IDEC

Think Automation and beyond...

S3 CONNECT

Safety Relay Modules
HR5S

Designing safety systems to satisfy risk level of machines

IDEC CORPORATION

Safety measures for low risk machines

Category 2 Safety Relay Module

Food machines

Creating a safety system for machines with different levels of risk

Mounting device for electrical components

Packaging machines

Semiconductor manufacturing equipment

Collaborative robots

Pharmaceutical manufacturing equipment

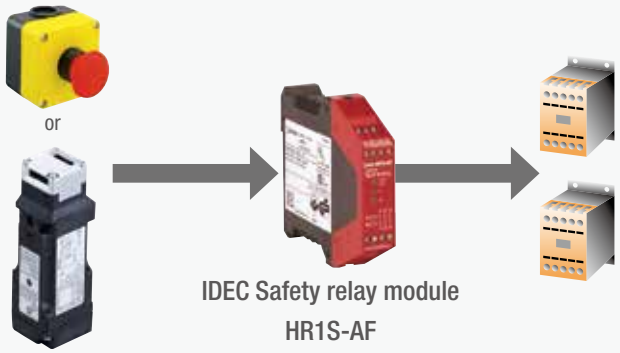
Non-redundant safety system

Introducing a safety system for low risk machines

Designing a category 2 system has been difficult and only a redundant system (category 3) could be used to protect machines against relatively minor hazards.
However, with the HR5S safety relay module, designing a category 2 system is easy and enables cost reduction and saves maintenance time.

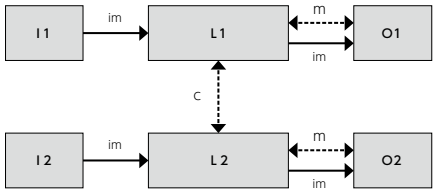
Category 3 and category 2 comparison

Category 3 example - When using IDEC safety relay module HR1S-AF



Category 3 system configuration

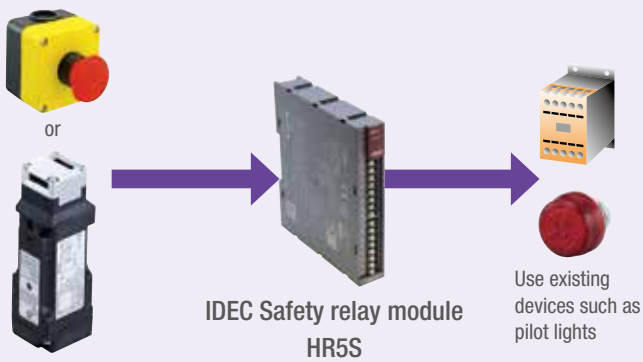
- Dual channel circuit with cross monitoring
- A single fault does not lead to the loss of the safety function



im: interconnecting means I1, I2: input device L1, L2: Logic processing
m: monitoring O1, O2: Output device
Dashed lines for monitoring represent reasonably practicable fault detection

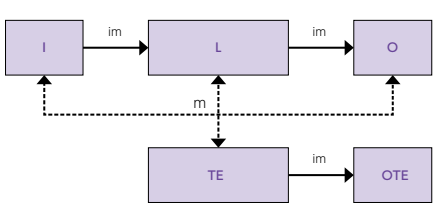
*According to ISO13849-1

Category 2 example - When using IDEC safety relay module HR5S



Category 2 system configuration

- The circuit is monitored but the output device does not require redundancy.
- If the safety function is impaired due to failure, the alarm (light or buzzer) is output by a fault detection signal. (In the case of a PLc system)



im: interconnecting means I2: input device L2: Logic processing
m: monitoring O: output device TE: Testing equipment
OTE: Output of testing equipment
Dashed lines represent reasonably practicable fault detection

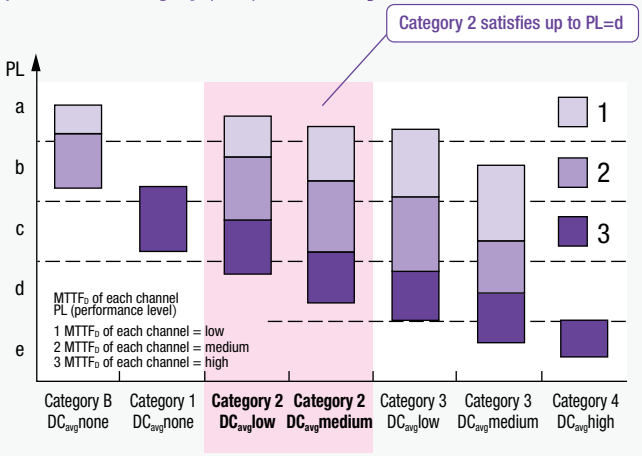
*According to ISO13849-1

- Category is an architecture for safety control defined in ISO13849-1.

Performance level

Degree of contribution to risk reduction in a safety system is categorized by performance levels.
In category 2 architecture, PL=c or PL=d control system can be acheived.
Risk assessment must be performed to check the perfomance level (PLr) required for the equipment.
PLr=C exists especially in food and packaging machines, semiconductor manufacturing equipment, and other production equipment and locations.

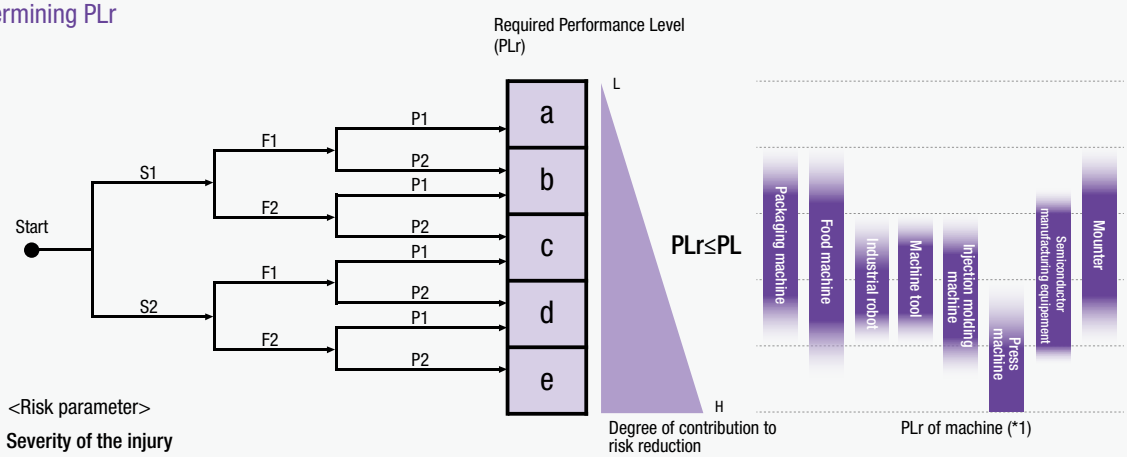
Relationship between category (Cat.), DC, $MTTF_D$ and PL



PL is determined by the combination of the architecture (Cat.), Mean Time to Dangerous Failure ($MTTF_D$), and Diagnostic Coverage (DCavg) of the system.

The illustration shows that the PL that can be acheived by combining Cat., $MTTF_D$, and DC_{avg}. The HR5S can construct a category 2 system so it can satisfy PL=a to d levels.

Determining PLr



<Risk parameter>

S Severity of the injury
S1 Minor injury (resulting in a full recovery)
S2 Serious injury (resulting in a permanent disability)

F Frequency and duration of exposure to the hazard
F1 Seldom to quite often, and/or short exposure time (15min. per sec maximum and 1/20 maximum of that operating time of the machine)
F2 Frequent to continous and/or long exposure time

P Possibility of avoiding the hazard (depending on the occurence speed of danger, ability to escape, and training)
P1 Possible under specific conditions
P2 Scarcely possible

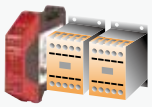
*1) The performance level is mapped according to the sales achievement of IDEC safety products, results of risk assessment, and request for international standards. The required performance level for machines should be determined by risk assesment of individual machines.

Illustrations on this page are based on ISO13849-1.

Performance of Category 2 system

System that eliminates short-circuit fault detection when wiring from an input device

HR1S-AF



Total width
41% DOWN
Cost
45% DOWN

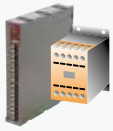
HR5S-C2S

System with off-delay control system

HR1S-ATE

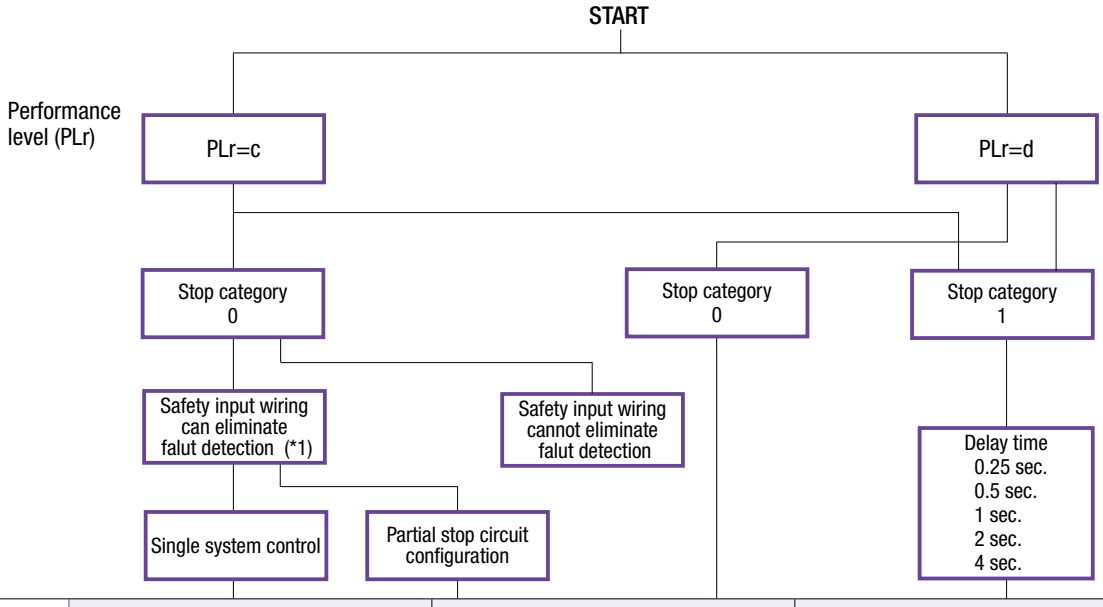
Total width
52% DOWN
Cost
39% DOWN

HR5S-C2D



Product Selection

Selection process flow chart & line up



		Simple model	Standard model	Off-delay model
Part number		HR5S-C2S (*1)	HR5S-C2B	HR5S-C2D-T025 HR5S-C2D-T050 HR5S-C2D-T100 HR5S-C2D-T200 HR5S-C2D-T400
Maximum applicable PL		c	d	d
Features		Minimum functions	• Input monitor available • Equipped with output that turns off when fault is detected • Equipped with fault detection input and can construct partial stop circuit.	• One of the safety outputs of the standard type changed to delay output • Off-delay, 5 models (0.25s, 0.5s, 1s, 2s, 4s)
Input	Safety input	1	1	1
	Switch monitor input	Not available	Available	Available
	Fault monitor input	Not available	Available	Available
Output	Safety output	2	2	Not available
	Auxiliary output	Not available	Not available	1
	Delay safety output	Not available	Not available	1
Fault detection output	ON output (Fault monitor output)	Available	Available	Available
	OFF output (Fault detection output)	Not available	Available	Available
Start		Manual/Automatic	Manual/Automatic	Manual/Automatic
Fault detection release		Manual	Manual	Manual

*1) Can be used in cases were failures caused by cables can be eliminated according to ISO13849-2, IEC60204-1 by using cable covers and shield cables.

HR5S Safety Relay Module

Category 2 safety relay modules for machines that require protection against minor hazards.

• See website for details on approvals and standards.

HR5S Safety Relay Module

Package Quantity: 1

Type	Performance level (PL)	Contact Configuration	Reaction time		Part No. (Ordering No.)
			Output without OFF-delay	Output with OFF-delay	
Simple	PL=c	2NO (Without OFF-delay): Safety output	0.02s max.	—	HR5S-C2S
Standard	PL=d				HR5S-C2B
OFF-delay	PL=d	1NO (Without OFF-delay): Auxiliary output + 1NO (With OFF-delay): Safety output	0.02s max.	0.25s ± 0.05s	HR5S-C2D-T025
				0.50s ± 0.07s	HR5S-C2D-T050
				1.00s ± 0.10s	HR5S-C2D-T100
				2.00s ± 0.15s	HR5S-C2D-T200
				4.00s ± 0.20s	HR5S-C2D-T400

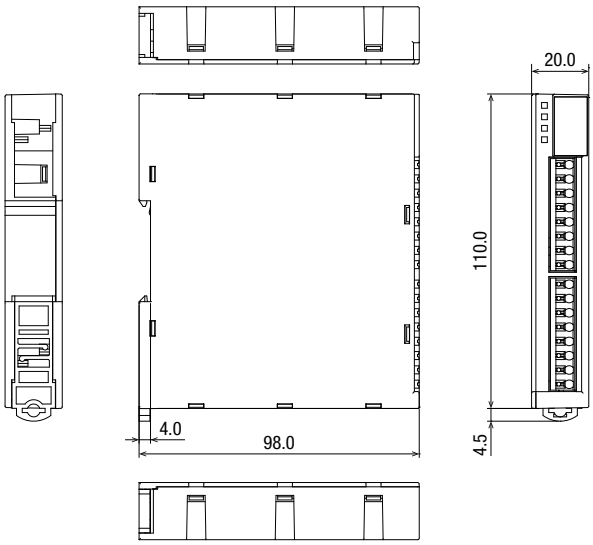
Maintenance Parts

Package Quantity: 1

Type	Part No. (Ordering No.)	Remarks
Bracket for direct mounting	HR5S-PSP	Direct mount

Dimensions

(All dimensions in mm)



Specifications

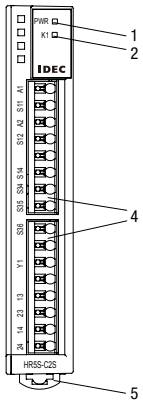
Type No.		HR5S-C2S	HR5S-C2B	HR5S-C2D-T□□□
Applicable standards		EN ISO13849-1: 2015, EN ISO13849-2: 2012, EN 60947-5-1: 2017, UL 508, CSA C22.2 No.14, GB/T 14048.5		
Performance level (PL) (EN ISO 13849-1)		PL=c	PL=d	
Category (Cat.)		2 (EN ISO 13849-1)		
Mean time to dangerous failure ($MTTF_D$)		330 years (100 years: When the limit value from EN ISO 13849-1 is applied) ($MTTF_D$ of fault output: 210 years)		
Diagnostics coverage (DC_{avg})		Medium (90% minimum) (EN ISO 13849-1)		
Mission time (T_M)		20 years (EN ISO 13849-1)		
Stop category (EN 60204-1: 2018)		0		1 (Safety output 2 with OFF-delay) (*1) 0 (Auxiliary output 1 without OFF-delay)
Rated operating voltage		24V DC (Tolerance -15% to +10%), Class 2 Only (For North America)		
Current consumption		100mA maximum at 24V DC (Without load)		
Input (*2)		30Ω maximum (Between S11 to S□□ *□□ : 12, 13, 14, 34, 35, 36)		
		—	30Ω max.(Between Y1 of the previous module to S15)	
Safety output / Auxiliary output (*2)	Configuration	2NO (Without OFF-delay): Safety output		1NO (Without OFF-delay): Auxiliary output + 1NO (With OFF-delay): Safety output
	Initial contact resistance	200mΩ maximum each output contact (*3)		
	Rated load (resistive load)	250V AC 3A / contact, 30V DC 3A / contact		
	Maximum operational voltage	250V AC, 30V DC		
	Minimum applicable load	5V DC, 1mA (reference value) [Failure rate level P (reference value)]		
	Electrical life	250V AC 3A resistive load: 100,000 operations minimum (*4), 30V DC 3A resistive load: 100,000 operations minimum (*4) 250V AC 1A resistive load: 500,000 operations minimum (*5), 30V DC 1A resistive load: 500,000 operations minimum (*5) [AC-15] 240V AC 2A inductive load: 100,000 operations minimum (operating frequency 1200 per hour, cosø= 0.3) [DC-13] 24V DC 1A inductive load: 100,000 operations minimum (operating frequency 1200 per hour, L/R = 48ms)		
	Mechanical life	10 million operations minimum (operating frequency 10,800 per hour)		
	Conditional short-circuit current	1,000A External fuse: 5A FH (IEC 60127-2)		
Fault Output (*2)	Fault monitor output	Semiconductor output, rated 24V DC 100mA maximum		
	Fault detection output	—	Semiconductor output, rated 24V DC 100mA max.	
Reaction time (*6) (*7)		0.02s maximum		• Output with OFF-delay D - T025 (0.25s): 0.25s ± 0.05s D - T050 (0.5s): 0.50s ± 0.07s D - T100 (1s): 1.00s ± 0.10s D - T200 (2s): 2.00s ± 0.15s D - T400 (4s): 4.00s ± 0.20s • Output without OFF-delay: 0.02s max.
Response time by failure diagnosis function (*8)	Detection by EDM	0.25s maximum		D - T025 (0.25s): 0.5s maximum D - T050 (0.5s): 0.8s maximum D - T100 (1s): 1.3s maximum D - T200 (2s): 2.4s maximum D - T400 (4s): 4.5s maximum
	Detection by SW monitor	—	0.6s maximum	
Turn ON time (*7)		0.05s maximum		
Operating temperature (*9)		-10 °C to +55 °C (no freezing, no condensation)		
Operating humidity		5 % RH to 85% RH (no condensation)		
Storage temperature		-25 °C to +85 °C (no freezing, no condensation)		
Storage humidity		5 % RH to 85% RH (no condensation)		
Altitude		Operation: 0 to 2,000m		
Operating atmosphere		Indoor use only (atmosphere free from corrosive gases)		
IP (protective structure specification)		Enclosure: IP40, Terminals: IP20		
Pollution degree		2		
Over voltage category		II		
Insulation		Basic insulation (reinforced insulation: between contact output circuits and other circuits)		
Rated insulation voltage		250V (contact outputs)		
Rated impulse withstand voltage		2,500V (between different terminal contact outputs) (4,000V: between contact output circuits and other circuits)		
Dielectric strength (1 minute)		3,750V AC (between enclosure and internal circuit), 2,500V AC (between different terminal contact outputs) (between contact output circuits and other circuits)		
Vibration resistance		5 Hz to 8.4 Hz: 3.5 mm amplitude, 8.4 Hz to 150 Hz: 10 m/s^2 peak, 1 octave/min, 10 cycles for 3 axes		
Shock resistance		150 m/s^2, pulse width: 11 msec, 3 times for 6 directions		
Mounting		DIN rail or panel mounting		
Terminal Style		Push-in terminals		
Weight (approx.)		150g		

*1) "Stop category 1" of EN 60204-1: 2018 is compliant to "SS1-t" of EN 61800-5-2: 2017.
*2) The external wiring length for inputs and outputs must be less than 30m maximum.
*3) Measured using 6V DC, 1A voltage drop method.
*4) Operating frequency 1200 per hour
*5) Operating frequency 1800 per hour
*6) The interval between when the safety input (S12) turns OFF and safety output contacts and/or the auxiliary output contact turn OFF.
*7) When measured at the rated voltage (at 20°C). Excluding contact bounce time.
*8) The interval between when the safety relay module detects a fault and the fault monitor output (Y1) turns ON, and the fault detection output (Y2) turns OFF at the same time.
*9) UL approved operating temperature is 40°C maximum when the product is installed in a control panel.

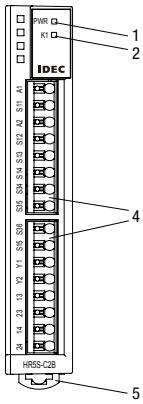
- The performance level and the category in accordance with EN ISO 13849-1 depends on the external wiring, application, control device used, and location in the equipment.
- The user must carry out a risk assessment in accordance with ISO 12100.
- The entire system/machine must be validated in accordance with the applicable standards.
- The safety relay module contains electromechanical relays. Therefore the shown performance level and $MTTF_D$ value depend on the load and the operating cycles in the application. The above mentioned performance level and $MTTF_D$ values are suitable for nominal load of maximum 8,760 switching cycles per year or for small load of maximum 525,600 switching cycles per year.

Parts Description and Definition of Terminals

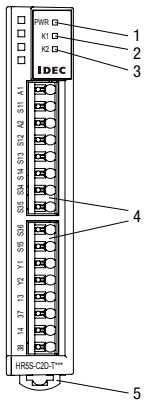
• HR5S-C2S



• HR5S-C2B



• HR5S-C2D-T□□□

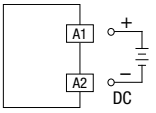


Parts No.	Parts Name and Functions
1	PWR LED: Indicates power supply
2	K1 LED: Indicates safety output(s) (or auxiliary output) without OFF-delay
3	K2 LED: Indicates safety output with OFF-delay
4	Push-in terminal
5	DIN Rail mounting hook

Product type symbol			Terminal no.	Terminal name	Function
S	B	D			
✓	✓	✓	A1, A2	Power supply	24V DC power supply (A1: 24V DC, A2: 0V)
✓	✓	✓	S11	Input driver	24V DC output for safety input, reset inputs, switch monitor input, and EDM input
✓	✓	✓	S12	Safety input	Switches with a direct opening action mechanism connects between S11 and S12.
	✓	✓	S13	Switch monitor input	Connect NO contacts of interlock switches (such as non-contact safety switches) between S11 and S13. When not used, do not connect S13.
✓	✓	✓	S14	EDM input	Connect NC contacts of external contactors between S11 and S14.
	✓	✓	S15	Fault monitor input	Connect fault monitor output (Y1) of the previous HR5S module. When not used, do not connect S15.
✓	✓	✓	S34	Manual reset input	Connect a switch between S11 and S34. Only a rising edge followed by a falling edge triggers the reset event.
✓	✓	✓	S35	Auto reset input	Connect a switch between S11 and S35. A rising edge triggers the reset event.
✓	✓	✓	S36	Fault reset input	Connect a switch between S11 and S36. Only a rising edge followed by a falling edge triggers the fault reset event. When the fault reset event is triggered after a failure is cleared, the fault detection output (Y2) turns ON from OFF and the fault monitor output (Y1) turns OFF from ON.
✓	✓		13 - 14	Safety output 1 Without OFF-delay	The contact configuration is NO. The contact is a part of the force guided relay (K1) embedded in HR5S.
		✓		Auxiliary output 1 Without OFF-delay	
✓	✓		23 - 24	Safety output 2 Without OFF-delay	The contact configuration is NO. The contact is a part of the force guided relay (K1) embedded in HR5S.
		✓	37 - 38	Safety output 2 With OFF-delay	The contact configuration is NO. The contact is a part of the force guided relay (K2) embedded in HR5S.
✓	✓	✓	Y1	Fault monitor output	The output is kept on high level (Typ. 24VDC) when the safety relay module detects a fault. (Semiconductor output)
	✓	✓	Y2	Fault detection output	The output is kept on low level (Typ. 0V) when the safety relay module detects a fault. (Semiconductor output)

Wiring Examples

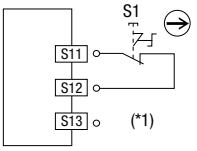
POWER



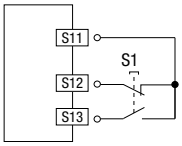
INPUT

E-STOP SWITCHES

Single channel

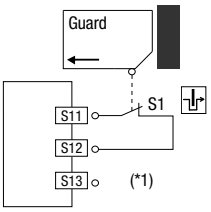


Single channel + short circuit detection

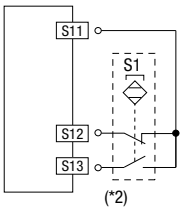


INTERLOCK SWITCHES

Single channel

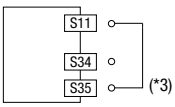


Single channel + short circuit detection

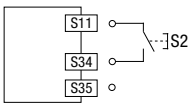


RESET

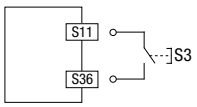
Auto reset



Manual reset

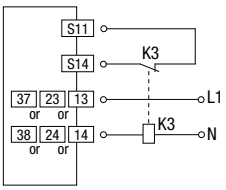


Fault reset

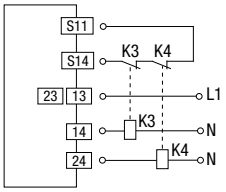


FEEDBACK (EDM)

One output used only

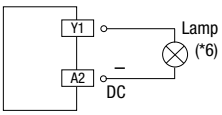


Two outputs used

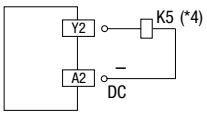


FAULT OUTPUT

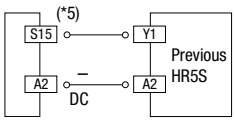
Fault monitor output



Fault detection output



Fault monitor input



*1) When the switch monitor input (S13) is not used, it is necessary to exclude a short circuit between the cable of safety input (S12) and other cables (e.g. to protect the cables and/or to shield the cables).

*2) Illustrates contact status when actuator exists.

*3) When the auto reset input (S35) is used, risk assessment must be performed to prevent an unexpected activation. In this case, the manual reset input (S34) must not be used.

*4) The fault detection output (Y2) turns OFF when a fault is detected, i.e. it is possible for K5 (e.g. a contactor) to stop the hazard source (e.g. a motor).

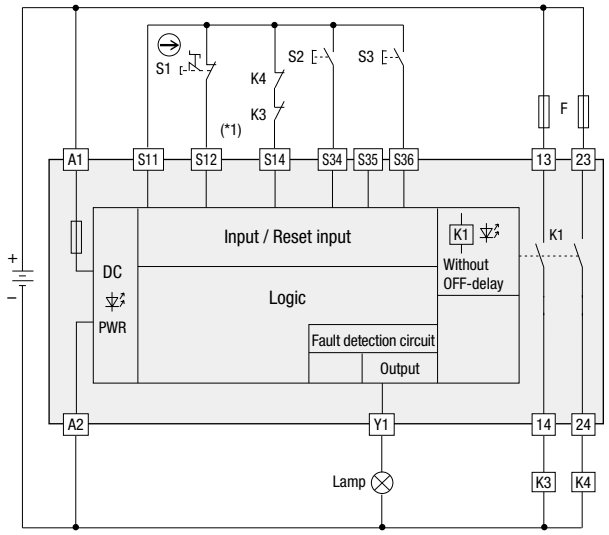
*5) The fault monitor input (S15) can be connected to the fault monitor output (Y1) of previous module (HR5S), i.e. each fault outputs can be combined.

*6) Leakage currents of the fault output may cause the LED lamp to illuminate dimly even when the output is off. In this case, insert a shunt resistor with the LED lamp.

Wiring Diagram (Typical application)

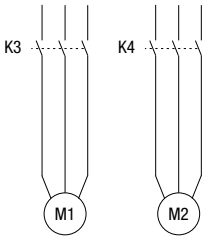
HR5S-C2S

The maximum achievable PL is “c”.
(In the figure below, the manual reset input (S34) is used.)

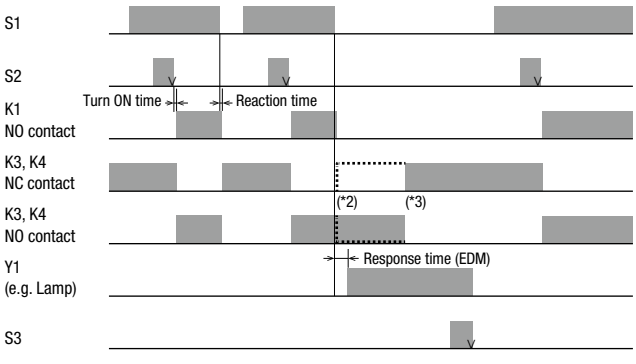


S1: Emergency stop switch
S2: Reset switch for start
S3: Reset switch for a fault
K1: Force guided relay embedded in the module
K3, K4: Contactor
M1, M2: Motor
F: External fuse

*1) It is necessary to exclude a short circuit between the cable of safety input (S12) and other cables (e.g. to protect the cables and/or to shield the cables).



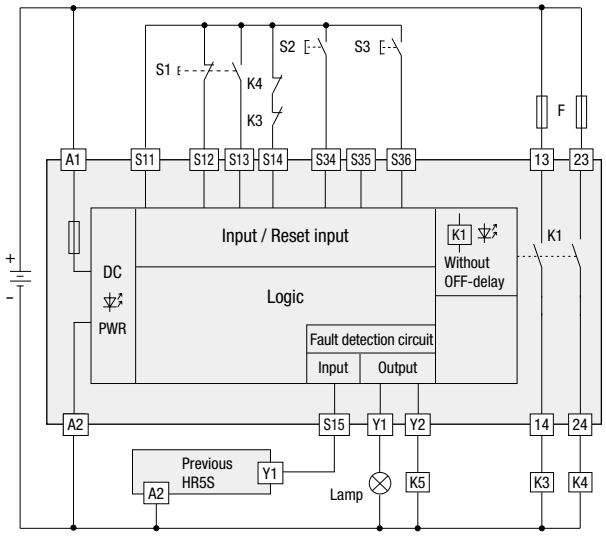
Timing Chart



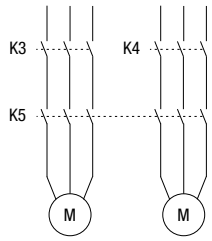
*2) Failure occurred.
*3) Failure removed.

HR5S-C2B

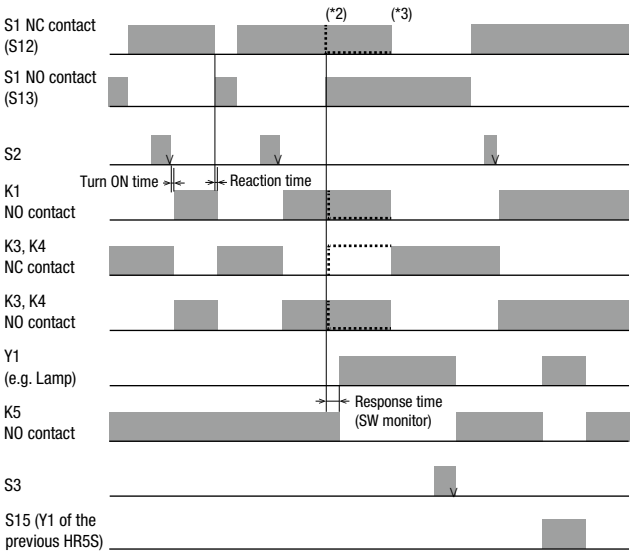
The maximum achievable PL is “d”.
(In the figure below, the manual reset input (S34) is used.)



S1 : Emergency stop switch
S2 : Reset switch for start
S3 : Reset switch for a fault
K1 : Force guided relay embedded in the module
K3, K4, K5 : Contactor
M : Motor
F : External fuse



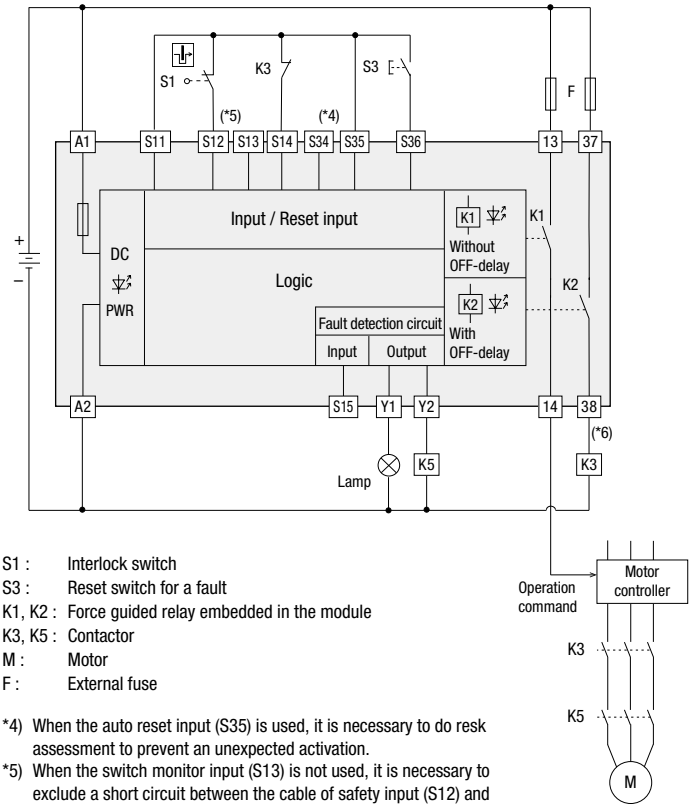
Timing Chart



*2) Failure occurred.
*3) Failure removed.

HR5S-C2D-T□□□

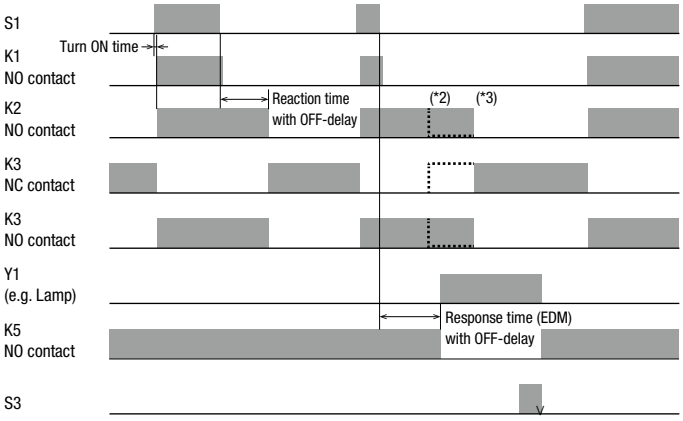
The maximum achievable PL is “d”.
(In the figure below, the auto reset input (S35) is used.)



S1 : Interlock switch
S3 : Reset switch for a fault
K1, K2 : Force guided relay embedded in the module
K3, K5 : Contactor
M : Motor
F : External fuse

*4) When the auto reset input (S35) is used, it is necessary to do resk assessment to prevent an unexpected activation.
*5) When the switch monitor input (S13) is not used, it is necessary to exclude a short circuit between the cable of safety input (S12) and other cables (e.g. to protect the cables and/or to shield the cables).
*6) “Stop category 1” of IEC 60204-1 is corresponding to “SS1-t” of IEC 61800-5-2.

Timing Chart



*2) Failure occurred.
*3) Failure removed.

⚠ Residual Risk (EN ISO / ISO 12100)

The wiring diagrams in this catalog have been tested under actual operating conditions. The HR5S safety relay module can be used in a safety circuit by connecting to safety equipment compliant to applicable standards. Consider residual risk in the following circumstances.

1. When circuits other than described in this catalog are used.
2. When the applicable standards of machine operation are not observed. Or, when machine is not adjusted or maintained properly (observe the maintenance schedule strictly).
3. When the contacts of relays and contactors for connecting with safety outputs are not forced guide types compliant with EN 50205.

⚠ Safety Precautions

- Do not disassemble, repair, or modify the product. This may cause impairment of the safe operability of the safety relay module.
- Turn off the power to the product before starting installation, removing, wiring, maintenance, or inspection of the safety relay module. Failure to turn power off may cause electric shocks or fire hazard.
- Be sure to read the instructions attached to the product or website and use under the appropriate environment. Insufficient installation may lead to damage or failure.
- Make sure to take measures to prevent electric shock due to insulation damage between output 1 and output 2.
- Use within the specified voltage. Do not use a power supply that produce high ripple voltage or abnormal voltage.
- Use a power supply that meets following required specifications;
  – Complies with SELV or PELV circuit specified by IEC 60364-4-41.
  – Has the functionality of the control voltage and current of class 2 circuit, as defined in UL508.
- Check the safety function of the product periodically, turn OFF the signal to the safety input (e.g. at least once a year) and make sure the safety outputs turn OFF.
- The product is designed for installation within an enclosure. Do not install the product outside an enclosure. Install the product in an enclosure rated IP54 or higher.
- Install the product in environments described in this instruction sheet. If the safety relay module is used in places where the product is subjected to high temperature, high humidity, condensation, corrosive gases, excessive vibrations, and excessive shocks then electric shocks, fire hazard, or malfunction may result.
- Environment for using the product is “Pollution degree 2”. Use the safety relay module under pollution degree 2 environment.
- When disposing the product, follow the laws and regulations of the country where it is disposed.
- Due to a power supply failure, the voltage of S11 (input driver) may rise to 34V DC maximum.

Instructions

See the instruction sheet for installation.

Applicable Wire

To wire the HR5S, use the following wires:

- Solid wire : 24 AWG to 16 AWG (0.2 to 1.5 mm^2)
- Stranded wire / Flexible wire : 24 AWG to 18 AWG (0.25 to 0.75 mm^2)
- Strip the cover of wire : 7 to 9 mm

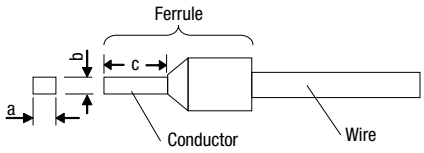
Use cables conforming to applicable standards.
When using stranded wire, insulated ferrule should be used.
Use below insulated ferrule.

Insulated ferrule (*1)

24 AWG to 18 AWG (0.25 to 0.75mm^2)

Connectable size

- Crimp width a : 2.1 mm max.
- Height b : 1.48 mm max.
- Conductor length c : 7 to 9 mm



*) When using a ferrule, refer to “Recommended Ferrules” below.
When using a Crimping tool, refer to “Recommended Tools” below.

Recommended Ferrules (Optional)

Applicable Wire		Weidmüller Recommended Part No.
mm^2	AWG	
0.25	24	**H0,25/12 HBL**
0.34	22	**H0,34/12 TK**
0.5	20	**H0,5/14 OR**
0.75	18	**H0,75/14 W**

Recommended Tools (Optional)

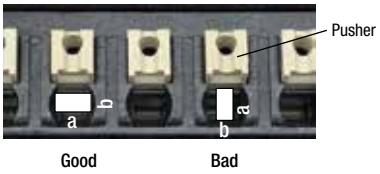
Name	Weidmüller Recommended Part No.
Crimping tool	**PZ 6/5**

Note 1) Note the crimping dimensions When using tools other than the recommended crimping tool. See "Connectable size" shown above for details.

Note 2) Use a tool recommended by the ferrule manufacturer.

Inserting solid wire and insulated ferrule

Insert the stripped solid wire or stranded wire with insulated ferrule in a straight direction. Tools are not required for wiring.
After inserting, pull lightly to make sure wire is connected to the push-in terminal.



Removing the wire

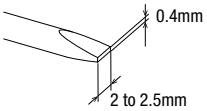
Be sure to turn off the power before removing the wire.

- Push the pusher using a screwdriver, such as a flat screwdriver, with a force of approx. 20N.
- With the pusher pressed, pull the wire out in the straight direction.

Recommended Tools (Optional)

Name	Weidmüller Recommended Part No.
Flat screwdriver	**SDS 0.4×2.0×60**
	SDS 0.4×2.5×75

Note) Use a flat screwdriver with a blade width of 0.4 × 2 to 2.5mm.



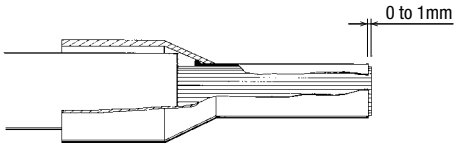
Be careful so that the push-in terminal is not damaged.

- Do not push the pusher by a force of more than 40N.
- Do not pull out the wire without pushing the pusher.

Instructions

Crimping of Ferrules and Wiring

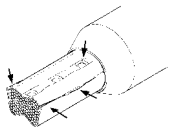
- Choose an appropriate ferrule for the wire.
- Cut the wire carefully to get a flat end.
- Make sure that ferrule sleeve is completely filled by the conductor. Depending on the cross section, the conductor should protrude approx. 0 to 1 mm from the ferrule sleeve.



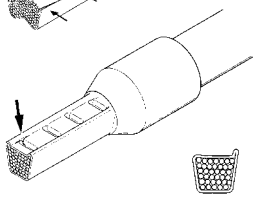
- When crimping, refer to the instructions of the crimping tool.

Faults which can occur during crimping:

- Cracks along the sides and die impressions
- Splitting of the ferrules
- Asymmetrical crimping shape
- Extreme burrs formed along the sides
- Ferrule not filled by conductor
- Single conductors pushed back by protruding from the insulation cover
- Single conductors squeezed off
- Insulation cover damaged by the crimping jaw
- Conductor insulation not pushed into the insulation cover
- Ferrule bent longitudinally after crimping



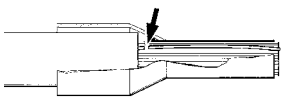
Formation of cracks at the sides.
Sides spilt open



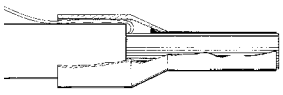
Formation of cracks at the impressions of the crimping jaw

Asymmetrical crimping shape.
Burr formation on one side

Asymmetrical crimping shape.
Burr formation on one side



Single conductor squeezed off



Single conductor pushed back

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EP1726-3