs of the safety relay follow the status of the input.

With **monitored restart modes**, the outputs of the safety relay are activated only if the safety relay inputs (terminals 7 & 8) are both active and after sending the RESTART signal to the relay using the push-button or by means of a specific command on the RESTART input (terminal 4).

The RESTART command is active with a voltage of 24VDC.

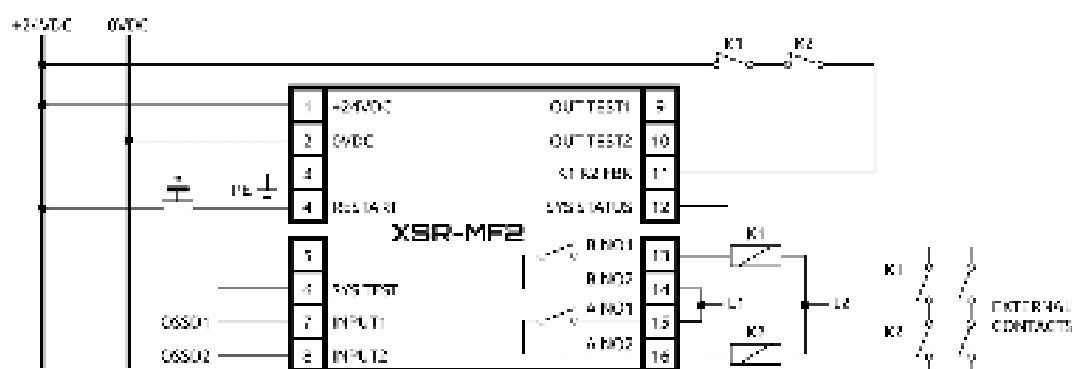
The minimum duration of the command is 100 ms.

With **manual restart mode** (2M), the outputs of the safety relay are activated only if the safety relay inputs (terminals 7, 8) are both active and after sending the RESTART signal to the relay using the push-button or by means of a specific command on the RESTART input (terminal 4) (*please refer to The RESTART command section*).

The RESTART command is active with a voltage of 24VDC.

- In manual restart mode (2M), with the RESTART signal permanently connected to 24VDC the safety relay works in automatic restart mode.
- Use in monitored restart mode (start/restart interlock activated) is mandatory in case the safety device controls an access protecting a danger zone and once a person has passed through the opening, he/she may remain in the danger zone without being detected (use as trip device according to EN 61496). Failure to comply with this rule may result in very serious risks for the persons exposed.

3.6.1 Operating Modes 1A, 1C



* not necessary if set in automatic operation mode (1A)

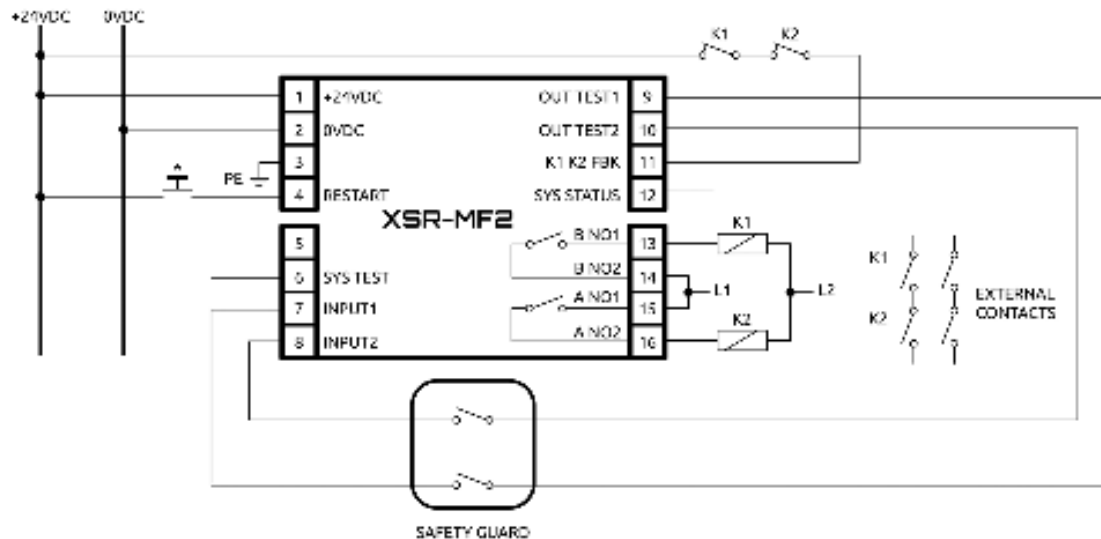
Figure 2

In these operating modes (1A, 1C) it is possible to monitor two semiconductor safety outputs (OSSD1, OSSD2) coming from ESPE (light curtains, laser scanner, etc) or other equipment with OSSD output pair (inductive safety sensor, RFID safety sensor, etc).

The selection between automatic or monitored restart mode is made by the rotary switch (1A or 1C) while the EDM control is selected with appropriate wiring.

- **Without EDM it is mandatory to connect terminal 11 to terminal 12 (e.g. in Figure 9).**

3.5.2 Operating Modes 2A, 2M, 2C



* not necessary if set in automatic operation mode (2A)

Figure 3

In these operating modes (2A, 2M, 2C) it is possible to monitor two inputs coming from safety gate, safety guard or similar (two channels electromechanical safety switch).

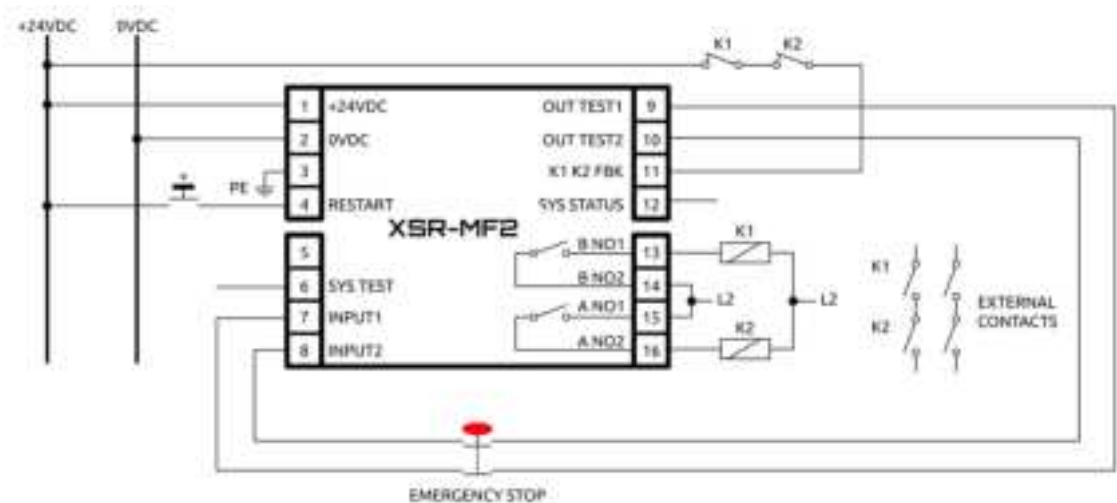
Short circuit between the two channels or between the channels and 24VDC are detected by means of the OUT TEST1, OUT TEST2 signals generated by the safety relay.

Between the two channels a simultaneity check is performed (within 1 sec).

If the simultaneity is not respected, the system remains in OFF with an alternate flashing of the LEDs IN1 – IN2/FAIL. To reactivate the outputs, it is necessary to re-open and close INPUT1 and INPUT2 (respecting the simultaneity).

The selection between automatic, monitored, or manual restart mode is made by the rotary switch (2A, 2M or 2C) while the EDM control is selected with appropriate wiring.

- Without EDM it is mandatory to connect terminal 11 to terminal 12 (e.g. in Figure 9).
- Same operating modes must be used to monitor emergency stop actuators.



* not necessary if set in automatic operation mode (2A)

Figure 4

3.5.3 Operating Mode 3A, 3C

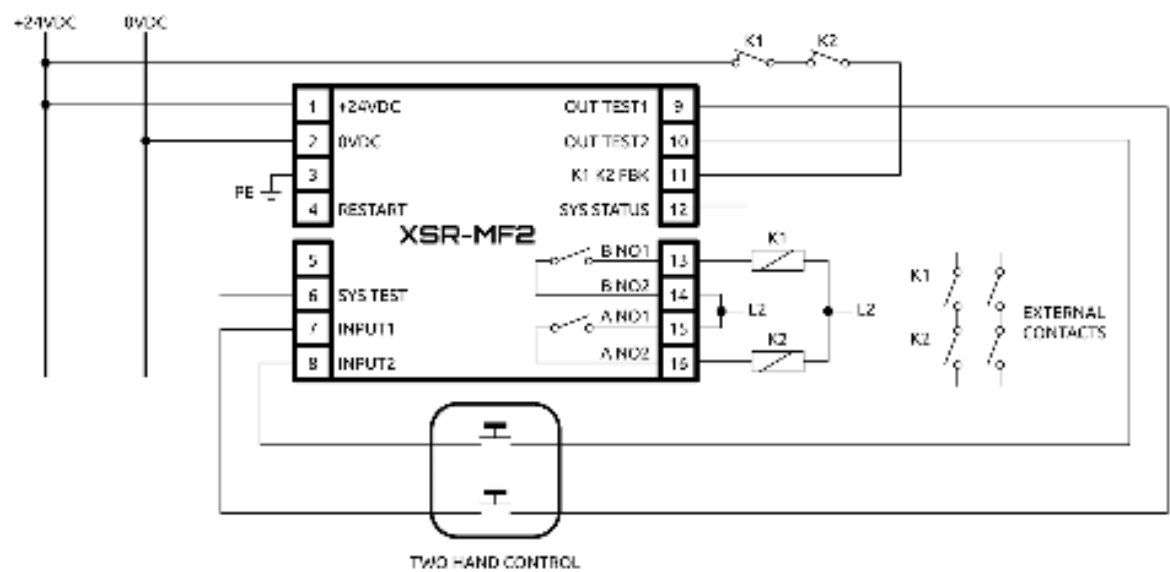


Figure 5 – Mode 3A

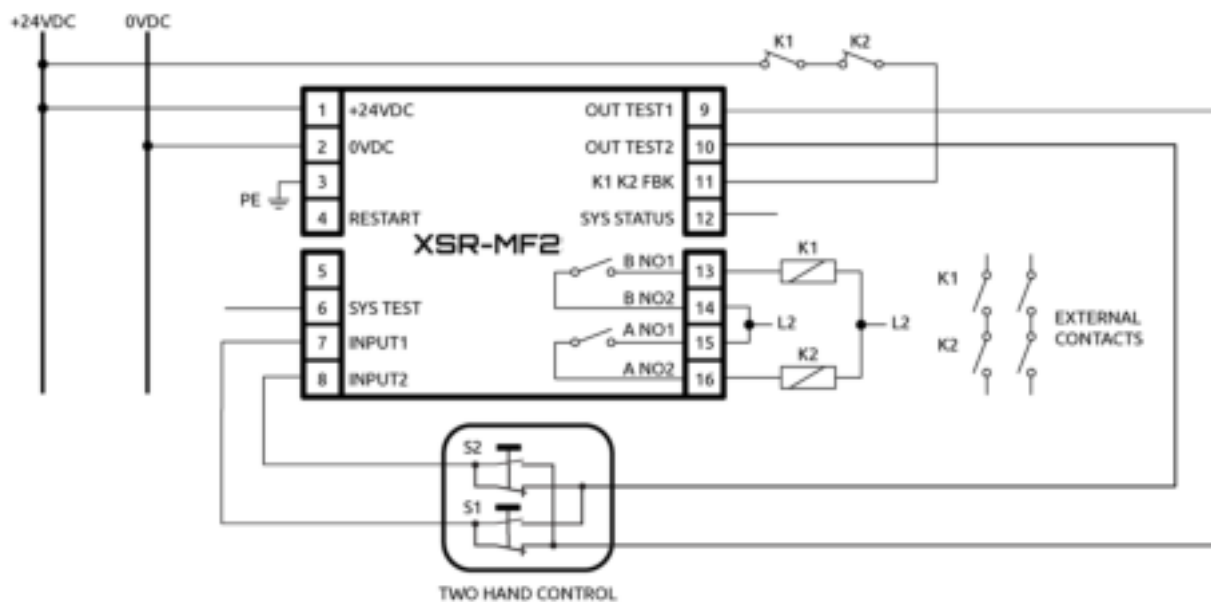


Figure 6 – Mode 3C

In these operating modes (3A, 3C) it is possible to perform a two-hands-control function.

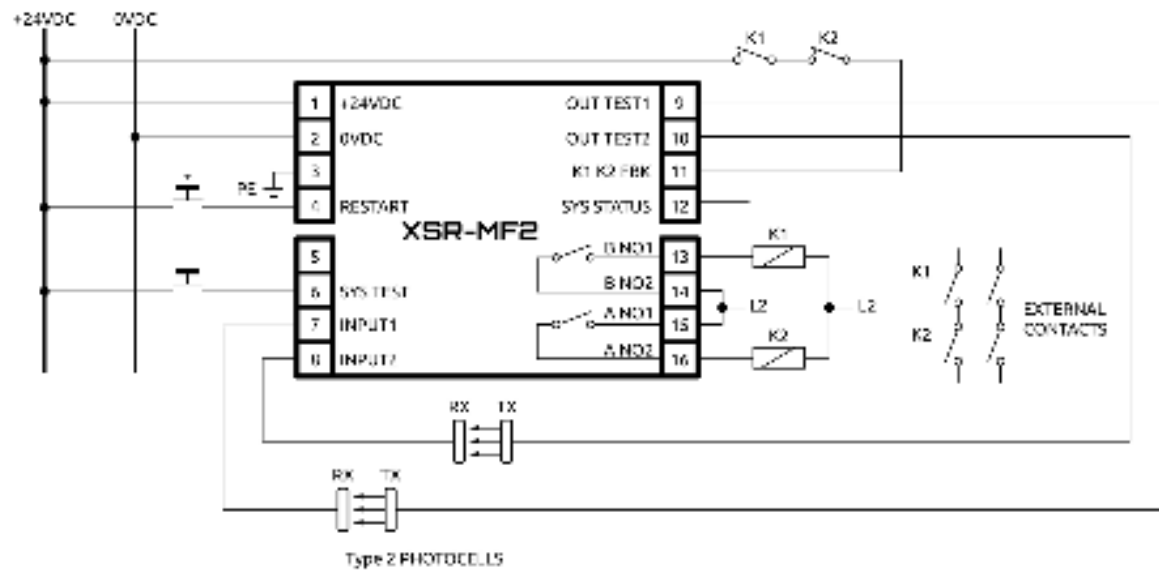
Short circuit between the two channels or between the channels and 24VDC are detected by means of the OUT TEST1, OUT TEST2 signals generated by the safety relay.

Between the two channels a simultaneity check is performed (within 500 msec).

The selection of the operating mode is made by the rotary switch (3A, 3C) while the EDM control is selected with appropriate wiring.

- **Without EDM it is mandatory to connect terminal 11 to terminal 12 (e.g. in Figure 9).**
- **Please note that the two-hands-control contacts can be:**
 - in mode 3A a double NO contact (according to EN 574 – IIIA)
 - in mode 3C a changeover contact (according to EN 574 – IIIC)

3.5.4 Operating Modes 4A, 4C



* not necessary if set in automatic operation mode (4A)

Figure 7

In these operating modes (4A, 4C) it is possible to monitor Type 2 photocells (from 1 to 4).

- Connecting XSR-MF2 to Type 2 photocell(s) the safety levels of the system will reduce to SIL 1, SILCL 1, PL c, Cat. 2, Type 2.
- Perform an in-depth risk analysis to determine the appropriate safety level for your specific application, based on all the applicable standards.

LS Electric recommend the use of ILION or a ULISSE UPC Type 2 safety photocell.

(Refer to the **NEW SAFETY PARAMETERS FOR TYPE 2 BARRIERS AND MANDATORY LABELLING** section).

The selection between automatic or monitored restart mode is made by the rotary switch (4A, 4C) while the EDM control is selected with appropriate wiring.

- Without EDM it is mandatory to connect terminal 11 to terminal 12 (e.g. in Figure 9).

A SYS TEST input is available to perform a complete test of the system.

➤ NEW SAFETY PARAMETERS FOR TYPE 2 BARRIERS AND MANDATORY LABELLING

- With the publication of Edition 3 of the harmonized EN 61496-1 standard it is no longer possible to use a Type 2 safety light barrier for safety functions assessed as SIL 2 / PL d.
- If a safety level of SIL 2 / PL d (or higher) is required and it is nevertheless intended to use a safety light barrier, then it will be necessary to use a Type 4 safety light barrier.
- This regulatory requirement derives from the fact that the reduction of risk that can be obtained via a photoelectric safety barrier is not only a function of the safety level of its electronic parts but is also determined by its systematic capabilities (for example: environmental influences, EMC, optical performance, and detection principle).

- The systematic capability of a Type 2 photoelectric barrier may in fact not be sufficient to ensure adequate risk reduction for SIL 2 / PL d applications.
- The standard also establishes that the labelling of Type 2 safety barriers must indicate such limitation to SIL 1 / PL c.
- The PFHd values declared for the electronic control part of the device, on the other hand, are not limited and therefore it is possible to use the PFHd value provided by the manufacturer of the device in the global assessment of the safety function, even if it exceeds the SIL 1 / PL c range.

Chapter 4 IO Port SIGNAL

4.1 INPUT

4.1.1 RESTART command

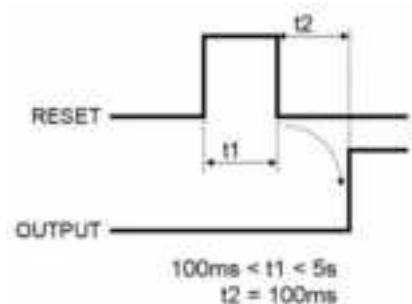
The RESTART command allows XSR-MF2 to manage Manual operation

- **The RESTART command must be installed outside the danger area in a position where the danger area and the entire work area concerned are clearly visible.**
- **It must not be possible to reach the control from inside the danger area.**

- RESTART in monitored restart modes

In monitored restart modes, the outputs of the safety relay are activated only if the safety relay inputs (terminals 7, 8) are both active and after sending the RESTART signal to the relay using the push-button or by means of a specific command on the RESTART input (terminal 4).

- The RESTART command must be sent to XSR-MF2 connecting terminal 4 to the 24VDC, respecting the behavior of the timing beside.
- The contact used for the RESTART command must be able to switch a voltage of 24VDC and a current of 10mA (guaranteeing a closing time $>100\text{ms}$).
- The whole SYSTEM RESET TIME is obtained by adding the reset time of any external contactors K1 K2 to the reset time of XSR-MF2.



4.1.2 K1K2 FEEDBACK input

Using the K1 and K2 auxiliary safety contactors with guided contact safety type, it is necessary to connect the +24VDC to the **K1 K2 FBK** through the series of the K1-1 and K2-1 N.C. control contacts.

- The control of the correct switching of K1 and K2 is performed with a delay of 300ms.
- **If the application requires it, the response time of the external contactors must be verified by an additional device.**
- **When the K1-1 and K2-1 N.C. control contacts are not used (or no control is provided) it is mandatory to connect the terminal 11 (K1K2 FBK) to terminal 12 (SYS STATUS).**
Following an example of 1A/1C mode wiring diagram without EDM (Figure 9)

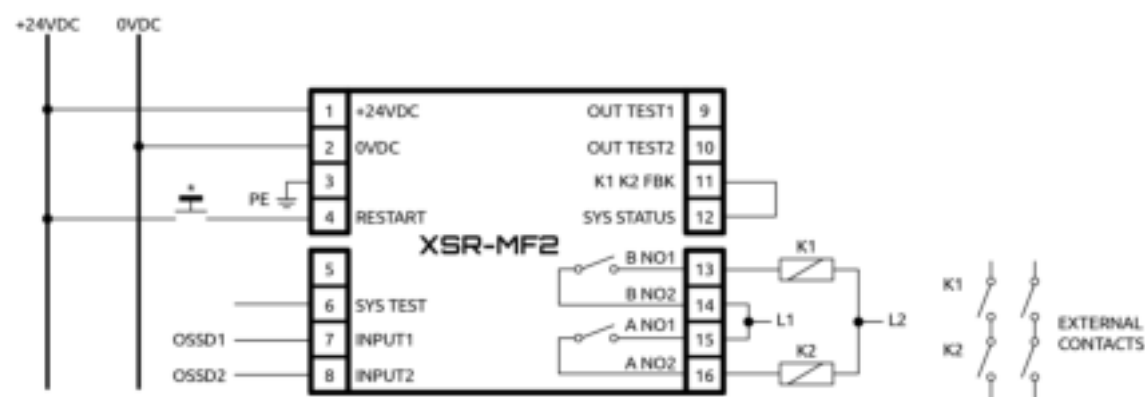


Figure 1

4.2 OUTPUTS

4.2.1 SYSTEM STATUS output

- The SYSTEM STATUS output reports exactly the output safety relays condition:
- When the output relays are opened, the SYSTEM STATUS reports 0VDC
 - When the output relays are closed, the SYSTEM STATUS reports +24VDC..

1. Characteristics of the output circuit

For the output circuit, the safety relay module uses two guided contact safety relays.

These relays are rated by the manufacturer for voltage and current values above those indicated in the technical data; however, to assure correct insulation and to avoid damage or premature aging, protect each output line with an appropriate fuse (depending on the load). Check that load characteristics comply with the indications given in the table below.

Minimum switching voltage	18 VDC
Minimum switching current	20 mA
Maximum switching voltage	250 VAC
Maximum switching current	6A(AC) / 6A(DC)

2. Use of K1 and K2 auxiliary contact elements.

For loads with higher voltage and current characteristics than those indicated in the table above, use of auxiliary external relays or contactors suitable for the load to be controlled is recommended.

- The K1 and K2 auxiliary contactors or relays must be of the guided contact safety type.
- Referring to the table below, pay particular attention to the configuration of the control contacts on terminal 11 and that of the contacts of use.
(See K1 K2 FEEDBACK input (EDM), page 10).

	Auxiliary Relay K1	Auxiliary Relay K2
Control contacts	K1-1 normally closed	K2-1 normally closed
Use contacts	K1-2 normally open	K2-2 normally open

- Control contacts K1-1 and K2-1 (terminal 11) must be able to switch a current of 20mA and a voltage of 24VDC

Chapter 5 Installation and Wiring

5.1 Installation

5.1.1 Environment

The product is highly reliability regardless of the environmental conditions. However, to maintain reliability and stability, please take care of the conditions described in this chapter.

1) Environmental conditions

- (1) Install in a waterproof and dust-proof cabinet.
- (2) Avoid continuous impact or vibration.
- (3) Avoid direct sunlight
- (4) Avoid rapid temperature change which may form dew drops
- (5) Ambient temperature shall be within 0 ~ 60 °C
- (6) Relative humidity shall be within 5 ~ 95 %
- (7) Avoid corrosive or flammable gases.

2) Installation Work

- (1) Protect the MODULE from foreign materials during installation and wiring work.
- (2) Select a position suitable for operation.
- (3) Do not install the same panel with a high voltage device.
- (4) Keep at least 50 mm of space between the wire duct and adjacent modules.
- (5) Ground the MODULE to a point where noise environment is favorable.

3) Control panel heat dissipation design

- (1) When installing the MODULE inside a sealed control panel, the heat generated by both other devices and the MODULE itself should be considered in the heat dissipation design.
- (2) When using vents and general fans to circulate air, it is recommended to install filters or use a sealed heat exchanger, as dust, gases, or other contaminants may affect the MODULE system.

5.1.2 Cautions for handling

- 1) Do not fall on the ground. Avoid shock.
- 2) Do not separate PCB from the case. Otherwise, failure may be caused.
- 3) Protect the module from debris generated from wiring work. Remove any foreign material entered in the module.
- 4) Do not connect or disconnect the module while power is on.
- 5) Use standard cables whose lengths do not exceed the maximum allowable length.
- 6) Keep the communication lines away from the surge and induction noise generated in the AC lines.
- 7) If the cables are laid in cable conduits, ground the conduits.
- 8) When wiring using conduits, grounding of the conduit is necessary.

5.1.3 Cautions for wiring

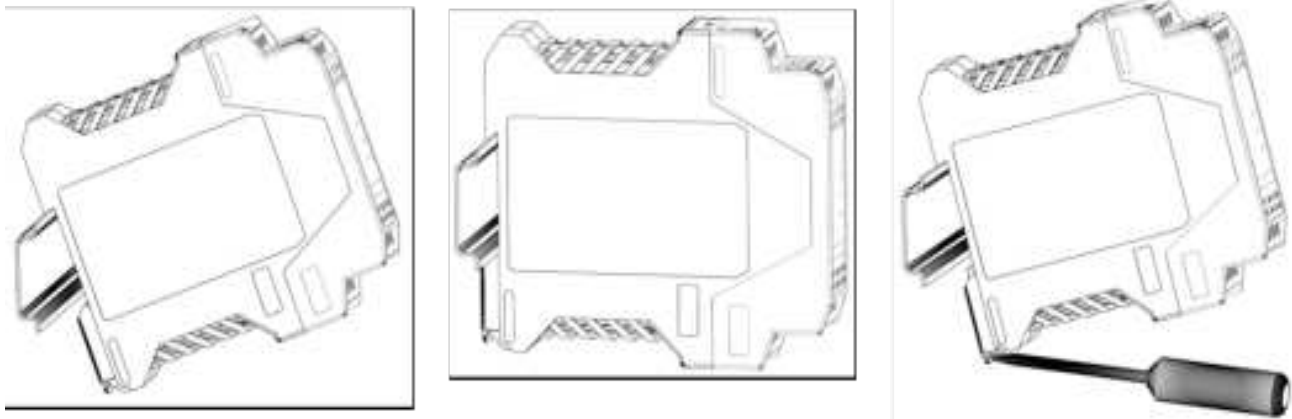
- 1) Do not lay AC power line and external signal lines of the module close together. Provide at least 100 mm distance or lay the lines in conduits. Sufficient space must be provided to avoid interference from the surge or induction noise from the AC lines.
- 2) The wires shall be selected taking the ambient temperature and allowable current into consideration, with a minimum size of AWG 12...30, (solid/stranded) (UL)

- 3) For power source monitoring, the wires should be twisted as densely as possible and arranged in the shortest path.
(Max. wiring distance 15 m or less)
- 4) Keep the wires away from heat source and oil or other harmful materials. Otherwise, short-circuit may occur leading to damage or malfunction of the system
- 5) Keep the wires away from high voltage and power lines to avoid induction interference which can cause malfunction or failure.
- 6) The total wiring length for safety inputs and test pulse outputs should be less than 100m.
- 7) The wiring length between safety outputs and output devices should be less than 100m for each

5.1.4 Installation and removal of module

Fix the Safety Relay unit to a 35mm DIN rail as follows:

1. Fasten the Safety Relay to the rail. Press the unit gently until you feel it snap into place.
2. To remove the unit, use a screwdriver to pull down the locking latch on the back of the unit; then lift the unit upwards and pull.



5.1.5 Cautions for installation

(1) General precaution

- 1) Safety Relay turns output off when any problem in the external power source or product itself is detected. The external circuit shall be so configured as to cut off the power supply to the load so that connected device(s) is shut down, when the output is turned off. Otherwise, the entire line may result in a severe problem or accident.
- 2) When changing data, program, or status of an operating Safety Relay, provide an interlock circuit with the sequence program and system outside to secure safe operation of the system. Read the manual carefully and determine the operating sequence before operating Safety Relay for safety. In addition, for online control of the Safety Relay at a PC, prepare countermeasures against communication error, may be due to cable connection failure, for the system.
- 3) When a safety function is activated and the output has been cut off, prepare an interlock program using reset button, etc., to prevent unauthorized manual restarting.
- 4) In case that the temperature inside of the operation panel where the Safety Relay is installed may exceed the allowable temperature range, it is highly recommended to install a heat exchanger in the operation panel to control the temperature. Using an ordinary ventilation fan may introduce dust from outside, affecting the function of the Safety Relay



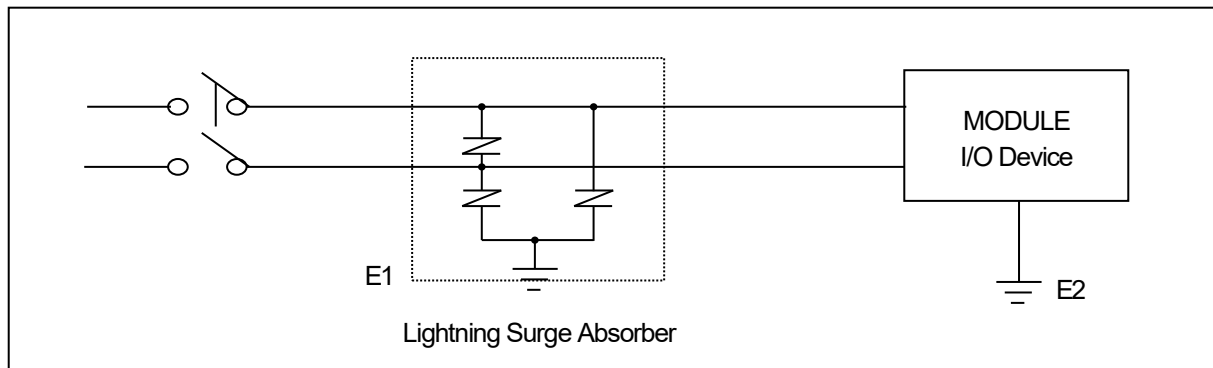
OPERATION / CONTROL	COMPLETE
1. Verify the correct fixing of XSR-MF2 to the Omega rail.	<input type="checkbox"/>
2. Verify that all the cables are correctly inserted and the terminal blocks well screwed.	<input type="checkbox"/>
3. Verify that all the LEDs (indicators) light on correctly.	<input type="checkbox"/>
4. Verify the positioning of all the actuators connected to XSR- MF 2.	<input type="checkbox"/>
5. Verify that all the external indicators (lamps) work properly.	<input type="checkbox"/>
6. Operate a complete System Test.	<input type="checkbox"/>

5.2 Wiring

This section provides information on the system wiring.

5.2.1 Power supply

- 1) Use a power source having low line-to-line, line-to-ground noise.
(If the noise is high, connect an insulation transformer.)
- 2) Please separate the power supply for the MODULE, input/output devices, and power devices as shown below
- 3) Please twist the power cables as tightly as possible and connect them at the shortest distance.
- 4) Do not run the DC24V cables close to the main circuit (high voltage, high current) cables or input/output signal cables. Keep them at least 100mm apart if possible
- 5) For surge protection against lightning and other surges, please use a surge absorber as shown in the diagram below.



NOTE

- 1) Please separate the grounding (E1) of the surge absorber from the grounding (E2) of the MODULE.
- 2) Select a surge absorber that does not exceed its maximum allowable voltage even during the maximum voltage rise of the power supply.

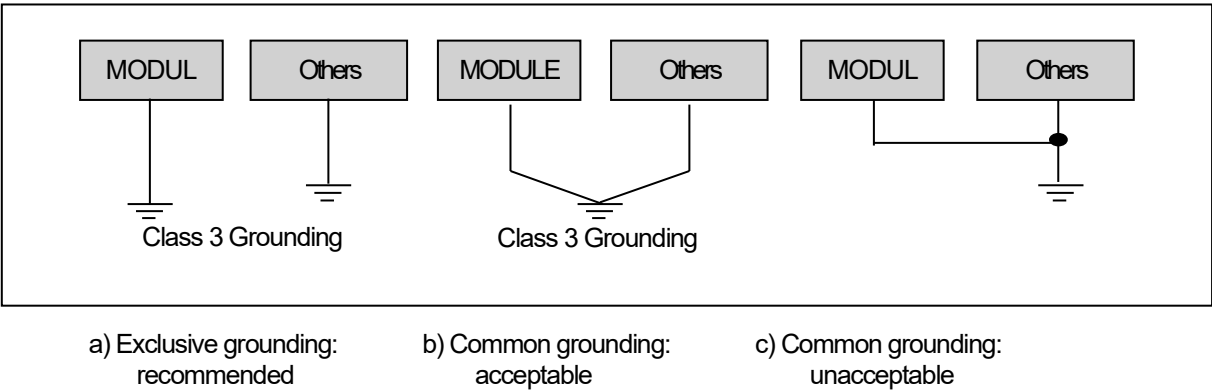
- 6) If noise interference is a concern, please use an isolation transformer or a noise filter.
- 7) Please twist the wiring for each input/output power as tightly as possible and ensure that the wiring for the shielding transformer or noise filter does not pass through the duct.
- 8) The same ground connection (0VDC) must be used for all system components

5.2.2 Input/Output Device Wiring

- 1) Wire size range: AWG 12...30, (solid/stranded) (UL)
- 2) Please separate the input and output wires when wiring.
- 3) Please wire the input/output cables at least 100mm away from the main circuit cables with high voltage and high current.
- 4) If it is not possible to separate the main circuit cables and power cables, please use a combined shielded cable and ground the MODULE side.
- 5) When wiring through conduit, please ensure that the conduit is properly grounded
- 6) Terminal tightening torque: 5...7lb-in (0,6...0,7 Nm)

5.2.3 Grounding circuit

- 1) MODULE is implemented with sufficient anti-noise measures; thus, ground is not necessary unless the system is subject to a very high noise level. If grounding is necessary, take the following information into consideration.
- 2) The ground circuit should be exclusive as possible.
The grounding work shall be Class 3 (Ground resistance 100 Ω or less).
- 3) If exclusive grounding is unavailable, install common grounding circuit as illustrated in figure b) below.



- 4) Ground wire shall be at least 2 mm². Grounding point shall be as close to the MODULE as possible to reduce the wire length

5.2.4 wire specification

- 1) Wire size range: AWG 12...30, (solid/stranded) (UL).
- 2) Use 60/75°C copper (Cu) conductor only.
- 3) We recommend the use of separate power supplies for the Safety Relay and for other electrical power equipment (electric motors, inverters, frequency converters) or other sources of disturbance.
- 4) Cables used for connections longer than 50m must have a cross-section of at least 1mm² (AWG16).

Chapter 6 Maintenance

Daily and regular maintenance must be performed to maintain the Safety Controller, always at the best condition.
The lifetime of the Safety Controller is about 20 years. However, the impact on the environment can cause damage to the devices.
Results for all of the checks and administrative actions must be recorded. Please record information about the serial number of the product.

6.1 Inspection and Maintenance

The table below presents the items which should be inspected 1~2 times per half year.

Items for Inspection		Decision Criteria	Corrective Action
Power supply		Within allowable range (Within -15% / +10%)	Adjust the power supply to meet the allowable voltage range.
Power supply for input/ output		Input/ output specification of each module	Adjust the power supply to meet the allowable voltage range of each module.
Environment	0~55 ℃	0~55 ℃	Control the operation temperature and humidity to meet the specification.
	10 ~95% RH	10 ~95% RH	
	No vibration	No vibration	Apply anti-vibration rubber pads or other means to prevent vibration.
Shaking of module		No free movement is acceptable	No module must show looseness.
Loose terminating screws		No loose screw	Tighten loose bolts and nuts.
Spare parts		Check inventory and storage condition	Replenish with shortage, keep in good condition.

6.2 Daily Inspection

Daily inspection shall be performed for the items listed below.

Items for Inspection			Actions	Decision Criteria	Corrective Action
Mounting of I/O module			Check mounting of I/O module	Shall be firmly mounted	-
Connection at terminal block and extension cables			Close crimped terminals	Shall have appropriate spacing	correction
Indicator LED	Safety Relay	IN1 LED	Check for OFF illumination in the Input contact1	Illumination	Refer to Chapter 4
		IN2/FAIL LED	Check for red illumination in the Fault detected. Check for OFF illumination in Input contact2.	Illumination	Refer to Chapter 4
		GUARD/ BREAK LED	Check for red illumination in Output relays opened Check for red blinking illumination in show the type of FAIL Check for yellow illumination while waiting for Restart	Illumination	Refer to Chapter 4
		IN1/IN2 LED	Check for green blinking illumination in Wrong simultaneity check detected	Illumination	Refer to Chapter 4

6. 3 Regular Inspection

Check the following items biannually and take corrective actions as necessary.

Items for Inspection		Inspection Method	Decision Criteria	Corrective Action
Environment	Ambient Temperature	Measure with thermometer/ hygrometer Measure corrosive gases	0 ~ 55 °C	Control within general specification. (Standard environment in the panel)
	Ambient humidity		10 ~ 95%RH	
	Ambient contamination		No corrosive gas allowed	
PLC	Looseness	Shake the modules	Shall be firmly mounted	Tighten the screws
	dust, foreign matter	Visual inspection	No contaminant	-
Connection	Loose screws	Tighten with screw driver	No loose screw	Tighten
	Close crimped terminals	Visual inspection	Shall have appropriate spacing	Correction
	Loose connection	Visual inspection	No loose screw	Correct the connector
Check supply voltage		Test the supply voltage with a tester	DC24V:DC19.2 ~ 28.8V	Adjust supply voltage
Fuses		Visual inspection	Shall be not blown	

NOTE

- 1) Please comply with the instructions for daily and regular inspections as specified in each device's manual, including all devices configured in the safety application (e.g., safety sensors, actuators).
- 2) During daily/regular inspections, please ensure that all safety functions operate correctly as intended.

Chapter 7 EMC Compliance

7.1 Requirements Complying with EMC Specifications

EMC Directions describe “Do not emit strong electromagnetic wave to the outside: Emission” and “Do not have an influence of electromagnetic wave from the outside: Immunity”, and the applicable products are requested to meet the directions. The chapter summarizes how to structure a system using XSR Relay to comply with the EMC directions. The description is the data summarized for the requirements and specifications of EMC regulation acquired by the company, but it does not mean that every system manufactured according to the description meets the following specifications. The method and determination to comply with the EMC directions should be finally determined by the system manufacturer self.

7.1.1 EMC specifications

The EMC specifications affecting the PLC are as follows.

Specification	Test items	Test details	Standard value
EN 50081-2	EN55011 Radiated noise * 2	Measure the wave emitted from a product.	30~230 MHz QP : 50 dB μ V/m * 1 230~1000 MHz QP : 57 dB μ V/m
	EN55011 conducted noise	Measure the noise that a product emits to the power line.	150~500 kHz QP : 79 dB Mean : 66 dB 500~230 MHz QP : 73 dB Mean : 60 dB
IEC 61131-2	EN61000-4- Electrostatic immunity	Immunity test allowing static electricity to the case of a device.	8 kV Air discharge 6 kV Contact discharge
	EN61000-4-4 Fast transient burst noise	Immunity test allowing a fast noise to power cable and signal cable.	Power line : 2 kV Digital I/O : 1 kV Analogue I/O, signal lines : 1 kV
	EN61000-4-3 Radiated field AM modulation	Immunity test injecting electric field to a product.	10Vm, 26~1000 MHz 80% AM modulation@ 1 kHz
	EN61000-4-12 Damped oscillatory wave immunity	Immunity test allowing attenuation vibration wave to power cable.	Power line : 1 kV Digital I/O(24V and higher) : 1 kV

* 1: QP: Quasi Peak, Mean: average value

* 2: PLC is a type of open device(installed on another device) and to be installed in a panel.

For any applicable tests, the system is tested with the system installed in a panel.

7.1.2 Panel

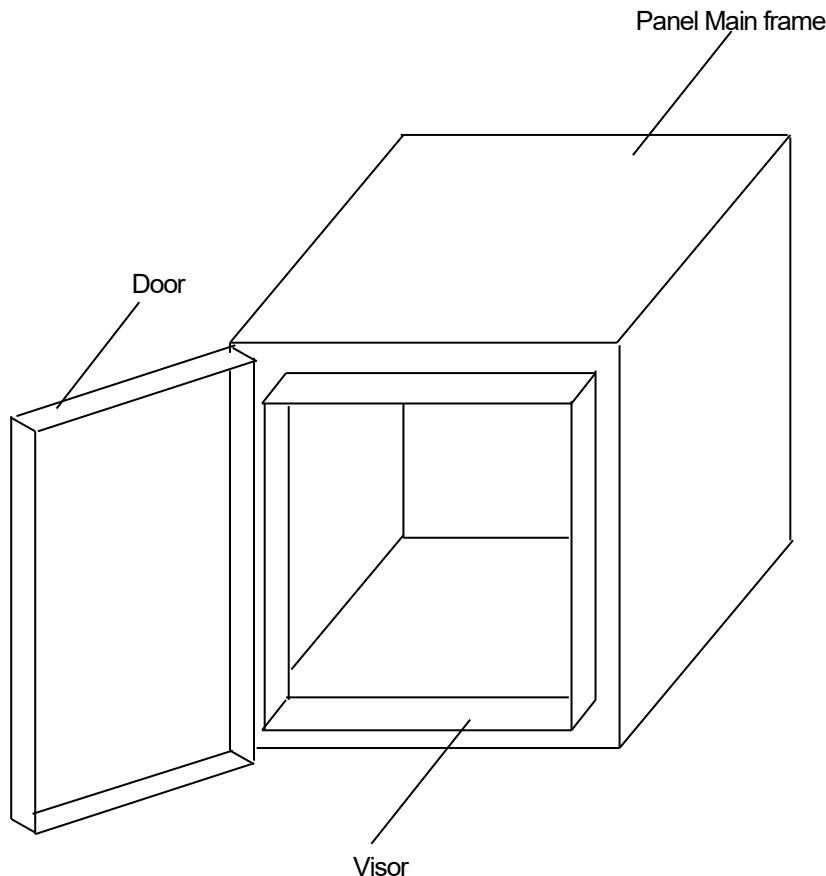
The Safety Relay is a kind of open device (installed on another device) and it should be installed in a panel. It is because the installation may prevent a person from suffering from an accident due to electric shock as the person contacts the product and the panel can attenuate the noise generating from the PLC.

In case of Safety Relay, to restrict EMI emitted from a product, it should be installed in a metallic panel. The specifications of the metallic panel are as follows.

1) Panel

The panel for PLC should be installed and manufactured as follows

- (1) The panel should be made of SPCC(Cold Rolled Mild Steel)
- (2) The plate should be 1.6mm and thicker
- (3) The power supplied to the panel should be protected against surge by using an insulated transformer.
- (4) The panel should be structured so that electric waves do not leak outside. For instance, make the door as a box as presented below. The main frame should be also designed to be covered with the door in order to restrict any radiating noise generated from the PLC.



- (5) The inside plate of panel should have proper conductivity with as wide a surface as possible by eliminating the plating of the bolt used to be mounted on the main frame to secure the electric contact with the frame.

2) Power cable and grounding cable

The grounding/power cable of PLC should be treated as follows.

- (1) The panel should be grounded with a thick wire to secure a lower impedance even in high frequency.
- (2) LG (Line Ground) terminal and PE (Protect Earth) terminal functionally let the noise inside the PLC flow into the ground, so

a wire of which impedance is low should be used.

(3) Since the grounding cable itself may generate noise, thick and short wiring may prevent it serving as an antenna.

3) Ferrite core

It is recommended to use this when cables are exposed outside the control panel and the shielding effect of the cable is insufficient for noise reduction.



7.1.3 Cable

1) Fixing a cable in the panel

If the extension cable of XSR series is to be installed on the metallic panel, the cable should be 1cm and more away from the panel, preventing direct contact.

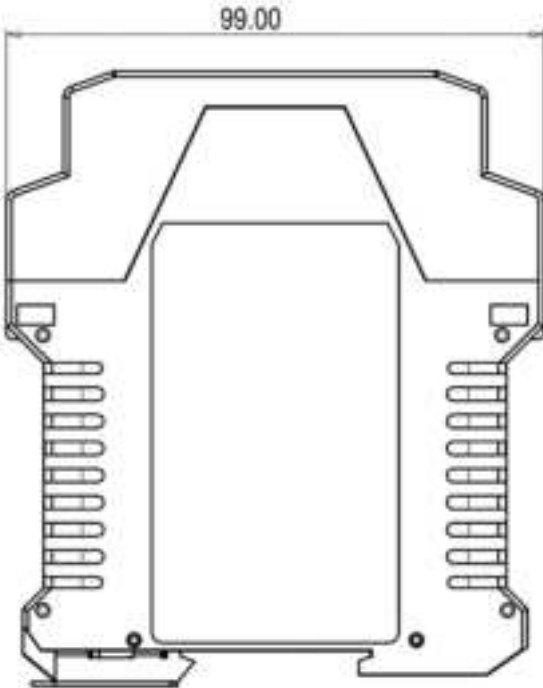
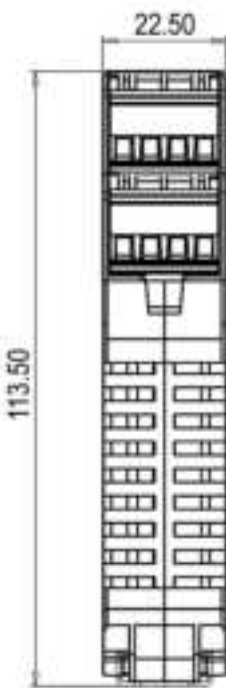
The metallic plate of panel may shield noise from electromagnetic waves while it a cable as a noise source is close to the place, It can serve as an antenna. Every fast signal cable as well as the extension cable needs proper spacing from the panel.

Appendix 1 PFH Value

Load	B10d	Number of Commutations	PFHd *	DCavg #	MTTFd #(years)	PL #	CCF #
2A@230Vac	400.000	1 every 30s	1,73E-07	99,00%	25,13	d	80%
		1 every min	8,89E-08	99,00%	46,92	e	80%
		1 every hour	6,45E-09	98,98%	318,27	e	80%
		1 every day	5,14E-09	98,97%	350,48	e	80%
0,5A@24VDC	200.000	1 every 30s	3,41E-07	99,00%	13,03	d	80%
		1 every min	1,73E-07	99,00%	25,13	d	80%
		1 every hour	7,85E-09	98,98%	289,86	e	80%
		1 every day	5,23E-09	98,97%	348,13	e	80%

* EN 61508:2010, EN 62061:2005/A2:2015; # EN ISO 13849-1: 2015

Appendix 2 Dimensions (Unit : mm)



Warranty

■ 1. Warranty Period

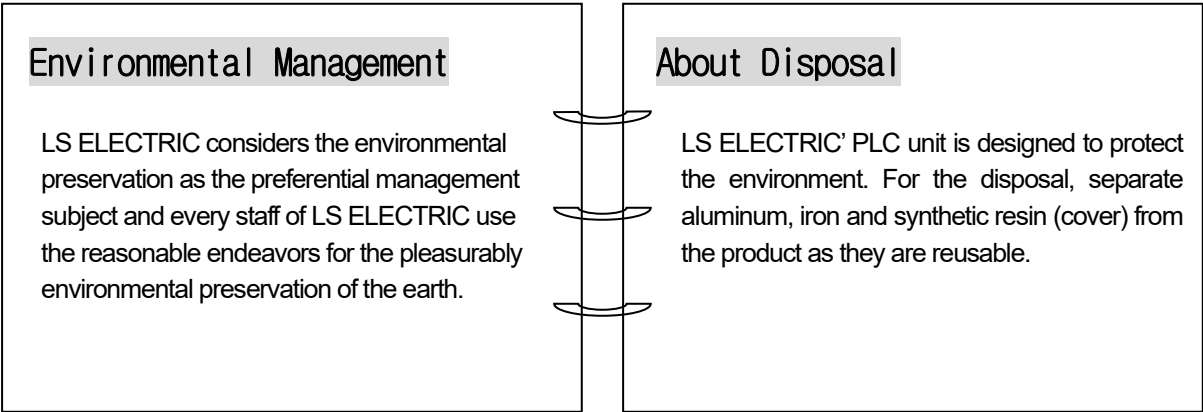
The product you purchased will be guaranteed for 36 months from the date of manufacturing.

2. Scope of Warranty

- (1) The initial diagnosis of faults is basically conducted by your company. However, upon your request, our company or our service network can undertake this task for a fee. If the cause of the fault lies with our company, this service will be provided free of charge.
- (2) This warranty only applies if the product is used under normal conditions according to the specifications and precautions described in the handling instructions, user manuals, catalogs, and caution labels.
- (3) Even within the free warranty period, the following cases will be subject to paid repairs:
 - 1) Replacement of consumable and life-limited parts (e.g., relays, fuses, electrolytic capacitors, fans, LCDs, batteries, etc.)
 - 2) Failures or damage caused by improper storage, handling, negligence, or accidents by the customer
 - 3) Failures resulting from the customer's hardware or software design
 - 4) Failures due to modifications without our consent
(Repairs will be refused, even for a fee, if recognized as modified or repaired outside our company)
 - 5) Failures that could have been avoided if the customer's equipment, in which our product is incorporated, had safety devices required by legal regulations or common industry standards
 - 6) Failures that could have been prevented if maintenance and replacement of consumable parts were performed normally according to the handling instructions or user manuals
 - 7) Failures and damages to the product caused by using connected equipment or inappropriate consumables
 - 8) Failures caused by external factors such as fire, abnormal voltage, force majeure, and natural disasters such as earthquakes, lightning, salt damage, wind, and flood damage
 - 9) Failures due to reasons that could not be predicted with the scientific and technical standards at the time of our shipment
 - 10) Other failures, damages, or defects recognized as the responsibility of your company.

Environmental Policy

LS ELECTRIC Co., Ltd supports and observes the environmental policy as below.





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