



INSTRUCTION MANUAL

SIL 3 mV to mA Converter

DIN-Rail Models

D1010S-054, D1010S-056, D1010S-057

SIL Applications

For Safety Related System and SIL2, SIL3 Applications according IEC61508 & IEC61511 Standards refer to "Functional Safety Manual" document number ISM0071

Characteristics

General Description: The single channel DIN Rail mV to mA converters, D1010S-054, D1010S-056, D1010S-057, convert a mV signal from sensors located in Hazardous Area, and repeat the current in floating circuit to drive a Safe Area load.

Function: 1 channel I.S. analog input, provides 3 port isolation (input/output/supply) and current (source) output signal.

Signalling LED: Power supply indication (green).

EMC: Fully compliant with CE marking applicable requirements.

Technical Data

Supply: 24 Vdc nom (20 to 30 Vdc) reverse polarity protected, ripple within voltage limits ≤ 5 Vpp.

Current consumption @ 24 V: 40 mA with 20 mA output typical.

Power dissipation: 0.9 W with 24 V supply voltage and 20 mA output typical.

Max. power consumption: at 30 V supply voltage and overload condition 1.2 W.

Isolation (Test Voltage): I.S. In/Out 1.5 KV; I.S. In/Supply 1.5 KV; Out/Supply 500 V.

Input:

-5 to +55 mV for D1010S-054;

-5 to +35 mV for D1010S-056;

-5 to +10 mV for D1010S-057;

Output: 4 to 20 mA, on 250 Ω load in source mode.

Response time: 25 ms (10 to 90 % step change) with 8.6 dB of NMRR.

Common mode rejection: better than 80 dB.

Output ripple: ≤ 20 mVrms on 250 Ω load.

Burnout: Upscale in 25 ms.

Performance: Ref. Conditions 24 V supply, 250 Ω load, 23 ± 1 °C ambient temperature.

Calibration accuracy: $\leq \pm 0.1$ % of full scale.

Linearity error: $\leq \pm 0.1$ % of full scale.

Supply voltage influence: $\leq \pm 0.02$ % of full scale for a min to max supply change.

Load influence: $\leq \pm 0.02$ % of full scale for a 0 to 100 % load resistance change.

Stability: estimated degradation in 3 years $\leq \pm 0.47$ % least sensitive range.

Compatibility:



CE mark compliant, conforms to 94/9/EC Atex Directive and to 2004/108/CE EMC Directive.

Environmental conditions: Operating: temperature limits -20 to + 60 °C, relative humidity max 90 % non condensing, up to 35 °C.

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

Safety Description:



II (1) G [Ex ia Ga] IIC, II (1) D [Ex ia Da] IIIC, I (M1) [Ex ia Ma] I, II 3G Ex nA II T4, [Ex ia Ga] IIC, [Ex ia Da] IIIC, [Ex ia Ma] I associated electrical apparatus.

$U_0/V_{oc} = 1.1$ V, $I_0/I_{sc} = 38$ mA, $P_0/P_o = 11$ mW at terminals 15-16. $U_i/V_{max} = 30$ V, $I_i/I_{max} = 104$ mA, $C_i = 1.05$ nF, $L_i = 0$ nH at terminals 15-16.

$U_m = 250$ Vrms, -20 °C $\leq T_a \leq 60$ °C.

Approvals: DMT 01 ATEX E 042 X conforms to EN60079-0, EN60079-11, EN60079-26, EN61241-0, EN61241-11,

IECEx BVS 07.0027X conforms to IEC60079-0, IEC60079-11, IEC60079-26, IEC61241-0, IEC61241-11, IMQ 09 ATEX 013 X conforms to EN60079-0, EN60079-15,

TUV Certificate No. C-IS-183645-01, SIL 2 / SIL 3 according to IEC 61508. Please refer to Functional Safety Manual for SIL applications.

Mounting: T35 DIN Rail according to EN50022.

Weight: about 110 g.

Connection: by polarized plug-in disconnect screw terminal blocks to accommodate terminations up to 2.5 mm².

Location: Safe Area or Zone 2, Group IIC T4 installation.

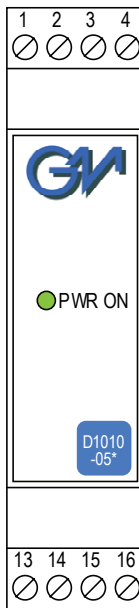
Protection class: IP 20.

Dimensions: Width 22.5 mm, Depth 99 mm, Height 114.5 mm.

Ordering information

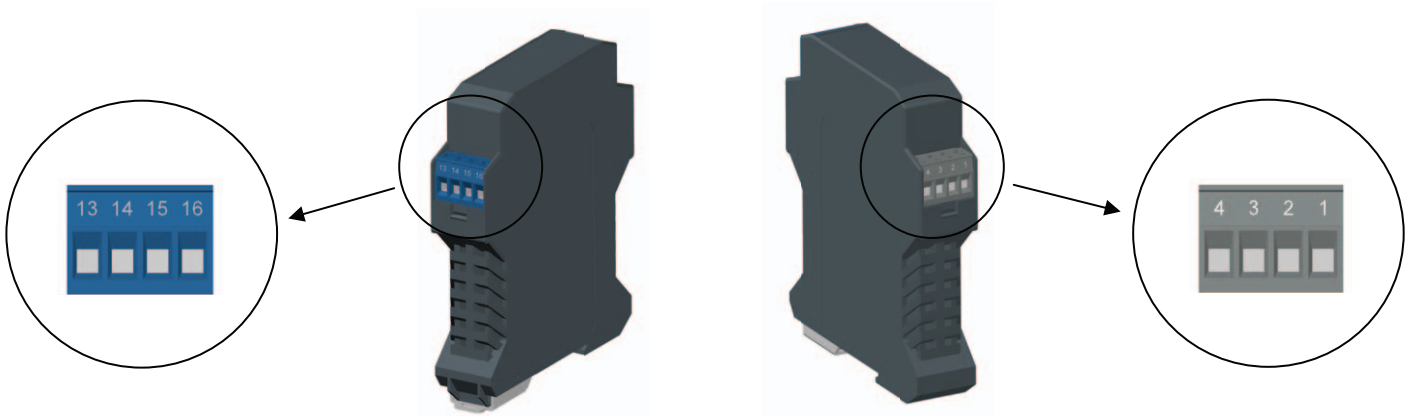
Model:	D1010S		
1 ch. range -5 to +55 mV		-054	
1 ch. range -5 to +35 mV		-056	
1 ch. range -5 to +10 mV		-057	
Power Bus enclosure			/B

Front Panel and Features



- SIL 3 according to IEC 61508 for Tproof = 1 year (20 % of total SIF).
- SIL 2 according to IEC 61508 for Tproof = 5 / 10 years (10 / 20 % of total SIF).
- PFDavg (1 year) 1.58 E-04, SFF 90.07 %.
- Input from Zone 0 (Zone 20), installation in Zone 2.
- -5 to +55 mV Input / 4 to 20 mA Output.
- Input and Output short circuit proof.
- High Accuracy.
- Three port isolation, Input/Output/Supply.
- EMC Compatibility to EN61000-6-2, EN61000-6-4.
- ATEX, IECEx Certifications.
- High Reliability, SMD components.
- Simplified installation using standard DIN Rail and plug-in terminal blocks.
- 250 Vrms (Um) max. voltage allowed to the instruments associated with the barrier.

Terminal block connections



HAZARDOUS AREA

13	Not used
14	Not used
15	+ Input Ch 1 for TC
16	- Input Ch 1 for TC

SAFE AREA

1	+ Output Ch 1 for Current Source mode
2	- Output Ch 1 for Current Source mode
3	+ Power Supply 24 Vdc
4	- Power Supply 24 Vdc

Parameters Table

In the system safety analysis, always check the Hazardous Area devices to conform with the related system documentation, if the device is Intrinsically Safe check its suitability for the Hazardous Area and gas group encountered and that its maximum allowable voltage, current, power (U_i/V_{max} , I_i/I_{max} , P_i/P_i) are not exceeded by the safety parameters (U_o/V_{oc} , I_o/I_{sc} , P_o/P_o) of the D1010-05* series Associated Apparatus connected to it. Also consider the maximum operating temperature of the field device, check that added connecting cable and field device capacitance and inductance do not exceed the limits (C_o/C_a , L_o/L_a , L_o/R_o) given in the Associated Apparatus parameters for the effective gas group. See parameters on enclosure side and the ones indicated in the table below:

D1010-054, D1010-056, D1010-057 Terminals		D1010-054, D1010-056, D1010-057 Associated Apparatus Parameters		Must be	Hazardous Area Device Parameters
Ch1	15 - 16	$U_o / V_{oc} = 1.1 \text{ V}$		\leq	U_i / V_{max}
Ch1	15 - 16	$I_o / I_{sc} = 38 \text{ mA}$		\leq	I_i / I_{max}
Ch1	15 - 16	$P_o / P_o = 11 \text{ mW}$		\leq	P_i / P_i
D1010-054, D1010-056, D1010-057 Terminals		D1010-054, D1010-056, D1010-057 Associated Apparatus Parameters		Must be	Hazardous Area Device + Cable Parameters
Ch1	15 - 16	$C_o / C_a = 100 \mu\text{F}$ $C_o / C_a = 1000 \mu\text{F}$ $C_o / C_a = 1000 \mu\text{F}$	(IIC-A, B) (IIB-C) (IIA-D)	\geq	$C_i / C_i \text{ device} + C \text{ cable}$
Ch1	15 - 16	$L_o / L_a = 11.3 \text{ mH}$ $L_o / L_a = 45.3 \text{ mH}$ $L_o / L_a = 90.7 \text{ mH}$	(IIC-A, B) (IIB-C) (IIA-D)	\geq	$L_i / L_i \text{ device} + L \text{ cable}$
Ch1	15 - 16	$L_o / R_o = 3490 \mu\text{H}/\Omega$ $L_o / R_o = 13963 \mu\text{H}/\Omega$ $L_o / R_o = 27927 \mu\text{H}/\Omega$	(IIC-A, B) (IIB-C) (IIA-D)	\geq	$L_i / R_i \text{ device and}$ $L \text{ cable} / R \text{ cable}$

When used with separate powered intrinsically safe devices, check that maximum allowable voltage, current (U_i/V_{max} , I_i/I_{max}) of the D1010-05* Associated Apparatus are not exceeded by the safety parameters (U_o/V_{oc} , I_o/I_{sc}) of the Intrinsically Safe device, indicated in the table below:

D1010-054, D1010-056, D1010-057 Terminals		D1010-054, D1010-056, D1010-057 Associated Apparatus Parameters		Must be	Hazardous Area Device Parameters
Ch1	15 - 16	$U_i / V_{max} = 30\text{V}$		\geq	U_o / V_{oc}
Ch1	15 - 16	$I_i / I_{max} = 104 \text{ mA}$		\geq	I_o / I_{sc}
Ch1	15 - 16	$C_i = 1.05 \text{ nF}$, $L_i = 0 \text{ nH}$			

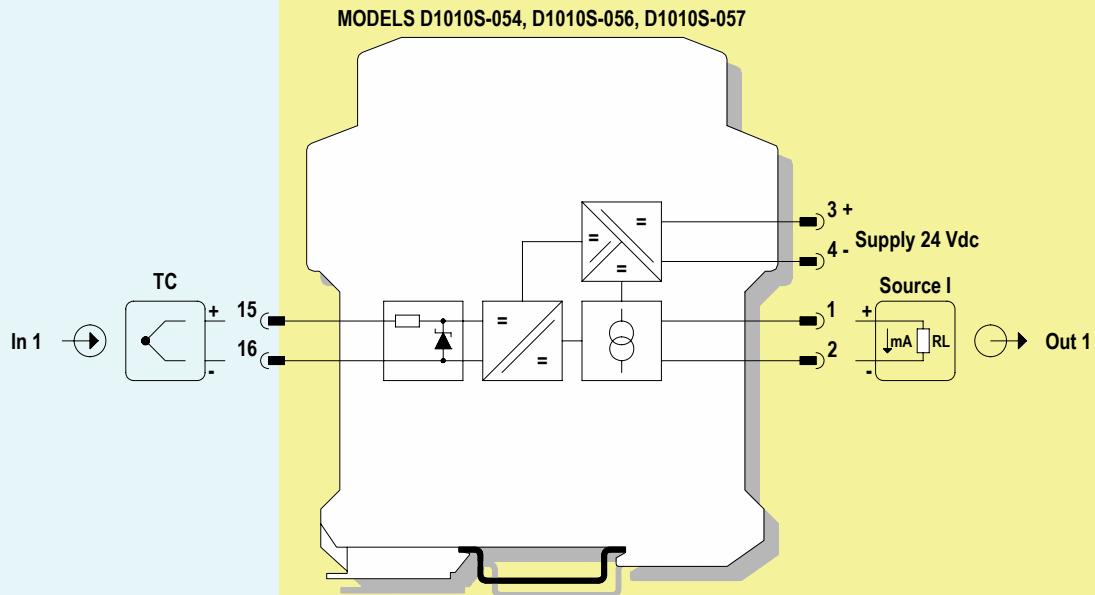
For installations in which both the C_i and L_i of the Intrinsically Safe apparatus exceed 1 % of the C_o and L_o parameters of the Associated Apparatus (excluding the cable), then 50 % of C_o and L_o parameters are applicable and shall not be exceeded (50 % of the C_o and L_o become the limits which must include the cable such that $C_i \text{ device} + C \text{ cable} \leq 50 \% \text{ of } C_o$ and $L_i \text{ device} + L \text{ cable} \leq 50 \% \text{ of } L_o$).

If the cable parameters are unknown, the following value may be used: Capacitance 60pF per foot (180pF per meter), Inductance 0.20μH per foot (0.60μH per meter).

Function Diagram

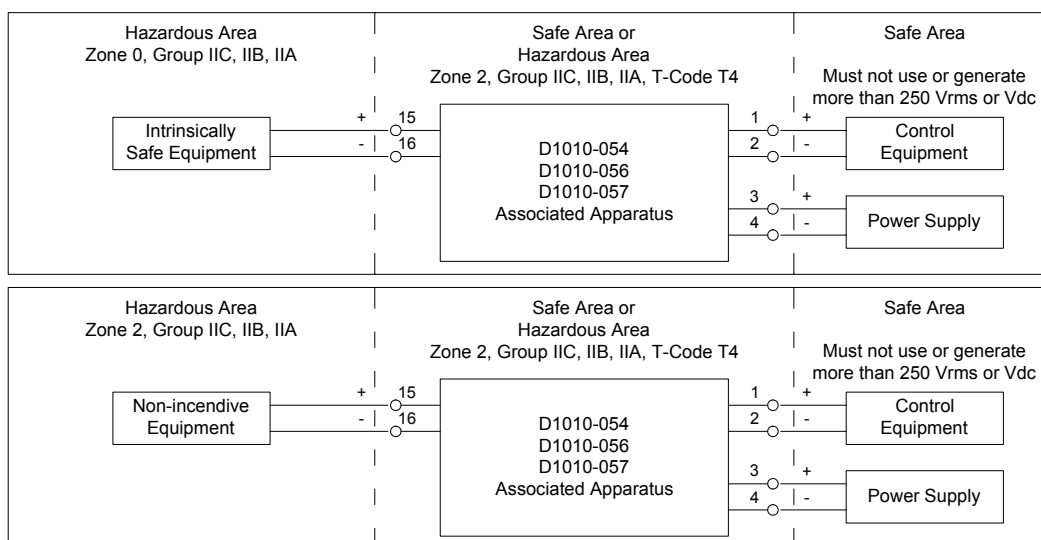
HAZARDOUS AREA ZONE 0 (ZONE 20), GROUP IIC

SAFE AREA, ZONE 2, GROUP IIC T4



Warning

D1010-054, D1010-056, D1010-057 are isolated Intrinsically Safe Associated Apparatus installed into standard EN50022 T35 DIN Rail located in Safe Area or Zone 2, Group IIC, Temperature Classification T4 Hazardous Area (according to EN/IEC60079-15) within the specified operating temperature limits Tamb -20 to +60 °C, and connected to equipment with a maximum limit for AC power supply Um of 250 Vrms.



For installation of the unit in a Zone 2 location, the wiring between the control equipment and the D1010-05* associated apparatus shall be accomplished via conduit connections or another acceptable Zone 2 wiring method.

Not to be connected to control equipment that uses or generates more than 250 Vrms with respect to earth ground.

D1010-054, D1010-056, D1010-057 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, BS 5345 Pt4, VDE 165, ANSI/ISA RP12.06.01 Installation of Intrinsically Safe System for Hazardous (Classified) Locations, National Electrical Code NEC ANSI/NFPA 70 Section 504 and 505, Canadian Electrical Code CEC) following the established installation rules, particular care shall be given to segregation and clear identification of I.S. conductors from non I.S. ones.

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.

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

D1010-054, D1010-056, D1010-057 convert a mV signal from sensors located in Hazardous Area into a 4-20 mA current signal floating output to drive a Safe Area load.

The circuit has a fast response time compared to microprocessor based unit and this allows the use of this module in applications with input variable signal changing quickly.

The circuit has also a fast burnout detection of input signal forcing to upscale the analog output. A "POWER ON" green led lits when input power is present.

D1010-054 is suitable to convert a -5 to +55 mV input signal to a 4 to 20 mA output.

D1010-056 is suitable to convert a -5 to +35 mV input signal to a 4 to 20 mA output.

D1010-054 is suitable to convert a -5 to +10 mV input signal to a 4 to 20 mA output.

Installation

D1010-054, D1010-056, D1010-057 are mV to mA Converter housed in a plastic enclosure suitable for installation on T35 DIN Rail according to EN50022.

D1010-05* unit can be mounted with any orientation over the entire ambient temperature range, see section "Installation in Cabinet" and "Installation of Electronic Equipments in Cabinet" Instruction Manual D1000 series for detailed instructions.

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 (**for Zone 2 installations check the area to be nonhazardous before servicing**).

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 and configuration DIP switches.

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 "3" and negative at terminal "4".

Connect positive output (mA source mode) at terminal "1" and negative output at "2".

For separately powered Transmitters or thermocouple connect input signal at terminal "15" for positive and "16" for negative.

Intrinsically Safe conductors must be identified and segregated from non I.S. and wired in accordance to the relevant national/international installation standards (e.g. EN/IEC60079-14 Electrical apparatus for explosive gas atmospheres - Part 14: Electrical installations in hazardous areas (other than mines), BS 5345 Pt4, VDE 165, ANSI/ISA RP12.06.01 Installation of Intrinsically Safe System for Hazardous (Classified) Locations, National Electrical Code NEC ANSI/NFPA 70 Section 504 and 505, Canadian Electrical Code CEC), make sure that conductors are well isolated from each other and do not produce any unintentional connection.

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.

Electrostatic Hazard: to avoid electrostatic hazard, the enclosure of D1010-05* 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.

According to EN61010, D1010-05* series must be connected to SELV or SELV-E supplies.

Start-up

Before powering the unit check that all wires are properly connected, particularly supply conductors and their polarity, input and output wires, also check that Intrinsically Safe conductors and cable trays are segregated (no direct contacts with other non I.S. conductors) and identified either by color coding, preferably blue, or by marking.

Check conductors for exposed wires that could touch each other causing dangerous unwanted shorts.

Turn on power, the "power on" green led must be lit, output signal should be corresponding to the input from the transmitter or the thermocouple.

If possible change the transmitter output and check the corresponding Safe Area output.

Installation in Cabinet

Power Dissipation of D1010S-05* Isolators


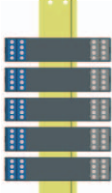

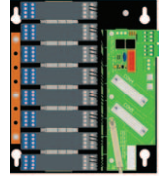
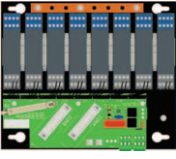
Section "Technical Data" of D1010-05* isolator specifies the current consumption (maximum current from the nominal power supply, typical 24 Vdc, in normal operation); this data serves to dimension the current rating of the power supply unit. Section "Technical Data" indicates also the maximum power consumption (maximum power required from the power supply in the worst (abnormal) operating conditions like for example supply voltage at 30 Vdc, short circuit on the outputs and on the inputs terminals).

The power dissipated P_d inside the enclosure for analog signal isolators is: $P_d = \text{Current Consumption (A)} * \text{Supply Voltage (V)} - \text{Power Dissipated into the input/output loads}$

Analog signal isolators have higher dissipation than digital signal isolators. In analog signal isolators each transmitter requires and dissipates $15\text{ V} * 0.02\text{ A} = 0.3\text{ W}$. Usually the loads outside the isolator dissipate 1/3 of the total power used. Isolators are not running at the maximum current all at the same time, the average power consumption of a multitude of isolators can be considered to be only 70 % of the value obtained from the section "Technical Data". Considering the 1/3 load power and the 70 % above discussed, the power effectively dissipated internally by the isolators can therefore become 1/2 of the actual power delivered by the power supply. Digital barriers dissipate all the supply power inside the enclosure consequently the total power dissipation into a cabinet, with mixed analog and digital barriers, is determined by the number of channels more than by the number of isolator enclosures. The following tables give advises for the DIN rail orientation (vertical or horizontal) of the barriers mounting, D1010S-05* (single channel) isolators, installed on DIN rail, bus or custom board assembly.




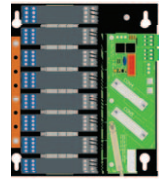
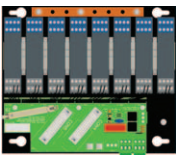
A) Cabinet with Natural Ventilation

Maximum recommended ambient temperature in °C depending on barrier type and installation method:

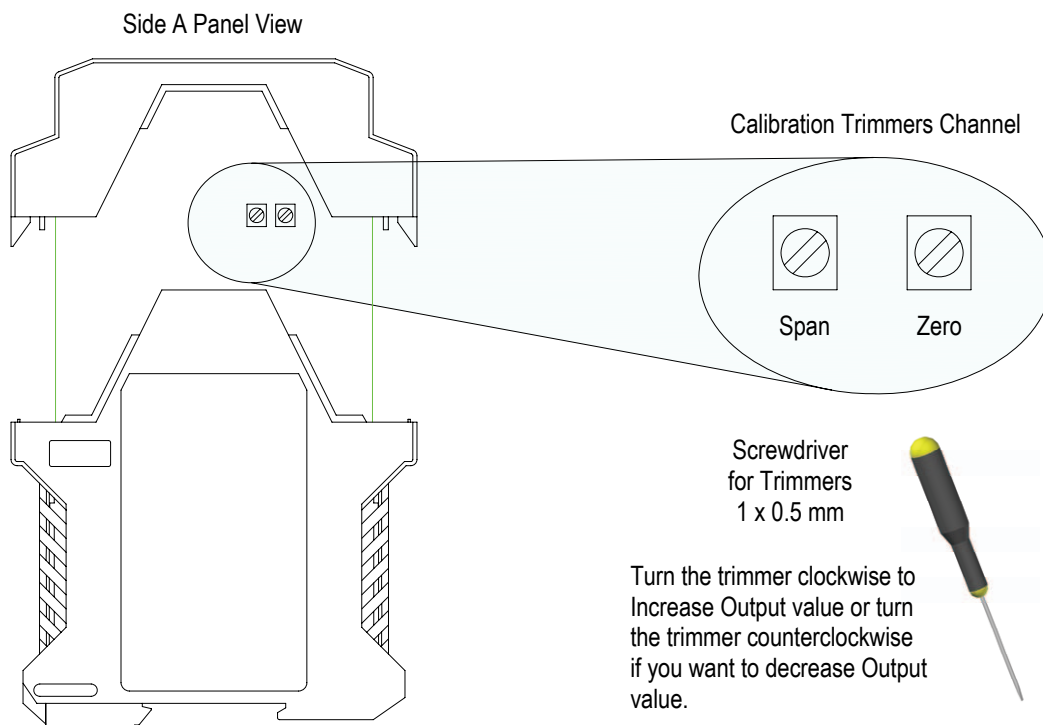
Type of Isolator	Single unit Installation	Installation of Multiple units with DIN-rail Bus		Installation on Custom Boards	
	Any orientation	Vertical	Horizontal	Vertical	Horizontal
					
D1010S-05*	60°C	30°C	35°C	35°C	40°C

B) Cabinet with Forced Ventilation

Maximum recommended ambient temperature in °C depending on barrier type and installation method:

Type of Isolator	Single unit Installation	Installation of Multiple units with DIN-rail Bus		Installation on Custom Boards	
	Any orientation	Vertical	Horizontal	Vertical	Horizontal
					
D1010S-05*	60°C	40°C	45°C	45°C	50°C

Configuration

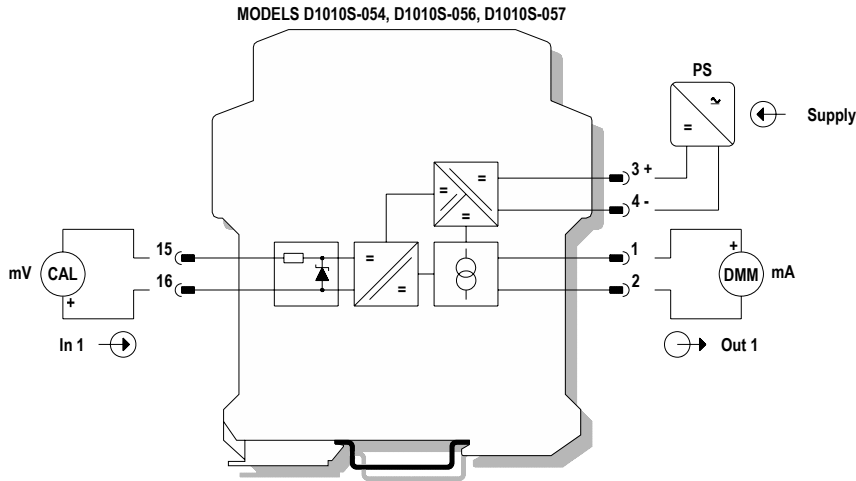


Calibration instruction and Troubleshooting

In case a calibration check or readjustment is necessary the following equipment is required:

Equipment Required	Instrument	Identification
Adjustable Power Supply Range 0-35 V Resolution 0.1 V, Accuracy 1% Output Capability 200 mA	Agilent E3611A	PS
Current Meter range 20 mA, Resolution 1 μ A Accuracy 0.01% or Voltage Meter Range 10 V, Resolution 1 mV Accuracy 0.01%	Agilent	DMM
Current Calibrator range 100 mV, Resolution 1 μ V Accuracy 0.01 %	Yokogawa 7651	CAL

- Connect the unit as shown below:



- Set power supply (PS) at 24.0 V at terminals 3 (+) and 4 (-), the calibrator (CAL) in the function "mV" 100 mV range at terminals 15 (-) and 16 (+), the multimeter (DMM) for the reading in DC supply 20 mA range at terminals 1 (+) and 2 (-).
- Verify that green led on the front panel is ON.

If the power ON Led is off, check supply voltage, polarity and wiring.

For D1010S-054

- Set calibrator (CAL) at - 5.000 mV and verify that the output current, read by multimeter (DMM), is correspondent with a maximum deviation presented in the section "Technical Data".
 - Set calibrator (CAL) at 55.000 mV and verify that the output current, read by multimeter (DMM), is correspondent with a maximum deviation presented in the section "Technical Data".
- If the maximum deviation is exceeded, repeat the board calibration and proceed in the following way:
- Set the calibrator (CAL) at 55.000 mV and regulate the current, read by multimeter (DMM), by turning the span trimmer of the unit (see "Configuration" section) until reading 20.000 mA \pm 5 μ A value.
 - Set the calibrator (CAL) at - 5.000 mV and regulate the current, read by multimeter (DMM), by turning the zero trimmer of the unit (see "Configuration" section) until reading 4.000 mA \pm 5 μ A value.
 - Repeat the last two steps to verify that the span trimmer' s movement has not significantly modified the value of zero (a dragging of 1/5 exists when moving span and zero values).
 - To execute a linearity test: set the calibrator (CAL) at - 5.000, 10.000, 25.000, 40.000, 55.000 mV and verify current output is correspondent at 4.000, 8.000, 12.000, 16.000, 20.000 mA with a maximum deviation presented in the section "Technical Data".

For D1010S-056

- Set calibrator (CAL) at - 5.000 mV and verify that the output current, read by multimeter (DMM), is correspondent with a maximum deviation presented in the section "Technical Data".
 - Set calibrator (CAL) at 35.000 mV and verify that the output current, read by multimeter (DMM), is correspondent with a maximum deviation presented in the section "Technical Data".
- If the maximum deviation is exceeded, repeat the board calibration and proceed in the following way:
- Set the calibrator (CAL) at 35.000 mV and regulate the current, read by multimeter (DMM), by turning the span trimmer of the unit (see "Configuration" section) until reading 20.000 mA \pm 5 μ A value.
 - Set the calibrator (CAL) at - 5.000 mV and regulate the current, read by multimeter (DMM), by turning the zero trimmer of the unit (see "Configuration" section) until reading 4.000 mA \pm 5 μ A value.
 - Repeat the last two steps to verify that the span trimmer' s movement has not significantly modified the value of zero (a dragging of 1/5 exists when moving span and zero values).
 - To execute a linearity test: set the calibrator (CAL) at - 5.000, 5.000, 15.000, 25.000, 35.000 mV and verify current output is correspondent at 4.000, 8.000, 12.000, 16.000, 20.000 mA with a maximum deviation presented in the section "Technical Data".

For D1010S-057

- Set calibrator (CAL) at - 5.000 mV and verify that the output current, read by multimeter (DMM), is correspondent with a maximum deviation presented in the section "Technical Data".
 - Set calibrator (CAL) at 10.000 mV and verify that the output current, read by multimeter (DMM), is correspondent with a maximum deviation presented in the section "Technical Data".
- If the maximum deviation is exceeded, repeat the board calibration and proceed in the following way:
- Set the calibrator (CAL) at 10.000 mV and regulate the current, read by multimeter (DMM), by turning the span trimmer of the unit (see "Configuration" section) until reading 20.000 mA \pm 5 μ A value.
 - Set the calibrator (CAL) at - 5.000 mV and regulate the current, read by multimeter (DMM), by turning the zero trimmer of the unit (see "Configuration" section) until reading 4.000 mA \pm 5 μ A value.
 - Repeat the last two steps to verify that the span trimmer' s movement has not significantly modified the value of zero (a dragging of 1/5 exists when moving span and zero values).
 - To execute a linearity test: set the calibrator (CAL) at - 5.000, - 1.250, 2.500, 6.250, 10.000 mV and verify current output is correspondent at 4.000, 8.000, 12.000, 16.000, 20.000 mA with a maximum deviation presented in the section "Technical Data".