INSTRUCTION MANUAL

5 A SIL 3 Relay Output Module for NE Load, with full diagnostic and Modbus, DIN-Rail, Power Bus and Termination Board, Model D5293S

gmi
technology for safety

Characteristics

General Description: The D5293S 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. A wide compatibility towards DCS/PLC is guaranteed: driving line pulse testing, executed by DCS/PLC, is permitted by a dedicated internal circuit, to prevent relay and LED flickering. D5293S provides 1+1 SPST contact for normally energized load. SIL 3 Safety Function for NE load (de-energized in fail safe state) is available at Terminal Blocks 13-14. When the driving signal is high (24 Vdc), the relay is energized (normal state), SIL 3 contacts at terminals 13-15 and 14-16 are closed, the load is energized. The safety function is met when the driving signal is low (0 Vdc), the relay is de-energized (fail safe state), SIL 3 contacts at terminals 13-15 and 14-16 are open, the load is de-energized. Load is isolated from supply on both polarities: +/AC, -/AC.

Load and Line Diagnostic: Line and load short/open circuit detection is provided. Load RMS voltage and current are measured by the module. Load voltage and current can automatically be acquired from field. User configurable limits set the minimum and maximum values of supply voltage (DC or AC) and load current.
The fault in the field is directly mirrored to the PLC DO: few systems may exceptionally require an external resistor at terminals 7 and 8.
All diagnostic conditions, that detect a fault on line and load, open the fault relay contacts and are also available from a RS485 Modbus output to identify any specific fault.
Diagnostic functions with fault relay NO contacts are SIL 2 rated according to IEC 61508:2010 Ed.2 (Route 2H).
Mounting on standard DIN-Rail, with or without Power Bus, 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.

FSM SIL 3

Technical Data

Supply: 24 Vdc nom (21.6 to 27.6 Vdc) reverse polarity protected, ripple within voltage limits ≤ 5 Vpp, 2 A time lag fuse internally protected.
  Current consumption @ 24 V: 40 mA typical, with channel energized and no fault.
  Power dissipation: 1 W typical.
Isolation (Test Voltage): Output/Input 2.5 KV; Output/Supply 2.5 KV;
  Output/Fault Outputs 2.5 KV; Output/RS485 Modbus 2.5 KV;
  Input/Supply 500 V; Input/Fault Output 1 500 V; Input/Fault Output 2 2.5 KV;
  Input/RS485 Modbus 500 V; Supply/Fault Output 1 500 V;
  Supply/Fault Output 2 2.5 KV; Supply/RS485 Modbus 500 V.
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 mirror and no fault).
  Power dissipation @ 24 V: 1 W (with mirror and no fault).
Output: voltage free 1 + 1 SPST relay contact at terminals 13-15 and 14-16, opens when relay is de-energized (fail safe state), close in energized condition.
  Contact material: Ag Alloy (Cd free), gold plated.
  Contact rating: 5 A 250 Vac 1250 VA, 5 A 250 Vdc 140 W (resistive load). Min. switching current 1 mA.
  Contact inrush current: 6 A at 24 Vdc, 250 Vac.
  Mechanical / Electrical life: $5 * 10^6$ / $3 * 10^4$ operation, typical.
  Operate / Release time: 30 / 30 ms, typical.
  Frequency response: 10 Hz maximum.
Fault detection: load and line short/open circuit monitoring
  Short output detection: programmable load current (5 mA to 5 A typical).
  Open output detection: programmable load current (5 mA to 5 A typical).
  Fault signaling: voltage free NE 1 + 1 SPST relay contacts (closed in normal operation), output de-energized (with contacts open) in fault condition. Fault contacts can be reversed via software.
  Fault 1 output rating: 500 mA 30 Vac 15 VA, 500 mA 50 Vdc 25 W (resistive load).
  Fault 2 output rating: 3 A 250 Vac 750 VA, 3 A 125 Vdc 120 W (resistive load).
  Response time: 3/4 sec typical.
Modbus Output: measure data, load and line diagnostic monitoring.
  Modbus RTU protocol up to 115.2 Kbit/s with RS-485 connection on terminal blocks and Power Bus connector.
  Terminating impedance: 100 Ω software selectable.
  Transmission speed: 4.8, 9.6, 19.2, 38.4, 57.6, 115.2 Kbit/s.
  Transmission cable length: ≤ 1200 m up to 93.75 Kbit/s, ≤ 1000 m up to 115.2 Kbit/s.
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 + 70 °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 (-40 °C ≤ Ta ≤ +60 °C)
EAC-EX: 2Ex nA nC IIC T4 Gc X.
CCC: Ex ec nC IIC T4 Gc
UKR TR n. 898: 2ExnAnCIICT4 X.
non-sparking electrical equipment.
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.
ЕАЭС RU C-IT.EX01.B.00018/19 conforms to GOST 31610.0, GOST 31610.15.
CCC n. 2020322316000978 conforms to GB/T 3836.1, GB/T 3836.3, GB/T 3834.8
CЦ 16.0036 X conforms to ДСТУ 7113, ДСТУ IEC 60079-15.
TÜV Certificate No. C-IS-236198-04, SIL 3 conforms to IEC61508:2010 Ed.2.
TÜV Certificate No. C-IS-722160171, SIL 2 conforms to IEC61508:2010 Ed.2 (Route 2H) for Line and Load Diagnostic Functionalities with fault relay NO contacts.
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 .
Patent No. 0001406495, released on 28/02/2014, valid for 20 years.
Mounting: EN/IEC60715 TH 35 DIN-Rail, with or without Power Bus or on customized Termination Board.
 *Weight:* about 230 g.
  Connection: by polarized plug-in disconnect screw terminal blocks to accommodate terminations up to 2.5 mm².
  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.
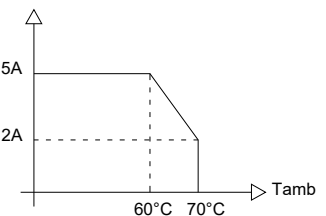 *Protection class:* IP 20.
  Dimensions: Width 22.5 mm, Depth 123 mm, Height 120 mm.

AC / DC Load breaking capacity:
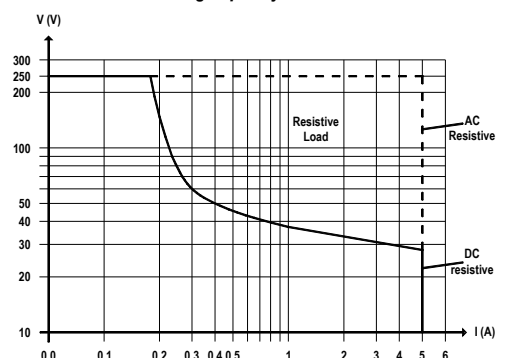
Programming

The module is fully programmable to set the operation parameters from PC by the GM Pocket Portable Adapter PPC5092 via USB serial line and SWC5090 Configurator software. Measured values and diagnostic alarms can be read on both serial configuration or Modbus output line.
Available diagnostic functions:

Load status	Load voltage	Load open circuit	Load short circuit	Load to earth leakage	Internal coil short
OFF	PF				
ON	PF	PF	PF		

F = available function
PF = available function with programmable thresholds

Ordering information

Model: **D5293S**

Operating parameters are programmable from PC by the GM Pocket Portable Adapter PPC5092 via USB serial line and SWC5090 Configurator software.
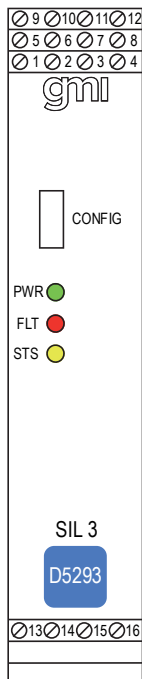
Power Bus and DIN-Rail accessories:
Connector JDFT050
Terminal block male MOR017

Cover and fix MCHP196
Terminal block female MOR022

Front Panel and Features

⊘9 ⊘10 ⊘11 ⊘12
⊘5 ⊘6 ⊘7 ⊘8
⊘1 ⊘2 ⊘3 ⊘4

gmi

CONFIG

PWR ●
FLT ●
STS ●

SIL 3

D5293

⊘13 ⊘14 ⊘15 ⊘16

- SIL 3 according to IEC 61508:2010 Ed. 2 with Tproof = 13 / 20 yrs (≤10% / >10 % of total SIF) for NE Load, PFDavg (1 year) 7.55 E-06, SFF 98.70% .
- SIL 2 according to IEC 61508:2010 Ed. 2 (Route 2H) with Tproof = 5 / 11 years (≤10% / >10 % of total SIF), PFDavg(1year) 1.74E-04, DC 60.11%, SFF 84.84% for diagnostic with fault relay NO contact.
- SC 3: Systematic Capability SIL 3.
- Installation in Zone 2 / Division 2.
- Compatible with DCS/PLC pulse testing.
- Line and Load short/open circuit detection.
- The fault in the field is directly mirrored to the PLC DO.
- RMS voltage and load current measurement.
- Automatic acquisition of voltage and current values.
- 5 A SIL 3 contacts for NE load.
- 6 A inrush current at 24 Vdc / 250 Vac.
- Input/Output/Supply isolation.
- EMC Compatibility to EN61000-6-2, EN61000-6-4, EN61326-1, EN61326-3-1 for safety system.
- ATEX, IECEx, FM & FM-C, INMETRO, EAC-EX, CCC, UKR TR n. 898, TÜV Certifications.
- TÜV Functional Safety Certification.
- Type Approval Certificate DNV and KR for maritime applications.
- Simplified installation using standard DIN-Rail and plug-in terminal blocks, with or without Power Bus, or customized Termination Boards.
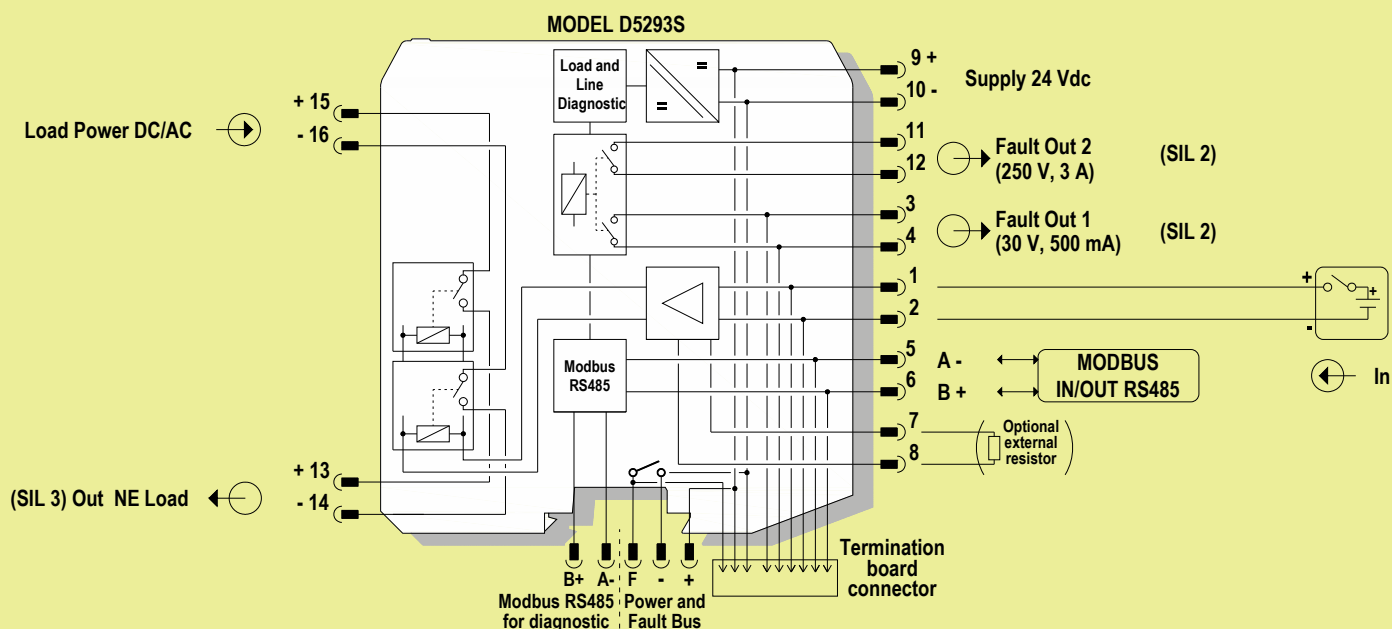
Terminal block connections

| 13 | 14 | 15 | 16 |

| 4 | 3 | 2 | 1 |

| 8 | 7 | 6 | 5 |

| 12 | 11 | 10 | 9 |
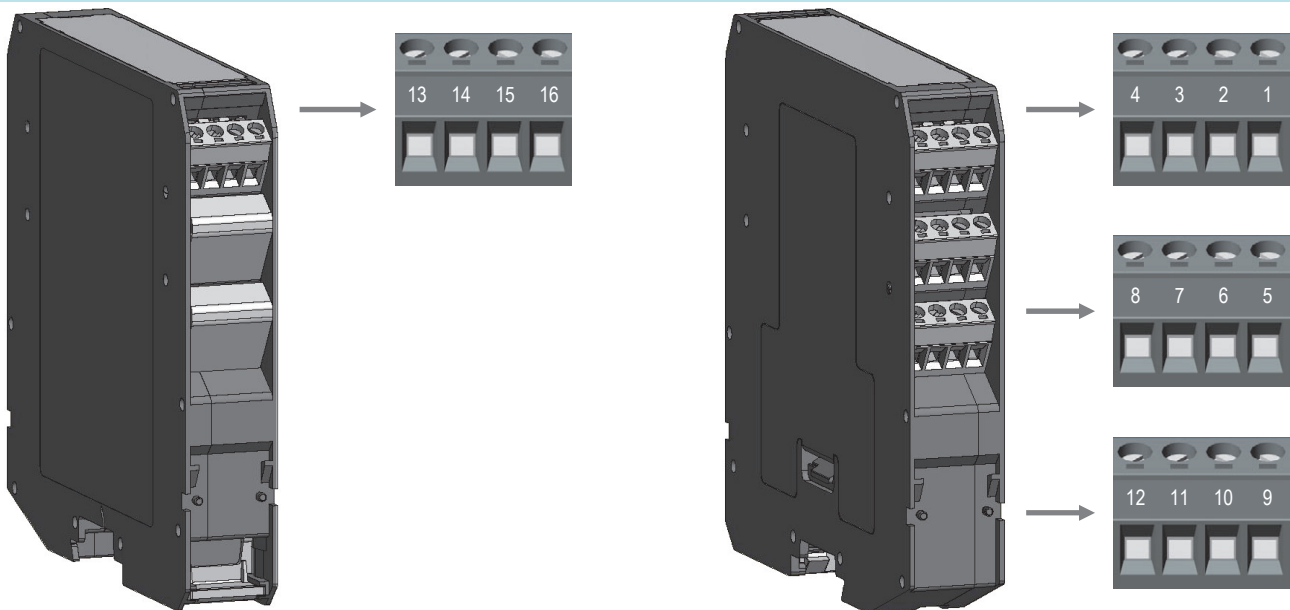
SAFE AREA

13	(SIL 3) + Output Normally Energized Load
14	(SIL 3) - Output Normally Energized Load
15	+ Load Power DC/AC
16	- Load Power DC/AC

1	+ Input
2	- Input
3	(SIL 2) Fault Output 1 (30 V, 500 mA)
4	(SIL 2) Fault Output 1 (30 V, 500 mA)
5	A- Modbus Input/Output RS485
6	B+ Modbus Input/Output RS485
7	(Optional External Resistor)
8	(Optional External Resistor)
9	+ Power Supply 24 Vdc
10	- Power Supply 24 Vdc
11	(SIL 2) Fault Output 2 (250 V, 3 A)
12	(SIL 2) Fault Output 2 (250 V, 3 A)

SAFE AREA, ZONE 2 GROUP IIC T4,
NON HAZARDOUS LOCATIONS, CLASS I, DIVISION 2,
GROUPS A, B, C, D T-Code T4, CLASS I, ZONE 2, GROUP IIC T4

MODEL D5293S

Load and Line Diagnostic

Load Power DC/AC

+ 15
- 16

9 +
10 -
Supply 24 Vdc

11
12
Fault Out 2
(250 V, 3 A)
(SIL 2)

3
4
Fault Out 1
(30 V, 500 mA)
(SIL 2)

1
2

5   A -
6   B +
MODBUS
IN/OUT RS485

In

Modbus RS485

7
8
Optional external resistor

+ 13
- 14
(SIL 3) Out NE Load

B+ A- F - +
Modbus RS485
for diagnostic
Power and
Fault Bus

Termination board connector

All relay contacts are shown
in de-energized position

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

Warning

D5293 series is an electrical apparatus installed into 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 +70 °C. D5293 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 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.

Operation

The single channel 5 A Relay Output D5293S 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. D5293S has 1+1 SPST contact for normally energized load. SIL 3 Safety Function for NE load (de-energized in fail safe state) is available at Terminal Blocks 13-14. When the driving signal is high (24 Vdc), the relay is energized (normal state), SIL 3 contacts at terminals 13-15 and 14-16 are closed, the load is energized. The safety function is met when the driving signal is low (0 Vdc), the relay is de-energized (fail safe state), SIL 3 contacts at terminals 13-15 and 14-16 are opened, the load is de-energized. Presence of diagnostic circuit power supply, status of input / output channel (energized or de-energized), as well as any type of fault condition (line and load short/open circuit, relay coil short circuit, etc.) are displayed by related signalling LEDs: green power supply, yellow for status channel and red for fault.

Installation

D5293 series is a relay output module housed in a plastic enclosure suitable for installation on EN/IEC60715 TH 35 DIN-Rail, with or without Power Bus or on customized Termination Board. D5293 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:
Connect 24 Vdc power supply positive at terminal "9" and negative at terminal "10".
Connect positive input at terminal "1" and negative input at terminal "2".
Connect Fault output 1 (30 V, 500mA) at terminals "3" and "4" and Fault output 2 (250 V, 3A) at terminals "11" and "12".
Connect A- Modbus RS845 for diagnostic at terminal "5" and B+ at terminal "6".
Connect positive output Normally Energized load at terminal "13" and negative at terminal "14".
Connect positive Load Power DC/AC at terminal "15" and negative at terminal "16".
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 1+1 SPST relay contacts checking the load rating to be within the contact maximum rating 5 A 250 Vac 1250 VA, 5 A 250 Vdc 140 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 D5293 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. D5293 series must be connected to SELV or PELV supplies. All circuits connected to D5293 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.
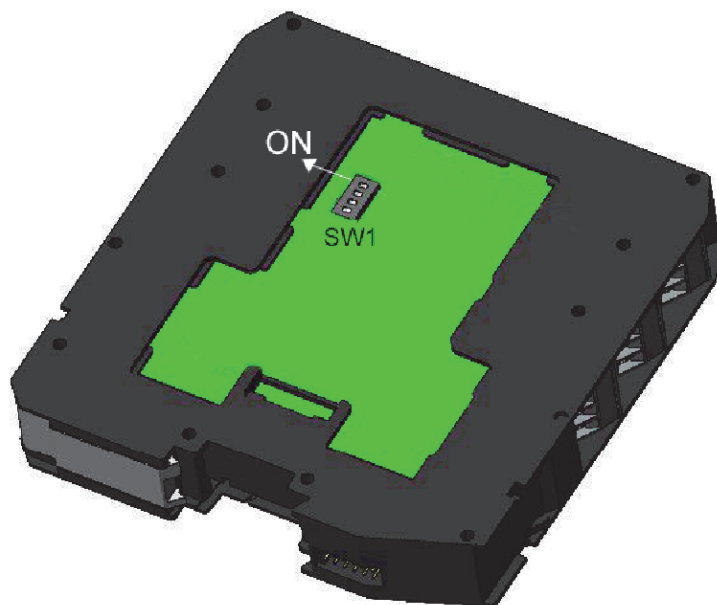
Start-up

Before powering the unit check that all wires are properly connected, particularly supply conductors and their polarity, input and output wires. Check conductors for exposed wires that could touch each other causing dangerous unwanted shorts. Turn on power for diagnostic circuit, the "power on" green led must be lit. Enabling input, the channel status yellow led must be lit and load circuit must be energized because 1+1 SPST relay output contacts are closed. Instead, disabling input, the channel status yellow led must be turned off and load circuit must be de-energized because 1+1 SPST relay output contacts are open.
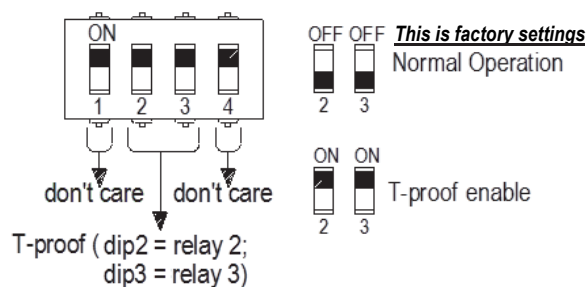
Configuration during T-proof testing for functional safety diagnostic application

For configuration of T-proof diagnostic circuits testing, some DIP Switches are located on component side of pcb.
These switches allow the T-proof diagnostic circuit test (SW1 dip-switch: 2 or 3 set "ON" and see "Testing procedure at T-proof for diagnostic application" on ISM0441 Safety Manual).

SW1 Dip switch configuration

This is factory settings
Normal Operation

T-proof enable

T-proof (dip2 = relay 2; dip3 = relay 3)
don't care   don't care

WARNING: after T-proof test, dip-switch 2-3 must be set to "OFF" position for normal operation.

The Pocket Portable Adapter type PPC5092 is suitable to connect the module D5293S to a PC via USB serial line, in order to configure and to monitor the operation parameters by means of SWC5090 software. The PPC5092 unit is connected to D5293S by mini USB and to PC by USB port. This adapter is not ATEX, UL or FM approved and is only to be used in Safe Area/Non Hazardous Locations. Do not use PPC5092 in Hazardous Area/Hazardous Locations. The PPC5092 adapter is powered by the PC (no battery power) when its USB port is plugged into the PC. It has a green LED as power-on indication.

SWC5090 Configuration & Monitoring Software

Configuration parameters:

USER MANUAL SETTINGS:

Load Supply Voltage RMS
- ☐ Voltage Upper Limit (V): Maximum allowed load RMS voltage
- ☐ Voltage Lower Limit (V): Minimum allowed load RMS voltage

Load Current RMS
- ☐ Current Upper Limit (A): Maximum allowed load RMS current
- ☐ Current Lower Limit (A): Minimum allowed load RMS current

FAULT CONDITIONS MONITORING (Command Status [ON]): Faults contributing to the output cumulative fault when the driver is on.

FAULT CONDITIONS MONITORING (Command Status [OFF]): Faults contributing to the output cumulative fault when the driver is off.
- Load Supply Voltage: When checked, the load supply voltage can activate the cumulative fault.
- Load Current: When checked, the load current can activate the cumulative fault.

TAG: Identification of the specific operating loop of the module.

ACQUIRE FUNCTIONS: Acquisition and saving of the diagnostics field parameters.
- Acquire OFF parameters: The currently measured OFF parameters are copied to the USER MANUAL SETTINGS (available only when the driver is OFF).
- Acquire ON parameters: The currently measured ON parameters are copied to the USER MANUAL SETTINGS (available only when the driver is ON).

**CONTINUOUS SCAN:** Continuous measurement of the field parameters.
- Start/Stop: Activates/de-activates the measurement of the field parameters.

INVERT FAULT RELAY: When not checked, the output fault contacts open in case of fault. When checked, the output fault contacts close in case of fault. For SIL application, this field must NOT be checked.
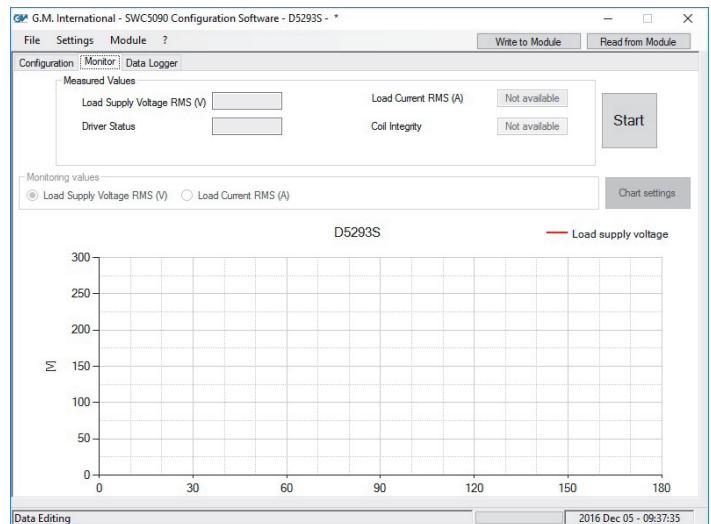
Note: For advanced options and details on SWC5090, please refer to ISM0154.

Screenshots:
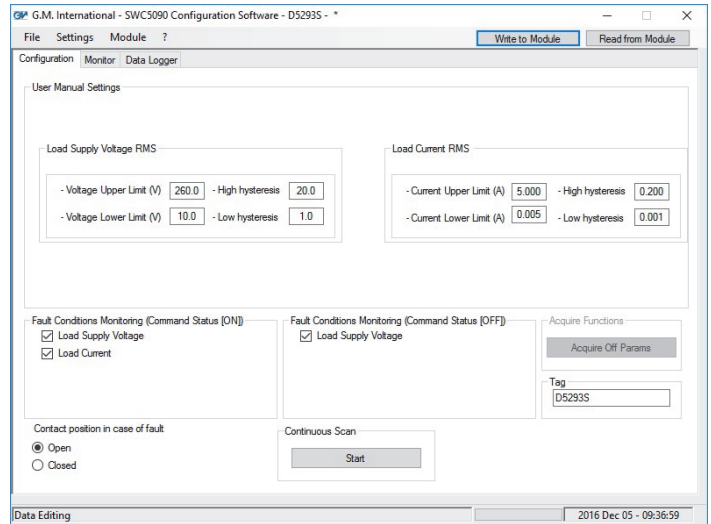
Configuration

Monitor

Supported ModBus Parameters:

D5293S communicates via Modbus RTU-485 protocol. Below are all available registers.

Param. Address	Description	Notes	Type[10]
0	G.M. Factory Code	Identification Data	R
1	Instrument Code		
2	Option Code		
3	Hardware Release		
4	Software Release		
16	Modbus Address	Communication Data	R/W
17	Modbus Baudrate[1]		
18	Modbus Format[1]		
64	Measured Load Voltage [2]	Input Data	R
65	Measured Load Current [3]		
69	Driver Status [4]		
72	Masked Fault Status[1]		
101	Load Voltage Upper Limit [2]	Input Configuration	R/W
102	Load Voltage Lower Limit [2]		
103	Load Current Upper Limit [3]		
104	Load Current Lower Limit [3]		
112	Fault Mirror Configuration [5]		
113	Invert Fault Relay [6]		
114	Load Voltage Upper Hysteresis [2]		
115	Load Voltage Lower Hysteresis [2]		
116	Load Current Upper Hysteresis [3]		
117	Load Current Lower Hysteresis [3]		
224	Fault Mask (Driver ON)	Alarm Control	R/W
225	Fault Mask (Driver OFF)		
464	Command execution[7]	Command	W
548 to 555	Tag[8]	Tags	R/W

Configuration Parameters:

Each Modbus parameter is described by one 16-bit word.

(1) See command details on the right.
(2) Expressed in 100 mV
(3) Expressed in mA
(4) 0= OFF; 1= ON
(5) 0= Fault mirror; 1= Always OFF; 2= Always ON
(6) 0= no inversion (open: fault, for SIL application); 1= inverted (open: ok)
(7) All configurations must be confirmed via Addr. 464, see details on the right.
(8) Tags are composed of 16 characters.
    Each address contains 2 chars, starting from left.
(9) Parameter Type:
    R= read only
    W= write only
    R/W= read and write

Code	Name	Notes
03	read holding registers	reads a stream of words from memory
04	read input registers	reads a stream of words from memory
08	diagnostics: subcode 0	returns query data
06	write single registers	writes a word in memory
16	write multiple registers	writes a stream of words in memory

Parameters Details:

Address 17: Supported ModBus Baudrates

Index	Baudrate
0	4800
1	9600
2	19200
3	38400
4	57600
5	115200

Address 18: Supported Modbus Formats

High Byte		Low Byte	
Bit position			
15 14 13 12 11 10 9 8	7 6 5 4	3 2	1 0

Endianness 32 bit Data (0 = Little; 1 = Big)

Termination resistance (1 = enabled)

Supported Modbus Parity:
0 8 data bit, no parity, 1 stop bit
1 8 data bit, even parity, 1 stop bit
2 8 data bit, odd parity, 1 stop bit

Address 72: Fault status

High Byte		Low Byte	
Bit position			
15 14 13 12 11 10 9 8 7 6 5	4	3 2	1	0

Don't care bit

Don't care bit

Coil Integrity

Load Current

Load Voltage

0= Ok
1= Fault

Addresses 224-225: Fault conditions

High Byte		Low Byte	
Bit position			
15 14 13 12 11 10 9 8 7 6 5	4	3 2	1	0

Don't care bit

Don't care bit

Coil Integrity

Load Current

Load Voltage

0= Ok
1= Fault

Address 464: Commands

High Byte		Low Byte	
Bit position			
15 14 13 12 11 10 9 8	7 6 5 4	3 2 1 0	

1 Save Input/Output Configuration
2 Save Modbus Configuration
8 Save Tags