INSTRUCTION MANUAL

10 A SIL 3 Relay Output Module for NE Load, DIN-Rail and Termination Board, Model D5290S/SA for Safe Area only

GM INTERNATIONAL
TECHNOLOGY FOR SAFETY

Characteristics

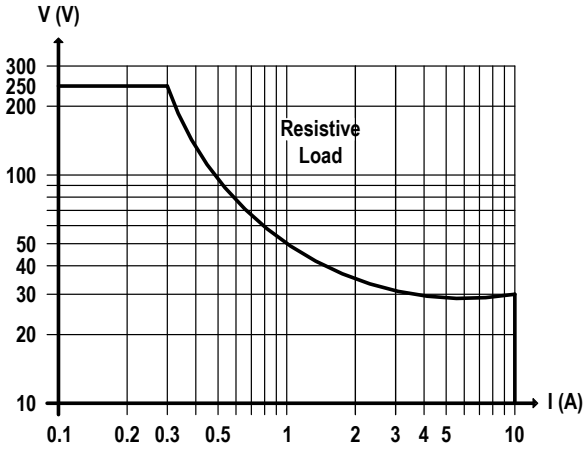
General Description: The single channel Relay Output, D5290S/SA is a relay module suitable for the switching of safety related circuits, up to SIL 3 level according to IEC 61508 for high risk industries. It provides isolation between input and output contacts.

D5290S/SA 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 the following pages for Functional Safety applications with related SIL value.

Mounting on standard DIN-Rail in Safe Area.

Technical Data

Input: 24 Vdc nom (21.6 to 27.6 Vdc) reverse polarity protected, ripple within voltage limits ≤ 5 Vpp.
Current consumption @ 24 V: 40 mA with relay energized, typical.
Power dissipation: 1 W with 24 V input voltage, relay energized, typical.
Isolation (Test Voltage): Input / All Outputs 2.5 KV ; Out 1 / Out 2: 500 V.
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 $AgSnO_2$.
Contact rating: 10 A 250 Vac 2500 VA, 10 A 250 Vdc 300 W (resistive load).
DC Load breaking capacity:



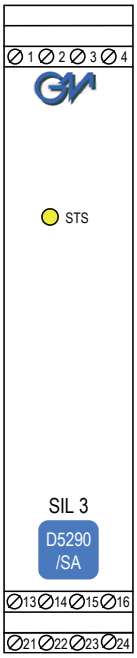
Mechanical / Electrical life: $10 * 10^6$ / $5 * 10^4$ operation, typical.
Bounce time NO / NC contact: 4 / 6 ms, typical.
Frequency response: 10 Hz maximum.
Compatibility:
CE mark compliant, conforms to 94/9/EC Atex Directive and to 2004/108/CE EMC Directive.
Environmental conditions:
Operating: temperature limits – 40 to + 70 °C, relative humidity 95 %, up to 55 °C.
Storage: temperature limits - 45 to + 80 °C.
Approvals:.
TUV Certificate No. C-IS-204194-01, SIL 2 / SIL 3 conforms to IEC61508.
Mounting:
T35 DIN-Rail according to EN50022 or on customized Termination Board.
Weight: about 145 g.
Connection: by polarized plug-in disconnect screw terminal blocks to accomodate terminations up to 2.5 mm^2.
Location: Safe Area installation.
Protection class: IP 20.
Dimensions: Width 22.5 mm, Depth 123 mm, Height 120 mm.

Ordering Information

Model: D5290S/SA

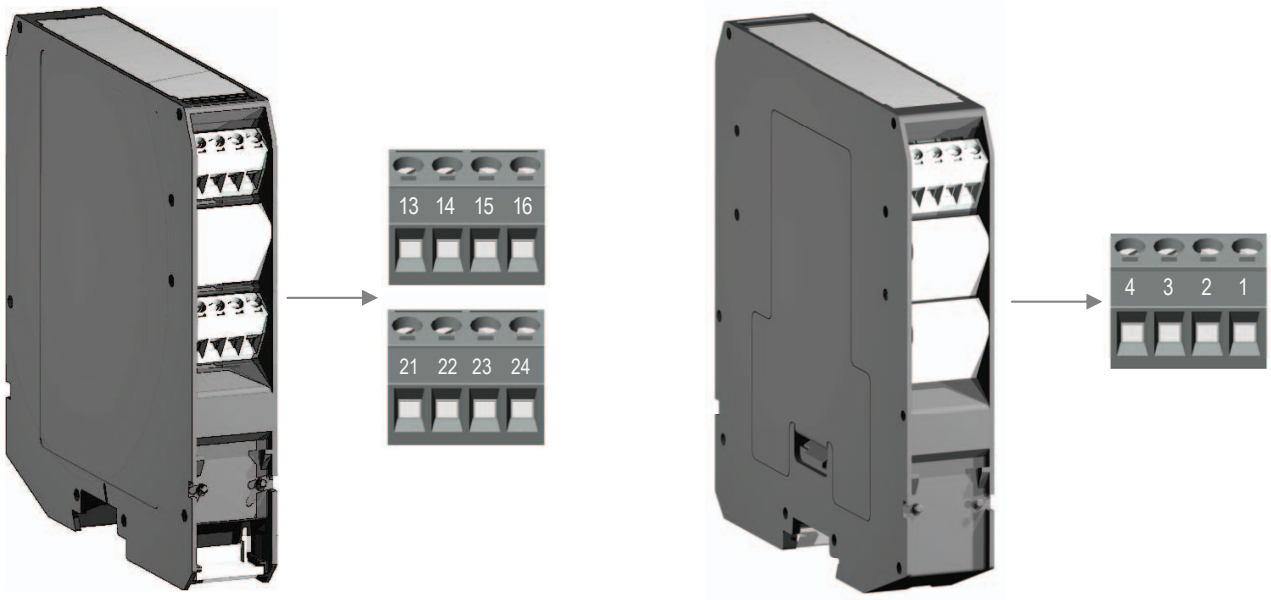
DIN-Rail accessories: Cover and fix MCHP196

Front Panel and Features



- SIL 3 according to IEC 61508 for Tproof = 10 / 20 yrs (10 / 20 % of total SIF).
- SIL 2 according to IEC 61508 for Tproof = 20 yrs (10 % of total SIF).
- PFDavg (1 year) 7.01 E-06, SFF 99.15 % for NE Load.
- 10 A SIL 3 contact for NE load and contact for service purpose.
- Input/Output isolation.
- EMC Compatibility to EN61000-6-2, EN61000-6-4, EN61326-1, EN61326-3-1 for safety system.
- Simplified installation using standard DIN-Rail and plug-in terminal blocks or customized Termination Boards.

Terminal block connections



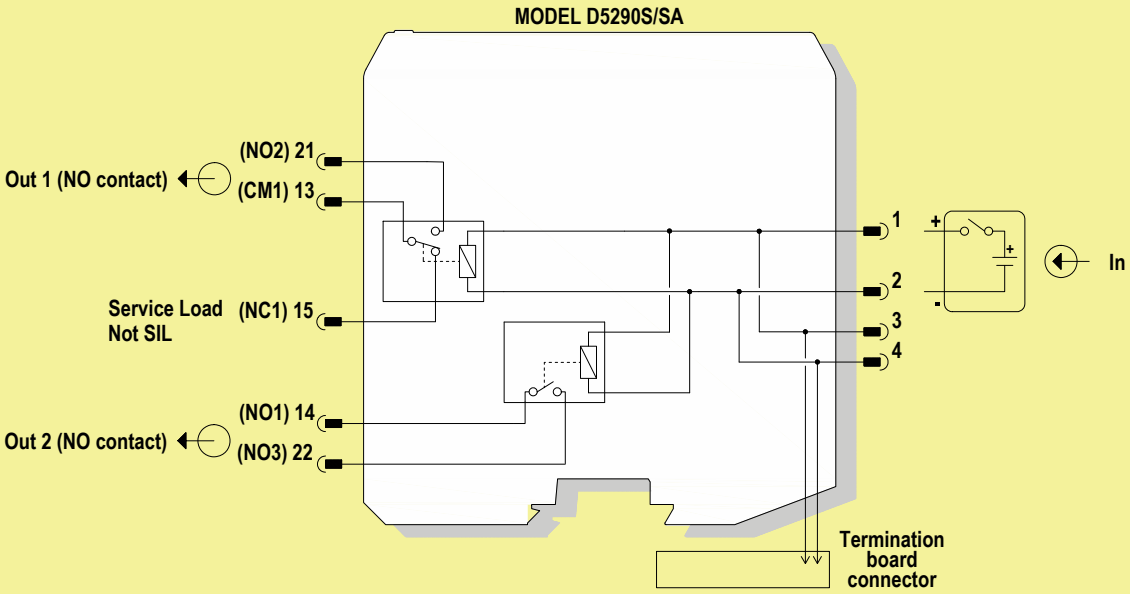
SAFE AREA

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

1	+ Input
2	- Input
3	+ Input
4	- Input

Function Diagram

SAFE AREA



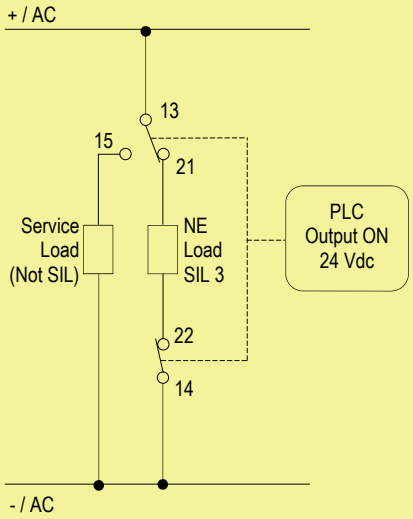
See the following pages for Functional Safety applications with related SIL value.

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

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

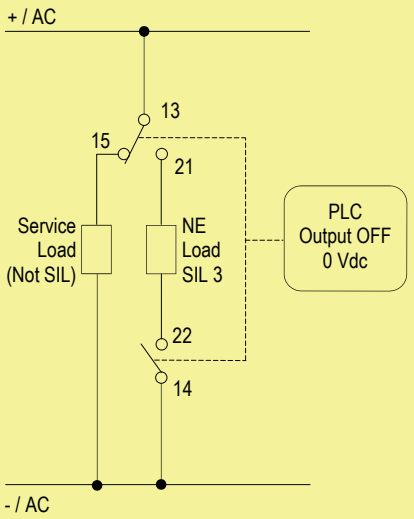
Application D5290S/SA - SIL 3 Load Normally Energized Condition (NE) and Normally Energized Relay, with interruption of both load supply lines

Normal state operation



Contacts 13-21 and 14-22: in normal operation relays are energized, contacts are closed, NE load is energized.
Contact 13-15: in normal operation relay is energized, contact is open, service load for NE load is de-energized.

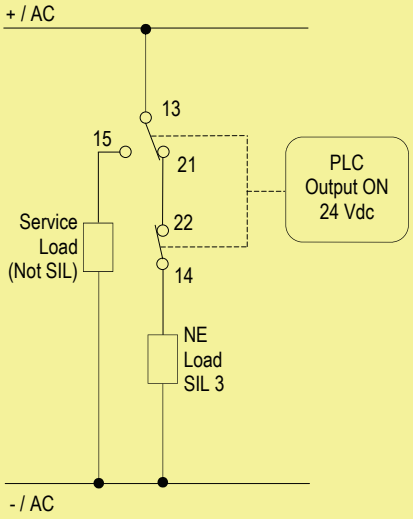
De-energized to trip operation



Contacts 13-21 and 14-22: the SIL 3 Safety Function is met when the relays are de-energized, contacts are open, NE load is de-energized.
Contact 13-15: in safe state the relay is de-energized, contact is closed, service load for NE load is energized.

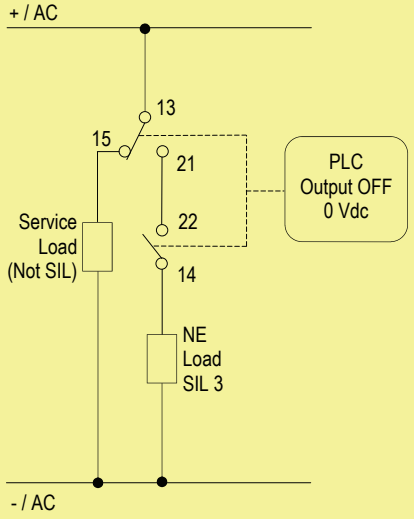
Application D5290S/SA - SIL 3 Load Normally Energized Condition (NE) and Normally Energized Relay, with interruption of only one load supply line

Normal state operation



Contacts 13-21 and 14-22: in normal operation relays are energized, contacts are closed, NE load is energized.
Contact 13-15: in normal operation relay is energized, contact is open, service load for NE load is de-energized.

De-energized to trip operation



Contacts 13-21 and 14-22: the SIL 3 Safety Function is met when the relays are de-energized, contacts are open, NE load is de-energized.
Contact 13-15: in safe state the relay is de-energized, contact is closed, service load for NE load is energized.

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

Warning

D5290S/SA is an electrical apparatus installed into standard EN50022 T35 DIN-Rail located in Safe Area within the specified operating temperature limits Tamb - 40 to +70 °C.
D5290S/SA must be installed, operated and maintained only by qualified personnel, in accordance to the relevant national/international installation standards, following the established installation rules.
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.
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.

Operation

D5290S/SA relay module is suitable for the switching of safety related circuits, providing isolation between the input and output contacts.
D5290S/SA 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 the previous pages for Functional Safety applications with related SIL value.
A "RELAY STATUS" yellow led lights when input is powered, showing that relay is energized.

Installation

D5290S/SA is a relay output module housed in a plastic enclosure suitable for installation on T35 DIN-Rail according to EN50022 or on customized Termination Board.
D5290S/SA unit can be mounted with any orientation over the entire ambient temperature range.
Electrical connection of conductors up to 2.5 mm² 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.
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, 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 mechanical protection (or similar to NEMA Standard 250 type 1) for indoor installation, outdoor installation requires an additional enclosure with higher degree of protection (i.e. IP54 to IP65 or NEMA type 12-13) consistent with the effective operating environment of the specific installation.
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.
Any penetration of cleaning liquid must be avoided to prevent damage to the unit. Any unauthorized card modification must be avoided.
Relay output contact must be connected to load non exceeding category II overvoltage limits.
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.

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.

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 detected 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 two relays for the single output channel, where the contacts are connected in series, requires to control coil and contact of each relay, as described in the following procedure . 1. 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 Out 1 and Out 2 contacts are open: **1st requisite is verified**). Instead, the presence of ohmic continuity at Out 1 or Out 2 implies that the relay contact 1 or 2 is blocked (for welding) into closed position. 2. 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 (both Out 1 and Out 2 contacts are closed: **2nd requisite is verified**). The absence of ohmic continuity at Out 1 or Out 2 implies that the relay contact 1 or 2 is blocked (for welding) into open position.
3	Remove the bypass from the safety-related PLC or restore normal operation inserting the unit.

This test detects almost 100 % of all possible Dangerous Undetected failures in the relay module.

SIL Applications

D5290S/SA Relay Output (Safe Area) Module for NE load

- Safety function

  The failure behaviour is described from the following definitions:
  - □ fail-Safe State: is defined as the output load being de-energized;
  - □ fail Safe: failure mode that causes the module to go to the defined fail-safe state without a demand from the process;
  - □ 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 is part of the safety function but that has no effect on the safety function.
    For the calculation of the SFF it is considered a safe undetected failure;
  - □ 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. It is also not considered for the total failure rate (safety function) evaluation.

- Failure rates 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	185.60
↳ Safe Undetected failures	159.60
↳ "No Effect" failures	26.00
$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = $\lambda_{dd} + \lambda_{du} + \lambda_{sd} + \lambda_{su}$	**187.20**
$\lambda_{notpart}$ = "Not Part" failures	0.00
$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe} + \lambda_{not\ part}$	**187.20**
MTBF (single channel) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)	**610 years**
$MTTF_S$ (Total Safe) = 1 / ($\lambda_{sd} + \lambda_{su}$)	615 years
$MTTF_D$ (Dangerous) = 1 / λ_{du}	71347 years

- Failure rates table according to IEC 61508:

λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF
0.00 FIT	185.60 FIT	0.00 FIT	1.60 FIT	99.15%

- PFDavg vs T[Proof] table, with determination of SIL supposing module contributes 10% of entire safety function:

T[Proof] = 1 year	T[Proof] = 10 years	T[Proof] = 20 years
PFDavg = 7.01 E-06 Valid for **SIL 3**	PFDavg = 7.01 E-05 Valid for **SIL 3**	PFDavg = 1.40 E-04 Valid for **SIL 2**

- PFDavg vs T[Proof] table, with determination of SIL supposing module contributes 20% of entire safety function:

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