



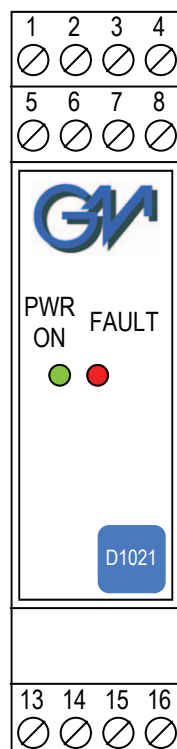
INSTRUCTION MANUAL

SIL 2 Powered Isolating Driver with
Fault Detection Smart-Hart compatible
DIN-Rail Model D1021S

D1021 Analog Output Isolating Drivers

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Front Panel and Features



- SIL 2 according to IEC 61508 for Tproof = 1 / 3 years (10 / 20 % of total SIF).
- PFDavg (1 year) 5.18 E-04, SFF 70.66 %.
- Output to Zone 0 (Zone 20), Division 1, installation in Zone 2, Division 2.
- 4-20 mA Input, Output Signal.
- Wide Band Smart Communication, Hart compatible.
- Field fault circuit detection with signalling.
- Control input fault detection with signalling.
- High Accuracy.
- Three port isolation, Input/Output/Supply.
- EMC Compatibility to EN61000-6-2, EN61000-6-4.
- ATEX, IECEx, FM & FM-C, Russian and Ukrainian Certifications.
- Type Approval Certificate DNV A-10169, KR ITA20769-EL001 for marine applications.
- 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.

Characteristics

General Description: The single channel DIN Rail Isolating Driver D1021S isolates and transfers a 4-20 mA signal from a controller located in Safe Area to a load of up to 750 Ω in Hazardous Area. It has a high output capacity of 15 V at 20 mA combined with a low drop across its input terminals. The circuit allows bi-directional communication signals, for Smart I/P. In the 4-20 mA input range, a field open / short circuit (load or wire fault) reflects a high impedance to the control device output circuit and actuates (de-energizes) the fault indication relay / transistor. An output underrange or overrange (< 1 mA or > 25 mA) also de-energizes the fault indication relay / transistor.

Function: 1 channel I.S. mA analog output for 2 wire I/P Smart converters or valve positioners, provides 3 port isolation (input/output/supply).

Signalling LEDs: Power supply indication (green), fault condition (red).

Smart Communication Frequency Band: 0.5 to 40 KHz within 3 dB (Hart and higher frequency protocols).

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: 70 mA with 20 mA output typical.

Power dissipation: 1.5 W with 24 V supply voltage and 20 mA output typical.

Max. power consumption: at 30 V supply voltage and overload condition 2.2 W.

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

In/Supply 500 V; In/Fault Out 1.5 KV; Supply/Fault Out 1.5 KV; Fault Out (relay)/Fault Out (transistor) 1.5 KV.

Input: 4 to 20 mA with ≤ 2.0 V voltage drop, reverse polarity protected.

Output: 4 to 20 mA, on max.750 Ω load, current limited at ≈ 24 mA.

Response time: 50 ms (10 to 90 % step change).

Output ripple: ≤ 20 mVrms on 250 Ω communication load on 0.5 to 40 KHz band.

Frequency response: 0.5 to 40 KHz bidirectional within 3 dB (Hart and higher frequency protocols).

Fault detection:

Input under/overrange: input current <1 mA or > 25 mA (± 0.5 mA).

Short output detection: load resistance configurable from 0 Ω (short fault disabled) to 200 Ω , default setting 50 Ω .

Open output detection: load resistance > 50 K Ω .

Fault signalling: voltage free NE SPST optocoupled open-collector transistor and voltage free NE SPST relay contact (each output is de-energized in fault condition).

Open-collector rating: 100 mA at 35 V (≤ 1 V voltage drop).

Leakage current: ≤ 50 μ A at 35 V.

Relay contact rating: 2 A 250 Vac 500 VA, 2 A 250 Vdc 80 W (resistive load).

Response time: from 20 to 500 ms typical.

Performance:

Ref. Conditions 24 V supply, 250 Ω load, 23 ± 1 $^{\circ}$ C ambient temperature.

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

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

Supply voltage influence: $\leq \pm 0.05$ % of full scale for a min to max supply change.

Load influence: $\leq \pm 0.05$ % of full scale for a 0 to 100 % load resistance change.

Temperature influence: $\leq \pm 0.01$ % on zero and span for a 1 $^{\circ}$ C change.

Compatibility:



CE mark compliant, conforms to 94/9/EC Atex Directive and to 89/336/CEE EMC Directive.

Environmental conditions:

Operating: temperature limits -20 to + 60 $^{\circ}$ C, relative humidity max 90 % non condensing, up to 35 $^{\circ}$ C.

Storage: temperature limits - 45 to + 80 $^{\circ}$ C.

Safety Description:



II (1) G [Ex ia] IIC, II (1) D [Ex iaD], I (M2) [Ex ia] I, II 3G Ex nA IIC T4, [Zone 0] [Ex ia] IIC, [Ex ia] I, [Ex iaD] associated electrical apparatus.

Uo/Voc = 25.2 V, Io/Isc = 87 mA, Po/Po = 548 mW at terminals 14-15.

Um = 250 Vrms, -20 $^{\circ}$ C \leq Ta \leq 60 $^{\circ}$ 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, GM International CRR028 conforms to EN60079-0, EN60079-15, FM & FM-C No. 3024643, 3029921C, conforms to Class 3600, 3610, 3611, 3810 and C22.2 No.142, C22.2 No.157, C22.2 No.213, E60079-0, E60079-11, E60079-15, Russia according to GOST 12.2.007.0-75, R 51330.0-99, R 51330.10-99 [Exia] IIC X, Ukraine according to GOST 12.2.007.0,22782.0,22782.5 Exia IIC X, EXIDA Report No. GM03/07-24 R001, SIL 2 according to IEC 61508. Please refer to Functional Safety Manual for SIL applications. DNV A-10169, KR ITA20769-EL001 Type Approval Certificate for marine applications.

Mounting: T35 DIN Rail according to EN50022.

Weight: about 130 g.

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

Location: Safe Area/Non Hazardous Locations or Zone 2, Group IIC T4, Class I, Division 2, Groups A, B, C, D Temperature Code T4 and Class I, Zone 2, Group IIC, IIB, IIA T4 installation.

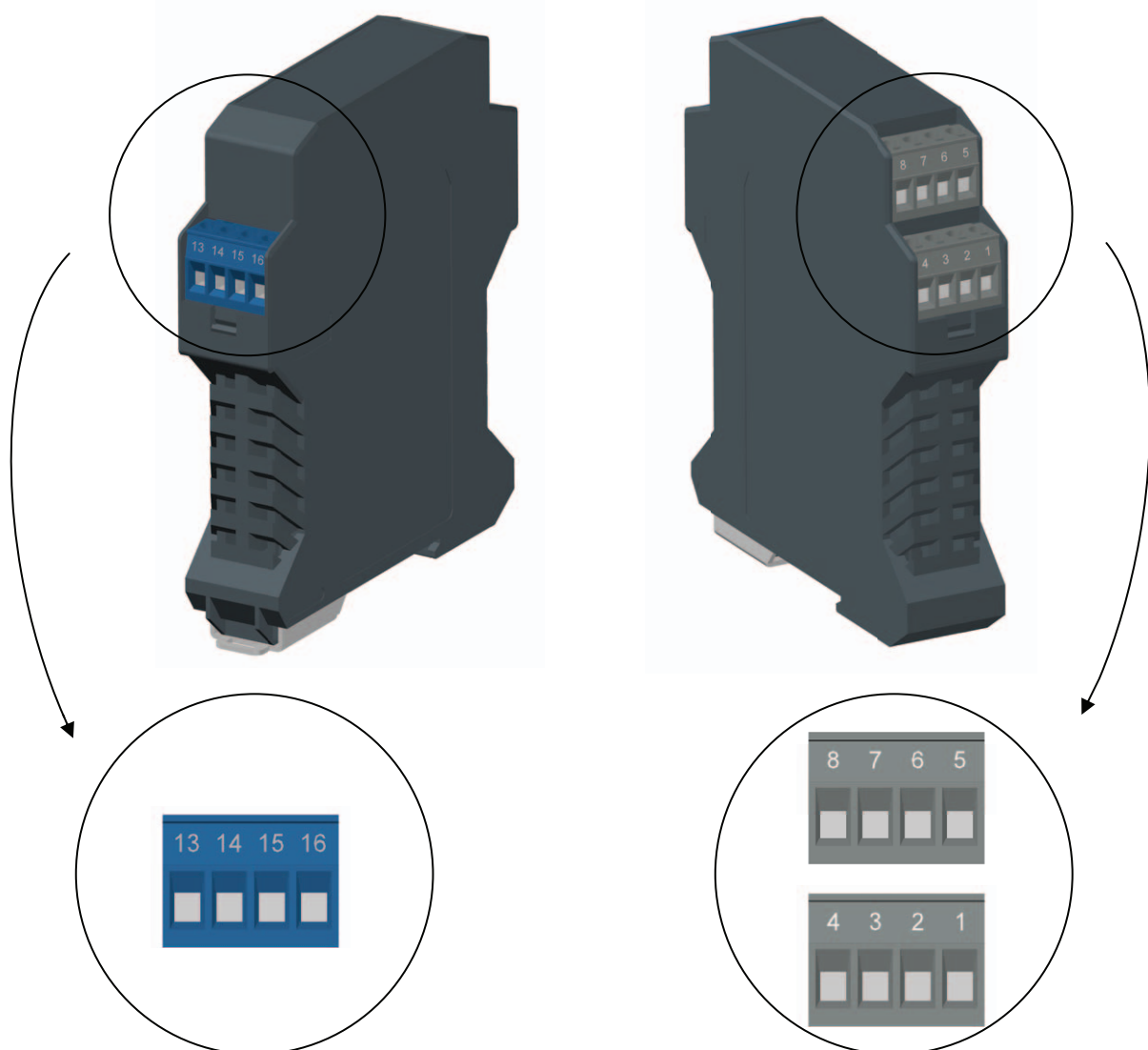
Protection class: IP 20.

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

Ordering information

Model:	D1021S	
Power Bus enclosure	/B	

Terminal block connections



D1031Q

HAZARDOUS AREA

13	Not used
14	+ Output Ch 1 for I/P Converter
15	- Output Ch 1 for I/P Converter
16	Not used

SAFE AREA

1	+ Input Ch 1 for Source I
2	- Input Ch 1 for Source I
3	+ Power Supply 24 Vdc
4	- Power Supply 24 Vdc
5	Output Relay Fault
6	Output Relay Fault
7	+ Output Transistor Fault
8	- Output Transistor Fault

Parameters Table

In the system safety analysis, always check the Hazardous Area/Hazardous Locations devices to conform with the related system documentation, if the device is Intrinsically Safe check its suitability for the Hazardous Area/Hazardous Locations 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 D1021 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:

D1021 Terminals		D1021 Associated Apparatus Parameters		Must be	Hazardous Area/ Hazardous Locations Device Parameters
Ch1	14 - 15	Uo / Voc = 25.2 V		≤	Ui / Vmax
Ch1	14 - 15	Io / Isc = 87 mA		≤	Ii/ Imax
Ch1	14 - 15	Po / Po = 548 mW		≤	Pi / Pi
D1021 Terminals		D1021 Associated Apparatus Parameters		Must be	Hazardous Area/ Hazardous Locations Device + Cable Parameters
Ch1	14 - 15	Co / Ca = 106 nF Co / Ca = 819 nF Co / Ca = 2.899 μF	(IIC-A, B) (IIB-C) (IIA-D)	≥	Ci / Ci device + C cable
Ch1	14 - 15	Lo / La = 4.6 mH Lo / La = 18.7 mH Lo / La = 37.5 mH	(IIC-A, B) (IIB-C) (IIA-D)	≥	Li / Li device + L cable
Ch1	14 - 15	Lo / Ro = 64.9 μH/Ω Lo / Ro = 259.6 μH/Ω Lo / Ro = 519.3 μH/Ω	(IIC-A, B) (IIB-C) (IIA-D)	≥	Li / Ri device and L cable / R cable

NOTE for USA and Canada:
IIC equal to Gas Groups A, B, C, D, E, F and G
IIB equal to Gas Groups C, D, E, F and G
IIA equal to Gas Groups D, E, F and G

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 $C_i \text{ device} + C \text{ cable} \leq 50 \%$ of C_o and $L_i \text{ device} + L \text{ cable} \leq 50 \%$ of L_o). If the cable parameters are unknown, the following value may be used: Capacitance 60pF per foot (180pF per meter), Inductance 0.20 μH per foot (0.60 μH per meter).

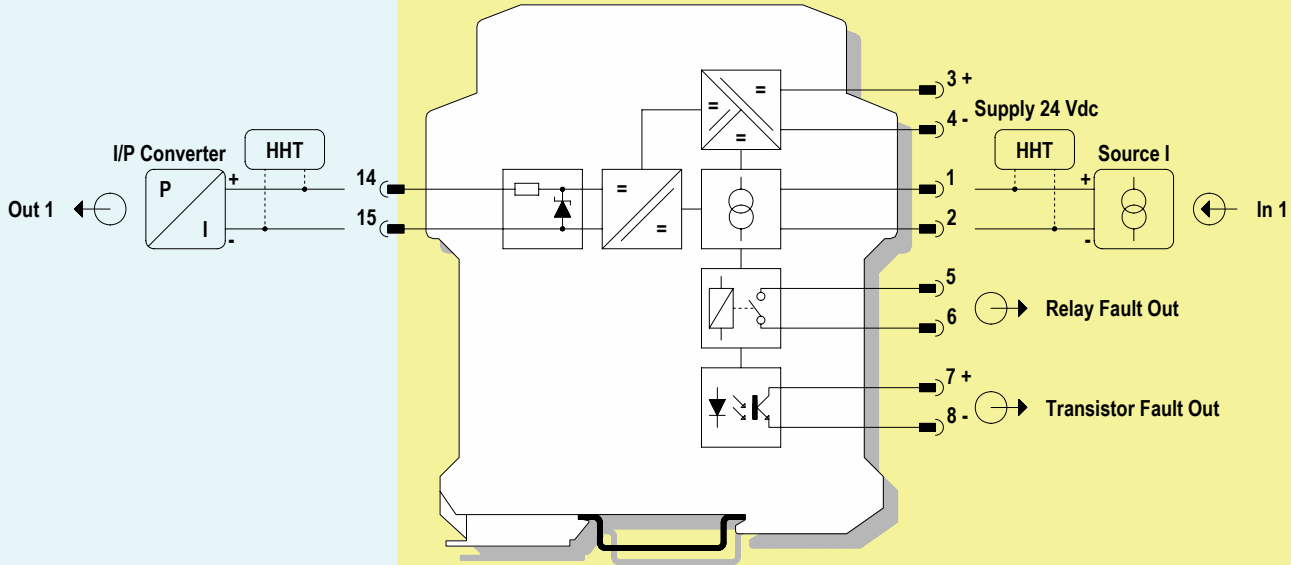
The Intrinsic Safety Entity Concept allows the interconnection of Intrinsically Safe devices approved with entity parameters not specifically examined in combination as a system when the above conditions are respected. For Division 1 and Zone 0 installations, the configuration of Intrinsically Safe Equipment must be FM approved under Entity Concept, UL Listed or third party approved; for Division 2 installations, the configuration of Intrinsically Safe Equipment must be FM approved under non-incendive field wiring or Entity Concept, UL Listed or third party approved.

Function Diagram

HAZARDOUS AREA ZONE 0 (ZONE 20) GROUP IIC,
HAZARDOUS LOCATIONS CLASS I, DIVISION 1, GROUPS A, B, C, D,
CLASS II, DIVISION 1, GROUPS E, F, G, CLASS III, DIVISION 1,
CLASS I, ZONE 0, GROUP IIC

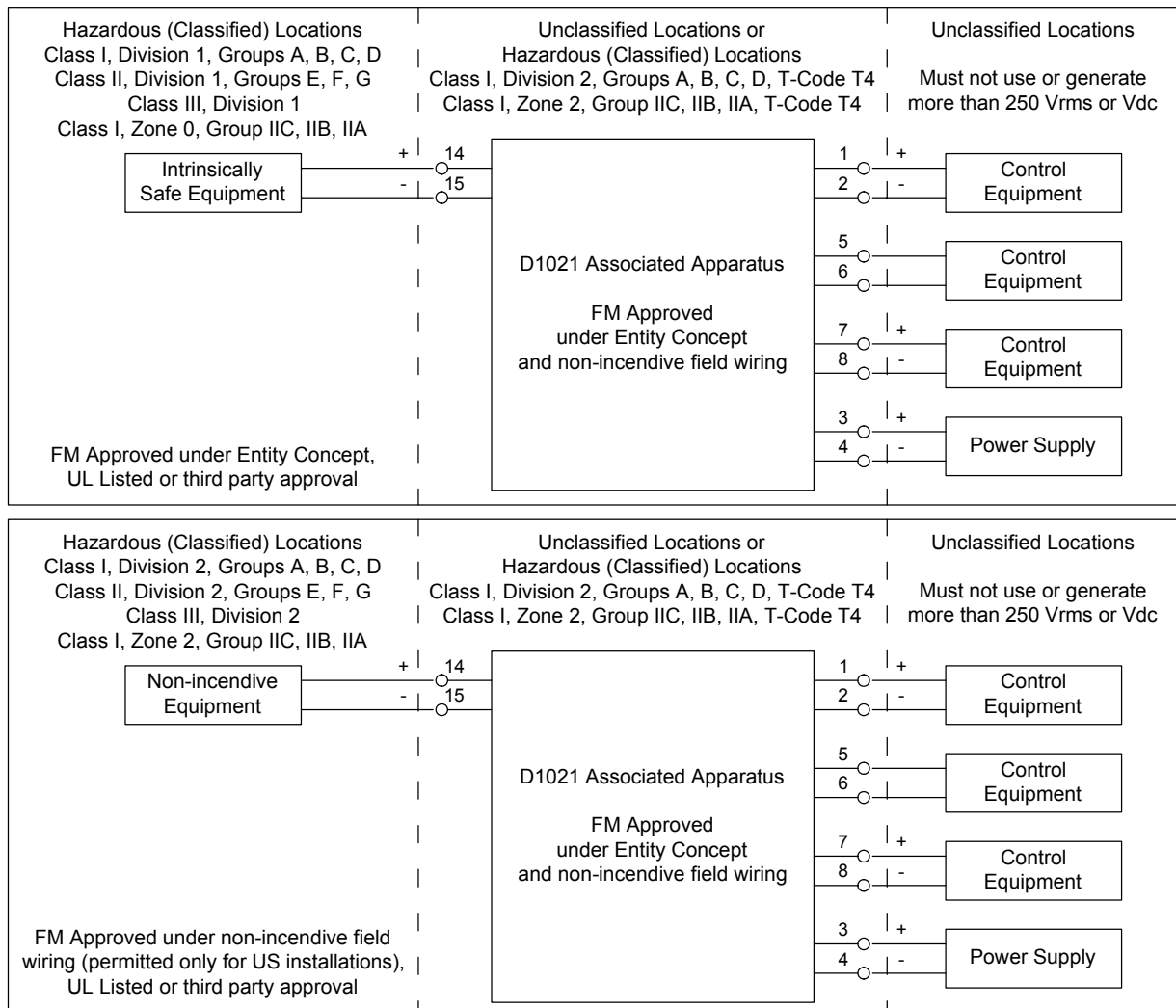
SAFE AREA, ZONE 2 GROUP IIC T4,
NON HAZARDOUS LOCATIONS, CLASS I, DIVISION 2,
GROUPS A, B, C, D T-Code T4, CLASS I, ZONE 2, GROUP IIC T4

MODEL D1021S



Warning

D1021 is an isolated Intrinsically Safe Associated Apparatus installed into standard EN50022 T35 DIN Rail located in Safe Area/ Non Hazardous Locations or Zone 2, Group IIC, Temperature Classification T4, Class I, Division 2, Groups A, B, C, D, Temperature Code T4 and Class I, Zone 2, Group IIC, IIB, IIA Temperature Code T4 Hazardous Area/Hazardous Locations (according to EN/IEC60079-15, UL 1604, UL 60079-15, FM Class No. 3611, CSA-C22.2 No. 213-M1987, CSA-E60079-15) within the specified operating temperature limits T_{amb} -20 to +60 °C, and connected to equipment with a maximum limit for AC power supply U_m of 250 Vrms.



Non-incendive field wiring is not recognized by the Canadian Electrical Code, installation is permitted in the US only.

For installation of the unit in a Class I, Division 2 or Class I, Zone 2 location, the wiring between the control equipment and the D1021 associated apparatus shall be accomplished via conduit connections or another acceptable Division 2, Zone 2 wiring method according to the NEC and the CEC. Not to be connected to control equipment that uses or generates more than 250 Vrms or Vdc with respect to earth ground.

D1021 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), 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, and the 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/Hazardous Locations or unless area is known to be nonhazardous.

Warning: substitution of components may impair Intrinsic Safety and suitability for Division 2, 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

D1021 isolates and transfers a 4-20 mA signal from a controller located in Safe Area/Non Hazardous Locations to an I/P converter, displays or similar equipment located in Hazardous Area/Hazardous Locations. The circuit allows bi-directional communication signal for smart/hart converters. A field open circuit or short circuit presents a high impedance to the control device and de-energize the fault signalation outputs (relay and open-collector transistor). An input over or under range also de-energize the fault signalation output.

A "POWER ON" green led lits when input power is present, a "FAULT" red led lits when fault condition is present.

Installation

D1021 is a powered isolating driver smart/hart compatible with field fault detection and signalation, housed in a plastic enclosure suitable for installation on T35 DIN Rail according to EN50022. D1021 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 or Division 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.

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 input at terminal "1" and negative input at "2".

Connect fault relay output contact at terminal "5" and "6".

Connect fault open collector output positive at terminal "7" and negative at terminal "8".

Connect signal output at terminal "14" for positive and "15" 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, and the Canadian Electrical Code CEC), make sure that conductors are well isolated from each other and do not produce any unintentional connection.

Connect SPST fault relay contacts checking the load rating to be within the contact maximum rating (2 A, 250 V, 500 VA 80 W resistive load).

Connect SPST fault transistors checking the load rating to be within the maximum rating (100 mA, 35 V resistive load).

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 D1021 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, D1021 must be connected to SELV or SELV-E supplies.

Relay output contact must be connected to loads non exceeding category I, pollution degree I overvoltage limits.

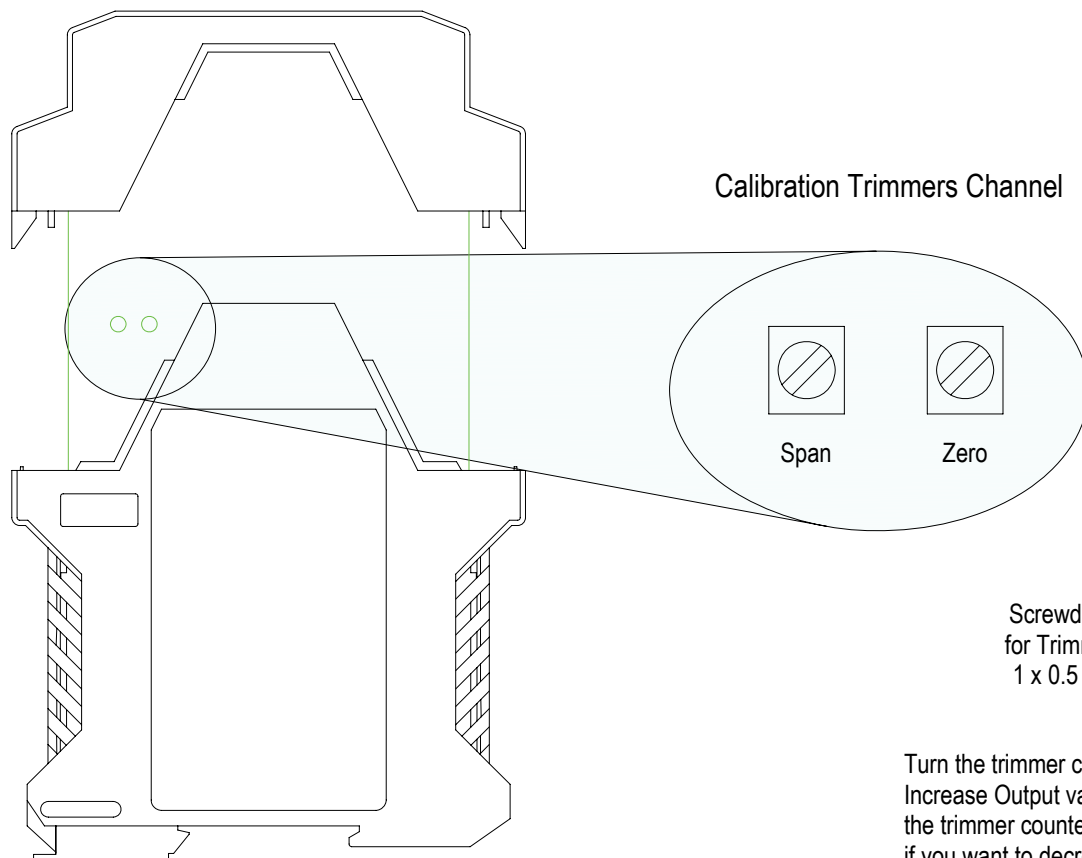
Warning: de-energize main power source (turn off power supply voltage) and disconnect plug-in terminal blocks before opening the enclosure to avoid electrical shock when connected to live hazardous potential.

Start-up

Before powering the 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 controller. If possible change the input value and check the corresponding Hazardous Area output.

Configuration

Side A Panel View



Screwdriver
for Trimmers
1 x 0.5 mm

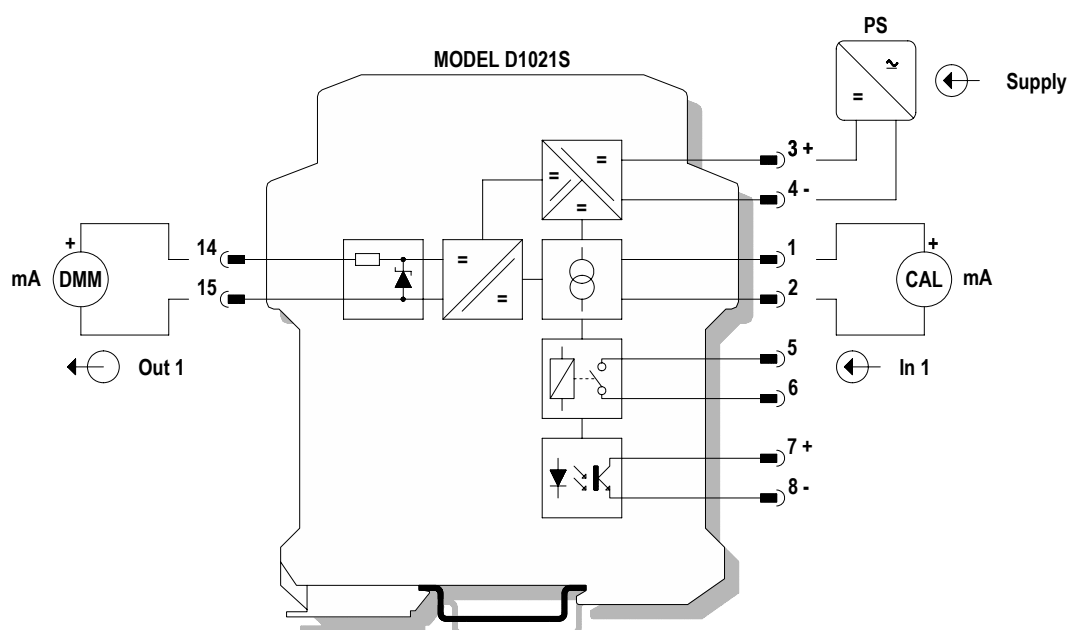
Turn the trimmer clockwise to
Increase Output value or turn
the trimmer counterclockwise
if you want to decrease Output
value.



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 34410A	DMM
Current Calibrator range 20 mA, Resolution 1 μ A 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 "mA" 20 mA range at terminals 1 (+) and 2 (-), the multimeter (DMM) for the reading in DC supply 20 mA range at terminals 14 (+) and 15 (-).
- Verify that green led on the front panel is ON.

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

- Set calibrator (CAL) at 4.000 mA 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 20.000 mA 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 20.000 mA 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.
- To execute a linearity test: set the calibrator (CAL) at 4.000, 8.000, 12.000, 16.000, 20.000 mA and verify current output is correspondent with a maximum deviation presented in the section "Technical Data".

Power Dissipation of D1021 Isolators

Section "Technical Data" of D1021 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.


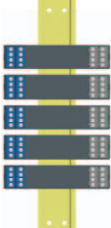

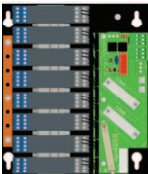
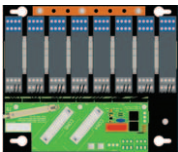
Isolators are not running at the maximum current all at the same time, the average power consumption of a multitude of isolators can be considered to be only 70 % of the value obtained from the section "Technical Data". Considering the 1/3 load power and the 70 % above discussed, the power effectively 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, D1021S (single channel) isolators, installed on DIN rail, bus or custom board assembly.


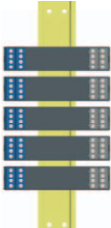

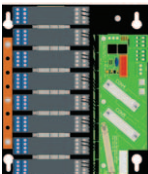
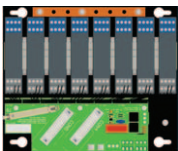
A) Cabinet with Natural Ventilation

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
					
D1021S	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
					
D1021S	60°C	40°C	45°C	45°C	50°C