INSTRUCTION & SAFETY MANUAL

SIL 3 Power Supply
for Hazardous Area Equipment
DIN-Rail,
Model PSD5201

technology for safety

Characteristics

General Description:

The PSD5201 is a single channel DIN Rail Power Supply able to drive measuring, process control equipment in IIB Group Hazardous Area, providing isolation between supply and output.
A typical application is to drive high power devices, transmitters or other equipment with 14.5 V, 150 mA supply capability.
Mounting on standard DIN-Rail, in Safe Area or in 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:

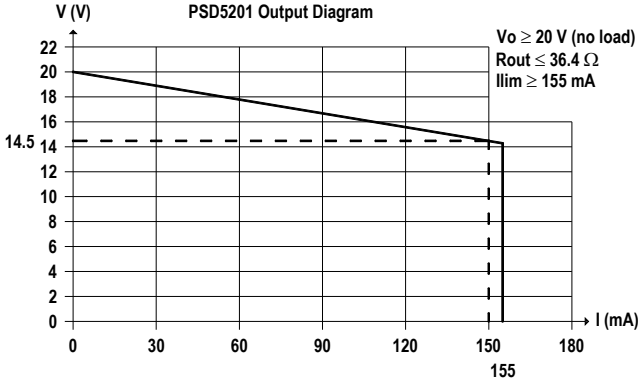
24 Vdc nom (21.5 to 30 Vdc) reverse polarity protected, ripple within voltage limits ≤ 5 Vpp, 2 A time lag fuse internally protected.
Current consumption @ 24 V: 200 mA with 150 mA nominal load, 210 mA with short circuited output.
Power dissipation: 2.5 W with 24 V supply voltage and 150 mA nominal load.

Isolation (Test Voltage):

I.S. Out/Supply 1.5 KV.

Output:

150 mA at 14.5 V (20 V no load, 36.4 Ω series resistance).



Short circuit current: ≥ 155 mA.

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.

Safety Description:

ATEX: II 3(1)G Ex nA [ia Ga] IIB T4 Gc, II (1)D [Ex ia Da] IIIC, I (M1) [Ex ia Ma] I
IECEx: Ex nA [ia Ga] IIB T4 Gc, [Ex ia Da] IIIC, [Ex ia Ma] I,
UKR TR n. 898: 2ExnAiaIICT4 X, Exial X
associated apparatus and non-sparking electrical equipment.
Uo/Voc = 21.5 V, Io/Isc = 604 mA, Po/Po = 3243 mW at terminals 13/15-14/16.
Um = 250 Vrms, -40 °C ≤ Ta ≤ 70 °C.
Approvals:
BVS 14 ATEX E 023 X conforms to EN60079-0, EN60079-11, EN60079-15.
IECEx BVS 14.0019X conforms to IEC60079-0, IEC60079-11, IEC60079-15.
СЦ 16.0036 X conforms to ДСТУ 7113, ГОСТ 22782.5-78, ДСТУ IEC 60079-15.
TÜV Certificate No. C-IS-236198-04, SIL 2 / SIL 3 conforms to IEC61508:2010 Ed.2.
TÜV Certificate No. C-IS-236198-09, SIL 3 Functional Safety Certificate conforms to IEC61508:2010 Ed.2, for Management of Functional Safety.

Mounting:

T35 DIN Rail according to EN50022.
Weight: about 145 g.
Connection: by polarized plug-in disconnect screw terminal blocks to accomodate terminations up to 2.5 mm².
Location: Safe Area or Zone 2, Group IIB T4 installation.
Protection class: IP 20.
Dimensions: Width 22.5 mm, Depth 123 mm, Height 120 mm.

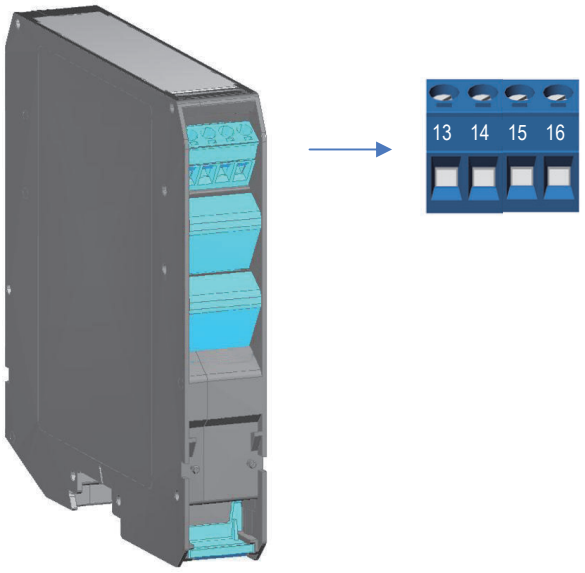
Ordering Information

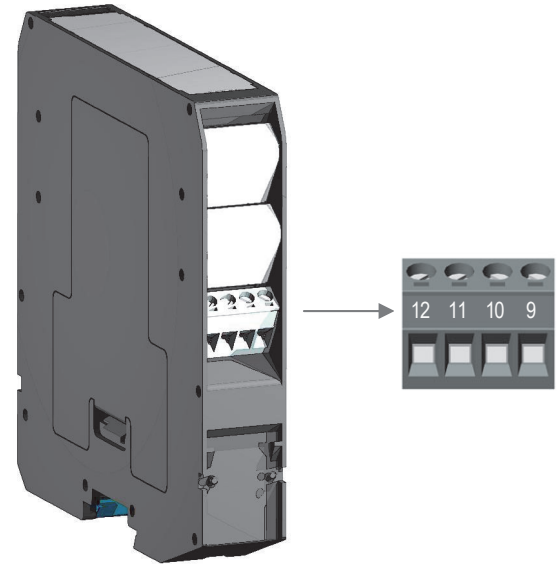
Model:	PSD5201	

Front Panel and Features

- SIL 3 according to IEC61508:2010 Ed. 2 for NE Loads for Tproof = 2 / 10 years (≤10% / >10 % of total SIF).
- SIL 2 according to IEC61508:2010 Ed. 2 for NE Loads for Tproof = 20 years (≤10% of total SIF).
- PFDavg (1 year) 4.33 E-05, SFF 91.15 %.
- Systematic capability SIL 3
- Output to Zone 0 (Zone 20), installation in Zone 2.
- High output capability Power Supply for Hazardous Area equipment.
- Output short circuit proof and current limited.
- Isolation Supply/Output.
- EMC Compatibility to EN61000-6-2, EN61000-6-4, EN61326-1, EN61326-3-1 for safety system.
- ATEX, IECEx, UKR TR n. 898, TÜV Certification.
- Simplified installation using standard DIN Rail and plug-in terminal blocks.
- 250 Vrms (Um) max. voltage allowed to the instruments associated with the module.

Terminal block connections





HAZARDOUS AREA	
13/15	+ Output for high power device
14/16	- Output for high power device

SAFE AREA	
9	+ Power Supply 24 Vdc
10	- Power Supply 24 Vdc

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 group encountered and that its maximum allowable voltage, current, power (Ui/Vmax, Ii/Imax, Pi/Pi) are not exceeded by the safety parameters (Uo/Voc, Io/Isc, Po/Po) of the PSD5201 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 (Co/Ca, Lo/La, Lo/Ro) given in the Associated Apparatus parameters for the effective group. See parameters indicated in the table below:

PSD5201 Terminals	PSD5201 Associated Apparatus Parameters		Must be	Hazardous Area/ Hazardous Locations Device Parameters
13/15-14/16	Uo / Voc = 21.5 V		≤	Ui / Vmax
	Io / Isc = 604 mA		≤	Ii/ Imax
	Po / Po = 3243 mW		≤	Pi / Pi

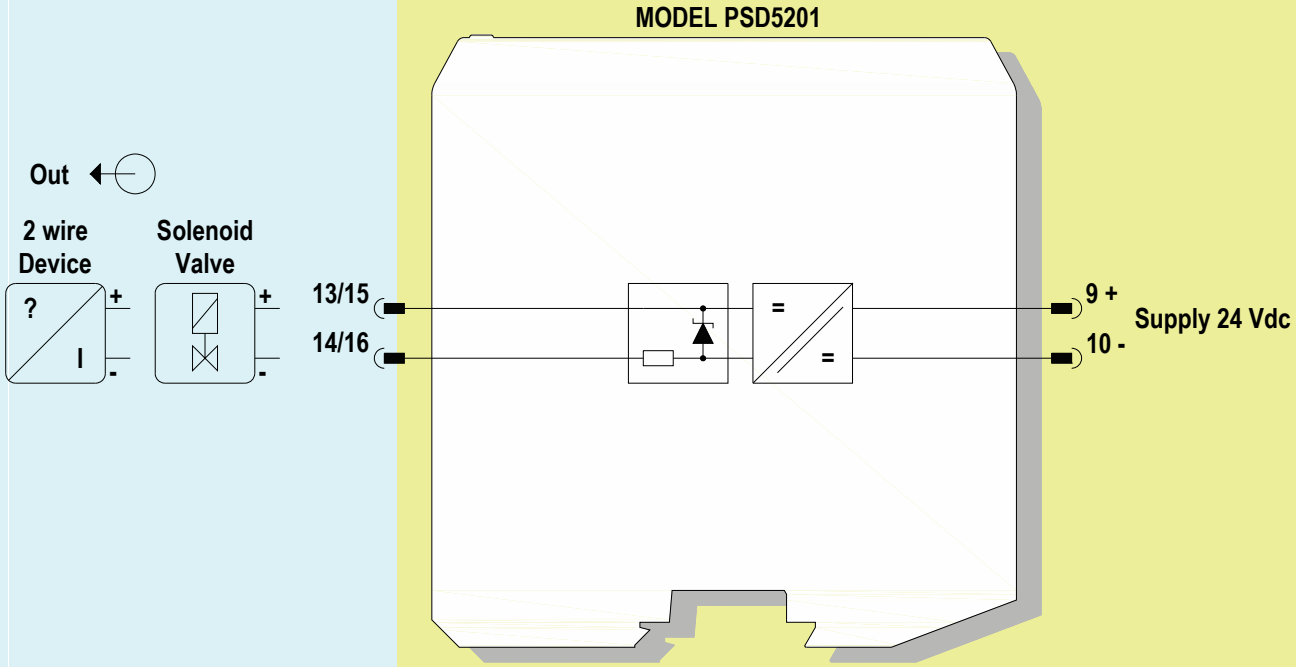
PSD5201 Terminals	PSD5201 Associated Apparatus Parameters Cenelec (US)		Must be	Hazardous Area/ Hazardous Locations Device + Cable Parameters
13/15-14/16	Co / Ca = 1.2 µF Co / Ca = 4.5 µF Co / Ca = 6.5 µF Co / Ca = 1.2 µF	IIB (C) IIA (D) I IIIC (E, F, G)	≥	Ci / Ci device + C cable
	Lo / La = 0.39 mH Lo / La = 0.78 mH Lo / La = 1.28 mH Lo / La = 0.39 mH	IIB (C) IIA (D) I IIIC (E, F, G)	≥	Li / Li device + L cable
	Lo / Ro = 43.8 µH/Ω Lo / Ro = 87.7 µH/Ω Lo / Ro = 143.9 µH/Ω Lo / Ro = 43.8 µH/Ω	IIB (C) IIA (D) I IIIC (E, F, G)	≥	Li / Ri device and L cable / R cable

For installations in which both the Ci and Li of the Intrinsically Safe apparatus exceed 1 % of the Co and Lo parameters of the Associated Apparatus (excluding the cable), then 50 % of Co and Lo parameters are applicable and shall not be exceeded (50 % of the Co and Lo become the limits which must include the cable such that Ci device + C cable ≤ 50 % of Co and Li device + L cable ≤ 50 % of Lo).
If the cable parameters are unknown, the following value may be used: Capacitance 180pF per meter (60pF per foot), Inductance 0.60µH per meter (0.20µH per foot).

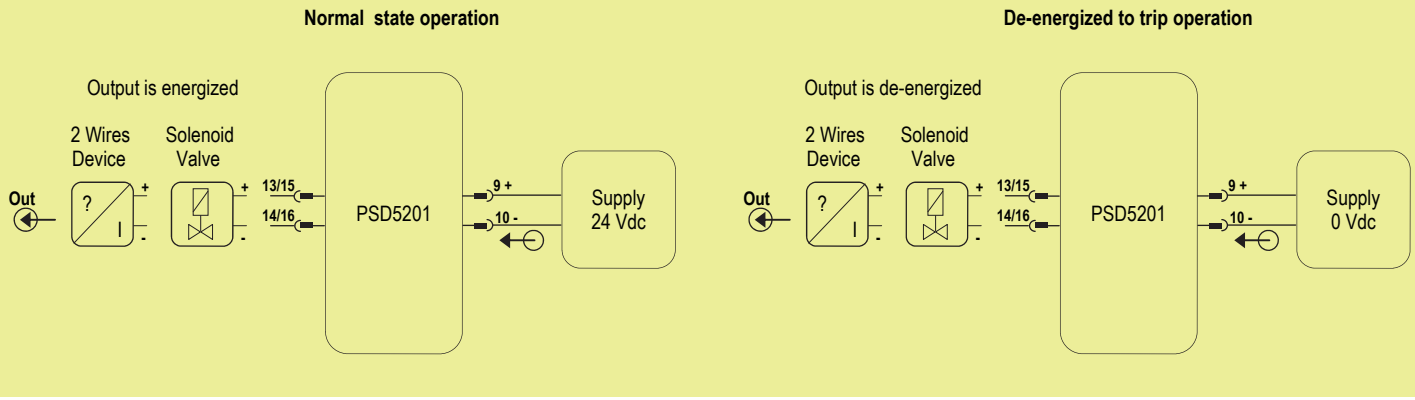
Function Diagram

HAZARDOUS AREA ZONE 0 (ZONE 20) GROUP IIB

SAFE AREA, ZONE 2 GROUP IIB T4



Application of PSD5201 for NE load



Description:

In normal operation the module is powered by connecting 24 Vdc nominal input supply to Pins 9 (+ positive) - 10 (- negative). The green LED is lit in presence of input supply.
In this condition the Output NE load (connected to positive pins 13/15 and to negative pins 14/16) is Normally Energized (NE).
In case of de-energized to trip operation, the module is shutdown and output load is de-energized (Safe State).
The following table describes the state (de-energized or energized) of output when input supply is present or absent:

Operation	Input Supply State Pins 9(+) - 10 (-)	Output State Pins 13/15(+) - 14/16 (-)
Normal	Present (24 Vdc nominal, 21.5 to 30 Vdc range)	Energized
Trip	Absent (0 Vdc)	De-energized (as safe state condition)

Safety Function and Failure behavior:

PSD5201 is considered to be operating in Low Demand mode, as a Type A module, having Hardware Fault Tolerance (HFT) = 0.
The failure behaviour of PSD5201 for NE loads is described by the following definitions :

- □ Fail-Safe State: it is defined as the output voltage being deviated below 2 Vdc.
- □ Fail Safe: failure mode that causes the module / (sub)system to go to the defined fail-safe state without a demand from the process.
- □ Fail Dangerous: it is defined as a failure 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 voltage is deviated between 2 and 12 Vdc or above 22 Vdc.
- □ Fail "No Effect": failure mode of a component that plays a part in implementing the safety function but that is neither a safe failure nor a dangerous failure, so that the output voltage is deviated between 12 and 22 Vdc. When calculating the SFF, this failure mode is not taken into account.
- □ Fail "Not part": failure mode of a component that 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	9.86
λ_{sd} = Total Safe Detected failures	0.00
λ_{su} = Total Safe Undetected failures	101.50
$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = $\lambda_{dd} + \lambda_{du} + \lambda_{sd} + \lambda_{su}$	**111.36**
MTBF (safety function, single channel) = (1 / $\lambda_{tot\ safe}$) + MTTR (8 hours)	**1025 years**
$\lambda_{no\ effect}$ = "No Effect" failures	133.64
$\lambda_{not\ part}$ = "Not Part" failures	9.60
$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe} + \lambda_{no\ effect} + \lambda_{not\ part}$	**254.60**
MTBF (device, single channel) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)	**448 years**

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

λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF
0.00 FIT	101.50 FIT	0.00 FIT	9.86 FIT	91.15%

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] = 2 years
PFDavg = 4.33E-05 Valid for **SIL 3**	PFDavg = 8.65E-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] = 10 years	T[Proof] = 20 years
PFDavg = 4.33E-04 Valid for **SIL 3**	PFDavg = 8.65E-04 Valid for **SIL 2**

Systematic capability SIL 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 fault, 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 any other appropriate action in order to avoid a false trip.
2	Supply the PSD5201 module by means of a DC power source connected between terminals 9-10, whose value must be comprised between 21.5 and 30 Vdc. Connect a current calibrator to the output terminals (13/15-14/16) and impose an output load condition up to 150 mA. Also connect a DC voltmeter between the output terminals (13/15-14/16). In this condition, the output voltage, measured by means of the DC voltmeter, should always be comprised between around 14.5 Vdc (for a 150 mA output load condition) and around 20 Vdc (for a 0 mA output load condition). If, on the other hand, an output voltage comprised between 2 and 12 Vdc or above 22 Vdc is measured, a dangerous failure which has produced a wrong output voltage deviation is detected.
3	Use the same setup described in the previous step and measure, by means of an AC voltmeter, the rms value of the output voltage. In normal operation conditions, the output supply voltage should have no AC component, that is its rms value should be ideally null. If an rms value well above 0 Vrms is measured (a reasonable value could be 50% of the power supply line value, i.e. 12 Vrms compared to 24 Vdc), a dangerous failure which has produced an oscillation of the output circuit is detected.
4	Restore the loop to full operation.
5	Remove the bypass from the safety-related PLC or restore normal operation.

This test will reveal approximately 99 % of possible Dangerous Undetected failures in the repeater.

Warning

The PSD5201 series devices are isolated Intrinsically Safe Associated Apparatus installed into standard EN50022 T35 DIN-Rail located in Safe Area or Zone 2, Group IIB, Temperature T4, Hazardous Area (according to EN/IEC60079-15) within the specified operating temperature limits Tamb –40 to +70 °C, and connected to equipment with a maximum limit for AC power supply Um of 250 Vrms.
Not to be connected to control equipment that uses or generates more than 250 Vrms or Vdc with respect to earth ground.
The PSD5201 series must be installed, operated and maintained only by qualified personnel, in accordance with 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; particular care must be given to segregation and clear identification of I.S. conductors from non I.S. ones.
De-energize the power source (turn off the power supply voltage) before plugging or unplugging the terminal blocks when installed in Hazardous Area or unless the area is known to be non-hazardous.
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 the area is known to be non-hazardous.
Failure to proper installation or use of the equipment may risk to damage the unit or cause 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 PSD5201 module provides an output (see the output diagram in the “Technical Data” section for the details of the voltage and current provided to the load) in IIB Group Hazardous Area to drive IntrinsicallySafe loads, typically high power devices, transmitters or other measuring or process control equipment.
The module provides full electrical isolation between supply and output and a “POWER ON” green led is lit when the unit is supplied.

Installation

The PSD5201 series devices are IIB Group power supplies for field devices housed in a plastic enclosure suitable for installation on T35 DIN-Rail according to EN50022,.
The PSD5201 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 inside/outside a powered unit without suffering or causing any damage **(for Zone 2 installations check the area to be non-hazardous before servicing)**.
The wiring cables have to be dimensioned according to their current and length.
In the “Function Diagram” section and on the enclosure side, a block diagram identifies all connections.
Identify the function and location of each connection terminal using the wiring diagram in the corresponding section, for example:
Connect a 24 Vdc power supply voltage between terminals “9” (positive pole) and “10” (negative pole).
Connect the output load between terminals “13” / “15” (positive pole) and “14” / “16” (negative pole).

Intrinsically Safe conductors must be identified and segregated from non I.S. ones and wired in accordance with 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)); 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 the 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 PSD5201 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 modification must be avoided.
According to EN61010, the PSD5201 series must be connected to SELV or SELV-E supplies.

Start-up

Before powering the unit, check that all wires are properly connected, in particular supply conductors and their polarity and output wires; also check that Intrinsically Safe conductors and cable trays are segregated (that is, they must have no direct contacts with other non I.S. conductors) and identified either by color coding, preferably blue, or marking.
Check conductors for exposed wires that could touch each other causing dangerous unwanted shorts. When the power supply voltage is turned on, the “power on” green led must be lit and the output must be able to power the Hazardous Area load according to the output diagram shown in the “Technical Data” section.