FS9Z-B1572

SafetyOne

FS1A-C21S

Safety Controller

SafetyOne

User's manual

IDEC CORPORATION

SAFETY PRECAUTIONS

- Carefully read this user's manual to ensure correct operation before starting installation, wiring, operation, maintenance, and inspection of the SafetyOne.
- In this user's manual, safety precautions are categorized in order of importance Warning and Caution, as follows:

Warning Warning notices are used to emphasize that improper operation may cause severe personal injury or death.

Caution Caution notices are used where inattention might cause personal injury or damage to equipment.

Warning

- Do not disassemble, repair, or modify SafetyOne. This will cause impairment of the safe operability of SafetyOne.
- Turn off the power to SafetyOne before starting installation, removing, wiring, maintenance, or inspection. This can cause electrical shocks or fire hazard.
- Before operating SafetyOne, carefully read the instruction sheet and this manual, and ensure that the environment conforms to the requirements of SafetyOne specifications. If SafetyOne is operated in an environment that exceeds the specifications, it causes impairment of the safe operation of SafetyOne.
- The installation, wiring, configuration, and operation of SafetyOne must be performed only by "Safety responsible persons". Safety responsible persons are personal who have requisite qualification authorizing them as being capable of safely carrying out each step including the designing, installation, operation, maintenance, and disposal of SafetyOne. Persons without technical expertise of safety products must not use SafetyOne.
- SafetyOne must be subjected to regular proof test verification that each function of SafetyOne is performing up to the required standard.
- Installation of SafetyOne must be performed according to the instructions found in the instruction sheet and this manual. Improper installation may cause the SafetyOne to fail.
- Do not use the monitor outputs or solenoid/lamp outputs as a safety outputs. When there is a failure in SafetyOne or peripheral devices, Impairment of the safe operation of the system is possible.
- The start switch has to be placed outside the danger zone and in a safe position from which there is good visibility for checking that no person is within the danger zone.
- Do not use the start input and the external device monitor input as a safety input. When there is a failure in SafetyOne or peripheral devices, Impairment of the safe operability of the system is possible.
- Use the SafetyOne in compliance with laws and regulations of the country in which it is being used.
- Use safety inputs and safety outputs in circuit configurations conforming to the application according to the usage, and the safety requirements.

Warning

- Calculate respective safety distances, taking into consideration the response time of the SafetyOne, safety devices to be connected to the SafetyOne, and each other device that forms a part of the system configuration.
- Applicable safety performance is dependent on each system configuration.
- Use a power supply that meets following required specifications:
  -Conforms to the power supply rating of SafetyOne.
  -Complies with the SELV/ PELV circuit specified by EN 50178 or IEC/EN 60950-1.
  -Has the functionality or the functional equivalent of the control voltage and current of class 2 circuit, as defined in UL508 or UL1310.
  -Is in compliance with safety laws and regulations relating to electrical safety, EMC, and like under the laws and regulations of the country in which it is being used.
- Ground the V- line (0V DC) for ground diagnosis.
- In the case of a new configuration or modified installation, be sure to perform a check for each input and output function.
- Implement protective measures that personal, other than safety responsible persons operating the SafetyOne, are unable to modify the configuration.
- Separate SafetyOne from devices and wires which are not in accordance with class 2 circuit requirements.

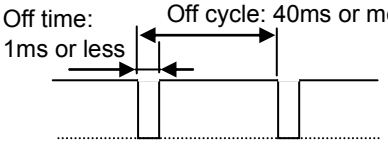
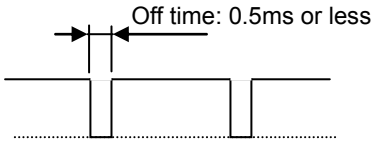
Warning

- Do not connect devices having input and output specifications that do not satisfy the requirements of the SafetyOne.
  Refer to the following for information on the requirements of connected devices.

Connected Control Device	Requirements
Emergency stop switch	Device equipped with a direct opening action mechanism conforming to IEC/EN60947-5-5 and indicated in IEC/EN60947-5-1
Interlock switch, limit switch	Device equipped with a direct opening action mechanism indicated in IEC/EN60947-5-1
Interlock switch with lock	Spring lock interlock switch with solenoid
Mode select switch	Device conforming to regulations of the country where used and required categories (for example, switch conforming to IEC/EN60947-1)
Enabling switch	Device conforming to IEC/EN60947-5-8 (or IEC/EN60947-5-1)
Solid state output device Safety sensor	Device conforming to regulations of the country where used (for example, safety light curtain conforming to IEC/EN61496-1) PNP output (See Note 1)
Non-contact interlock switch	IDEC HS7A series, IDEC HS3A serise
Safety relay	Relay equipped with forced guide mechanism or conforming to EN50205
Contactor (electromagnetic switch)	Contactor equipped with forced guide mechanism
Other control devices	Use start switches and other devices that conform to the regulations of the country where used.
Muting sensor	Device conforming to IEC/EN60947-5-2 as shown below -3 wire transmission (dark on) photoelectric switch which has a PNP open collector output. -3 wire (normal open) proximity switch which has a PNP open collector output.
Muting lamp	Indicator light conforming to IEC/EN60947-1 or IEC/EN60947-5-1 Note 2: In the case of software version 1.00, there is a possibility to detect a false disconnection of the muting lamp when using an LED indicator light.
Input device for two-hand control	Device witch the structure conforming to ISO13851, and consists of momentary switches conforming to IEC/EN 60947-5-1 with NO/NC contacts.

- Make sure that the end-user thoroughly understands the contents of this user's manual.

Note 1. SafetyOne reads input data at regular intervals. Use a solid state output device that sends output signals of the waveforms shown below. Otherwise the SafetyOne cannot process the input signal correctly.

Applicable solid state output device (Waveform of solid sate output)	Pulse output off cycle of 40ms or more and an off time of 1ms or less. 	Pulse output off time of 0.5ms or less. 

The device may not be usable even if the above specifications are satisfied. Be sure to thoroughly confirm operations using the actual device.

Note 2. Software version (SW version) is described at the next of serial number on the product label.

Example: S/N *****-***** 1V100 2V*** HV***

Software version 1.00

Serial number

Caution

- SafetyOne is designed for installation within an enclosure. Do not install SafetyOne outside an enclosure. Install SafetyOne in enclosure rated IP54 or higher.
- Install SafetyOne in environments described in the catalog, instruction sheet, and user's manual. If SafetyOne is used in places where it is subjected to high temperature, high humidity, condensation, corrosive gases, excessive vibrations, and excessive shocks then electrical shocks, fire hazard, or malfunction may result.
- Environment for using the SafetyOne is "Pollution degree 2". Use SafetyOne in environments of pollution degree 2 (according to IEC/EN60664-1).
- Prevent SafetyOne from falling while moving or transporting otherwise damage or malfunction of the SafetyOne may result.
- Prevent metal fragments and pieces of wire from dropping inside the SafetyOne housing. Put a cover on the SafetyOne during installation and wiring. Ingress of such fragments and chips may cause fire hazard, damage or malfunction.
- Install SafetyOne, so that there is adequate distance from the walls, heat generating bodies, and peripherals, taking into consideration space requirements for maintenance and ventilation.
- Install SafetyOne on 35mm DIN rails with BNL6 mounting clips (sold separately) on both sides of SafetyOne.
- Wire the connectors with conforming cables or ferrules.
- Ground FE terminal to assure electromagnetic compatibility.
- Use common 0V DC, if different power supplies are used for SafetyOne and other devices (ex. safety light curtain).
- Wire the inputs and outputs so that they are separated from power lines.
- When overcurrent flows into output terminals, the protective function turns off the output. However, when overcurrent status lasts long, internal protective elements will fuse. To protect the internal elements, insert fuses of double the rated value to each terminal.
- Use IEC60127 approved fuses on the power line of SafetyOne. (This is required for equipment incorporating SafetyOne that is destined for Europe.)
- When disposing of SafetyOne, handle it under the laws and regulations of the country in which it is disposed.

BEFORE GETTING STARTED

Thank you for your purchase of the IDEC SafetyOne (Type Number FS1A-C21S).
This user's manual describes the specifications, and the procedures for installing and operating the SafetyOne.
Read this manual carefully before using the SafetyOne so that you have an adequate understanding of its functions and performance.

■ About directives and standards

SafetyOne is approved for following directives and standards by TÜV SÜD.

1. EU directives

-Machinery Directive: Directive 2006/42/EC

2. EN standards / IEC standards / ISO standards

IEC/EN 61131-2, IEC 61508 Part1-4, EN ISO 13849-1, IEC/EN 62061, IEC 61326-3-1

SafetyOne is approved for following directives and standards by UL.

1. UL standards

- UL 508

2. CSA standards

- CSA C22.2 No.142

SafetyOne has not undergone the type examination in accordance with Article 44-2 of the Japanese Industrial Safety and Law. SafetyOne, therefore, cannot be used in Japan as a "Safety Device for Press or Shearing machine" as established in Article 42 of that law.

NOTE

- The reproduction, transfer, sale, assignment, or loan of any or a part of this manual is strictly prohibited.
- The contents of this manual are subject to change without notice.
- Thorough measures have been taken in preparing the contents of this manual; however, in the case you find an error or the like, please bring it to the attention of your IDEC sales representative.

CONTENTS

Chapter1 OVERVIEW

This chapter provides an understanding of the SafetyOne. Make efficient use of the SafetyOne by thoroughly familiarizing yourself with its functions.

About the SafetyOne

The FS1A series of SafetyOne™ controllers provides safeguarding measures for various factory automation equipment and systems, including robots, production machinery, semiconductor manufacturing apparatus, food packaging machinery, and printing machinery. You can easily configure the safety circuits by using multiple safety inputs and outputs and selecting the circuit (logic) built into the SafetyOne.

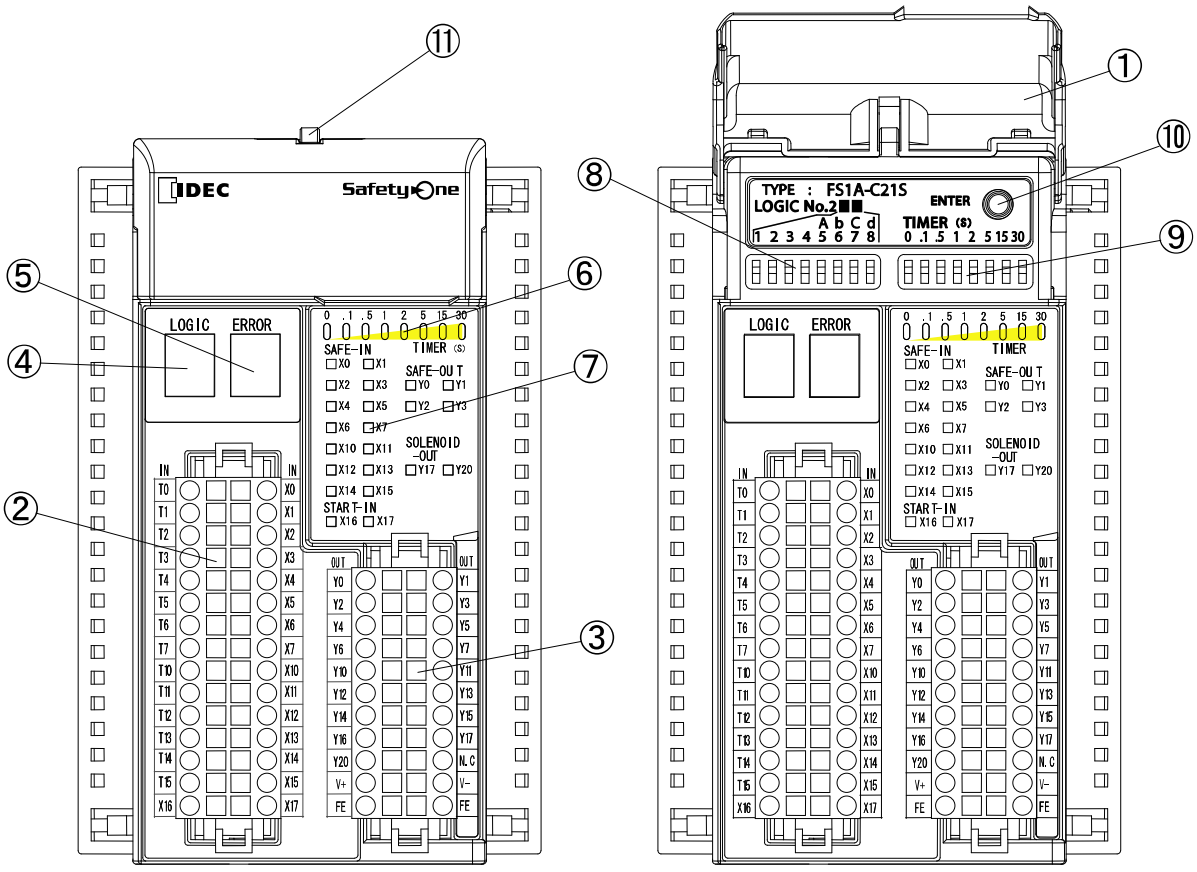
Features of the SafetyOne

- **You can configure safety circuits without the use of complicated external wiring or special software, thereby greatly reducing the number of developmental man-hours required for product certification and the training time of safety responsible persons.**
- **You can use the DIP switches to select from Max. 24 different types of logic circuits and set the OFF-delay timer value to best match your application.**
  The SafetyOne has 16 DIP switches and an ENTER button, which can be used to set the built-in types of logic and the delay timer values for the safety output is OFF.
  You can choice logic circuit from integrated Max. 24 types.
  You can set the timer value to 0, 0.1, 0.5, 1, 2, 5, 15, or 30 seconds. You can set the stop category to 0 or 1.
- **Conforms to the international safety standards IEC 61508 SIL 3 and EN ISO 13849-1 PL e (Control category 4).**
  The SafetyOne can be used for functional safety standard IEC 61508 series and IEC 62061 SIL 1 to 3, which define the safety performance of machinery that uses microprocessors and software, and for performance levels a to e of EN ISO 13849-1 and Control category B to 4 of EN ISO 13849-1, which define safety performance of machinery control systems.
- **You can directly connect an emergency stop switch, interlock switch, light curtain, and other various safety devices.**
  The SafetyOne provides dual channel direct opening inputs such as an emergency stop switch or interlock switch; dual channel NO/NC inputs such as a non-contact interlock switch; and dual channel safety inputs such as a safety light curtain or safety laser scanner. These inputs can be enabled by selecting a certain type of logic, thereby enabling various safety devices.
- **The SafetyOne comes with monitor outputs and solenoid/lamp outputs, which can be used as control signals.**
  With monitor outputs, you can monitor the status of the SafetyOne, including safety inputs and outputs and error information. When connected to a PLC, the SafetyOne can be used to control all apparatus and the entire system. The SafetyOne is also provided with solenoid/lamp outputs, which can be used to directly control spring lock safety switches with solenoids. Muting lamps can be connected to solenoid/lamp outputs.
- **Obtain detailed diagnostic information with the LED displays**.
  The SafetyOne has two 7-segment LED displays for displaying internal information and 30 LED lights for displaying status. You can use these to display input and output information and to obtain detailed diagnostic information on the status of the SafetyOne.
- **Control multiple safety devices (12 safety inputs and 4 safety outputs) by a single unit.**
  The SafetyOne has 12 safety inputs and 4 safety outputs, and it can be configured for up to 6 dual channel inputs and 2 dual channel outputs (in case of use as a single channel output, up to 4 outputs)

Chapter2 PRODUCT SPECIFICATIONS

This chapter describes product specifications of the SafetyOne.

Parts Description



The protective cover is closed　　The protective cover is open

1. Protective cover: The cover protects unauthorized changing of configuration switches.
2. Input connector: Spring clamp connector for input devices. (Crimp connector can also be used.)
3. Output connector: Spring clamp connector for output devices and power supply.
   (Crimp connector can also be used)
4. Logic LED: The 7-segment green LED indicates the number of logic pattern selected.
5. Error LED: The 7-segment red LED indicates an error in the SafetyOne and peripherals.
6. Timer LED: The eight Timer LEDs indicate the selected timer value.
7. Input/output status LED: The input LEDs indicate the state of inputs.
   The output LEDs indicate the state of outputs.
   - SAFE-IN: Status of safe inputs, e.g. X0 … X15
   - START-IN: Status of start inputs, e.g. X16, 17
   - SAFE-OUT: Status of safe outputs, e.g. Y0 … Y3
   - SOLENOID-OUT: Status of solenoid outputs, e.g. Y17, 20
8. Logic switch: DIP switch for selecting the internal logic.
9. Timer switch: DIP switch for selecting the OFF-delay time for the safe output.
10. Enter button: button for activation of parameter changes.
11. Locking ring: ring for locking the protective cover

General specifications

Operating conditions		
	Operating temperature (Surrounding air temperature)	-10 to +55 ºC (no freezing)
	Relative operating humidity	10 to 95% (non-condensing)
	Storage temperature	-40 to +70 ºC (no freezing)
	Relative storage humidity	10 to 95% (non-condensing)
	Pollution degree	2 (IEC/EN 60664-1)
	Degree of protection	IP20 (IEC/EN 60529)
	Corrosion immunity	Atmosphere be free from corrosive gas
	Altitude	Operation: 0 to 2,000m (0 to 6,565 feet)
		Transportation: 0 to 3,000m (0 to 9,840 feet)
	Vibration resistance	Vibration (IEC/EN 60068-2-6): 5 to 8.4 Hz amplitude 3.5 mm, 8.4 to 150 Hz acceleration 9.8 m/s^2 (1G), 2 hours per each of XYZ axes Bump (IEC/EN 60068-2-29): Acceleration 98 m/s^2 (10G), 16ms duration, 1000 times per each of XYZ axes
	Shock resistance	147 m/s^2 (15G), 11 ms duration, 3 times per each of XYZ axes (IEC/EN 60068-2-27)
	Connector durability	50 times maximum
	Operation strength of configuration switches	100 operations maximum (per 1 switch)
	Operation strength of enter button	1000 operations maximum
	Enclosure material	modified-Poly Phenylene Ether (m-PPE)
	Weight	Approximately 330g
	Life time	10 years (at 40 ºC of operating temperature)
	Over voltage category	II
Electrical conditions		
	Rated voltage	24V DC
	Allowable voltage range	20.4V DC to 28.8V DC
	Maximum power consumption	48W (at 24V DC, all inputs and outputs are ON, includes output loads)
	Allowable momentary power interruption	10ms minimum (at rated voltage DC)
	Reaction time	ON to OFF: 40 ms maximum [Note1] : 50 ms maximum [Note1] (In case of logic 22b and 22C) : 100ms maximum [Note2]
		OFF to ON: 100 ms maximum [Note3]
	Start-up time [Note4]	6s maximum
	Dielectric strength	Between live part and FE terminal: 500VAC, 1 minute
		Between enclosure and FE terminal: 500VAC, 1 minute
	Insulation resistance	Between live part and FE terminal: 10MΩ minimum (at 500V DC megger)
		Between enclosure and FE terminal: 10MΩ minimum (at 500V DC megger)
	Noise immunity (Noise simulator)	DC power terminals: ±1.0 kV, 50 ns to 1 μs
		I/O terminals: ±2.0 kV, 50 ns to 1 μs (with coupling adapter)

	Inrush current	25A maximum
	Affect of improper power supply connection	Reverse polarity: No operation, no damage
		Improper voltage: Permanent damage may occur

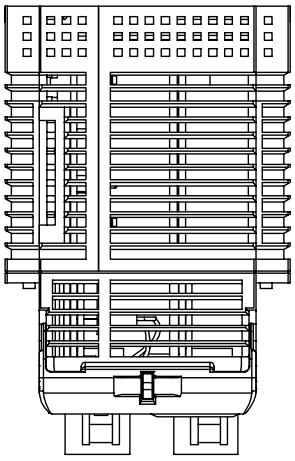
Note1. Time to shut OFF safety outputs after safety inputs are turned OFF or input monitor error is detected (in case of OFF-delay timer is 0s). If the timer value except 0s, add the selected OFF-delay time to this reaction time.

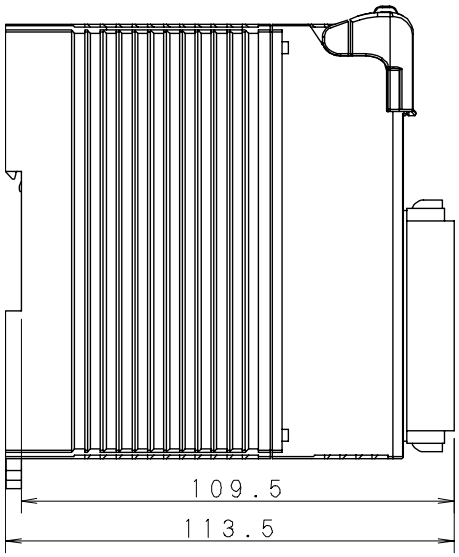
Note2. Time to shut OFF safety outputs after error (except input monitor error) is detected, or configuration change is detected. This reaction time does not depend on OFF-delay timer value.

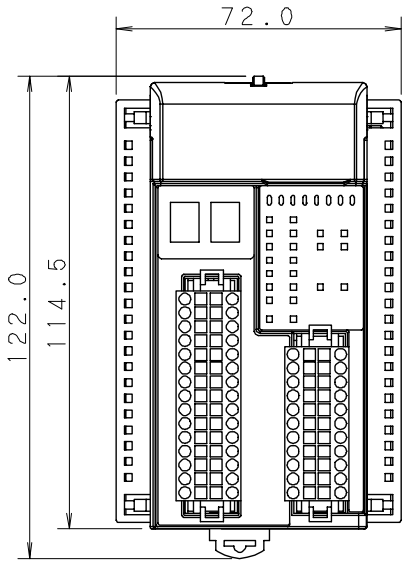
Note3. Time to turn ON safety outputs after safety inputs are turned ON (in case of auto start). In case of manual start, it means time turn ON safety outputs after start input is turned ON. In case of control start, it means time to turn ON safety outputs after start input transits from ON to OFF.

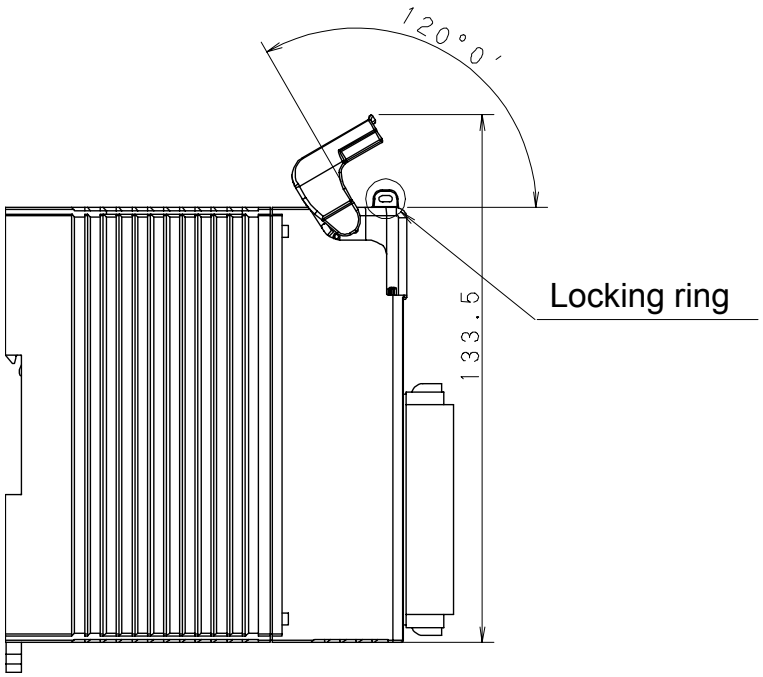
Note4. Time to change to Run state after power ON.

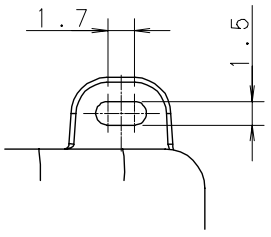
Dimensions











Detail of locking ring

Applicable standards

Standard	Title
IEC 61508 Part1-7 : 2010	Functional safety of electrical/electronic/programmable electronic safety-related systems
EN ISO 13849-1 : 2008	Safety of machinery -- Safety-related parts of control systems -- Part 1: General principles for design
IEC 62061 : 2005/A1: 2012 EN 62061 : 2005/A1: 2013	Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems
IEC 61496-1 : 2012 EN 61496-1 : 2013	Safety of machinery - Electro-sensitive protective equipment - Part 1: General requirements and tests
IEC/EN 61131-2 : 2007	Programmable controllers Part 2: Equipment requirements and tests
IEC/EN 61000-6-2 : 2005	Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments
IEC 61000-6-4 : 2006/A1:2010 EN 61000-6-4 : 2007/A1:2011	Electromagnetic compatibility (EMC) – Part 6-4: Generic emission standards – Residential, commercial, and light industry
IEC/EN 61326-3-1 : 2008	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) - General industrial applications
ISO13851 : 2002	Safety of machinery -- Two-hand control devices -- Functional aspects and design principles
UL 508	Industrial control equipment
CSA C22.2 No.142	Process control equipment

Safety performance

In the case of using safety outputs as dual channel outputs, SafetyOne can be used in a system for control category B to 4 and performance level a to e in accordance with EN ISO13849-1.
In the case of using safety outputs as single channel outputs, SafetyOne can be used in a system for control category B to 3 and performance level a to d in accordance with EN ISO13849-1.

Average probability of failure on demand (PFD) and Probability of a dangerous failure per hour (PFH)

・ In the case of using safety outputs as dual channel outputs

The following table describes PFD and PFH in the case of dual channel outputs. They are needed for calculation of safety integrity level (SIL) which is applied to a system with SafetyOne.
In this case SafetyOne can be used in a system for SIL 1 to 3 in accordance with IEC61508.

Proof test interval I[Note]	Average Probability of Failure on Demand (PFD)	Probability of a dangerous Failure per Hour (PFH)
6 months	$< 2.1 \times 10^{-5}$	$< 7.1 \times 10^{-9}$
1 year	$< 3.6 \times 10^{-5}$	
2 years	$< 6.7 \times 10^{-5}$	
5 years	$< 1.6 \times 10^{-4}$ (SIL2)	
10 years	$< 3.2 \times 10^{-4}$ (SIL2)	

In this case SafetyOne can be used in a system for SIL 1 to 3 in accordance with IEC/EN62061.

Proof test interval [Note]	Probability of a dangerous Failure per Hour (PFH)
10 years	$< 1.4 \times 10^{-8}$

・ In the case of using safety outputs as single channel outputs

The following table describes PFD and PFH in the case of single channel outputs. They are needed for calculation of safety integrity level (SIL) which is applied to a system with SafetyOne.
In this case SafetyOne can be used in a system for SIL 1 to 2 in accordance with IEC61508.

Proof test interval [Note]	Average Probability of Failure on Demand (PFD)	Probability of a dangerous Failure per Hour (PFH)
6 months	$< 4.1 \times 10^{-5}$	$< 1.6 \times 10^{-8}$
1 year	$< 7.5 \times 10^{-5}$	
2 years	$< 1.5 \times 10^{-4}$	
5 years	$< 3.6 \times 10^{-4}$	
10 years	$< 7.0 \times 10^{-4}$	

In this case SafetyOne can be used in a system for SIL 1 to 2 in accordance with IEC/EN62061.

Proof test interval [Note]	Probability of a dangerous Failure per Hour (PFH)
10 years	$< 2.0 \times 10^{-8}$

Note. Refer to Maintenance and Inspection in “APPENDIX” for proof test procedure.

Mean Time To dangerous Failure ($MTTF_d$) and diagnostic coverage (DC)

・ In the case of using safety outputs as dual channel outputs

The following table describes $MTTF_d$ and DC in the case of dual channel outputs. They are needed for the calculation of Performance Level (PL) which is applied to a system with SafetyOne. In this case SafetyOne can be used in a system for PL a to e in accordance with EN ISO13849-1.

Mean time to dangerous failure ($MTTF_d$)	Diagnostic Coverage (DC)
100 years	High

・ In the case of using safety outputs as single channel outputs

The following table describes $MTTF_d$ and DC in the case of single channel outputs. They are needed for the calculation of Performance Level (PL) which is applied to a system with SafetyOne. In this case SafetyOne can be used in a system for PL a to d in accordance with EN ISO13849-1.

Mean time to dangerous failure ($MTTF_d$)	Diagnostic Coverage (DC)
100 years	Medium

Safety input specifications

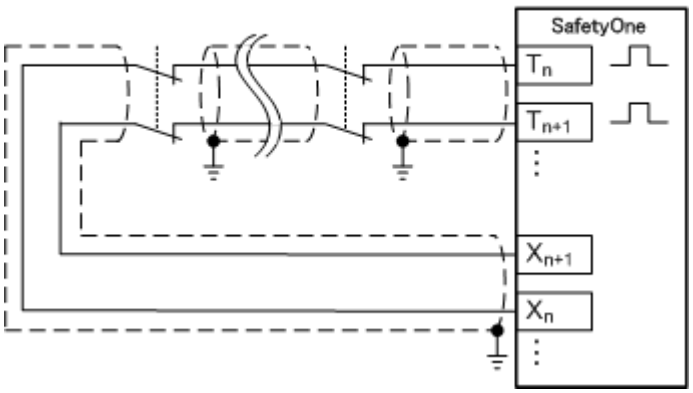
Drive terminal specifications (T0, T1, T2, T3, T4, T5, T6, T7, T10, T11, T12, T13, T14, T15)		
	Rated drive voltage	Power supply voltage
	Minimum drive voltage	Power supply voltage – 2.0V
	Number of drive terminals	14
	Maximum drive current	20mA per port (at 28.8V DC) Note1
Receive terminal specifications (X0, X1, X2, X3, X4, X5, X6, X7, X10, X11, X12, X13, X14, X15)		
	Rated input voltage	24V DC
	Input ON voltage	15.0V DC to 28.8V DC
	Input OFF voltage	Open or 0V DC to 5.0V DC
	Number of receive terminals	14
	Rated input current	10mA per port (at rated voltage)
	Type of input	Sink type input (for PNP output), Type 1 (IEC/EN 61131-2)
Wiring specifications		
	Cable length Note2	100m maximum (total wiring length per 1 input)
	Allowable wiring resistance	300Ω maximum

Note1. The drive port generates check pulses in order to diagnose input devices and internal circuits. (Wiring and the diagnostic function are different depending on the logic selected. See “Chapter 5 LOGIC” for details. But the basic function is same.)

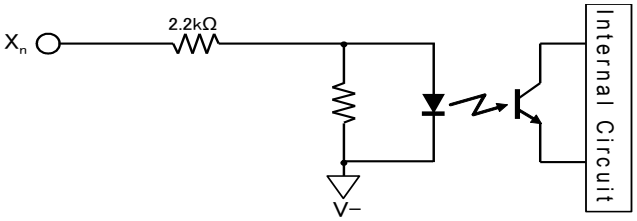
Note2. For cables longer than 30m between SafetyOne and connected devices, or wiring drive terminals and receive terminals separately, use grounded shielded cables to assure electromagnetic compatibility.

Note3. In the common connection of several interlock switches, applicable safety performance depends on result of risk assessment for whole of the safety configuration. Refer to ISO14119 for analysis the connection.

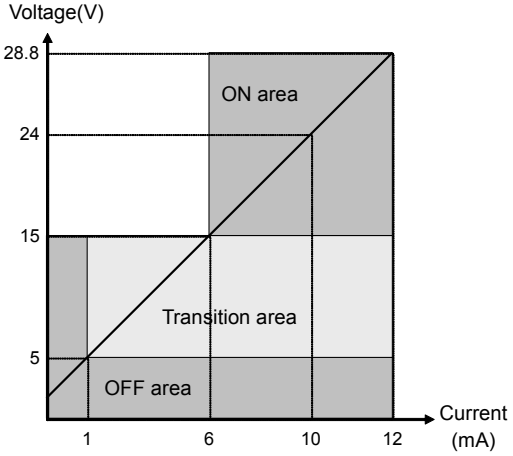
Common connection of several interlock switches



Safety input equivalent circuit



Safety input operating range

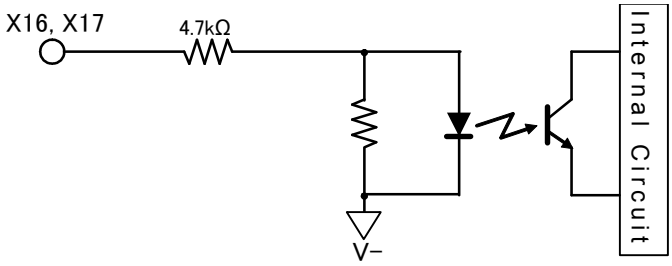


Start input specifications

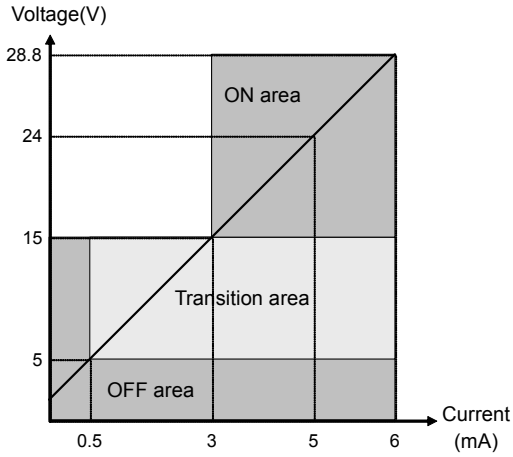
Rated input voltage	24V DC
Input ON voltage	15.0V DC to 28.8V DC
Input OFF voltage	Open or 0V DC to 5.0V DC
Number of start input terminals	2 (X16,17)
Input current	5mA per port (at rated voltage)
Type of input	Sink type input (for PNP output), Type 1 (IEC/EN61131-2)
Cable length[Note1]	100m maximum (total wiring length per 1 input)
Allowable wiring resistance	300Ω maximum

Note1. For cables longer than 30m between SafetyOne and connected devices, use grounded shielded cables to assure electromagnetic compatibility.

Start input equivalent circuit



Start input operating range



The specifications of the start inputs changes depending on the Logic selected. See further information in “Chapter 5 LOGIC”. But basic specifications are same.

Warning

Do not use start inputs as safety inputs. This may cause the loss of safety functions and possible failure in the SafetyOne or peripherals.

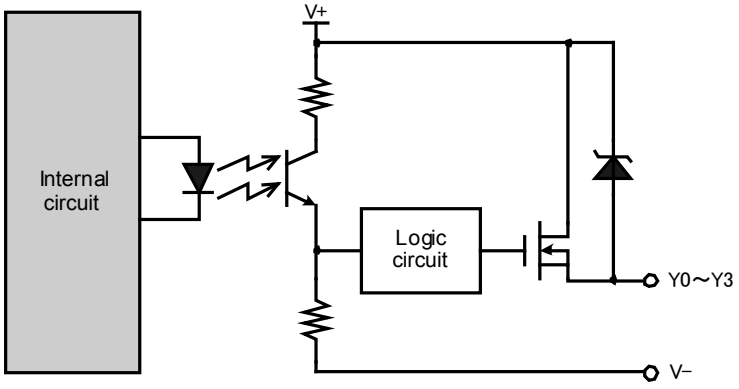
Safety output specifications

Output type		Source output (N channel MOSFET)
Rated output voltage		Power supply voltage
Minimum voltage		Power supply voltage - 2.0V
Number of output terminals		4 (Y0, Y1, Y2, Y3)
Maximum output current	Point	500mA maximum
	total	1A maximum
Leakage current		0.1mA maximum
Allowable inductive Load Note1		L / R = 25ms
Allowable capacitive load		1uF maximum
Cable length Note2		100m maximum (total wiring length per 1 output)

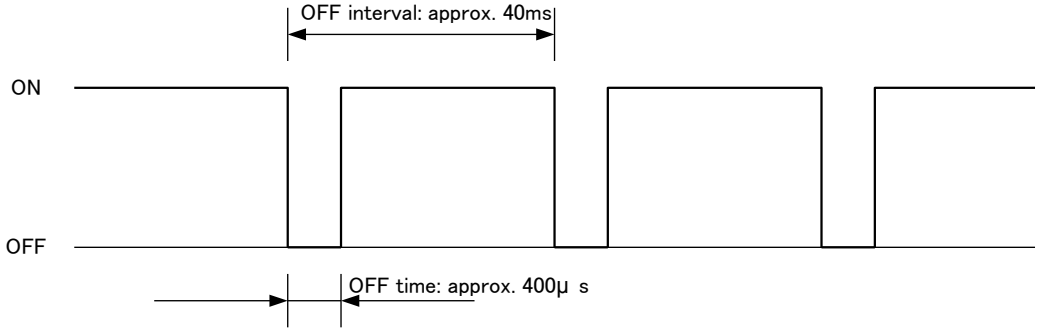
Note1. For protection of output circuits, protection devices such as diodes should be connected to output circuits with inductive loads.

Note2. For cables longer than 30m between SafetyOne and connected devices, use grounded shielded cables to assure electromagnetic compatibility.

Safety output equivalent circuit



Safety outputs of the SafetyOne are semiconductor outputs. For diagnostics of the shut-off function, the SafetyOne generates off-pulses in certain intervals when the outputs are in ON state. The specifications of the safety outputs changes depending on the Logic selected. See further information in “Chapter 5 LOGIC”. But basic specifications are same.



Caution

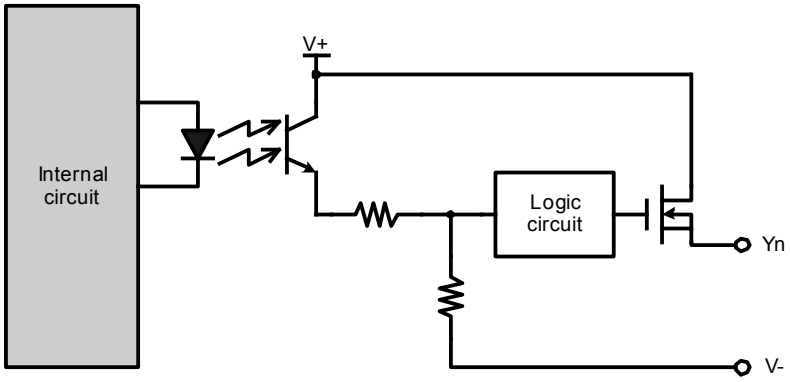
Check the response time of external devices so that they do not correspond to the off pulses. Monitor and solenoid/lamp outputs do not generate off pulses.

Monitor output specifications

Output type		Source output (N channel MOSFET)
Rated output voltage		Power supply voltage
Minimum output voltage		Power supply voltage - 2.0V
Number of outputs		11 (Y4, Y5, Y6, Y7, Y10, Y11, Y12, Y13, Y14, Y15, Y16)
Maximum output current	Point	20mA maximum
	total	220mA maximum
Leakage current		0.1mA maximum
Cable length[Note1]		100m maximum (total wiring length per 1output)

Note1. For cables longer than 30m between SafetyOne and connected devices, use grounded shielded cables to assure electromagnetic compatibility.

Monitor output equivalent circuit



The specifications of the monitor outputs change depending on the Logic selected. See further information in “Chapter 5 LOGIC”. But basic specifications are the same.

Warning

Do not use monitor outputs for safety related purposes. This may cause a loss of safety functions in case of failure of the SafetyOne or peripherals.

Caution

Use an IEC60127-approved fuse on the monitor output circuit. (This is required for equipment incorporating SafetyOne that is destined for Europe.)
Ex. Fast-Acting fuse, Amp rating 0.125A, Voltage rating 250V

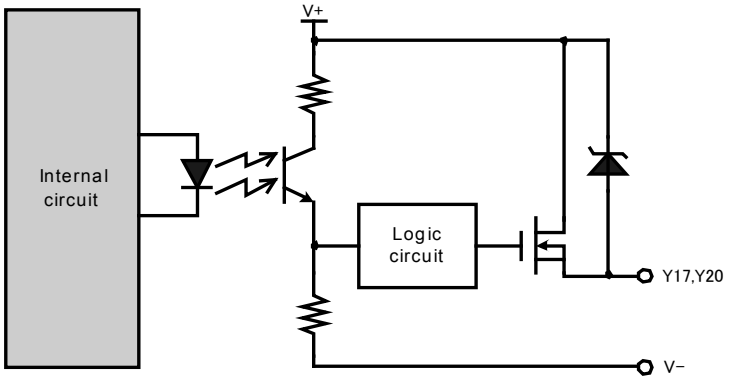
Solenoid/Lamp output specifications

Output type		Source output (N channel MOSFET)
Rated output voltage		Power supply voltage
Minimum output voltage		Power supply voltage - 2.0V
Number of outputs		2 (Y17, Y20)
Maximum output current	point	500mA maximum
	total	500mA maximum
Leakage current		0.1mA maximum
Allowable Inductive Load Note1		L / R = 25ms
Cable length Note2		100m maximum (total wiring length per 1 output)

Note1. For protection of output circuits, protection devices such as diodes should be connected to output circuits with inductive loads.

Note2. For cables longer than 30m between SafetyOne and connected devices, use grounded shielded cables to assure electromagnetic compatibility.

Solenoid/lamp output equivalent circuit



The specifications of the solenoid/lamp outputs changes depending on the Logic selected. See further information in “Chapter 5 Logic”. But basic specifications are the same.

Warning

Do not use solenoid/lamp outputs for safety related purposes. This may cause a loss of safety functions in case of failure of the SafetyOne or peripherals.

Caution

Use an IEC60127-approved fuse on the Solenoid/Lamp output circuit. (This is required for equipment incorporating SafetyOne that is destined for Europe.)

Ex. Time-Lag fuse, Amp rating 2A, Voltage rating 250V

Logic number

The logic number of the SafetyOne is composed by a 3-digit code as following.

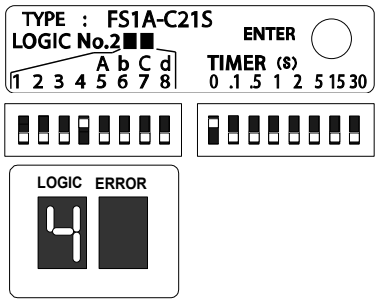
Example 1: LOGIC No.204

The first code “2” inidicates the type number “FS1A-C21S”.

Following 2-digit code “04” indicates the state of the logic switch.

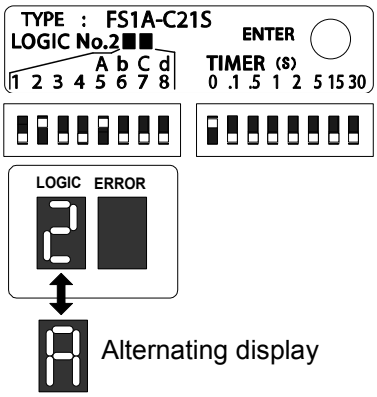
The logic LED displays this 2-digit code. But “0” is not displayed.

Ex. 1: Logic 204



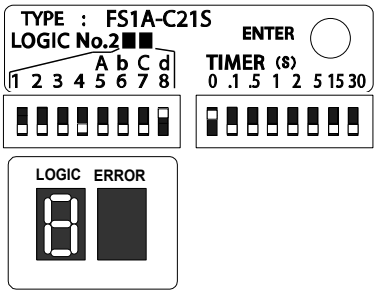
“0” is not displayed.

Ex. 2: Logic 22A



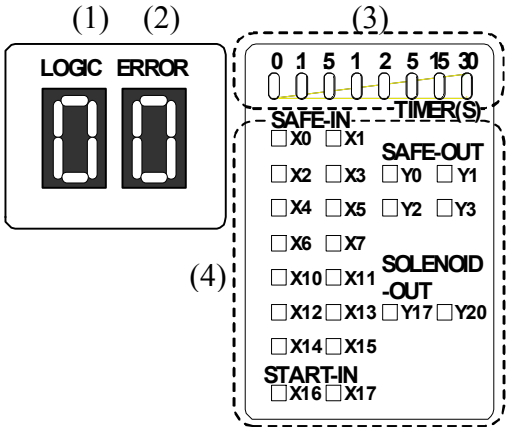
Alternating display

Ex. 3: Logic 208



“0” is not displayed.

Indicators



(1) Logic LED (green)
(2) Error LED (red)
(3) Timer LED (green)
(4) Input/Output status LED (orange)
- SAFE-IN
- START-IN
- SAFE-OUT
- SOLENOID-OUT

(1) Logic LED

Indication	Status	Descriptions
"1"... "8" "A", "b", "C", "d"	ON	The selected logic is in Run or Protection state. (Ex. : In case of logic 24A 4 → A → 4 → A → 4 → …)
	Blink	The selected logic is in Configuration state. (Ex. : In case of logic 24A 4 → A → OFF → 4 → A → OFF →4 → A →…)
"E"	Blink	The selected logic has Configuration error (The logic is not selected or incorrect multiple switches are selected[Note1].)
Random pattern	ON/Blink	Initializing (Initial state)
Blank	OFF	Error (Stop state)

Note1. Proper logic switch configurations are shown below.
-Select one of "1" to "8" switches.
-Select one of "1" to "4" and one of "A", "b", "C", "d" switches.
Other than above selections are incorrect.

(2) Error LED

Indication	Status	Descriptions
"1"	ON	Input monitor error (Protection state)
"2"	ON	Wiring error at safety inputs or error in safety input circuits (Stop state)
"3"	ON	Wiring error at start inputs or error in start input circuits (Stop state)
"4"	ON	Wiring error at safety outputs or error in safety output circuits (Stop state)
"5"	ON	Muting lamp error (disconnection) (Logics with lamp output) (Stop state) (Software version 1.00 only)
"6"	ON	Power supply error or internal power supply circuit error (Stop state)
"7"	ON	Internal error, power supply error or internal power supply circuit error (Stop state)
"9"	ON	EMC disturbance (Stop state)
"C"	ON	Configuration procedure is in progress (Configuration state)
	Blink	Configuration is valid [Note1] (Configuration state)
Random	ON/Blink	Initializing (Initial state)
Blank	OFF	Normal operation (Run state)

Note1. Blinks for 1 to 5 seconds after the enter button is pressed. Releasing the button during blinking activates the setting. The blinking LED becomes ON if the button is pressed for more than 5 seconds, and the setting becomes invalid even after the button is released.

(3) Timer LED

Indication	Status	Descriptions
0	ON	No OFF-delay (safety outputs shut off immediately)
.1	ON	OFF-delay timer 0.1s
.5	ON	OFF-delay timer 0.5s
1	ON	OFF-delay timer 1s
2	ON	OFF-delay timer 2s
5	ON	OFF-delay timer 5s
15	ON	OFF-delay timer 15s
30	ON	OFF-delay timer 30s
Each LED	Blink	Selected timer value (Configuration state)
Random	ON/Blink	Initializing (Initial state)
Blank	OFF	Timer value is not selected or SafetyOne is in the Stop state

(4) Input LED: SAFE-IN (X0 … X15), START-IN (X16, X17)

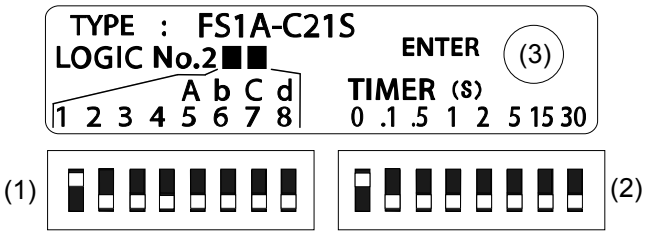
Indication	Status	Descriptions
X0 to X15	ON	Input ON
	OFF	Input OFF, or SafetyOne is in the Stop or Configuration state
	Blink	Input monitor error (Blink input number the error occurred, error number is displayed at Error LED)
X16, X17	ON	Input ON
	OFF	Input OFF, or SafetyOne is in the Stop or Configuration state
	Blink	Input monitor error (Blink input number the error occurred, error number is displayed at Error LED)

Indicators specification of input LEDs are different depending on the selected logic.

(5) Output LED: SAFE-OUT (Y0 … Y3), SOLENOID-OUT (Y17, Y20)

Indication	Status	Descriptions
Y0 to Y3	ON	Output ON
	OFF	Output OFF, or SafetyOne is in the Stop or Configuration state
	Blink	During OFF-delay timer operation, or output monitor error (Blink output number the error occurred, error number is displayed in Error LED display)
Y17, Y20	ON	Output ON
	OFF	Output OFF, or SafetyOne is in the Stop or Configuration state
	Blink	Output monitor error (Blink output number the error occurred, error number is displayed at Error LED display)

Specification of configuration switches



(1) Logic switch
(2) Timer switch
(3) Enter button

(1) Logic switch

The logic switch is an 8-digit DIP switch for use in logic configuration. When one of “1” to ”8” is selected, or one of “1” to “4” and one of “A”, “b”, “C”, ”d” are selected, the corresponding logic in the SafetyOne is activated. See “Chapter 5 Logic” for further information of each logic. The upper position of each digit is the ON state. Other than above selections are not valid.

(2) Timer switch

The timer switch is an 8-digit DIP switch for use in OFF-delay timer value configuration. When one of 8 digits is selected, the delay time at shut-off operation is activated. The upper position of each digit is ON state. Multiple switches must not be selected. One of 8 digits must be selected for all logics (includes the logic dose not have Safety output with timer).

Switch	(Indication)	Descriptions
0	1	No OFF-delay (safety outputs shut OFF immediately)
.1	2	OFF-delay timer 0.1s
.5	3	OFF-delay timer 0.5s
1	4	OFF-delay timer 1s
2	5	OFF-delay timer 2s
5	6	OFF-delay timer 5s
15	7	OFF-delay timer 15s
30	8	OFF-delay timer 30s

(3) Enter button

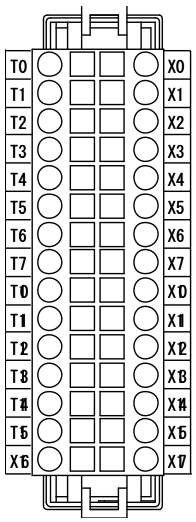
The enter button is used to activate the configuration of logic and timer value. Error LED will blink for 1 to 5 seconds after pressing the enter button. Releasing the button during blinking activates the setting. The blinking LED becomes ON if the button is pressed for more than 5 seconds, and the setting becomes invalid even after the button is released.

Caution

For setting the switches and enter button, use the configuration tool supplied with the SafetyOne.

Connector specifications

■Input connector

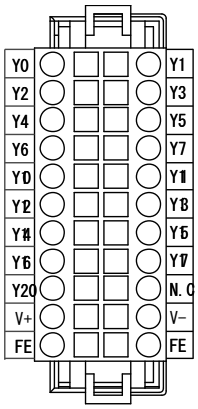


Connector type: - Spring clamp connector (30 poles)
FS9Z-CN01 [IDEC]
(Tyco Electronics AMP type Number: 2-1871940-5)
- Crimp connector (30 poles)[Note1]
(Tyco Electronics AMP type Number: 2-1871946-5)

Terminal name	Terminal No.	Descriptions	Terminal name	Terminal No.	Descriptions
T0	A1	Safety input drive terminal 0	X0	B1	Safety input receive terminal 0
T1	A2	Safety input drive terminal 1	X1	B2	Safety input receive terminal 1
T2	A3	Safety input drive terminal 2	X2	B3	Safety input receive terminal 2
T3	A4	Safety input drive terminal 3	X3	B4	Safety input receive terminal 3
T4	A5	Safety input drive terminal 4	X4	B5	Safety input receive terminal 4
T5	A6	Safety input drive terminal 5	X5	B6	Safety input receive terminal 5
T6	A7	Safety input drive terminal 6	X6	B7	Safety input receive terminal 6
T7	A8	Safety input drive terminal 7	X7	B8	Safety input receive terminal 7
T10	A9	Safety input drive terminal 10	X10	B9	Safety input receive terminal 10
T11	A10	Safety input drive terminal 11	X11	B10	Safety input receive terminal 11
T12	A11	Safety input drive terminal 12	X12	B11	Safety input receive terminal 12
T13	A12	Safety input drive terminal 13	X13	B12	Safety input receive terminal 13
T14	A13	Safety input drive terminal 14	X14	B13	Safety input receive terminal 14
T15	A14	Safety input drive terminal 15	X15	B14	Safety input receive terminal 15
X16	A15	Start input terminal 16	X17	B15	Start input terminal 17

Note1. For detailed information of Crimp connector, consult Tyco Electronics AMP.

■Output connector



Connector type: - Spring Clamp connector (22 poles)
FS9Z-CN02 [IDEC]
(Tyco Electronics AMP type No.:2-1871940-1)
- Crimp connector (22 poles) Note1
(Tyco Electronics AMP type No.: 2-1871946-1)

Terminal name	Terminal No.	description	Terminal name	Terminal No.	Description
Y0	A1	Safety output terminal 0	Y1	B1	Safety output terminal 1
Y2	A2	Safety output terminal 2	Y3	B2	Safety output terminal 3
Y4	A3	Monitor output terminal 4	Y5	B3	Monitor output terminal 5
Y6	A4	Monitor output terminal 6	Y7	B4	Monitor output terminal 7
Y10	A5	Monitor output terminal 10	Y11	B5	Monitor output terminal 11
Y12	A6	Monitor output terminal 12	Y13	B6	Monitor output terminal 13
Y14	A7	Monitor output terminal 14	Y15	B7	Monitor output terminal 15
Y16	A8	Monitor output terminal 16	Y17	B8	Solenoid/lamp output terminal 17
Y20	A9	Solenoid/lamp output terminal 20	N.C	B9	No connection terminal
V+	A10	Power supply 24VDC terminal	V-	B10	Power supply 0VDC terminal
FE	A11	Functional Earth terminal	FE	B11	Functional Earth terminal

Note1. For detailed information of the Crimp type connector, consult Tyco Electronics AMP.

Chapter3 INSTALLATION AND WIRING

This chapter describes methods and precautions for installing and wiring the SafetyOne. Before starting installation and wiring, be sure to read “SAFETY PRECAUTIONS” in the beginning of this manual and understand the precautions described under WARNING and CAUTION.

WARNIG and CAUTION

Warning

- Turn off power to SafetyOne before starting installation, removing, wiring, maintenance, or inspection. Failure to turn power off may cause electrical shocks or fire hazard.
- Before operating SafetyOne, carefully read the instruction sheet and this manual, and ensure that the environment conforms to the requirements of SafetyOne specifications. If SafetyOne is operated in an environment that exceeds the specifications, it causes impairment of the safe operation of SafetyOne.
- . The installation, wiring, configuration, and operation of SafetyOne must be performed only by “Safety responsible personnel”. Safety responsible personnel are personnel who have requisite qualifications as being capable of safely carrying out each step, including designing, installation, operation, maintenance, and disposal of SafetyOne. Personnel without technical expertise of safety personnel must not use SafetyOne.
- Installation of SafetyOne must be performed according to the instructions found in the instruction sheet and this manual. Improper installation may cause the SafetyOne to fail.
- Use a power supply that meets following required specifications:
  -Conforms to the power supply rating of SafetyOne
  -Complies with the SELV/ PELV circuit specified by EN 50178 or IEC/EN 60950-1.
  -Has the functionality or the functional equivalent of the control voltage and current of a class 2 circuit, as defined in UL 508 or UL 1310.
  -Is in compliance with safety laws and regulations relating to electrical safety, and EMC, under the laws and regulations of the country in which it is being used.
- Ground the V-line (0V DC) for ground fault diagnosis.
- In the case of a new configuration or modified installation, be sure to perform a check for each input and output function.
- Separate SafetyOne from devices and wires which are not in accordance with class 2 circuit requirements.

Caution

- SafetyOne is designed for installation in an enclosure. Do not install SafetyOne outside an enclosure. Install SafetyOne in enclosure with a rating of IP54 or higher.
- Install SafetyOne in environments described in the catalog, instruction sheet, and user’s manual. If SafetyOne is used in places where it is subjected to high temperature, high humidity, condensation, corrosive gases, excessive vibrations, and excessive shocks, then electrical shocks, fire hazard, or malfunction may result.

- Environment for using the SafetyOne is “Pollution degree 2”. Use SafetyOne in environments of pollution degree 2 (according to IEC/EN 60664-1).
- Prevent SafetyOne from falling while moving or transporting otherwise damage or malfunction of the SafetyOne may result.
- Prevent metal fragments and pieces of wire from dropping inside the SafetyOne housing. Put a cover on the SafetyOne during installation and wiring. Ingress of such fragments and chips may cause fire hazard, damage or malfunction.
- Install SafetyOne, so that there is adequate spacing from walls, heat generating bodies, and peripherals, taking into consideration space requirements for maintenance and ventilation.
- Install SafetyOne on 35mm DIN rails with BNL6 mounting clips (sold separately) on both sides of SafetyOne.
- Perform wiring to the connectors with proper cables or ferrules.
- Ground FE terminal to assure electromagnetic compatibility (EMC)
- Use common 0V DC, if different power supplies are used for SafetyOne and other devices (ex. safety light curtains).
- Install wiring for the inputs and outputs so that it is separated from power lines.

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Installation method

■ Installation location and direction

When the SafetyOne is installed in an enclosure, confirm that installation environments meet the product specifications. Using in environments as a described below, (over the product specifications) may cause fire hazard, damage, or malfunction.

- SafetyOne should not be exposed to excessive dust, dirt, salt, vibration or shocks.
- Do not use SafetyOne in an area where corrosive chemicals or flammable gases are present.
- Do not use SafetyOne near induction heat sources.

Mount SafetyOne with enough space from any device as shown at Fig3.1 for maintenance and ventilation. Do not install SafetyOne near, and especially above, any heating device or heat source.

Use SafetyOne in surrounding air temperature, -10 to +55 ºC.

Note1. Consider opening and closing of protective cover. (Min. 20mm)

Note2. Consider instllation to DIN rail and ventilation characteristic. (Approx. 20mm)

Note3. Consider distance to other devices can be heat source, such as safety relays. (Approx. 40mm)

Note4. Consider wiring the cables connected to input/output connectors. (Approx. 80mm)

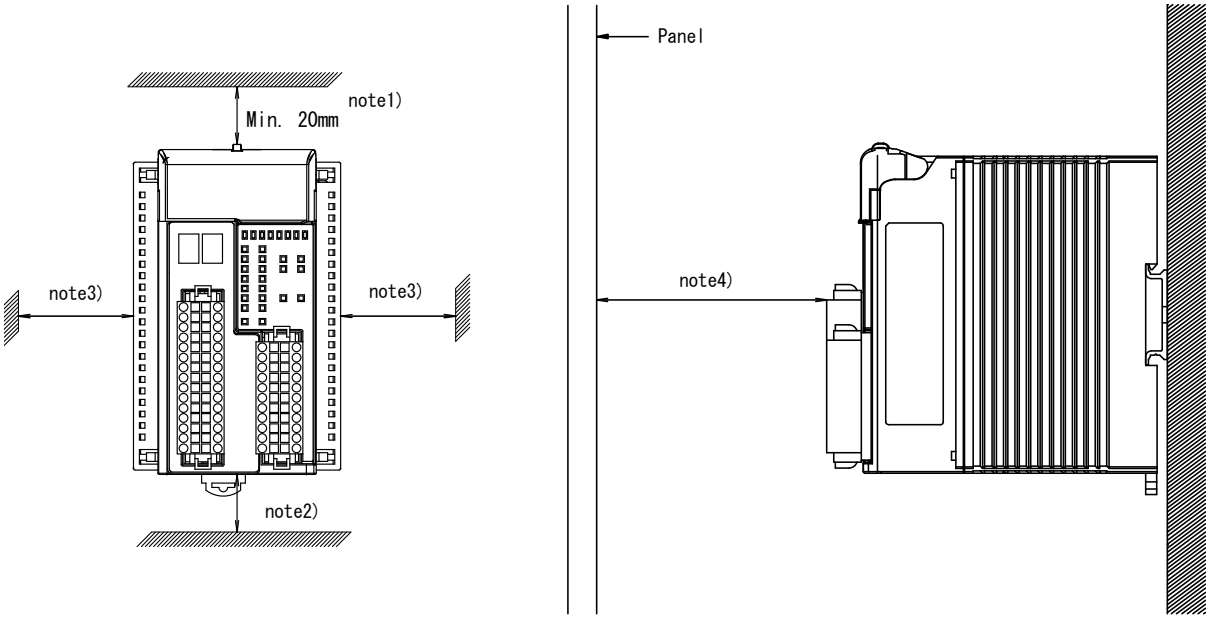


Fig. 3.1 Installation location

Mount SafetyOne on a vertical plane as shown in Fig.3.2.
All other installation directions are not allowed.

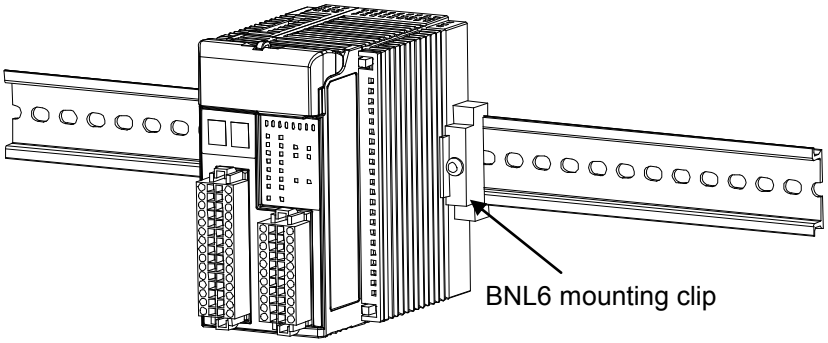
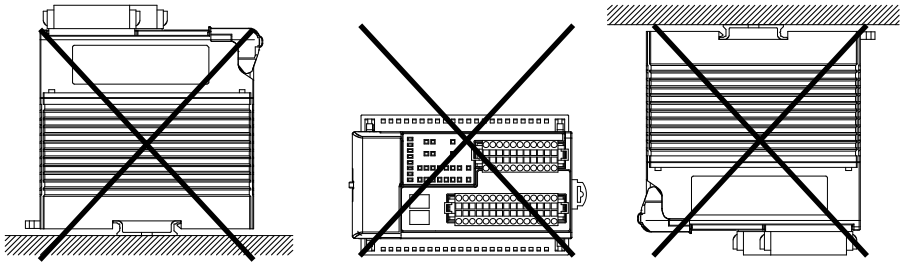


Fig. 3.2 Correct installation direction



Upwards Sideways Downwards

Fig. 3.3 Incorrect installation directions

■ Installing on DIN Rails

Mount and remove SafetyOne on 35mm-wide DIN rails according to the following instructions.
Applicable DIN rail: (for example) BAA1000 (IDEC)

Mounting on DIN rail

1. Fasten DIN rail to a panel using screws.
2. With the top of SafetyOne unit facing up, as shown in Fig. 3.4, insert the groove, on the rear of the unit, and press the unit in the direction of the arrow.
3. Use BNL6 (IDEC) mounting clips (sold separately) on both sides to prevent it from moving sideways.

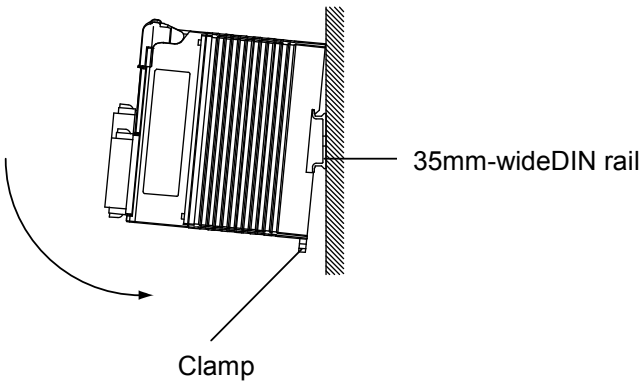


Fig. 3.4 Mounting

Removing from DIN Rail

1. Insert a flat screwdriver into the slot in the clamp.
2. Pull the clamp until you hear a click, as shown in Fig. 3.5.
3. Remove SafetyOne from the bottom.

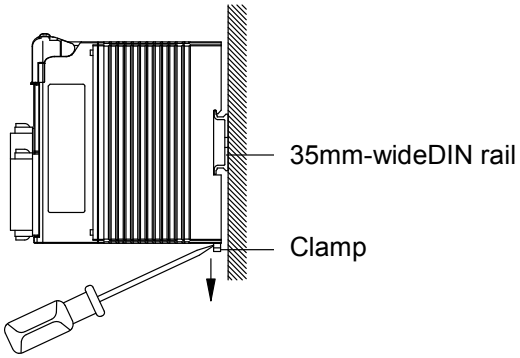


Fig. 3.5 Removing

Wiring method

SafetyOne has two kinds of connectors spring clamp (optional) and crimp.[Note1]

Note1. For detailed information of Crimp connector, consult Tyco Electronics AMP.

■ Applicable connectors and mounting to SafetyOne

Applicable connectors

Type	No. of pole	Part No.	Remarks
Spring clamp	30	FS9Z-CN01	IDEC (optional)
		2-1871940-5	Tyco Electronics AMP
	22	FS9Z-CN02	IDEC (optional)
		2-1871940-1	Tyco Electronics AMP
Crimp	30	2-1871946-5	Tyco Electronics AMP
	22	2-1871946-1	Tyco Electronics AMP

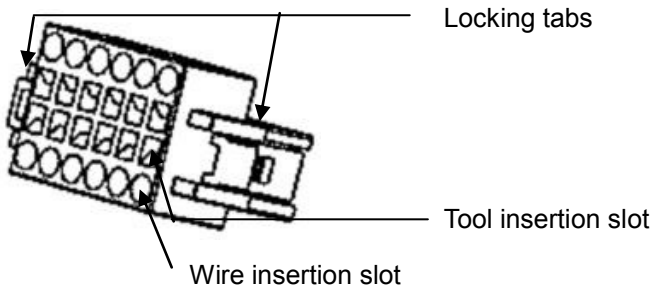


Fig. 3.6 Spring clamp connector (FS9Z-CN0*)

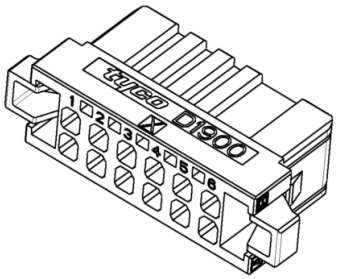


Fig. 3.7 Crimp connector

When mounting a connector to the SafetyOne, be sure to insert the connector straight and completely in until you hear a click or feel it click into position. To remove the connector, press down on the locking tabs completely, and then pull out the connector. If pressing down on the locking tabs is incomplete damage to the connector and wire may occur.

■ Applicable wire and ferrule sizes for spring clamp connector

AWG#18-24 (UL1007 recommended) Stripped length: 7.0±0.3mm

When using ferrules, specification are shown below.

Long size: 1.02mm (min.) - 1.21mm (max.) (”a” in the figure below)

Short size: 0.95mm (min.) - 1.21mm (max.) (”b” in the figure below)

Applicable wire: AWG#24 (UL1007 recommended)

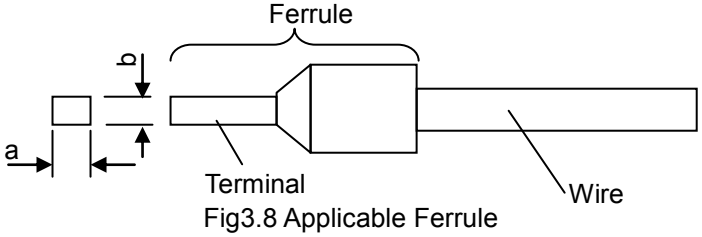


Fig3.8 Applicable Ferrule

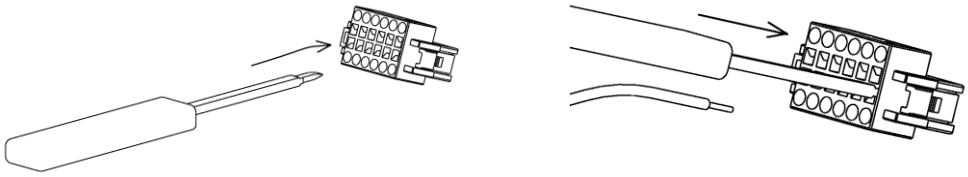
■ Wiring for spring clamp connector

Do not wire the connector while it is connected to the SafetyOne, as this can damage the connector and the SafetyOne.

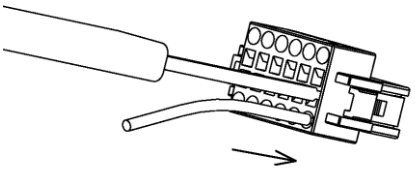
To connect the wire, use a connecting tool (FS9Z-SD01 [IDEC] (Tyco Electronics AMP Type Number: 0-2040798-1) or a commercially-available screwdriver. It is recommended that you use a dedicated connecting tool to prevent any scratches or damage to the connector housing and spring. When rewiring, use wire of the same gauge.

● Wiring with a connecting tool

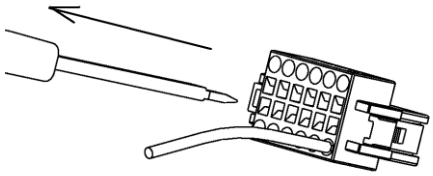
1. Insert the connecting tool into the tool insertion slot on the connector at an angle until the tool comes to a stop.



2. Insert the wire into wire insertion slot. (If there are any loose strands, twist the wire to make it even.)



3. With the wire pressed down, remove the connecting tool to finish. Lightly tug on the wire to check that it is securely connected.



4. To remove the wire, press down the spring with the connecting tool, as if you are connecting the wire, and pull out the wire.

■ Wiring with a commercially-available screwdriver

Use a screwdriver with a tip width that does not exceed 2.4 mm. Be careful when wiring with a screwdriver as this can damage the connector.

1. Insert the screwdriver into the tool insertion slot on the connector at an angle, and press down so as to open the spring. Be careful not to insert the screwdriver with too much force, as this can damage the connector. Do not insert the screwdriver into the wire insertion slot.
2. With the screwdriver inserted, as described in Step 1 above, insert the wire into wire insertion slot. (If there are any loose strands, twist the wire to make it even.)
3. With the wire pressed down, remove the screwdriver to finish. Lightly tug on the wire to check that it is securely connected.
4. To remove the wire, press down the spring with the screwdriver, as if you are connecting the wire, and pull out the wire.

Chapter4 BASIC OPERATIONS

This chapter describes the basic operations of SafetyOne. Make proper use of the SafetyOne by thoroughly familiarizing yourself with basic operations and functions.

Internal states

The SafetyOne operates in five internal states, as shown in Table 4.1.

The LED display and output status for each state are shown in Table 4.2.1and 4.2.2.

Table 4.1 Internal states

State	Description
Initial	Initial processing is performed immediately after power is supplied to the SafetyOne. The internal circuits are checked and the LEDs show operation confirmation (blinking) for 6 seconds (approx)..
Run	The SafetyOne is under normal operation. Logic processing continues without failures or wiring errors. (Refer to "Chapter 5 LOGIC" for details.)
Configuration	A logic or OFF-delay timer value is being configured. Configuration enables the logic and OFF-delay timer value. When completed, the SafetyOne changes to the Run state. (Refer to "Logic configuration" and "Timer configuration" in this chapter for details.)
Protection	An input monitor error has occurred with dual channel input, EDM input, or muting input. When the problem is removed, the SafetyOne changes to Run state. (Refer to "Canceling the Protection state" in this chapter for details.)
Stop	A failure or error has occurred with an external device or internal circuit. When the problem is removed and the power is turned on, Stop state is cleared. (Refer to "Canceling the Stop state" in this chapter for details.)

Table 4.2.1 LED display and output status for each state

(When safety outputs are dual channel outputs)

State	Logic LED	Error LED	Timer LED	Safety output	Solenoid/ lamp output	Monitor output			
				Y0…Y3	Y17,Y20	Y4…Y13	Y14	Y15	Y16
Initial	(1)	(1)	(1)	□OFF	□OFF	□OFF	■ON	■ON	□OFF
Run	Logic #	Blank	Selected Value	(2)	(2)	(2)	□OFF	□OFF	■ON
Configuration	(3)	“C”	(3)	□OFF	□OFF	□OFF	□OFF	■ON	□OFF
Protection	Logic #	“1”	Selected Value	□OFF (6)	□OFF	(4)	□OFF	■ON	□OFF
Stop	Blank	(5)	Blank	□OFF	□OFF	(7)	■ON	■ON or □OFF	□OFF

Table 4.2.2 LED display and output status for each state

(When safety outputs are single channel outputs)

State	Logic LED	Error LED	Timer LED	Safety output	Monitor output			
				Y0…Y3	Y4…Y13, Y17, Y20	Y14	Y15	Y16
Initial	(1)	(1)	(1)	□OFF	□OFF	■ON	■ON	□OFF
Run	Logic #	Blank	Selected Value	(2)	(2)	□OFF	□OFF	■ON
Configuration	(3)	“C”	(3)	□OFF	□OFF	□OFF	■ON	□OFF
Protection	Logic #	“1”	Selected Value	□OFF (6)	(4)	□OFF	■ON	□OFF
Stop	Blank	(5)	Blank	□OFF	(7)	■ON	■ON or □OFF	□OFF

(1) Random display of Initial state.
(2) Output and LED display of the selected logic.
(3) Blinking LED display of the selected logic number or the selected timer value.
(4) The monitor output corresponding to the input or the output of error is turned OFF, and the input or the output LED is pulsed. Other monitor outputs and LEDs maintain the display of Run state. In the case of SW version 1.00, the monitor output corresponding to the input or the output of error is pulsed.
(5) Error number is displayed.
(6) Safety output with timer is turned OFF after the preset OFF-delay time.
(7) Monitor outputs are turned OFF, and the LED corresponding to the input or the output of error is pulsed. Other LEDs are turned off. In the case of SW version 1.00, the monitor output corresponding to the input or the output of error is pulsed.

Refer to “Chapter2 PRODUCT SPECIFICATIONS” for detail information of LED display.

Caution

Solenoid/lamp outputs (Y17, Y20) turn ON for 1 second maximum when the state changes to Run state. Take operation of connected components into consideration.

Turning on the power

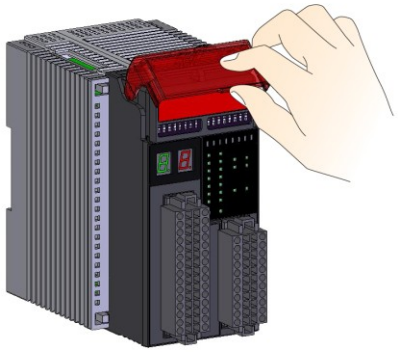
After the SafetyOne is turned on, it transitions to the Initial state and checks internal circuits. SafetyOne changes to the appropriate state (in approximately 6s) according to the result of the internal circuit check. During the Initial state, the LEDs blink to check operation.

Logic switch and timer switch are set Logic: “201” and Timer: “1 (0s)” at the factory. When initially powering up the SafetyOne, thoroughly confirm the configuration and the operation.

Using the protective cover

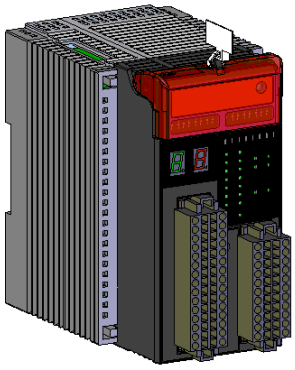
●Opening and closing the protective cover

Place your finger at the bottom right of the protective cover, and open the cover to a position that enables you to view the configuration options. The protective cover can be set at two opened positions (60° or 120°). Be careful not to open the cover beyond 120°, as this causes the cover to separate from the body.



●Locking the protective cover

After configuration of SafetyOne and confirming, close the protective cover. To protect the configuration, it is recommended that the protective cover be locked.
Use the attached marking tie or commercially-available wire or a similar equipment to lock the protective cover. In case of using commercially-available wire, use wire that perspnnel, other than safety responsible persons operating the SafetyOne, are not able to modify. (ex. Φ1.0 or more metal wire)



Refer to Dimensions in “Chapter 2 PRODUCT SPECIFICATIONS” for Detail of locking hole.

The protective cover and marking tie do not ensure mechanical strength against strong force. The protective cover and marking tie can be broken with the strong force.

Logic configuration

The SafetyOne offers Max. 24 types of logic, and by performing the logic configuration procedure listed below, you can enable the desired logic.
The SafetyOne can transition to the Configuration state from the Run or Protection state. Configuration operations are disabled in the Initial and Stop states.
Once any logic is configured, it is kept in the SafetyOne even if the power is turned off.
The logic and timer settings can be configured at the same time. Confirm the configuration methods, and configure the logic and timer properly.
The default setting of the logic switch is set to “201” at the factory. When initially powering on the SafetyOne, thoroughly confirm the configuration and the operation.

1. Open the protective cover.
Open the cover to a position that enables you to set the configuration operations.
Refer to "Using the protective cover" for details.

2. Select the logic switch.
Select and operate the logic switch. Select one of “1” to “8” switches, or one of “1” to “4” and one of “A”, “b”, “C”, “d” switches. When operating the logic switch, use the attached configuration tool.
When the logic configuration is changed, "C" is displayed in the error LED display and the new number of the logic configuration blinks in the logic LED display.
If any logic switch is not selected or incorrect selection is done, "E" is displayed in the logic LED display.

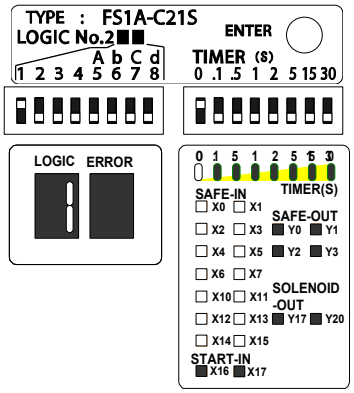


Fig. 4.1 Normally switch configuration and LED indication (Run state)

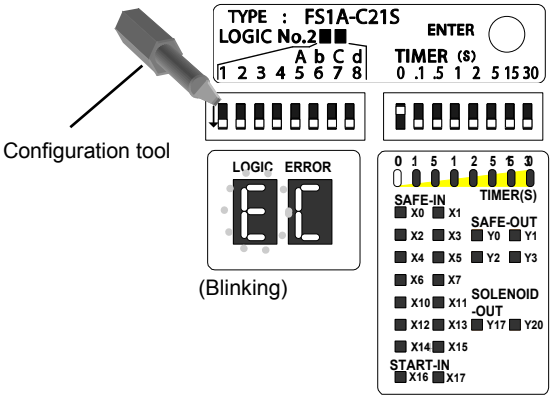


Fig. 4.2 Logic switch is not selected (Configuration state)

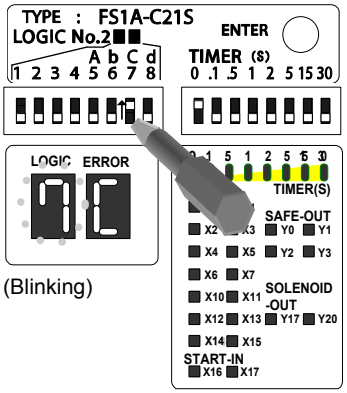


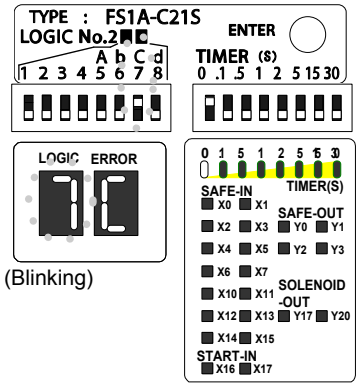
Fig. 4.3 Logic number “207” is selected (Configuration state)

3. Confirm the configuration and press the enter button.

Confirm that the selected logic switch matches the blinking logic LED, and then press the enter button by using configuration tool.

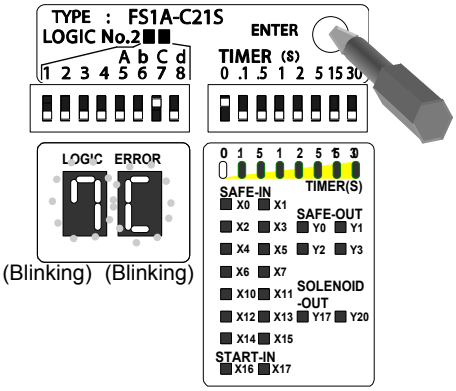
Be sure to confirm that they match. If the switch configuration and display do not match and you press the enter button, unintended logic may be activated.

Press and hold the enter button for 1 to 5s to enable the configuration. "C" blinks in the error LED display while you press the enter button. If you press the enter button for less than 1s or more than 5s, the logic is not activated.



(Blinking)

Fig. 4.4 Confirmation of logic switch configuration and LED indication (Configuration state)



(Blinking) (Blinking)

Fig. 4.5 LED indication during enter button is valid (Configuration state)

4. Confirm that the logic is activated.

The logic LED display changes from a blinking display to solid display, the error LED turns off, and the selected logic is activated.

After configuring the logic, be sure to confirm that the selected logic is activated.

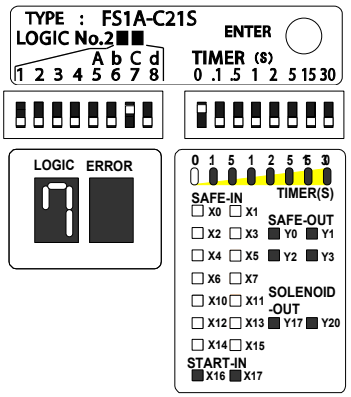


Fig. 4.6 Completion the configuration of Logic “207 “(Run state)

5. Lock the protective cover.

Close the protective cover.

Refer to "Using the protective cover" in this chapter for details. To protect the configuration setting, it is recommended that the protective cover be locked.

Timer configuration

SafetyOne has an OFF-delay timer function that retains safety outputs during the configured time and after that turns OFF the safety outputs. You can use this function to configure stop category "0" or "1". Perform the configuration procedure listed below to configure the OFF-delay timer to one of the following eight settings, using the same procedure as that for configuring the logic:
0, 0.1, 0.5, 1, 2, 5, 15 or 30 s.

Configuration operations are disabled in the Initial and Stop states.
Once any timer value is configured, it is kept in the SafetyOne even if the power is turned off.
Logic and timer settings can be configured at the same time. Confirm the configuration methods, and configure the logic and timer properly.
The timer switch is set at a default value of “1(0s)” at the factory. When initially powering on the SafetyOne, thoroughly confirm the configuration and the operation.
One of 8 digits must be selected for all logics (includes the logic dose not have Safety output with timer).

1. Open the protective cover.
Open the cover to a position that enables you to set configuration operations.
Refer to "Using the protective cover" for details.

2. Select the timer switch.
Select and operate a timer switch. When operating a timer switch, use the configuration tool.
When the timer configuration is changed, "C" is displayed in the error LED display and the timer LED light that corresponds to the selected timer configuration switch blinks.

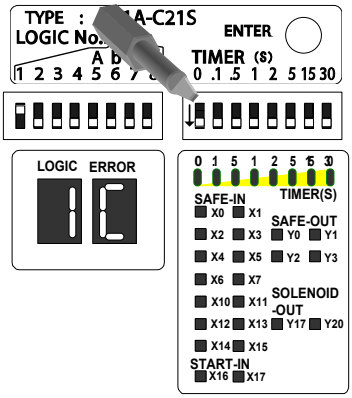


Fig. 4.7 Timer switch is not selected (Configuration state)

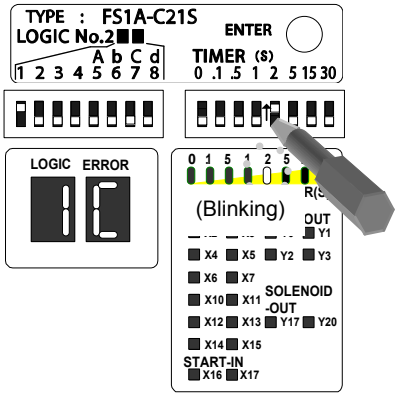


Fig. 4.8 OFF-delay timer value “2s” is selected (Configuration state)

3. Confirm the configuration and press the enter button.

Confirm that the selected timer switch matches the blinking timer LED, and then press the enter button by using the configuration tool.

Be sure to confirm that they match. If the switch configuration and display do not match and you press the enter button, an unintended delay timer may be activated.

Press and hold the enter button for 1 to 5s to activate the configuration. "C" blinks in the error LED display while you press the enter button. If you press the enter button for less than 1s or more than 5s, the timer is not activated.

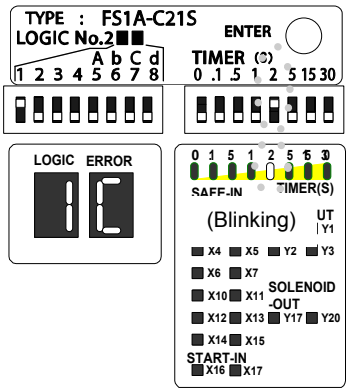


Fig. 4.9 Confirmation of timer switch configuration and LED indication (Configuration state)

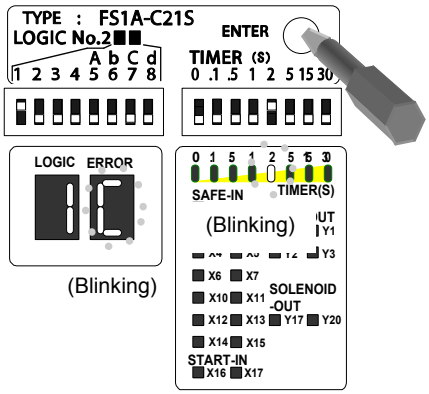


Fig. 4.10 LED indication during enter button is valid (Configuration state)

4. Confirm that the timer is activated.

The timer LED light changes from a blinking display to solid display, the error LED display turns off, and the selected timer value is activated. After configuring the timer, be sure to confirm that the selected timer value is activated.

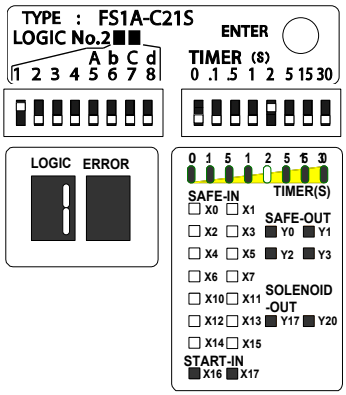


Fig. 4.11 Completion the configuration of OFF-delay timer value “2s“ (Run state)

5. Close and lock the protective cover.

Close the protective cover.

Refer to "Using the protective cover" for details.

To protect the configuration setting, it is recommended that the protective cover be locked.

Canceling the Protection state

SafetyOne transitions to the Protection state if a failure is detected in an external device or an error is detected in external wiring, such as when different operations are performed between dual channel inputs or two muting inputs, when the EDM input is OFF while the safety outputs are transitioning from OFF to ON or the EDM input is ON while the safety outputs are transitioning from ON to OFF by output control. In the Protection state, the safety outputs are turned OFF and "1" is displayed in the error LED display. The Protection state can be cancelled by the following methods.

• Cancellation by the connected control devices

•In case of an error with the dual channel input, the Protection state is cancelled by turning OFF the appropriate dual channel input. (For example: Press an emergency stop switch or open a guard equipped with an interlock device.) But cancellation is not achieved during OFF-delay operation of safety outputs.

•In case of an error with muting input, the Protection state is cancelled by turning OFF of the appropriate muting input. But cancellation is not achieved during OFF-delay operation of safety outputs.

•In case of an error with mode select input, the Protection state is cancelled by turning OFF 1 of the appropriate 2 inputs. But the cancellation is not achieved during OFF-delay operation of safety outputs.

•In case of an error with the EDM input, the Protection state is cancelled by turning ON the appropriate EDM input. When an EDM input causes an error, the corresponded safety output is not turned ON, but the other safety output can be turned ON and after approximately 1s turned OFF. For the relationship between EDM inputs and safety outputs, refer Table 4.3 shown below.

Table 4.3 EDM inputs and corresponded safety outputs

Safety output types	EDM inputs (External Device Monitor inputs)	Safety outputs
Dual channel outputs	T14-X14	Y0, Y1
	T15-X15	Y2, Y3
Single channel outputs	T12-X12	Y0
	T13-X13	Y1
	T14-X14	Y2
	T15-X15	Y3

• Cancellation by resetting power to SafetyOne

The Protection state is cancelled by restarting power to SafetyOne after removing the error factor.
If the error factor that caused the change to the Protection state has been not removed, the unit returns to the Protection state again.

• Cancellation by transition to Protection state

By the changing the configuration of a logic or timer switch, the state changes from Protection state to Configuration state.

Warning

Turn OFF the power to SafetyOne before inspection and/or connecting of the wires.

Canceling the Stop state

If the SafetyOne detects any wiring errors, abnormalities or internal circuit failure, it changes to the Stop state and locks out operations. The Stop state can be cancelled by the following method.

- **Cancellation by removal of power to SafetyOne**

The Stop state is cancelled by restarting power to SafetyOne after removing the error.

Refer "Chapter 6 TROUBLESHOOTING" for information to identify the cause that generated the Protection state or Stop state.

Chapter5 LOGIC

This chapter describes the Logics in the SafetyOne. Make proper use of the SafetyOne by thoroughly familiarizing yourself with the basic operations and function of each Logic.

About the Logics in FS1A-C21S

FS1A-C21S has reserve logics [Note1]. When a reserve logic is selected, the configuration is not valid.

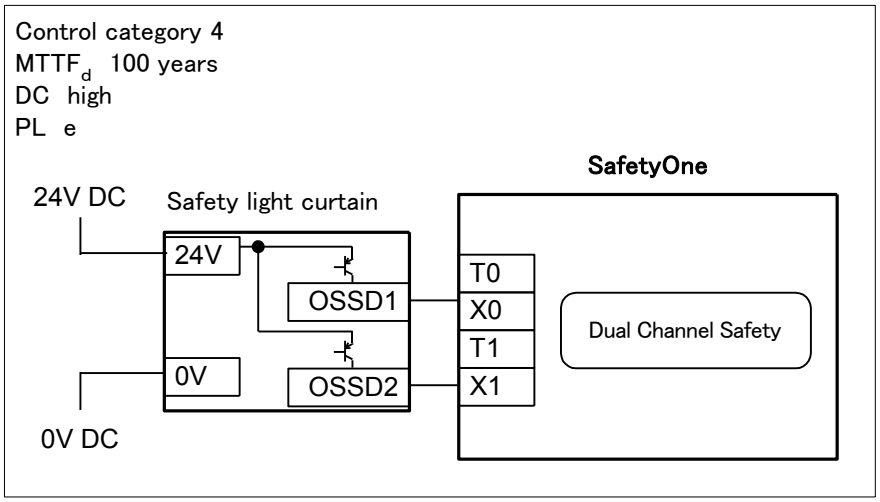
Type No.	Logic No.	Logic	Interlock switch・Emergency stop switch	Enabling switch	Mode selection	Safety light curtain, Safety Laser Scanner	Muting function	NO/NC contact device	Two-hand control device	2 dual channel outputs (same operation)	2 dual channel outputs (separate operation)	4 single channel outputs
FS1A-C21S	2 01	General-purpose logic for various apparatus	*							*		
	2 2A	The logic for apparatus with a two-hand control device	*	*		*	*		*		*	
	2 2b	The logic for apparatus with openings	*	*		*					*	
	2 2C	The logic for apparatus with openings	*	*		*					*	
	2 2d	Partial control logic for apparatus with openings	*	*		*					*	
	2 3C	The logic applicable for selection of active safety input devices	*	*	*						*	
	2 4A	Muting function logic for apparatus with openings	*	*		*	*					*
	2 4b	Muting function logic for apparatus with openings	*	*		*	*					*
	2 4C	The logic applicable for selection of active safety input devices	*	*	*	*						*
	2 4d	The logic constructing an OR circuit for various apparatus	*	*		*						*
	2 08	Partial stop logic for various apparatus	*					*			*	

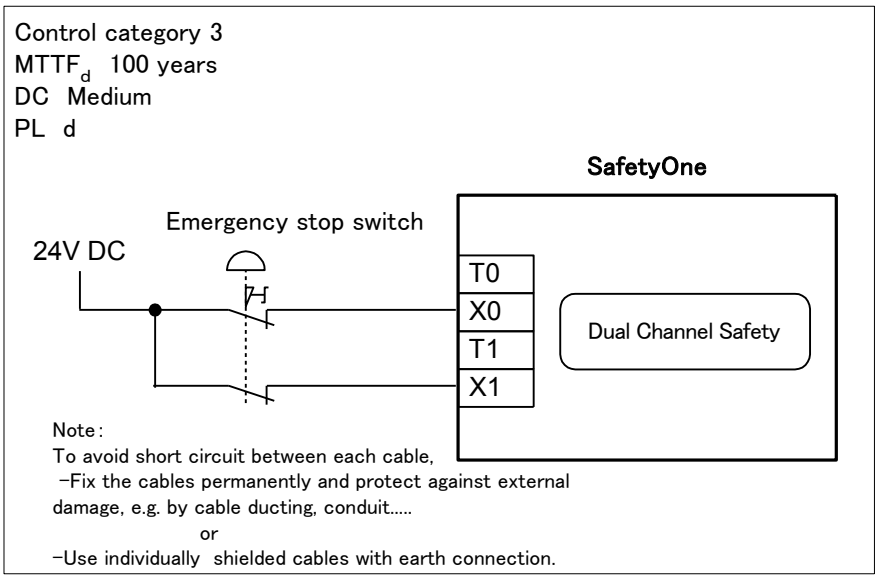
Note1. Following the logics are reserved : 21A, 21b, 21C, 21d, 202, 203, 23A, 23b, 23d, 204, 205, 206, and 207.
In the case of software version 1.00, following the logics are reserved : 21A, 21b, 21C, 21d, 202, 203, 23A, 23b, 23C, 23d, 204, 24C, 24d, 205, 206, 207, and 208.

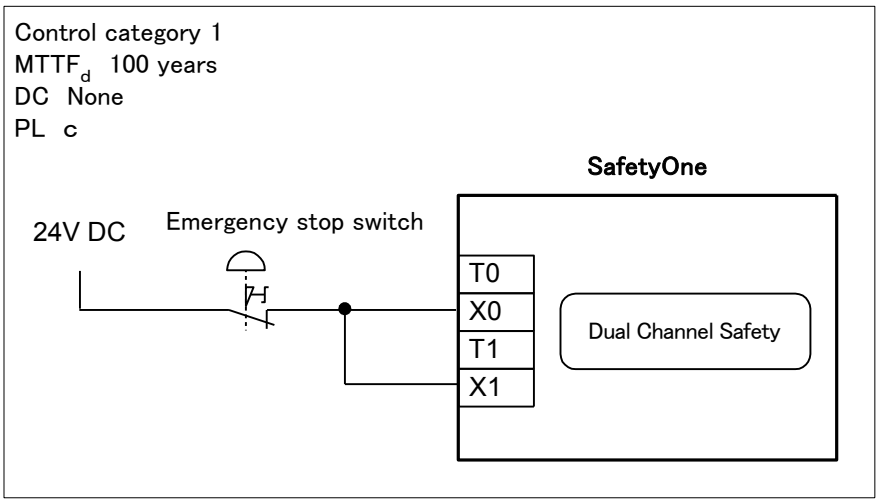
Safety performance on each wiring of inputs and outputs

Applicable safety performance of SafetyOne depends on wiring of the inputs and outputs.
Wiring examples and achivable safety performances are shown below.

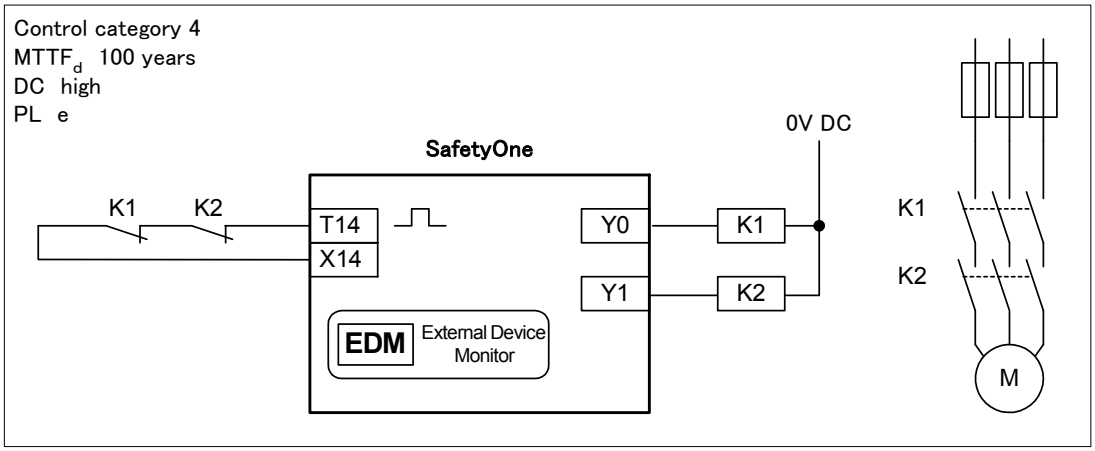
- **Wiring example of dual channel safety input or dual channel safety input II**



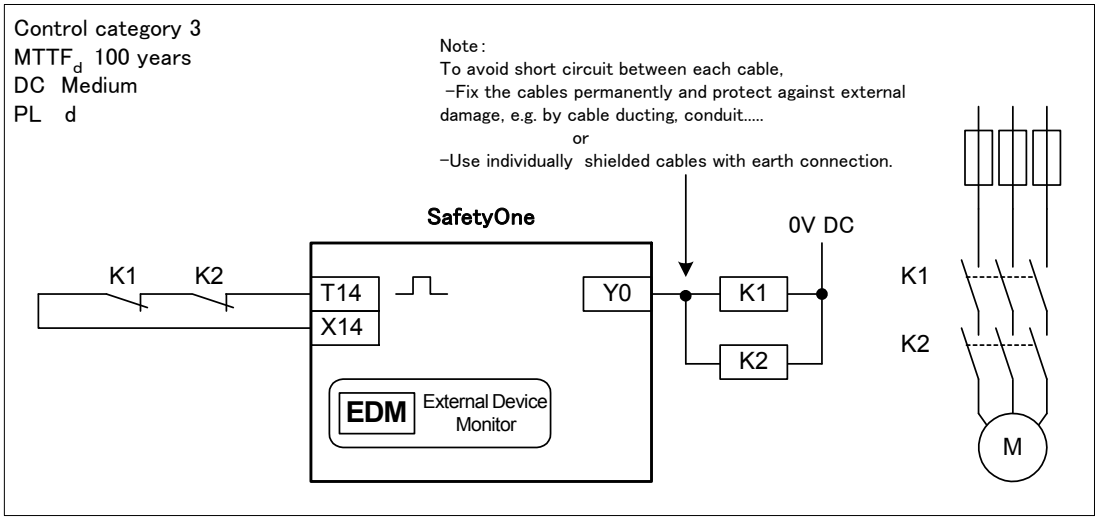


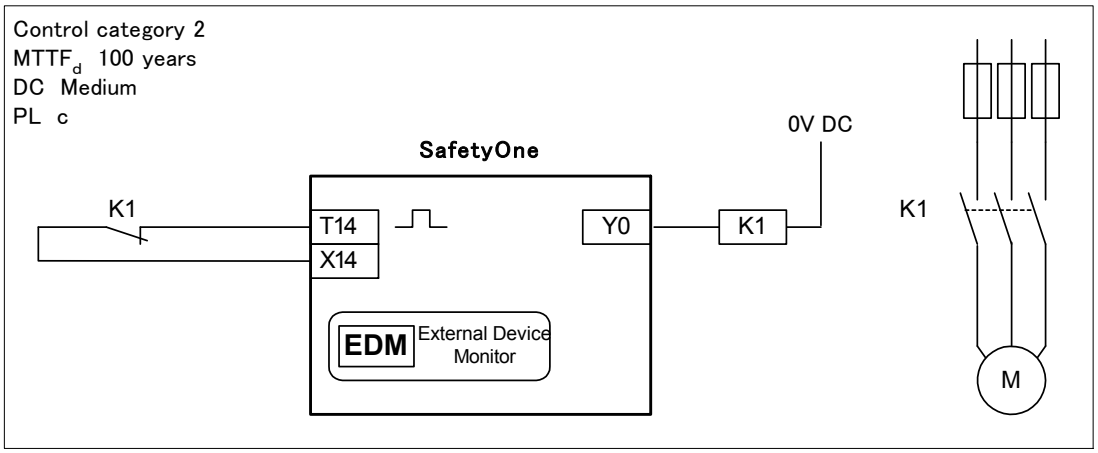


• **Wiring example of safety outputs**



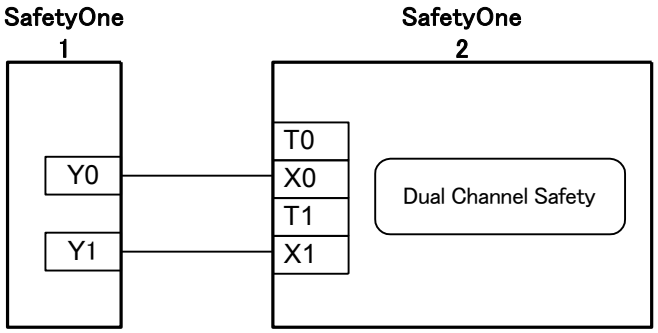
K : Contactor
M : Motor





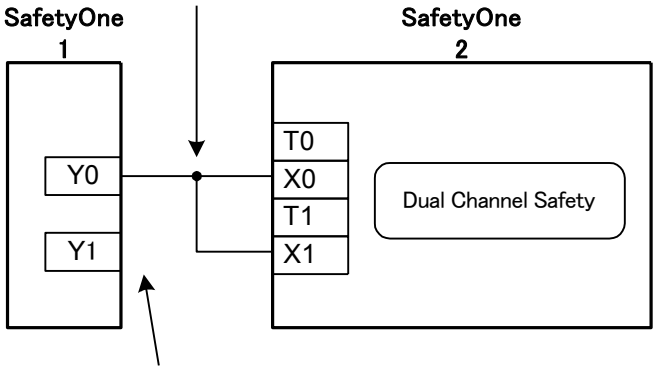
• Wiring example of a SafetyOne and a SafetyOne

Control category 4
$MTTF_d$ 100 years
DC high
PL e



Control category 3
$MTTF_d$ 100 years
DC Medium
PL d

Note:
To avoid short circuit between each cable,
–Fix the cables permanently and protect against external damage, e.g. by cable ducting, conduit.....
or
–Use individually shielded cables with earth connection.



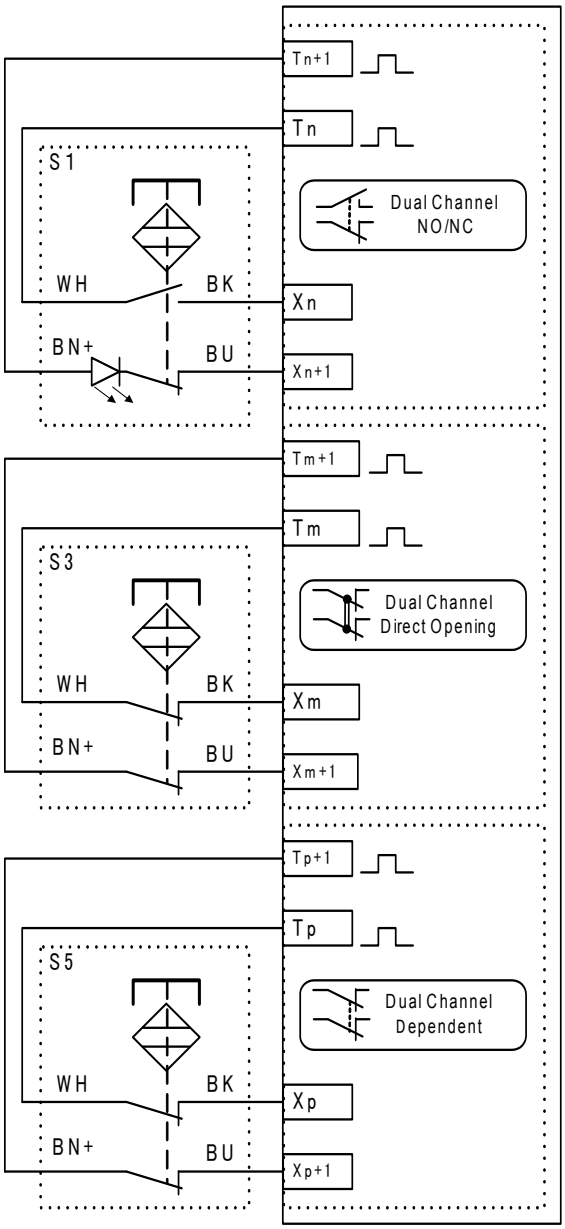
note:
Stopping the whole system by the safety output of SafetyOne 1 is recommended.
(In case of a short circuit between Y0 and external conductors, only SafetyOne 1 detects the error.)

Warning

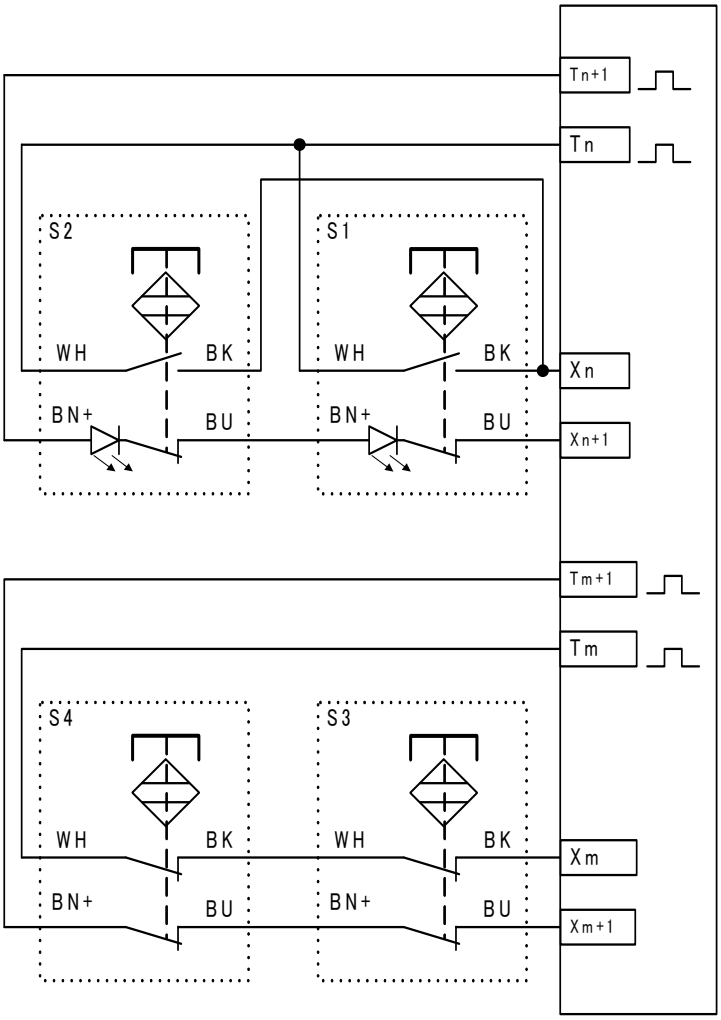
Applicable safety performance depends on the whole system configuration.

Using non-contact interlock switches

S1, 2 : 1NO+1NC Contact, with LED / without LED or
1NO+2NC Contact, with LED / without LED
S3, 4, 5 : 2NO Contact, without LED or
2NO+1NC Contact, without LED



Common connection of several non-contact interlock switches [note6)]

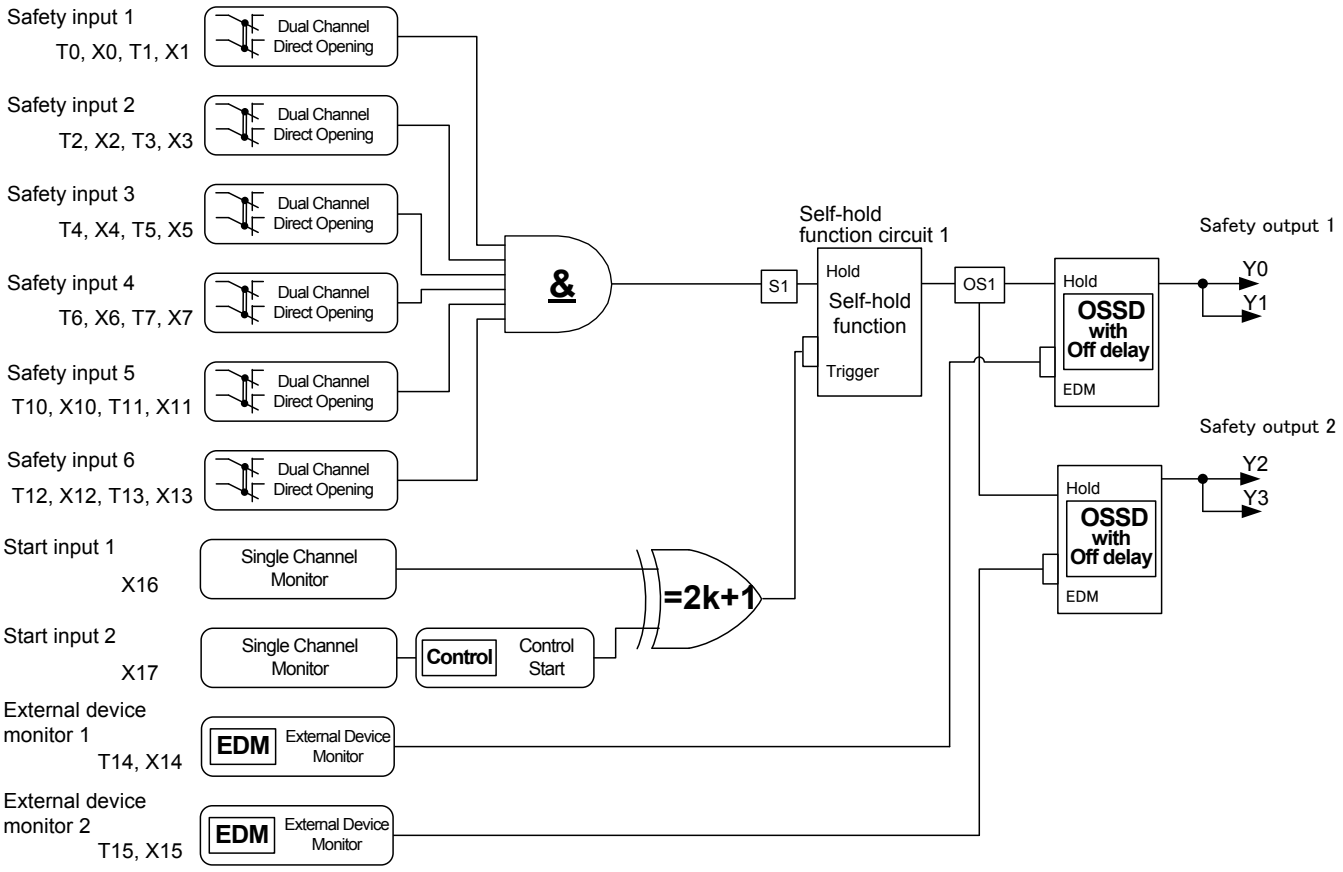


Note 1) Above illustration shows contact when actuator is present.

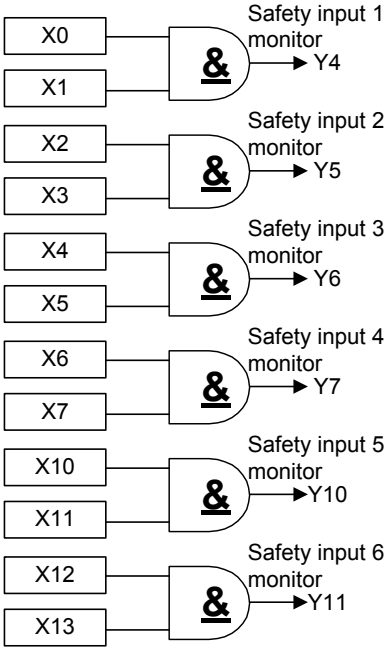
Note 2) In the common connection of several non-contact interlock switches, applicable safety performance depends on result of risk assessment for whole of the safety configuration. Refer to ISO14119 for analysis the connection.

Logic 201: General –purpose logic for various apparatus

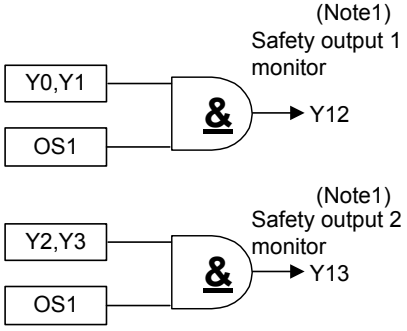
Logic circuit (Logic 201)



●Monitor output for safety input

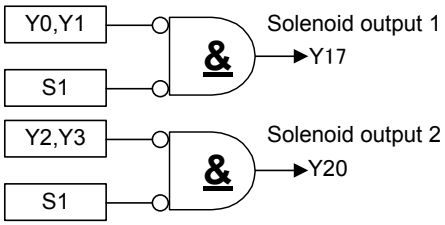


●Monitor output for safety output



Note1:
Safety output 1 monitor and 2 monitor turn off immediately independent of OFF-delay time.

●Solenoid output (Note 2)

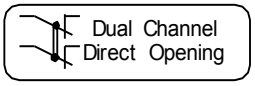


Note2:
In Run state, when the safety outputs are OFF and one or more safety inputs are OFF, the solenoid outputs turn ON.
When all safety inputs are ON, the solenoid outputs turn OFF, even when the start input is OFF.

Functions (Logic 201)

●Safety inputs: X0 to X13 (T0 to T13)

Safety inputs are used to diagnose the status of connected safety devices, such as emergency stop switches, and interlock switches.

Intended inputs (Terminal names)	Function	
Safety input 1 (X0-T0, X1-T1) Safety input 2 (X2-T2, X3-T3) Safety input 3 (X4-T4, X5-T5) Safety input 4 (X6-T6, X7-T7) Safety input 5 (X10-T10, X11-T11) Safety input 6 (X12-T12, X13-T13)	Function name	Dual channel direct opening input
	Symbol	
	Description of operation	This function diagnoses the status of connected safety devices. This function diagnoses the time interval of status transition between each input of duplicated inputs (0.5s).
	Detail information	Logic functions (5-130)

Warning

For connected control devices, refer to “SAFETY PRECAUTIONS”.

Safety check signals (pulses signals) are sent from the drive terminals (T0 to T13) to diagnose connected safety devices and input circuits. Safety check signals can not be used as a power supply for connected devices.

Note. Solid state outputs, such as safety light curtains, can not be connected.

Note. Use safety inputs as specified combinations, such as receive terminal (Xn) and drive terminal (Tn). If the combinations are incorrect, SafetyOne does not work correctly.

Note. If there are unused safety inputs, connect the unused receive terminals (Xn) to the corresponding drive terminals (Tn). If they are not connected, the SafetyOne does not turn ON the safety outputs.

●External device monitor inputs: X14 and X15 (T14 and T15)

External device monitor inputs are used to diagnose the status of devices connected to safety outputs.

Intended inputs (Terminal names)	Target safety outputs (Terminal names)	Function	
External device monitor input 1 (X14-T14)	Safety output 1 (Y0, Y1)	Function name	External device monitor input
External device monitor input 2 (X15-T15)	Safety output 2 (Y2, Y3)	Symbol	
		Description of operation	This function diagnoses the status of devices connected to a target safety output.
		Detail information	Logic Functions (5-147)

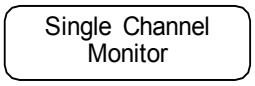
Warning

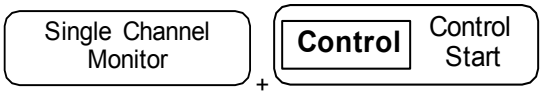
Safety check signals (pulses signals) are sent from the drive terminals (T14, T15) to diagnose external devices and monitor circuits. Safety check signals can not be used as a power supply for connected devices.

Note. If there are unused safety outputs, connect the intended external device monitor terminals (Xn) to the corresponding drive terminals (Tn). If they are not connected, the SafetyOne detects an input monitor error. As the result, the error LED displays “1” and the unit changes to the Protection state.

●Start inputs: X16 and X17

Start inputs are used to control the start of safety outputs.

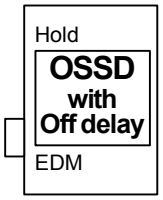
Intended inputs (Terminal names)	Target safety inputs (Terminal names)	Function	
Start input 1 (X16)	Safety input 1 (X0-T0, X1-T1) Safety input 2 (X2-T2, X3-T3) Safety input 3 (X4-T4, X5-T5) Safety input 4 (X6-T6, X7-T7) Safety input 5 (X10-T10, X11-T11) Safety input 6 (X12-T12, X13-T13)	Function name	Monitor input
		Symbol	
		Description of operation	Safety outputs are started, when all target safety inputs are in the safe state and this function is in the ON state. This function is turned ON by 0.1s or more ON operation.
		Detail information	Logic Functions (5-146)

Intended inputs (Terminal names)	Target safety inputs (Terminal names)	Function	
Start input 2 (X17)	Safety input 1 (X0-T0, X1-T1) Safety input 2 (X2-T2, X3-T3) Safety input 3 (X4-T4, X5-T5) Safety input 4 (X6-T6, X7-T7) Safety input 5 (X10-T10, X11-T11) Safety input 6 (X12-T12, X13-T13)	Function name	Monitor input + Control start
		Symbol	
		Description of operation	Safety outputs are started, when this function becomes ON after all intended safety inputs are in the safe state. This function is turned ON by 0.1s to 5s ON operation.
		Detail information	Logic Functions (5-146, 5-152)

Note. If both of X16 and X17 are turned ON, the SafetyOne will detect an error. As a result, the error LED displays “3” and the state changes to the Stop state. Use only X16 or X17.

●Safety outputs: Y0 to Y3

Safety outputs are used to output safety information processed by SafetyOne.

Intended outputs (Terminal names)	Function	
Safety output 1 (Y0, Y1) Safety output 2 (Y2, Y3)	Function name	Safety output with timer
	Symbol	
	Description of operation	This function is a safety output to output safety information processed by SafetyOne. The output is turned OFF after the preset time of the OFF-delay timer (OFF-delay output).
	Detail information	Logic functions (5-157)

Note. When the SafetyOne changes to Protection state due to input monitor error, safety outputs with timer are turned OFF after the preset OFF-delay time.

Note. When the SafetyOne changes to Stop state due to circuit failure or other errors, all safety outputs (safety output 1 and safety output 2) are turned OFF, immediately.

●Safety input monitor outputs: Y4 to Y11

Safety input monitor outputs are used to output the status of safety inputs in SafetyOne.

Intended outputs (Terminal names)	Target safety inputs (Terminal names)	Description of operation
Safety input 1 monitor output (Y4)	Safety input 1 (X0-T0, X1-T1)	When the target safety input is ON, the monitor output is ON. When the target safety input is OFF, the monitor output is OFF.
Safety input 2 monitor output (Y5)	Safety input 2 (X2-T2, X3-T3)	
Safety input 3 monitor output (Y6)	Safety input 3 (X4-T4, X5-T5)	
Safety input 4 monitor output (Y7)	Safety input 4 (X6-T6, X7-T7)	
Safety input 5 monitor output (Y10)	Safety input 5 (X10-T10, X11-T11)	
Safety input 6 monitor output (Y11)	Safety input 6 (X12-T12, X13-T13)	

Note. In the case of SW version 1.00, when the targeted safety input detects an input monitor error, input circuit failure, or EMC the disturbance, corresponding safety input monitor output becomes a pulse output (1Hz). The monitor output is OFF in other errors, Initial state, or Configuration state. In the case of SW version 2.00 or higher, the monitor output is OFF in errors, Initial state, or Configuration state.

●Safety output monitor outputs: Y12 and Y13

Safety output monitor outputs are used to output status of safety outputs in SafetyOne.

Intended outputs (Terminal names)	Target safety outputs (Terminal names)	Description of operation
Safety output 1 monitor output (Y12)	Safety output 1 (Y0, Y1)	When the target safety output is ON, the monitor output is ON. When the target safety output is OFF, this function is OFF. The monitor output turns OFF immediately, independent of the preset OFF-delay time.
Safety output 2 monitor output (Y13)	Safety output 2 (Y2, Y3)	

Note. In the case of SW version 1.00, when the safety output detects an output circuit failure, the corresponding safety output monitor output becomes a pulse output (1Hz). The monitor output is OFF in other errors, Initial state, or Configuration state. In the case of SW version 2.00 or higher, the monitor output is OFF in errors, Initial state, or Configuration state.

●State monitor outputs: Y14 to Y16

State monitor outputs are used to output the internal state of SafetyOne.

Intended outputs (Terminal names)	State				
	Initial	Run	Configuration	Protection	Stop
State monitor output 1 (Y14)	■ON	□OFF	□OFF	□OFF	■ON
State monitor output 2 (Y15)	■ON	□OFF	■ON	■ON	■ON or □OFF
State monitor output 3 (Y16)	□OFF	■ON	□OFF	□OFF	□OFF

Refer to “Chapter 4 BASIC OPERATIONS” and to “Chapter 6 TROUBLE SHOOTING” for details of each state.

Warning

The monitor outputs are not safety outputs. Do not use these to construct a safety system.

●Solenoid outputs: Y17 and Y20

Solenoid outputs are used to control a solenoid in an interlock switch.

Intended outputs (Terminal names)	Description of operation
Solenoid output 1 (Y17)	When safety output 1 is OFF, the solenoid output is ON. When safety Output 1 is ready to turn ON (safety output 1 can be turned ON by operation of the start input), the solenoid output is OFF.
Solenoid output 2 (Y20)	When safety output 2 is OFF, the solenoid output is ON. When safety Output 2 is ready to turn ON (safety output 2 can be turned ON by operation of the start input), the solenoid output is OFF.

Warning

The solenoid outputs are not safety outputs. Do not use these to construct a safety system.

Caution

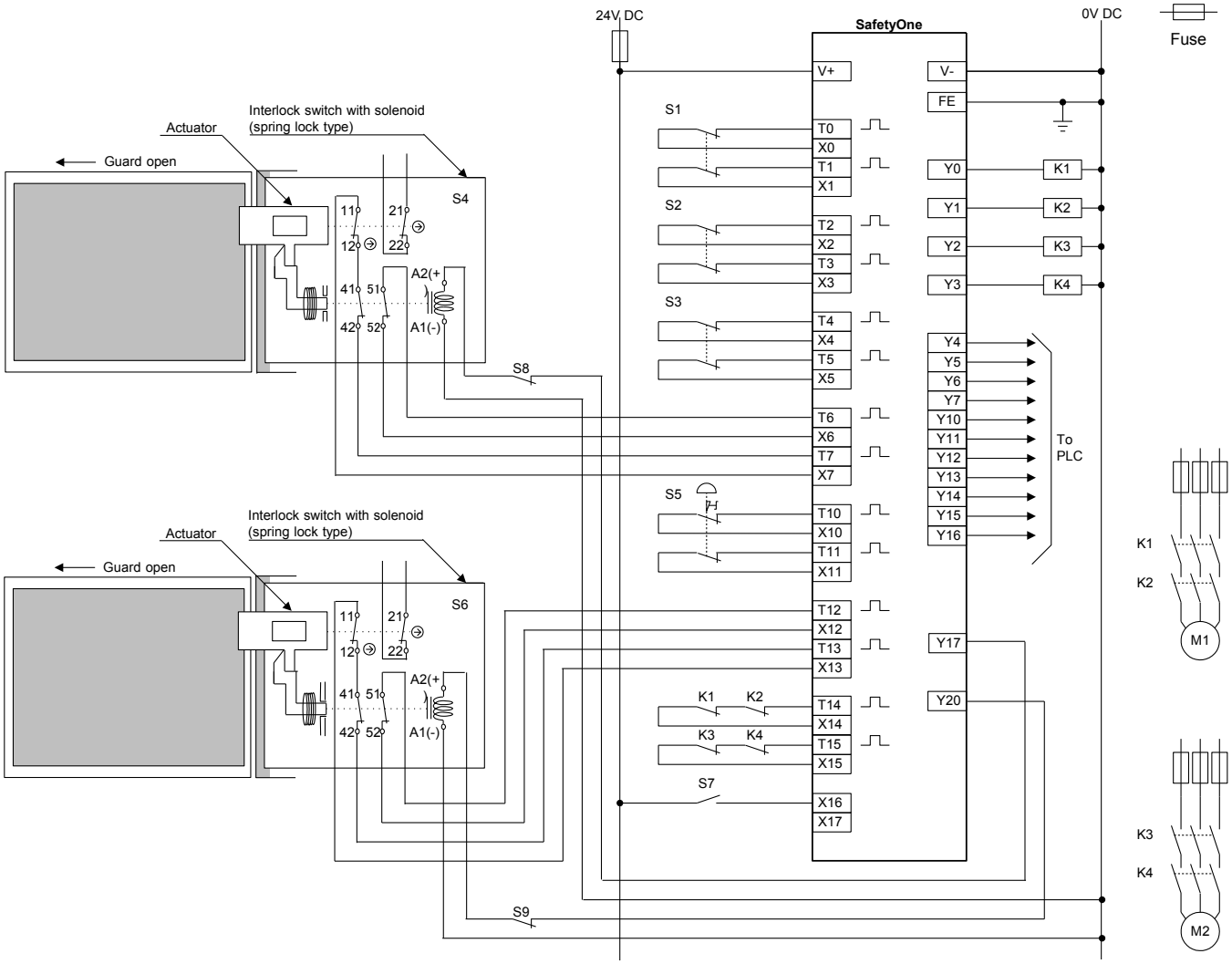
Refer to "Chapter 2 PRODUCT SPECIFICATIONS" for specifications of each input and output.

Note. The solenoid outputs are OFF in each state except Run state.

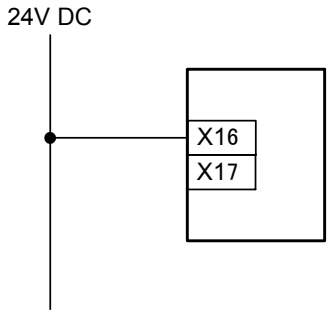
Wiring example (Logic 201)

In the case where 3 interlock switches, 2 interlock switches with solenoid (spring lock type), and 1 emergency stop switch are connected.

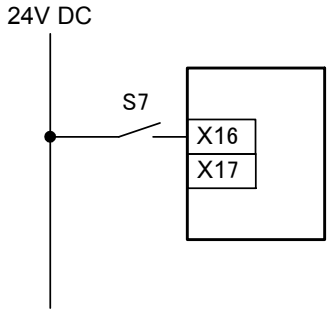
S1, 2, 3 : Interlock switch
S4, 6 : Interlock switch with solenoid (spring lock type)
S5 : Emergency stop switch
S7 : Start switch
S8, 9 : Solenoid control switch
(Pressing the solenoid control switches after closing the guard door, contacts 41-42 and 51-52 of S4 and S6 turn on, allowing the SafetyOne to restart.)
K1 to 4 : Contactor
M1, 2 : Motor



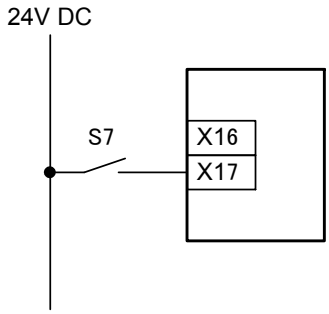
When not using the start switch (Auto start)



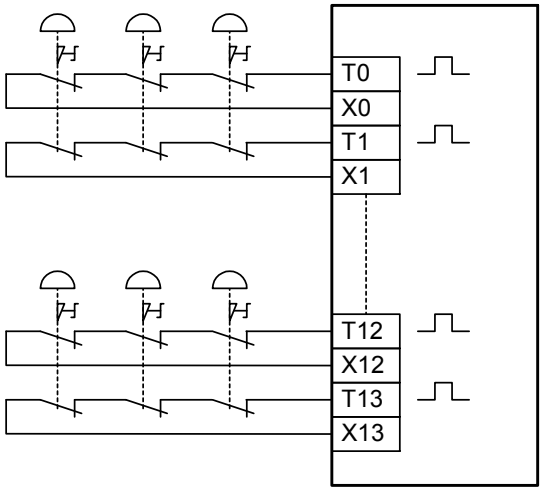
When not detecting the welding of start switch (Manual start)



When detecting the welding of start switch (Control start)



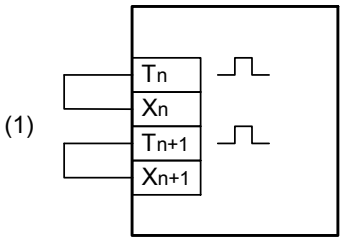
When connecting multiple emergency stop switches in series



NOTE: Safety performance depends on the system configuration.

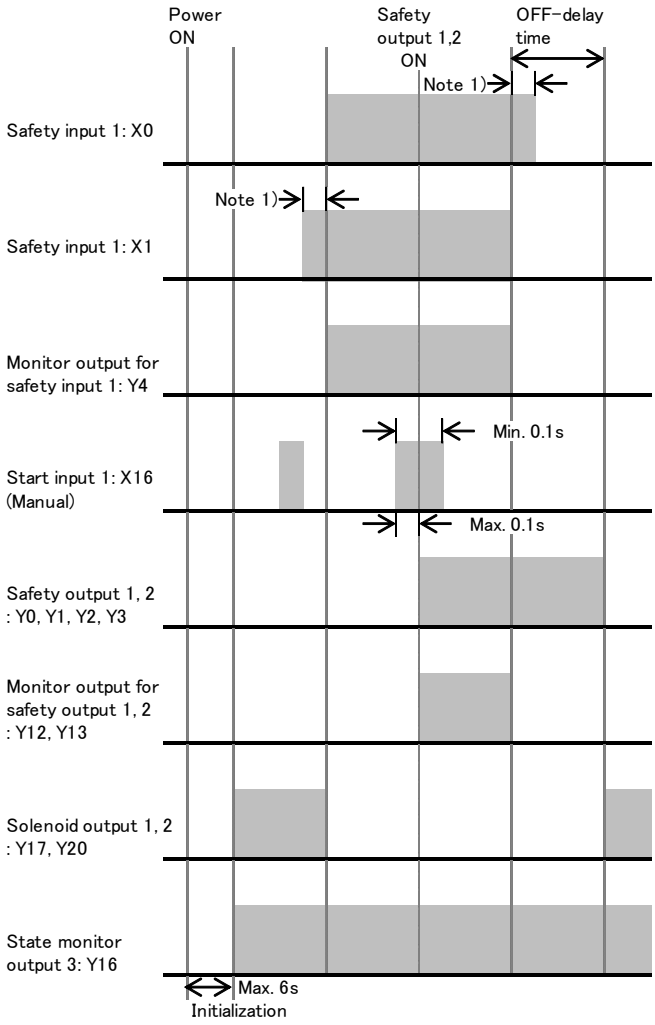
When not using some inputs

・If there are unused safety inputs, connect the unused receive terminals to the corresponding drive terminals. (Refer to (1))



Timing chart (Logic 201)

Example: Manual start input 1 (X16) is used.



Safety input 2 to 6 are all ON in this chart.

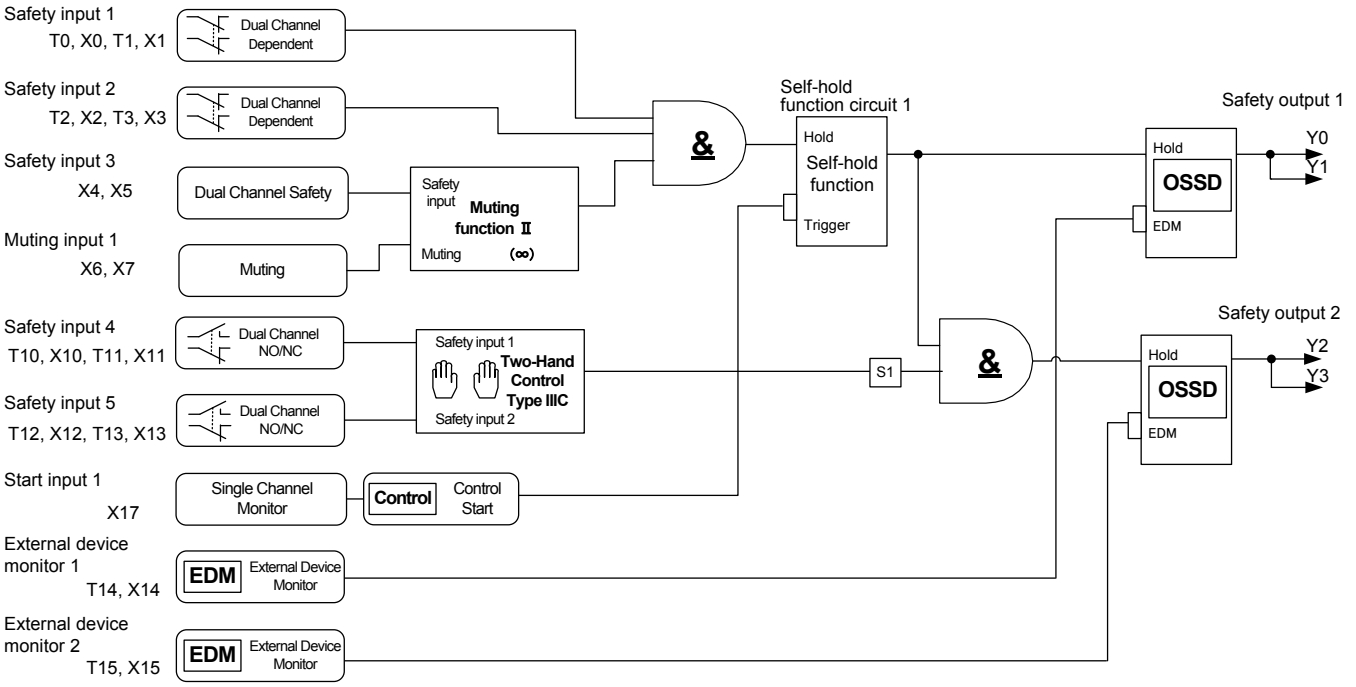
Example: Control start input 2 (X17) is used.

Safety input 2 to 6 are all ON in this chart.

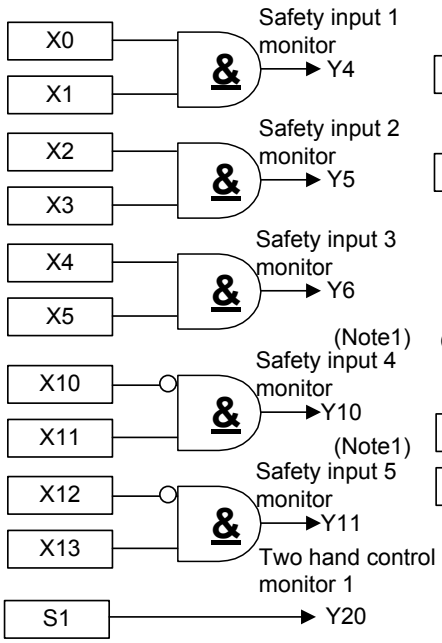
Note 1) Input monitor error detection time is 0.5s.
About safety inputs that are not described in this chart, input monitor error detection time is as follows.
The time of dual channel direct opening input (X2 to X13) is 0.5s.
Refer to the following “Logic functions” (5-128) for more details.

Logic 22A: The logic for apparatus with a two-hand control device

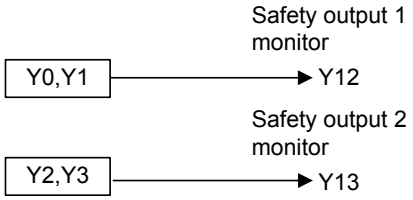
Logic circuit (logic 22A)



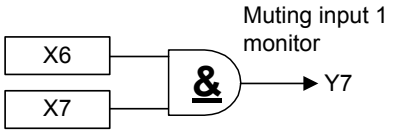
●Monitor output for safety input



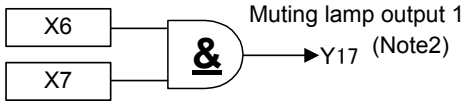
●Monitor output for safety output



●Monitor output for muting input



●Muting lamp output



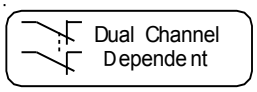
Note2:
The muting lamp output turns ON when the safety function of the safety input is temporarily suspended.
Even if the muting input is ON when the safety output is OFF, the muting lamp output doesn't turn ON.
In case of the SafetyOne is turned ON when the muting input is ON or the safety output turns OFF when the muting input is ON, muting function is not activated without turning off of muting input.

Note1:
When X_n is OFF and X_{n+1} is ON, Safety input 5 monitor and Safety input 6 monitor turn ON. (n = 10,12)

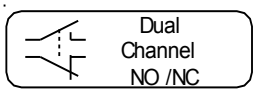
Functions (Logic 22A)

●Safety inputs: X0 to X5, X10 to X13 (T0 to T3, T10 to T13)

Safety inputs are used to diagnose the status of connected safety devices, such as emergency stop switches, and input devices for two-hand control.

Intended inputs (Terminal names)	Function	
Safety input 1 (X0-T0, X1-T1) Safety input 2 (X2-T2, X3-T3)	Function name	Dual channel dependent input
	Symbol	
	Description of operation	This function diagnoses the status of connected safety devices. This function does not diagnose the time interval of status transition between each input of duplicated inputs.
	Detail information	Logic functions (5-132)

Intended inputs (Terminal names)	Function	
Safety input 3 (X4, X5)	Function name	Dual channel safety input
	Symbol	
	Description of operation	This function diagnoses the status of connected safety devices. This function diagnoses the time interval of status transition between each input of duplicated inputs (0.1s). The function does not use drive terminals (T4, T5).
	Detail information	Logic functions (5-136)

Intended inputs (Terminal names)	Function	
Safety input 4 (X10-T10, X11-T11) Safety input 5 (X12-T12, X13-T13)	Function name	Dual channel NO/NC input
	Symbol	
	Description of operation	This function diagnoses the status of connected safety devices. This function diagnoses the time interval of status transition between each input of duplicated inputs (0.5s).
	Detail information	Logic functions (5-134)

Warning

For connected control devices, refer to “SAFETY PRECAUTIONS”.

Safety check signals (pulses signals) are sent from the drive terminals (T0 to T3, T10 to T13) to diagnose connected safety devices and input circuits. Safety check signals can not be used as a power supply for connected devices.

Note. Solid state outputs, such as safety light curtains, can not be connected to safety input 1, 2, 4, and 5.

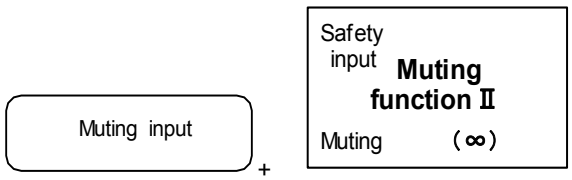
Note. Use safety input 1, 2, 4, and 5 as specified combinations, such as receive terminal (Xn) and drive terminal (Tn). If the combinations are incorrect, SafetyOne does not work correctly.

Note. If there are unused safety inputs in safety input 1 and 2, connect the unused receive terminals (Xn) to the corresponding drive terminals (Tn). If they are not connected, the SafetyOne does not turn ON the safety outputs.

Note. If there are unused safety inputs in safety input 3, connect the unused receive terminals (Xn) to a 24V DC power supply (V+). If they are not connected, the SafetyOne does not turn ON the safety outputs.

●Muting inputs: X6 and X7

Muting inputs are used to diagnose the status of muting devices, such as sensors or limit switches.

Intended inputs (Terminal names)	Function	
Muting input 1 (X6, X7)	Function name	Muting input+Muting II
	Symbol	
	Description of operation	This function diagnoses the status of connected muting devices. This function diagnoses the time interval of status transition between each input of duplicated inputs (3s). The function does not use a drive terminal (T6, T7).
	Detail information	Logic functions (5-144, 5-151)

Warning

Muting inputs are not safety inputs. Do not use these to construct a safety system.

The maximum time to suspend the safety function continuously (muting monitor time) is not specified in the SafetyOne. Based on risk assessment, monitor the muting monitor time that is suitable for the safety system, by external circuit or devices.

●External device monitor inputs: X14 and X15 (T14 and T15)

External device monitor inputs are used to diagnose the status of devices connected to safety outputs.

Intended inputs (Terminal names)	Target safety outputs (Terminal names)	Function	
External device monitor input 1 (X14-T14)	Safety output 1 (Y0, Y1)	Function name	External device monitor input
External device monitor input 2 (X15-T15)	Safety output 2 (Y2, Y3)	Symbol	
		Description of operation	This function diagnoses the status of devices connected to a target safety output.
		Detail information	Logic functions (5-147)

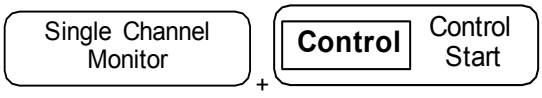
Warning

Safety check signals (pulses signals) are sent from the drive terminals (T14, T15) to diagnose external devices and monitor circuits. Safety check signals can not be used as a power supply for connected devices.

Note. If there are unused safety outputs, connect the intended external device monitor terminals (Xn) to the corresponding drive terminals (Tn). If they are not connected, the SafetyOne detects an input monitor error. As the result, the error LED displays “1” and the unit changes to the Protection state.

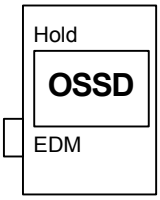
●Start input: X17

Start inputs are used to control the start of safety outputs.

Intended inputs (Terminal names)	Target safety inputs (Terminal names)	Function	
Start input 1 (X17)	Safety input 1 (X0-T0, X1-T1) Safety input 2 (X2-T2, X3-T3) Safety input 3 (X4, X5)	Function name	Monitor input + Control start
		Symbol	
		Description of operation	Safety outputs are started, when this function becomes ON after all intended safety inputs are in the safe state. This function is turned ON by 0.1s to 5s ON operation.
		Detail information	Logic functions (5-146, 5-152)

●Safety outputs: Y0 to Y3

Safety outputs are used to output safety information processed by SafetyOne.

Intended outputs (Terminal names)	Function	
Safety output 1 (Y0, Y1) Safety output 2 (Y2, Y3)	Function name	Safety output without timer
	Symbol	
	Description of operation	This function is a safety output to output safety information processed by SafetyOne. The output is turned OFF immediately by OFF operation (instantaneous OFF output).
	Detail information	Logic functions (5-154)

Note. When the SafetyOne changes to Protection state due to input monitor error, safety outputs without timer are turned OFF.

●Safety input monitor outputs: Y4 to Y11

Safety input monitor outputs are used to output status of safety inputs in SafetyOne.

Intended outputs (Terminal names)	Target safety inputs (Terminal names)	Description of operation
Safety input 1 monitor output (Y4)	Safety input 1 (X0-T0 X1-T1)	When the target safety input is ON, the monitor output is ON. When the target safety input is OFF, the monitor output is OFF.
Safety input 2 monitor output (Y5)	Safety input 2 (X2-T2, X3-T3)	
Safety input 3 monitor output (Y6)	Safety input 3 (X4, X5)	
Muting input 1 monitor output (Y7)	Muting input 1 (X6, X7)	
Safety input 4 monitor output (Y10)	Safety input 4 (X10-T10, X11-T11)	
Safety input 5 monitor output (Y11)	Safety input 5 (X12-T12, X13-T13)	

Note. In the case of SW version 1.00, when the targeted safety input detects an input monitor error, input circuit failure, or EMC the disturbance, corresponding safety input monitor output becomes a pulse output (1Hz). The monitor output is OFF in other errors, Initial state, or Configuration state. In the case of SW version 2.00 or higher, the monitor output is OFF in errors, Initial state, or Configuration state.

●Two-hand control monitor output: Y20

Two-hand control monitor output is used to output status of the two-hand control function.

Intended outputs (Terminal names)	Description of operation
Two-hand control monitor output (Y20)	When two-hand control function is ON, the monitor output is ON. When this function is OFF, the monitor output is OFF.

●Safety output monitor outputs: Y12 and Y13

Safety output monitor outputs are used to output status of safety outputs in SafetyOne.

Intended outputs (Terminal names)	Target safety outputs (Terminal names)	Description of operation
Safety output 1 monitor output (Y12)	Safety output 1 (Y0, Y1)	When the target safety output is ON, the monitor output is ON. When the target safety output is OFF, this function is OFF.
Safety output 2 monitor output (Y13)	Safety output 2 (Y2, Y3)	

Note. In the case of SW version 1.00, when the safety output detects an output circuit failure, the corresponding safety output monitor output becomes a pulse output (1Hz). The monitor output is OFF in other errors, Initial state, or Configuration state. In the case of SW version 2.00 or higher, the monitor output is OFF in errors, Initial state, or Configuration state.

●State monitor outputs: Y14 to Y16

State monitor outputs are used to output the internal state of SafetyOne.

Intended outputs (Terminal names)	State				
	Initial	Run	Configuration	Protection	Stop
State monitor output 1 (Y14)	■ON	□OFF	□OFF	□OFF	■ON
State monitor output 2 (Y15)	■ON	□OFF	■ON	■ON	■ON or □OFF
State monitor output 3 (Y16)	□OFF	■ON	□OFF	□OFF	□OFF

Refer to “Chapter 4 BASIC OPERATIONS” and to “Chapter 6 TROUBLE SHOOTING” for details of each state.

●Muting lamp output: Y17

Muting lamp output is used to control muting lamps.

Intended outputs (Terminal names)	Target safety inputs (Terminal names)	Description of operation
Muting lamp output 1 (Y17)	Safety input 3 (X4, X5)	The output is ON, during safety input 3 is muting state by muting input 1.

Warning

The monitor outputs and the muting lamp output are not safety outputs. Do not use these to construct a safety system.

Be sure to check the operation of the muting function before its use. Furthermore, check the state of the muting lamp. The muting function is maintained even if a lamp blows or a lamp is not connected. In the case of SW version 1.00, the SafetyOne changes to the Stop state.

Caution

Refer to "Chapter 2 PRODUCT SPECIFICATIONS" for specifications of each input and output.

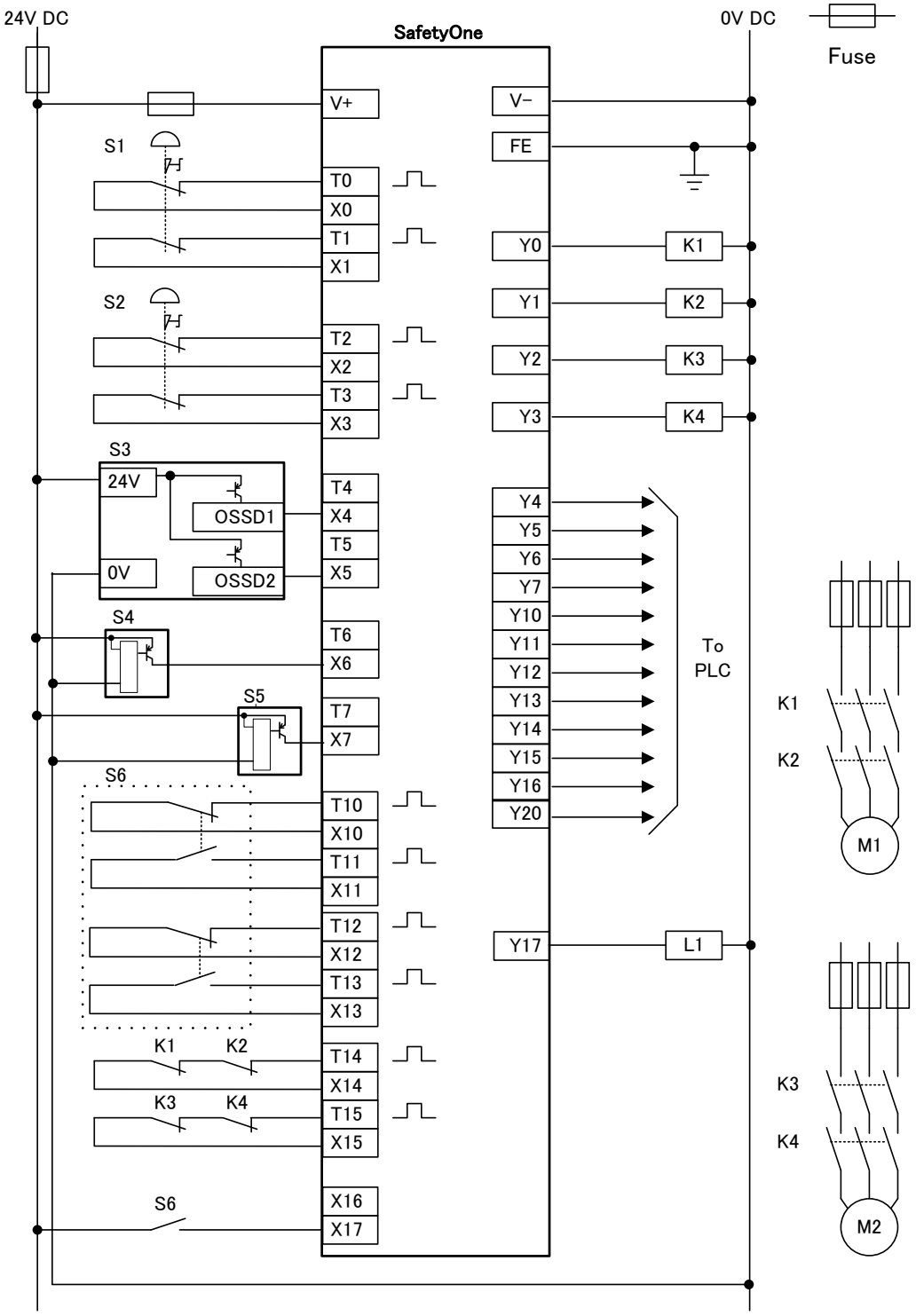
Note. In the case of SW version 1.00, muting lamp output terminal (Y17) detects that muting lamp is disconnected or unconnected. If these failures are detected, the error LED displays “5” and the state changes to the Stop state.

Note. In the case of SW version 1.00, if there is an unused muting lamp output, connect a resistor (10 kΩ, 1/4W) to the unused terminal.

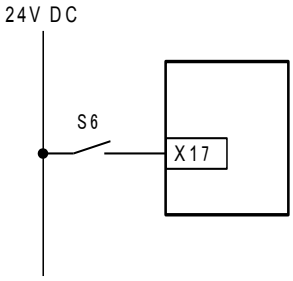
Wiring example (Logic 22A)

In the case where 2 emergency stop switches, 1 safety light curtain, 2 muting sensors, and 1 two hand control switch are connected.

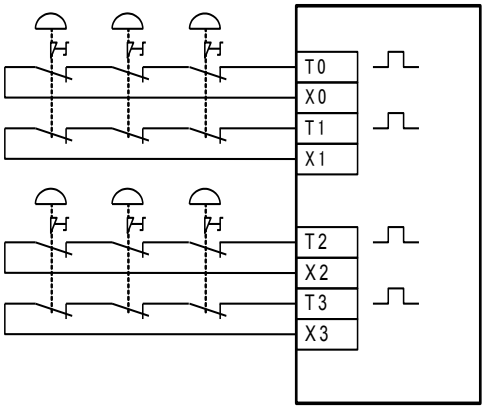
S1, 2 : Emergency stop switch
S3 : Safety light curtain
S4, 5 : Muting sensor
S6 : Two hand control switch (The figure represents the contacts when the switches are not pushed.)
S7 : Start switch
K1 to 4 : Contactor
L1 : Muting lamp
M1, 2 : Motor



When detecting the welding of start switch (Control start)



When connecting multiple emergency stop switches in series

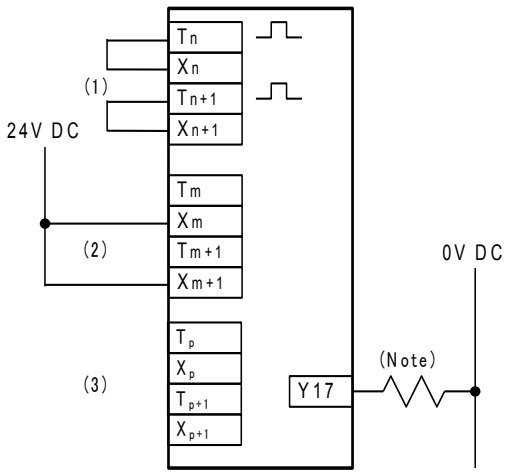


NOTE: Safety performance depends on the system configuration.

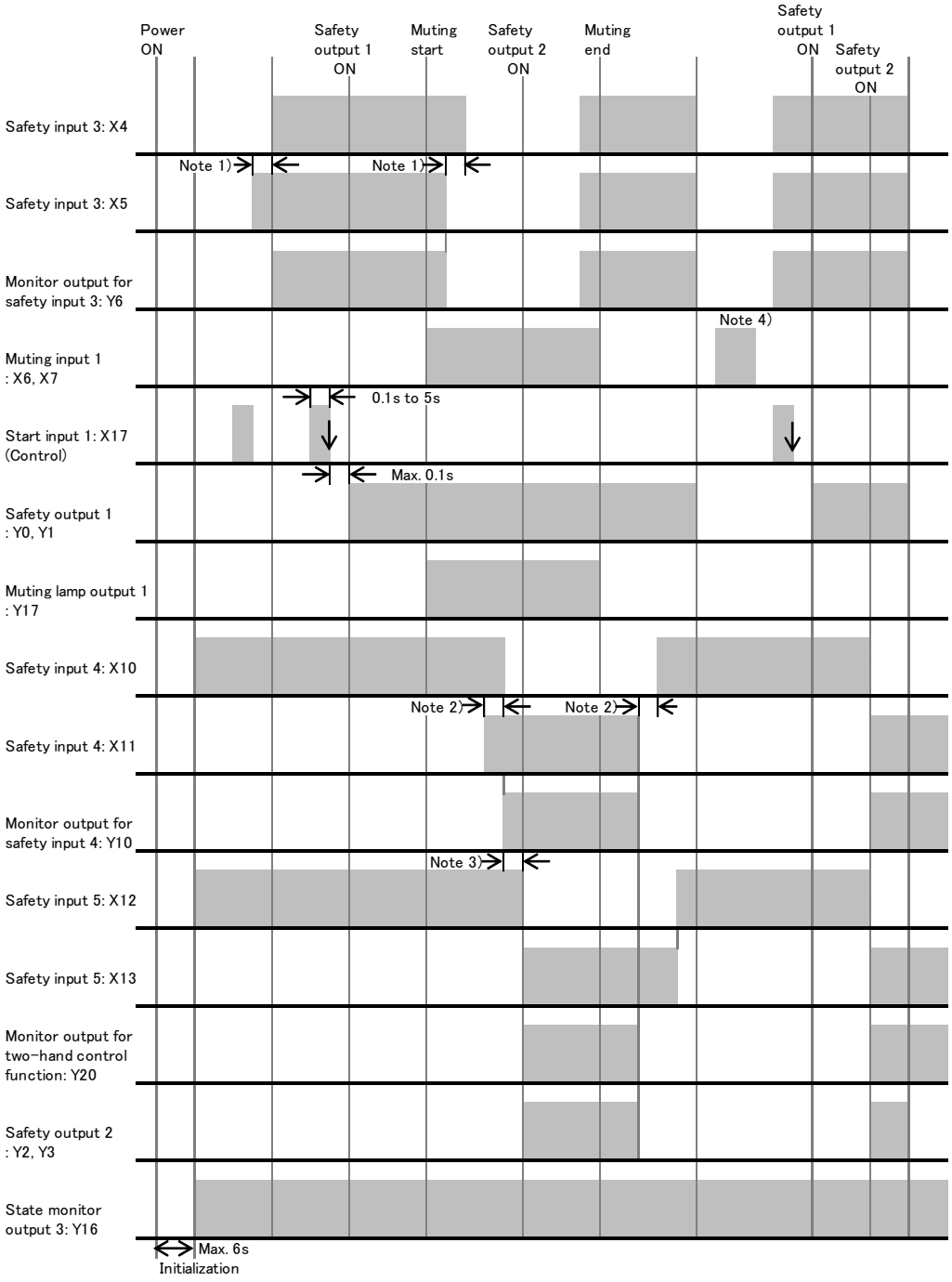
When not using some safety inputs

- If there are unused safety inputs in S1 and S2, connect the unused receive terminals to the corresponding drive terminals. (Refer to (1))
- If there are unused safety inputs in S3, connect the unused receive terminals to 24V DC power supply (V+). (Refer to (2))
- If there are unused muting inputs in S4 and S5, open between the unused receive terminals and the corresponding drive terminals . (Refer to (3))

Note: In the case of SW version 1.00, the muting lamp output terminal (Y17) Detects that connected indicator light is disconnected or unconnected. When not using the muting function, connect a resistor across the terminal. If no resistor is connected, then the SafetyOne Detects any wiring errors and locks out operations.



Timing chart (Logic 22A)



Safety input 1 and 2 are all ON in this chart.

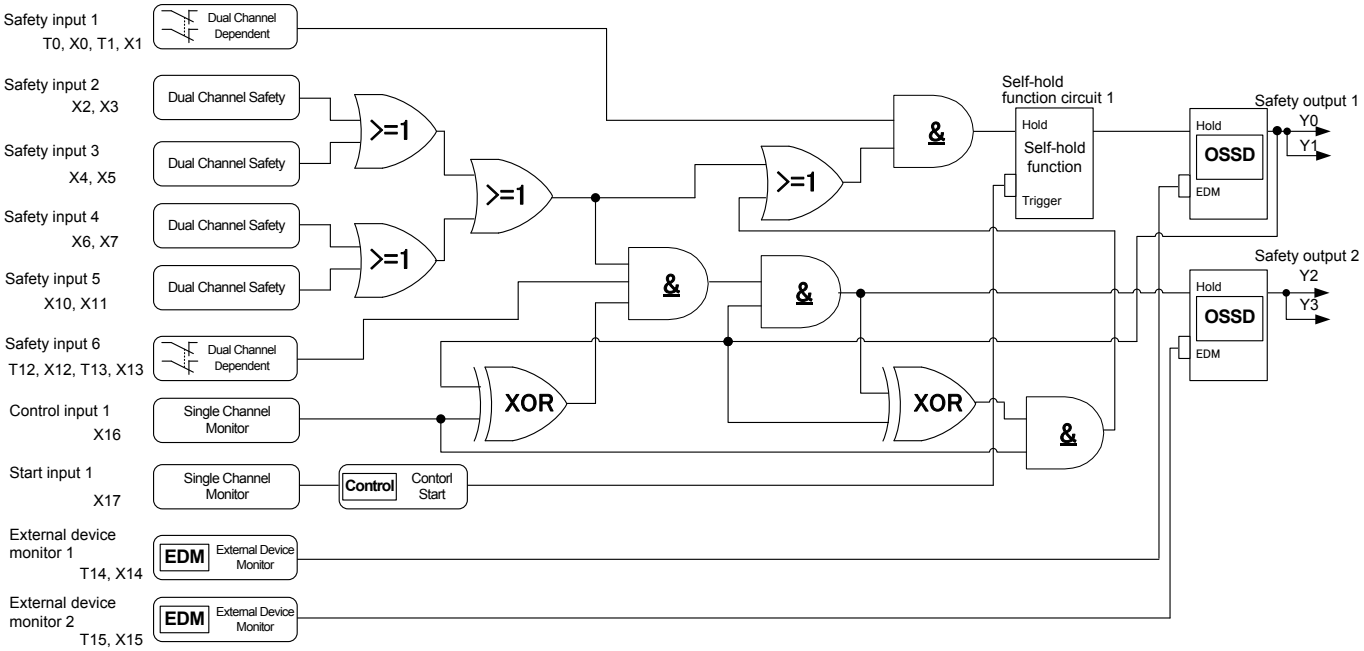
Note 1) Input monitor error detection time is 0.1s.
Note 2) Input monitor error detection time is 0.5s
Note 3) “Safety output 2” is not turned ON when time lag between “Safety input 4” and “Safety input 5” for two-hand control function is more than 0.5s. Refer to the following “Logic function” for more details.
Note 4) When “Safety input 3” is turned OFF before “Muting input 1” is turned ON, muting function is not effective and all of “Safety output” are not turned ON.

About safety inputs that are not described in this chart, input monitor error detection time is as follows.
The time of dual channel dependent input (X0 to X3) is infinity.
The time of dual channel NO/NC input (X12 and X13) is 0.5s.
The time of muting input (X6 and X7) is 3s.
Refer to the following “Logic functions” (5-128) for more details.

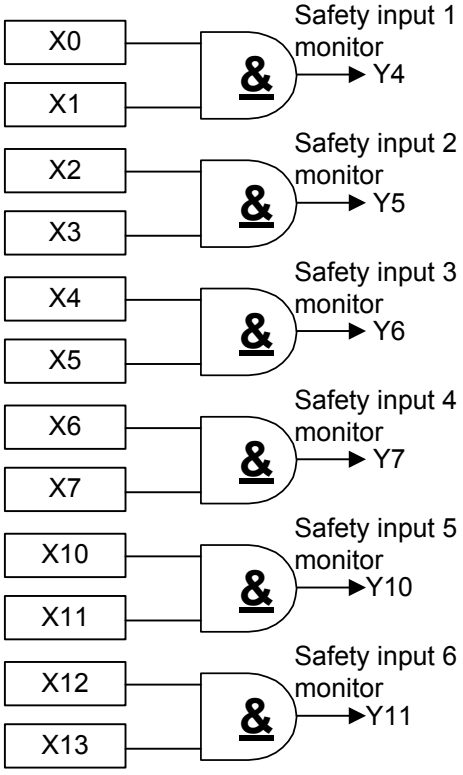
Logic 22b: The logic for apparatus with openings

Logic circuit (logic 22b)

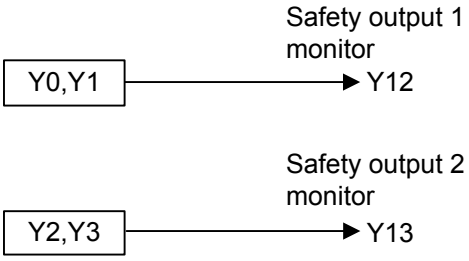
In the case of SW version 1.00



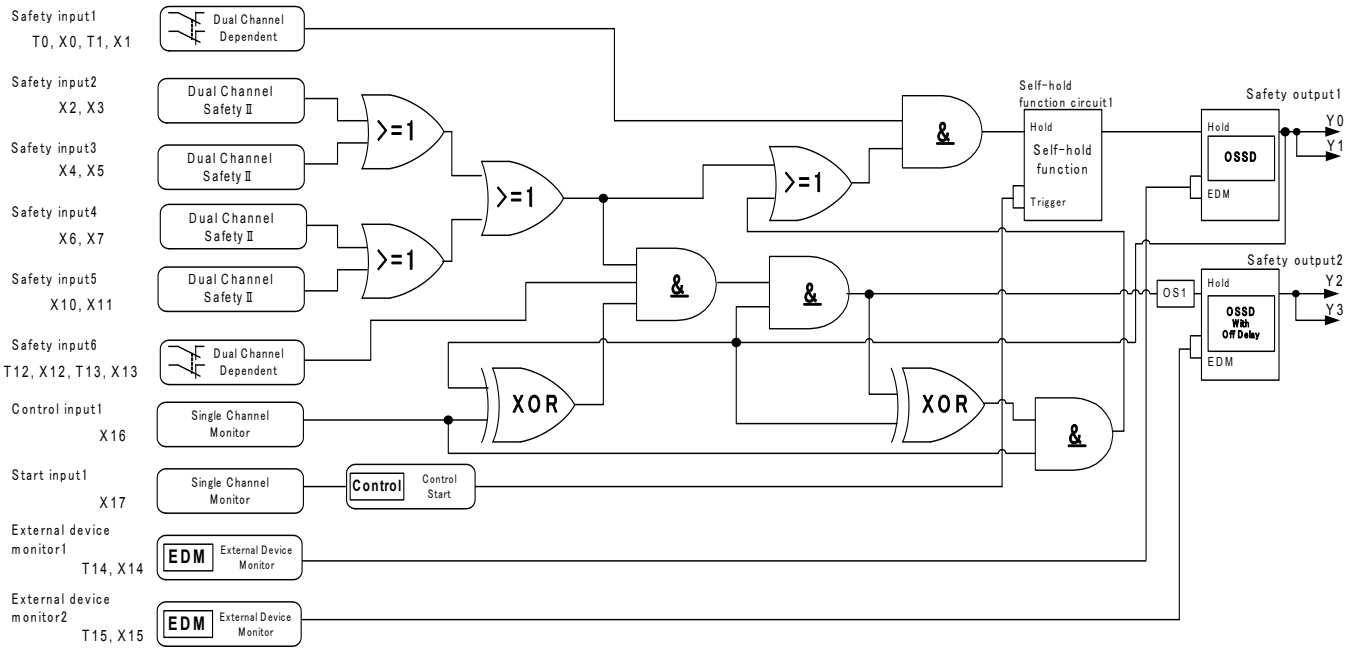
●Monitor output for safety input



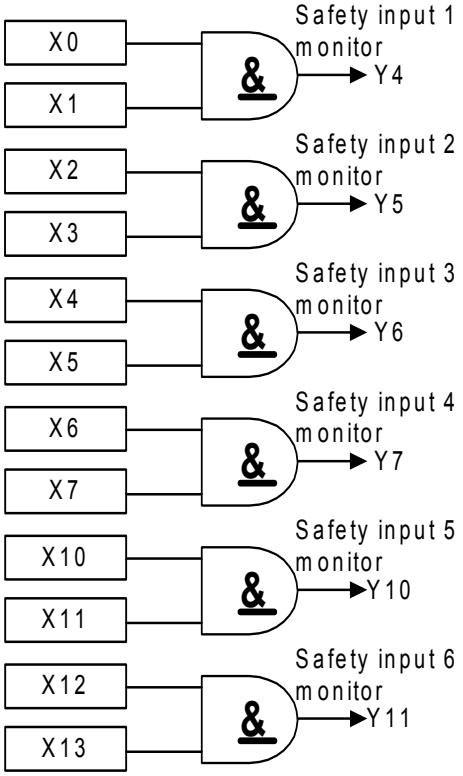
●Monitor output for safety output



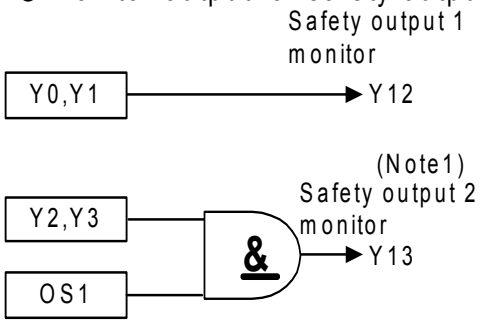
In the case of SW version 2.00 or higher



● Monitor output for safety input



● Monitor output for safety output

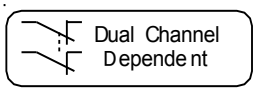


Note1:
Safety output 2 monitor turn off immediately independent of OFF-delay time.

Functions (Logic 22b)

●Safety inputs: X0 to X13 (T0, T1, T12, T13)

Safety inputs are used to diagnose the status of connected safety devices, such as emergency stop switches, and interlock switches.

Intended inputs (Terminal names)	Function	
Safety input 1 (X0-T0, X1-T1) Safety input 6 (X12-T12, X13-T13)	Function name	Dual channel dependent input
	Symbol	
	Description of operation	This function diagnoses the status of connected safety devices. This function does not diagnose the time interval of status transition between each input of duplicated inputs.
	Detail information	Logic functions (5-132)

In the case of SW version 1.00

Intended inputs (Terminal names)	Function	
Safety input 2 (X2, X3) Safety input 3 (X4, X5) Safety input 4 (X6, X7) Safety input 5 (X10, X11)	Function name	Dual channel safety input
	Symbol	
	Description of operation	This function diagnoses the status of connected safety devices. This function diagnoses the time interval of status transition between each input of duplicated inputs (0.1s). The function does not use drive terminals (T2 to T11).
	Detail information	Logic functions (5-136)

In the case of SW version 2.00 or higher

Intended inputs (Terminal names)	Function	
Safety input 2 (X2, X3) Safety input 3 (X4, X5) Safety input 4 (X6, X7) Safety input 5 (X10, X11)	Function name	Dual channel safety input II
	Symbol	
	Description of operation	This function diagnoses the status of connected safety devices. This function dose not diagnoses the time interval of status transition between each input of duplicated inputs. The function does not use drive terminals (T2 to T11).
	Detail information	Logic functions (5-138)

Warning

For connected control devices, refer to “SAFETY PRECAUTIONS”.
Safety check signals (pulses signals) are sent from the drive terminals (T0, T1, T12, T13) to diagnose connected safety devices and input circuits. Safety check signals cannot be used as a power supply for connected devices.
In the case of SW version 1.00, input states of all safety inputs are monitored when SafetyOne is in Run state or Protection state. For example, if input monitor error is occurred in safety input 3 although safety input 2 is in ON state, SafetyOne detects the error and transits to Protection state.
In the case of SW version 2.00 or higher, input states of all safety inputs are monitored when SafetyOne is in Run state or Protection state. However, for example, when safety input 2 is in ON state and safety output is ON state, if faults, such as grounding or an open circuit, at one of the safety input 3 occur SafetyOne is kept in Run state and the safety output is kept ON state. In this case safety input 3 monitor output (Y6) is OFF.

Note. Solid state outputs, such as safety light curtains, can not be connected to safety input 1 and 6.
Note. Use safety input 1 and 6 as specified combinations, such as receive terminal (Xn) and drive terminal (Tn). If the combinations are incorrect, SafetyOne does not work correctly.

●External device monitor inputs: X14 and X15 (T14 and T15)

External device monitor inputs are used to diagnose the status of devices connected to safety outputs.

Intended inputs (Terminal names)	Target safety outputs (Terminal names)	Function	
External device monitor input 1 (X14-T14)	Safety output 1 (Y0, Y1)	Function name	External device monitor input
External device monitor input 2 (X15-T15)	Safety output 2 (Y2, Y3)	Symbol	
		Description of operation	This function diagnoses the status of devices connected to a target safety output.
		Detail information	Logic Functions (5-147)

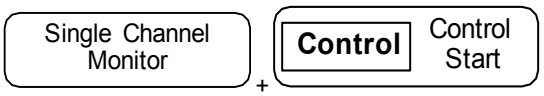
Warning

Safety check signals (pulses signals) are sent from the drive terminals (T14, T15) to diagnose external devices and monitor circuits. Safety check signals can not be used as a power supply for connected devices.

Note. If there are unused safety outputs, connect the intended external device monitor terminals (Xn) to the corresponding drive terminals (Tn). If they are not connected, the SafetyOne detects an input monitor error. As the result, the error LED displays “1” and the unit changes to the Protection state.

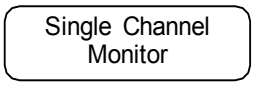
●Start input: X17

Start input is used to control the start of safety outputs.

Intended inputs (Terminal names)	Target safety inputs (Terminal names)	Function	
Start input 1 (X17)	Safety input 1 (X0-T0, X1-T1) Safety input 2 (X2, X3) Safety input 3 (X4, X5) Safety input 4 (X6, X7) Safety input 5 (X10, X11)	Function name	Monitor input + Control start
		Symbol	
		Description of operation	Safety outputs are started, when this function becomes ON after all intended safety inputs are in the safe state. This function is turned ON by 0.1s to 5s ON operation.
		Detail information	Logic Functions (5-146, 5-152)

●Control input: X16

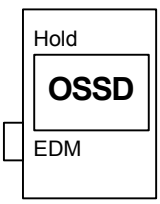
Control input is used to control of safety outputs.

Intended inputs (Terminal names)	Target safety outputs (Terminal names)	Function	
Control input 1 (X16)	Safety output 1 (Y0, Y1) Safety output 2 (Y2, Y3)	Function name	Monitor input
		Symbol	
		Description of operation	Target safety outputs are controled by these control inputs.
		Detail information	Logic Functions (5-146)

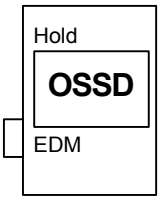
●Safety outputs: Y0 to Y3

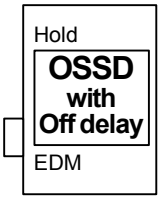
Safety outputs are used to output safety information processed by SafetyOne.

In the case of SW version 1.00

Intended outputs (Terminal names)	Function	
Safety output 1 (Y0, Y1) Safety output 2 (Y2, Y3)	Function name	Safety output without timer
	Symbol	
	Description of operation	This function is a safety output to output safety information processed by SafetyOne. The output is turned OFF immediately by OFF operation (instantaneous OFF output).
	Detail information	Logic Functions (5-154)

In the SW version 2.00 or higher

Intended outputs (Terminal names)	Function	
Safety output 1 (Y0, Y1)	Function name	Safety output without timer
	Symbol	
	Description of operation	This function is a safety output to output safety information processed by SafetyOne. The output is turned OFF immediately by OFF operation (instantaneous OFF output).
	Detail information	Logic Functions (5-154)

Intended outputs (Terminal names)	Function	
Safety output 2 (Y2, Y3)	Function name	Safety output with timer
	Symbol	
	Description of operation	This function is a safety output to output safety information processed by SafetyOne. The output is turned OFF after the preset time of the OFF-delay timer (OFF-delay output).
	Detail information	Logic functions (5-157)

Note. When the SafetyOne changes to Protection state due to input monitor error, safety output without timer is turned OFF. Safety output with timer is turned OFF after the preset OFF-delay time.

Note. When the SafetyOne changes to Stop state due to circuit failure or other errors, all safety outputs (safety output 1 and safety output 2) are turned OFF, immediately.

●Safety input monitor outputs: Y4 to Y11

Safety input monitor outputs are used to output the status of safety inputs in SafetyOne.

Intended outputs (Terminal names)	Target safety inputs (Terminal names)	Description of operation
Safety input 1 monitor output (Y4)	Safety input 1 (X0-T0, X1-T1)	When the target safety input is ON, the monitor output is ON. When the target safety input is OFF, the monitor output is OFF.
Safety input 2 monitor output (Y5)	Safety input 2 (X2, X3)	
Safety input 3 monitor output (Y6)	Safety input 3 (X4, X5)	
Safety input 4 monitor output (Y7)	Safety input 4 (X6, X7)	
Safety input 5 monitor output (Y10)	Safety input 5 (X10, X11)	
Safety input 6 monitor output (Y11)	Safety input 6 (X12-T12, X13-T13)	

Note. In the case of SW version 1.00, when the targeted safety input detects an input monitor error, input circuit failure, or EMC the disturbance, corresponding safety input monitor output becomes a pulse output (1Hz). The monitor output is OFF in other errors, Initial state, or Configuration state. In the case of SW version 2.00 or higher, the monitor output is OFF in errors, Initial state, or Configuration state.

●Safety output monitor outputs: Y12 and Y13

Safety output monitor outputs are used to output the status of safety outputs in SafetyOne.

Intended outputs (Terminal names)	Target safety outputs (Terminal names)	Description of operation
Safety output 1 monitor output (Y12)	Safety output 1 (Y0, Y1)	When the target safety output is ON, the monitor output is ON. When the target safety output is OFF, this function is OFF. The monitor output turns OFF immediately, independent of the preset OFF-delay time.
Safety output 2 monitor output (Y13)	Safety output 2 (Y2, Y3)	

Note. In the case of SW version 1.00, when the safety output detects an output circuit failure, the corresponding safety output monitor output becomes a pulse output (1Hz). The monitor output is OFF in other errors, Initial state, or Configuration state. In the case of SW version 2.00 or higher, the monitor output is OFF in errors, Initial state, or Configuration state.

●State monitor outputs: Y14 to Y16

State monitor outputs are used to output the internal state of SafetyOne.

Intended outputs (Terminal names)	State				
	Initial	Run	Configuration	Protection	Stop
State monitor output 1 (Y14)	■ON	□OFF	□OFF	□OFF	■ON
State monitor output 2 (Y15)	■ON	□OFF	■ON	■ON	■ON or□OFF
State monitor output 3 (Y16)	□OFF	■ON	□OFF	□OFF	□OFF

Refer to “Chapter 4 BASIC OPERATIONS” and to “Chapter 6 TROUBLE SHOOTING” for details of each state.

Warning

The monitor outputs are not safety outputs. Do not use these to construct a safety system.

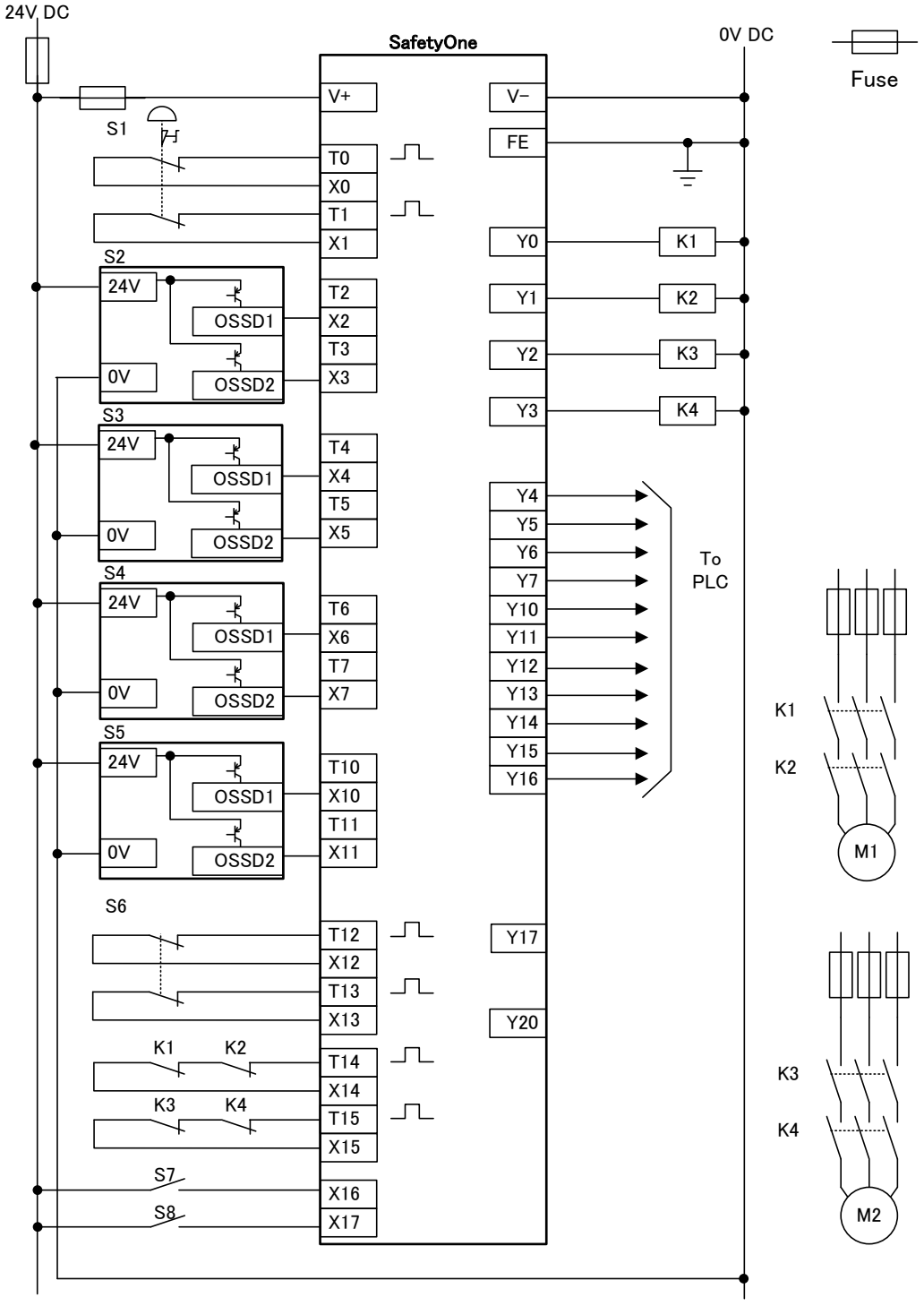
Caution

Refer to "Chapter 2 PRODUCT SPECIFICATIONS" for specifications of each input and output.

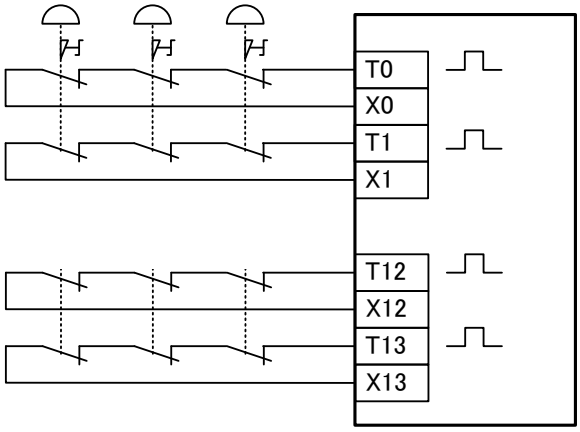
Wiring example (Logic 22b)

In the case where 1 emergency stop switch, 2 safety light curtains, 2 RFID-type non contact-safety switches, and 1 interlock switch are connected.

S1 : Emergency stop switch
S2, 3 : Safety light curtain
S4, 5 : RFID-type non contact-safety switch
S6 : Interlock switch
S7 : Control input switch
S8 : Start switch
K1 to 4 : Contactor
M1, 2 : Motor



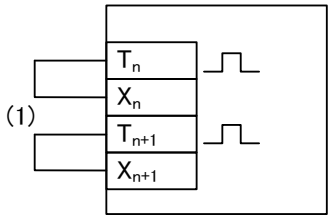
When connecting multiple emergency stop switches in series



NOTE: Safety performance depends on the system configuration.

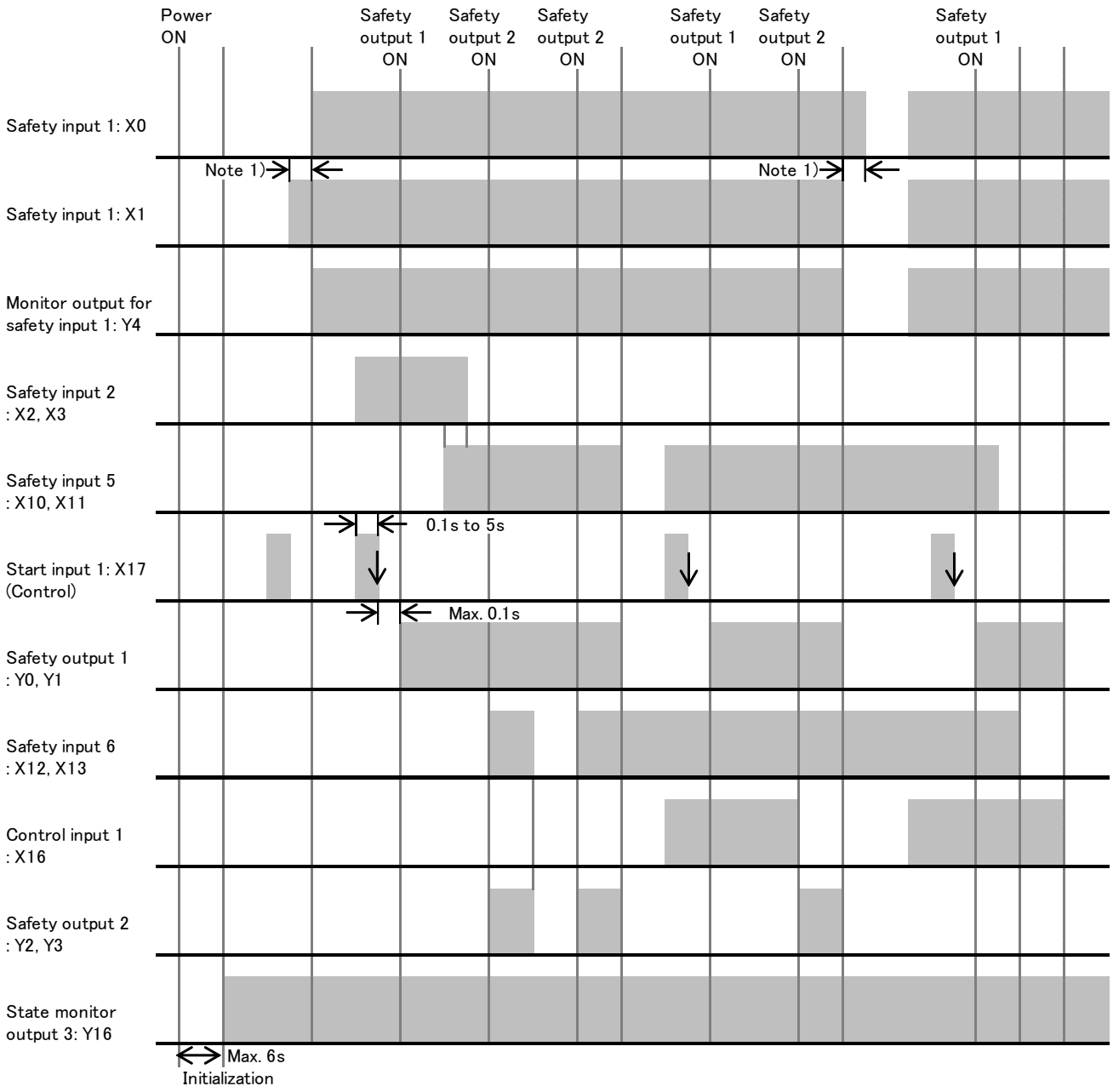
When not using some inputs

・If there are unused safety inputs in S1 and S6, connect the unused receive terminals to the corresponding drive terminals. (Refer to (1))



Timing chart (Logic 22b)

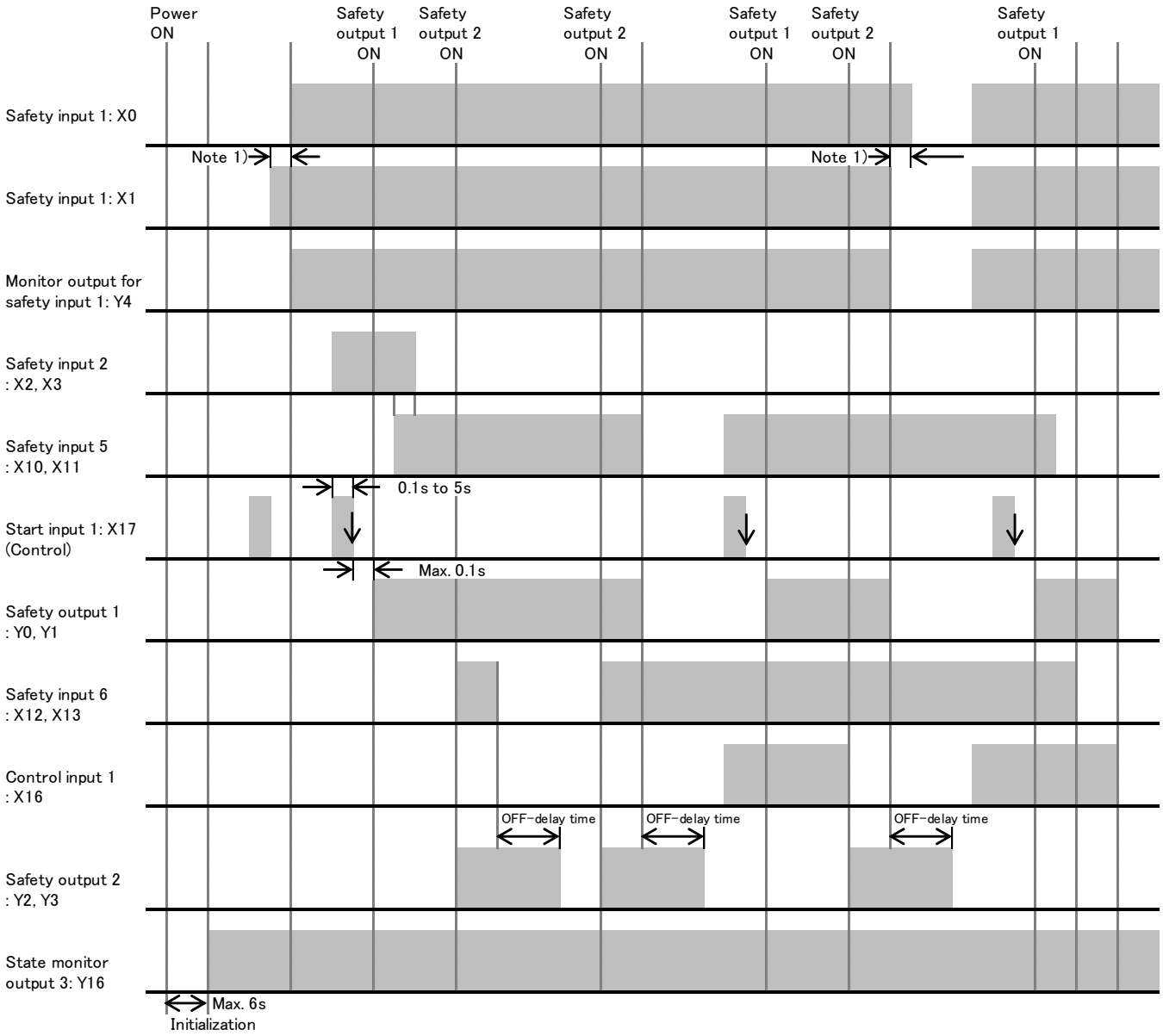
In the case of SW version 1.00



Safety input 3 and 4 are OFF in this chart.

Note 1) Input monitor error detection time is infinity.
About safety inputs that are not described in this chart, input monitor error detection time is as follows.
The time of dual channel safety input (X2 to X11) is 0.1s.
The time of dual channel dependent input (X12 and X13) is infinity.
Refer to the following “Logic functions” (5-128) for more details.

In the case of SW version 2.00 or higher



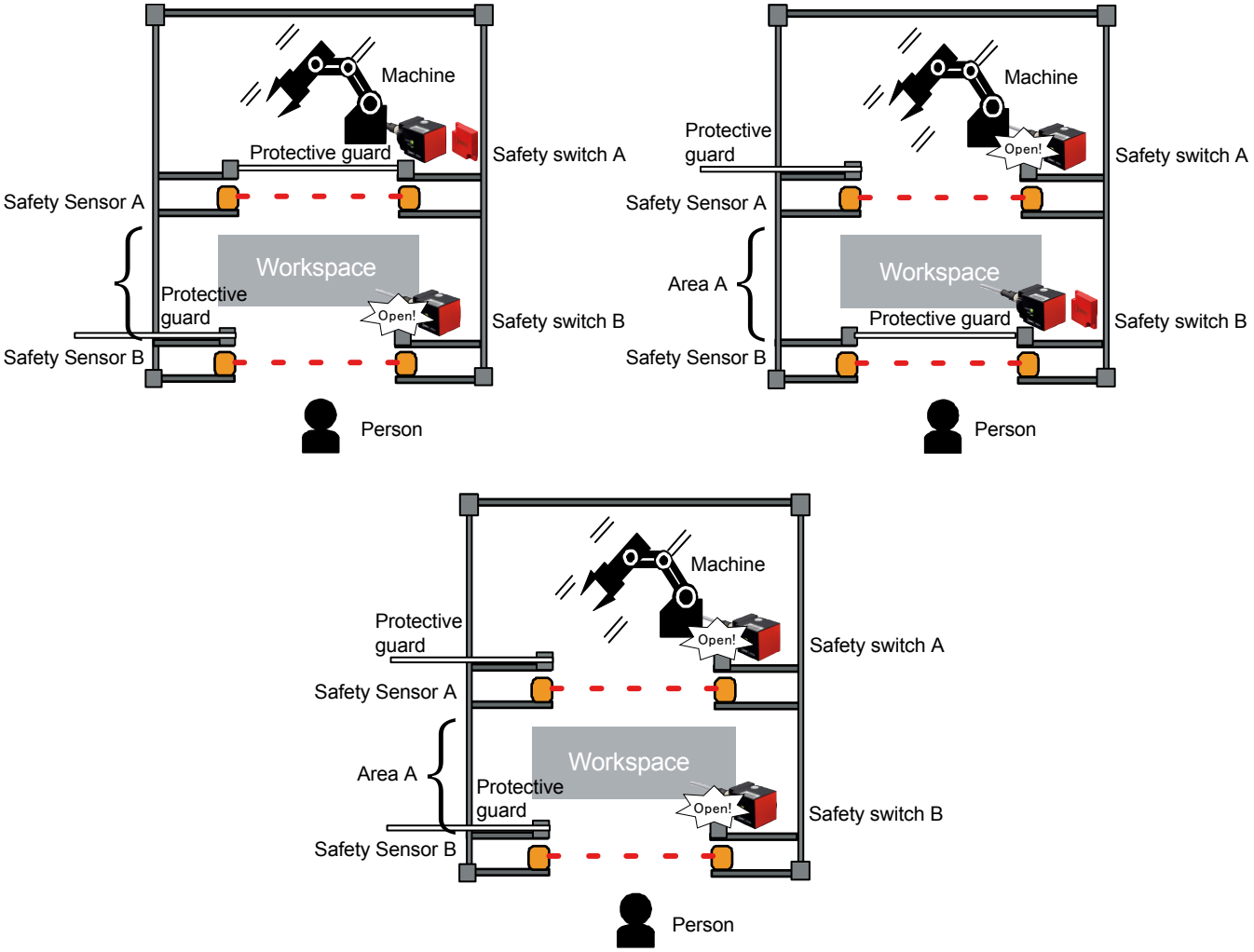
Safety input 3 and 4 are OFF in this chart.

Note 1) Input monitor error detection time is infinity.
About safety inputs that are not described in this chart, input monitor error detection time is as follows.
The time of dual channel safety input II (X2 to X11) is infinity.
The time of dual channel dependent input (X12 and X13) is infinity.
Refer to the following “Logic functions” (5-128) for more details.

Safety system configuration example (Logic 22b)

Warning

Serious injury may possibly occur due to loss of safety functions. Construct an appropriate safety system as shown in the following precautions.



- Use only appropriate components or devices complying with relevant safety standards corresponding to the required level of safety categories. Conformity to requirements of safety category is determined as an entire system. It is recommended to consult a certification body regarding assessment of conformity to the required safety level.
- Validate safety function of entire system by customer's responsibility.
- Select Safety Sensors that satisfy the following condition:

  1. Diameter of the smallest detectable object < Diameter of the object to be detected.

- Install the Safety Sensors so that they satisfy the following conditions:

  1. Use Safety Sensor A to detect the entry of the machine into area A, and Safety Sensor B to detect the entry of a person into area A.
  2. Make sure that the machine can reach area A only by passing through Safety Sensor A, and that a person can reach area A only by passing through Safety Sensor B.

- Provide a protective structure to prevent a person from passing completely through Safety Sensor B and stepping into area A. If this is not possible, install a sensor that will detect the presence of a person inside area A and prevent the machine from being restarted while the person is inside area A.
- Make the intensity of the protective guard strong enough so that the operator in the area A is physically unaffected even when the machine touches the guard at full power.
- Design the structure of the protective guard so that the tip of the machine does not intrude into the area A through a gap in the guard (the safety switch A turns to the ON status).
- Select the safety switch A/B on which safety approval is obtained for use of the category 4 such as an RFID-type non contact-safety switch.
- Enter the conditions of complete machine stoppage in the safety input when the safety switch B is not used.
- Provide a sufficient safety distance (S1) considering the entry speed of a person and a sufficient safety distance (S2) considering the entry speed of the machine. For details, refer to Safety Distance on next page.

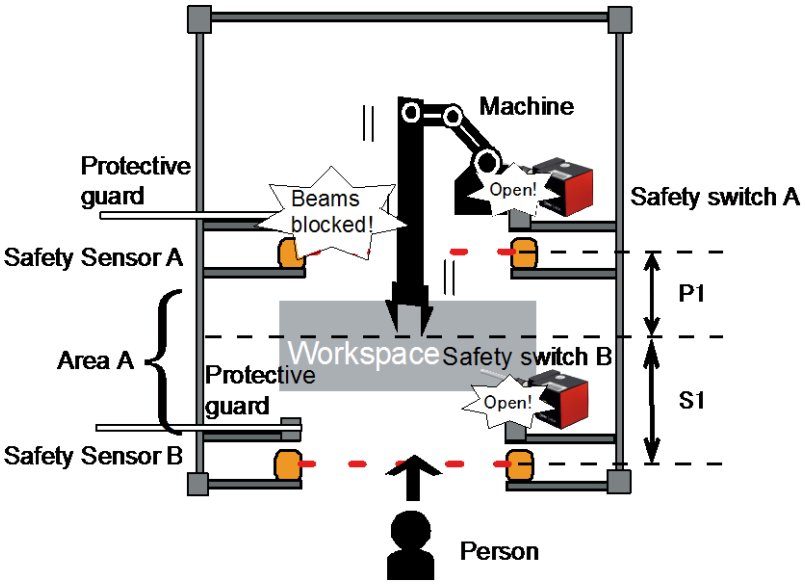
Safety Distance

The safety distance is the minimum distance that must be provided between the safety input device and a machine's hazardous part to stop the hazardous part before a person or object reaches it. The safety distance varies according to the standards of each country and the specifications of each machine.

In addition, the calculation of the safety distance differs if the direction of approach is not perpendicular to the detection zone of the safety input device. Always refer to the relevant standards.

■ Safety Distance Concepts

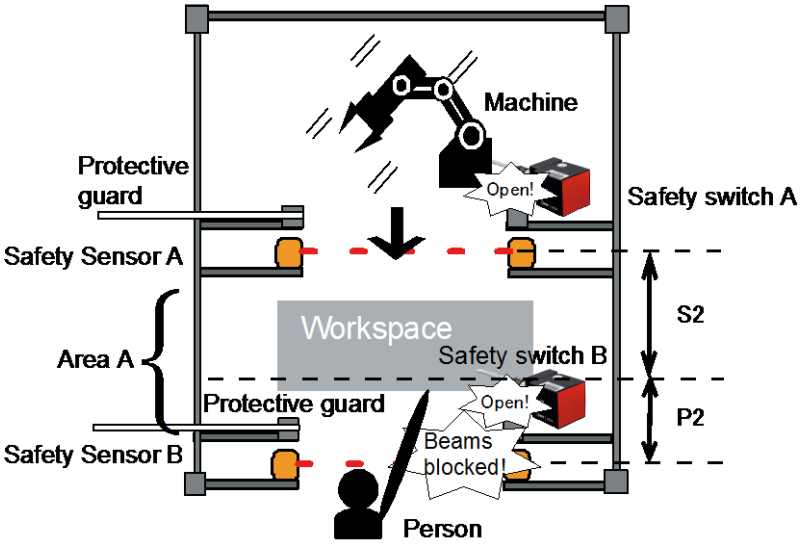
● When a person approaches a hazard (machine)



S1: Safety distance 1

P1: The closest that a machine can come to a person while operating (the boundary of the machine's operating area)

● When a hazard (machine) approaches a person



S2: Safety distance 2

P2: The closest that a part of a person can come to a machine

■ Safety Distance Calculation Examples (Reference)

● Calculating the safety distance specified by international standard ISO 13855-2002 (European standard EN 999-1999)

If a person approaches the detection zone perpendicularly, calculate the safety distance as shown below.

S1 = K1 × T + C

S2 = K2 × T + C

S1: Safety distance 1
S2: Safety distance 2
K1: Approach speed of a person to the detection zone (area A)
K2: Maximum approach speed of a machine to the detection zone (area A)
T: Total response time of the machine and the SafetyOne system
C: Additional distance calculated by the detection capability (the diameter of the smallest detectable object) of the Safety Sensor.

● Calculating the safety distance specified by American standard ANSI B11.19

If a person approaches the detection zone perpendicularly, calculate the safety distance as shown below.

S1 = K1 × (Ts + Tc + Tr + Tbm) + Dpf

S2 = K2 × (Ts + Tc + Tr + Tbm) + Dpf

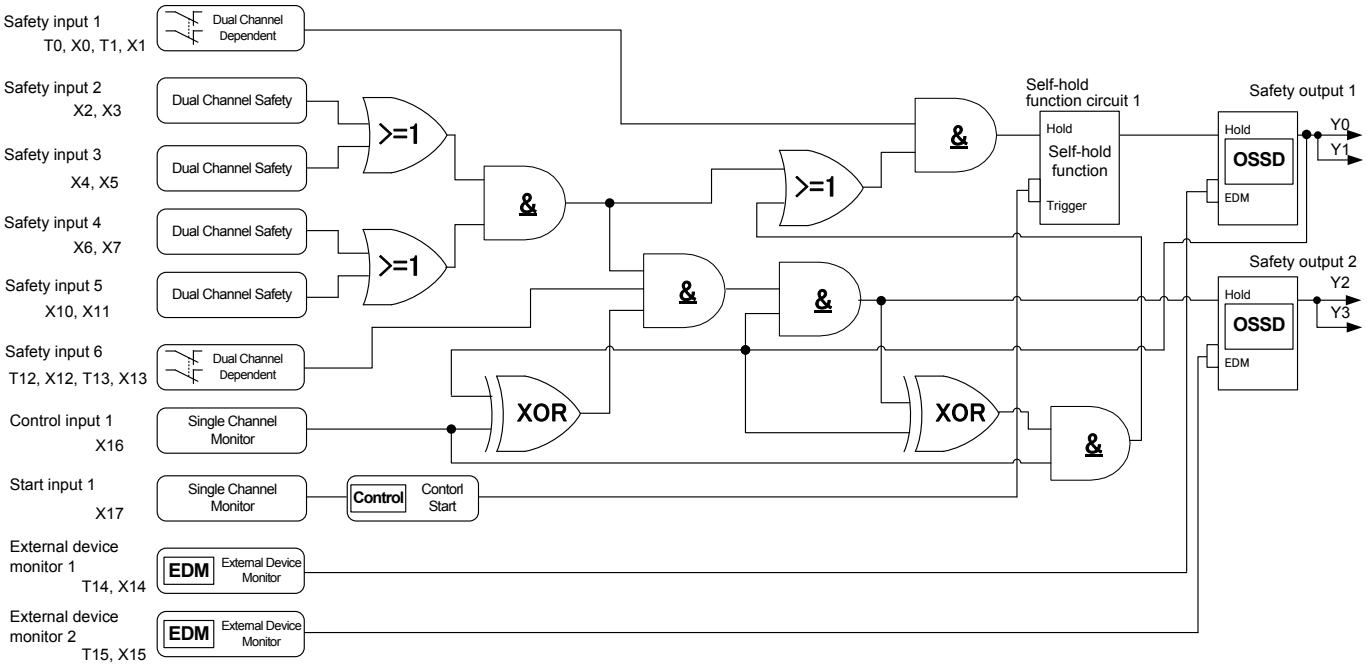
S1: Safety distance 1
S2: Safety distance 2
K1: Approach speed of a person to the detection zone (area A)
K2: Maximum approach speed of a machine to the detection zone (area A)
Ts: Machine's stop time (s)
Tr: Response time of the SafetyOne system from ON to OFF (s)
Tc: Machine control circuit's maximum response time required to activate its brake (s)
Tbm: Additional time (s)
Dpf: Additional distance

● To determine the approach speed K1, consider all factors, including the operator's physical abilities.
● To determine the maximum approach speed K2, consult with a notified body or other authoritative institutes.
● The response time of a machine is the time from when the machine receives a stop signal to the time when the machine's hazardous part stops. Measure the response time on the actual system. Also, periodically check that the machine's response time has not changed.
● To determine the safety distance to hazards, take into account the delay of safety outputs caused by the following times:
1. Response time of safety inputs

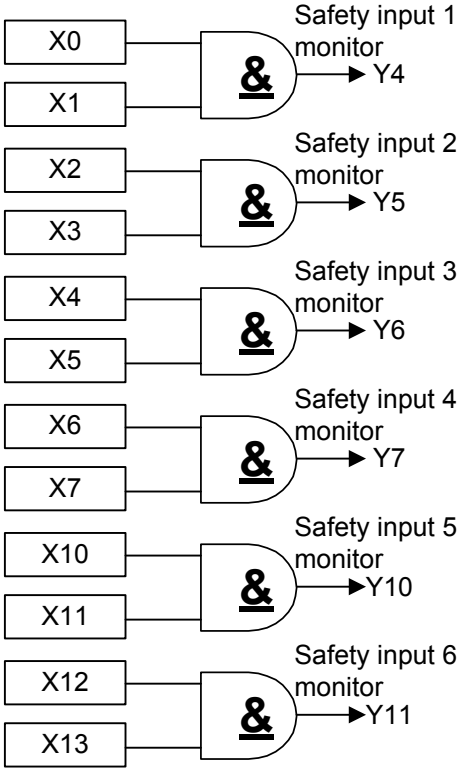
Logic 22C: The logic for apparatus with openings

Logic circuit (logic 22C)

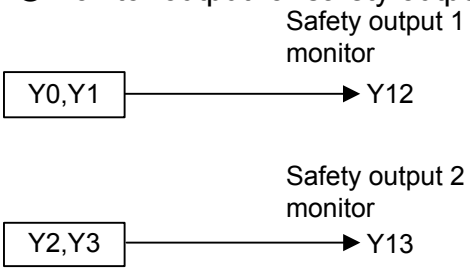
In the case of SW version 1.00



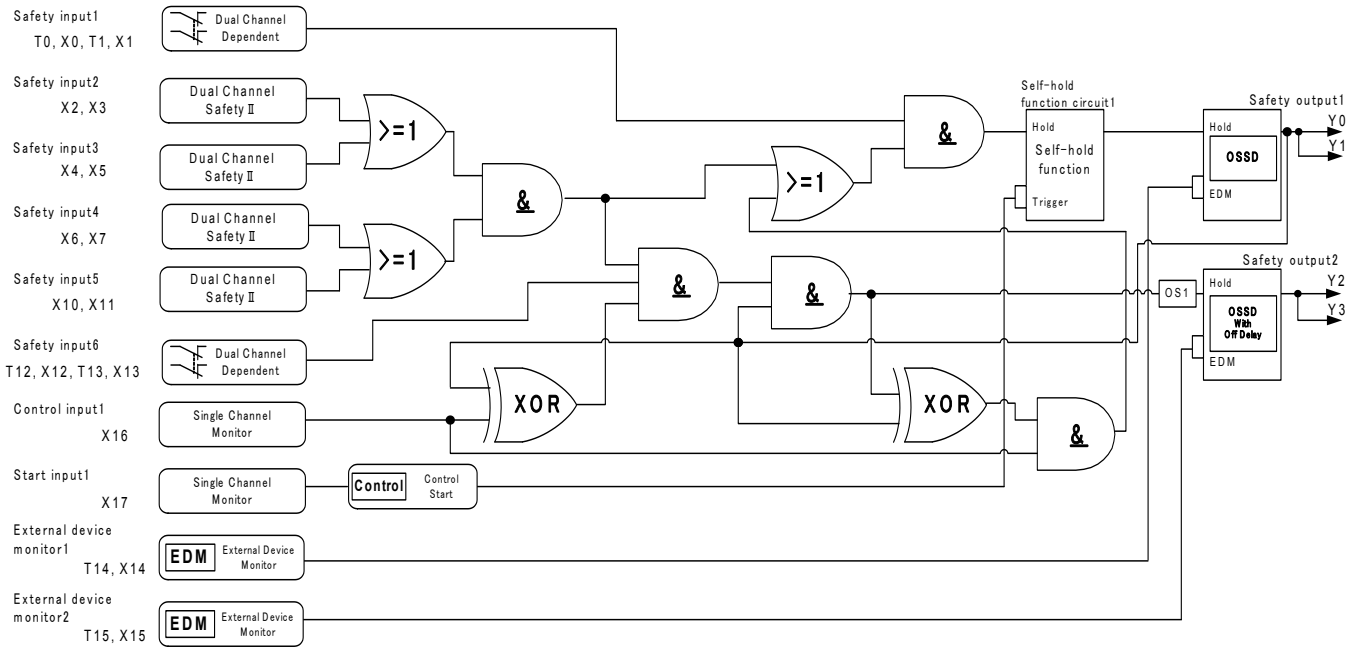
●Monitor output for safety input



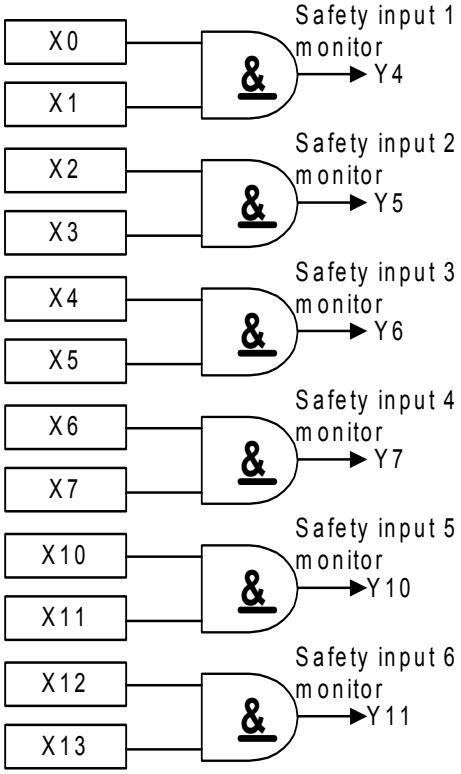
●Monitor output for safety output



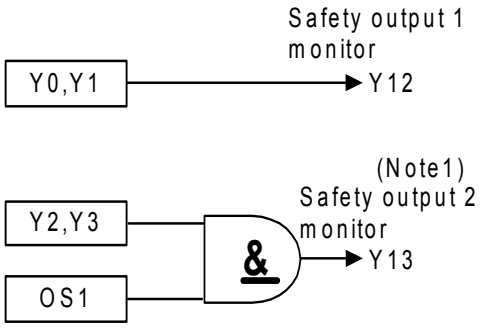
In the case of SW version 2.00 or higher



● Monitor output for safety input



● Monitor output for safety output

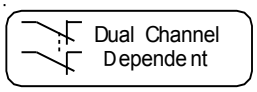


Note1:
Safety output 2 monitor turn off immediately independent of OFF-delay time.

Functions (Logic 22C)

●Safety inputs: X0 to X13 (T0, T1, T12, T13)

Safety inputs are used to diagnose the status of connected safety devices, such as emergency stop switches, and interlock switches.

Intended inputs (Terminal names)	Function	
Safety input 1 (X0-T0, X1-T1) Safety input 6 (X12-T12, X13-T13)	Function name	Dual channel dependent input
	Symbol	
	Description of operation	This function diagnoses the status of connected safety devices. This function does not diagnose the time interval of status transition between each input of duplicated inputs.
	Detail information	Logic functions (5-132)

In the case of SW version 1.00

Intended inputs (Terminal names)	Function	
Safety input 2 (X2, X3) Safety input 3 (X4, X5) Safety input 4 (X6, X7) Safety input 5 (X10, X11)	Function name	Dual channel safety input
	Symbol	
	Description of operation	This function diagnoses the status of connected safety devices. This function diagnoses the time interval of status transition between each input of duplicated inputs (0.1s). The function does not use drive terminals (T2 to T11).
	Detail information	Logic functions (5-136)

In the case of SW version 2.00 or higher

Intended inputs (Terminal names)	Function	
Safety input 2 (X2, X3) Safety input 3 (X4, X5) Safety input 4 (X6, X7) Safety input 5 (X10, X11)	Function name	Dual channel safety input II
	Symbol	
	Description of operation	This function diagnoses the status of connected safety devices. This function dose not diagnoses the time interval of status transition between each input of duplicated inputs. The function does not use drive terminals (T2 to T11).
	Detail information	Logic functions (5-138)

Warning

For connected control devices, refer to “SAFETY PRECAUTIONS”.
Safety check signals (pulses signals) are sent from the drive terminals (T0, T1, T12, T13) to diagnose connected safety devices and input circuits. Safety check signals can not be used as a power supply for connected devices.
In the case of SW version 1.00, input states of all safety inputs are monitored when SafetyOne is in Run state or Protection state. For example, if input monitor error is occurred in safety input 3 although safety input 2 is in ON state, SafetyOne detects the error and transits to Protection state.
In the case of SW version 2.00 or higher, input states of all safety inputs are monitored when SafetyOne is in Run state or Protection state. However, for example, when safety input 2 is in ON state and safety output is ON state, if faults, such as grounding or an open circuit, at one of the safety input 3 occur SafetyOne is kept in Run state and the safety output is kept ON state. In this case safety input 3 monitor output (Y6) is OFF.

Note. Solid state outputs, such as safety light curtains, can not be connected to safety input 1 and 6.
Note. Use safety input 1 and 6 as specified combinations, such as receive terminal (Xn) and drive terminal (Tn). If the combinations are incorrect, SafetyOne does not work correctly.

●External device monitor inputs: X14 and X15 (T14 and T15)

External device monitor inputs are used to diagnose the status of devices connected to safety outputs.

Intended inputs (Terminal names)	Target safety outputs (Terminal names)	Function	
External device monitor input 1 (X14-T14)	Safety output 1 (Y0, Y1)	Function name	External device monitor input
External device monitor input 2 (X15-T15)	Safety output 2 (Y2, Y3)	Symbol	
		Description of operation	This function diagnoses the status of devices connected to a target safety output.
		Detail information	Logic Functions (5-147)

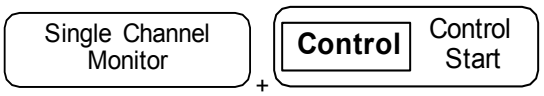
Warning

Safety check signals (pulses signals) are sent from the drive terminals (T14, T15) to diagnose external devices and monitor circuits. Safety check signals can not be used as a power supply for connected devices.

Note. If there are unused safety outputs, connect the intended external device monitor terminals (Xn) to the corresponding drive terminals (Tn). If they are not connected, the SafetyOne detects an input monitor error. As the result, the error LED displays “1” and the unit changes to the Protection state.

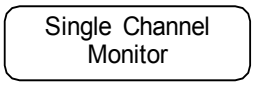
●Start input: X17

Start input is used to control the start of safety outputs.

Intended inputs (Terminal names)	Target safety inputs (Terminal names)	Function	
Start input 1 (X17)	Safety input 1 (X0-T0, X1-T1) Safety input 2 (X2, X3) Safety input 3 (X4, X5) Safety input 4 (X6, X7) Safety input 5 (X10, X11)	Function name	Monitor input + Control start
		Symbol	
		Description of operation	Safety outputs are started, when this function becomes ON after all intended safety inputs are in the safe state. This function is turned ON by 0.1s to 5s ON operation.
		Detail information	Logic Functions (5-146, 5-152)

●Control input: X16

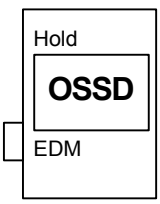
Control input is used to control of safety outputs.

Intended inputs (Terminal names)	Target safety outputs (Terminal names)	Function	
Control input 1 (X16)	Safety output 1 (Y0, Y1) Safety output 2 (Y2, Y3)	Function name	Monitor input
		Symbol	
		Description of operation	Target safety outputs are controled by these control inputs.
		Detail information	Logic Functions (5-146)

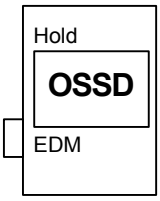
●Safety outputs: Y0 to Y3

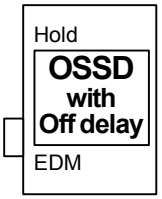
Safety outputs are used to output safety information processed by SafetyOne.

In the case of SW version 1.00

Intended outputs (Terminal names)	Function	
Safety output 1 (Y0, Y1) Safety output 2 (Y2, Y3)	Function name	Safety output without timer
	Symbol	
	Description of operation	This function is a safety output to output safety information processed by SafetyOne. The output is turned OFF immediately by OFF operation (instantaneous OFF output).
	Detail information	Logic Functions (5-154)

In the SW version 2.00 or higher

Intended outputs (Terminal names)	Function	
Safety output 1 (Y0, Y1)	Function name	Safety output without timer
	Symbol	
	Description of operation	This function is a safety output to output safety information processed by SafetyOne. The output is turned OFF immediately by OFF operation (instantaneous OFF output).
	Detail information	Logic Functions (5-154)

Intended outputs (Terminal names)	Function	
Safety output 2 (Y2, Y3)	Function name	Safety output with timer
	Symbol	
	Description of operation	This function is a safety output to output safety information processed by SafetyOne. The output is turned OFF after the preset time of the OFF-delay timer (OFF-delay output).
	Detail information	Logic functions (5-157)

Note. When the SafetyOne changes to Protection state due to input monitor error, safety output without timer is turned OFF. Safety output with timer is turned OFF after the preset OFF-delay time.

Note. When the SafetyOne changes to Stop state due to circuit failure or other errors, all safety outputs (safety output 1 and safety output 2) are turned OFF, immediately.

●Safety input monitor outputs: Y4 to Y11

Safety input monitor outputs are used to output the status of safety inputs in SafetyOne.

Intended outputs (Terminal names)	Target safety inputs (Terminal names)	Description of operation
Safety input 1 monitor output (Y4)	Safety input 1 (X0-T0, X1-T1)	When the target safety input is ON, the monitor output is ON. When the target safety input is OFF, the monitor output is OFF.
Safety input 2 monitor output (Y5)	Safety input 2 (X2, X3)	
Safety input 3 monitor output (Y6)	Safety input 3 (X4, X5)	
Safety input 4 monitor output (Y7)	Safety input 4 (X6, X7)	
Safety input 5 monitor output (Y10)	Safety input 5 (X10, X11)	
Safety input 6 monitor output (Y11)	Safety input 6 (X12-T12, X13-T13)	

Note. In the case of SW version 1.00, when the targeted safety input detects an input monitor error, input circuit failure, or EMC the disturbance, corresponding safety input monitor output becomes a pulse output (1Hz). The monitor output is OFF in other errors, Initial state, or Configuration state. In the case of SW version 2.00 or higher, the monitor output is OFF in errors, Initial state, or Configuration state.

●Safety output monitor outputs: Y12 and Y13

Safety output monitor outputs are used to output the status of safety outputs in SafetyOne.

Intended outputs (Terminal names)	Target safety outputs (Terminal names)	Description of operation
Safety output 1 monitor output (Y12)	Safety output 1 (Y0, Y1)	When the target safety output is ON, the monitor output is ON. When the target safety output is OFF, this function is OFF. The monitor output turns OFF immediately, independent of the preset OFF-delay time.
Safety output 2 monitor output (Y13)	Safety output 2 (Y2, Y3)	

Note. In the case of SW version 1.00, when the safety output detects an output circuit failure, the corresponding safety output monitor output becomes a pulse output (1Hz). The monitor output is OFF in other errors, Initial state, or Configuration state. In the case of SW version 2.00 or higher, the monitor output is OFF in errors, Initial state, or Configuration state.

●State monitor outputs: Y14 to Y16

State monitor outputs are used to output the internal state of SafetyOne.

Intended outputs (Terminal names)	State				
	Initial	Run	Configuration	Protection	Stop
State monitor output 1 (Y14)	■ON	□OFF	□OFF	□OFF	■ON
State monitor output 2 (Y15)	■ON	□OFF	■ON	■ON	■ON or□OFF
State monitor output 3 (Y16)	□OFF	■ON	□OFF	□OFF	□OFF

Refer to “Chapter 4 BASIC OPERATIONS” and to “Chapter 6 TROUBLE SHOOTING” for details of each state.

Warning

The monitor outputs are not safety outputs. Do not use these to construct a safety system.

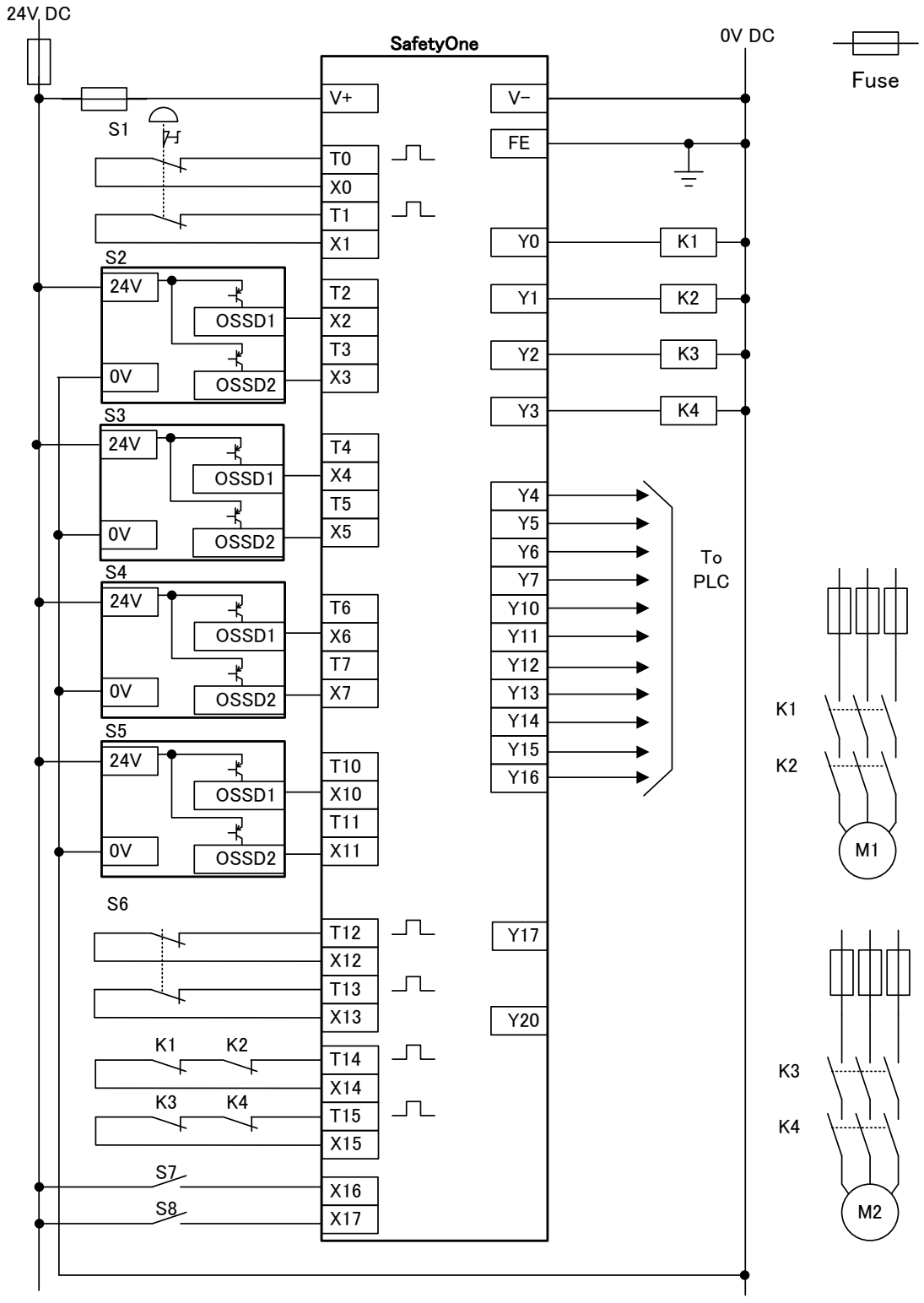
Caution

Refer to "Chapter 2 PRODUCT SPECIFICATIONS" for specifications of each input and output.

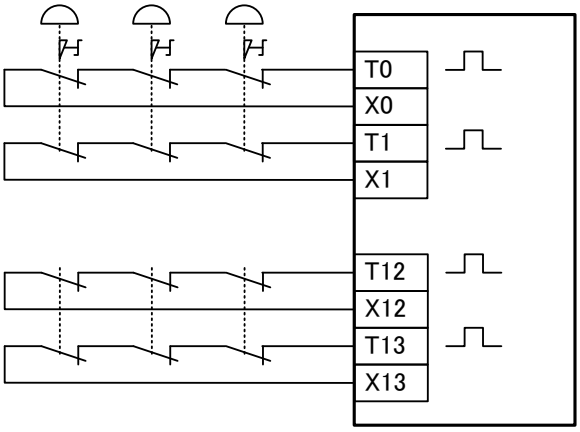
Wiring example (Logic 22C)

In the case where 1 emergency stop switch, 4 safety light curtains, and 1 interlock switch are connected.

S1 : Emergency stop switch
S2 to 5 : Safety light curtain
S6 : Interlock switch
S7 : Control input switch
S8 : Start switch
K1 to 4 : Contactor
M1, 2 : Motor



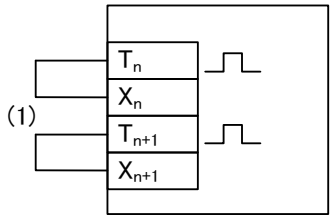
When connecting multiple emergency stop switches in series



NOTE: Safety performance depends on the system configuration.

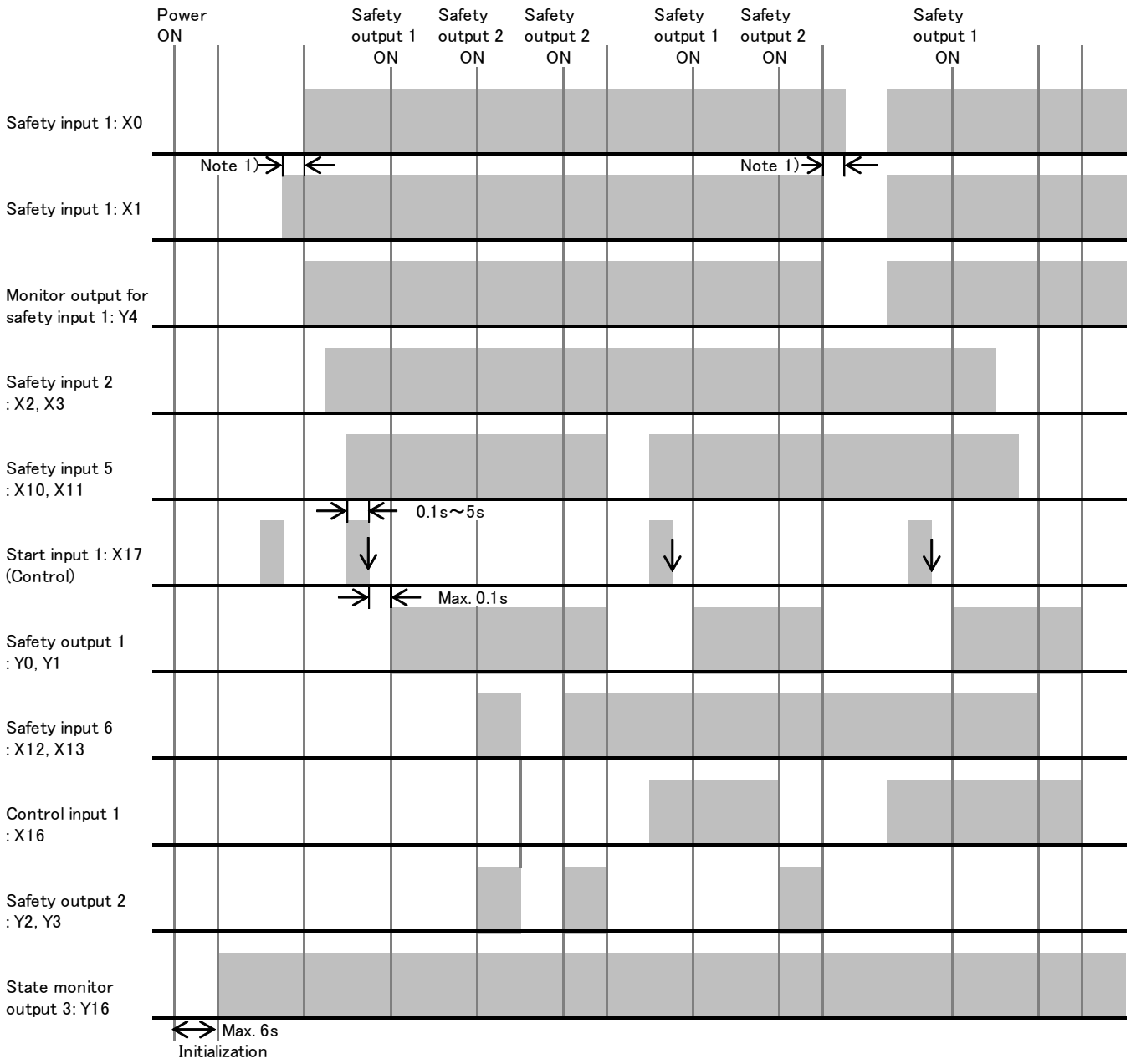
When not using some inputs

・If there are unused safety inputs in S1 and S6, connect the unused receive terminals to the corresponding drive terminals. (Refer to (1))



Timing chart (Logic 22C)

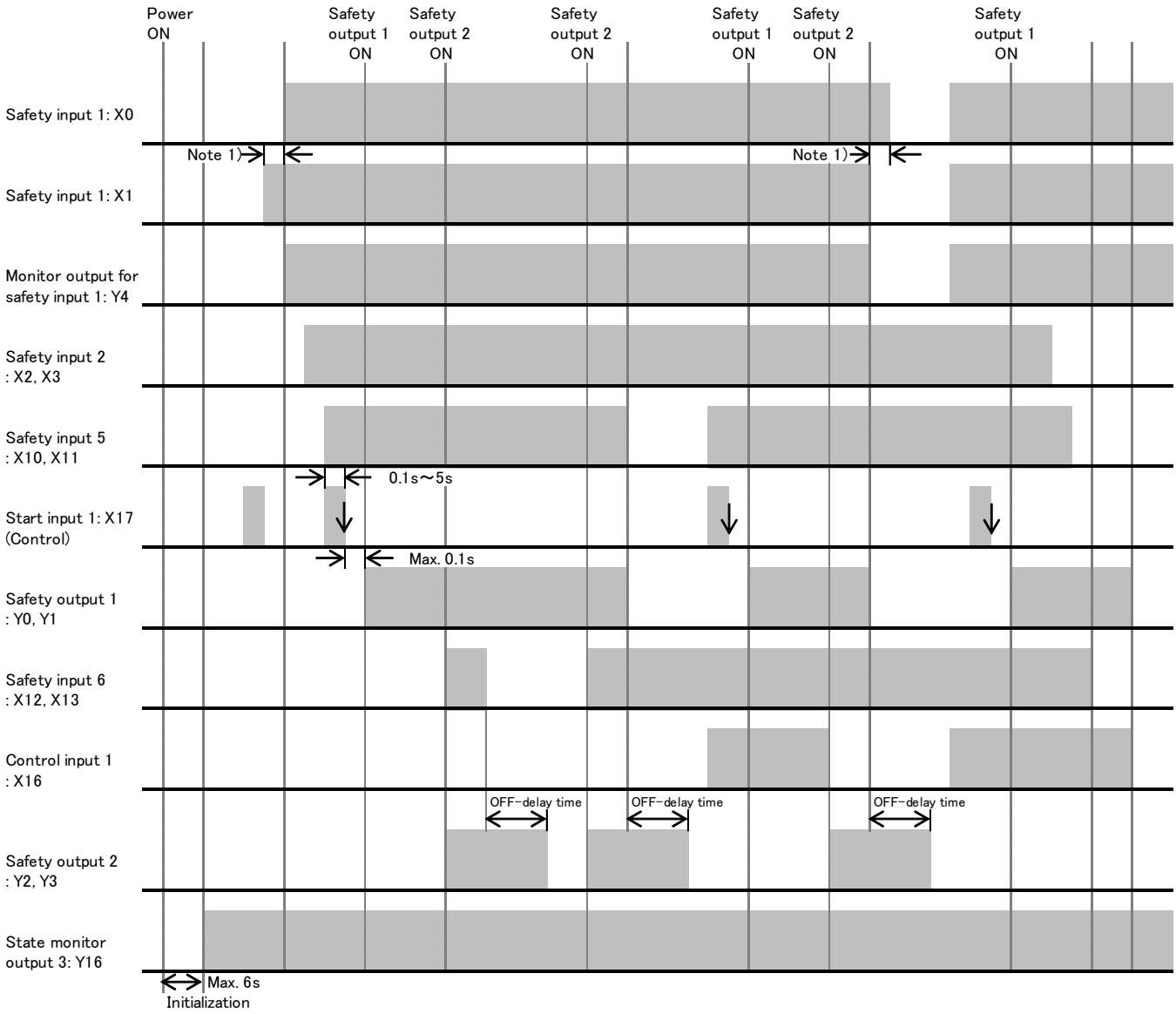
In the case of SW version 1.00



Safety input 3 and 4 are OFF in this chart.

Note 1) Input monitor error detection time is infinity.
About safety inputs that are not described in this chart, input monitor error detection time is as follows.
The time of dual channel safety input (X2 to X11) is 0.1s.
The time of dual channel dependent input (X12 and X13) is infinity.
Refer to the following “Logic functions” (5-128) for more details.

In the case of SW version 2.00 or higher



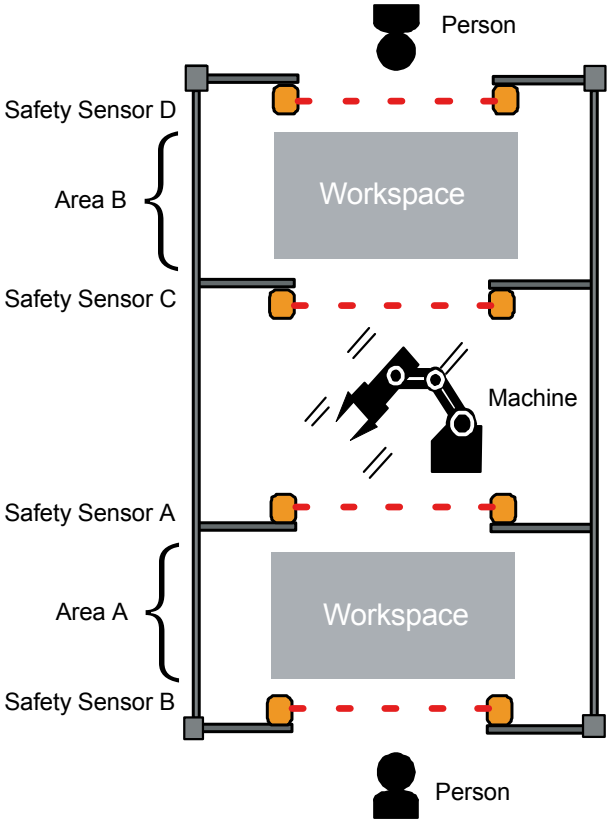
Safety input 3 and 4 are OFF in this chart.

Note 1) Input monitor error detection time is infinity.
About safety inputs that are not described in this chart, input monitor error detection time is as follows.
The time of dual channel safety input II (X2 to X11) is infinity.
The time of dual channel dependent input (X12 and X13) is infinity.
Refer to the following “Logic functions” (5-128) for more details.

Safety system configuration example (Logic 22C)

Warning

Serious injury may possibly occur due to loss of safety functions. Construct an appropriate safety system as shown in the following precautions.



- Use only appropriate components or devices complying with relevant safety standards corresponding to the required level of safety categories. Conformity to requirements of safety category is determined as an entire system. It is recommended to consult a certification body regarding assessment of conformity to the required safety level.
- Validate safety function of entire system by customer's responsibility.
- Select Safety Sensors that satisfy the following condition:

  1. Diameter of the smallest detectable object < Diameter of the object to be detected.

- Install the Safety Sensors so that they satisfy the following conditions:

  1. Use Safety Sensor A/C to detect the entry of the machine into area A/B, and Safety Sensor B/D to detect the entry of a person into area A/B.
  2. Make sure that the machine can reach area A/B only by passing through Safety Sensor A/C, and that a person can reach area A/B only by passing through Safety Sensor B/D.

- Provide a protective structure to prevent a person from passing completely through Safety Sensor B/D and stepping into area A/C. If this is not possible, install a sensor that will detect the presence of a person inside area A/B and prevent the machine from being restarted while the person is inside area A/B.
- Provide a sufficient safety distance (S1) considering the entry speed of a person and a sufficient safety distance (S2) considering the entry speed of the machine. For details, refer to Safety Distance on next page.

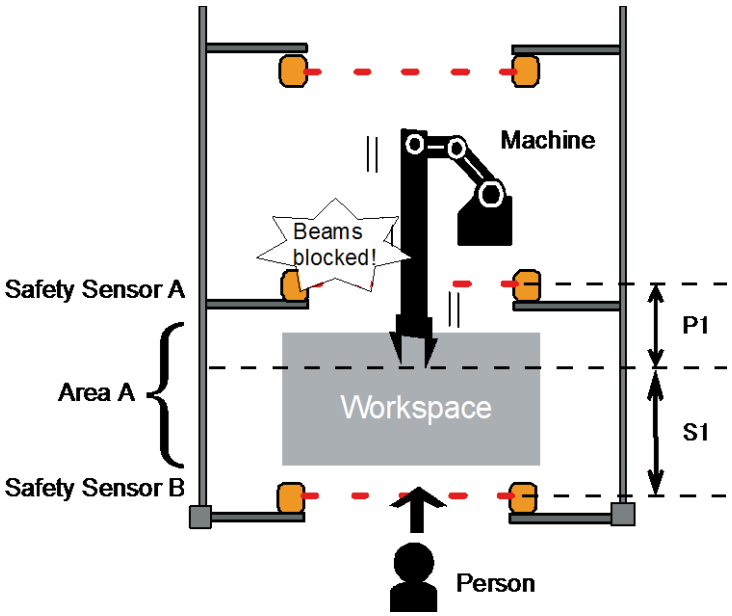
Safety Distance

The safety distance is the minimum distance that must be provided between the safety input device and a machine's hazardous part to stop the hazardous part before a person or object reaches it. The safety distance varies according to the standards of each country and the specifications of each machine.

In addition, the calculation of the safety distance differs if the direction of approach is not perpendicular to the detection zone of the safety input device. Always refer to the relevant standards.

■ Safety Distance Concepts

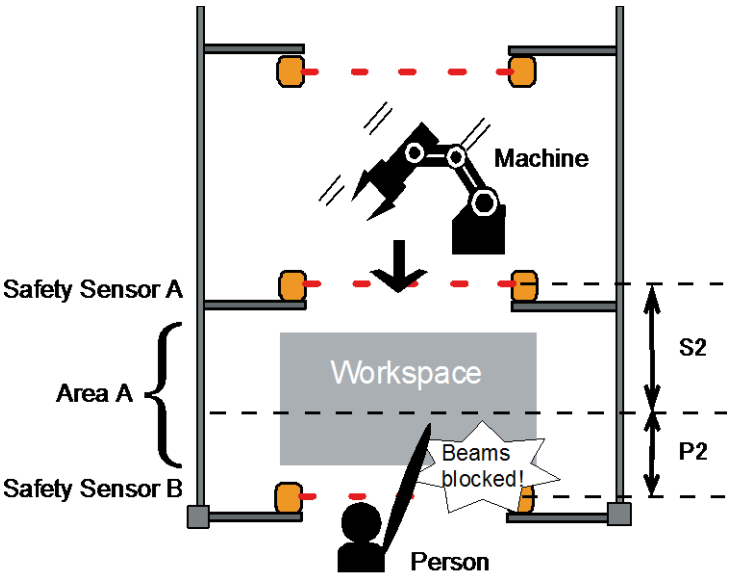
● When a person approaches a hazard (machine)



S1: Safety distance 1

P1: The closest that a machine can come to a person while operating (the boundary of the machine's operating area)

● When a hazard (machine) approaches a person



S2: Safety distance 2

P2: The closest that a part of a person can come to a machine

■ Safety Distance Calculation Examples (Reference)

● Calculating the safety distance specified by international standard ISO 13855-2002 (European standard EN 999-1999)

If a person approaches the detection zone perpendicularly, calculate the safety distance as shown below.

$S1 = K1 \times T + C$

$S2 = K2 \times T + C$

S1: Safety distance 1
S2: Safety distance 2
K1: Approach speed of a person to the detection zone (area A)
K2: Maximum approach speed of a machine to the detection zone (area A)
T: Total response time of the machine and the SafetyOne system
C: Additional distance calculated by the detection capability (the diameter of the smallest detectable object) of the Safety Sensor.

● Calculating the safety distance specified by American standard ANSI B11.19

If a person approaches the detection zone perpendicularly, calculate the safety distance as shown below.

$S1 = K1 \times (Ts + Tc + Tr + Tbm) + Dpf$

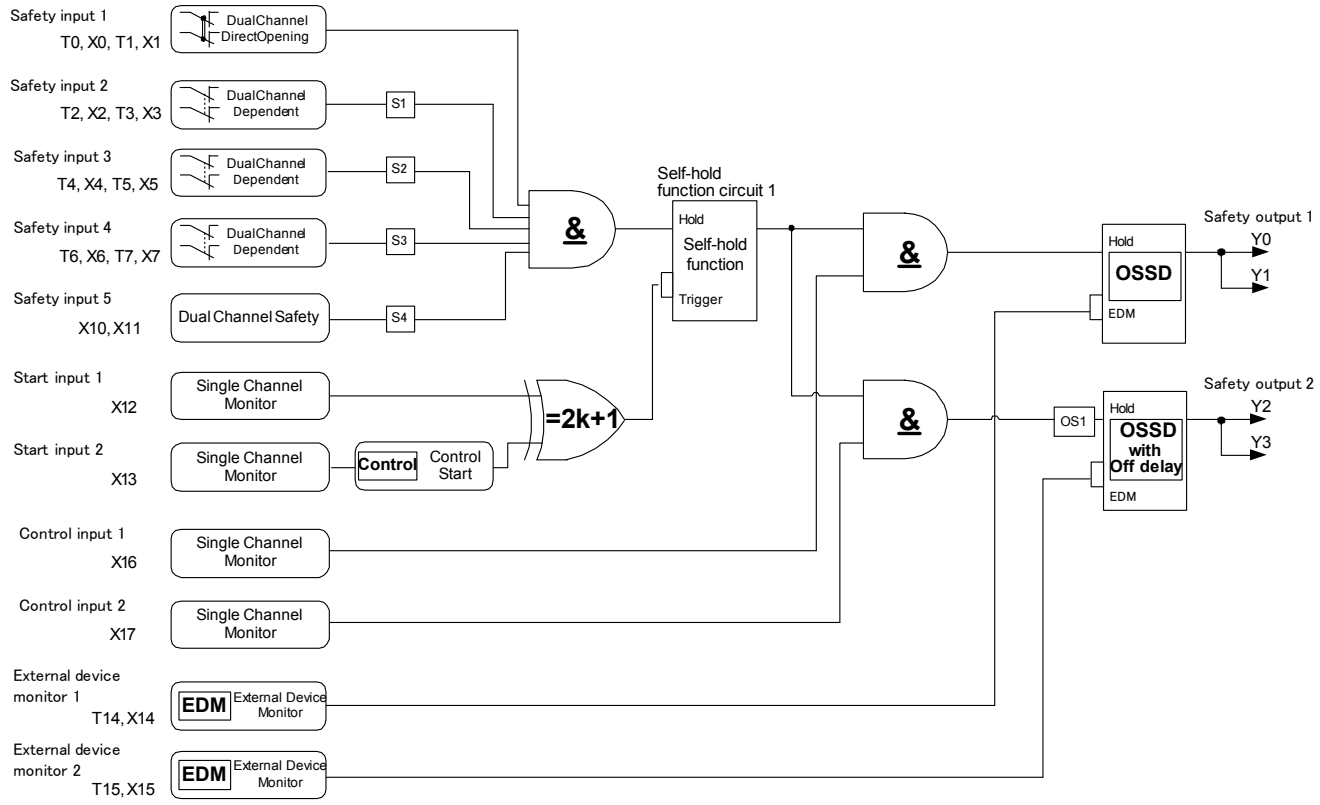
$S2 = K2 \times (Ts + Tc + Tr + Tbm) + Dpf$

S1: Safety distance 1
S2: Safety distance 2
K1: Approach speed of a person to the detection zone (area A)
K2: Maximum approach speed of a machine to the detection zone (area A)
Ts: Machine's stop time (s)
Tr: Response time of the SafetyOne system from ON to OFF (s)
Tc: Machine control circuit's maximum response time required to activate its brake (s)
Tbm: Additional time (s)
Dpf: Additional distance

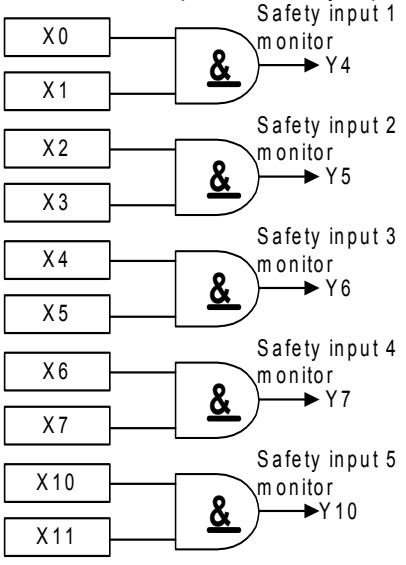
● To determine the approach speed K1, consider all factors, including the operator's physical abilities.
● To determine the maximum approach speed K2, consult with a notified body or other authoritative institutes.
● The response time of a machine is the time from when the machine receives a stop signal to the time when the machine's hazardous part stops. Measure the response time on the actual system. Also, periodically check that the machine's response time has not changed.
● To determine the safety distance to hazards, take into account the delay of safety outputs caused by the following times:
1. Response time of safety inputs

Logic 22d: Partial control logic for apparatus with openings

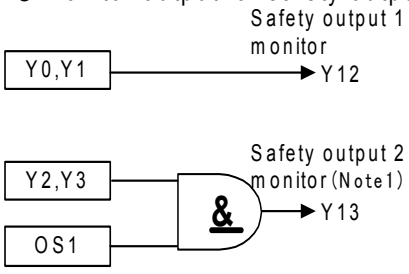
Logic circuit (logic 22d)



● Monitor output for safety input

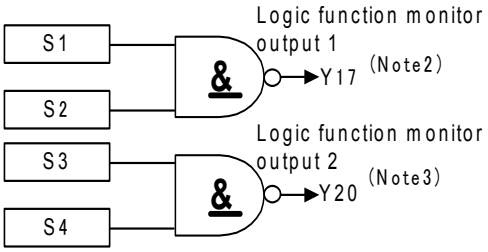


● Monitor output for safety output



Note1:
Safety output 2 monitor turns OFF immediately independent of OFF-delay time.

● Monitor output for logic



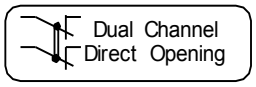
Note2:
When both safety input 2 and 3 are ON, Logic function monitor output 1 turns OFF.
When either safety input 2 or 3 is OFF, Logic function monitor output 1 turns ON.

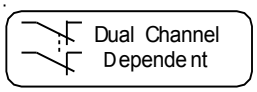
Note3:
When both safety input 4 and 5 are ON, Logic function monitor output 2 turns OFF.
When either safety input 4 or 5 is OFF, Logic function monitor output 2 turns ON.

Functions (Logic 22d)

●Safety inputs: X0 to X11 (T0 to T7)

Safety inputs are used to diagnose the status of connected safety devices, such as emergency stop switches, and interlock switches.

Intended inputs (Terminal names)	Function	
Safety input 1 (X0-T0, X1-T1)	Function name	Dual channel direct opening input
	Symbol	
	Description of operation	This function diagnoses the status of connected safety devices. This function diagnoses the time interval of status transition between each input of duplicated inputs (0.5s).
	Detail information	Logic functions (5-130)

Intended inputs (Terminal names)	Function	
Safety input 2 (X2-T2, X3-T3) Safety input 3 (X4-T4, X5-T5) Safety input 4 (X6-T6, X7-T7)	Function name	Dual channel dependent input
	Symbol	
	Description of operation	This function diagnoses the status of connected safety devices. This function does not diagnose the time interval of status transition between each input of duplicated inputs.
	Detail information	Logic functions (5-132)

Intended inputs (Terminal names)	Function	
Safety input 5 (X10, X11)	Function name	Dual channel safety input
	Symbol	
	Description of operation	This function diagnoses the status of connected safety devices. This function diagnoses the time interval of status transition between each input of duplicated inputs (0.1s). The function does not use drive terminals (T10, T11).
	Detail information	Logic functions (5-136)

Warning

For connected control devices, refer to “SAFETY PRECAUTIONS”.
Safety check signals (pulses signals) are sent from the drive terminals (T0 to T7) to diagnose connected safety devices and input circuits. Safety check signals can not be used as a power supply for connected devices.

Note. Solid state outputs, such as safety light curtains, can not be connected to safety input 1 through safety input 4.
Note. Use safety input 1 through safety input 4 as specified combinations, such as receive terminal (Xn) and drive terminal (Tn). If the combinations are incorrect, SafetyOne does not work correctly.
Note. If there are unused safety inputs in safety input 1 through safety input 4, connect the unused receive terminals (Xn) to the corresponding drive terminals (Tn). If they are not connected, the SafetyOne does not turn ON the safety outputs.
Note. If safety input 5 is not used, connect the receive terminal (X10 and X11) to a 24V DC power supply (V+). If they are not connected, the SafetyOne does not turn ON the safety outputs.

●External device monitor inputs: X14 and X15 (T14 and T15)
External device monitor inputs are used to diagnose the status of devices connected to safety outputs.

<table>
<tr><th>Intended inputs
(Terminal names)</th><th>Target safety outputs
(Terminal names)</th><th colspan="2">Function</th></tr>
<tr><td rowspan="3">External device monitor input 1
(X14-T14)

External device monitor input 2
(X15-T15)</td><td rowspan="3">Safety output 1
(Y0, Y1)

Safety output 2
(Y2, Y3)</td><td>Function name</td><td>External device monitor input</td></tr>
<tr><td>Symbol</td><td> 
</td></tr>
<tr><td>Description of operation</td><td>This function diagnoses the status of devices connected to a target safety output.</td></tr>
<tr><td colspan="2"></td><td>Detail information</td><td>Logic functions (5-147)</td></tr>
</table>

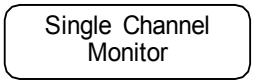
Warning

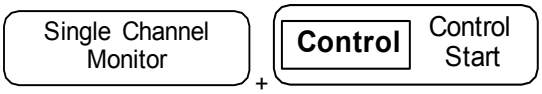
Safety check signals (pulses signals) are sent from the drive terminals (T14, T15) to diagnose external devices and monitor circuits. Safety check signals can not be used as a power supply for connected devices.

Note. If there are unused safety outputs, connect the intended external device monitor terminals (Xn) to the corresponding drive terminals (Tn). If they are not connected, the SafetyOne detects an input monitor error. As the result, the error LED displays “1” and the unit changes to the Protection state.

●Start inputs: X12 and X13

Start inputs are used to control the start of safety outputs.

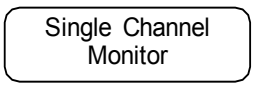
Intended inputs (Terminal names)	Target safety inputs (Terminal names)	Function	
Start input 1 (X12)	Safety input 1 (X0-T0, X1-T1) Safety input 2 (X2-T2, X3-T3) Safety input 3 (X4-T4, X5-T5) Safety input 4 (X6-T6, X7-T7) Safety input 5 (X10, X11)	Function name	Monitor input
		Symbol	
		Description of operation	Safety outputs are started, when all target safety inputs are in the safe state and this function is in the ON state. This function is turned ON by 0.1s or more ON operation.
		Detail information	Logic functions (5-146)

Intended inputs (Terminal names)	Target safety inputs (Terminal names)	Function	
Start input 2 (X13)	Safety input 1 (X0-T0, X1-T1) Safety input 2 (X2-T2, X3-T3) Safety input 3 (X4-T4, X5-T5) Safety input 4 (X6-T6, X7-T7) Safety input 5 (X10, X11)	Function name	Monitor input + Control start
		Symbol	
		Description of operation	Safety outputs are started, when this function becomes ON after all intended safety inputs are in the safe state. This function is turned ON by 0.1s to 5s ON operation.
		Detail information	Logic functions (5-146, 5-152)

Note. If both of X12 and X13 are turned ON, the SafetyOne will detect an error. As a result, the error LED displays “3” and the state changes to the Stop state. Use only X12 or X13.

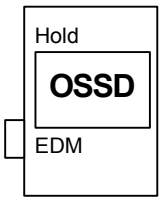
●Control inputs: X16 and X17

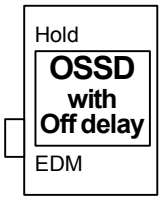
Control inputs are used to control of safety outputs.

Intended inputs (Terminal names)	Target safety outputs (Terminal names)	Function	
Control input 1 (X16)	Safety output 1 (Y0, Y1)	Function name	Monitor input
		Symbol	
Control input 2 (X17)	Safety output 2 (Y2, Y3)	Description of operation	Target safety outputs are controled by these control inputs.
		Detail information	Logic functions (5-146)

●Safety outputs: Y0 to Y3

Safety outputs are used to output safety information processed by SafetyOne.

Intended outputs (Terminal names)	Function	
Safety output 1 (Y0, Y1)	Function name	Safety output without timer
	Symbol	
	Description of operation	This function is a safety output to output safety information processed by SafetyOne. The output is turned OFF immediately by OFF operation (instantaneous OFF output).
	Detail information	Logic functions (5-154)

Intended outputs (Terminal names)	Function	
Safety output 2 (Y2, Y3)	Function name	Safety output with timer
	Symbol	
	Description of operation	This function is a safety output to output safety information processed by SafetyOne. The output is turned OFF after the preset time of the OFF-delay timer (OFF-delay output).
	Detail information	Logic functions (5-157)

Note. When the SafetyOne changes to Protection state due to input monitor error, safety output without timer (safety output 1) is turned OFF. Safety output with timer (safety output 2) is turned OFF after the preset OFF-delay time.

Note. When the SafetyOne changes to Stop state due to circuit failure or other errors, all safety outputs (safety output 1 and safety output 2) are turned OFF, immediately.

●Safety input monitor outputs: Y4 to Y10

Safety input monitor outputs are used to output status of safety inputs in SafetyOne.

Intended outputs (Terminal names)	Target safety inputs (Terminal names)	Description of operation
Safety input 1 monitor output (Y4)	Safety input 1 (X0-T0, X1-T1)	When the target safety input is ON, the monitor output is ON. When the target safety input is OFF, the monitor output is OFF.
Safety input 2 monitor output (Y5)	Safety input 2 (X2-T2, X3-T3)	
Safety input 3 monitor output (Y6)	Safety input 3 (X4-T4, X5-T5)	
Safety input 4 monitor output (Y7)	Safety input 4 (X6-T6, X7-T7)	
Safety input 5 monitor output (Y10)	Safety input 5 (X10, X11)	

Note. In the case of SW version 1.00, when the targeted safety input detects an input monitor error, input circuit failure, or EMC the disturbance, corresponding safety input monitor output becomes a pulse output (1Hz). The monitor output is OFF in other errors, Initial state, or Configuration state. In the case of SW version 2.00 or higher, the monitor output is OFF in errors, Initial state, or Configuration state.

●Safety output monitor outputs: Y12 and Y13

Safety output monitor outputs are used to output the status of safety outputs in SafetyOne.

Intended outputs (Terminal names)	Target safety outputs (Terminal names)	Description of operation
Safety output 1 monitor output (Y12)	Safety output 1 (Y0, Y1)	When the target safety output is ON, the monitor output is ON. When the target safety output is OFF, this function is OFF. The monitor output turns OFF immediately independent on set OFF-delay time.
Safety output 2 monitor output (Y13)	Safety output 2 (Y2, Y3)	

Note. In the case of SW version 1.00, when the safety output detects an output circuit failure, the corresponding safety output monitor output becomes a pulse output (1Hz). The monitor output is OFF in other errors, Initial state, or Configuration state. In the case of SW version 2.00 or higher, the monitor output is OFF in errors, Initial state, or Configuration state.

The monitor outputs are not safety outputs. Do not use these to construct a safety system.

●State monitor outputs: Y14 to Y16

State monitor outputs are used to output the internal state of SafetyOne.

Intended outputs (Terminal names)	State				
	Initial	Run	Configuration	Protection	Stop
State monitor output 1 (Y14)	■ON	□OFF	□OFF	□OFF	■ON
State monitor output 2 (Y15)	■ON	□OFF	■ON	■ON	■ON or□OFF
State monitor output 3 (Y16)	□OFF	■ON	□OFF	□OFF	□OFF

Refer to “Chapter 4 BASIC OPERATIONS” and to “Chapter 6 TROUBLE SHOOTING” for details of each state.

●Logic function monitor outputs: Y17 and Y20

Logic function monitor outputs are used to monitor the state of internal logic function.

Intended outputs (Terminal names)	Description of operation
Logic function monitor output 1 (Y17)	When both safety input 2 and 3 are ON, the monitor output is OFF. When either safety input 2 or 3 is OFF, the monitor output is ON.
Logic function monitor output 2 (Y20)	When both safety input 4 and 5 are ON, the monitor output is OFF. When either safety input 4 or 5 is OFF, the monitor output is ON.

Note. The Logic function monitor output is OFF in errors, Initial state, or Configuration state.

Warning

The monitor outputs are not safety outputs. Do not use these to construct a safety system.

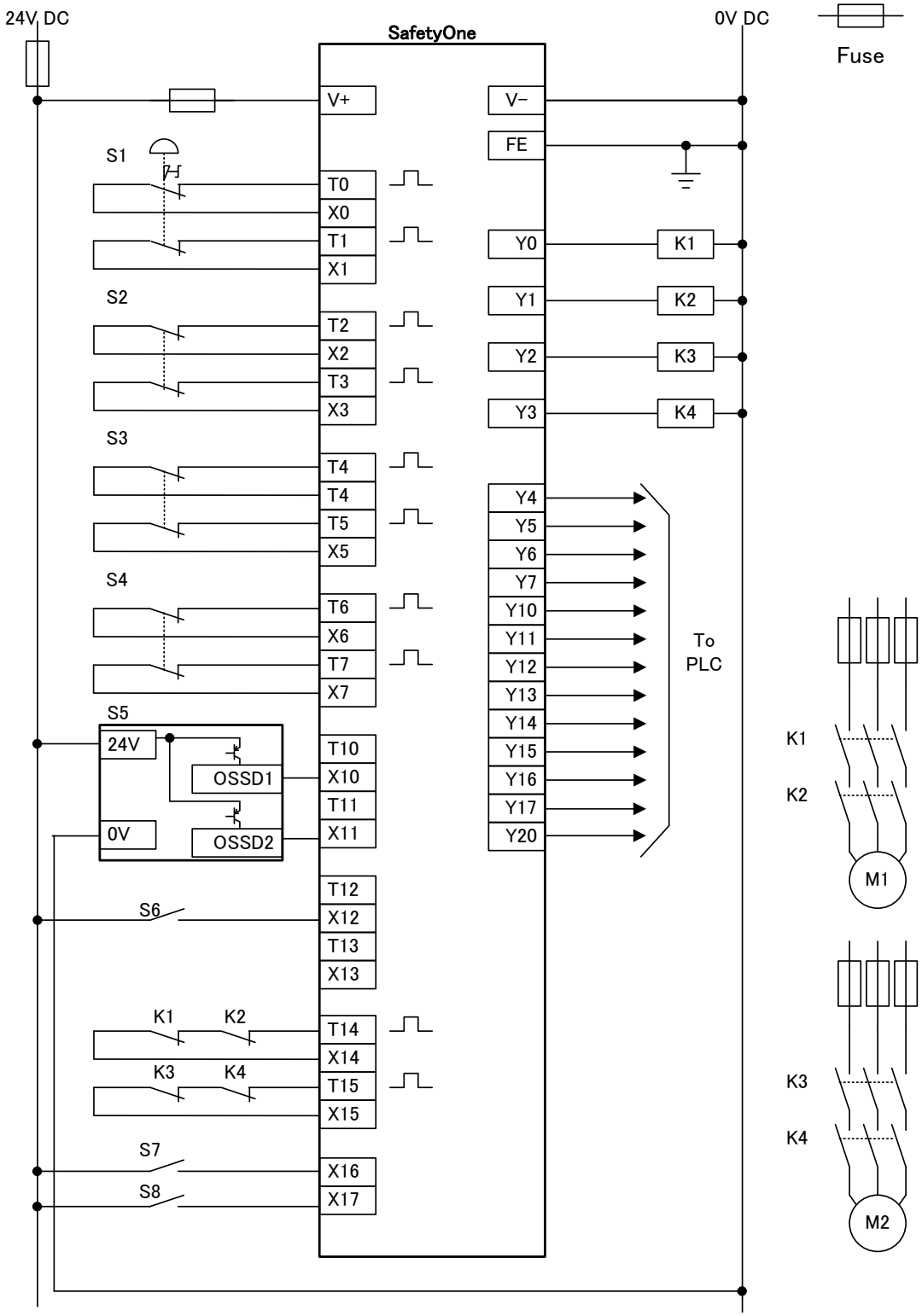
Caution

Refer to "Chapter 2 PRODUCT SPECIFICATIONS" for specifications of each input and output.

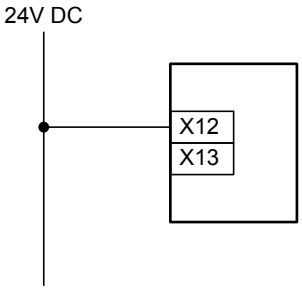
Wiring example (Logic 22d)

In the case where 1 emergency stop switch, 3 interlock switches, and 1 safety light curtain are connected.

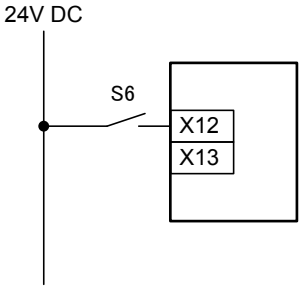
S1 : Emergency stop switch
S2, 3, 4 : Interlock switch
S5 : Safety light curtain
S6 : Start switch
S7, 8 : Control input switch
K1 to 4 : Contactor
M1, 2 : Motor



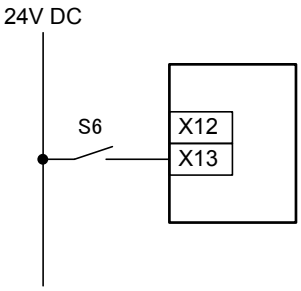
When not using the start switch (Auto start)



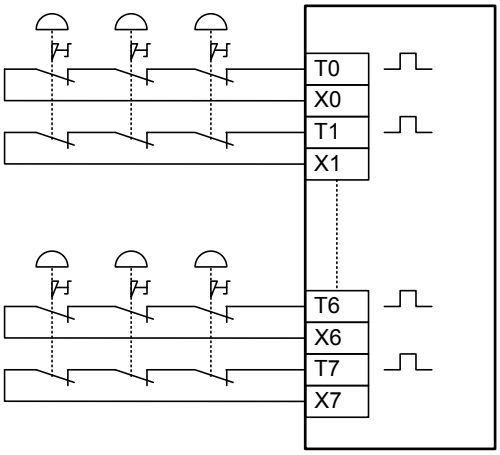
When not detecting the welding of start switch (Manual start)



When detecting the welding of start switch (Control start)



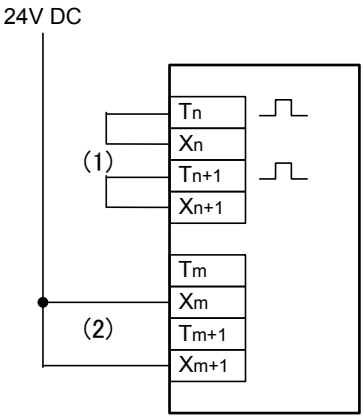
When connecting multiple emergency stop switches in series



NOTE: Safety performance depends on the system configuration.

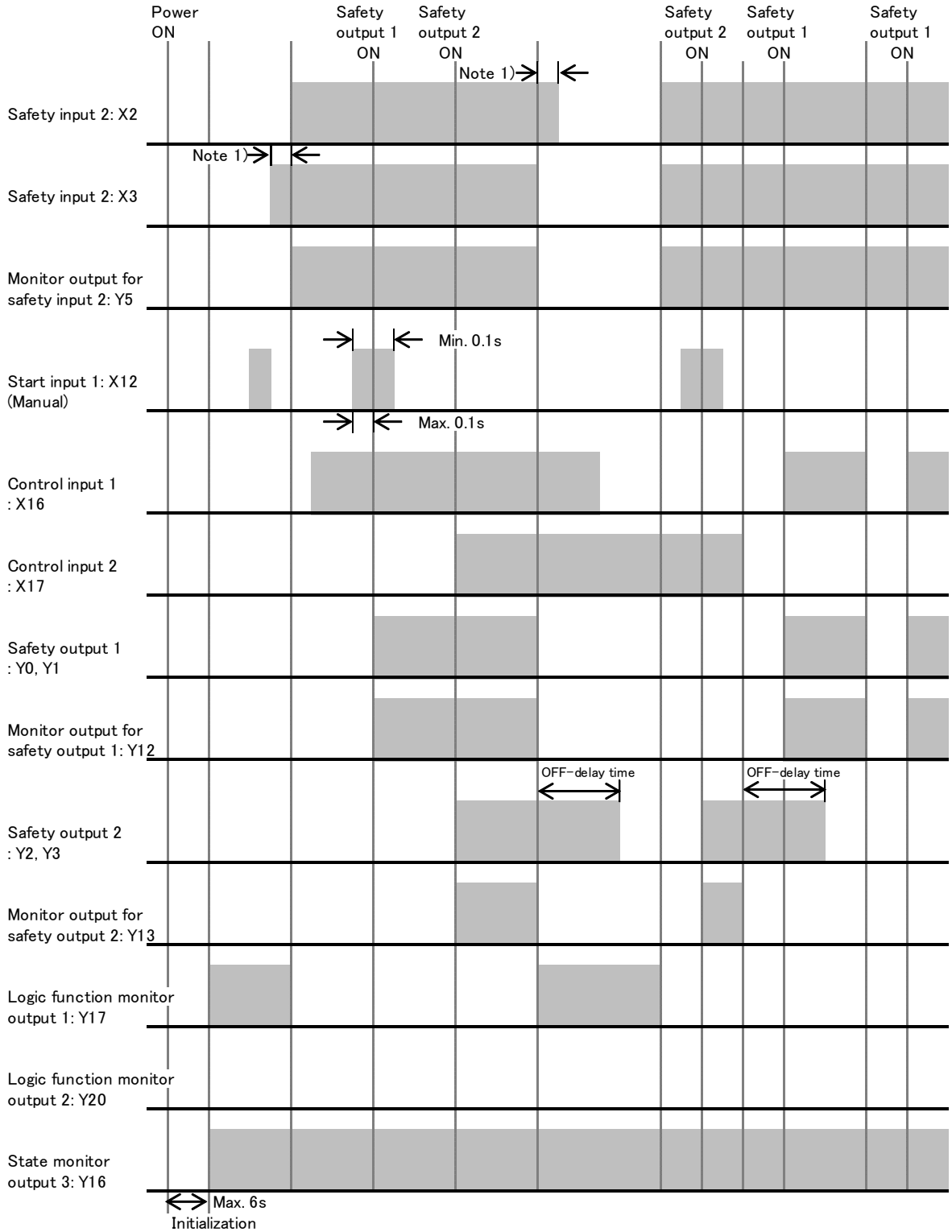
When not using some inputs

- If there are unused safety inputs in S1 to S4, connect the unused receive terminals to the corresponding drive terminals. (Refer to (1))
- If S5 is not used, connect the receive terminal to 24V DC power supply (V+). (Refer to (2))



Timing chart (Logic 22d)

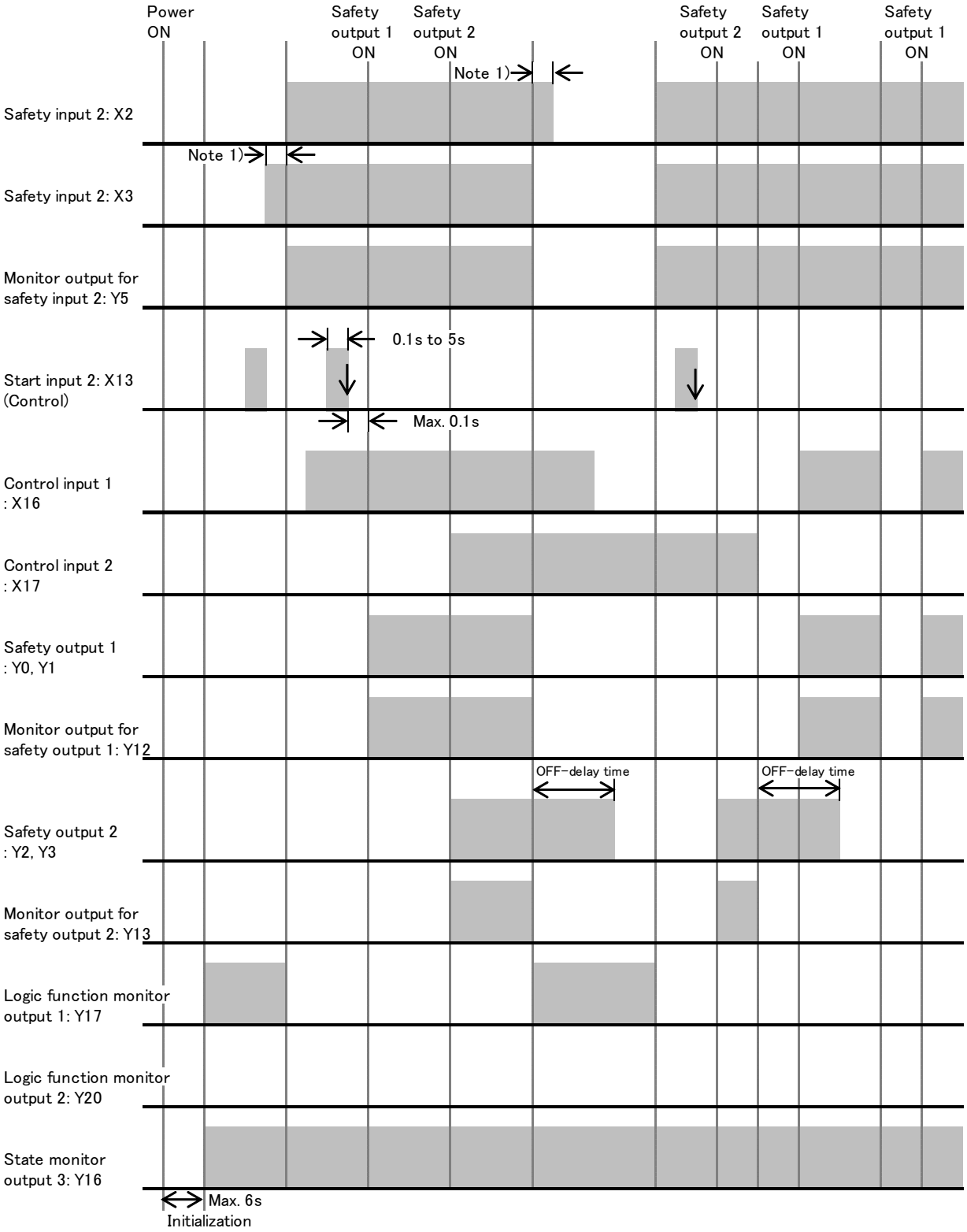
Example: Manual start input 1 (X12) is used.



Safety input 1, 3, 4, and 5 are all ON in this chart.

Note 1) Input monitor error detection time is infinity.
About safety inputs that are not described in this chart, input monitor error detection time is as follows.
The time of dual channel direct opening input (X0 and X1) is 0.5s.
The time of dual channel dependent input (X4 to X7) is infinity.
The time of dual channel safety input (X10 and X11) is 0.1s.
Refer to the following “Logic functions” (5-128) for more details.

Example: Control start input 2 (X13) is used.

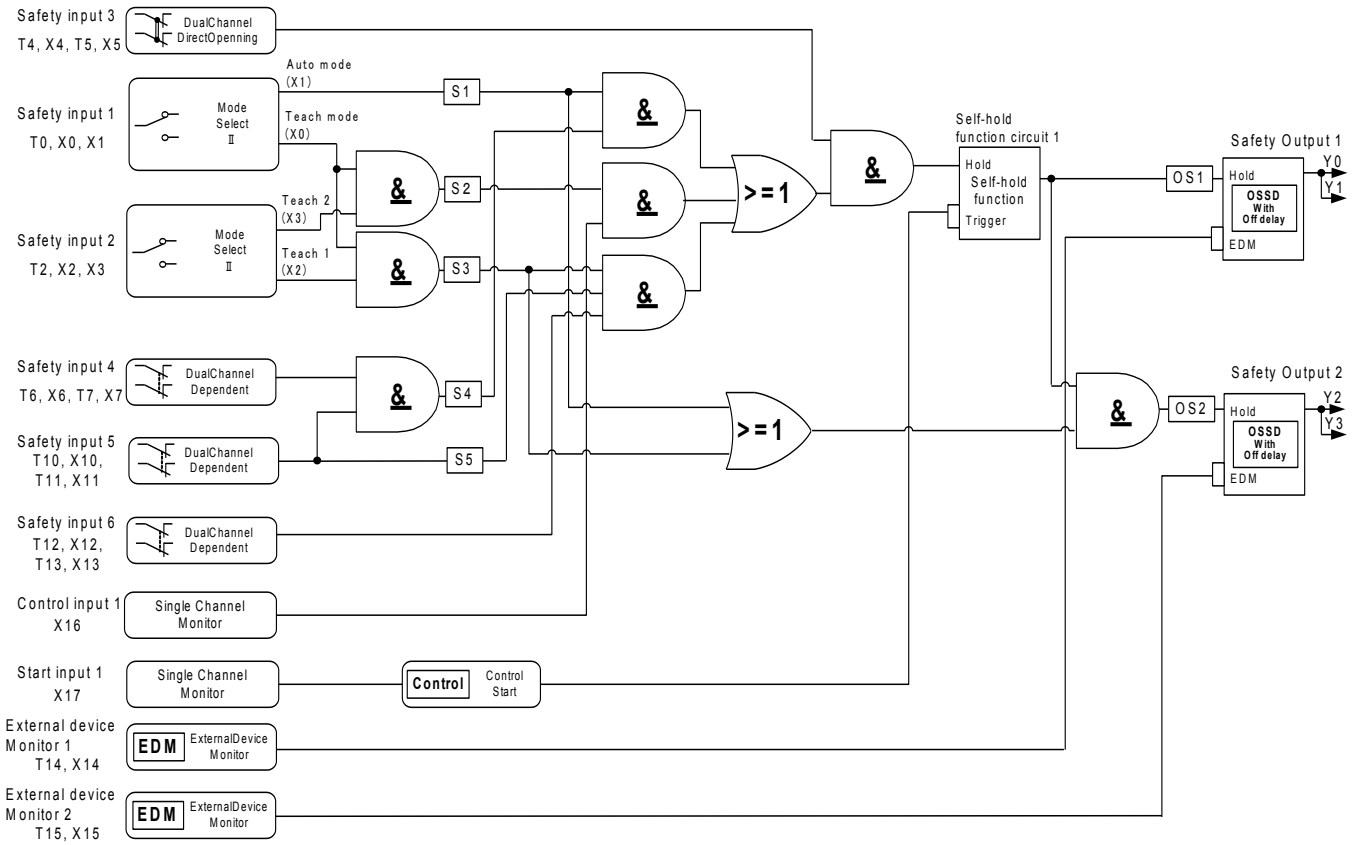


Safety input 1, 3, 4, and 5 are all ON in this chart.

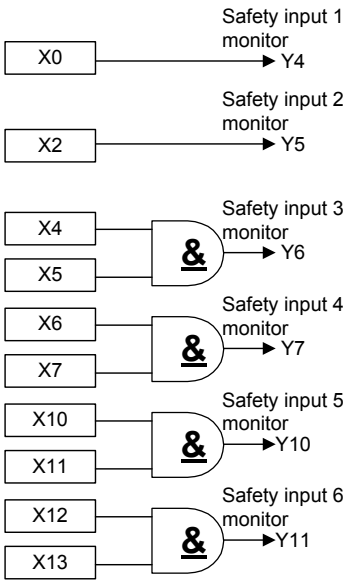
Note 1) Input monitor error detection time is infinity.

Logic 23C: The logic applicable for selection of active safety input devices

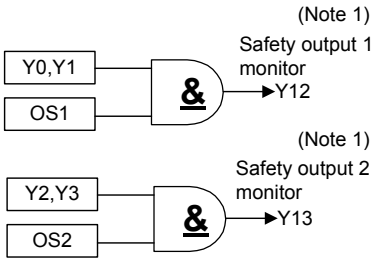
Logic circuit (Logic 23C) (in the case of SW version 2.00 or higher)



●Monitor output for safety input

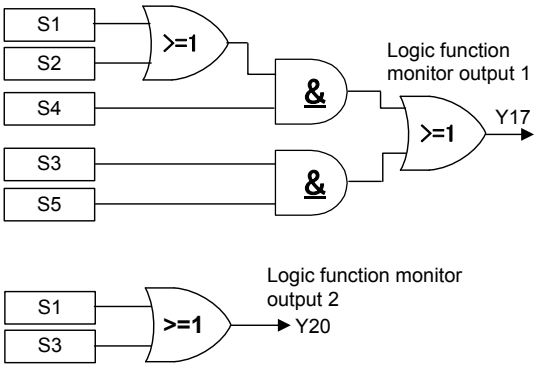


●Monitor output for safety output



Note1:
Safety output 1 monitor and 2 monitor turn OFF immediately independent of OFF-delay time.

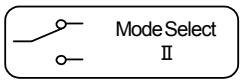
●Monitor output for logic

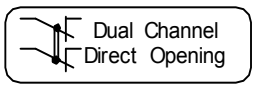


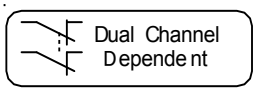
Functions (Logic 23C)

●Safety inputs: X0 to X13 (T0, T2, T4 to T7, T10 to T13)

Safety inputs are used to diagnose the status of connected safety devices, such as emergency stop switches, interlock switches, and mode select switches.

Intended inputs (Terminal names)	Function	
Safety input 1 (X0/X1-T0) Safety input 2 (X2/X3-T2)	Function name	Mode select input II
	Symbol	
	Description of operation	This function is for connecting devices with a mode selector function, such as mode selector switch. When the switching of inputs is performed within 3s, this function output is kept at previous state. This function diagnoses time interval of status transition between each input (0.5s).
	Detail information	Logic functions (5-142)

Intended inputs (Terminal names)	Function	
Safety input 3 (X4-T4, X5-T5)	Function name	Dual channel direct opening input
	Symbol	
	Description of operation	This function diagnoses the status of connected safety devices. This function diagnoses the time interval of status transition between each input of duplicated inputs (0.5s).
	Detail information	Logic functions (5-130)

Intended inputs (Terminal names)	Function	
Safety input 4 (X6-T6, X7-T7) Safety input 5 (X10-T10, X11-T11) Safety input 6 (X12-T12, X13-T13)	Function name	Dual channel dependent input
	Symbol	
	Description of operation	This function diagnoses the status of connected safety devices. This function does not diagnose the time interval of status transition between each input of duplicated inputs.
	Detail information	Logic functions (5-132)

Warning

For connected control devices, refer to “SAFETY PRECAUTIONS”.
Safety check signals (pulses signals) are sent from the drive terminals (T0, T2, T4 to T7, T10 to T13) to diagnose connected safety devices and input circuits. Safety check signals can not be used as a power supply for connected devices.

Note. Solid state outputs, such as safety light curtains, can not be connected to safety input 1 through Safety input 6.
Note. Use safety input 1 through safety input 6, as specified combinations, such as receive terminal (Xn) and drive terminal (Tn). If the combinations are incorrect, SafetyOne does not work correctly.
Note. When SafetyOne is in Run state or Protection state, input states are monitored in all safety inputs. For example, if input monitor error is detected in safety input 6 although AUTO mode is selected, SafetyOne detects error and transits to Protection state.
Note. If there are unused safety inputs in safety input 3, safety input 4, safety input 5, or safety input 6, connect the unused receive terminals (Xn) to the corresponding drive terminals (Tn). If they are not connected, the SafetyOne does not turn ON the safety outputs.

●External device monitor inputs: X14 and X15 (T14 and T15)
External device monitor inputs are used to diagnose status of the devices connected to safety outputs.

Intended inputs (Terminal names)	Target safety outputs (Terminal names)	Function	
External device monitor input 1 (X14-T14)	Safety output 1 (Y0, Y1)	Function name	External device monitor input
External device monitor input 2 (X15-T15)	Safety output 2 (Y2, Y3)	Symbol	
		Description of operation	This function diagnoses the status of devices connected to a target safety output.
		Detail information	Logic functions (5-147)

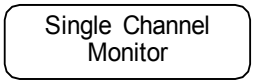
Warning

Safety check signals (pulses signals) are sent from the drive terminals (T14, T15) to diagnose external devices and monitor circuits. Safety check signals can not be used as a power supply for connected devices.

Note. If there are unused safety outputs, connect the intended external device monitor terminals (Xn) to the corresponding drive terminals (Tn). If they are not connected, the SafetyOne detects an input monitor error. As the result, the error LED displays “1” and the unit changes to the Protection state.

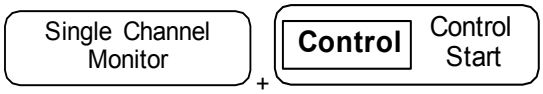
●Control input: X16

Control input is used to control of safety outputs.

Intended inputs (Terminal names)	Target safety outputs (Terminal names)	Function	
Control input 1 (X16)	Safety output 1 (Y0, Y1) Safety output 2 (Y2, Y3)	Function name	Monitor input
		Symbol	
		Description of operation	Target safety outputs are controled by the control input.
		Detail information	Logic functions (5-146)

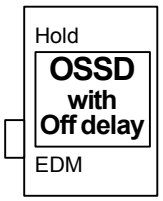
●Start input: X17

Start input is used to control the start of safety outputs.

Intended inputs (Terminal names)	Target safety inputs (Terminal names)	Function	
Start input 1 (X17)	Safety input 1 (X0/X1-T0) Safety input 2 (X2/X3-T2) Safety input 3 (X4-T4, X5-T5) Safety input 4 (X6-T6, X7-T7) Safety input 5 (X10-T10, X11-T11) Safety input 6 (X12-T12, X13-T13)	Function name	Monitor input + Control start
		Symbol	
		Description of operation	Safety outputs are started, when this function becomes ON after all intended safety inputs are in the safe state. This function is turned ON by 0.1s to 5s ON operation.
		Detail information	Logic functions (5-146, 5-152)

●Safety outputs: Y0 to Y3

Safety outputs are used to output safety information processed by SafetyOne.

Intended outputs (Terminal names)	Function	
Safety output 1 (Y0, Y1) Safety output 2 (Y2, Y3)	Function name	Safety output with timer
	Symbol	
	Description of operation	This function is a safety output to output safety information processed by SafetyOne. The output is turned OFF after the preset time of the OFF-delay timer (OFF-delay output).
	Detail information	Logic functions (5-157)

Note. When the SafetyOne changes to Protection state due to input monitor error, safety output with timer (safety output 1 and safety output 2) are turned OFF after the preset OFF-delay time.

Note. When the SafetyOne changes to Stop state due to circuit failure or other errors, all safety outputs (safety output 1 and safety output 2) are turned OFF, immediately.

Note. Set time of safety output with timer is active independent of the selected mode.

Safety input monitor outputs: Y4 to Y11

Safety input monitor outputs are used to output the status of safety inputs in SafetyOne.

Intended outputs (Terminal names)	Target safety inputs (Terminal names)	Description of operation
Safety input 1 monitor output (Y4)	Safety input 1 (X0-T0: TEACH mode)	When TEACH mode (X0) is selected, the monitor output is ON. When TEACH mode is not selected, the monitor output is OFF.
Safety input 2 monitor output (Y5)	Safety input 2 (X2-T2: TEACH 1 mode)	When TEACH 1 mode (X2) is selected, the monitor output is ON. When TEACH 1 mode is not selected, the monitor output is OFF.
Safety input 3 monitor output (Y6)	Safety input 3 (X4-T4, X5-T5)	When the target safety input is ON, the monitor output is ON. When the target safety input is OFF, the monitor output is OFF.
Safety input 4 monitor output (Y7)	Safety input 4 (X6-T6, X7-T7)	
Safety input 5 monitor output (Y10)	Safety input 5 (X10-T10, X11-T11)	
Safety input 6 monitor output (Y11)	Safety input 6 (X12-T12, X13-T13)	

Note. The monitor output is OFF in errors, Initial state, or Configuration state.

●Safety output monitor outputs: Y12 and Y13

Safety output monitor outputs are used to output the status of safety outputs in SafetyOne.

Intended outputs (Terminal names)	Target safety outputs (Terminal names)	Description of operation
Safety output 1 monitor output (Y12)	Safety output 1 (Y0, Y1)	When the target safety output is ON, the monitor output is ON. When the target safety output is OFF, this function is OFF. The monitor output turns OFF immediately, independent of the preset OFF-delay time.
Safety output 2 monitor output (Y13)	Safety output 2 (Y2, Y3)	

Note. The monitor output is OFF in errors, Initial state, or Configuration state.

●State monitor outputs: Y14 to Y16

State monitor outputs are used to output the internal state of SafetyOne.

Intended outputs (Terminal names)	State				
	Initial	Run	Configuration	Protection	Stop
State monitor output 1 (Y14)	■ON	□OFF	□OFF	□OFF	■ON
State monitor output 2 (Y15)	■ON	□OFF	■ON	■ON	■ON or□OFF
State monitor output 3 (Y16)	□OFF	■ON	□OFF	□OFF	□OFF

Refer to “Chapter 4 BASIC OPERATIONS” and to “Chapter 6 TROUBLE SHOOTING” for details of each state.

●Logic function monitor outputs: Y17 and Y20

Logic function monitor outputs are used to monitor the state of internal logic function.

Intended outputs (Terminal names)	Target safety inputs (Terminal names)	Description of operation
Logic function monitor output 1 (Y17)	Safety input 1 (X0/X1-T0) Safety input 2 (X2/X3-T2) Safety input 4 (X6-T6, X7-T7) Safety input 5 (X10-T10, X11-T11)	When one of modes is selected and Safety input 4 and/or 5 which correspond to each mode are ON, the monitor output is ON.
Logic function monitor output 2 (Y20)	Safety input 1 (X0/X1-T0) Safety input 2 (X2-T2: TEACH 1)	When AUTO mode is selected or TEACH mode and TEACH 1 are selected, the monitor output is ON.

Note. The Logic function monitor output is OFF in errors, Initial state, or Configuration state.

Warning

The Logic function monitor outputs are not safety output. Do not use these to construct a safety system.

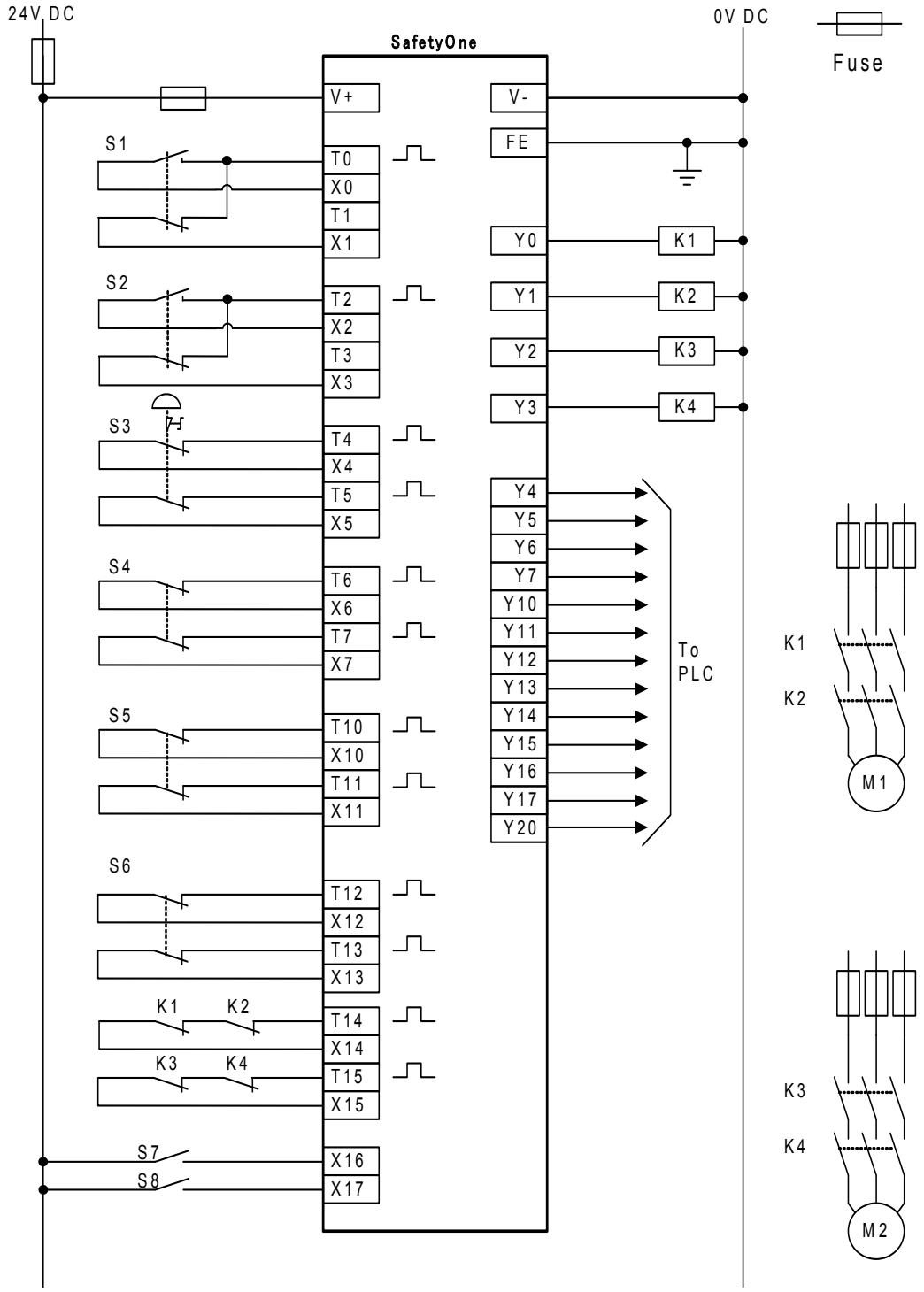
Caution

Refer to "Chapter 2 PRODUCT SPECIFICATIONS" for specifications of each input and output.

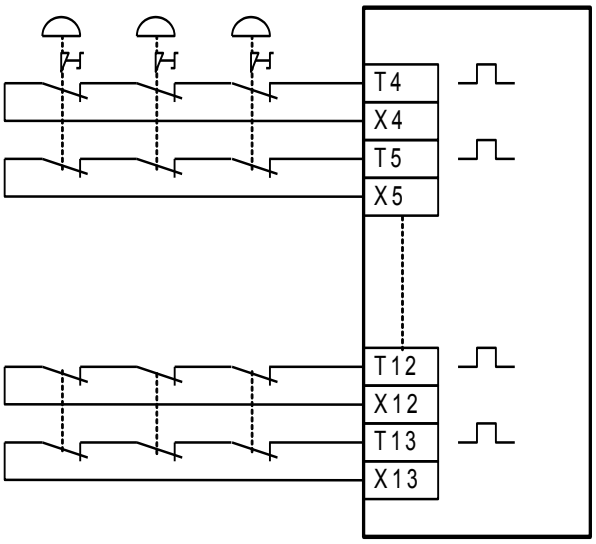
Wiring example (Logic 23C)

In the case where 2 selector switches, 1 emergency stop switch, 2 interlock switches, and 1 enabling switch are connected.

S1, 2 : Selector switch
S3 : Emergency stop switch
S4, 5 : Interlock switch
S6 : Enabling switch
S7 : Control input switch
S8 : Start switch
K1 to 4 : Contactor
M1, 2 : Motor



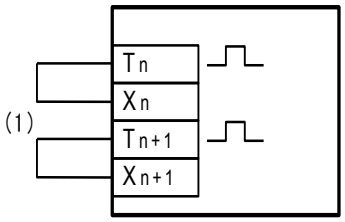
When connecting multiple emergency stop switches in series



NOTE: Safety performance depends on the system configuration.

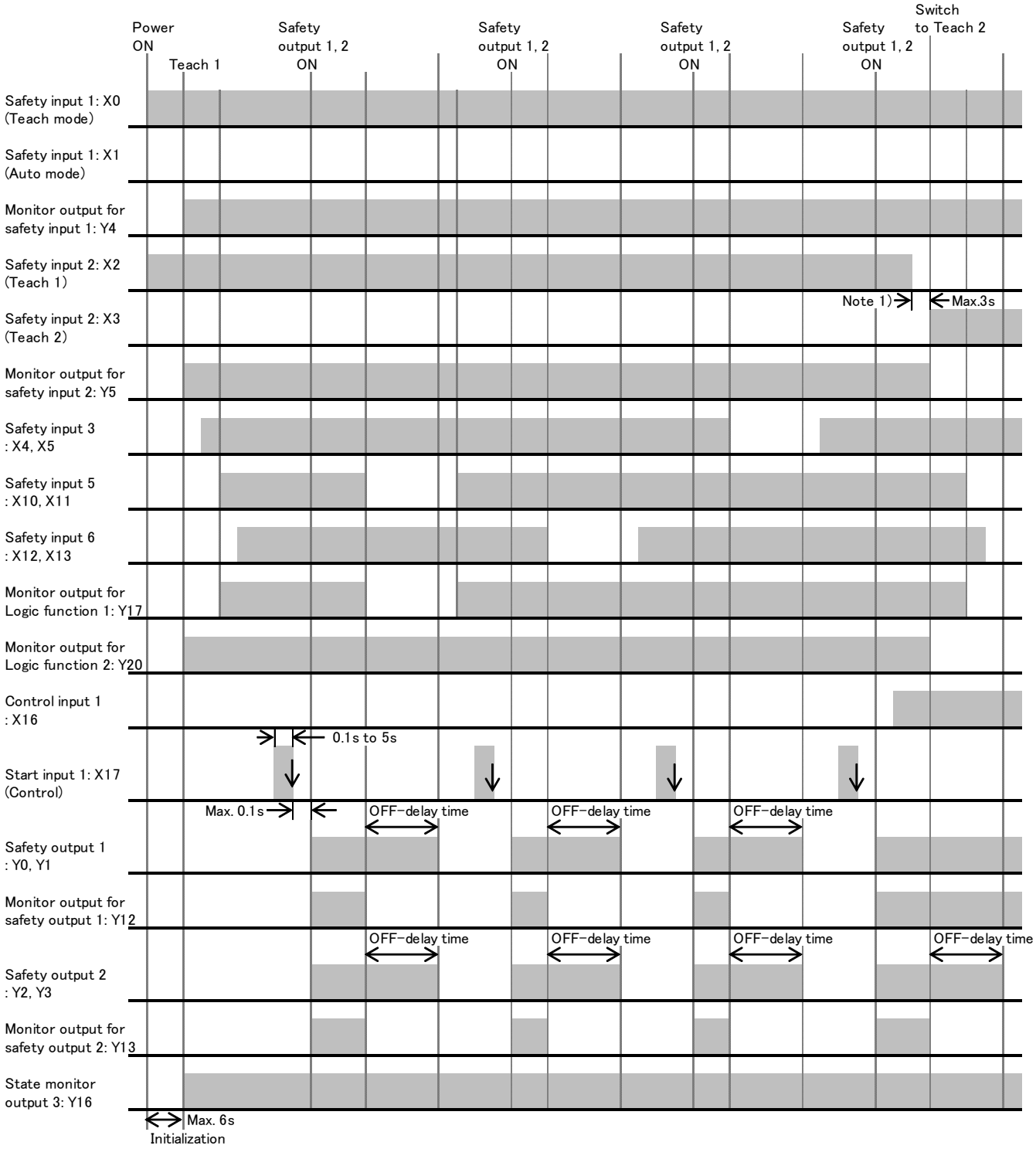
When not using some safety inputs

- If there are unused safety inputs in S3, S4, S5, or S6, connect the unused receive terminals to the corresponding drive terminals. (Refer to (1))



Timing chart (Logic 23C)

Example: TEACH 1 -> TEACH 2



Safety input 4 is ON in this chart.

Note 1) When “Safety input 2 (mode select input II)” is switched to another mode within 3s, “Safety output 1” is kept ON.

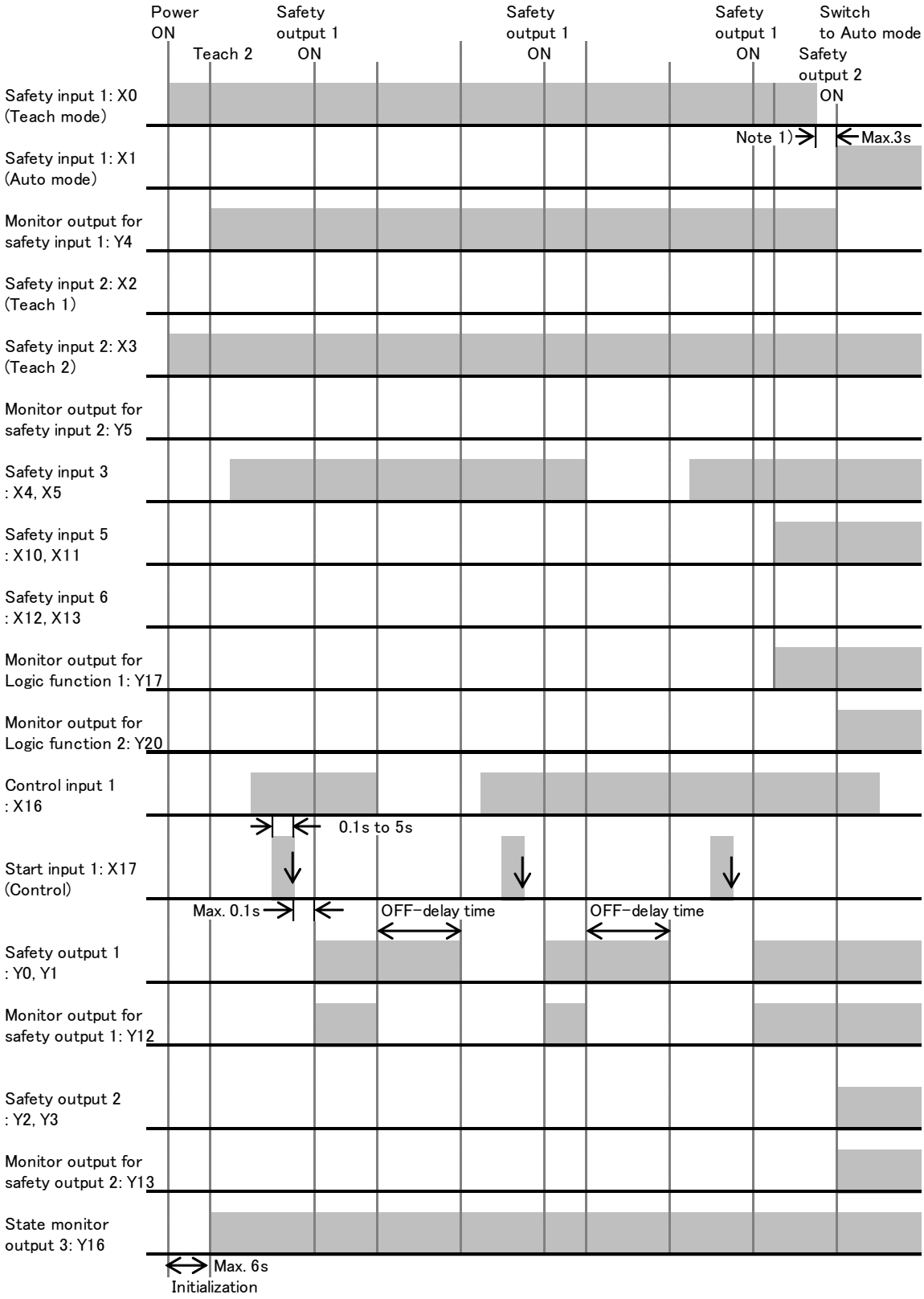
About safety inputs that are not described in this chart, input monitor error detection time is as follows.

The time of dual channel direct opening input (X4 and X5) is 0.5s.

The time of dual channel dependent input (X6 to X13) is infinity.

Refer to the following “Logic functions” (5-128) for more details.

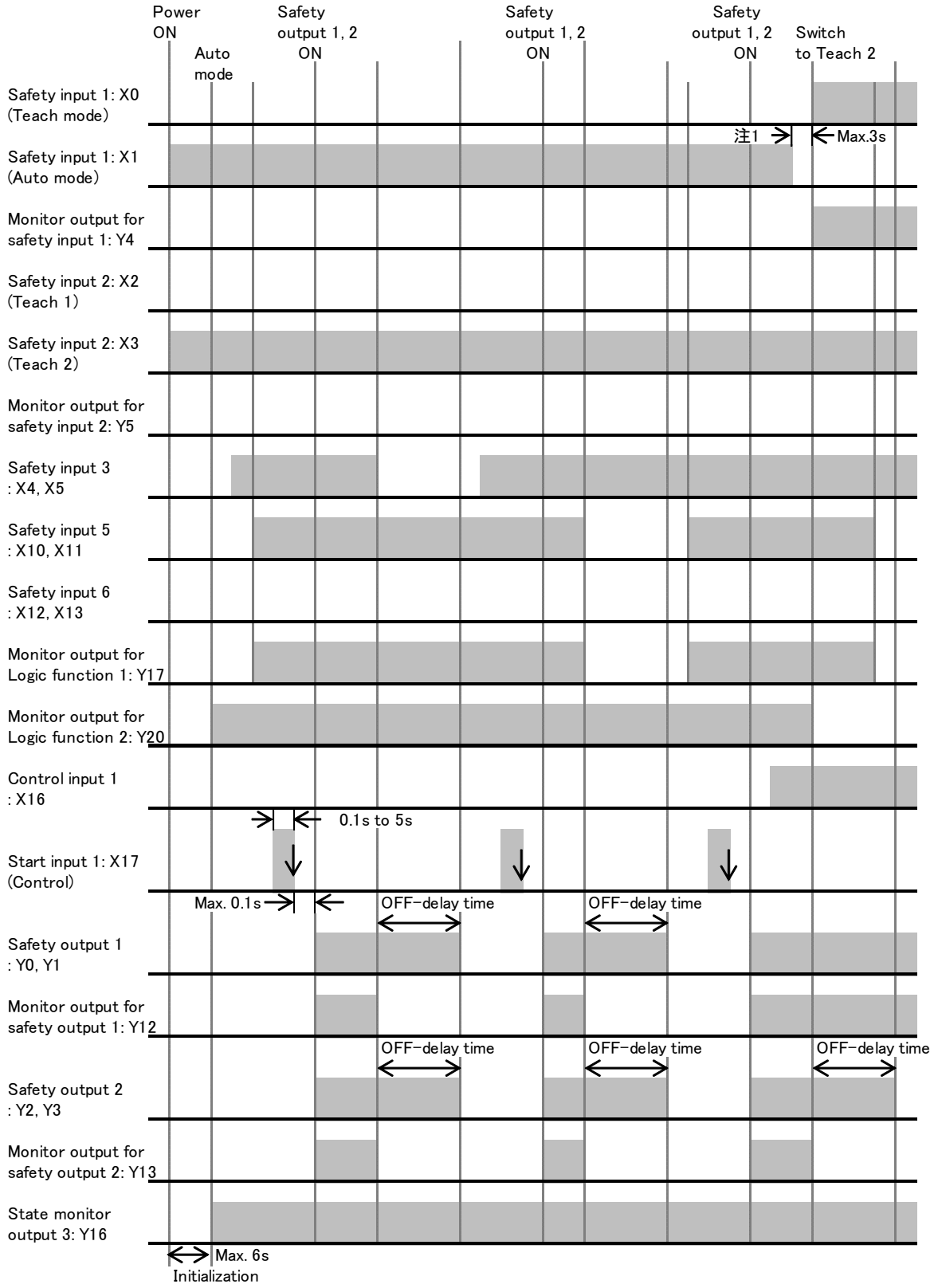
Example: TEACH 2 -> AUTO mode



Safety input 4 is ON in this chart.

Note 1) When “Safety input 1 (mode select input II)” is switched to another mode within 3s, “Safety output 1” is kept ON.

Example: Auto mode -> TEACH 2

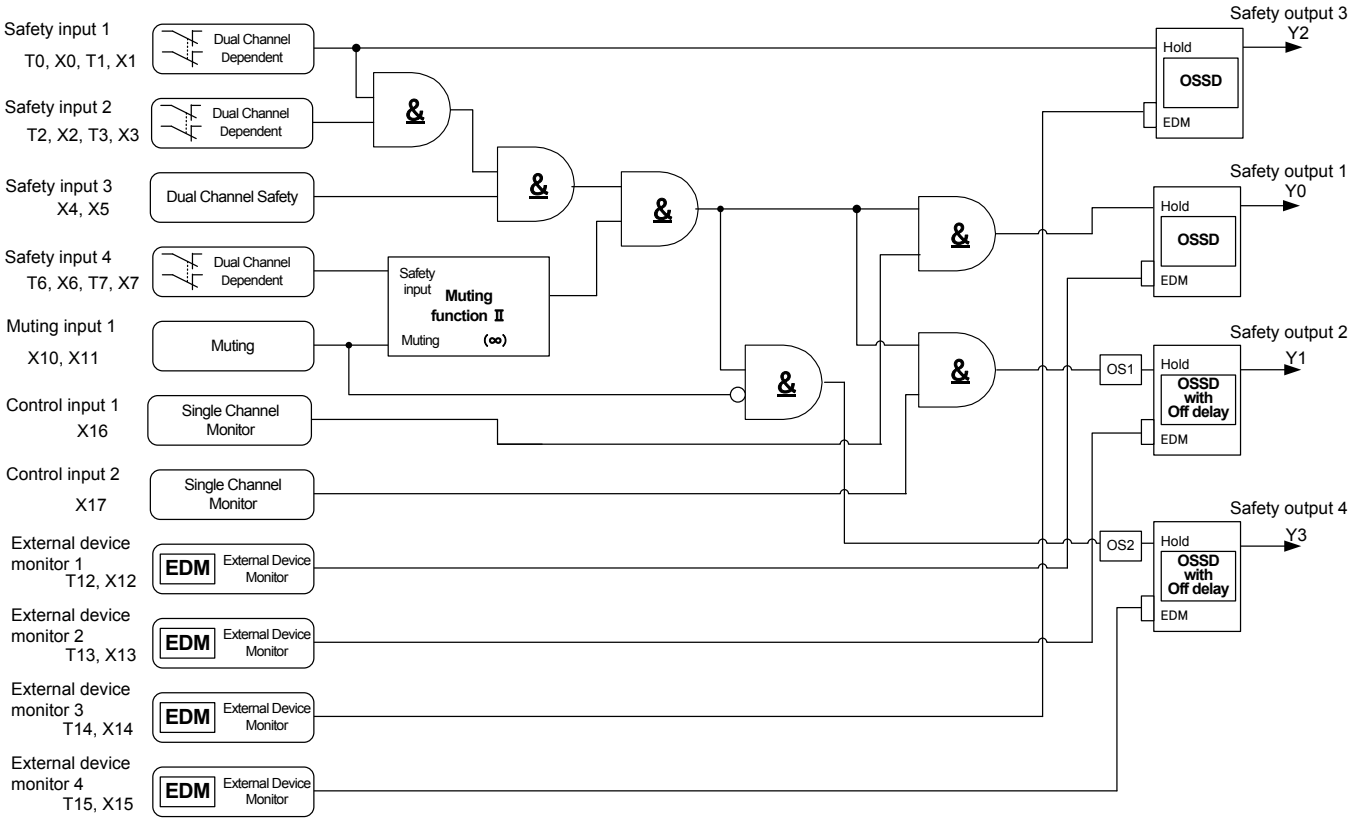


Safety input 4 is ON in this chart.

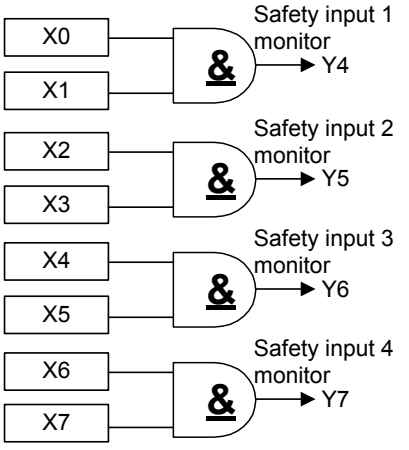
Note 1) When “Safety input 1 (mode select input II)” is switched to another mode within 3s, “Safety output 1” is kept ON.

Logic 24A: Muting function logic for apparatus with openings

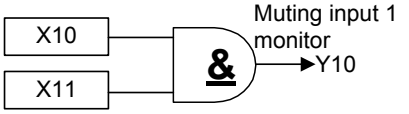
Logic circuit (Logic 24A)



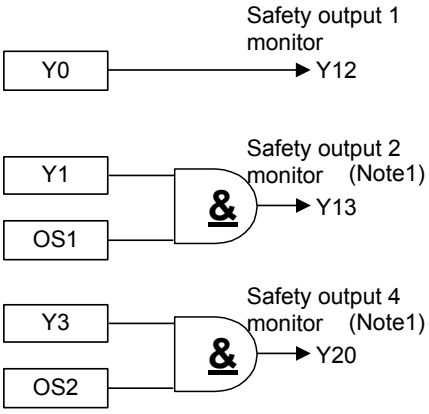
●Monitor output for safety input



●Monitor output for muting input

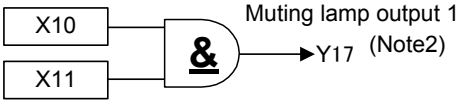


●Monitor output for safety output



Note1:
Safety output 2 and safety output 4 turn OFF immediately independent of OFF-delay time.

●Muting lamp output

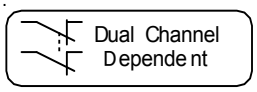


Note2:
The muting lamp output turns ON when the safety function of the safety input is temporarily suspended.
Even if the muting input is ON when the safety output is OFF, the muting lamp output doesn't turn ON.
In case of the SafetyOne is turned ON when the muting input is ON or the safety output turns OFF when the muting input is ON, muting function is not activated without turning off of muting input.

Function (Logic 24A)

●Safety inputs: X0 to X7 (T0 to T3, T6, T7)

Safety inputs are used to diagnose the status of connected safety devices, such as emergency stop switches and interlock switches.

Intended inputs (Terminal names)	Function	
Safety input 1 (X0-T0, X1-T1) Safety input 2 (X2-T2, X3-T3) Safety input 4 (X6-T6, X7-T7)	Function name	Dual channel dependent input
	Symbol	
	Description of operation	This function diagnoses the status of connected safety devices. This function does not diagnose the time interval of status transition between each input of duplicated inputs.
	Detail information	Logic functions (5-132)

Intended inputs (Terminal names)	Function	
Safety input 3 (X4, X5)	Function name	Dual channel safety input
	Symbol	
	Description of operation	This function diagnoses the status of connected safety devices. This function diagnoses the time interval of status transition between each input of duplicated inputs (0.1s). The function does not use drive terminals (T4, T5).
	Detail information	Logic functions (5-136)

Warning

For connected control devices, refer to “SAFETY PRECAUTIONS”.

Safety check signals (pulses signals) are sent from the drive terminals (T0 to T3, T6, T7) to diagnose connected safety devices and input circuits. Safety check signals can not be used as a power supply for connected devices.

Note. Solid state outputs, such as safety light curtains, can not be connected to safety input 1, 2, and 4.

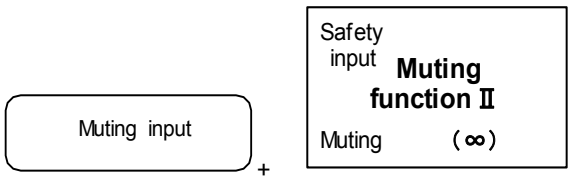
Note. Use safety input 1, 2, and 4 as specified combinations, such as receive terminal (Xn) and drive terminal (Tn). If the combinations are incorrect, SafetyOne does not work correctly.

Note. If there are unused safety inputs in safety input 1, 2, and 4, connect the unused receive terminals (Xn) to the corresponding drive terminals (Tn). If they are not connected, the SafetyOne does not turn ON the safety outputs.

Note. If there are unused safety inputs in safety input 3, connect the unused receive terminals (Xn) to a 24V DC power supply (V+). If they are not connected, the SafetyOne does not turn ON the safety outputs.

●Muting inputs: X10 and X11

Muting inputs are used to diagnose the status of muting devices, such as sensors or limit switches.

Intended inputs (Terminal names)	Function	
Muting input 1 (X10, X11)	Function name	Muting input+Muting II
	Symbol	
	Description of operation	This function diagnoses the status of connected muting devices. This function diagnoses the time interval of status transition between each input of duplicated inputs (3s). The function does not use a drive terminal (T10, T11).
	Detail information	Logic functions (5-144, 5-151)

Warning

Muting inputs are not safety inputs. Do not use these to construct a safety system.
The maximum time to suspend the safety function continuously (muting monitor time) is not specified in the SafetyOne. Based on risk assessment, monitor the muting monitor time that is suitable for the safety system, by external circuit or devices.

●External device monitor inputs: X12 to X15 (T12 to T15)

External device monitor inputs are used to diagnose status of the devices connected to safety outputs.

Intended inputs (Terminal names)	Target safety outputs (Terminal names)	Function	
External device monitor input 1 (X12-T12)	Safety output 1 (Y0)	Function name	External device monitor input
External device monitor input 2 (X13-T13)	Safety output 2 (Y1)	Symbol	
External device monitor input 3 (X14-T14)	Safety output 3 (Y2)	Description of operation	This function diagnoses the status of devices connected to a target safety output.
External device monitor input 4 (X15-T15)	Safety output 4 (Y3)	Detail information	Logic functions (5-147)

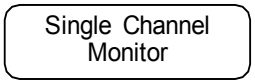
Warning

Safety check signals (pulses signals) are sent from the drive terminals (T12 to T15) to diagnose external devices and monitor circuits. Safety check signals can not be used as a power supply for connected devices.

Note. If there are unused safety outputs, connect the intended external device monitor terminals (Xn) to the corresponding drive terminals (Tn). If they are not connected, the SafetyOne detects an input monitor error. As the result, the error LED displays “1” and the unit changes to the Protection state.

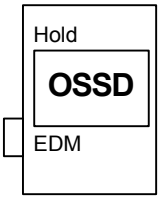
●Control inputs: X16, X17

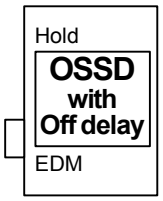
Control inputs are used to control of safety outputs.

Intended inputs (Terminal names)	Target safety outputs (Terminal names)	Function	
Control input 1 (X16)	Safety output 1 (Y0)	Function name	Monitor input
		Symbol	
Control input 2 (X17)	Safety output 2 (Y1)	Description of operation	Target safety outputs are controled by these control inputs.
		Detail information	Logic Functions (5-146)

●Safety outputs: Y0 to Y3

Safety outputs are used to output safety information processed by SafetyOne.

Intended outputs (Terminal names)	Function	
Safety output 1 (Y0) Safety output 3 (Y2)	Function name	Safety output without timer
	Symbol	
	Description of operation	This function is a safety output to output safety information processed by SafetyOne. The output is turned OFF immediately by OFF operation (instantaneous OFF output).
	Detail information	Logic functions (5-154)

Intended outputs (Terminal names)	Function	
Safety output 2 (Y1) Safety output 4 (Y3)	Function name	Safety output with timer
	Symbol	
	Description of operation	This function is a safety output to output safety information processed by SafetyOne. The output is turned OFF after the preset time of the OFF-delay timer (OFF-delay output).
	Detail information	Logic functions (5-157)

Note. When the SafetyOne changes to Protection state due to input monitor error, safety output without timer (safety output 1 and safety output 3) is turned OFF. Safety output with timer (safety output 2 and safety output 4) is turned OFF after the preset OFF-delay time.

Note. When the SafetyOne changes to Stop state due to circuit failure or other errors, all safety outputs (safety output 1, safety output 2, safety output 3, and safety output 4) are turned OFF, immediately.

Safety input monitor outputs: Y4 to Y10

Safety input monitor outputs are used to output the status of safety inputs in SafetyOne.

Intended outputs (Terminal names)	Target safety inputs (Terminal names)	Description of operation
Safety input 1 monitor output (Y4)	Safety input 1 (X0-T0, X1-T1)	When the target safety input is ON, the monitor output is ON. When the target safety input is OFF, the monitor output is OFF.
Safety input 2 monitor output (Y5)	Safety input 2 (X2-T2, X3-T3)	
Safety input 3 monitor output (Y6)	Safety input 3 (X4, X5)	
Safety input 4 monitor output (Y7)	Safety input 4 (X6-T6, X7-T7)	
Muting input 1 monitor output (Y10)	Muting input 1 (X10, X11)	

Note. In the case of SW version 1.00, when the targeted safety input detects an input monitor error, input circuit failure or EMC the disturbance, corresponding safety input monitor output becomes a pulse output (1Hz). The monitor output is OFF in other errors, Initial state, or Configuration state. In the case of SW version 2.00 or higher, the monitor output is OFF in errors, Initial state, or Configuration state.

●Safety output monitor outputs: Y12, Y13, and Y20

Safety output monitor outputs are used to output the status of safety outputs in SafetyOne.

Intended outputs (Terminal names)	Target safety outputs (Terminal names)	Description of operation
Safety output 1 monitor output (Y12)	Safety output 1 (Y0)	When the target safety output is ON, the monitor output is ON. When the target safety output is OFF, the function is OFF. The monitor output turns OFF immediately independent on set OFF-delay time.
Safety output 2 monitor output (Y13)	Safety output 2 (Y1)	
Safety output 4 monitor output (Y20)	Safety output 4 (Y3)	

Note. In the case of SW version 1.00, when the safety output detects an output circuit failure, corresponding safety output monitor output becomes a pulse output (1Hz). The monitor output is OFF in other errors, Initial state, or Configuration state. In the case of SW version 2.00 or higher, the monitor output is OFF in errors, Initial state, or Configuration state.

●State monitor outputs: Y14 to Y16

State monitor outputs are used to output the internal state of SafetyOne.

Intended outputs (Terminal names)	State				
	Initial	Run	Configuration	Protection	Stop
State monitor output 1 (Y14)	■ON	□OFF	□OFF	□OFF	■ON
State monitor output 2 (Y15)	■ON	□OFF	■ON	■ON	■ON or□OFF
State monitor output 3 (Y16)	□OFF	■ON	□OFF	□OFF	□OFF

Refer to “Chapter 4 BASIC OPERATIONS” and to “Chapter 6 TROUBLE SHOOTING” for details of each state.

●Muting lamp output: Y17

Muting lamp output is used to control muting lamps.

Intended outputs (Terminal names)	Target safety inputs (Terminal names)	Description of operation
Muting lamp output 1 (Y17)	Safety input 4 (X6-T6, X7-T7)	The output is ON, during safety input 4 is muting state by muting input 1.

Warning

The monitor outputs and the muting lamp output are not safety outputs. Do not use these to construct a safety system.

Be sure to check the operation of the muting function before its use. Furthermore, check the state of the muting lamp. The muting function is maintained even if a lamp blows or a lamp is not connected. In the case of SW version 1.00, the SafetyOne changes to the Stop state.

Caution

Refer to "Chapter 2 PRODUCT SPECIFICATIONS" for specifications of each input and output.

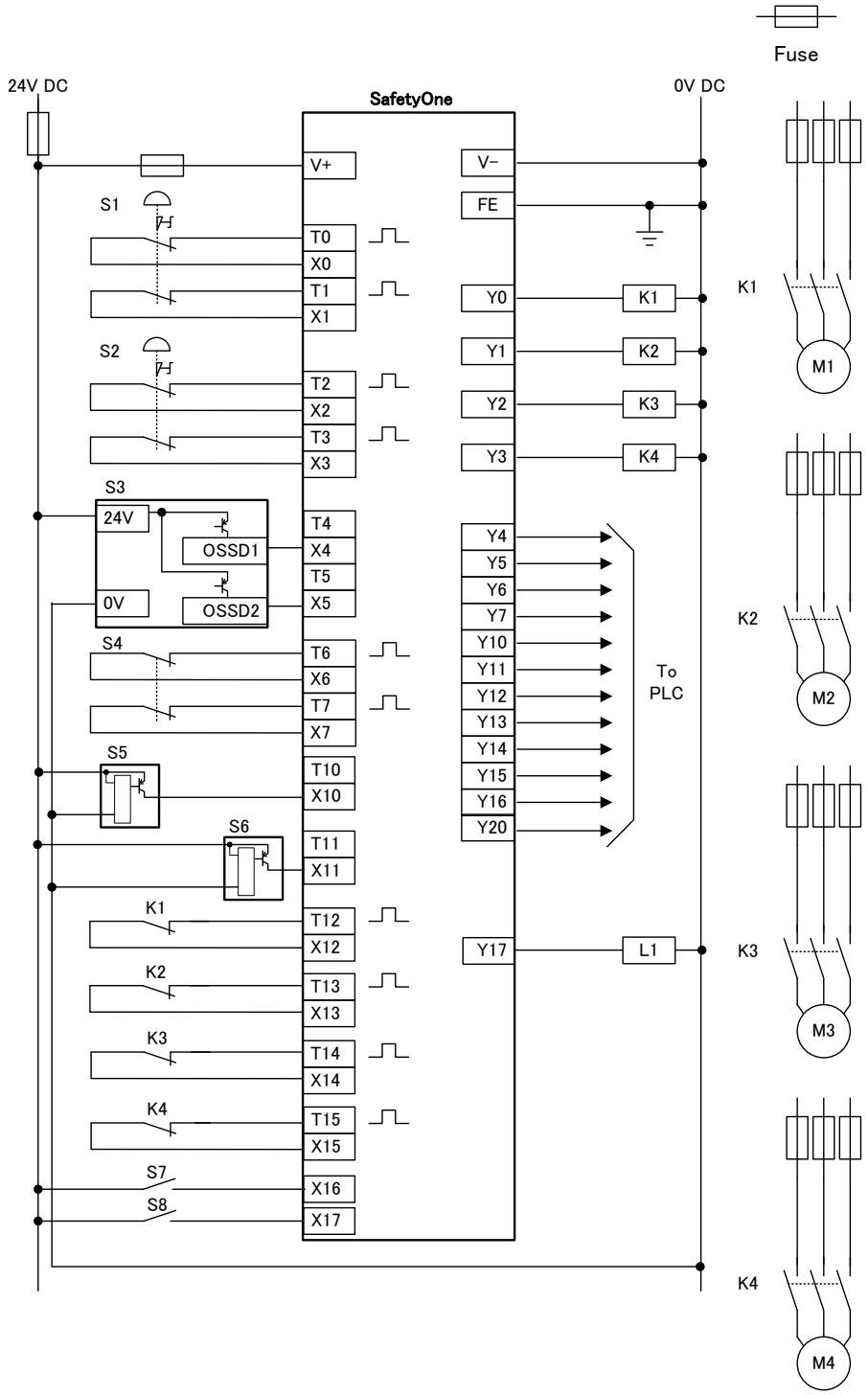
Note. In the case of SW version 1.00, muting lamp output terminal (Y17) detects that muting lamp is disconnected or unconnected. If these failures are detected, the error LED displays “5” and the state changes to the Stop state.

Note. In the case of SW version 1.00, if there is an unused muting lamp output, connect a resistor (10 kΩ, 1/4W) to the unused terminal.

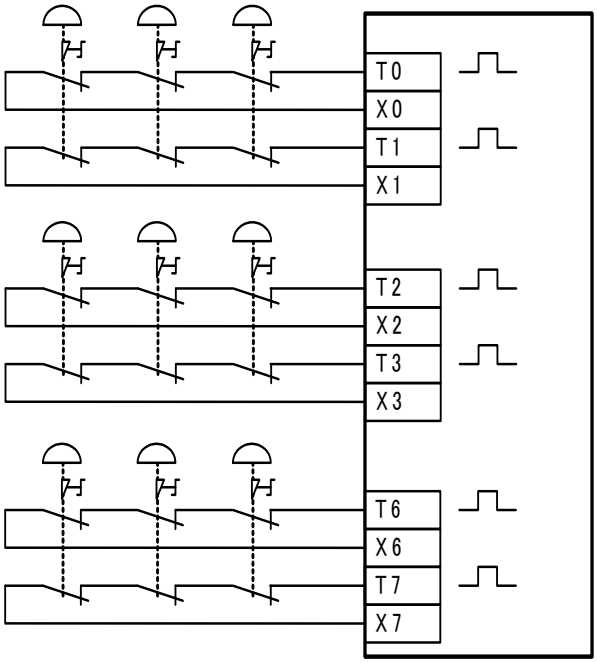
Wiring example (Logic 24A)

In the case where 2 emergency stop switches, 1 safety light curtains, 1 interlock switch, and 2 muting sensors are connected.

S1, 2 : Emergency stop switch
S3 : Safety light curtain
S4 : Interlock switch
S5, 6 : Muting sensor
S7, 8 : Control input switch
K1 to 4 : Contactor
L1 : Muting lamp
M1 to 4 : Motor



When connecting multiple emergency stop switches in series

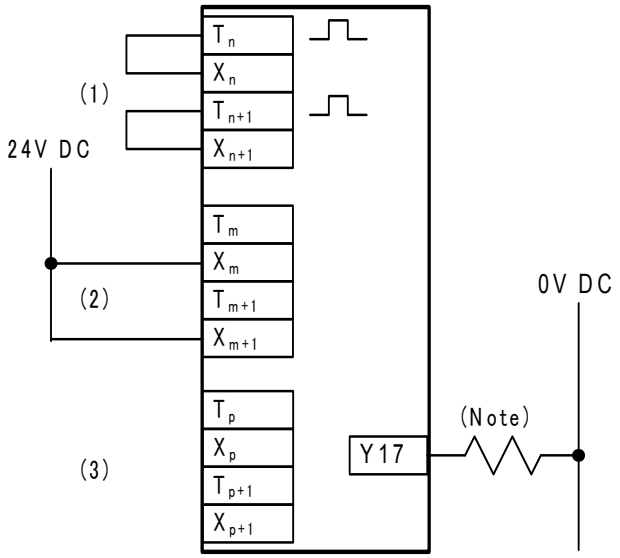


NOTE: Safety performance depends on the system configuration.

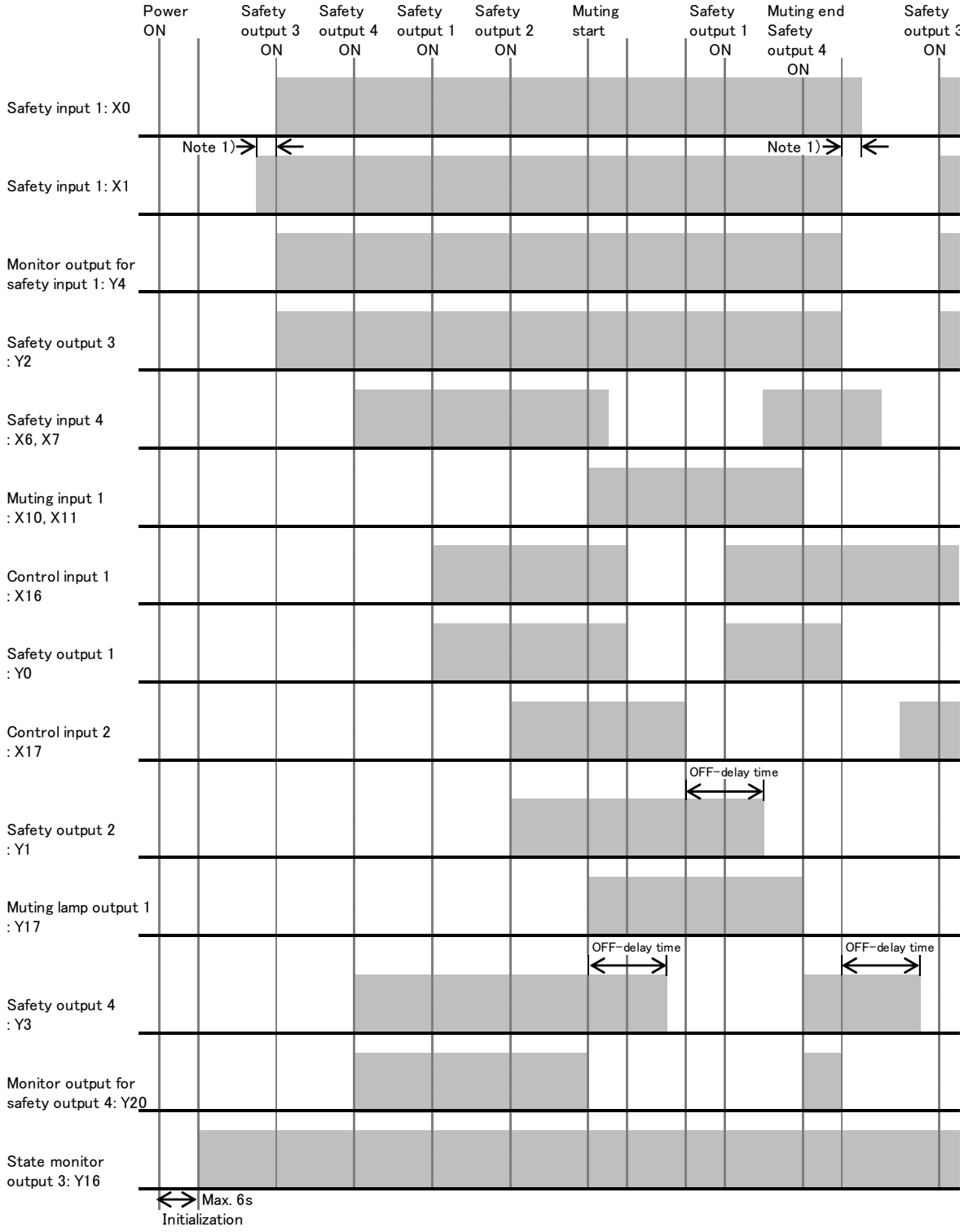
When not using some safety inputs

- If there are unused safety inputs in S1, S2, and S4 connect the unused receive terminals to the corresponding drive terminals. (Refer to (1))
- If there are unused safety inputs in S3, connect the unused receive terminals to 24V DC power supply (V+). (Refer to (2))
- If there are unused muting inputs in S5 and S6, open between the unused receive terminals and the corresponding drive terminals . (Refer to (3))

Note: In the case of SW version 1.00, the muting lamp output terminal (Y17) Detects that connected indicator light is disconnected or unconnected. When not using the muting function, connect a resistor across the terminal. If no resistor is connected, then the SafetyOne Detects any wiring errors and locks out operations.



Timing chart (Logic 24A)

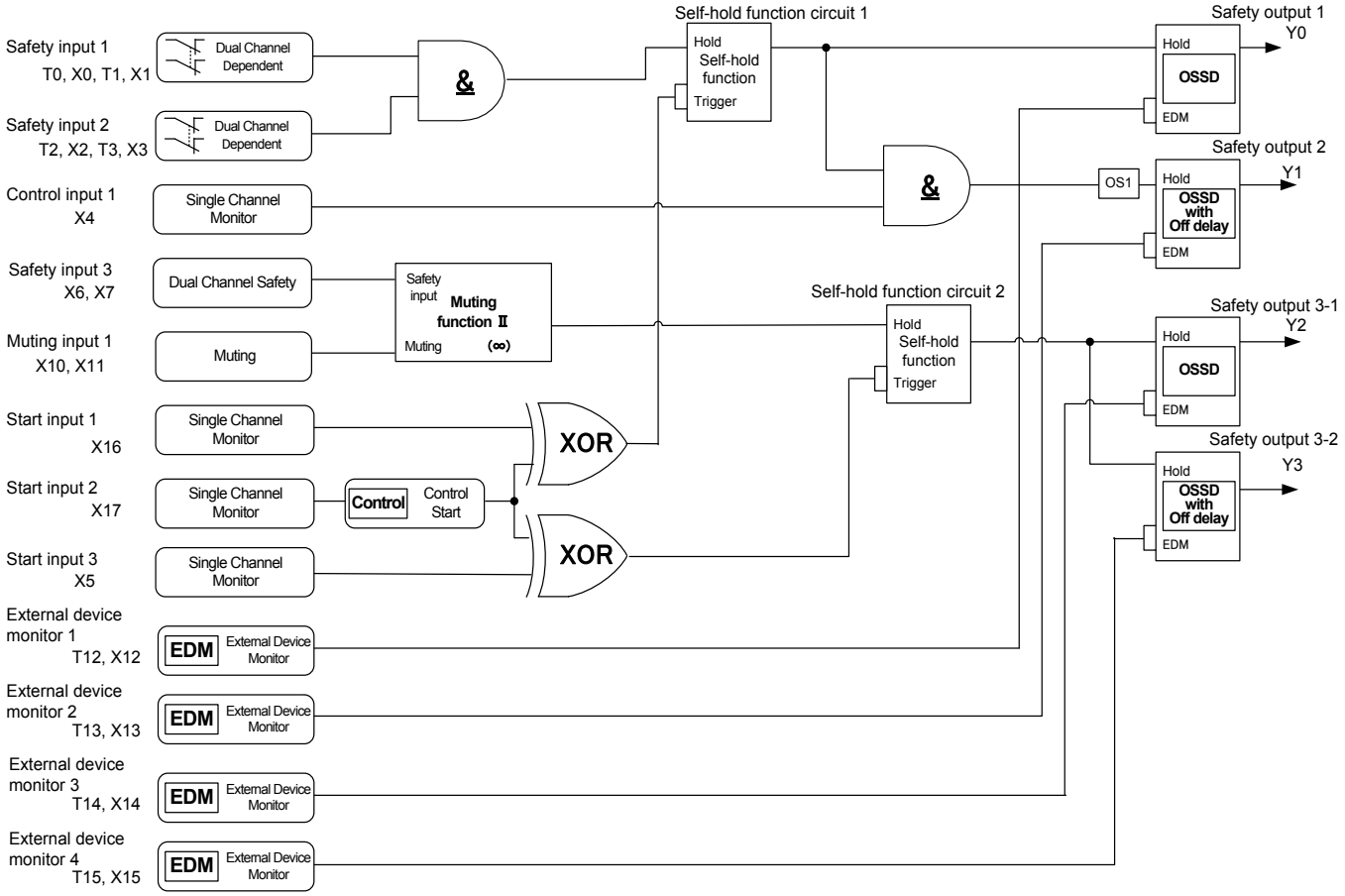


Safety input 2 and 3 are ON in this chart.

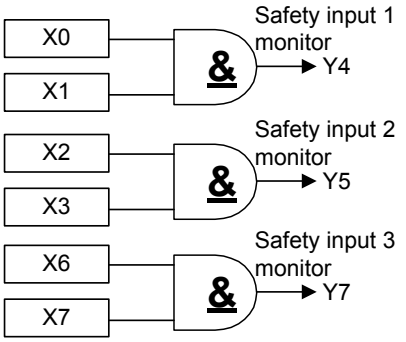
Note 1) Input monitor error detection time is infinity.
When “Safety input 4” is turned OFF before “Muting input 1” is turned ON, muting function is not effective and “Safety output 1” and “Safety output 2” are not turned ON.
About safety inputs that are not described in this chart, input monitor error detection time is as follows.
The time of dual channel dependent input (X2, X3, X6, and X7) is infinity.
The time of dual channel safety input (X4 and X5) is 0.1s.
The time of muting input (X10 and X11) is 3s.
Refer to the following "Logic functions" (5-128) for more details.

Logic 24b: Muting function logic for apparatus with openings

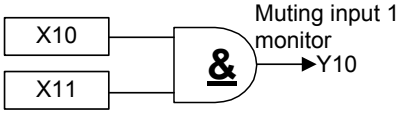
Logic circuit (Logic 24b)



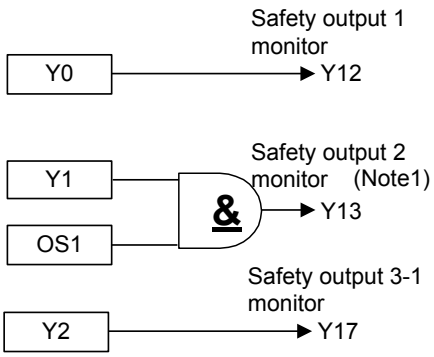
●Monitor output for safety input



●Monitor output for muting input

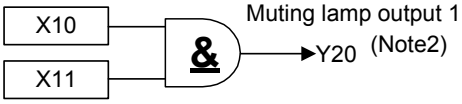


●Monitor output for safety output



Note1:
Safety output 2 turns OFF immediately independent of OFF-delay time.

●Muting lamp output

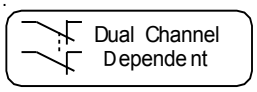


Note2:
The muting lamp output turns ON when the safety function of the safety input is temporarily suspended.
Even if the muting input is ON when the safety output is OFF, the muting lamp output doesn't turn ON.
In case of the SafetyOne is turned ON when the muting input is ON or the safety output turns OFF when the muting input is ON, muting function is not activated without turning off of muting input.

Function (Logic 24b)

●Safety inputs: X0 to X3, X6, and X7 (T0 to T3)

Safety inputs are used to diagnose the status of connected safety devices, such as emergency stop switches and interlock switches.

Intended inputs (Terminal names)	Function	
Safety input 1 (X0-T0, X1-T1) Safety input 2 (X2-T2, X3-T3)	Function name	Dual channel dependent input
	Symbol	
	Description of operation	This function diagnoses the status of connected safety devices. This function does not diagnose the time interval of status transition between each input of duplicated inputs.
	Detail information	Logic functions (5-132)

Intended inputs (Terminal names)	Function	
Safety input 3 (X6, X7)	Function name	Dual channel safety input
	Symbol	
	Description of operation	This function diagnoses the status of connected safety devices. This function diagnoses the time interval of status transition between each input of duplicated inputs (0.1s). The function does not use drive terminals (T6, T7).
	Detail information	Logic functions (5-136)

Warning

For connected control devices, refer to “SAFETY PRECAUTIONS”.

Safety check signals (pulses signals) are sent from the drive terminals (T0 to T3) to diagnose connected safety devices and input circuits. Safety check signals can not be used as a power supply for connected devices.

Note. Solid state outputs, such as safety light curtains, can not be connected to safety input 1 and 2.

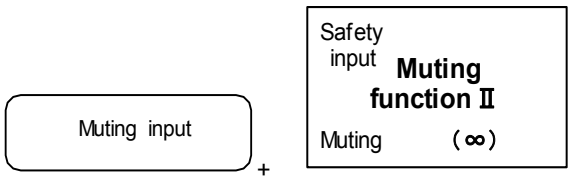
Note. Use safety input 1 and 2, as specified combinations, such as receive terminal (Xn) and drive terminal (Tn). If the combinations are incorrect, SafetyOne does not work correctly.

Note. If there are unused safety inputs in safety input 1 and 2, connect the unused receive terminals (Xn) to the corresponding drive terminals (Tn). If they are not connected, the SafetyOne does not turn ON the safety outputs.

Note. If there are unused safety inputs in safety input 3, connect the unused receive terminals (Xn) to a 24V DC power supply (V+). If they are not connected, the SafetyOne does not turn ON the safety outputs.

●Muting inputs: X10 and X11

Muting inputs are used to diagnose the status of muting devices, such as sensors or limit switches.

Intended inputs (Terminal names)	Function	
Muting input 1 (X10, X11)	Function name	Muting input+Muting II
	Symbol	
	Description of operation	This function diagnoses the status of connected muting devices. This function diagnoses the time interval of status transition between each input of duplicated inputs (3s). The function does not use a drive terminal (T10, T11).
	Detail information	Logic functions (5-144, 5-151)

Warning

Muting inputs are not safety inputs. Do not use these to construct a safety system.
The maximum time to suspend the safety function continuously (muting monitor time) is not specified in the SafetyOne. Based on risk assessment, monitor the muting monitor time that is suitable for the safety system, by external circuit or devices.

●External device monitor inputs: X12 to X15 (T12 to T15)

External device monitor inputs are used to diagnose status of the devices connected to safety outputs.

Intended inputs (Terminal names)	Target safety outputs (Terminal names)	Function	
External device monitor input 1 (X12-T12)	Safety output 1 (Y0)	Function name	External device monitor input
External device monitor input 2 (X13-T13)	Safety output 2 (Y1)	Symbol	
External device monitor input 3 (X14-T14)	Safety output 3-1 (Y2)	Description of operation	This function diagnoses the status of devices connected to a target safety output.
External device monitor input 4 (X15-T15)	Safety output 3-2 (Y3)	Detail information	Logic functions (5-147)

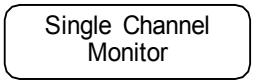
Warning

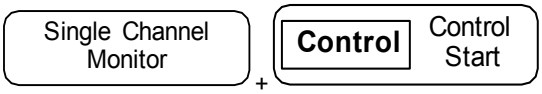
Safety check signals (pulses signals) are sent from the drive terminals (T12 to T15) to diagnose external devices and monitor circuits. Safety check signals can not be used as a power supply for connected devices.

Note. If there are unused safety outputs, connect the intended external device monitor terminals (Xn) to the corresponding drive terminals (Tn). If they are not connected, the SafetyOne detects an input monitor error. As the result, the error LED displays “1” and the unit changes to the Protection state.

●Start inputs: X5, X16, and X17

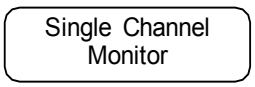
Start inputs are used to control the start of safety outputs.

Intended inputs (Terminal names)	Target safety inputs (Terminal names)	Function	
Start input 1 (X16)	Safety input 1 (X0-T0, X1-T1) Safety input 2 (X2-T2, X3-T3)	Function name	Monitor input
		Symbol	
Start input 3 (X5)	Safety input 3 (X6, X7)	Description of operation	Safety outputs are started, when all target safety inputs are in the safe state and this function is in the ON state. This function is turned ON by 0.1s or more ON operation.
		Detail information	Logic functions (5-146)

Intended inputs (Terminal names)	Target safety inputs (Terminal names)	Function	
Start input 2 (X17)	Safety input 1 (X0-T0, X1-T1) Safety input 2 (X2-T2, X3-T3) Safety input 3 (X6, X7)	Function name	Monitor input + Control start
		Symbol	
		Description of operation	Safety outputs are started, when this function becomes ON after all intended safety inputs are in the safe state. This function is turned ON by 0.1s to 5s ON operation.
		Detail information	Logic functions (5-146, 5-152)

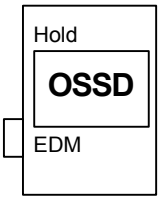
●Control input: X4

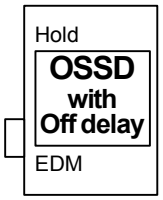
Control input is used to control of safety output.

Intended inputs (Terminal names)	Target safety outputs (Terminal names)	Function	
Control input 1 (X4)	Safety output 2 (Y1)	Function name	Monitor input
		Symbol	
		Description of operation	Target safety output is controled by this control input.
		Detail information	Logic Functions (5-146)

●Safety outputs: Y0 to Y3

Safety outputs are used to output safety information processed by SafetyOne.

Intended outputs (Terminal names)	Function	
Safety output 1 (Y0) Safety output 3-1 (Y2)	Function name	Safety output without timer
	Symbol	
	Description of operation	This function is a safety output to output safety information processed by SafetyOne. The output is turned OFF immediately by OFF operation (instantaneous OFF output).
	Detail information	Logic functions (5-154)

Intended outputs (Terminal names)	Function	
Safety output 2 (Y1) Safety output 3-2 (Y3)	Function name	Safety output with timer
	Symbol	
	Description of operation	This function is a safety output to output safety information processed by SafetyOne. The output is turned OFF after the preset time of the OFF-delay timer (OFF-delay output).
	Detail information	Logic functions (5-157)

Note. When the SafetyOne changes to Protection state due to input monitor error, safety output without timer (safety output 1 and safety output 3-1) is turned OFF. Safety output with timer (safety output 2 and safety output 3-2) is turned OFF after the preset OFF-delay time.

Note. When the SafetyOne changes to Stop state due to circuit failure or other errors, all safety outputs (safety output 1, safety output 2, safety output 3-1, and safety output 3-2) are turned OFF, immediately.

●Safety input monitor outputs: Y4 to Y10

Safety input monitor outputs are used to output the status of safety inputs in SafetyOne.

Intended outputs (Terminal names)	Target safety inputs (Terminal names)	Description of operation
Safety input 1 monitor output (Y4)	Safety input 1 (X0-T0, X1-T1)	When the target safety input is ON, the monitor output is ON. When the target safety input is OFF, the monitor output is OFF.
Safety input 2 monitor output (Y5)	Safety input 2 (X2-T2, X3-T3)	
Safety input 3 monitor output (Y7)	Safety input 3 (X6, X7)	
Muting input 1 monitor output (Y10)	Muting input 1 (X10, X11)	

Note. In the case of SW version 1.00, when the targeted safety input detects an input monitor error, input circuit failure or EMC the disturbance, corresponding safety input monitor output becomes a pulse output (1Hz). The monitor output is OFF in other errors, Initial state, or Configuration state. In the case of SW version 2.00 or higher, the monitor output is OFF in errors, Initial state, or Configuration state.

●Safety output monitor outputs: Y12, Y13, and Y17

Safety output monitor outputs are used to output the status of safety outputs in SafetyOne.

Intended outputs (Terminal names)	Target safety outputs (Terminal names)	Description of operation
Safety output 1 monitor output (Y12)	Safety output 1 (Y0)	When the target safety output is ON, the monitor output is ON. When the target safety output is OFF, this function is OFF. The monitor output turns OFF immediately, independent of the preset OFF-delay time.
Safety output 2 monitor output (Y13)	Safety output 2 (Y1)	
Safety output 3-1 monitor output (Y17)	Safety output 3-1 (Y2)	

Note. In the case of SW version 1.00, when the safety output detects an output circuit failure, corresponding safety output monitor output becomes a pulse output (1Hz). The monitor output is OFF in other errors, Initial state, or Configuration state. In the case of SW version 2.00 or higher, the monitor output is OFF in errors, Initial state, or Configuration state.

●State monitor outputs: Y14 to Y16

State monitor outputs are used to output the internal state of SafetyOne.

Intended outputs (Terminal names)	State				
	Initial	Run	Configuration	Protection	Stop
State monitor output 1 (Y14)	■ON	□OFF	□OFF	□OFF	■ON
State monitor output 2 (Y15)	■ON	□OFF	■ON	■ON	■ON or□OFF
State monitor output 3 (Y16)	□OFF	■ON	□OFF	□OFF	□OFF

Refer to “Chapter 4 BASIC OPERATIONS” and to “Chapter 6 TROUBLE SHOOTING” for details of each state.

●Muting lamp output: Y20

Muting lamp output is used to control muting lamps.

Intended outputs (Terminal names)	Target safety inputs (Terminal names)	Description of operation
Muting lamp output 1 (Y20)	Safety input 3 (X6, X7)	The output is ON, during safety input 3 is muting state by muting input 1.

Warning

The monitor outputs and the muting lamp output are not safety outputs. Do not use these to construct a safety system.

Be sure to check the operation of the muting function before its use. Furthermore, check the state of the muting lamp. The muting function is maintained even if a lamp blows or a lamp is not connected. In the case of SW version 1.00, the SafetyOne changes to the Stop state.

Caution

Refer to "Chapter 2 PRODUCT SPECIFICATIONS" for specifications of each input and output.

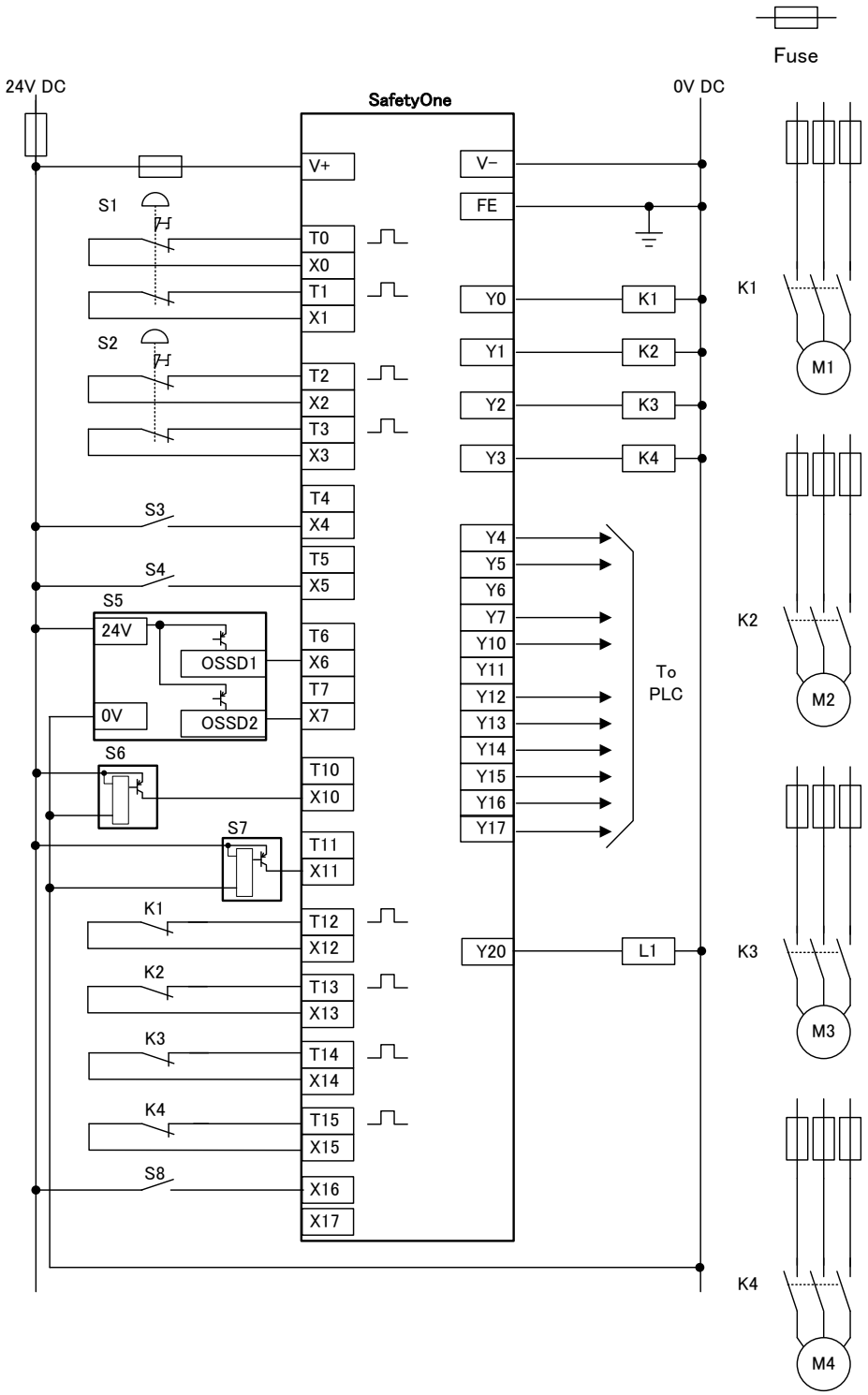
Note. In the case of SW version 1.00, muting lamp output terminal (Y20) detects that muting lamp is disconnected or unconnected. If these failures are detected, the error LED displays “5” and the state changes to the Stop state.

Note. In the case of SW version 1.00, if there is an unused muting lamp output, connect a resistor (10 kΩ, 1/4W) to the unused terminal.

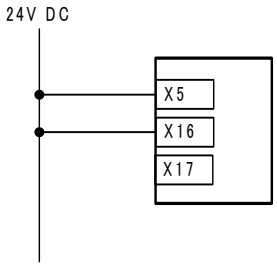
Wiring example (Logic 24b)

In the case where 2 emergency stop switches, 1 safety light curtain, and 2 muting sensores are connected.

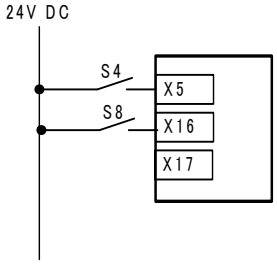
S1, 2 : Emergency stop switch
S3 : Control input switch
S4, 8 : Start switch
S5 : Safety light curtain
S6, 7 : Muting sensor
K1 to 4 : Contactor
L1 : Muting lamp
M1 to 4 : Motor



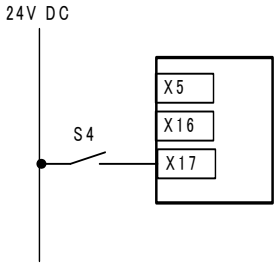
When not using the start switch (Auto start)



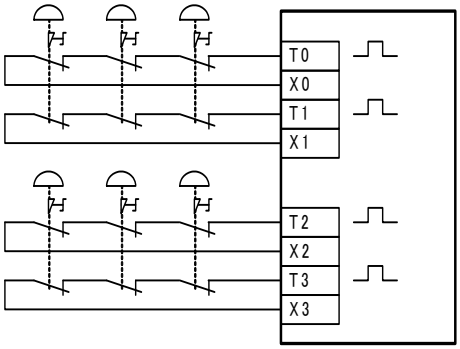
When not detecting the welding of start switch (Manual start)



When detecting the welding of start switch (Control start)



When connecting multiple emergency stop switches in series

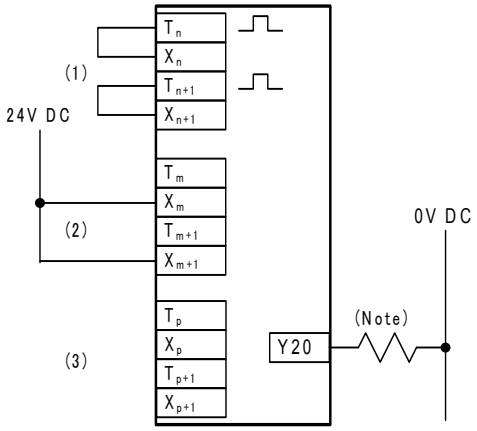


NOTE: Safety performance depends on the system configuration.

When not using some safety inputs

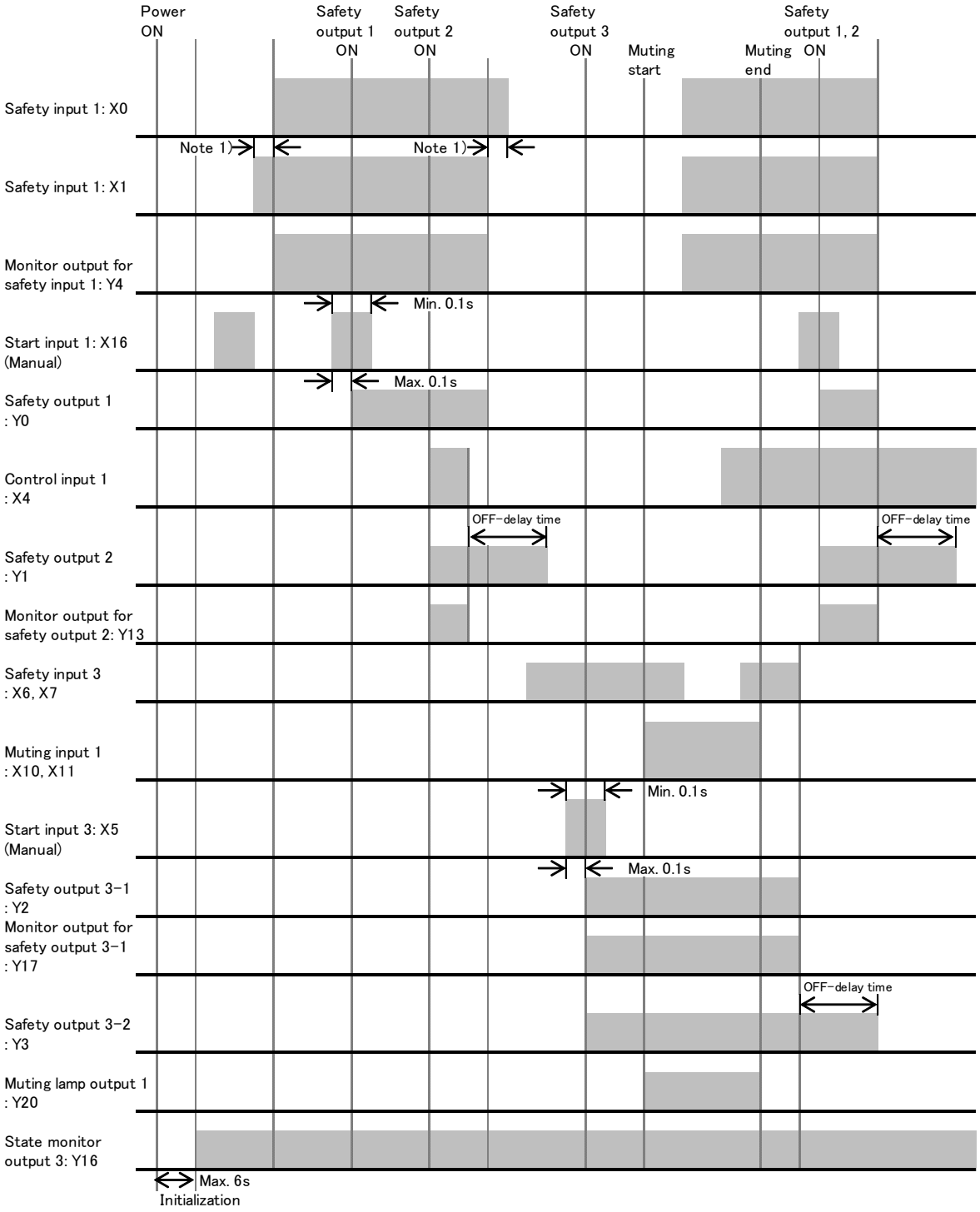
- If there are unused safety inputs in S1 and S2, connect the unused receive terminals to the corresponding drive terminals. (Refer to (1))
- If there are unused safety inputs in S5, connect the unused receive terminals to 24V DC power supply (V+). (Refer to (2))
- If there are unused muting inputs in S6 and S7, open between the unused receive terminals and the corresponding drive terminals . (Refer to (3))

Note: In the case of SW version 1.00, the muting lamp output terminal (Y20) Detects that connected indicator light is disconnected or unconnected. When not using the muting function, connect a resistor across the terminal. If no resistor is connected, then the SafetyOne Detects any wiring errors and locks out operations.



Timing chart (Logic 24b)

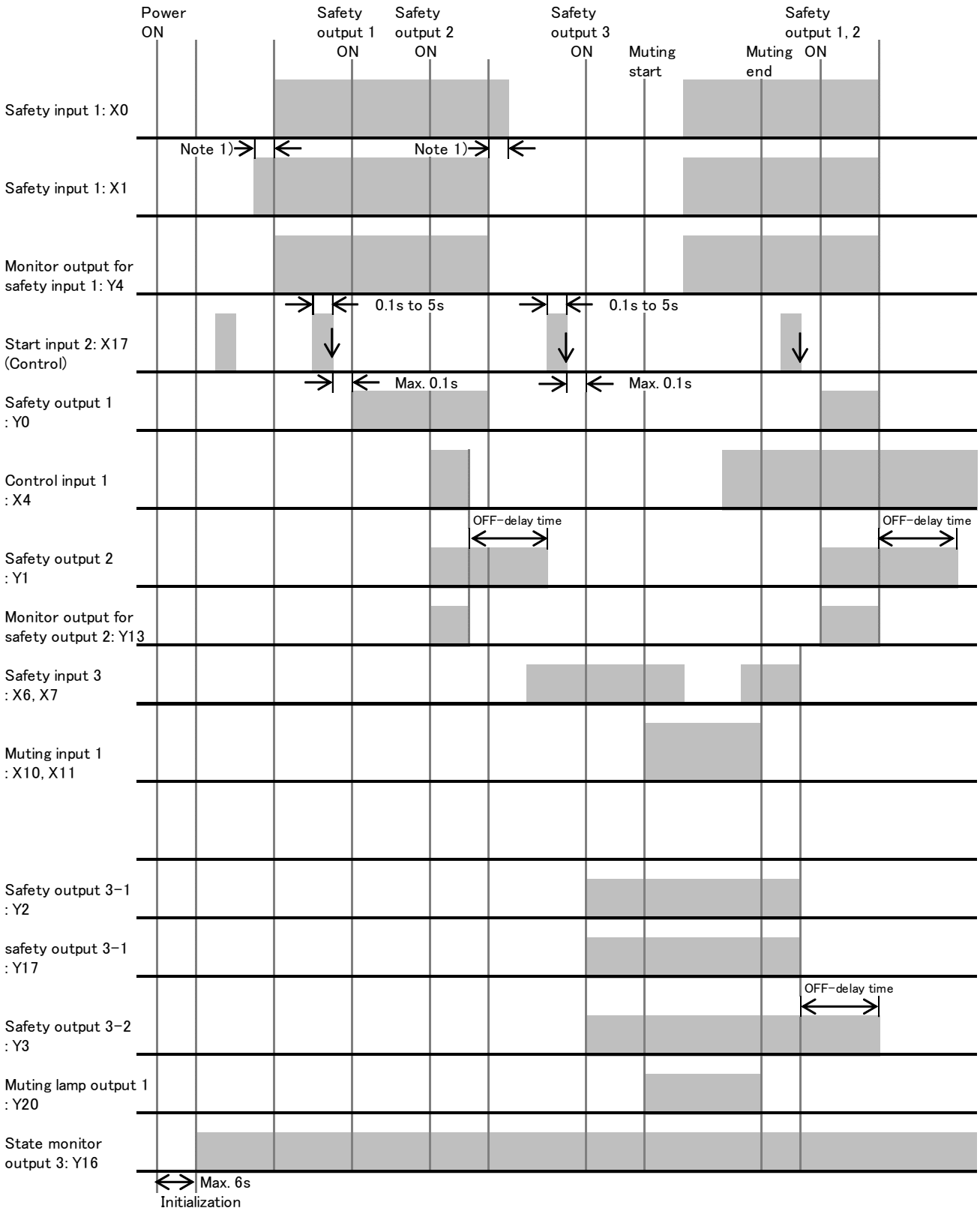
Example: Manual start input 1 (X16) and Manual start input 3 (X5) are used.



Safety input 2 is ON in this chart.

Note 1) Input monitor error detection time is infinity.
When “Safety input 3” is turned OFF before “Muting input 1” is turned ON, muting function is not effective and “Safety output 3-1” and “Safety output 3-2” are not turned ON.
About safety inputs that are not described in this chart, input monitor error detection time is as follows.
The time of dual channel dependent input (X2 and X3) is infinity.
The time of dual channel safety input (X6 and X7) is 0.1s.
The time of muting input (X10 and X11) is 3s.
Refer to the following "Logic functions" (5-128) for more details.

Example: Control start input 2 (X17) is used.

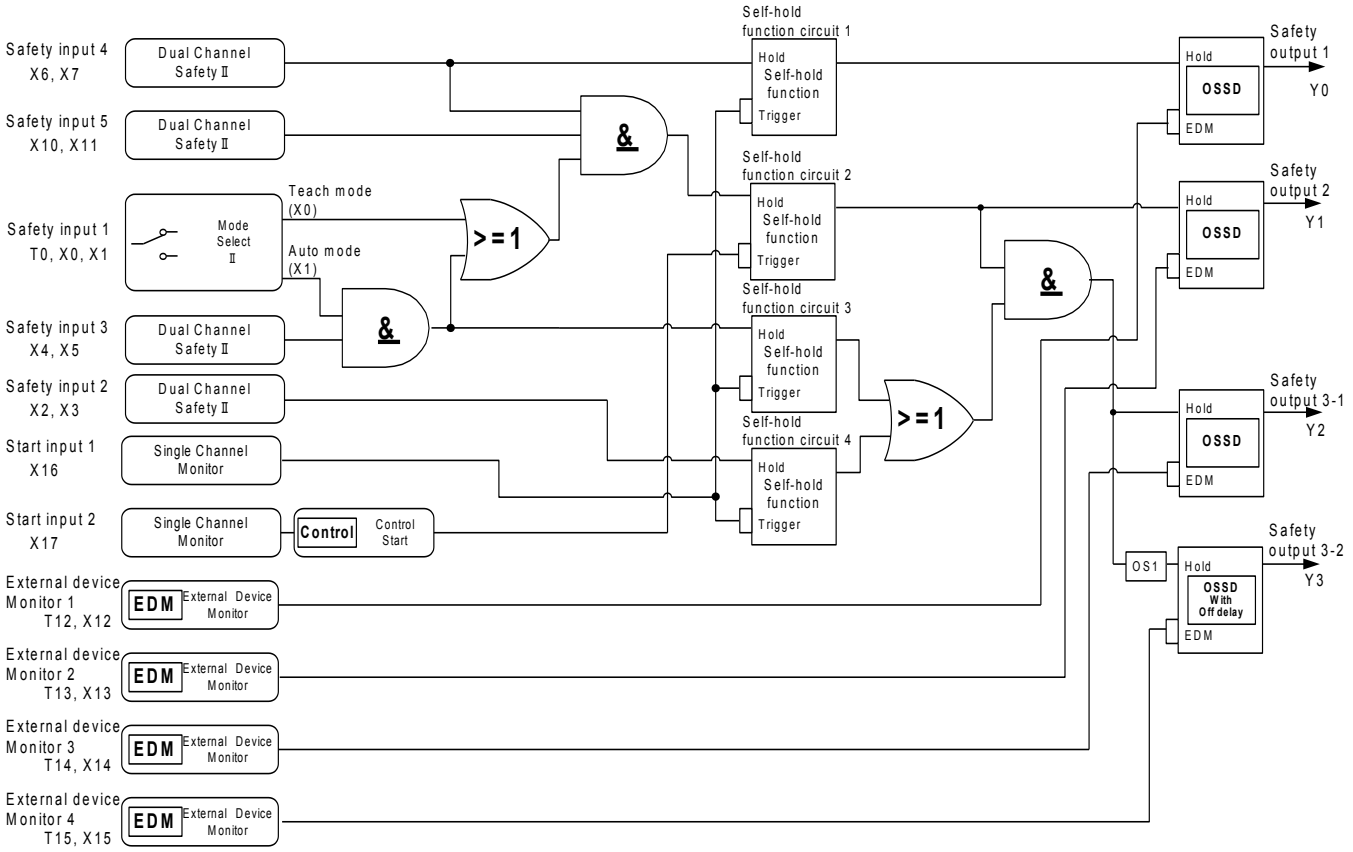


Safety input 2 is ON in this chart.

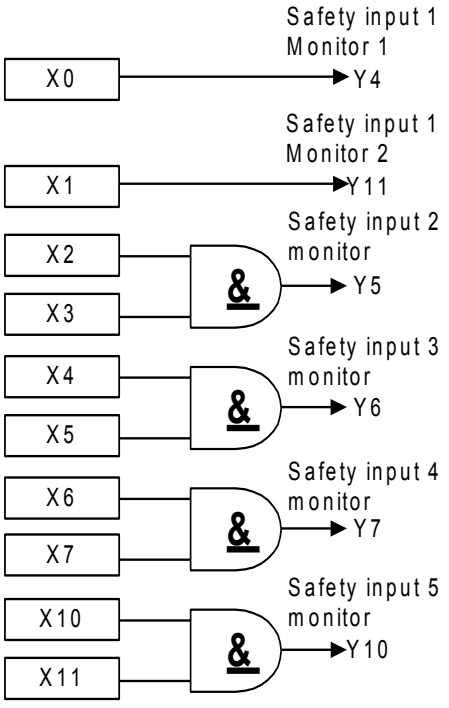
Note 1) Input monitor error detection time is infinity.

Logic 24C: The logic applicable for selection of active safety input devices

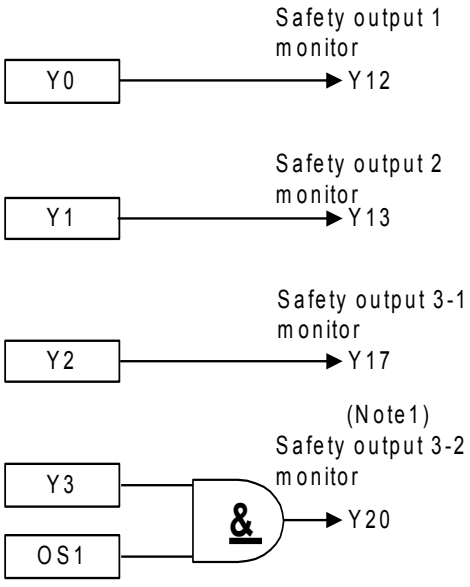
Logic circuit (Logic 24C) (in the case of SW version 2.00 or higher)



● Monitor output for safety input



● Monitor output for safety output

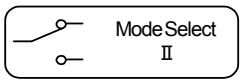


Note 1:
Safety output 3-2 monitor turns OFF immediately independent of OFF-delay time

Function (Logic 24C)

●Safety inputs: X0 to X11 (T0)

Safety inputs are used to diagnose the status of connected safety devices, such as emergency stop switches, interlock switches, and mode select switches.

Intended inputs (Terminal names)	Function	
Safety input 1 (X0/X1-T0)	Function name	Mode select input II
	Symbol	
	Description of operation	This function is for connecting devices with a mode selector function, such as mode selector switch. When the switching of inputs is performed within 3s, this function output is kept at previous state. This function diagnoses time interval of status transition between each input (0.5s).
	Detail information	Logic functions (5-142)

Intended inputs (Terminal names)	Function	
Safety input 2 (X2, X3) Safety input 3 (X4, X5) Safety input 4 (X6, X7) Safety input 5 (X10, X11)	Function name	Dual channel safety input II
	Symbol	
	Description of operation	This function diagnoses the status of connected safety devices. This function dose not diagnoses the time interval of status transition between each input of duplicated inputs. The function does not use drive terminals (T2 to T11).
	Detail information	Logic functions (5-138)

Warning

For connected control devices, refer to “SAFETY PRECAUTIONS”.

Safety check signals (pulses signals) are sent from the drive terminals (T0) to diagnose connected safety devices and input circuits. Safety check signals can not be used as a power supply for connected devices.

Note. Solid state outputs, such as safety light curtains, can not be connected to safety input1.

Note. Use safety input 1, as specified combinations, such as receive terminal (Xn) and drive terminal (Tn). If the combinations are incorrect, SafetyOne does not work correctly.

Note. When SafetyOne is in Run state or Protection state, input states are monitored in all safety inputs. For example, if input monitor error is detected in safety input 3 although TEACH mode is selected, SafetyOne detects error and transits to Protection state.

Note. If safety input 2 through safety input 5 are not used, connect the receive terminals (Xn) to a 24V DC power supply (V+). If they are not connected, the SafetyOne does not turn ON the safety outputs.

●External device monitor inputs: X12 to X15 (T12 to T15)

External device monitor inputs are used to diagnose status of the devices connected to safety outputs.

Intended inputs (Terminal names)	Target safety outputs (Terminal names)	Function	
External device monitor input 1 (X12-T12)	Safety output 1 (Y0)	Function name	External device monitor input
External device monitor input 2 (X13-T13)	Safety output 2 (Y1)	Symbol	
External device monitor input 3 (X14-T14)	Safety output 3-1 (Y2)	Description of operation	This function diagnoses the status of devices connected to a target safety output.
External device monitor input 4 (X15-T15)	Safety output 3-2 (Y3)	Detail information	Logic functions (5-147)

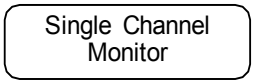
Warning

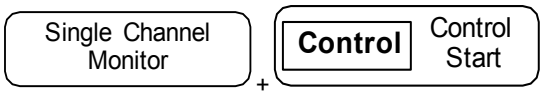
Safety check signals (pulses signals) are sent from the drive terminals (T12 to T15) to diagnose external devices and monitor circuits. Safety check signals can not be used as a power supply for connected devices.

Note. If there are unused safety outputs, connect the intended external device monitor terminals (Xn) to the corresponding drive terminals (Tn). If they are not connected, the SafetyOne detects an input monitor error. As the result, the error LED displays “1” and the unit changes to the Protection state.

●Start inputs: X16 and X17

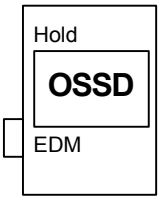
Start inputs are used to control the start of safety outputs.

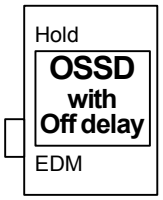
Intended inputs (Terminal names)	Target safety inputs (Terminal names)	Function	
Start input 1 (X16)	Safety input 1 (X1-T0: AUTO) Safety input 2 (X2, X3) Safety input 3 (X4, X5) Safety input 4 (X6, X7)	Function name	Monitor input
		Symbol	
		Description of operation	Safety outputs are started, when all target safety inputs are in the safe state and this function is in the ON state. This function is turned ON by 0.1s or more ON operation.
		Detail information	Logic functions (5-146)

Intended inputs (Terminal names)	Target safety inputs (Terminal names)	Function	
Start input 2 (X17)	Safety input 1 (X0/X1-T0) Safety input 3 (X4, X5) Safety input 4 (X6, X7) Safety input 5 (X10, X11)	Function name	Monitor input + Control start
		Symbol	
		Description of operation	Safety outputs are started, when this function becomes ON after all intended safety inputs are in the safe state. This function is turned ON by 0.1s to 5s ON operation.
		Detail information	Logic functions (5-146, 5-152)

●Safety outputs: Y0 to Y3

Safety outputs are used to output safety information processed by SafetyOne.

Intended outputs (Terminal names)	Function	
Safety output 1 (Y0) Safety output 2 (Y1) Safety output 3-1 (Y2)	Function name	Safety output without timer
	Symbol	
	Description of operation	This function is a safety output to output safety information processed by SafetyOne. The output is turned OFF immediately by OFF operation (instantaneous OFF output).
	Detail information	Logic functions (5-154)

Intended outputs (Terminal names)	Function	
Safety output 3-2 (Y3)	Function name	Safety output with timer
	Symbol	
	Description of operation	This function is a safety output to output safety information processed by SafetyOne. The output is turned OFF after the preset time of the OFF-delay timer (OFF-delay output).
	Detail information	Logic functions (5-157)

Note. When the SafetyOne changes to Protection state due to input monitor error, safety outputs without timer (safety output 1, safety output 2, and safety output 3-1) are turned OFF. Safety output with timer (safety output 3-2) is turned OFF after the preset OFF-delay time.

Note. When the SafetyOne changes to Stop state due to circuit failure or other errors, all safety outputs (safety output 1, safety output 2, safety output 3-1, and safety output 3-2) are turned OFF, immediately.

Note. Set time of safety output with timer is active independent of the selected mode.

●Safety input monitor outputs: Y4 to Y11

Safety input monitor outputs are used to output the status of safety inputs in SafetyOne.

Intended outputs (Terminal names)	Target safety inputs (Terminal names)	Description of operation
Safety input 1 monitor 1 output (Y4)	Safety input 1 (X0-T0: TEACH)	When TEACH mode (X0) is selected, the monitor output is ON. When TEACH mode is not selected, the monitor output is OFF.
Safety input 1 monitor 2 output (Y11)	Safety input 1 (X1-T0: AUTO)	When AUTO mode (X1) is selected, the monitor output is ON. When AUTO mode is not selected, the monitor output is OFF.
Safety input 2 monitor output (Y5)	Safety input 2 (X2, X3)	When the target safety input is ON, the monitor output is ON. When the target safety input is OFF, the monitor output is OFF.
Safety input 3 monitor output (Y6)	Safety input 3 (X4, X5)	
Safety input 4 monitor output (Y7)	Safety input 4 (X6, X7)	
Safety input 5 monitor output (Y10)	Safety input 5 (X10, X11)	

Note. The monitor output is OFF in errors, Initial state, or Configuration state.

●Safety output monitor outputs: Y12, Y13, Y17, and Y20

Safety output monitor outputs are used to output status of safety outputs in SafetyOne.

Intended outputs (Terminal names)	Target safety outputs (Terminal names)	Description of operation
Safety output 1 monitor output (Y12)	Safety output 1 (Y0)	When the target safety output is ON, the monitor output is ON. When the target safety output is OFF, this function is OFF. The monitor output turns OFF immediately, independent of the preset OFF-delay time.
Safety output 2 monitor output (Y13)	Safety output 2 (Y1)	
Safety output 3-1 monitor output (Y17)	Safety output 3-1 (Y2)	
Safety output 3-2 monitor output (Y20)	Safety output 3-2 (Y3)	

Note. The monitor output is OFF in errors, Initial state, or Configuration state.

●State monitor outputs: Y14 to Y16

State monitor outputs are used to output the internal state of SafetyOne.

Intended outputs (Terminal names)	State				
	Initial	Run	Configuration	Protection	Stop
State monitor output 1 (Y14)	■ON	□OFF	□OFF	□OFF	■ON
State monitor output 2 (Y15)	■ON	□OFF	■ON	■ON	■ON or□OFF
State monitor output 3 (Y16)	□OFF	■ON	□OFF	□OFF	□OFF

Refer to “Chapter 4 BASIC OPERATIONS” and to “Chapter 6 TROUBLE SHOOTING” for details of each state.

Warning

The monitor outputs are not safety outputs. Do not use these to construct a safety system.

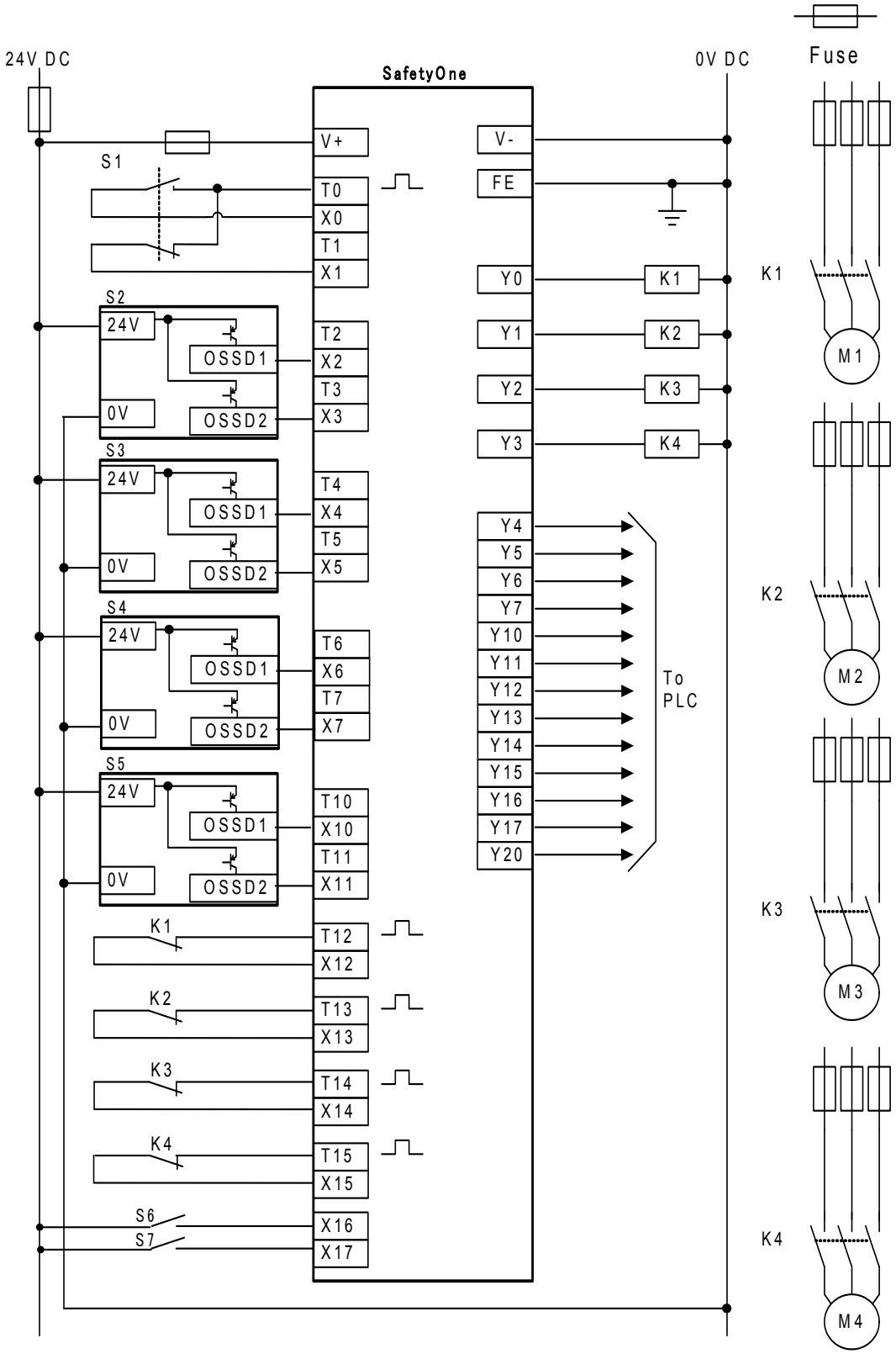
Caution

Refer to "Chapter 2 PRODUCT SPECIFICATIONS" for specifications of each input and output.

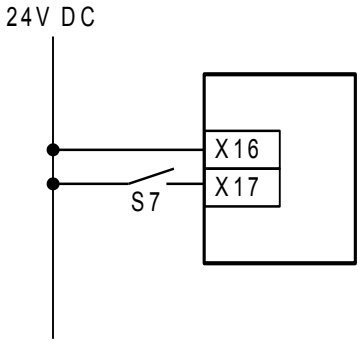
Wiring example (Logic 24C)

In the case where 1 selector switch and 4 safety light curtains are connected.

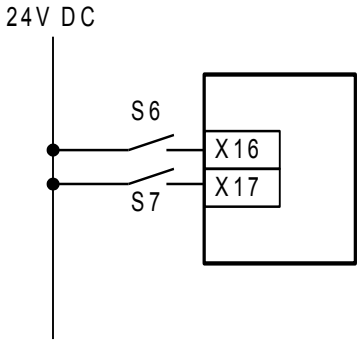
S1 :Selector switch
S2, 3, 4, 5 :Safety light curtain
S6, 7 :Start switch
K1 to 4 :Contactor
M1 to 4 :Motor



When not using the start S6 (Auto start)

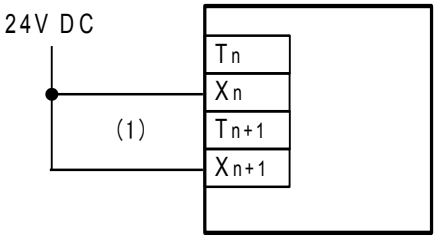


When using the start switch S6 (Manual start)



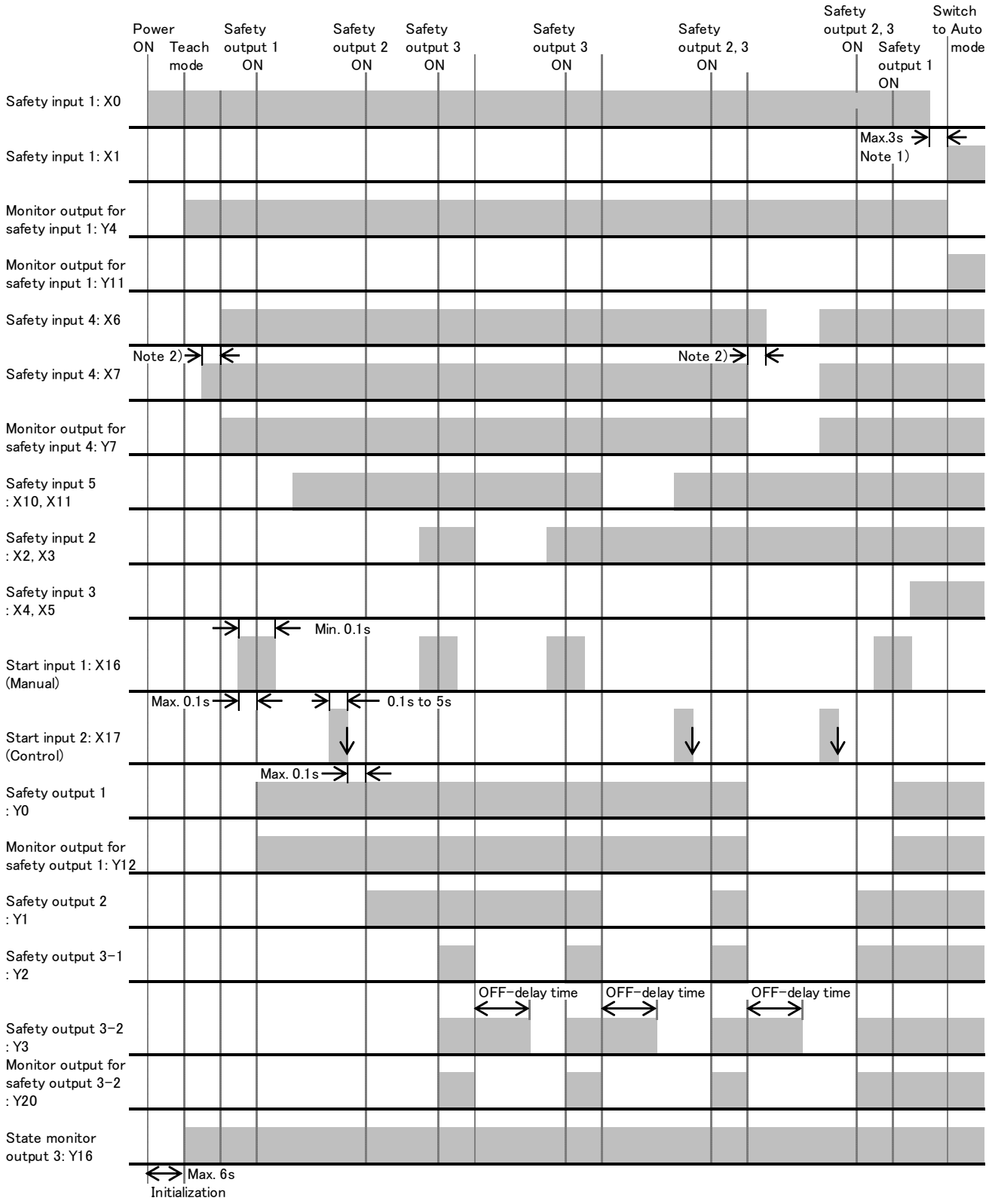
When not using some safety inputs

・If there are unused safety inputs in S2 to S5, connect the unused receive terminals to 24V DC power supply (V+). (Refer to (1))



Timing chart (Logic 24C)

Example: Teach mode



Note 1) When “Safety input 1 (mode select input II)” is switched to another mode within 3s, all of Safety output are kept ON.

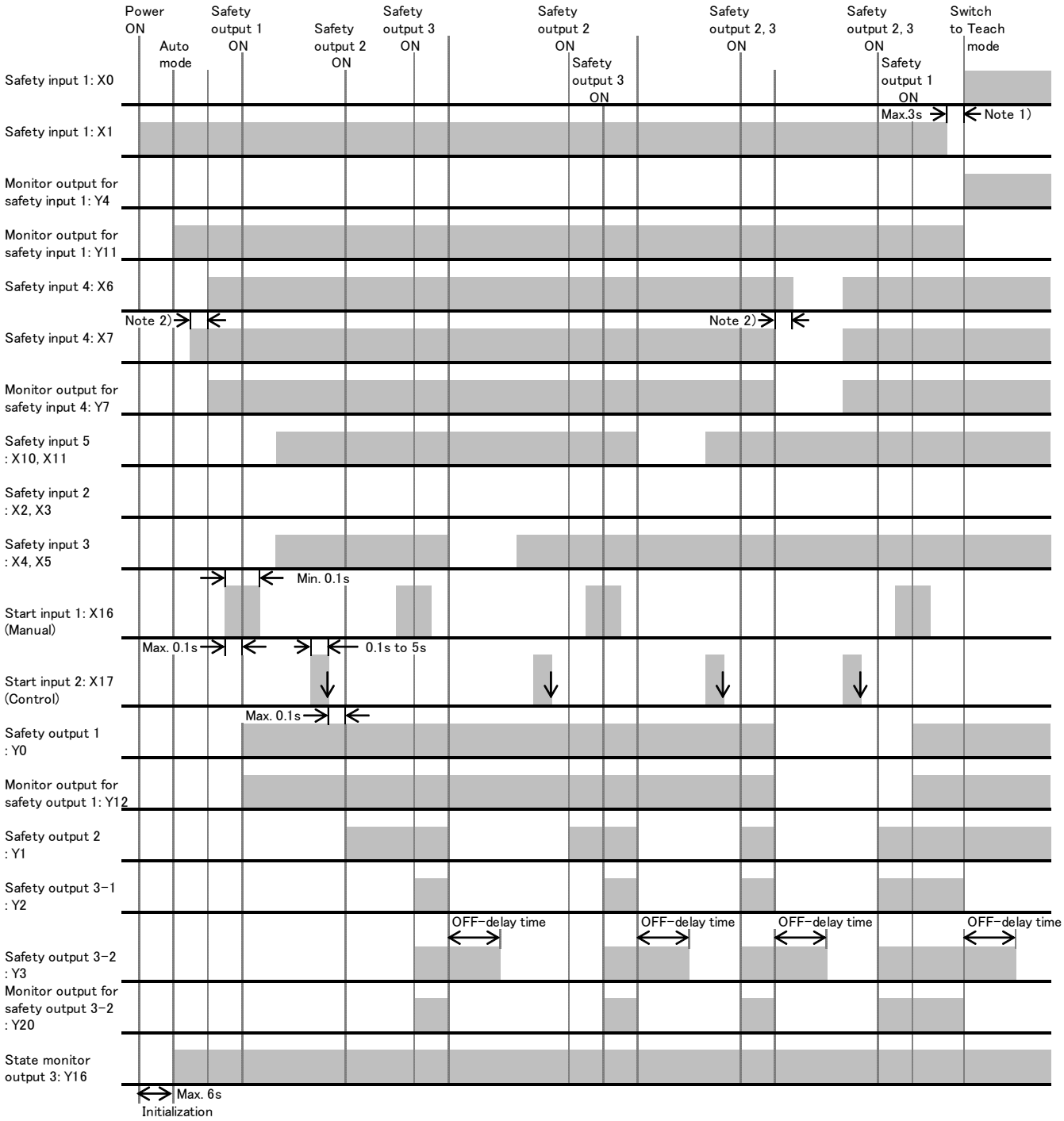
Note 2) Input monitor error detection time is infinity.

About safety inputs that are not described in this chart, input monitor error detection time is as follows.

The time of dual channel safety input II (X2 to X5, X10, and X11) is infinity.

Refer to the following “Logic functions” (5-128) for more details.

Example: Auto mode

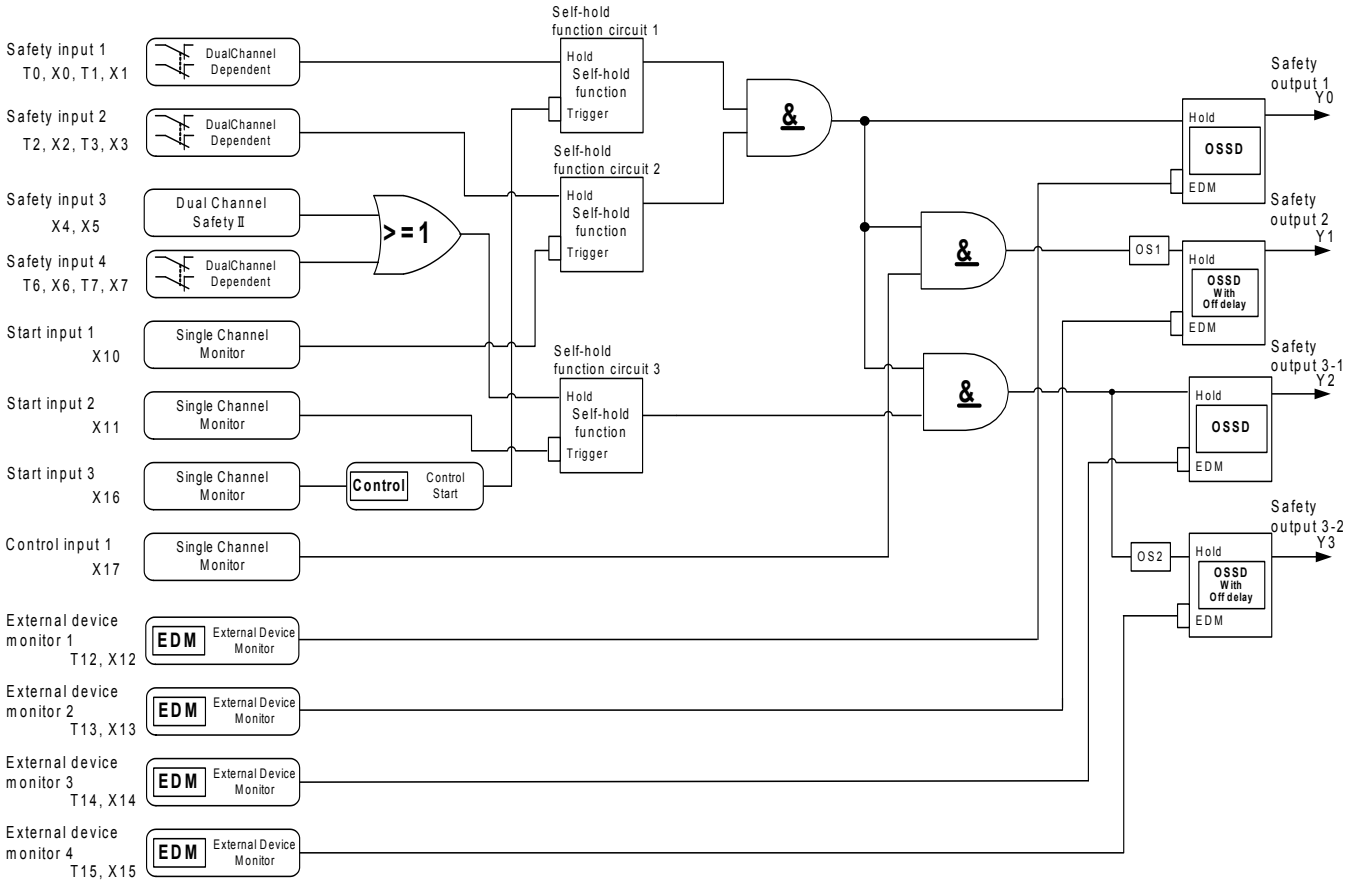


Note 1) When “Safety input 1 (mode select input II)” is switched to another mode within 3s, “Safety output 1” is kept ON.

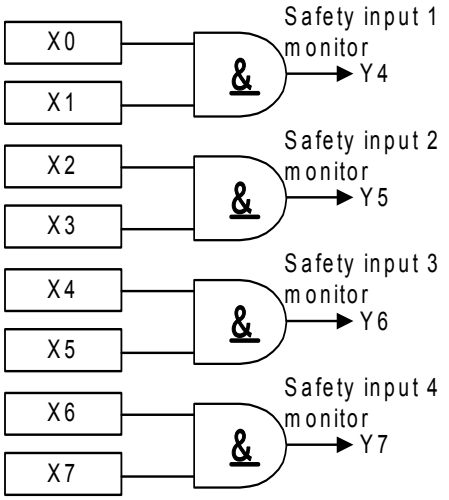
Note 2) Input monitor error detection time is infinity.

Logic 24d: The logic constructing an OR circuit for various apparatus

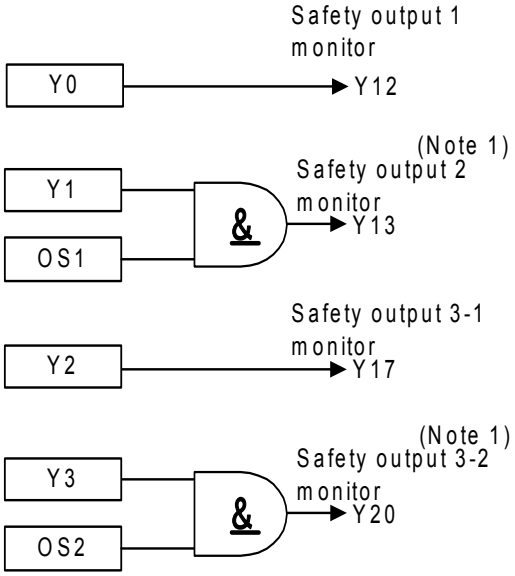
Logic circuit (Logic 24d) (in the case of SW version 2.00 or higher)



● Monitor output for safety input



● Monitor output for safety output

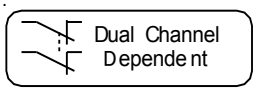


Note 1:
Safety output 2 and safety output 3-2 turn OFF immediately independent of OFF-delay time.

Function (Logic 24d)

●Safety inputs: X0 to X7 (T0 to T3, T6, and T7)

Safety inputs are used to diagnose the status of connected safety devices, such as emergency stop switches and interlock switches.

Intended inputs (Terminal names)	Function	
Safety input 1 (X0-T0, X1-T1) Safety input 2 (X2-T2, X3-T3) Safety input 4 (X6-T6, X7-T7)	Function name	Dual channel dependent input
	Symbol	
	Description of operation	This function diagnoses the status of connected safety devices. This function does not diagnose the time interval of status transition between each input of duplicated inputs.
	Detail information	Logic functions (5-132)

Intended inputs (Terminal names)	Function	
Safety input 3 (X4, X5)	Function name	Dual channel safety input II
	Symbol	
	Description of operation	This function diagnoses the status of connected safety devices. This function dose not diagnoses the time interval of status transition between each input of duplicated inputs. The function does not use drive terminals (T4 and T5).
	Detail information	Logic functions (5-138)

Warning

For connected control devices, refer to “SAFETY PRECAUTIONS”.

Safety check signals (pulses signals) are sent from the drive terminals (T0 to T3, T6, and T7) to diagnose connected safety devices and input circuits. Safety check signals can not be used as a power supply for connected devices.

This logic enables constructing an OR circuit.

Conformity to requirements of safety category is determined as an entire system.

Validate safety function of entire system by customer's responsibility.

Input states of all safety inputs are monitored when SafetyOne is in Run state or Protection state. However, for example, when safety input 3 is in ON state and safety output is ON state, if faults, such as grounding or an open circuit, at one of the safety input 4 occur SafetyOne is kept in Run state and the safety output is kept ON state. In this case safety input 4 monitor output (Y7) is OFF.

Note. Solid state outputs, such as safety light curtains, can not be connected to safety input 1, 2, and 4.

Note. Use safety input 1, 2, and 4, as specified combinations, such as receive terminal (Xn) and drive terminal (Tn). If the combinations are incorrect, SafetyOne does not work correctly.

Note. If there are unused safety inputs in safety input 1, 2, and 4, connect the unused receive terminals (Xn) to the corresponding drive terminals (Tn). If they are not connected, the SafetyOne does not turn ON the safety outputs.

●External device monitor inputs: X12 to X15 (T12 to T15)

External device monitor inputs are used to diagnose status of the devices connected to safety outputs.

Intended inputs (Terminal names)	Target safety outputs (Terminal names)	Function	
External device monitor input 1 (X12-T12)	Safety output 1 (Y0)	Function name	External device monitor input
External device monitor input 2 (X13-T13)	Safety output 2 (Y1)	Symbol	
External device monitor input 3 (X14-T14)	Safety output 3-1 (Y2)	Description of operation	This function diagnoses the status of devices connected to a target safety output.
External device monitor input 4 (X15-T15)	Safety output 3-2 (Y3)	Detail information	Logic functions (5-147)

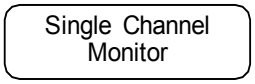
Warning

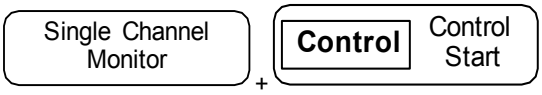
Safety check signals (pulses signals) are sent from the drive terminals (T12 to T15) to diagnose external devices and monitor circuits. Safety check signals can not be used as a power supply for connected devices.

Note. If there are unused safety outputs, connect the intended external device monitor terminals (Xn) to the corresponding drive terminals (Tn). If they are not connected, the SafetyOne detects an input monitor error. As the result, the error LED displays “1” and the unit changes to the Protection state.

●Start inputs: X10, X11, and X16

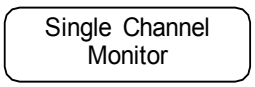
Start inputs are used to control the start of safety outputs.

Intended inputs (Terminal names)	Target safety inputs (Terminal names)	Function	
Start input 1 (X10)	Safety input 2 (X2-T2, X3-T3)	Function name	Monitor input
		Symbol	
Start input 2 (X11)	Safety input 3 (X4, X5) Safety input 4 (X6-T6, X7-T7)	Description of operation	Safety outputs are started, when all target safety inputs are in the safe state and this function is in the ON state. This function is turned ON by 0.1s or more ON operation.
		Detail information	Logic functions (5-146)

Intended inputs (Terminal names)	Target safety inputs (Terminal names)	Function	
Start input 3 (X16)	Safety input 1 (X0-T0, X1-T1)	Function name	Monitor input + Control start
		Symbol	
		Description of operation	Safety outputs are started, when this function becomes ON after all intended safety inputs are in the safe state. This function is turned ON by 0.1s to 5s ON operation.
		Detail information	Logic functions (5-146, 5-152)

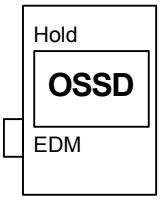
●Control input: X17

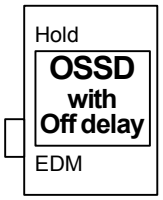
Control input is used to control of safety outputs.

Intended inputs (Terminal names)	Target safety outputs (Terminal names)	Function	
Control input 1 (X17)	Safety output 2 (Y1)	Function name	Monitor input
		Symbol	
		Description of operation	Target safety outputs are controled by these control inputs.
		Detail information	Logic Functions (5-146)

●Safety outputs: Y0 to Y3

Safety outputs are used to output safety information processed by SafetyOne.

Intended outputs (Terminal names)	Function	
Safety output 1 (Y0) Safety output 3-1 (Y2)	Function name	Safety output without timer
	Symbol	
	Description of operation	This function is a safety output to output safety information processed by SafetyOne. The output is turned OFF immediately by OFF operation (instantaneous OFF output).
	Detail information	Logic functions (5-154)

Intended outputs (Terminal names)	Function	
Safety output 2 (Y1) Safety output 3-2 (Y3)	Function name	Safety output with timer
	Symbol	
	Description of operation	This function is a safety output to output safety information processed by SafetyOne. The output is turned OFF after the preset time of the OFF-delay timer (OFF-delay output).
	Detail information	Logic functions (5-157)

Note. When the SafetyOne changes to Protection state due to input monitor error, safety output without timer (safety output 1 and safety output 3-1) is turned OFF. Safety output with timer (safety output 2 and safety output 3-2) is turned OFF after the preset OFF-delay time.

Note. When the SafetyOne changes to Stop state due to circuit failure or other errors, all safety outputs (safety output 1, safety output 2, safety output 3-1, and safety output 3-2) are turned OFF, immediately.

●Safety input monitor outputs: Y4 to Y7

Safety input monitor outputs are used to output the status of safety inputs in SafetyOne.

Intended outputs (Terminal names)	Target safety inputs (Terminal names)	Description of operation
Safety input 1 monitor output (Y4)	Safety input 1 (X0-T0, X1-T1)	When the target safety input is ON, the monitor output is ON. When the target safety input is OFF, the monitor output is OFF.
Safety input 2 monitor output (Y5)	Safety input 2 (X2-T2, X3-T3)	
Safety input 3 monitor output (Y6)	Safety input 3 (X4, X5)	
Safety input 4 monitor output (Y7)	Safety input 4 (X6-T6, X7-T7)	

Note. The monitor output is OFF in errors, Initial state, or Configuration state.

●Safety output monitor outputs: Y12, Y13, Y17, and Y20

Safety output monitor outputs are used to output the status of safety outputs in SafetyOne.

Intended outputs (Terminal names)	Target safety outputs (Terminal names)	Description of operation
Safety output 1 monitor output (Y12)	Safety output 1 (Y0)	When the target safety output is ON, the monitor output is ON. When the target safety output is OFF, this function is OFF. The monitor output turns OFF immediately, independent of the preset OFF-delay time.
Safety output 2 monitor output (Y13)	Safety output 2 (Y1)	
Safety output 3-1 monitor output (Y17)	Safety output 3-1 (Y2)	
Safety output 3-2 monitor output (Y20)	Safety output 3-2 (Y3)	

Note. The monitor output is OFF in errors, Initial state, or Configuration state.

●State monitor outputs: Y14 to Y16

State monitor outputs are used to output the internal state of SafetyOne.

Intended outputs (Terminal names)	State				
	Initial	Run	Configuration	Protection	Stop
State monitor output 1 (Y14)	■ON	□OFF	□OFF	□OFF	■ON
State monitor output 2 (Y15)	■ON	□OFF	■ON	■ON	■ON or □OFF
State monitor output 3 (Y16)	□OFF	■ON	□OFF	□OFF	□OFF

Refer to “Chapter 4 BASIC OPERATIONS” and to “Chapter 6 TROUBLE SHOOTING” for details of each state.

Warning

The monitor outputs are not safety outputs. Do not use these to construct a safety system.

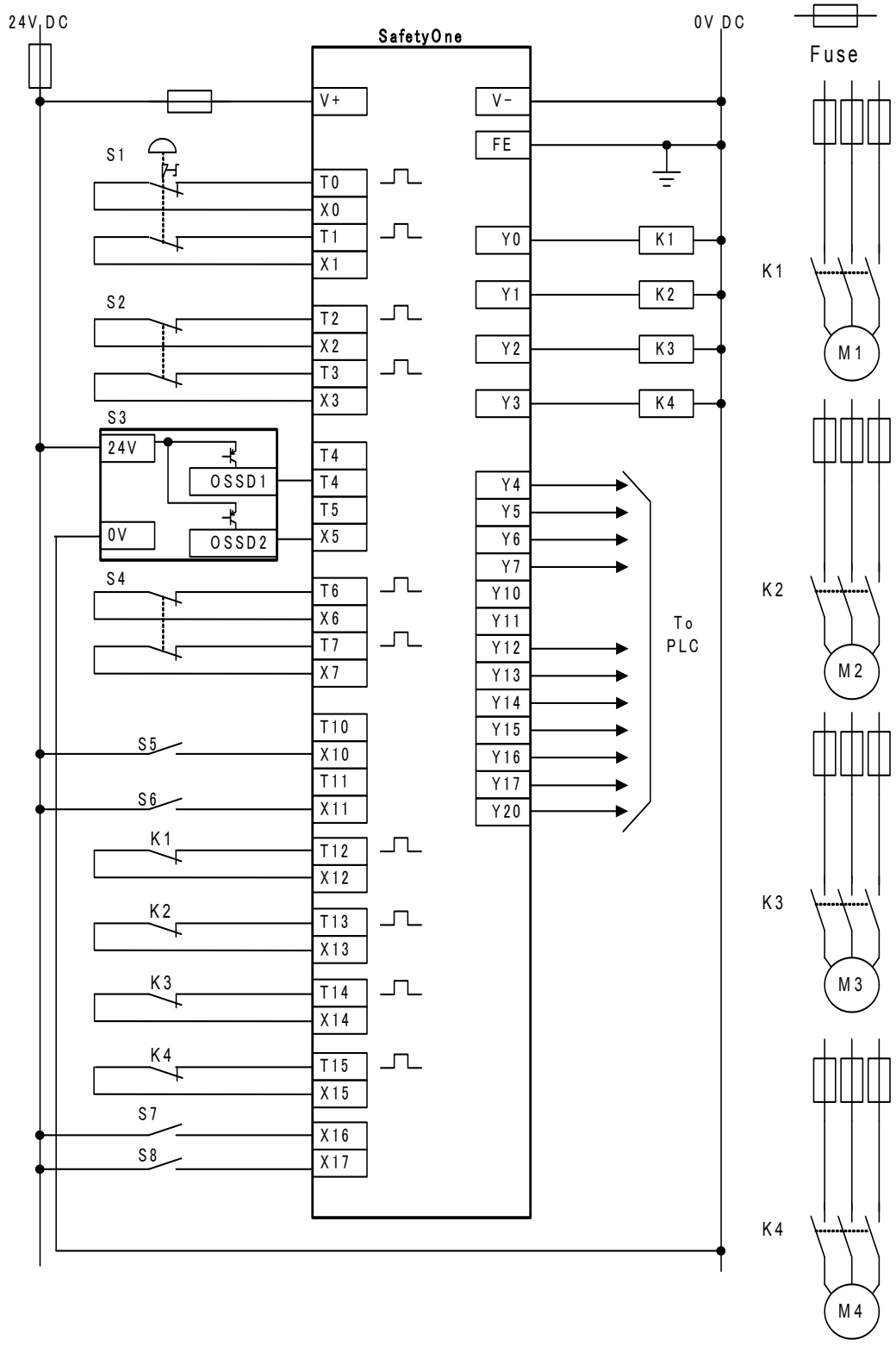
Caution

Refer to "Chapter 2 PRODUCT SPECIFICATIONS" for specifications of each input and output.

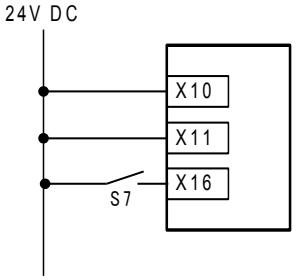
Wiring example (Logic 24d)

In the case where 1 emergency stop switch, 2 interlock switches, and 1 safety light curtain are connected.

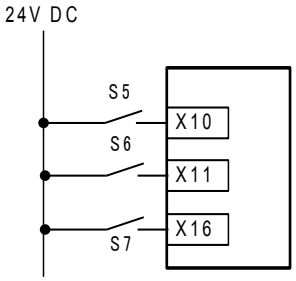
S1 : Emergency stop switch
S2, 4 : Interlock switch
S3 : Safety light curtain
S5, 6, 7 : Start switch
S8 : Control input switch
K1 to 4 : Contactor
M1 to 4 : Motor



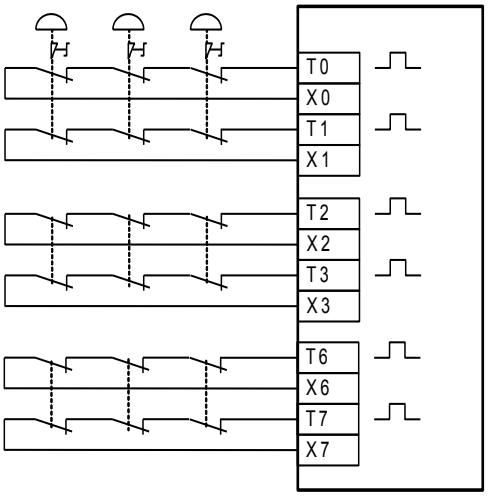
When not using the start switch (Auto start)



When not detecting the welding of start switch (Manual start)



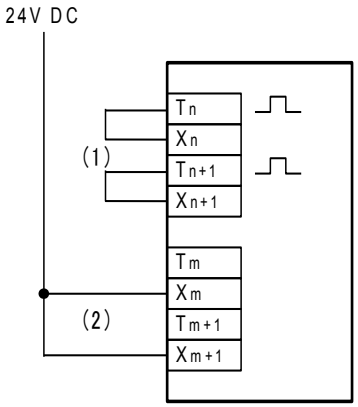
When connecting multiple emergency stop switches in series



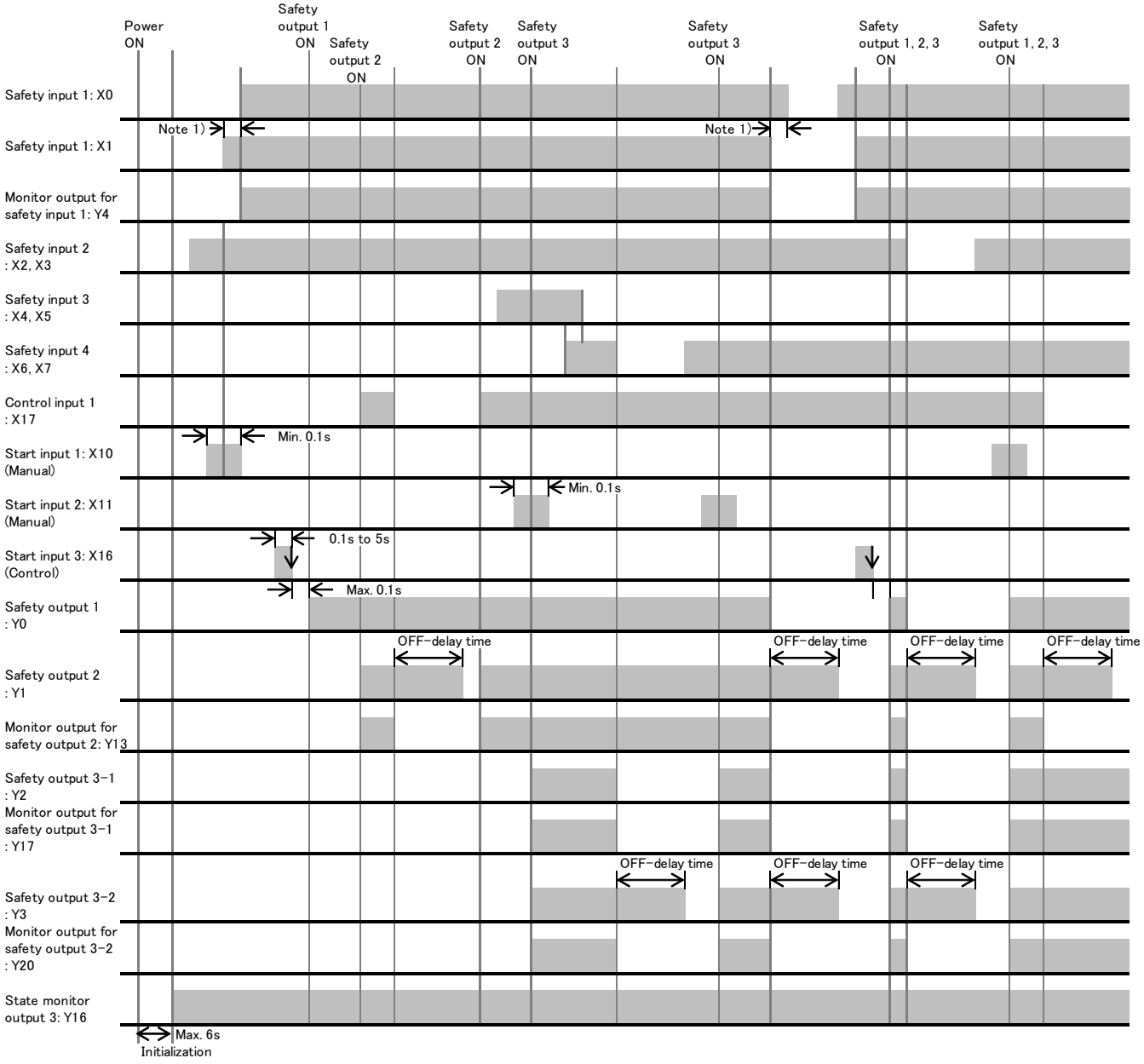
NOTE: Safety performance depends on the system configuration.

When not using some inputs

- If there are unused safety inputs in S1, S2, and S4, connect the unused receive terminals to the corresponding drive terminals. (Refer to (1))
- If S3 is not used, connect the receive terminal to 24V DC power supply (V+). (Refer to (2))



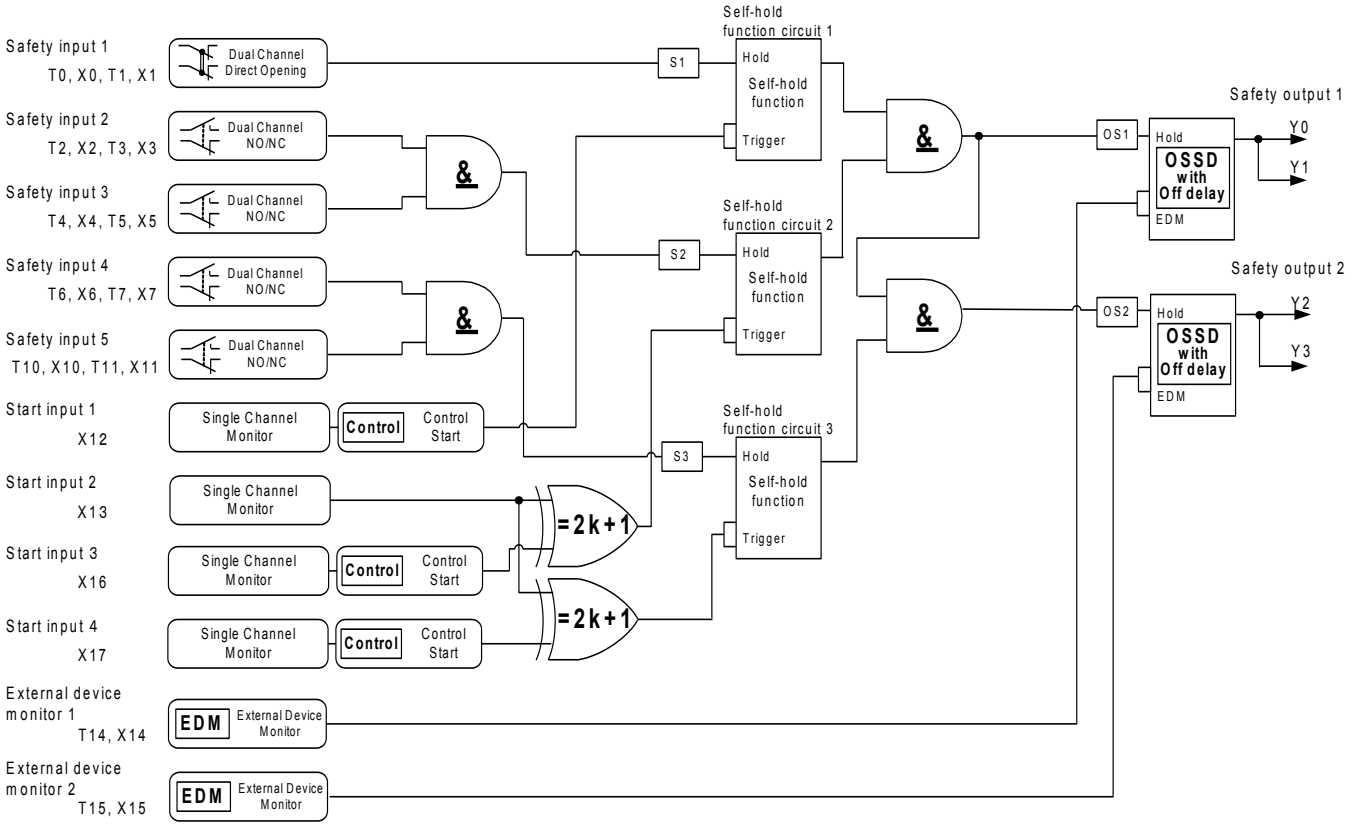
Timing chart (Logic 24d)



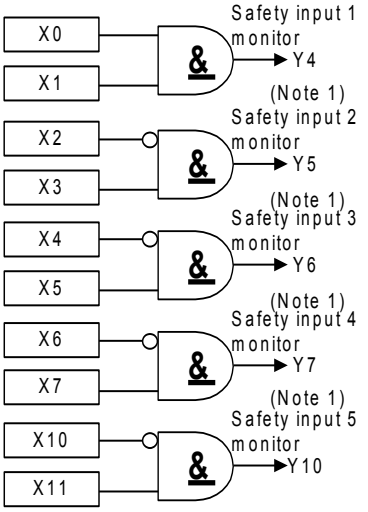
Note 1) Input monitor error detection time is infinity.
About safety inputs that are not described in this chart, input monitor error detection time is as follows.
The time of dual channel dependent input (X2, X3, X6, and X7) is infinity.
The time of dual channel safety input II (X4 and X5) is infinity.
Refer to the following "Logic functions" (5-128) for more details.

Logic 208: Partial stop logic for various apparatus

Logic circuit (Logic 208) (in the case of SW version 2.00 or higher)

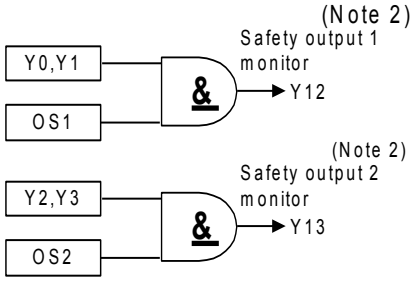


● Monitor output for safety input



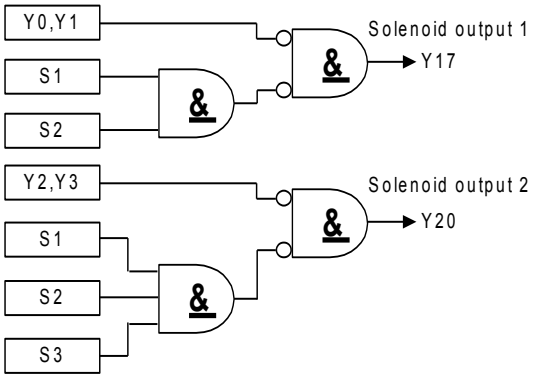
Note1:
When X_n is OFF and X_{n+1} is ON, safety input 2 monitor to safety input 5 monitor turn ON.
(n = 2, 4, 6, and 10)

● Monitor output for safety output



Note 2:
Monitoring outputs for safety output 1 and 2 are turned OFF immediately independent of preset OFF-Delay time.

● Solenoid output (Note 3)

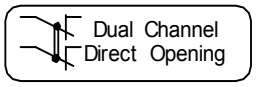


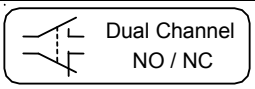
Note 3:
In the Run state, when the safety Outputs are OFF and 1 or more corresponding safety inputs are OFF the solenoid outputs are turned ON. When all corresponding safety inputs are ON, the solenoid outputs are turned OFF without the ON signal of the start input.

Functions (Logic 208)

●Safety inputs: X0 to X7, X10, and X11 (T0 to T7, T10, and T11)

Safety inputs are used to diagnose the status of connected safety devices, such as emergency stop switches, and non-contact interlock switches.

Intended inputs (Terminal names)	Function	
Safety input 1 (X0-T0, X1-T1)	Function name	Dual channel direct opening input
	Symbol	
	Description of operation	This function diagnoses the status of connected safety devices. This function diagnoses the time interval of status transition between each input of duplicated inputs (0.5s).
	Detail information	Logic functions (5-130)

Intended inputs (Terminal names)	Function	
Safety input 2 (X2-T2, X3-T3) Safety input 3 (X4-T4, X5-T5) Safety input 4 (X6-T6, X7-T7) Safety input 5 (X10-T10, X11-T11)	Function name	Dual channel NO/NC input
	Symbol	
	Description of operation	This function diagnoses the status of connected safety devices. This function diagnoses the time interval of status transition between each input of duplicated inputs (0.5s).
	Detail information	Logic functions (5-134)

Warning

For connected control devices, refer to “SAFETY PRECAUTIONS”.

Safety check signals (pulses signals) are sent from the drive terminals (T0 to T7, T10, and T11) to diagnose connected safety devices and input circuits. Safety check signals can not be used as a power supply for connected devices.

Note. Solid state outputs, such as safety light curtains, can not be connected to safety input 1 to 5.

Note. Use safety input 1 to 5 as specified combinations, such as receive terminal (Xn) and drive terminal (Tn). If the combinations are incorrect, SafetyOne does not work correctly.

Note. If there are unused safety inputs in safety input 1, connect the unused receive terminals (Xn) to the corresponding drive terminals (Tn). If they are not connected, the SafetyOne does not turn ON the safety outputs.

Note. If there are unused safety inputs in safety input 2 to 5, open or connect the unused receive terminals (Xn) to the corresponding drive terminals (Tn) as shown below. If they are not connected, the SafetyOne does not turn ON the safety outputs.

Open: X2-T2, X4-T4, X6-T6, X10-T10

Connect: X3-T3, X5-T5, X7-T7, X11-T11

●External device monitor inputs: X14 and X15 (T14 and T15)

External device monitor inputs are used to diagnose the status of devices connected to safety outputs.

Intended inputs (Terminal names)	Target safety outputs (Terminal names)	Function	
External device monitor input 1 (X14-T14)	Safety output 1 (Y0, Y1)	Function name	External device monitor input
External device monitor input 2 (X15-T15)	Safety output 2 (Y2, Y3)	Symbol	
		Description of operation	This function diagnoses the status of devices connected to a target safety output.
		Detail information	Logic functions (5-147)

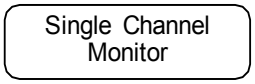
Warning

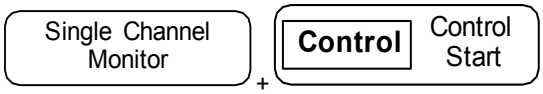
Safety check signals (pulses signals) are sent from the drive terminals (T14, T15) to diagnose external devices and monitor circuits. Safety check signals can not be used as a power supply for connected devices.

Note. If there are unused safety outputs, connect the intended external device monitor terminals (Xn) to the corresponding drive terminals (Tn). If they are not connected, the SafetyOne detects an input monitor error. As the result, the error LED displays “1” and the unit changes to the Protection state.

●Start inputs: X12, X13, X16, and X17

Start inputs are used to control the start of safety outputs.

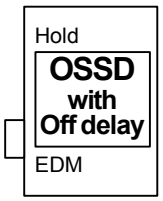
Intended inputs (Terminal names)	Target safety inputs (Terminal names)	Function	
Start input 2 (X13)	Safety input 2 (X2-T2, X3-T3) Safety input 3 (X4-T4, X5-T5) Safety input 4 (X6-T6, X7-T7) Safety input 5 (X10-T10, X11-T11)	Function name	Monitor input
		Symbol	
		Description of operation	Safety outputs are started, when all target safety inputs are in the safe state and this function is in the ON state. This function is turned ON by 0.1s or more ON operation.
		Detail information	Logic Functions (5-146)

Intended inputs (Terminal names)	Target safety inputs (Terminal names)	Function	
Start input 1 (X12)	Safety input 1 (X0-T0, X1-T1)	Function name	Monitor input + Control start
Start input 3 (X16)	Safety input 2 (X2-T2, X3-T3) Safety input 3 (X4, X5)	Symbol	
Start input 4 (X17)	Safety input 4 (X6-T6, X7-T7) Safety input 5 (X10-T10, X11-T11)	Description of operation	Safety outputs are started, when this function becomes ON after all intended safety inputs are in the safe state. This function is turned ON by 0.1s to 5s ON operation.
		Detail information	Logic functions (5-146, 5-152)

Note. If both of X13 and X16 are turned ON or both of X13 and X17 are turned ON, the SafetyOne will detect an error. As a result, the error LED displays “3” and the state changes to the Stop state. Use only X16 or X17.

●Safety outputs: Y0 to Y3

Safety outputs are used to output safety information processed by SafetyOne.

Intended outputs (Terminal names)	Function	
Safety output 1 (Y0, Y1) Safety output 2 (Y2, Y3)	Function name	Safety output with timer
	Symbol	
	Description of operation	This function is a safety output to output safety information processed by SafetyOne. The output is turned OFF after the preset time of the OFF-delay timer (OFF-delay output).
	Detail information	Logic functions (5-157)

Note. When the SafetyOne changes to Protection state due to input monitor error, safety outputs with timer are turned OFF after the preset OFF-delay time.

Note. When the SafetyOne changes to Stop state due to circuit failure or other errors, all safety outputs (safety output 1 and safety output 2) are turned OFF, immediately.

●Safety input monitor outputs: Y4 to Y10

Safety input monitor outputs are used to output status of safety inputs in SafetyOne.

Intended outputs (Terminal names)	Target safety inputs (Terminal names)	Description of operation
Safety input 1 monitor output (Y4)	Safety input 1 (X0-T0 X1-T1)	When the target safety input is ON, the monitor output is ON. When the target safety input is OFF, the monitor output is OFF.
Safety input 2 monitor output (Y5)	Safety input 2 (X2-T2, X3-T3)	
Safety input 3 monitor output (Y6)	Safety input 3 (X4-T4, X5-T5)	
Safety input 4 monitor output (Y7)	Safety input 4 (X6-T6, X7-T7)	
Safety input 5 monitor output (Y10)	Safety input 5 (X10-T10, X11-T11)	

Note. The monitor output is OFF in errors, Initial state, or Configuration state.

●Safety output monitor outputs: Y12 and Y13

Safety output monitor outputs are used to output status of safety outputs in SafetyOne.

Intended outputs (Terminal names)	Target safety outputs (Terminal names)	Description of operation
Safety output 1 monitor output (Y12)	Safety output 1 (Y0, Y1)	When the target safety output is ON, the monitor output is ON. When the target safety output is OFF, this function is OFF. The monitor output turns OFF immediately, independent of the preset OFF-delay time.
Safety output 2 monitor output (Y13)	Safety output 2 (Y2, Y3)	

Note. The monitor output is OFF in errors, Initial state, or Configuration state.

●State monitor outputs: Y14 to Y16

State monitor outputs are used to output the internal state of SafetyOne.

Intended outputs (Terminal names)	State				
	Initial	Run	Configuration	Protection	Stop
State monitor output 1 (Y14)	■ON	□OFF	□OFF	□OFF	■ON
State monitor output 2 (Y15)	■ON	□OFF	■ON	■ON	■ON or □OFF
State monitor output 3 (Y16)	□OFF	■ON	□OFF	□OFF	□OFF

Refer to “Chapter 4 BASIC OPERATIONS” and to “Chapter 6 TROUBLE SHOOTING” for details of each state.

Warning

The monitor outputs are not safety outputs. Do not use these to construct a safety system.

●Solenoid outputs: Y17 and Y20

Solenoid outputs are used to control a solenoid in an interlock switch.

Intended outputs (Terminal names)	Description of operation
Solenoid output 1 (Y17)	When safety output 1 is OFF, the solenoid output is ON. When safety Output 1 is ready to turn ON (safety output 1 can be turned ON by operation of the start input), the solenoid output is OFF.
Solenoid output 2 (Y20)	When safety output 2 is OFF, the solenoid output is ON. When safety Output 2 is ready to turn ON (safety output 2 can be turned ON by operation of the start input), the solenoid output is OFF.

Warning

The solenoid outputs are not safety outputs. Do not use these to construct a safety system.

Caution

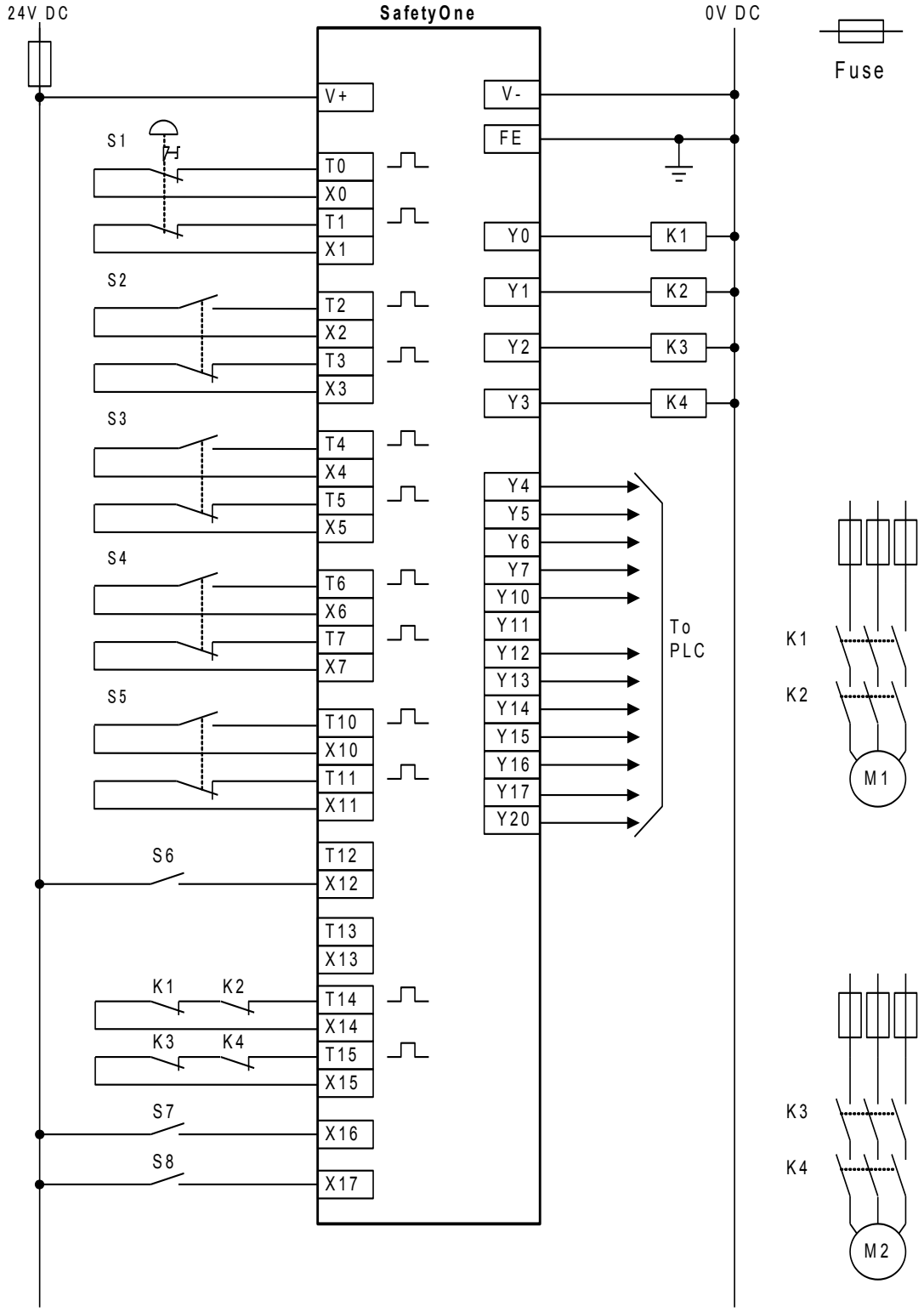
Refer to "Chapter 2 PRODUCT SPECIFICATIONS" for specifications of each input and output.

Note. The solenoid outputs are OFF in each state except Run state.

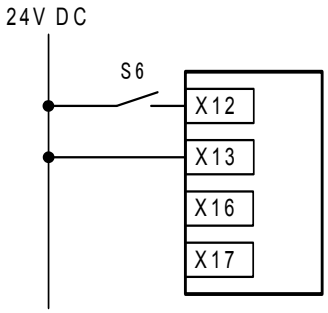
Wiring example (Logic 208)

In the case where 1 emergency stop switch and 4 non-contact interlock switches are connected.

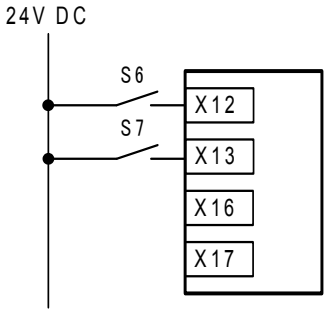
S1 : Emergency stop switch
S2 to 5 : Non-contact interlock switch (Illustration shows contact status when actuator is present.)
S6, 7, 8 : Start switch
K1 to 4 : Contactor
M1, 2 : Motor



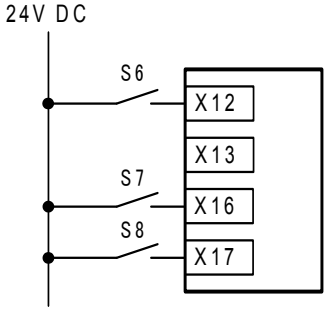
When not using the start switch (Auto start)



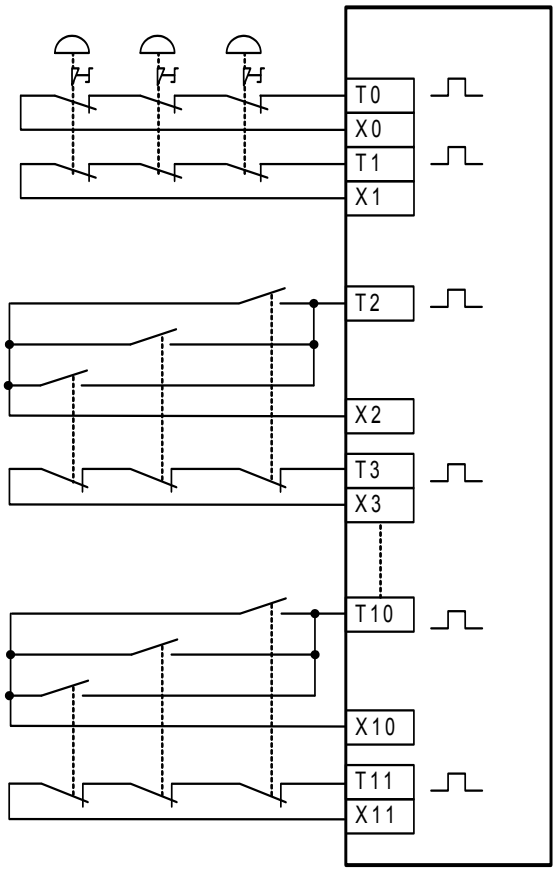
When not detecting the welding of start switch (Manual start)



When detecting the welding of start switch (Control start)



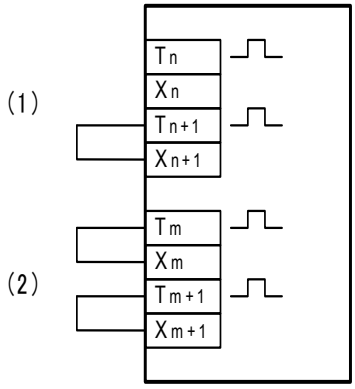
When connecting multiple components in series



NOTE: Safety performance depends on the system configuration.

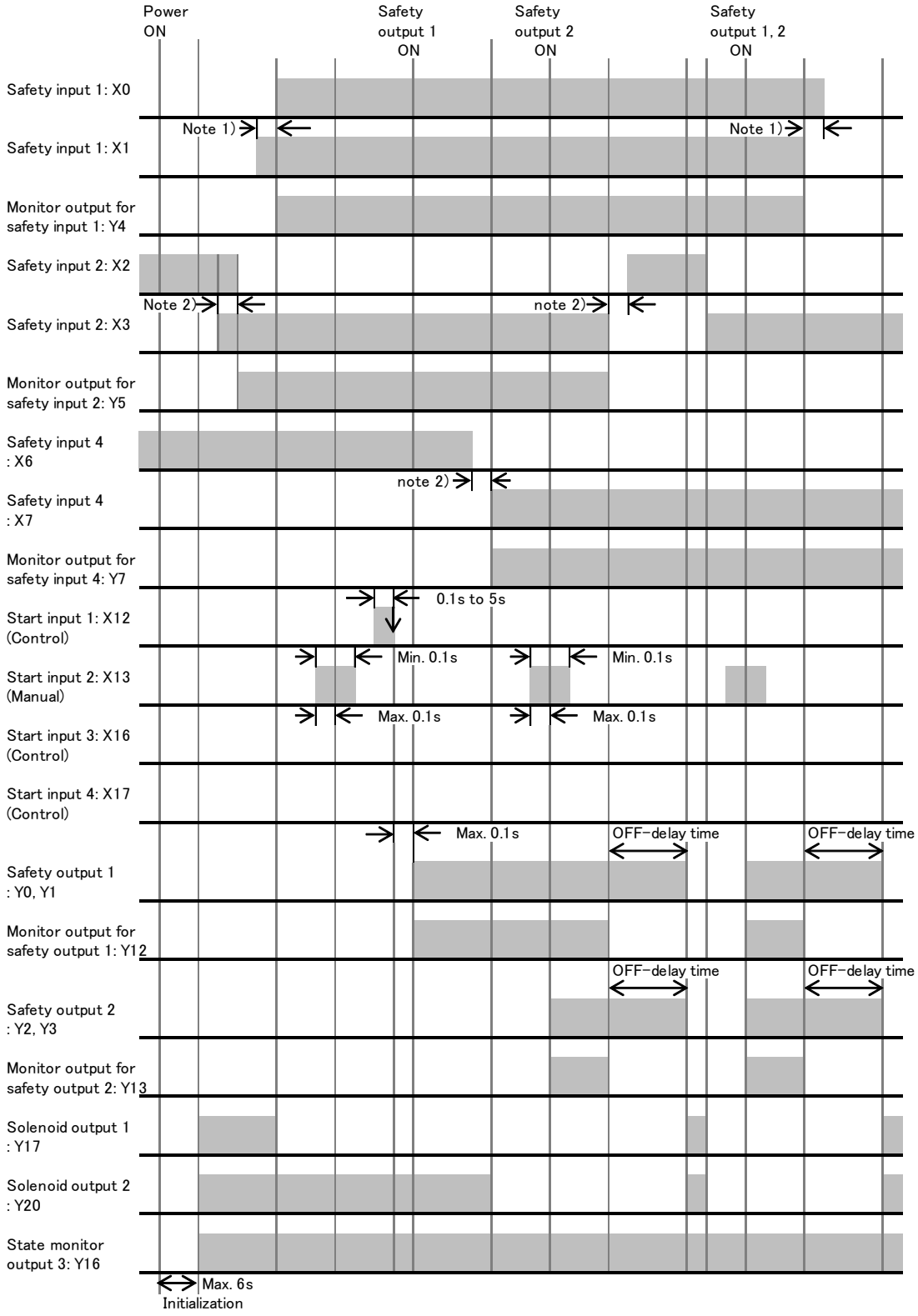
When not using some safety inputs

- If there are unused safety inputs in S2 to S5, open between Tn and Xn and connect Xn+1 to Tn+1. (Refer to (1)) (n = 2, 4, 6, 10)
- If there are unused safety inputs in S1, connect the unused receieve terminals to corresponding drive terminals. (Refer to (2))



Timing chart (Logic 208)

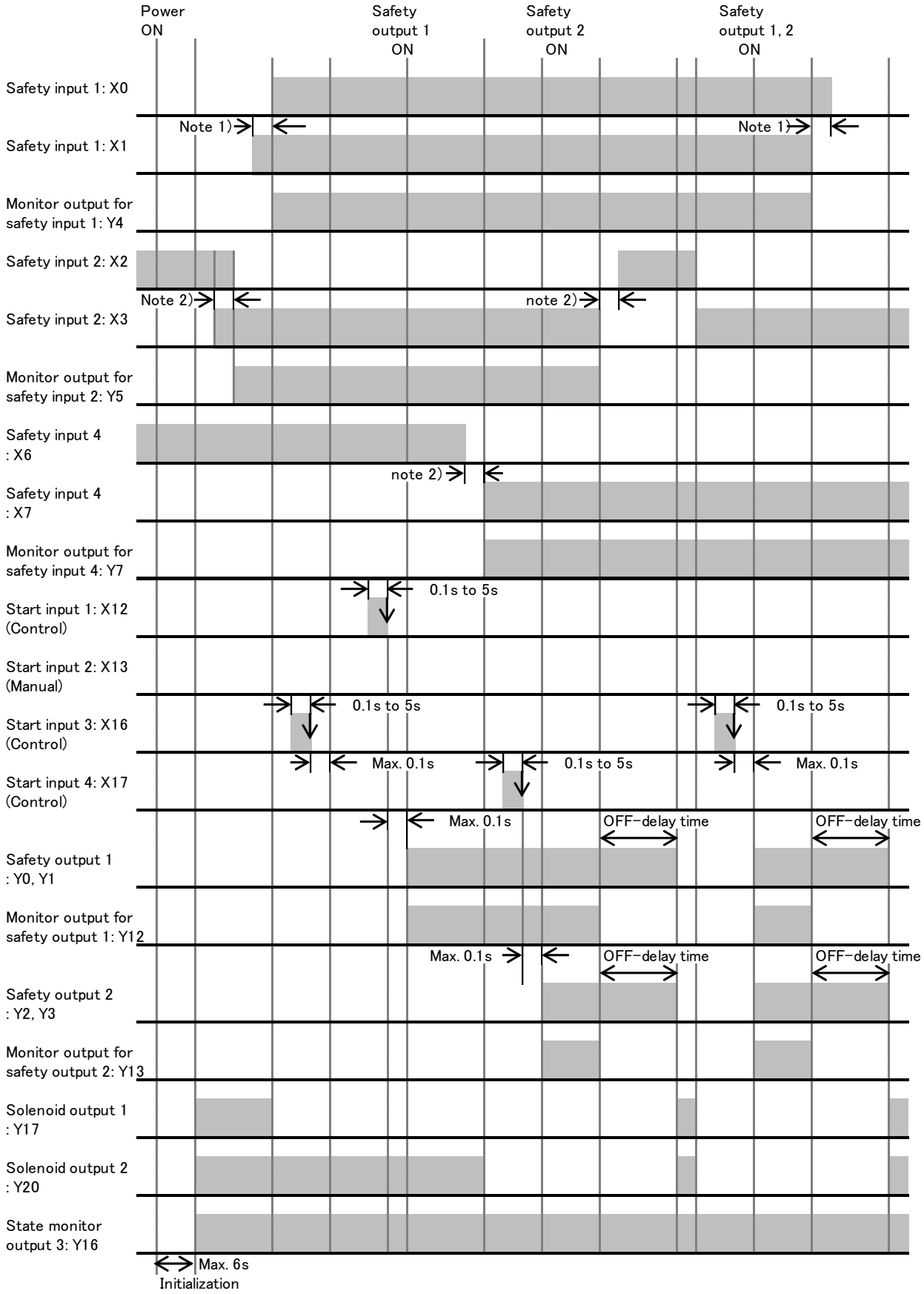
Example: Manual start input 2 (X13) is used.



Safety input 3 and 5 are all ON in this chart.

Note 1) Input monitor error detection time is 0.5s.
Note 2) Input monitor error detection time is 0.5s
About safety inputs that are not described in this chart, input monitor error detection time is as follows.
The time of dual channel NO/NC input (X4, X5, X10, and X11) is 0.5s.
Refer to the following “Logic functions” (5-128) for more details.

Example: Control start input 3 (X16) and Control start input 4 (X17) are used.



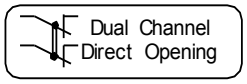
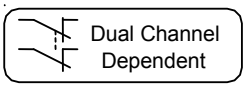
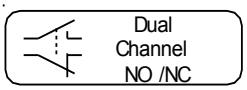
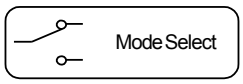
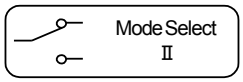
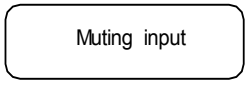
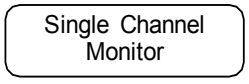
Safety input 3 and 5 are all ON in this chart.

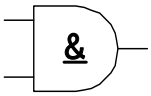
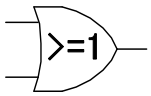
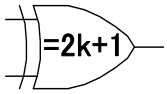
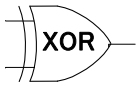
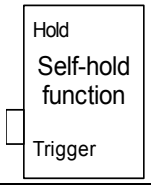
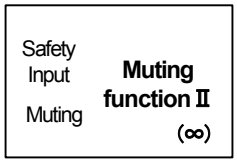
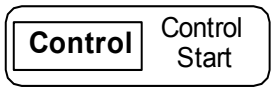
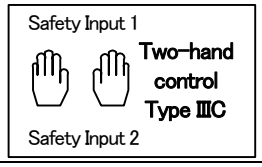
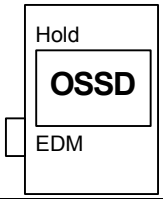
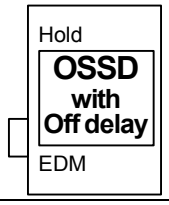
Note 1) Input monitor error detection time is 0.5s.
Note 2) Input monitor error detection time is 0.5s

Logic functions

This section describes the functions of each logic circuit. The logic functions are separated into input, logic operation, and output functions in Table 5-1. Select the appropriate logic after understanding its functionality.

Table 5-1 List of logic functions

Type	Function	Symbol	Description	Reference page
Input function	Dual channel direct opening input		This function is for connecting safety devices with dual channel direct opening action mechanisms, such as emergency stop switches or interlock switches.	5-130
	Dual channel dependent input		This function is for connecting safety devices with dual channel dependent action mechanisms, such as enabling switches.	5-132
	Dual channel NO/NC input		This function is for connecting a safety device with a dual channel NO/NC mechanism, such as a non-contact interlock switch.	5-134
	Dual channel safety input		This function is for connecting safety devices with dual channel solid state outputs (PNP output), such as safety light curtains, safety laser scanners, or safety devices with dual channel contacts, such as emergency stop switches.	5-136
	Dual channel safety input II		This function is for connecting safety devices with dual channel solid state outputs (PNP output), such as safety light curtains or safety devices with dual channel dependent action mechanisms, such as enabling switches.	5-138
	Mode select input		This function is for connecting devices with a mode selector function, such as a mode selector switch.	5-140
	Mode select input II		This function is for connecting devices with a mode selector function, such as mode selector switch. In case of switching if the input is performed within 3s, the function output is kept at the previous state.	5-142
	Muting input		This function is for connecting a sensor or any other input device to perform muting.	5-144
	Monitor input		This function is for connecting a switch or sensor for use as a start input.	5-146
	External device monitor input		This function is for monitoring external devices controlled by the SafetyOne. External devices are diagnosed for errors by connecting a NC contact, such as a contactor or safety relay.	5-147

Type	Function	Symbol	Description	Reference page
Logic operation function	AND		This function means logical (AND) of multiple inputs.	5-148
	OR		This function means logical (OR) of multiple inputs.	5-148
	XOR		This function means exclusive logical (XOR) of multiple inputs. When two or more inputs are turned ON, the SafetyOne will detect an error.	5-149
	XOR II		This function means exclusive logical (XOR) of multiple inputs.	5-149
	Self-hold		This function means self-holding of an input.	5-150
	Muting II		This function adds a muting function to connected safety devices. (∞) means the limit of muting time is undefined.	5-151
	Control start		This function adds an operation confirmation function to the connected start input devices.	5-152
	Two-hand control		This function means two-hand control function. This function is applicable as Type IIIC according to ISO13851.	5-153
Output function	Safety output		This function is for controlling the safety output.	5-154
	Safety output with timer		This function is for controlling the safety output with an OFF delay timer.	5-157

Input functions

Dual channel direct opening input

This function is for connecting safety devices with dual channel direct opening action mechanisms, such as an emergency stop switch or an interlock switch. As shown in Fig.5-1, this function is comprised of a dual channel input receive circuit (X_n, X_{n+1}), drive circuit (T_n, T_{n+1}), and function output (I_n).

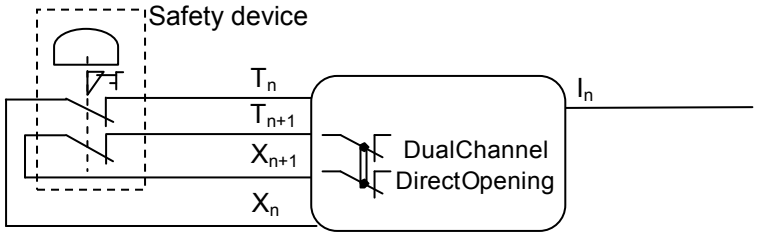


Fig. 5-1 Circuit for dual channel direct opening input functions

Connects to

Safety devices with direct opening mechanisms, such as emergency stop switches or interlock switches.

Note. This cannot be connected to a safety light curtain or other safety solid state outputs.

Description of operation

The operation timing is described in Fig.5-2.

I When safety check signals from 2 drive circuits are supplied to 2 receiving circuits, the output is turned ON. (Ex. Emergency stop switch is released, the guard is closed.)

II When safety check signal to either of the receiving circuits is turned OFF, the output is turned OFF. (Ex. Emergency stop switch is released, the guard is opened.)

III If safety check signals are not correctly supplied to the receiving circuits, due to an error in the safety device or input circuit, the output is turned OFF immediately. Status of any detected error is reflected by the error LED and input LEDs. (Ex. Fault in emergency stop switch or interlock switch, or wiring error.)

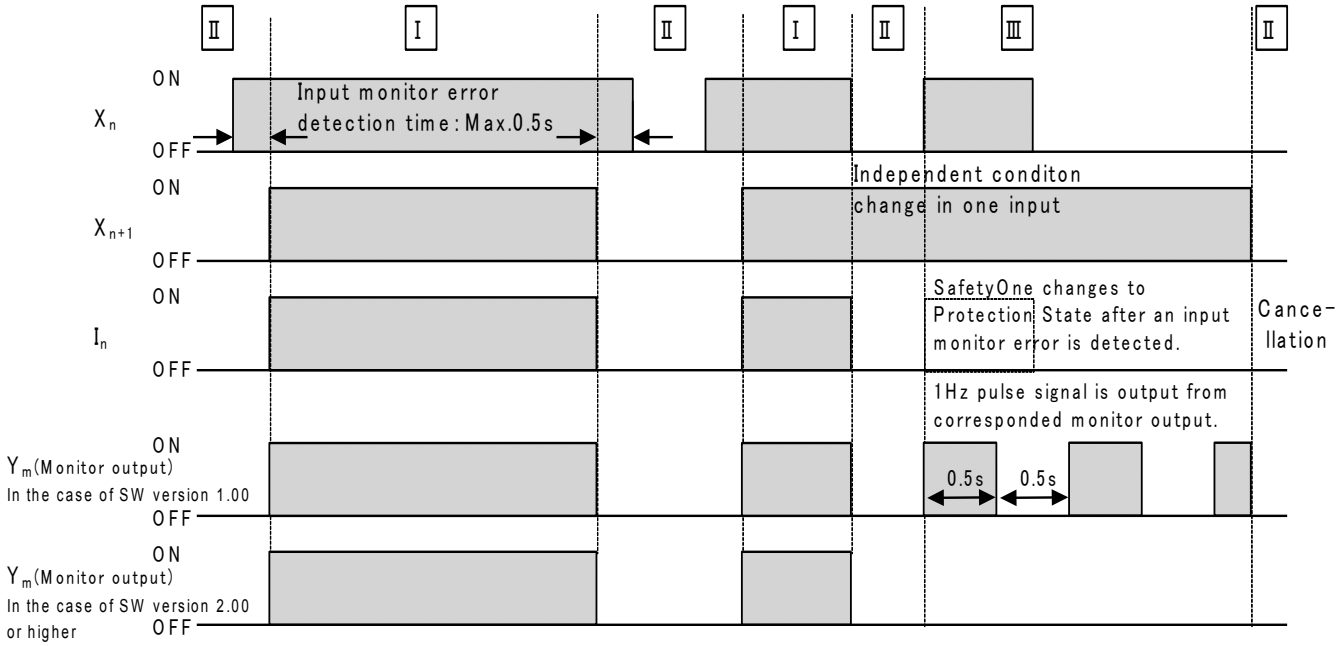


Fig. 5-2 Operation timing of a dual channel direct opening input function

Error detection function

Input monitoring and grounding detection

When an error is detected between dual channel inputs, the SafetyOne changes to the Protection state and displays "1" on the error LED display. The conditions to be detected as input errors are shown below.

- ●When the input monitor error detection time (0.5s) is exceeded during 2 input conditions or do not match (namely ON/OFF or OFF/ON).
- ●When there is an independent condition change at 1 of the inputs.
- ●When the ON state input circuit has been grounded.

The input LEDs blink to notify the operator of the corresponding input.
In the case of SW version 1.00, the monitor output (Ym) outputs pulses (1Hz).

Short circuit

When an input error, such as a short circuit or circuit failure, is detected, the SafetyOne changes to the Stop state and displays "2" on the error LED display.
The input LEDs blink to notify the operator of the corresponding input.
In the case of SW version 1.00, the monitor output (Ym) outputs pulses (1Hz).

Noise detection filter

The SafetyOne is tested acording to IEC/EN 61000-6-2, however in the case when the SafetyOne is used in an environment with severe noise, the SafetyOne changes to the Stop state and displays "9" on the error LED display.

Warning

Safety check signals (pulses signals) are transmitted from the drive circuits (T_n) to diagnose connected safety devices and input circuits. Safety check signals can not be used as a power for connected devices.

Dual channel dependent input

This function is for connecting safety devices with dual channel dependent action mechanisms, such as an enabling switch. As shown in Fig.5-3, this function is comprised of a dual channel input receive circuit (X_n, X_{n+1}), a drive circuit (T_n, T_{n+1}), and a functional output (I_n). The difference from dual channel direct opening input, is that the dependency of the 2 inputs is monitored with the dual channel dependent input function, but the dependent time is infinite.

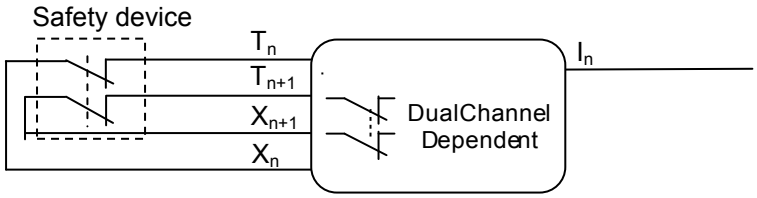


Fig. 5-3 Circuit for dual channel dependent input function

Connects to

Safety devices with a direct opening mechanism, such as emergency stop switches or interlock switches.
Safety devices with a contact dependent mechanism, such as an enabling switch.

Note. This cannot be connected to a safety light curtain or any other safety solid state outputs.

Description of operation

The operation timing is described in Fig.5-4.

Ⅰ When safety check signals from 2 drive circuits are correctly supplied to 2 input receiving circuits, the output is turned ON. (Ex. Guard is closed.)

Ⅱ When the safety check signal to either of the receiving circuits is turned OFF, the output is turned OFF. (Ex. Guard is opened.)

Ⅲ If safety check signals are not supplied correctly to the receiving circuits, due to an error in the safety device or input circuit, the output is turned OFF immediately. Status of a detected error is displayed by the error LED and input LEDs. (Ex. Fault in Interlock switch or wiring error)

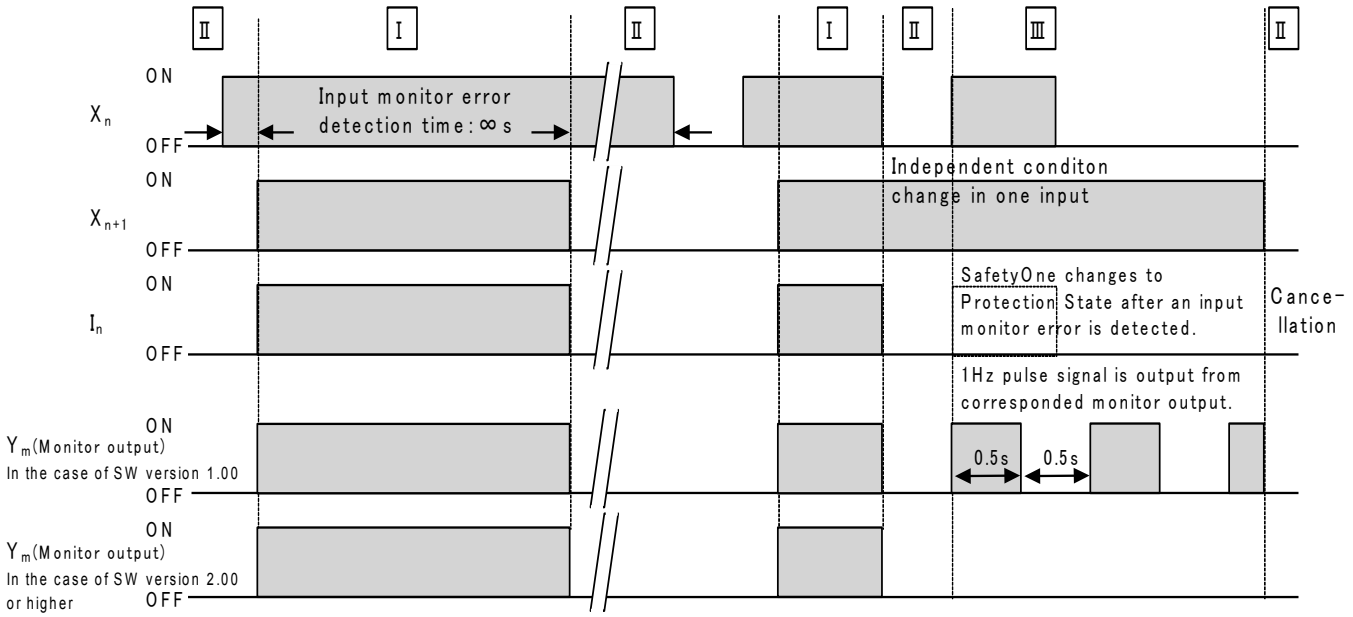


Fig. 5-4 Operation timing of a dual channel dependent input function

Error detection function

Input monitoring

When an error is detected between dual channel inputs, the SafetyOne changes to the Protection state and displays "1" on the error LED display. The condition to be detected as an input error is shown below.

●When there is an independent condition change of 1 of the inputs

The input LEDs blink to notify the operator of the corresponding input.
In the case of SW version 1.00, the monitor output (Ym) outputs pulses (1Hz).

Note. The dependency of the 2 inputs is monitored with the dual channel dependent input function, but the dependent time is infinite.

Short circuit

When an input error, such as a short circuit or circuit failure, is detected, the SafetyOne changes to the Stop state and displays "2" on the error LED display.
The input LEDs blink to notify the operator of the corresponding input.
In the case of SW version 1.00, the monitor output (Ym) outputs pulses (1Hz).

Noise detection filter

The SafetyOne is tested acording to IEC/EN 61000-6-2, however in the case when the SafetyOne is used in an environment with severe noise, the SafetyOne changes to the Stop state and displays "9" on the error LED display.

Safety check signals (pulses signals) are supplied from the drive circuits (T_n) to diagnose connected safety devices and input circuits. Safety check signals can not be used as a power for connected devices.

Dual channel NO/NC input

This function is for connecting safety devices with dual channel NO/NC mechanisms, such as a non-contact interlock switch or an interlock switch. As shown in Fig.5-5, this function is comprised of a dual channel input receiving circuit (X_n, X_{n+1}), a drive circuit (T_n, T_{n+1}), and a functional output (I_n). Because safety devices comprised of NO and NC contacts are connected, during normal operation, 1 of the dual channel inputs is ON while the other is OFF.

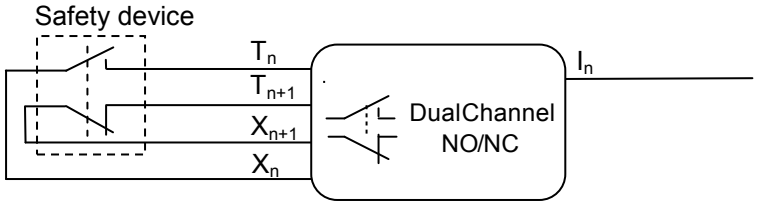


Fig. 5-5 Circuit for dual channel NO/NC input function

Connects to

Safety devices with NO/NC contacts, such as non-contact interlock switches or interlock switches.

Note. This cannot be connected to a safety light curtain or any other safety solid state output.

Description of operation

The operation timing is described in Fig.5-6.

Ⅰ When a safety check signal from 1 of the 2 drive circuits (T_{n+1}) is supplied to the corresponding receiving circuit (X_{n+1}) and the other receiving circuit (X_n) is OFF, the output is turned ON. (Ex. Guard is closed.)

Ⅱ When a safety check signal from 1 of the 2 drive circuits (T_n) is supplied to the corresponding receiving circuit (X_n), and the other receiving circuit (X_{n+1}) is OFF, the output is turned OFF. (Ex. Guard is opened.)

Ⅲ If safety check signals are not supplied correctly to the receiving circuits, due to an error in the safety device or input circuit, the output is turned OFF immediately. Status of any detected error is displayed on the error LED and input LEDs. (Ex. Fault in the non-contact Interlock switch or wiring error)

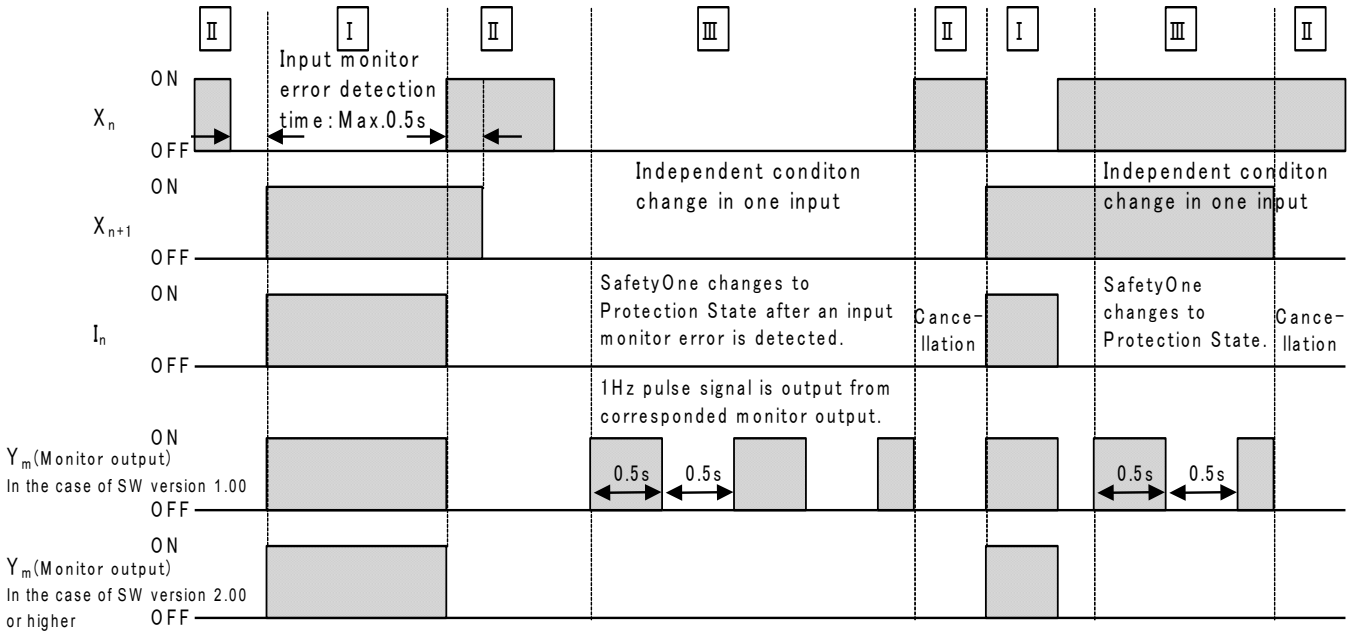


Fig. 5-6 Operation timing of a dual channel NO/NC input function

Error detection function

Input monitoring and grounding detection

When an error is detected between the dual channel inputs, the SafetyOne changes to the Protection state and displays "1" on the error LED display. The conditions to be detected as input errors are shown below.

- When an input monitoring error detection time (0.5 s) is exceeded during the 2 input conditions are the same condition (namely ON/ON or OFF/OFF).
- When there is an independent condition change of 1 of the inputs.
- When the ON state input circuit has been grounded.

The input LEDs blink to notify the operator of the corresponding input.
In the case of SW version 1.00, the monitor output (Ym) outputs pulses (1Hz).

Short circuit

When an input error, such as short circuit or circuit failure, is detected, the SafetyOne changes to the Stop state and displays "2" on the error LED display.
The input LEDs blink to notify the operator of the corresponding input.
In the case of SW version 1.00, the monitor output (Ym) outputs pulses (1Hz).

Noise detection filter

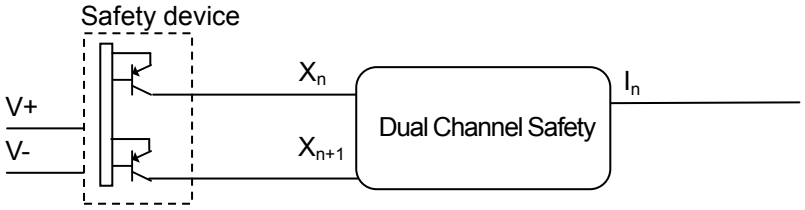
The SafetyOne is tested acording to IEC/EN 61000-6-2, however in the case when the SafetyOne is used in an environment with severe noise, the SafetyOne changes to the Stop state and displays "9" on the error LED display.

Safety check signals (pulses signals) are supplied from the drive circuits (T_n) to diagnose connected safety devices and input circuits. Safety check signals can not be used as a power for connected devices.

Dual channel safety input

This function is for connecting a safety device with a dual channel solid state output (PNP output), such as a safety light curtain or a safety laser scanner, or a safety device with contacts such as an emergency stop switch or an interlock switch. As shown in Fig.5-7, this function is comprised of a dual channel receive circuit (X_n, X_{n+1}) and a functional output (I_n). Use safety devices with diagnostic functions or prevent the short circuit of an input circuit, because the drive circuit is not used for this function.

-For safety device with dual channel solid state output (PNP out put)



-For safety device with contacts

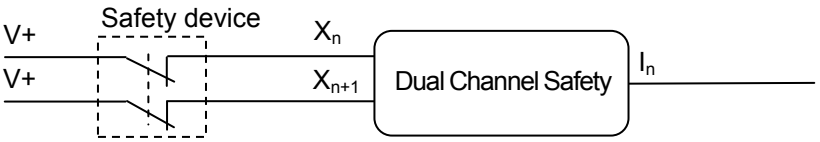


Fig. 5-7 Circuit for dual channel safety input function

Connects to

Safety devices with dual channel solid state outputs (PNP output), such as a safety light curtain or a safety laser scanner, and safety devices with contacts such as emergency stop switches or interlock switches.

Warning

Safety performance depends on used safety devices when connecting mechanical contact devices, such as emergency stop switches or interlock switches.

Note. Solid state output devices with sink outputs (NPN output) cannot be connected.

Description of operation

The operation timing is described in Fig.5-8.

I When the dual channel safety check signals from the safety device are correctly supplied to the 2 input receiving circuits, the output is turned ON. (Ex. Safety light curtain is not shaded.)

II When the safety check signal to either of the receiving circuits is turned OFF, the output is turned OFF immediately. (Ex. Safety light curtain is shaded.)

III If safety check signals are not supplied correctly to the input receiving circuits, due to an error in the safety device or input circuit, the output is turned OFF immediately. Status of the detected error is displayed by the error LED and input LEDs. (Ex. Fault in the light curtain or wiring error)

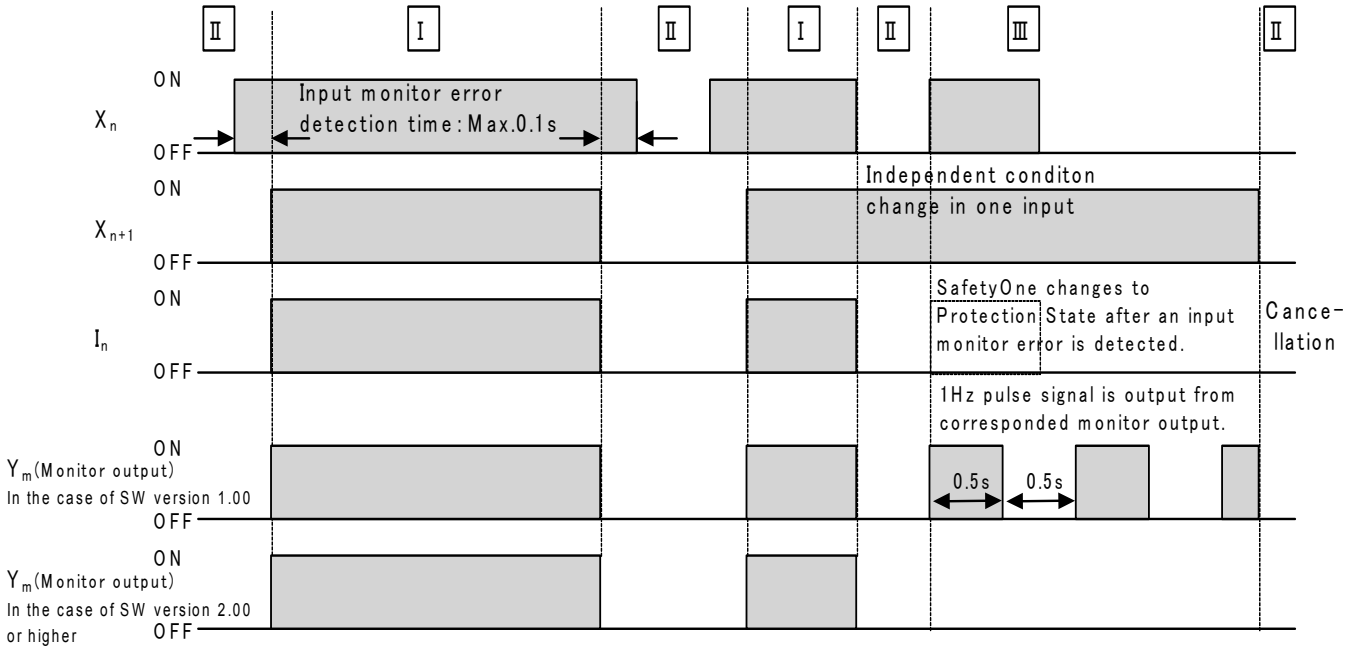


Fig. 5-8 Operation timing of a dual channel safety input function

Error detection function

Input monitoring and grounding detection

When an error is detected between the dual channel inputs, the SafetyOne changes to the Protection state and displays "1" on the error LED display. The conditions to be detected as input errors are shown below.

- ●When an input monitoring error detection time (0.1s) is exceeded during the 2 input conditions and they do not match (namely ON/OFF or OFF/ON).
- ●When there is an independent condition change of 1 of the inputs.
- ●The input circuit of the ON state has gone to ground.

The input LEDs blink to notify the operator of the corresponding input.
In the case of SW version 1.00, the monitor output (Ym) outputs pulses (1Hz).

Noise detection filter

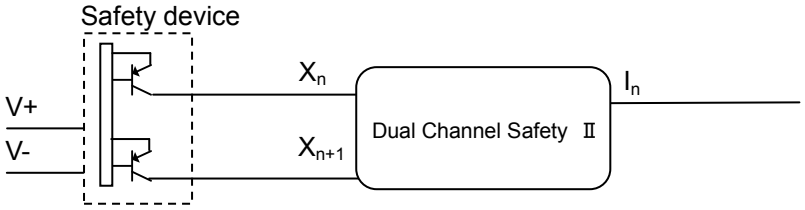
The SafetyOne is tested acording to IEC/EN 61000-6-2, however in the case when the SafetyOne is used in an environment with severe noise, the SafetyOne changes to the Stop state and displays "9" on the error LED display.

Note. Drive circuit corresponding to the dual channel safety input (T_n, T_{n+1}) is always OFF.

Dual channel safety input II

This function is for connecting a safety device with a dual channel solid state output (PNP output), such as a safety light curtain or a safety laser scanner, or a safety device with dual channel dependent action mechanisms, such as an enabling switch. As shown in Fig.5-9, this function is comprised of a dual channel receive circuit (X_n, X_{n+1}) and a functional output (I_n). Use safety devices with diagnostic functions or prevent the short circuit of an input circuit, because the drive circuit is not used for this function.

-For safety device with dual channel solid state output (PNP out put)



-For safety device with contacts

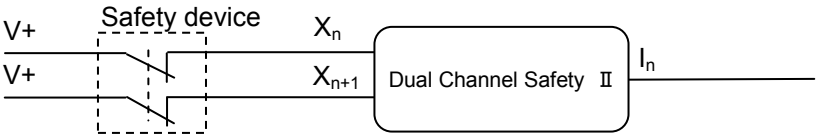


Fig. 5-9 Circuit for dual channel safety input II function

Connects to

Safety devices with dual channel solid state outputs (PNP output), such as a safety light curtain or a safety laser scanner, and safety devices with contacts such as enabling switches.

Warning

Safety performance depends on used safety devices when connecting mechanical contact devices, such as enabling switches.

Note. Solid state output devices with sink outputs (NPN output) cannot be connected.

Description of operation

The operation timing is described in Fig.5-10.

Ⅰ When the dual channel safety check signals from the safety device are correctly supplied to the 2 input receiving circuits, the output is turned ON. (Ex. Safety light curtain is not shaded.)

Ⅱ When the safety check signal to either of the receiving circuits is turned OFF, the output is turned OFF immediately. (Ex. Safety light curtain is shaded.)

Ⅲ If safety check signals are not supplied correctly to the input receiving circuits, due to an error in the safety device or input circuit, the output is turned OFF immediately. Status of the detected error is displayed by the error LED and input LEDs. (Ex. Fault in the light curtain or wiring error)

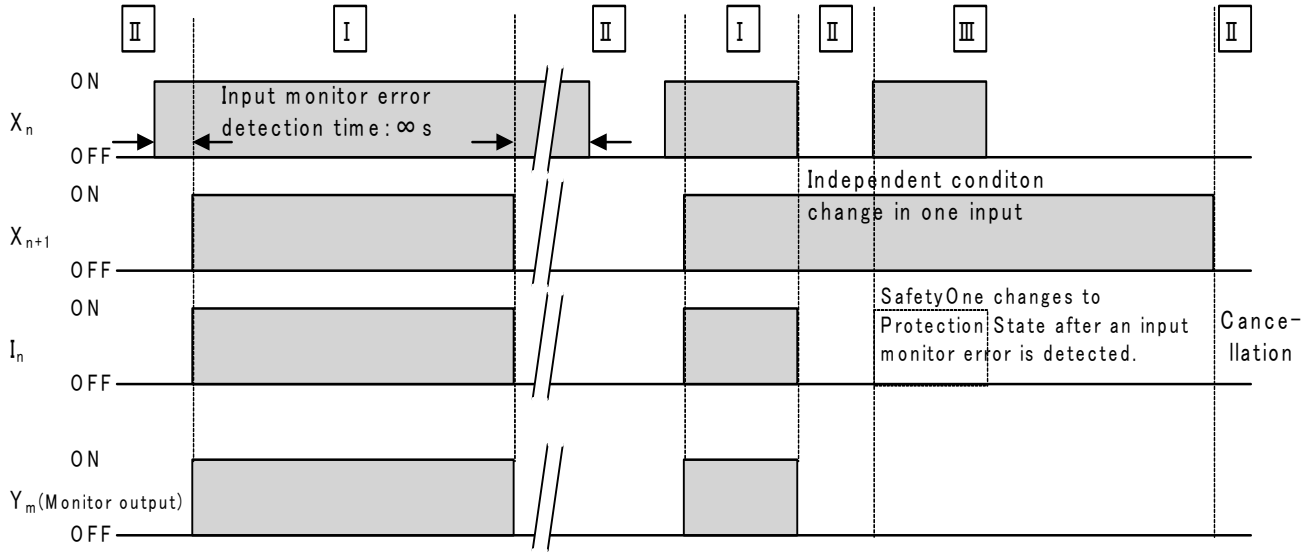


Fig. 5-10 Operation timing of a dual channel safety input II function

Error detection function

Input monitoring

When an error is detected between the dual channel inputs, the SafetyOne changes to the Protection state and displays "1" on the error LED display. The condition to be detected as an input error is shown below.

●When there is an independent condition change of 1 of the inputs.

The input LEDs blink to notify the operator of the corresponding input.

Note. The dependency of the 2 inputs is monitored with the dual channel safety input II function, but the dependent time is infinite.

Noise detection filter

The SafetyOne is tested acording to IEC/EN 61000-6-2, however in the case when the SafetyOne is used in an environment with severe noise, the SafetyOne changes to the Stop state and displays "9" on the error LED display.

Note. Drive circuit corresponding to the dual channel safety input II (T_n, T_{n+1}) is always OFF.

Mode select input

This function is for connecting devices with a mode select function, such as a selector switch.
As shown in Fig.5-11, this function is comprised of 2 input receiving circuits (X_n, X_{n+1}), 1 drive circuit (T_n), and a functional output (TEACH, AUTO).

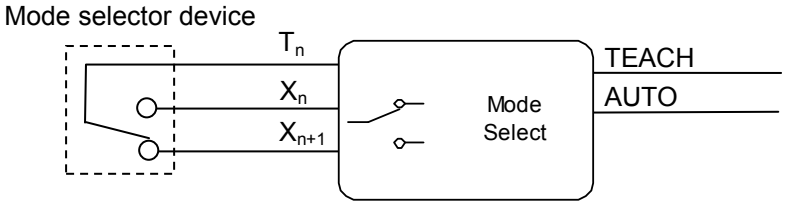


Fig. 5-11 Circuit for mode select input function

Connects to

Mode selecting device such as a selector switch or a rotary switch

Note: This cannot be connected to a safety light curtain or any other safety solid state output.

Description of operation

The operation timing is described in Fig.5-12.

I-1 When a safety check signal from the drive circuit (T_n) is supplied to 1 of the receiving circuits (X_{n+1}), and the other receiving circuit (X_n) is OFF, the output “AUTO” is turned ON.

I-2 When a safety check signal from the drive circuit (T_n) is supplied to 1 of the receiving circuits (X_n), and the other receive circuit (X_{n+1}) is OFF, the output “TEACH” is turned ON.

II-1 When both receiving circuits are OFF, both of outputs “TEACH” and “AUTO” are turned OFF. (Ex. The selector switch is in the intermediate position.)

II-2 When both receiving circuits are ON, both of outputs “TEACH” and “AUTO” are turned OFF. And if the input monitoring error detection time (0.5s) is exceeded during the time both receiving circuits are ON, an input monitoring error is detected.

III If safety check signals are not supplied correctly to the receiving circuits due to an error in the selected mode device or input circuit, the output is turned OFF immediately. Status of the error is displayed by the error LED and input LEDs. (Ex. Fault in selector switch or wiring error)

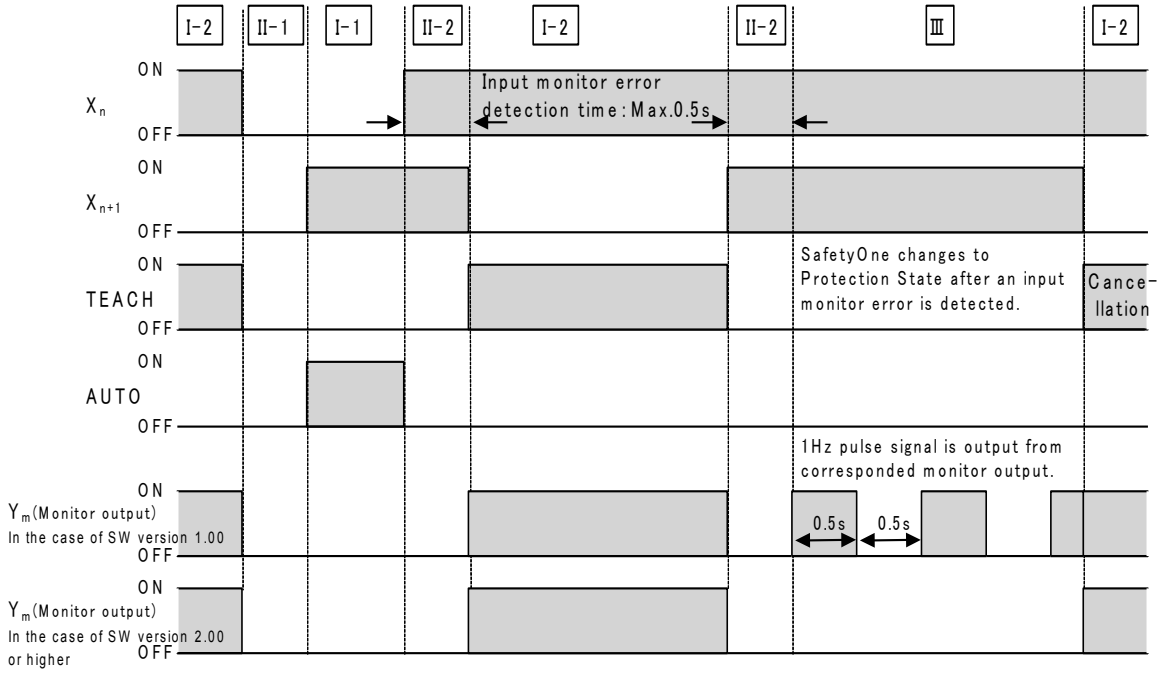


Fig. 5-12 Operation timing of a mode select input function

Error detection function

Input monitoring

When an error is detected at the inputs, the SafetyOne changes to the Protection state and displays "1" on the error LED display. The condition to be detected as an input error is shown below.

- When an input monitoring error detection time (0.5s) is exceeded while both of the 2 input conditions are ON.

The input LEDs blink to notify the operator of the corresponding input.
In the case of SW version 1.00, the monitor output (Ym) outputs pulses (1Hz).

Short circuit detection

When an input error, such as a short circuit, or a circuit failure, is detected, the SafetyOne changes to the Stop state and display "2" on the error LED display.
The input LEDs blink to notify the operator of the corresponding input.
In the case of SW version 1.00, the monitor output (Ym) outputs pulses (1Hz).

Noise detection filter

The SafetyOne is tested acording to IEC/EN 61000-6-2, however in the case when the SafetyOne is used in an environment with severe noise, the SafetyOne changes to the Stop state and displays "9" on the error LED display.

Warning

Safety check signals (pulses signals) are supplied from the drive circuits (T_n) to diagnose connected safety devices and input circuits. Safety check signals can not be used as a power for connected devices.

Note. Drive circuit "T_{n+1}" is always OFF.

Mode select input II

This function is for connecting devices with a mode select function, such as a selector switch. In case of switching the input is performed within 3 s, the function output is kept at previous state.
As shown in Fig.5-13, this function is comprised of 2 input receiving circuits (X_n, X_{n+1}), 1 drive circuit (T_n), and functional output (TEACH, AUTO).

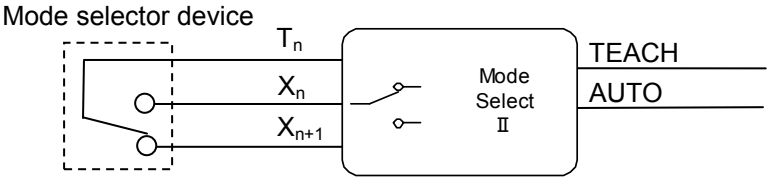


Fig. 5-13 Circuit for mode select input II function

Connects to

Mode selecting device such as a selector switch or a rotary switch

Note. This cannot be connected to a safety light curtain or any other safety solid state output.

Description of operation

The operation timing is described in Fig.5-14.

Ⅰ-1 When a safety check signal from the drive circuit (T_n) is supplied to 1 of the receiving circuits (X_{n+1}), and the other receiving circuit (X_n) is OFF, the output “AUTO” is turned ON. The output “AUTO” is kept ON state within input switching time (3s: the time from receiving circuit (X_{n+1}) is turned OFF to receiving circuit (X_n) is turned ON).

Ⅰ-2 When a safety check signal from the drive circuit (T_n) is supplied to 1 of the receiving circuits (X_n), and the other receive circuit (X_{n+1}) is OFF, the output “TEACH” is turned ON. The output “TEACH” is kept ON state within input switching time (3s: the time from receiving circuit (X_n) is turned OFF to receiving circuit (X_{n+1}) is turned ON).

Ⅱ-1 When both receiving circuits are OFF over the input switching time (3s), both of outputs “TEACH” and “AUTO” are turned OFF. (Ex. The selector switch is in the intermediate position.)

Ⅱ-2 When both receiving circuits are ON, both of outputs “TEACH” and “AUTO” are turned OFF. And if the input monitoring error detection time (0.5s) is exceeded during the time both receiving circuits are ON, an input monitoring error is detected.

Ⅲ If safety check signals are not supplied correctly to the receiving circuits due to an error in the selected mode device or input circuit, the output is turned OFF immediately. Status of the error is displayed by the error LED and input LEDs. (Ex. Fault in selector switch or wiring error)

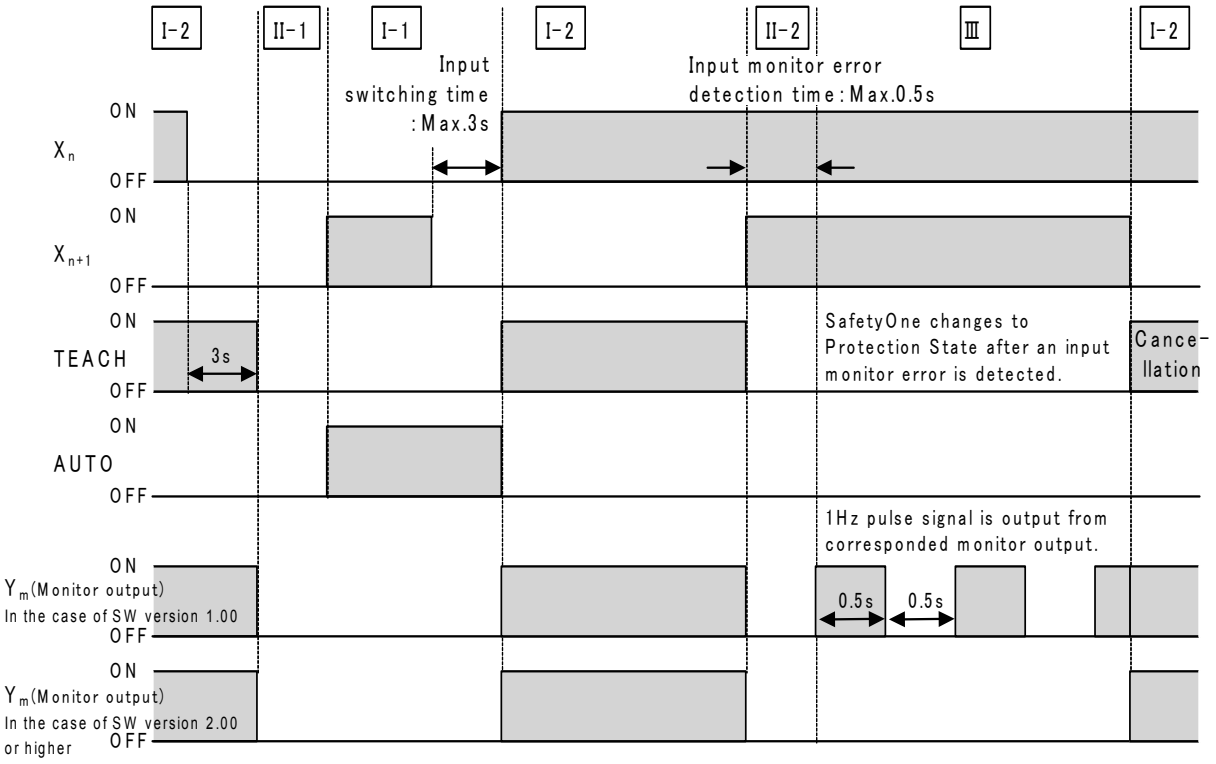


Fig. 5-14 Operation timing of a mode select input II function

Error detection function

Input monitoring

When an error is detected at the inputs, the SafetyOne changes to the Protection state and displays "1" on the error LED display. The condition to be detected as an input error is shown below.

- When an input monitoring error detection time (0.5s) is exceeded while both of the 2 input conditions are ON.

The input LEDs blink to notify the operator of the corresponding input.
In the case of SW version 1.00, the monitor output (Ym) outputs pulses (1Hz).

Short circuit detection

When an input error, such as a short circuit, or a circuit failure, is detected, the SafetyOne changes to the Stop state and display "2" on the error LED display.
The input LEDs blink to notify the operator of the corresponding input.
In the case of SW version 1.00, the monitor output (Ym) outputs pulses (1Hz).

Noise detection filter

The SafetyOne is tested acording to IEC/EN 61000-6-2, however in the case when the SafetyOne is used in an environment with severe noise, the SafetyOne changes to the Stop state and displays "9" on the error LED display.

Warning

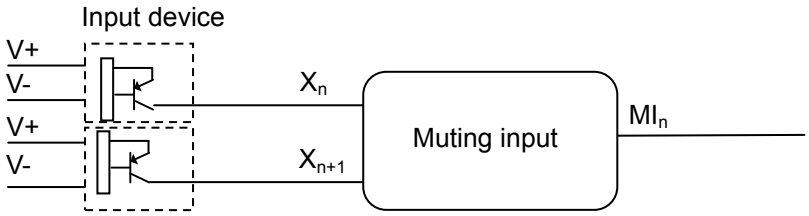
Safety check signals (pulses signals) are supplied from the drive circuits (T_n) to diagnose connected safety devices and input circuits. Safety check signals can not be used as a power for connected devices.

Note. Drive circuit "T_{n+1}" is always OFF.

Muting input

This function is for connecting a muting sensor with a solid state output (PNP output) or a mechanical contact device such as a limit switch. As shown in Fig.5-15, this function is comprised of 2 input receiving circuits (X_n) and one functional output (MI_n).

・ For muting sensors with a solid state output (PNP)



・ For a mechanical contact device

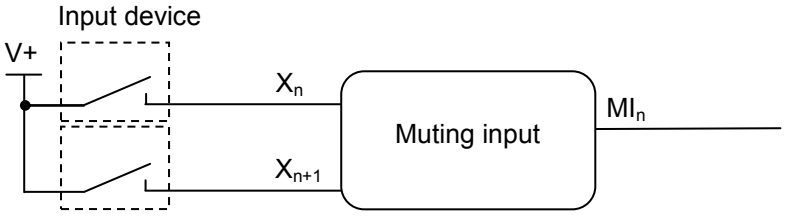


Fig. 5-15 Circuit for muting input function

Connects to

Through-beam dark ON photoelectric switches with 3-wire PNP open collector outputs
Normally open proximity sensors with 3-wire PNP open collector output

Warning

Do not use the muting input as a safety input.

Description of operation

The operation timing is described in Fig.5-16.

I When the 2 output signals from the muting input devices, such as muting sensor, are correctly connected to the 2 receiving circuits, the output is turned ON. (Ex. Sensor detects objects.)

II When the input signal to either of receiving circuits is turned OFF, the output is turned OFF. (Ex. Sensor object detection is canceled.)

III If safety check signals are not correctly supplied to the receiving circuit due to an error in the sensor device or input circuit, the output is turned OFF immediately. Status of the detected error is displayed by the error LED and input LEDs. (Ex. Fault in sensor or wiring error)

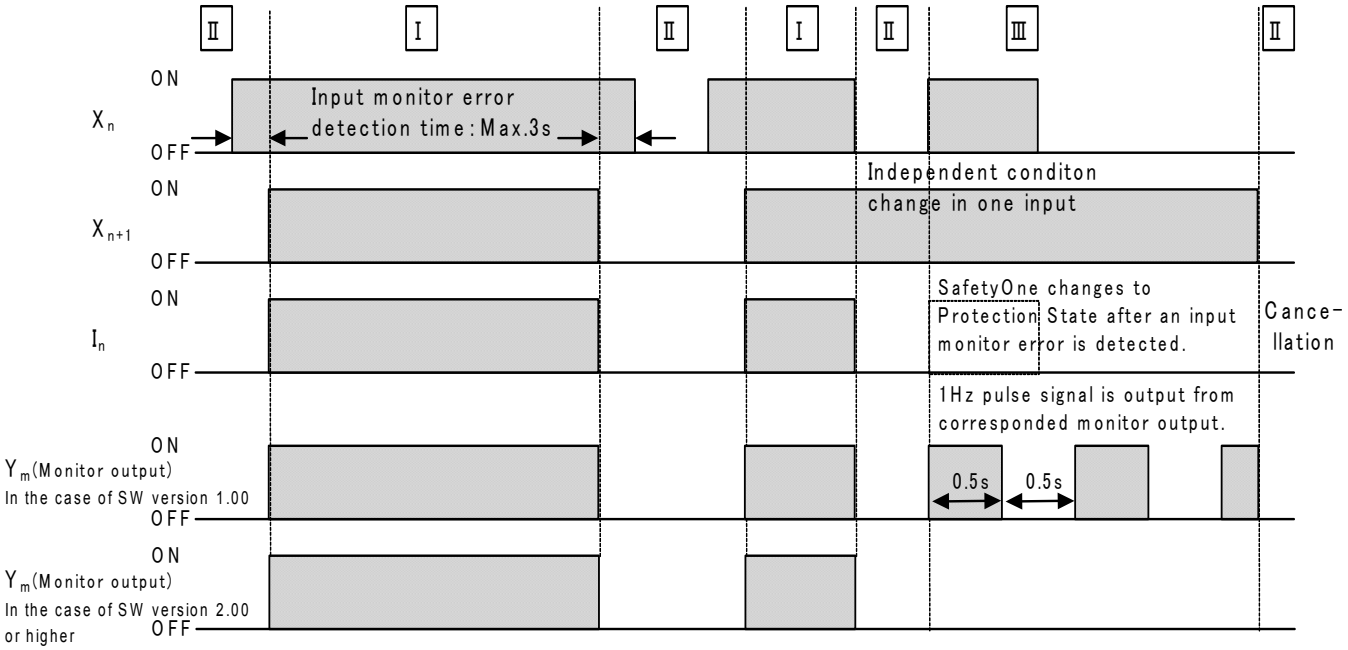


Fig. 5-16 Operation timing of the muting input function

Error detection function

Input monitoring and grounding detection

When an error is detected at the inputs, the SafetyOne changes to the Protection state and displays "1" on the error LED display. The conditions to be detected as an input error are shown below.

- ●When the input monitor error detection time (3s) is exceeded during the 2 input conditions and they do not match (namely ON/OFF or OFF/ON).
- ●When there is an independent condition change of the 1 of the input.
- ●When the ON state of the input goes to the ground state.

The input LEDs blink to notify the operator of the corresponding input.
In the case of SW version 1.00, the monitor output (Ym) outputs pulses (1Hz).

Noise detection filter

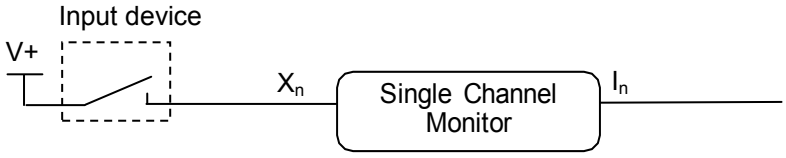
The SafetyOne is tested acording to IEC/EN 61000-6-2, however in the case when the SafetyOne is used in an environment with severe noise, the SafetyOne changes to the Stop state and displays "9" on the error LED display.

Note. Drive circuit corresponding to muting input (T_n, T_{n+1}) is always OFF.

Monitor input

This function is for connecting a switch (mechanical contact device) or sensor with a solid state output (PNP output) as a start input. As shown in Fig.5-17, this function is comprised of 1 receiving circuit (X_n) and 1 functional output (I_n).

- For mechanical contact device



- For input device with solid state output (PNP)

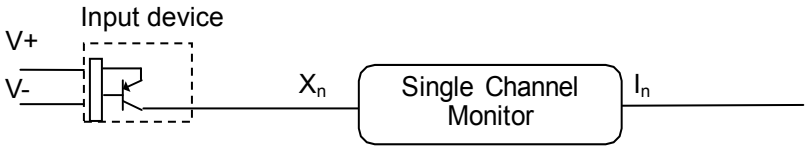


Fig. 5-17 Circuit for monitor input function

Connects to

Input device such as a mechanical contact switch, a photoelectric switch, or a proximity switch

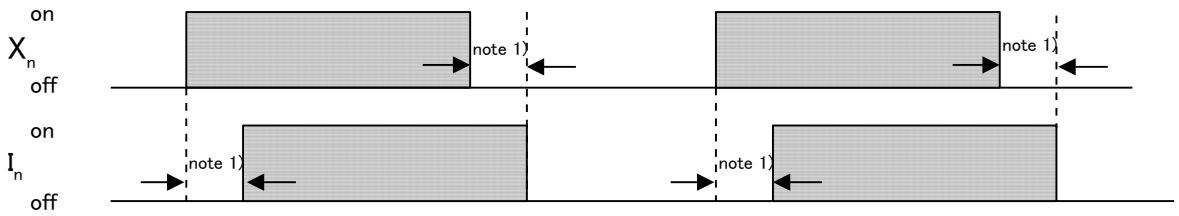
Warning

Do not use the monitor input as a safety input. When there is a failure in the SafetyOne or peripheral devices, the safety system will not function properly as intended.

Description of operation

Operation timing is described in Fig.5-18.

When the output signals from the start input device are correctly supplied to the receiving circuit, the output (I_n) turns ON.



note 1) This time is part of the Reaction time which is shown at "Electrical conditions" in General specifications.

Fig. 5-18 Operation timing of the monitor input

Error detection function

Noise detection filter

The SafetyOne is tested acording to IEC/EN 61000-6-2, however in the case when the SafetyOne is used in an environment with severe noise, the SafetyOne changes to the Stop state and displays "9" on the error LED display.

External device monitoring input

This function is for monitoring external devices controlled by the SafetyOne. External devices can be diagnosed for errors by connecting a NC contact, such as a contactor or a safety relay. As shown in Fig.5-19, this function is comprised of an input receiving circuit (X_n), drive circuit (T_n), and functional output.

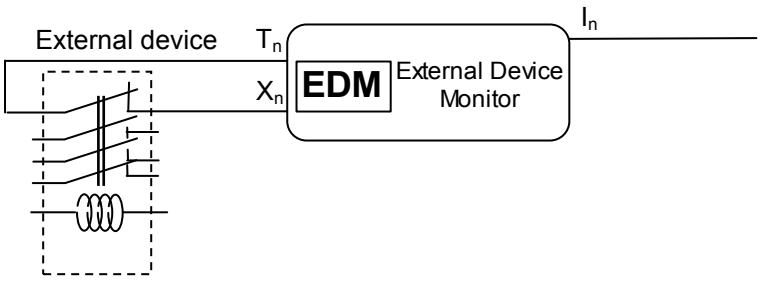


Fig. 5-19 Circuit for external device monitor input function

Connects to

NC contact on devices such as a contactor, safety relay, or other devices equipped with forced guided mechanisms

Note. Solid state output devices cannot be connected.

Description of operation

I When a safety check signal from the drive circuit is supplied correctly to the receiving circuit, the output is turned ON. (Ex. External device is turned OFF.)

II When safety check signal input to the receiving circuit is turned OFF, the output is turned OFF. (Ex. External device is turned ON.)

III If the safety check signal is not supplied correctly to the receiving circuit due to an error in an external device or input circuit, the output is turned OFF immediately. Status of the detected error is displayed on error LED and input LED. (Ex. Fault in external device or wiring error)

Error detection function

Noise detection filter

The SafetyOne is tested acording to IEC/EN 61000-6-2, however in the case when the SafetyOne is used in an environment with severe noise, the SafetyOne changes to the Stop state and displays "9" on the error LED display.

Note. Refer to “Safety output without timer” or to “Safety output with timer” for details of EDM input monitoring.

LOGIC FUNCTION

AND

As shown in Fig.5-20 and 5-21, this function reflects the results of a logic (AND) function processing for multiple inputs (I_n) in the function output (O_n).

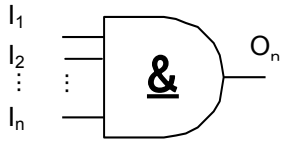


Fig. 5-20 AND function circuit

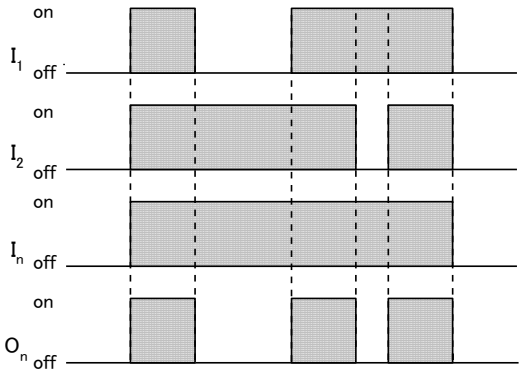


Fig. 5-21 Operation timing of the AND function

OR

As shown in Fig.5-22 and 5-23, this function reflects the results of a logic (OR) function processing for multiple inputs (I_n) in the function output (O_n).

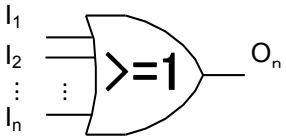


Fig. 5-22 OR function circuit

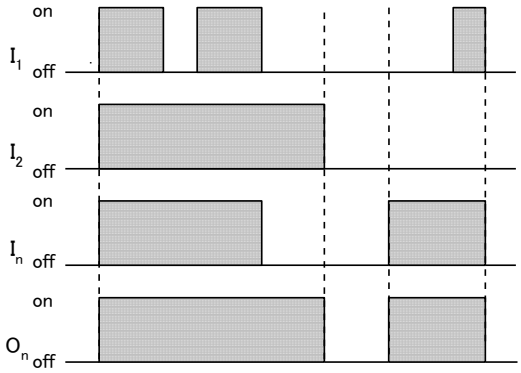


Fig. 5-23 Operation timing of the OR function

XOR

As shown in Fig.5-24 and 5-25, this function reflects the results of an exclusive logic (XOR) function processing for multiple inputs (I_n) in the function output (O_n). When two or more inputs are turned ON, the SafetyOne will detect an error.

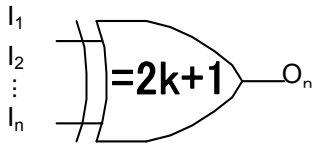


Fig. 5-24 XOR function circuit

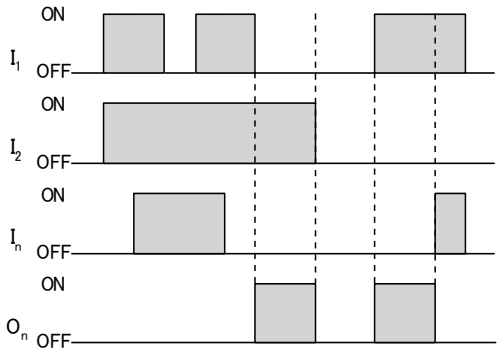


Fig. 5-25 Operation timing of XOR function

XOR II

As shown in Fig.5-26 and 5-27, this function reflects the results of an exclusive logic (XOR) function processing for multiple inputs (I_n) in the function output (O_n).

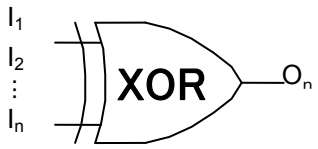


Fig. 5-26 XOR II function circuit

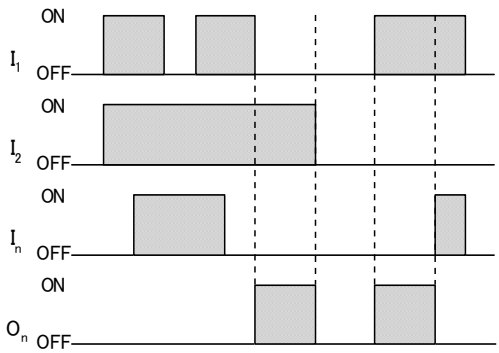


Fig. 5-27 Operation timing of XOR II function

Self-hold

As shown in Fig.5-28 and 5-29, this function is comprised of a hold input (IH_n), a trigger input (IT_n), and a functional output (O_n), and reflects the results of self-holding processing by the hold input and trigger input in the output.

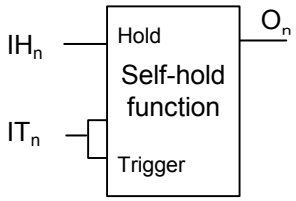


Fig. 5-28 Self-holding function circuit

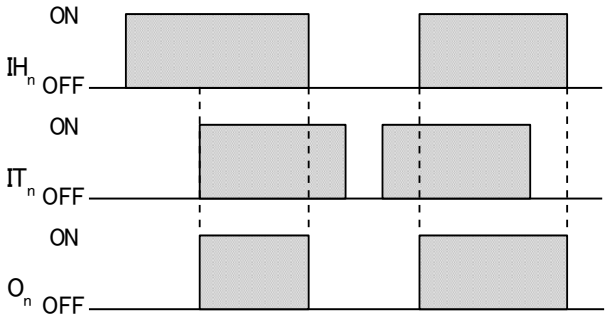


Fig. 5-29 Operation timing of the self-holding function

Note. When the SafetyOne changes to the Configuration, Protection, or Stop state, the self-holding function is canceled.

Muting II

This function adds muting to connected safety devices.
As shown in Fig.5-30, this function is comprised of a safety input (I_n), a muting input (IM_n), and a functional output (O_n). The output of the muting input function is connected to the muting input (IM_n).

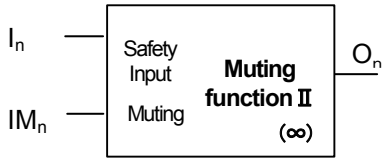


Fig. 5-30 Muting II function circuit

Description of operation

The timing is described in Fig.5-31.

Ⅰ When the muting input is turned ON while the safety input is ON, the OFF status of the safety input is suspended, and the output remains ON.

Ⅱ When the muting input is turned OFF, muting is canceled and the ON/OFF status of the safety input is shown by the output.

Ⅲ If muting is not used under the correct conditions, the muting function is disabled and the ON/OFF status of the safety input is shown by the output.

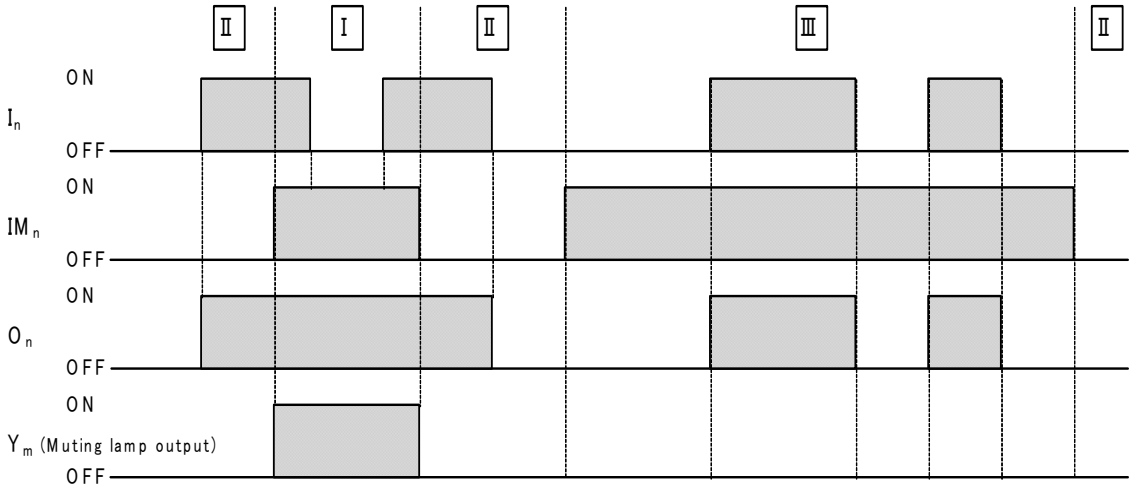


Fig. 5-31 Operation timing of the muting II function

Error detection function

Muting monitor

When of the following condition is satisfied, the SafetyOne disables the muting function.

●When the safety device to be muted is OFF

When the muting input is turned ON while the safety input to be muted is OFF, the muting function is disabled.

Warning

Be sure to check the operation of the muting function before its use. Furthermore, check the state of the muting lamp. The muting function is maintained even if a lamp blows or a lamp is not connected. In the case of SW version 1.00, the SafetyOne changes to the Stop state.

Note: In the case of SW version 1.00, muting lamp outputs (Y17, Y20) have diagnostic functions of wire breaking or no connection of an indicator. When wire breaking or no connection of an indicator, the SafetyOne changes to the Stop state and displays "5" in the error LED display.

Control start

This function confirms operation of the connected start input device. As shown in Fig.5-32, this function is comprised of a functional input (I_n) and a functional output (O_n).
The start input (I_n) ON operation is monitored to determine whether it is performed within the designated control time (0.1 s to 5 s).

Fig. 5-32 Control start function circuit

Description of operation

The operation timing is described in Fig.5-33.

Ⅰ If the input turns ON within the designated control time (0.1 s to 5 s), the output turns ON until the connected self-holding function or another trigger input turns ON. (The function output turns OFF after the other trigger input turns ON.)

Ⅱ If the input does not turn ON within the designated control time (0.1 s to 5 s) (If the function input turns on before 0.1 s or after 5 s), the output does not turn ON.

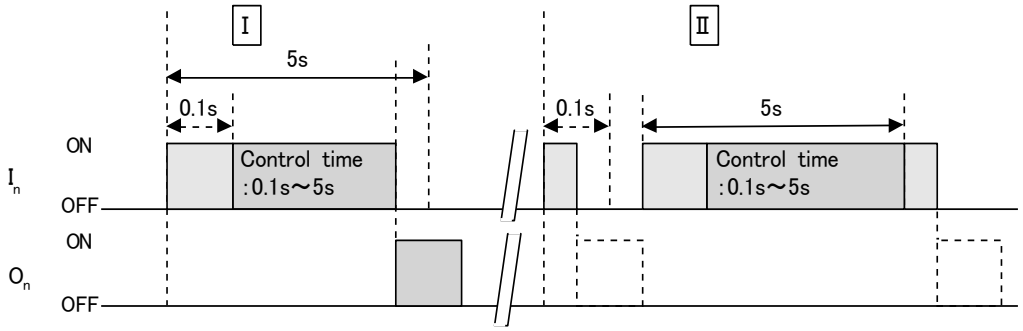


Fig. 5-33 Operation timing of the control start function

Two hand control

This function adds a two hand control function to the connected the safety device. As shown in Fig.5-34, this function is comprised of 2 safety inputs (I_n, I_{n+1}) and a functional output (O_n). The function outputs of dual channel NO/NC output are connected to safety inputs (I_n, I_{n+1}) of this function.

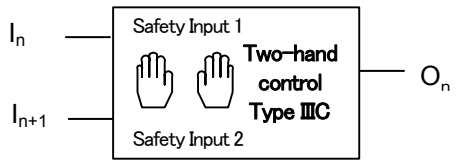


Fig. 5-34 Two hand control function circuit

Description of operation

The operation timing is described in Fig.5-35.

I If the both of safety inputs turn ON, function output turns ON.

II If the one of safety outputs turns, function output turns OFF.

(1) The input status of both of safety inputs are different over the input monitoring error detection time (0.5s), function output kept at OFF state.

(2) The one of inputs change the state independently on another input, function output kept at OFF state.

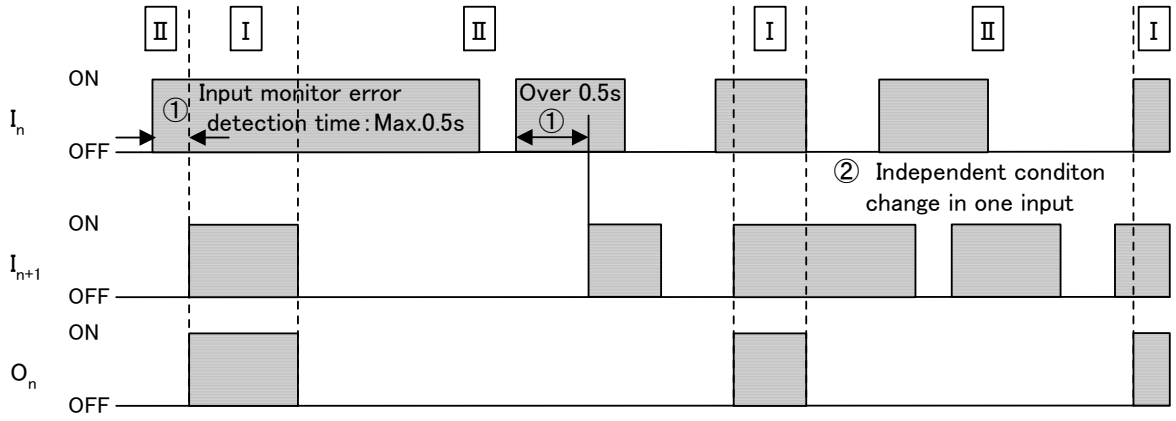


Fig. 5-35 Operation timing of the two hand control function

Output function

Safety output (without timer)

This function is for controlling the safety output without OFF delay timer.
As shown in Fig.5-36, this function is comprised of a hold input (O_n), an EDM input (I_n), and a safety output (Y_n). The function output of this external device monitoring input function is connected to the EDM input (I_n).

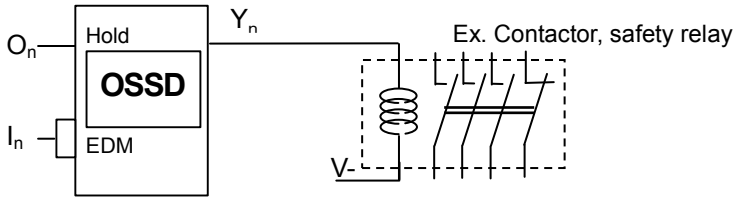


Fig. 5-36 Safety output function circuit

Connects to

Equipment with force guided mechanisms, such as, contactors, safety relays.
Input of safety PLC, or other safety controllers.

Description of operation

The operation timing is described in Fig.5-37 and 5-38.

Ⅰ When hold input is turned ON, the safety output is turned ON after confirmation that the EDM input is ON.

Ⅱ When hold input is turned OFF, the safety output is turned OFF.

Ⅲ If the EDM input is not applied correctly (ON state of EDM input is not detected during EDM monitoring time (1s) after hold input is turned ON, ON state of EDM input is not detected during EDM monitoring time (1s) after safety output turns OFF, or ON state of EDM input is not detected during EDM monitoring time (1s) after EDM input turns OFF due to the error during safety output is OFF state), the SafetyOne changes to the Protection state, and indicates “1” on the error LED without turning ON the safety output. (See Fig.5-38.)

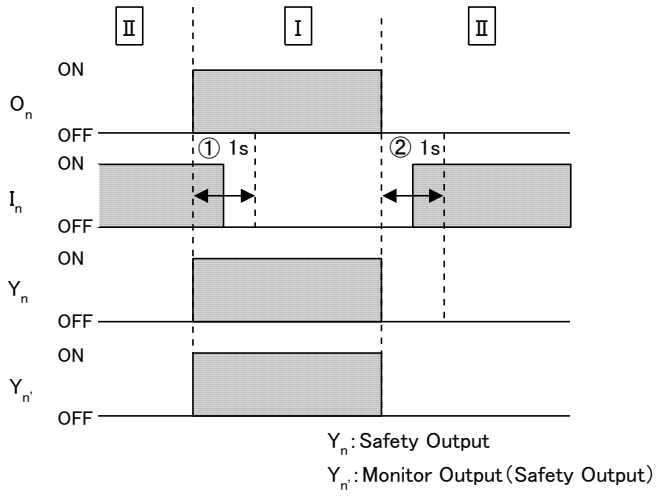


Fig. 5-37 Operation timing of the safety output with timer function

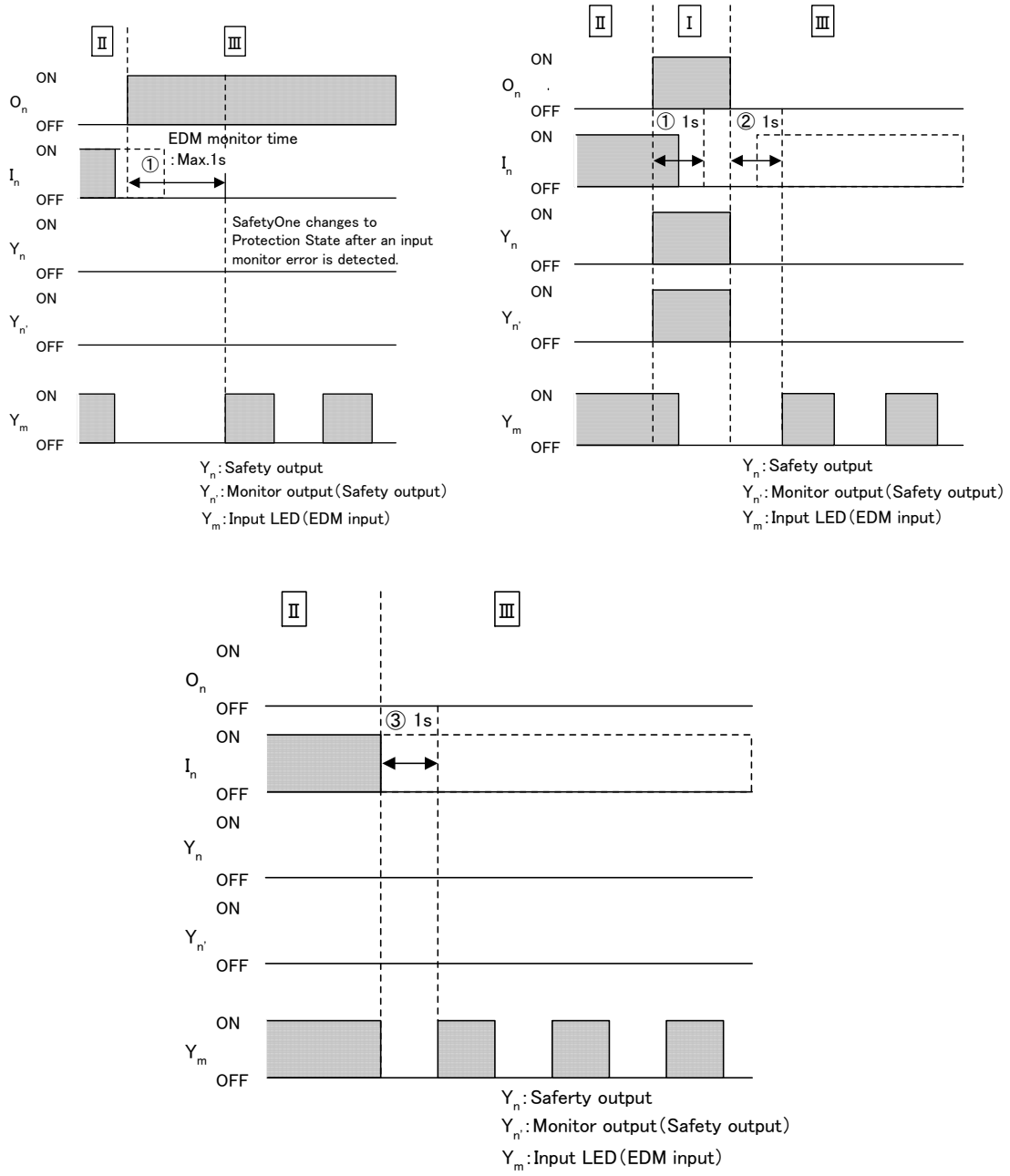


Fig. 5-38 Operation timing when EDM input error occurs

Error detection function

EDM input monitoring

When the following condition is satisfied, the SafetyOne changes to the Protection state and displays "1" in the error LED display.

(1) When the EDM input does not turn ON within the EDM monitoring time (1 s) after the hold input turns ON.

(2) When the EDM input does not turn ON within the EDM monitoring time (1s) after safety output turns OFF.

(3) When the EDM input does not turn ON within the EDM monitoring time (1s) after EDM input turns OFF during safety output is OFF state.

The input LEDs (Y_m) blink transmits pulses, to notify the operator of the corresponding EDM input (I_n).

Short circuit and grounding detection

When an output error, such as short circuit, grounding or circuit failure, is detected, the SafetyOne changes to the Stop state and displays "4" on the error LED display.

The output LEDs blink to notify the operator of the corresponding output.

In the case of SW version 1.00, the monitor output (Yn') outputs pulses (1Hz).

Note. OFF check signals are outputted at a fixed interval while the safety output is ON for checking the OFF function of the output circuit. Refer to "Chapter 2 PRODUCT SPECIFICATION" for details.

Safety output with timer

This function is for controlling the safety output with OFF delay timer.
As shown in Fig.5-39, this function is comprised of a hold input (O_n), an EDM input (I_n), and a safety output (Y_n). The function output of this external device monitoring input function is connected to the EDM input (I_n).

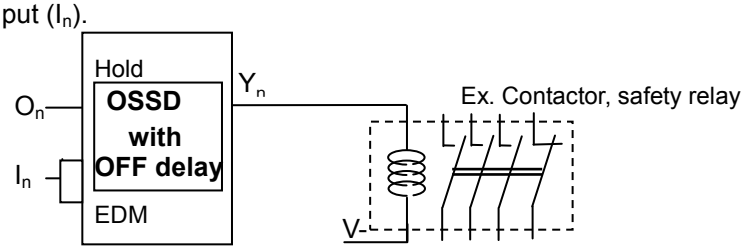


Fig. 5-39 Safety output with timer function circuit

Connects to

Equipment with force guided mechanisms, such as, contactors, safety relays.
Input of safety PLC, or other safety controllers.

Description of operation

The operation timing is described in Fig.5-40 and 5-41.

Ⅰ When hold input is turned ON, the safety output is turned ON after confirmation that the EDM input is ON.

Ⅱ When hold input is turned OFF, the safety output is turned OFF.

Ⅲ When the OFF-delay timer is set, after the hold input is turned OFF, the safety output is turned OFF after the set time of the OFF-delay timer. However, the monitor outputs for safety outputs are turned OFF immediately after the hold input is turned OFF regardless of the set time of the OFF-delay timer.

Ⅳ If the EDM input is not applied correctly (ON state of EDM input is not detected during EDM monitoring time (1s) after hold input is turned ON, ON state of EDM input is not detected during EDM monitoring time (1s) after safety output turns OFF, or ON state of EDM input is not detected during EDM monitoring time (1s) after EDM input turns OFF due to the error during safety output is OFF state), the SafetyOne changes to the Protection state, and indicates “1” on the error LED without turning ON the safety output. (See Fig.5-41.)

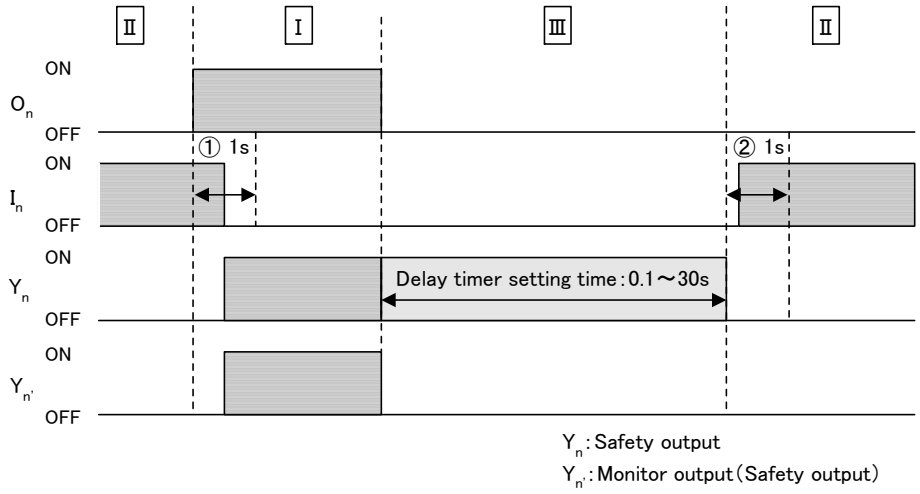


Fig. 5-40 Operation timing of the safety output with timer function

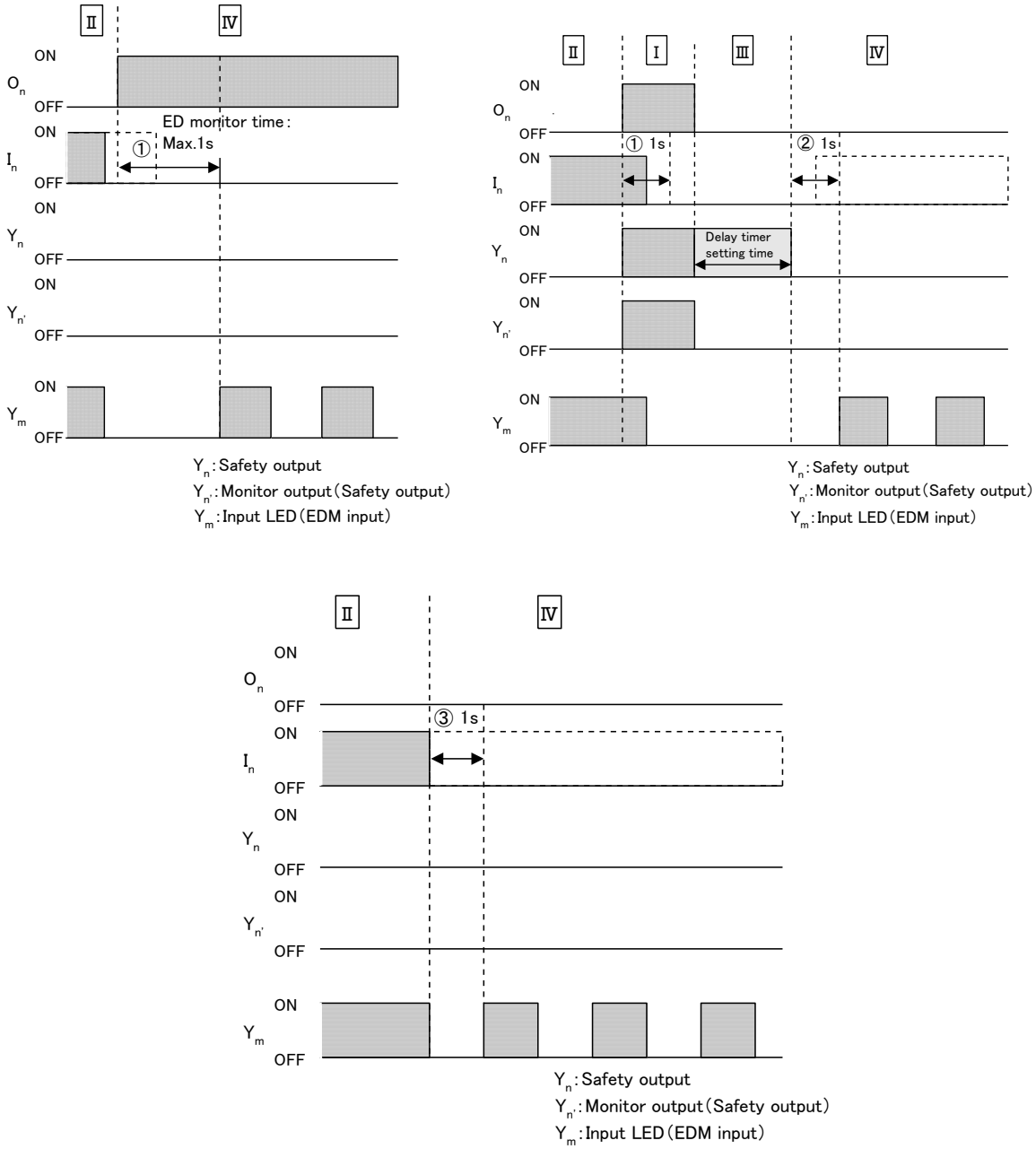


Fig. 5-41 Operation timing when EDM input error occurs

Error detection function

EDM input monitoring

When the following condition is satisfied, the SafetyOne changes to the Protection state and displays "1" in the error LED display.

(1) When the EDM input does not turn ON within the EDM monitoring time (1 s) after the hold input turns ON.

(2) When the EDM input does not turn ON within the EDM monitoring time (1s) after safety output turns OFF.

(3) When the EDM input does not turn ON within the EDM monitoring time (1s) after EDM input turns OFF during safety output is OFF state.

The input LEDs (Y_m) blink transmits pulses, to notify the operator of the corresponding EDM input (I_n).

Short circuit and grounding detection

When an output error, such as short circuit, grounding or circuit failure, is detected, the SafetyOne changes to the Stop state and displays "4" on the error LED display.

The output LEDs blink to notify the operator of the corresponding output.

In the case of SW version 1.00, the monitor output (Yn') outputs pulses (1Hz).

Note. OFF check signals are outputted at a fixed interval while the safety output is ON for checking the OFF function of the output circuit. Refer to "Chapter 2 PRODUCT SPECIFICATION" for details.

Chapter6 TROUBLE SHOOTING

This chapter describes how to determine the cause of a failure or error that occurs with the SafetyOne or connected device, and the measures to take to solve the problem.

Error descriptions and troubleshooting

The SafetyOne uses advanced diagnostic functions to detect any problems within the SafetyOne and its peripheral devices, thereby ensuring safety performance of the entire system. You can obtain information about a detected failure or error by using the error LED display, input LEDs, and monitor outputs.

Error information from error LED display and monitor outputs

Error LED	Monitor output			Description	Cause	Possible solution
	Y14	Y15	Y16			
-	OFF	OFF	ON	Normal operation	-	-
1	OFF	ON	OFF	Input monitor error	1. Fault in the dual channel input 2. Fault in the muting input 3. Both inputs of the mode selector inputs are ON 4. EDM input is OFF	1. Check the corresponding dual channel input device and wiring. 2. Check the corresponding muting input device and wiring. 3. Check the mode selecting device and wiring. 4. Check the corresponding external device and wiring.
2	ON	OFF	OFF	Fault in safety input wiring or safety input circuit	1. Broken or shorted safety input wiring 2. Fault in safety input device	1. Check safety input wiring. 2. Check operation the safety input device.
3	ON	OFF	OFF	Fault in start input wiring or start input circuit	1. Shorted start input wiring 2. Fault in start input device	1. Check start input wiring. 2. Check operation of the start input device.
4	ON	OFF	OFF	Fault in safety output wiring or safety output circuit	1. Shorted safety output wiring 2. Fault in safety output device	1. Check safety output wiring. 2. Check operation of safety output device.

5 (Software version 1.00 only)	ON	OFF	OFF	Muting lamp error (broken wire) (For logics with lamp output)	1. Broken wire of muting lamp wiring 2. Broken wire of Muting lamp	1. Check functionality and wiring of the muting lamp. 2. Check the operation of the muting lamp.
6	ON	ON	OFF	Fault in power supply or internal power supply circuit	1. The voltage of the power supply to SafetyOne is not within the allowable range.	1. Check voltage of power supply to the SafetyOne.
7	ON	ON	OFF	Fault in power supply or internal power supply circuit	1. The voltage of power supply to SafetyOne is not within the allowable range.	1. Check voltage of power supply to SafetyOne.
7	ON	OFF	OFF	Internal circuit error	1. Internal failure of the SafetyOne	1. Replace the SafetyOne.
9	ON	OFF	OFF	Noise filter error	1. Noise influences to the SafetyOne or input/output line.	1. Check noise in surrounding environment.
C	OFF	ON	OFF	Changing to the Configuration state	-	-

The state of the input LEDs and monitoring output varies depending upon the logic selected. Refer to “Chapter 4 BASIC OPERATIONS” and to "Chapter 5 LOGIC" for details.

APPENDIX

Minimum Distance

The minimum distance is the distance required to minimize the risk of contact with the hazard in the danger zone.

Be sure to maintain a sufficient minimum distance while taking into consideration the stopping time of the entire system, including the reaction time of the SafetyOne and the reaction time of any connected devices. If sufficient minimum distance is not maintained, the machinery may not be able to come to the sudden stop before a person meets a hazard, resulting in death or serious injury.

Calculating the minimum distance when connecting a safety light curtain

■ For ISO 13855-2002

You must take the following 5 points into consideration when determining the minimum distance.

1. Reaction time of the safety light curtain and SafetyOne
   (The time it takes for the safety outputs of the SafetyOne are turned OFF after the safety light curtain is shaded)
2. Stopping time of the machinery
   (The time it takes for dangerous machinery operation to come to the stop after the safety outputs of the SafetyOne are turned OFF)
3. Size of the minimum detectable object of the safety light curtain
4. Speed of the detected object entering the danger zone
5. Height of the maximum allowable optical axis of the safety light curtain

Parameters

S: Minimum distance (mm)

K: Speed of the detected object, arm or leg entering the danger zone (mm/s)

Tc: t1+t2

(t1: Reaction time of the SafetyOne (s)
  t2: Preset OFF-delay time of the SafetyOne (s))

T1: Reaction time of the safety light curtain (s)

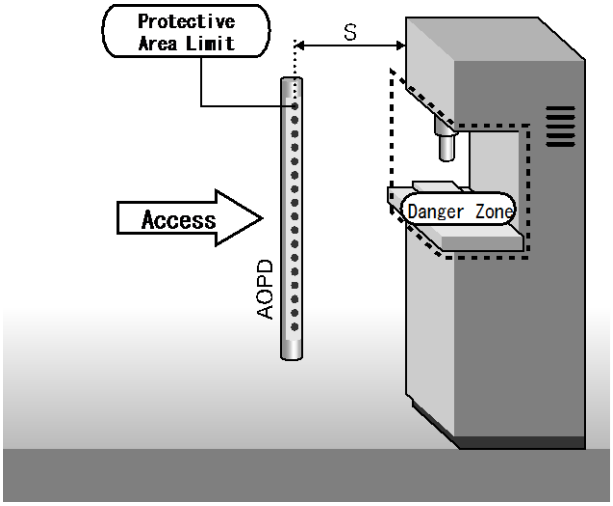
T2: Maximum time from when the safety output of SafetyOne is turned OFF to when the hazard is stopped (s)

C: Additional distance calculated from the minimum detectable object of the safety light curtain (mm)

H: Height of the maximum allowable optical axis of the safety light curtain

β: Angle of the ground surface and the safety light curtain to the direction of entry

Example in which the direction of entry is perpendicular to the safety light curtain



- When the size of the minimum detected object is 40 (mm) or smaller

Use the following formula to calculate the minimum distance.

S = K× (Tc + T1 + T2) + C

Tc = t1 + t2

If using the SafetyOne and a safety light curtain, the following parameters are used for the above formula.

K = 2000 (mm/s)

t1 = 0.04 (s) [in case of logic 22b and 22C, t1 = 0.05 (s)]

t2 = 0 (s), 0.1 (s), 0.5 (s), 1 (s), 2 (s), 5 (s), 15 (s), 30 (s)

T1 (s) (Check the specifications of the safety light curtain)

T2 (s) (Check the maximum time from when the safety output of the SafetyOne is turned OFF when the hazard is stopped)

C = 8 × (Size of the minimum detectable object of the safety light curtain d (mm) − 14 (mm))

Under the above conditions, when the minimum distance (S) is less than 100 (mm), it becomes 100 (mm).

When the minimum distance (S) is greater than 500 (mm), calculate again with K = 1600 (mm/s). When the result of the recalculation with K = 1600 (mm/s) is less than 500 (mm), it becomes 500 (mm).

- When the size of the minimum detected object is greater than 40 (mm)

Use the following formula to calculate the minimum distance.

S = K × (Tc + T1 + T2) + C

Tc = t1 + t2

K = 1600 (mm/s)

t1 = 0.04 (s) [in case of logic 22b and 22C, t1 = 0.05 (s)]

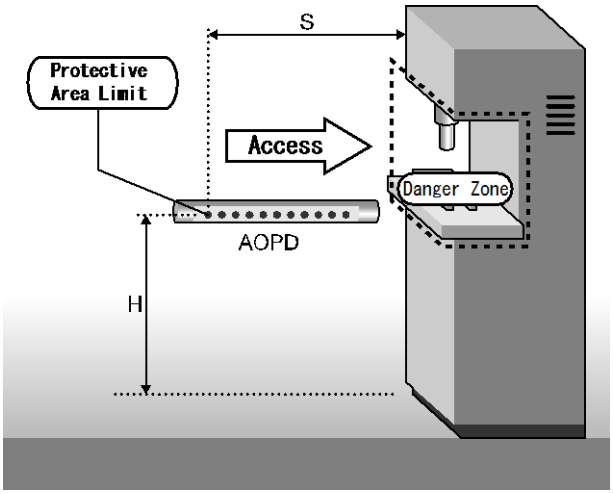
t2 = 0 (s), 0.1 (s), 0.5 (s), 1 (s), 2 (s), 5 (s), 15 (s), 30 (s)

T1 (s) (Check the specifications of the safety light curtain.)

T2 (s) (Check the maximum time from when the safety output of the SafetyOne is turned OFF when the hazard is stopped)

C = 850 (mm)

Example in which the direction of entry is horizontal to the safety light curtain



Use the following formula to calculate the minimum distance (distance to the farthest optical axis).

$S = K \times (Tc + T1 + T2) + C$

$Tc = t1 + t2$

$C = (1200 - 0.4 \times H)$

K = 1600 (mm/s)

t1 = 0.04 (s) [in case of logic 22b and 22C, t1 = 0.05 (s)]

t2 = 0 (s), 0.1 (s), 0.5 (s), 1 (s), 2 (s), 5 (s), 15 (s), 30 (s)

T1(s) (Check the specifications of the safety light curtain.)

T2(s) (Check the maximum time from when the safety output of the SafetyOne is turned OFF when the hazard is stopped)

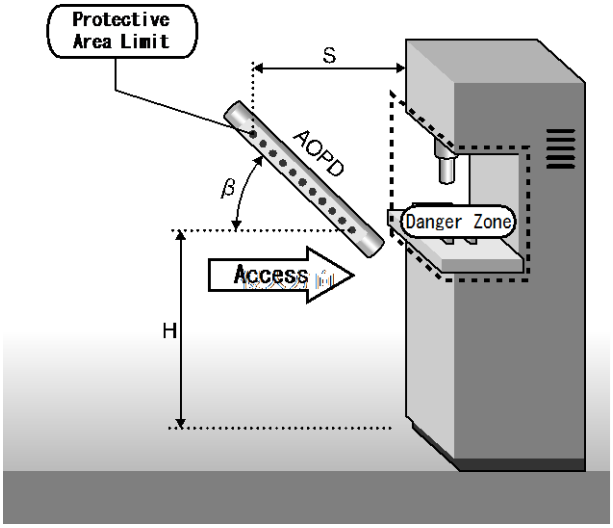
C = (1200 – 0.4 × Height of the optical axis H (mm)) (However, C ≥ 850 (mm))

The height of the maximum allowable optical axis (H) must be within a range of

15 (d – 50 (mm)) ≤ H ≤ 1000 (mm) .

Futhermore, when the valus of H calculated using H ≥ 15 (d – 50) is H ≥ 300 (mm) , there is an unexpected proximity risk in where objects can not be detected below the detection zone. This must be taken into consideration for a risk assessment.

Example in which the direction of entry is at an angle to the safety light curtain



The angle of entry is set within a range of 5°≤ β ≤ 85°.

At β > 30°, the direction of entry is calculated as being perpendicular.
At β < 30°, the direction of entry is calculated as being horizontal.

The minimum distance is the distance to the farthest optical axis, and the height of the optical axis is calculated using ≤ 1000 (mm)
The height of the lowest optical axis is calculated using H ≥ 15 (d – 50) (mm) .

■ For ANSI B11.19

Use the following formula to calculate the minimum distance.

$S = K \times (Ts + Tc + Tr + Tbm) + Dpf$

$Tr = t1 + t2 + T1$

Parameters

S: Minimum distance (mm)

K: Speed of the detected object or arm or leg entering the danger zone (mm/s)

(However, the speed of entry K is not defined by ANSI B11.19.
Take into consideration various factors such as the physical ability of the operator.
The OSHA recommended value is K = 63 (inch/s) ≒ 1600 (mm/s))

Ts: Machinery stopping time (s) as calculated from the last control elements (air valves, etc.) to come to a stop

Tc: Maximum reaction time (s) of the machine control circuit required for operating the machine brake

Tr: t1 + t2 + T1 (s)

(t1: Reaction time of the SafetyOne (s)
t2: Preset OFF-delay time of the SafetyOne (s)
T1: Reaction time of the safety light curtain (s))

Tbm: Additional stop time allowed by the brake monitor (s)

(If the machinery is equipped with a brake monitor, the following formula applies.
Tbm = Ta – (Ts + Tc)
Ta: Brake monitor set time (s)
(If the machinery is not equipped with brake monitor, it is recommended that 20% or more of (Ts+Tc) become an additional stop time.))

Dpf: Additional distance calculated from the minimum detected object of the safety light curtain (mm)

(Dpf = 3.4 × (d – 0.275) (inch)
= 3.4 × (d – 7) (mm)
However, Dpf cannot be 0 or less.)

In case of using the SafetyOne and a safety light curtain, the following parameter is used for the above formula.

K = 63 (inch/s) ≒ 1600 (mm/s)

Tr = t1 + t2 + T1 (s)

(t1 = 0.04 (s) [in case of logic 22b and 22C, t1 = 0.05 (s)]
t2 = 0 (s), 0.1 (s), 0.5 (s), 1 (s), 2 (s), 5 (s), 15 (s), 30 (s)
T1 (s) (Check the specifications of the safety light curtain.))

Maintenance and Inspection

Warning

To ensure safety, use the SafetyOne after performing inspections described below and confirming that the entire safety system incorporating the SafetyOne is operating normally.
The following checklist contains only the minimum items for use of the SafetyOne. Depending on the machinery on which the SafetyOne is installed and the regulations that apply in the country or region where the SafetyOne is used, additional inspection items may be required.

Note. Record and store inspection results.
Note. Perform inspections with a clear understanding of the operations of the SafetyOne and the machine on which it is used.

Daily inspection

Before beginning operations, check the following items.

Inspection items	Check
Check that the power supply of the SafetyOne is OFF.	
Check that the power supply of the machine being controlled by the safety output of the SafetyOne is OFF.	
Before turning ON the power supply of the SafetyOne, make sure that no person is in the danger zone.	
Check that there is no damage on the input devices and wiring.	
Operate the connected safety devices, and check that they are operating normally.(Ex. Press the emergency stop switch, shade the light curtain, check the state of the muting lamp)	

Periodic inspection

Every testing interval and after changing the settings of the machinery, check the following items.

Inspection items	Check
Check that unintended changes are not introduced into the safety system.	
Check that the safety system incorporating the SafetyOne operates as expected.	
Check that the SafetyOne is installed securely. Check that the DIN rail hooks has not come off and that the DIN rails and end clip screws are not loose.	
Check that the connectors and the wiring are not loose.	
Check that the protective cover is on the SafetyOne to prevent changes to the logic or OFF-delay timer setting by anyone other than the safety responsible person.	

Type number

Item	Type number
Module	FS1A-C21S

Accessories

Item	Type number	Quantity
Input connector	FS9Z-CN01	1
Output connector	FS9Z-CN02	1
Configuration tool	----------	1
Marking tie	FS9Z-MT01	3
Instruction sheet (English / Japanese)	B-1570 / B-1571	1 for each

Options (sold separately)

Item	Type number	Quantity
Input connector	FS9Z-CN01	1
Output connector	FS9Z-CN02	1
Marking tie	FS9Z-MT01PN10	10
Connecting tool	FS9Z-SD01	1

DECLARATION OF CONFORMITY

We, IDEC CORPORATION
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declare under our sole responsibility that the product:

Description: Safety Controller
Series Name: FS1A
Model No.: FS1A-C21S

to which this declaration relates is in conformity with the EC Directive on the following standard(s) or other normative document(s). In case of alteration of the product, not agreed upon by us, this declaration will lose its validity.

Applicable EC Directive: Machinery Directive (2006/42/EC)
EC Directive of Electromagnetic Compatibility (2004/108/EC)

Applicable Standard(s) : EN ISO 13849-1:2008
IEC 61131-2:2007 / EN 61131-2:2007
IEC 62061:2005/A1:2012 / EN 62061:2005/A1:2013
IEC 61000-6-2:2005 / EN 61000-6-2:2005
IEC 61000-6-4:2006/A1:2010 / EN 61000-6-4:2007/A1:2011

Reference Standard(s) : IEC 61508:2010 Part 1 to 4
IEC 61326-3-1:2008 / EN 61326-3-1:2008

Authorized Representative in EU : IDEC ELEKTROTECHNIK GmbH
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FS1A-C21S SafetyOne User's manual (Original instructions)

- B-1572(2)
- April, 2015
- 2-6-64 Nishi-Miyahara, Yodogawa-ku, Osaka, 532-0004 Japan

IDEC CORPORATION

Specifications and other descriptions in this manual are subject to change without notice.

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