D5290

SIL3 Relay Out Module for 10 A NE Loads

Models D5290S

INSTRUCTION AND SAFETY MANUAL

SUMMARY OF CONTENT

1. CHARACTERISTICS

General Description: The single channel Relay Output, D5090S is a relay module suitable for the switching of safety related circuits, up to SIL 3 level according to IEC 61508:2010 Ed.2 for high risk industries. It provides isolation between input and output contacts.

Three mutually exclusive (by DIP-Switch programming) monitoring circuits are provided:

- line input monitoring, to allow DCS/PLC line monitoring function: when enabled, the module permits a wide compatibility towards different DCS/PLC. Driving line pulse testing, executed by DCS/PLC, is permitted by a dedicated internal circuit, to prevent relay and LED flickering;
- low voltage input monitoring: when enabled, the module reflects a high impedance state to the control unit when the driving voltage is below the specified threshold;
- short circuit fault detection: when enabled, it allows DCS/PLC to detect short circuit fault of module.

D5290S provides two NO contacts for normally energized load and a NC contact for service purpose, in order to switch the NE load on both supply lines.

This relay module is not suitable for low-current consumption applications (system-to-system signalling, driving LEDs, etc.).

See proper section for Functional Safety applications with related SIL value. Mounting on standard DIN-Rail or on customized Termination Boards, in Safe Area / Non Hazardous Location or in Zone 2 / Class I, Division 2 or Class I, Zone 2.

Functional Safety Management Certification:

G.M. International is certified by TUV to conform to IEC61508:2010 part 1 clauses 5-6 for safety related systems up to and included SIL3.

2. TECHNICAL DATA

Input: 24 Vdc nom (21.6 to 27.6 Vdc) reverse polarity protected, ripple within voltage limits ≤ 5 Vpp.

The following monitoring circuits are mutually exclusive:

1) Line input monitoring (DIP-Switch selectable): to allow DCS/PLC line monitoring function (pulse test).

2) Voltage monitoring (DIP-Switch selectable): ≥ 21.6 Vdc for normal operation, ≤ 17 Vdc reflects a high impedance (≤ 10 mA consumption) to the control device.

3) Short circuit fault detection (DIP-Switch selectable): to allow DCS/PLC to detect short circuit fault of module.

Current consumption @ 24 V: 60 mA with relay energized, typical.

Power dissipation: 1.5 W with 24 V input voltage, relay energized, typical.

Isolation (Test Voltage): Input / All Outputs 2.5 KV ; Out 1 / Out 2: 500V.

Output: 1 voltage free SPDT relay contact identified with outputs: Out 1 (NO contact) terminals 13-21 and Service Load Out (NC contact) terminals 13-15;

1 voltage free SPST relay contact identified with output Out 2 (NO contact) terminals 14-22.

Terminals 13-21 (Out 1) and 14-22 (Out 2) are open when relay is de-energized, closed in energized relay condition.

Service load output (not SIL) at terminals 13-15 is normally close when relay is de-energized, open in energized relay condition.

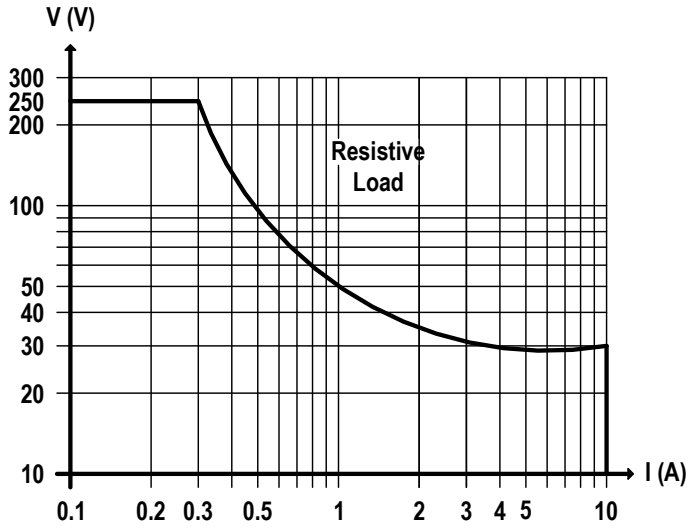
Contact material: Ag Alloy (Cd free) or AgSnO2.

Contact rating: 10 A 250 Vac 2500 VA, 10 A 250 Vdc 300 W (resistive load).

Contact inrush current: 16 A at 24 Vdc, 250 Vac.

Contact min. switching current: 100 mA.

DC Load breaking capacity:



Mechanical / Electrical life: 10 * 106 / 5 * 104 operation, typical.

Operate / Release time: 50 / 15 ms, typical.

Frequency response: 10 Hz maximum.

Compatibility:

CE mark compliant, conforms to Directive: 2014/34/EU ATEX, 2014/30/EU EMC, 2014/35/EU LVD, 2011/65/EU RoHS.

Environmental conditions:

Operating: temperature limits – 40 to + 60 °C, relative humidity 95 %, up to 55 °C.

Storage: temperature limits - 45 to + 80 °C.

Max altitude: 2000 m a.s.l.

Safety Description:

ATEX: II 3G Ex ec nC IIC T4 Gc

IECEx / INMETRO: Ex ec nC IIC T4 Gc

FM: NI / I / 2 / ABCD /T4, I / 2 / AEx nA nC / IIC /T4; ***FMC:*** NI / I / 2 / ABCD /T4, I / 2 / Ex nA nC / IIC /T4

EAC-EX: 2Ex ec nC IIC T4 Gc X.

CCC: Ex ec nC IIC T4 Gc

PESO: Ex ec nC IIC T4 Gc

non-sparking electrical equipment. -40 °C ≤ Ta ≤ 70 °C.

Approvals:

BVS 10 ATEX E 114 conforms to EN60079-0, EN60079-7, EN60079-15.

IECEx BVS 10.0072 X conforms to IEC60079-0, IEC60079-7, IEC60079-15.

INMETRO DNV 13.0109 X conforms to ABNT NBR IEC60079-0, ABNT NBR IEC60079-7, ABNT NBR IEC60079-15.
FM 3046304 and FMC 3046304C conforms to Class 3600, 3611, 3810, ANSI/ISA-60079-0, ANSI/ISA-60079-15, C22.2 No.142, C22.2 No.213, C22.2 No. 60079-0, C22.2 No. 60079-15.
EAЭC RU C-IT.AA87.B.01310/24 conforms to GOST 31610.0, GOST 31610.7, GOST 31610.15.
CCC n. 2020322316000978 conforms to GB/T 3836.1, GB/T 3836.3, GB/T 3834.8
PESO P652307 conforms to IEC60079-0, IEC60079-7, IEC60079-15.
TÜV Certificate No. TUV IT 25 SIL 0633, SIL 3 conforms to IEC61508:2010 Ed.2.
SIL 3 Functional Safety TÜV Certificate conforms to IEC61508:2010 Ed.2, for Management of Functional Safety.
DNV Type Approval Certificate No. TAA00001U0 and KR No.MIL20769-EL002 Certificates for maritime applications.

Mounting:

EN/IEC60715 TH 35 DIN-Rail or on customized Termination Board.

Weight: about 165 g.

Connection: by polarized plug-in disconnect screw terminal blocks to accommodate terminations up to 2.5 mm^2.

Location: installation in Safe Area/Non Hazardous Locations or Zone 2, Group IIC T4 or Class I, Division 2, Group A,B,C,D, T4 or Class I, Zone 2, Group IIC, T4.

Protection class: IP 20.

Dimensions: Width 22.5 mm, Depth 123 mm, Height 120 mm.

3. ORDERING INFORMATION

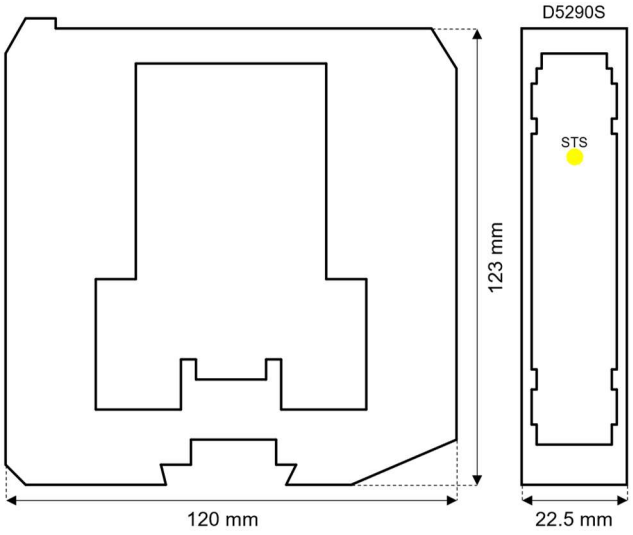
3.1 Ordering codes

D5290S: 1 channel

3.1 Accessories

DIN-Rail stopper MCHP196.

4. OVERALL DIMENSIONS



5. TERMINAL BLOCK CONNECTIONS

5.1 Field Side

13: CM1 Common pole of: Normally Open contact (Out 1) and
Normally Closed contact (Service Load (Not SIL) out)
14: NO1 pole of Normally Open contact (Out 2)
15: NC1 pole of Normally Closed contact (Service Load (Not SIL) out)
16: Not used
21: NO2 pole of Normally Open contact (Out 1)
22: NO3 pole of Normally Open contact (Out 2)
23: Not used

24: Not used

5.2 System Side

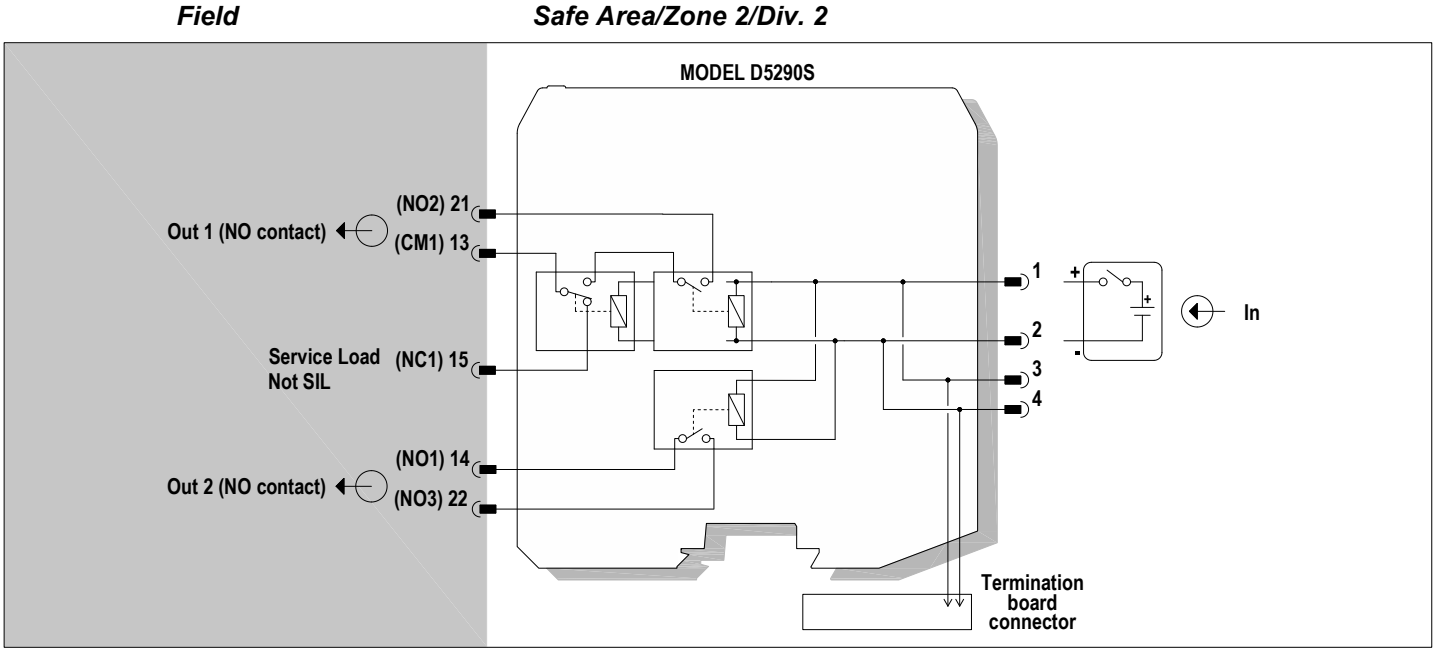
1: + Input

2: - Input

3: + Input

4: - Input

6. FUNCTION DIAGRAM



Relay contact shown in de-energized position. Terminals 13-21 and 14-22 are open; terminal 13-15 is closed.

7. WARNING

D5290 series is an electrical apparatus installed into standard EN/IEC60715 TH 35 DIN-Rail located in Safe Area or Zone 2, Group IIC, Temperature Classification T4, Hazardous Area within the specified operating temperature limits Tamb -40 to +60°C.

D5290 series must be installed, operated and maintained only by qualified personnel, in accordance to the relevant national/international installation standards (e.g. IEC/EN60079-14 Electrical apparatus for explosive gas atmospheres - Part 14: Electrical installations in hazardous areas (other than mines)), following the established installation rules.

De-energize power source (turn off power supply voltage) before plug or unplug the terminal blocks when installed in Hazardous Area or unless area is known to be nonhazardous.

Warning: substitution of components may impair Intrinsic Safety and suitability for Zone 2.

Warning: de-energize main power source (turn off power supply voltage) and disconnect plug-in terminal blocks before opening the enclosure to avoid electrical shock when connected to live hazardous potential.

Explosion Hazard: to prevent ignition of flammable or combustible atmospheres, disconnect power before servicing or unless area is known to be nonhazardous.

Failure to properly installation or use of the equipment may risk to damage the unit or severe personal injury.

The unit cannot be repaired by the end user and must be returned to the manufacturer or his authorized representative.

Any unauthorized modification must be avoided.

8. OPERATION

D5290S relay module is suitable for the switching of safety related circuits, providing isolation between the input and output contacts.

D5290S provides two NO contacts for normally energized load and a NC contact for service purpose, in order to switch the NE load on both supply lines.

See proper section for Functional Safety applications with related SIL value.

A “RELAY STATUS” yellow led lights when input is powered, showing that relay is energized.

9. INSTALLATION

D5290 series is a relay output module housed in a plastic enclosure suitable for installation on EN/IEC60715 TH 35 DIN-Rail or on customized Termination Board.

D5290 series can be mounted with any orientation over the entire ambient temperature range.

Electrical connection are accommodated by polarized plug-in removable screw terminal blocks which can be plugged in/out into a powered unit without suffering or causing any damage (**for Zone 2 installations check the area to be nonhazardous before servicing**). Connect only one individual conductor per each clamping point, use conductors up to 2.5 mm² (13 AWG) and a torque value of 0.5-0.6 Nm. The wiring cables have to be proportionate in base to the current and the length of the cable.

On the section “Function Diagram” and enclosure side a block diagram identifies all connections.

Identify the function and location of each connection terminal using the wiring diagram on the corresponding section, as an example (interruption of both NE load supply lines):

- Connect positive input at terminal “1” and negative input at “2” (positive input at terminal “3” and negative input at “4” are provided for daisy chain connection to the next module).
- Connect positive or AC load supply line to CM1 Common pole (terminal “13” (for SIL 3 NE load and Not SIL Service Load)).
- Connect SIL 3 Normally Energized (NE) Load at terminal “21” and “22”.
- Connect negative or AC load supply line at terminal “14” (for SIL 3 NE load).
- Connect Not SIL Service Load at terminal “15” and to negative or AC load supply line.

Installation and wiring must be in accordance to the relevant national or international installation standards (e.g. IEC/EN60079-14 Electrical apparatus for explosive gas atmospheres Part 14: Electrical installations in hazardous areas (other than mines)), make sure that conductors are well isolated from each other and do not produce any unintentional connection.

Connect SPST relay contacts checking the load rating to be within the contact maximum rating (10 A 250 Vac 2500 VA, 10 A 250 Vdc 300 W resistive load).

To prevent relay contacts from damaging, connect an external protection (fuse or similar), chosen according to the relay breaking capacity diagram on data sheet.

The enclosure provides, according to EN60529, an IP20 minimum degree of protection (or similar to NEMA Standard 250 type 1). The equipment shall only be used in an area of at least pollution degree 2, as defined in IEC 60664-1. When installed in EU Zone 2, the unit shall be installed in an enclosure that provides a minimum ingress protection of IP54 in accordance with IEC 60079-0. The enclosure must have a door or cover accessible only by the use of a tool. The end user is responsible to ensure that the operating temperature of the module is not exceeded in the end use application. Units must be protected against dirt, dust, extreme mechanical (e.g. vibration, impact and shock) and thermal stress, and casual contacts.

If enclosure needs to be cleaned use only a cloth lightly moistened by a mixture of detergent in water.

Electrostatic Hazard: to avoid electrostatic hazard, the enclosure of D5290 series must be cleaned only with a damp or antistatic cloth.

Any penetration of cleaning liquid must be avoided to prevent damage to the unit. Any unauthorized card modification must be avoided.

All circuits connected to D5290 series must comply with the overvoltage category II (or better) according to EN/IEC60664-1.

Warning: de-energize main power source (turn off power supply voltage) and disconnect plug-in terminal blocks before opening the enclosure to avoid electrical shock when connected to live hazardous potential.

10. START-UP

Before powering the inputs of unit check that all wires are properly connected, also verifying their polarity. Check conductors for exposed wires that could touch each other causing dangerous unwanted shorts. Enabling input, the “RELAY STATUS” yellow led must be lit and load circuit must be energized because relay output contacts (Out 1 and Out 2) are closed.

Indeed, disabling input, the “RELAY STATUS” yellow led must be turned off and load circuit must be de-energized because relay output contacts (Out 1 and Out 2) are open.

11. CONFIGURATION

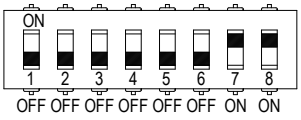
11.1 D5290S

An eight position DIP Switch is located on component side of pcb in order to set four mutually exclusive configurations:

1) line input monitoring, to allow DCS/PLC line input monitoring function (driving line pulse testing);
2) low voltage input monitoring (UVLO—under voltage lock out): module reflects a high impedance state to the control unit when the driving voltage is below the specified threshold;
3) short circuit fault detection: it allows DCS/PLC to detect short circuit fault of module;
4) T-proof relay testing.

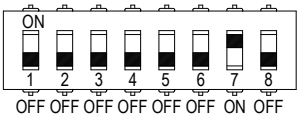
DIP switch configurations:

1) line input monitoring:

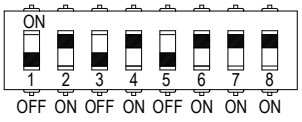


This is factory setting

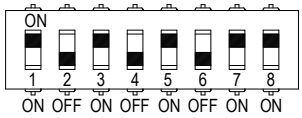
2) low voltage input monitoring:



3) short circuit fault detection:

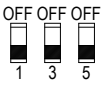


4) T-proof relay testing:



T-proof relays (dip1 = relay1; dip3 = relay2; dip5 = relay3)

T-proof relays enable



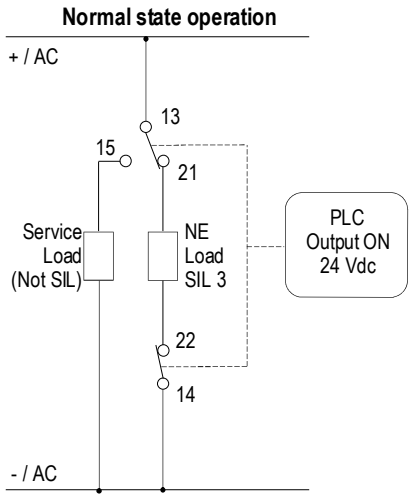
Normal Operation

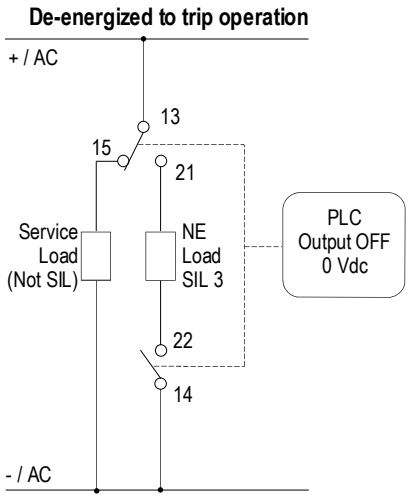
Please, see proper section for testing procedure at T-proof.

WARNING: after T-proof test, dip-switch 1-3-5 must be set to "OFF" position for normal operation.

12. FUNCTIONAL SAFETY MANUAL AND APPLICATION

12.1 Application D5290S - SIL 3 Load Normally Energized Condition (NE) and Normally Energized Relay, with interruption of both load supply lines





Description:

Input Signal from PLC/DCS is normally High (24 Vdc) and is applied to pins 1-2 or 3-4 in order to Normally Energize (NE) the internal relays.

Input Signal from PLC/DCS is Low (0 Vdc) during “de-energize to trip” operation, in order de-energize the internal relays.

The Load is Normally Energized (NE), therefore its safe state is to be de-energized; the Service Load is normally de-energized, therefore it energizes during “de-energized to trip” operation.

Disconnection of the NE Load is done on both supply lines.

The following table describes the status (open or closed) of each output contact when the input signal is High or Low.

Operation	Input signal Pins 1-2 or 3-4	Pins 13-21	Pins 14-22	Pins 13-15	NE Load (SIL3) Pins 21-22	Service Load (Not SIL) Pins 15 -- - / AC Supply
Normal	High (24 Vdc)	Closed	Closed	Open	Energized	De-Energized
Trip	Low (0 Vdc)	Open	Open	Closed	De-Energized	Energized

Safety Function and Failure behavior:

D5290S is considered to be operating in Low Demand mode, as a Type A module, having Hardware Fault Tolerance (HFT) = 0.

In the 1st Functional Safety application, the normal state operation of relay module is energized, with NE (Normally Energized) load.

In case of alarm or request from process, the relay module is de-energized (safe state), de-energizing the load.

The failure behaviour of the relay module is described by the following definitions:

- fail-Safe State: it is defined as the output load being de-energized;
- fail Safe: this failure causes the system to go to the defined fail-safe state without a process demand;
- fail Dangerous: failure mode that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state), so that the output load remains energized.
- fail “No effect”: failure mode of a component that plays a part in implementing the safety function but is neither a safe failure nor a dangerous failure. When calculating the SFF this failure mode is not taken into account.
- fail “Not part”: failure mode of a component which is not part of the safety function but part of the circuit diagram and is listed for completeness. When calculating the SFF this failure mode is not taken into account.

Failure rate data: taken from Siemens Standard SN29500.

Failure rate table:

Failure category	Failure rates (FIT)
λ_{dd} = Total Dangerous Detected failures	0.00
λ_{du} = Total Dangerous Undetected failures	1.60
λ_{sd} = Total Safe Detected failures	0.00
λ_{su} = Total Safe Undetected failures	191.40
$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = λ_{dd} + λ_{du} + λ_{sd} + λ_{su}	**193.00**
MTBF (safety function, single channel) = (1 / $\lambda_{tot\ safe}$) + MTTR (8 hours)	**591 years**
$\lambda_{no\ effect}$ = "No Effect" failures	209.60
$\lambda_{not\ part}$ = "Not Part" failures	0.00
$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe}$ + $\lambda_{no\ effect}$ + $\lambda_{not\ part}$	**402.60**
MTBF (device, single channel) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)	**283 years**
$MTTF_S$ (Total Safe) = 1 / (λ_{sd} + λ_{su})	596 years
$MTTF_D$ (Dangerous) = 1 / λ_{du}	71347 years

Failure rates table according to IEC 61508:2010 Ed.2:

λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF
0.00 FIT	191.40 FIT	0.00 FIT	1.60 FIT	99.17%

PFDavg vs T[Proof] table (assuming Proof Test coverage of 99%), with determination of SIL supposing module contributes ≤10% of total SIF dangerous failures:

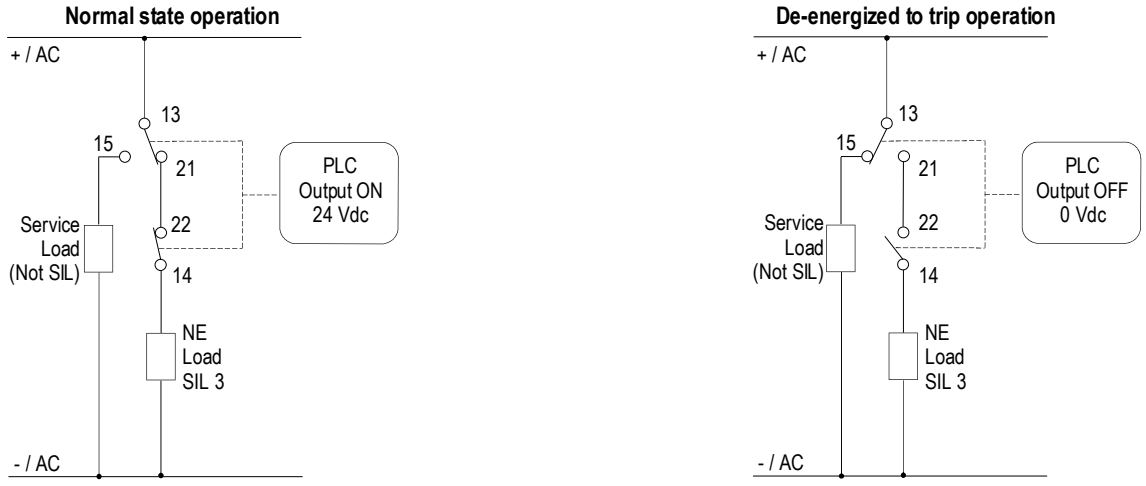
T[Proof] = 1 year	T[Proof] = 14 year
PFDavg = 7.01 E-06 - Valid for SIL 3	PFDavg = 9.81 E-05 - Valid for SIL 3

PFDavg vs T[Proof] table (assuming Proof Test coverage of 99%), with determination of SIL supposing module contributes >10% of total SIF dangerous failures:

T[Proof] = 20 year
PFDavg = 1.40 E-04 - Valid for SIL 3

Systematic capability SIL 3.

12.2 Application D5290S - SIL 3 Load Normally Energized Condition (NE) and Normally Energized Relay, with interruption of only one load supply line



Description:

Input Signal from PLC/DCS is normally High (24 Vdc) and is applied to pins 1-2 or 3-4 in order to Normally Energize (NE) the internal relays.

Input Signal from PLC/DCS is Low (0 Vdc) during "de-energize to trip" operation, in order de-energize the internal relays.

The Load is Normally Energized (NE), therefore its safe state is to be de-energized; the Service Load is normally de-energized, therefore it energizes during “de-energized to trip” operation.

Disconnection of the NE Load is done on only one load supply line.

The following table describes the status (open or closed) of each output contact when the input signal is High or Low.

Operation	Input signal Pins 1-2 or 3-4	Pins 13-21	Pins 14-22	Pins 13-15	NE Load (SIL3) Pins 14 -- - / AC Supply	Service Load (Not SIL) Pins 15 -- - / AC Supply
Normal	High (24 Vdc)	Closed	Closed	Open	Energized	De-Energized
Trip	Low (0 Vdc)	Open	Open	Closed	De-Energized	Energized

Safety Function and Failure behavior:

D5290S is considered to be operating in Low Demand mode, as a Type A module, having Hardware Fault Tolerance (HFT) = 0.

In the 2nd Functional Safety application, the normal state operation of relay module is energized, with NE (Normally Energized) loads.

In case of alarm or request from process, the relay module is de-energized (safe state), de-energizing loads.

The failure behaviour of the relay module is described by the following definitions:

- fail-Safe State: it is defined as the output load being de-energized;
- fail Safe: this failure causes the system to go to the defined fail-safe state without a process demand;
- fail Dangerous: failure mode that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state), so that the output load remains energized.
- fail “No effect”: failure mode of a component that plays a part in implementing the safety function but is neither a safe failure nor a dangerous failure. When calculating the SFF this failure mode is not taken into account.
- fail “Not part”: failure mode of a component which is not part of the safety function but part of the circuit diagram and is listed for completeness. When calculating the SFF this failure mode is not taken into account.

Failure rate data: taken from Siemens Standard SN29500.

Failure rate table:

Failure category	Failure rates (FIT)
λ_{dd} = Total Dangerous Detected failures	0.00
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λ_{sd} = Total Safe Detected failures	0.00
λ_{su} = Total Safe Undetected failures	191.40
$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = $\lambda_{dd} + \lambda_{du} + \lambda_{sd} + \lambda_{su}$	**193.00**
MTBF (safety function, single channel) = (1 / $\lambda_{tot\ safe}$) + MTTR (8 hours)	**591 years**
$\lambda_{no\ effect}$ = “No Effect” failures	209.60
$\lambda_{not\ part}$ = “Not Part” failures	0.00
$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe} + \lambda_{no\ effect} + \lambda_{not\ part}$	**402.60**
MTBF (device, single channel) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)	**283 years**
$MTTF_S$ (Total Safe) = 1 / ($\lambda_{sd} + \lambda_{su}$)	596 years
$MTTF_D$ (Dangerous) = 1 / λ_{du}	71347 years

Failure rates table according to IEC 61508:2010 Ed.2:

λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF
0.00 FIT	191.40 FIT	0.00 FIT	1.60 FIT	99.17%

PFDavg vs T[Proof] table (assuming Proof Test coverage of 99%), with determination of SIL supposing module contributes ≤10% of total SIF dangerous failures:

T[Proof] = 1 year	T[Proof] = 14 year
PFDavg = 7.01 E-06 - Valid for SIL 3	PFDavg = 9.81 E-05 - Valid for SIL 3

PFDavg vs T[Proof] table (assuming Proof Test coverage of 99%), with determination of SIL supposing module contributes >10% of total SIF dangerous failures:

T[Proof] = 20 year
PFDavg = 1.40 E-04 - Valid for SIL 3

Systematic capability SIL 3.

12.3 Testing procedure at T-proof

The proof test shall be performed to reveal dangerous faults which are undetected by diagnostic. This means that it is necessary to specify how dangerous undetected faults, which have been noted during the FMEDA, can be revealed during proof test. The Proof test consists of the following steps:

Steps	Action
1	Bypass the safety-related PLC or take other appropriate action to avoid a false trip when removing the unit for test.
2	For the single channel, verify the input-to-output functionality: the output load is normally energized by supplying the input channel, while shutdown of the input channel de-energizes the load (safe state). The channel functionality must be verified for a min to max input voltage change (21.6 to 27.6 Vdc). In addition, the use of three relays for the single output channel, where the contacts are connected in series, requires to control the single coil by means of DIP-switches (n°1, 3, 5) and to check the ohmic continuity of the contacts, as described in the following procedure. • Do not supply the input channel (terminals “1”-“2” or “3”-“4”) of the unit under test and verify that the ohmic continuity at the Out 1 and Out 2 contacts (terminals “13”-“21” and “14”-“22”) is absent (i.e. both the Out 1 contact (series connection of two relay contacts) and the Out 2 contact are open: 1st requisite is verified). For Out 1 contact, this condition could also be true if only one of two relay contacts in series is open and other is blocked (for welding) into closed or open position: this will be verified by testing the channel when input is supplied, as described in the point 3 of the procedure. Instead, the presence of ohmic continuity at the Out 1 implies that both relay contacts in series are blocked (for welding) into closed position, while the presence of ohmic continuity at the Out 2 implies that the relay contact is blocked (for welding) into closed position. • Supply the input channel (terminals “1”-“2” or “3”-“4”) of the unit under test and verify that the ohmic continuity at the Out 1 and Out 2 contacts (terminals “13”-“21” and “14”-“22”) is present (i.e. both the Out 1 contact (series connection of two relay contacts) and the Out 2 contact are closed: 2nd requisite is verified). The absence of ohmic continuity at the Out 1 contact implies that one of two relay contacts in series is blocked (for welding) into open position: this could only be verified disassembling and individually testing each of two relay contacts. Instead, the absence of ohmic continuity at the Out 2 contact implies this relay contact is blocked (for welding) into open position. • Always supplying the input channel (terminals “1”-“2” or “3”-“4”) of the unit under test, to verify if one of two relay contacts in series (Out 1) is blocked (for welding) into closed position, use internal DIP-switches (n°1 and 3) to put in short circuit one relay coil at a time (starting with the 1st coil by DIP-switch n°1, then going on with the 2nd one by DIP-switch n°3), verifying that the ohmic continuity is always absent between terminals “13”-“21”. The presence of ohmic continuity implies that a relay contact (the only one with de-energized coil) is blocked (for welding) into closed position.
3	Remove the bypass from the safety-related PLC or restore normal operation inserting the unit.

This test reveals almost 99 % of all possible Dangerous Undetected failures in the relay module.