INSTRUCTION & SAFETY MANUAL

SIL 2 Vibration Transducer Interface, DIN-Rail and Termination Board, Model D5062S

GM INTERNATIONAL
TECHNOLOGY FOR SAFETY

Characteristics

General Description: The single channel DIN Rail Vibration Transducer Interface D5062S is a high integrity analog input interface suitable for applications requiring SIL 2 level (according to IEC 61508:2010 Ed. 2) in safety related systems for high risk industries. It provides a fully floating dc supply for energizing vibration transducers, accelerometers or 2-3 wires sensors located in Hazardous Area, and repeats the sensor input voltage in a totally isolated circuit located in Safe Area to drive vibration monitors or analyzers for rotating machinery control and supervision purposes.
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

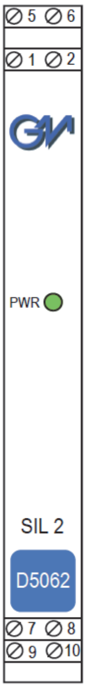
Supply:
24 Vdc nom (18 to 30 Vdc) reverse polarity protected, ripple within voltage limits ≤ 5 Vpp, 2 A time lag fuse internally protected.
Current consumption @ 24 V: 75 mA with 20 mA transducer consumption and 2 mA output load, typical.
Power dissipation: 1.3 W with 24 V supply voltage, 20 mA transducer consumption and 2 mA output load typical.
Isolation (Test Voltage):
I.S. In/Out 1.5 KV; I.S. In/Supply 1.5 KV; Out/Supply 500 V.
Input:
0 V to -20 V (10 KΩ impedance at terminals 7-8 or 8-9).
3 wires sensor supply voltage:
more than -22 V at 0 mA supply, more than -17 V at 15 mA supply
(current limited at ≈ 23 mA) at terminals 7-10 or 9-10.
2 wires sensor supply voltage:
more than -17 V with constant current supply mode at terminals 7-8 or 8-9.
Supply current selectable at 4 mA, 6 mA or 10 mA via internal DIP– Switch.
Output:
0 to -20 V on 10 KΩ load, with 10 Ω output resistance.
Response time: ≤10 μs (10 to 90 % step change).
Output ripple: ≤ 20 mVrms on 0.5 to 20 KHz band.
Frequency response: DC to 20 KHz within 1 dB maximum.
Performance:
Ref. Conditions 24 V supply, 10 KΩ load, 23 ± 1 °C ambient temperature.
Calibration accuracy: ≤ ± 0.05 % of full scale.
Linearity error: ≤ ± 0.05 % of full scale.
Supply voltage influence: ≤ ± 0.005 % of full scale for a min to max supply change.
Temperature influence: ≤ ± 0.005 % on zero and span for a 1 °C change.
Compatibility:
CE 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] IIC T4 Gc, II (1)D [Ex ia Da] IIIC, I (M1) [Ex ia Ma] I
IECEx: Ex nA [ia Ga] IIC T4 Gc, [Ex ia Da] IIIC, [Ex ia Ma] I,
UKR TR n. 898: 2ExnAiaIICT4 X, ExiaI X
associated apparatus and non-sparking electrical equipment.
Uo/Voc = 25.9 V, Io/Isc = 90 mA, Po/Po = 576 mW at terminals 7-10 or 9-10
(when used with 3 wires transducer).
Uo/Voc = 27 V, Io/Isc = 90 mA, Po/Po = 576 mW at terminals 7-8 or 8-9
(when used with 2 wire constant current supply mode).
Uo/Voc = 27 V, Io/Isc = 90 mA, Po/Po = 576 mW at terminals 7-8 or 8-9;
Ui/Vmax = 30 V, Ci = 0 nF, Li = 0 nH at terminals 7-8 or 8-9
(when used with 2 wires AC sensor).
Um = 250 Vrms, -40 °C ≤ Ta ≤ 70 °C.
Approvals :
BVS 14 ATEX E 073 X conforms to EN60079-0, EN60079-11, EN60079-15.
IECEx BVS 14.0044 X 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-224248-01, SIL 2 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.
DNV No.A-13625 and KR No.MIL20769-EL002 for maritime applications .
Mounting:
T35 DIN-Rail according to EN50022, with or without Power Bus or on customized Termination Board.
Weight: about 150 g.
Connection: by polarized plug-in disconnect screw terminal blocks to accommodate terminations up to 2.5 mm^2.
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 12.5 mm, Depth 123 mm, Height 120 mm.

Ordering information

Model: D5062S

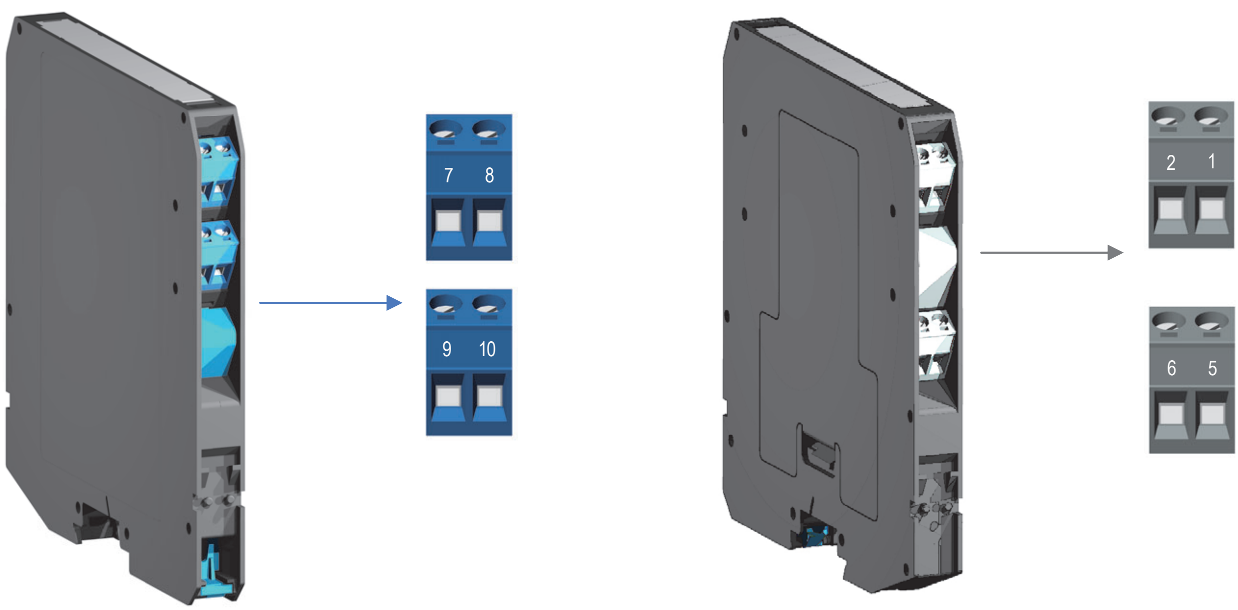
Power Bus and DIN-Rail accessories:
Connector JDFT049
Cover and fix MCHP196
Terminal block male MOR017
Terminal block female MOR022

Front Panel and Features



- SIL 2 according to IEC 61508:2010 Ed. 2 for Tproof = 3 / 20 yrs (≤10% / >10 % of total SIF)
- PFDavg (1 year) 3.35 E -04, SFF 68.08%
- Systematic capability SIL 3
- Input from Zone 0 (Zone 20), installation in Zone 2.
- 0 to –20 V Input/Output Signal.
- Input selection via DIP-Switch.
- Wide band signal transfer.
- Input and Output short circuit proof.
- High Accuracy.
- Three port isolation, Input/Output/Supply.
- EMC Compatibility to EN61000-6-2, EN61000-6-4, EN61326-1, EN61326-3-1 for safety system.
- ATEX, IECEx, 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.
- 250 Vrms (Um) max. voltage allowed to the instruments associated with the barrier.

Terminal block connections



HAZARDOUS AREA

7/9	Common Input
8	- Signal Input
10	- Power Input

SAFE AREA

1	- Signal Output
2	Common Output
5	+ Power Supply 24 Vdc
6	- 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 D5062 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:

D5062 Terminals	D5062 Associated Apparatus Parameters	Must be	Hazardous Area/Hazardous Locations Device Parameters
7 - 10 or 9 - 10 (3 wires sensor) 7 - 8 or 8 - 9 (2 wires constant current supply) 7 - 8 or 8 - 9 (2 wires AC sensor)	Uo / Voc = 25.9 V Uo / Voc = 27.0 V Uo / Voc = 27.0 V	≤	Ui / Vmax
7 - 10 or 9 - 10 (3 wires sensor) 7 - 8 or 8 - 9 (2 wires constant current supply) 7 - 8 or 8 - 9 (2 wires AC sensor)	Io / Isc = 90 mA Io / Isc = 90 mA Io / Isc = 90 mA	≤	Ii / Imax
7 - 10 or 9 - 10 (3 wires sensor) 7 - 8 or 8 - 9 (2 wires constant current supply) 7 - 8 or 8 - 9 (2 wires AC sensor)	Po / Po = 576 mW Po / Po = 576 mW Po / Po = 576 mW	≤	Pi / Pi

D5062 Terminals	D5062 Associated Apparatus Parameters Cenelec (US)		Must be	Hazardous Area/Hazardous Locations Device Parameters
7 - 10 or 9 - 10 (3 wires sensor)	Co / Ca = 100 nF Co / Ca = 770 nF Co / Ca = 2.63 μF Co / Ca = 4.02 μF Co / Ca = 770 nF	IIC (A,B) IIB (C) IIA (D) I IIIC (E, F, G)	≥	Ci / Ci device + C cable
7 - 8 or 8 - 9 (2 wires constant current supply)	Co / Ca = 90 nF Co / Ca = 705 nF Co / Ca = 2.3 μF Co / Ca = 3.75 μF Co / Ca = 705 nF	IIC (A,B) IIB (C) IIA (D) I IIIC (E, F, G)		
7 - 8 or 8 - 9 (2 wires AC sensor)	Co / Ca = 90 nF Co / Ca = 705 nF Co / Ca = 2.3 μF Co / Ca = 3.75 μF Co / Ca = 705 nF	IIC (A,B) IIB (C) IIA (D) I IIIC (E, F, G)		
7 - 10 or 9 - 10 (3 wires sensor)	Lo / La = 4.4 mH Lo / La = 17.9 mH Lo / La = 35.8 mH Lo / La = 58.7 mH Lo / La = 17.9 mH	IIC (A,B) IIB (C) IIA (D) I IIIC (E, F, G)	≥	Li / Li device + L cable
7 - 8 or 8 - 9 (2 wires constant current supply)	Lo / La = 4.1 mH Lo / La = 16.4 mH Lo / La = 33.9 mH Lo / La = 54 mH Lo / La = 16.4 mH	IIC (A,B) IIB (C) IIA (D) I IIIC (E, F, G)		
7 - 8 or 8 - 9 (2 wires AC sensor)	Lo / La = 4.1 mH Lo / La = 16.4 mH Lo / La = 33.9 mH Lo / La = 54 mH Lo / La = 16.4 mH	IIC (A,B) IIB (C) IIA (D) I IIIC (E, F, G)		
7 - 10 or 9 - 10 (3 wires sensor)	Lo / Ro = 61.7 μH/Ω Lo / Ro = 247.1 μH/Ω Lo / Ro = 494.3 μH/Ω Lo / Ro = 811 μH/Ω Lo / Ro = 247.1 μH/Ω	IIC (A,B) IIB (C) IIA (D) I IIIC (E, F, G)	≥	Li / Ri device and L cable / R cable
7 - 8 or 8 - 9 (2 wires constant current supply)	Lo / Ro = 56.8 μH/Ω Lo / Ro = 227.3 μH/Ω Lo / Ro = 459.7 μH/Ω Lo / Ro = 746.1 μH/Ω Lo / Ro = 227.3 μH/Ω	IIC (A,B) IIB (C) IIA (D) I IIIC (E, F, G)		
7 - 8 or 8 - 9 (2 wires AC sensor)	Lo / Ro = 56.8 μH/Ω Lo / Ro = 227.3 μH/Ω Lo / Ro = 459.7 μH/Ω Lo / Ro = 746.1 μH/Ω Lo / Ro = 227.3 μH/Ω	IIC (A,B) IIB (C) IIA (D) I IIIC (E, F, G)		

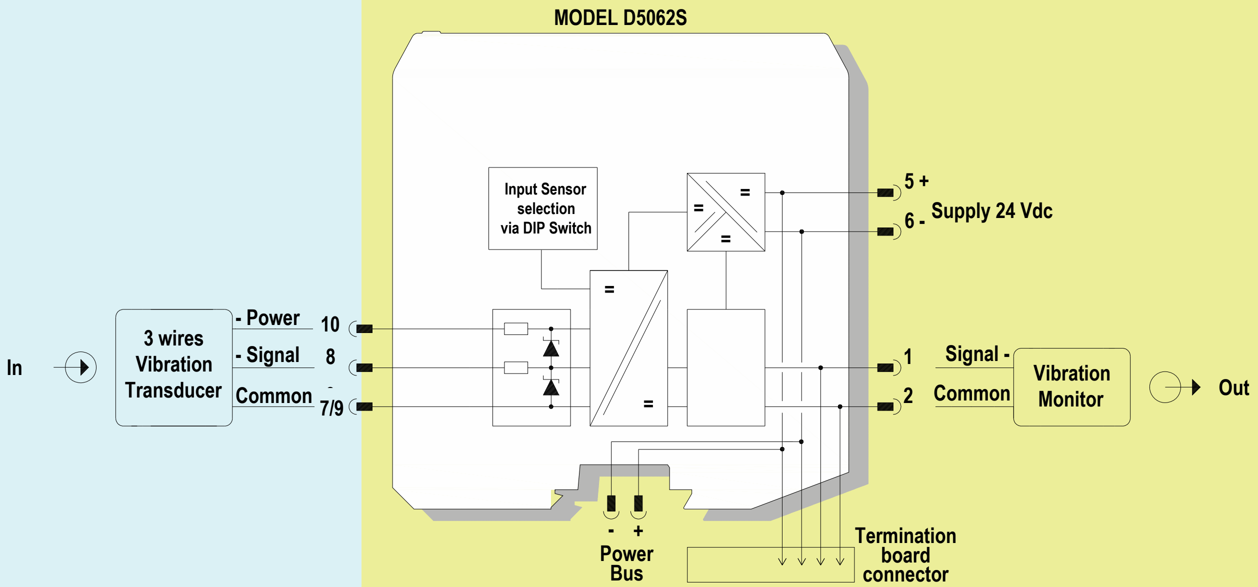
When used with separate powered intrinsically safe devices, check that maximum allowable voltage, current (Ui/Vmax, Ii/Imax) of the D5062 Associated Apparatus are not exceeded by the safety parameters (Uo/Voc, Io/Isc) of the Intrinsically Safe device, indicated in the table below:

D5062 Terminals	D5062 Associated Apparatus Parameters	Must be	Hazardous Area/ Hazardous Locations Device Parameters
7- 8 or 8-9	Ui / Vmax = 30 V	≥	Uo / Voc
7- 8 or 8-9	Ci = 0 nF, Li= 0 nH		

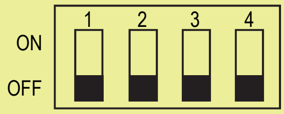
For installations in which both the Ci and Li of the Intrinsically Safe apparatus exceed 1 % of the Co and Lo parameters of the Associated Apparatus (excluding the cable), then 50 % of Co and Lo parameters are applicable and shall not be exceeded (50 % of the Co and Lo become the limits which must include 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 IIC.	SAFE AREA, ZONE 2 GROUP IIC T4.



Input configuration selection via internal Dip-Switch

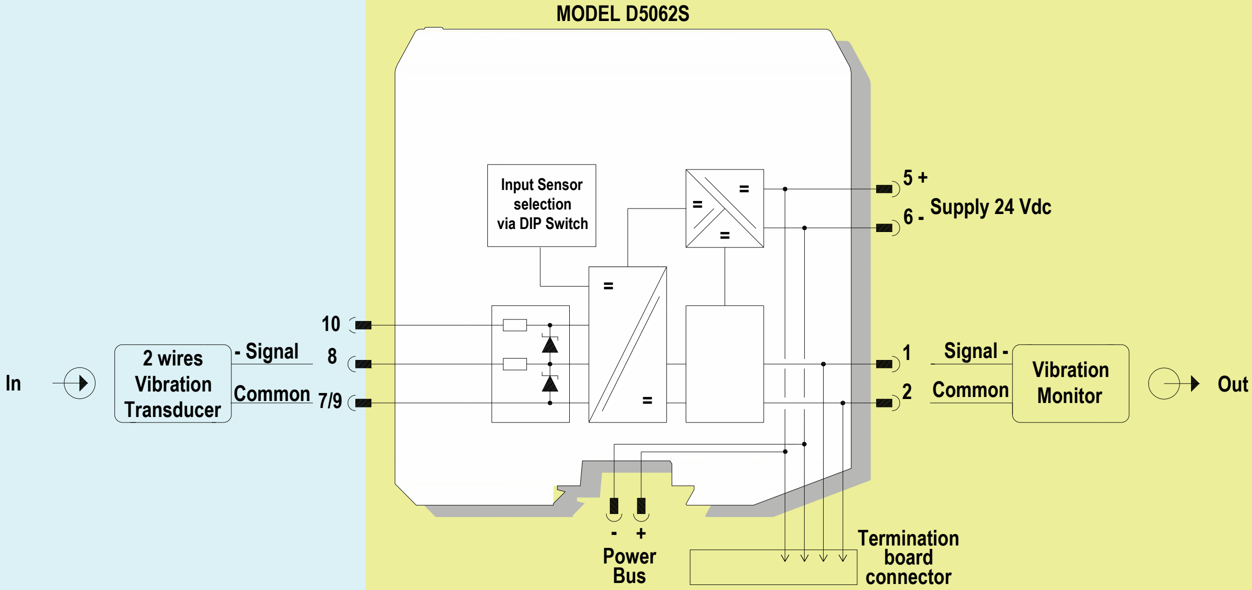


3 wires transducers

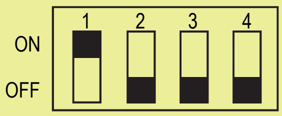
1 = OFF, 2 = OFF, 3 = OFF, 4 = OFF.

Function Diagram

HAZARDOUS AREA ZONE 0 (ZONE 20) GROUP IIC.	SAFE AREA, ZONE 2 GROUP IIC T4.

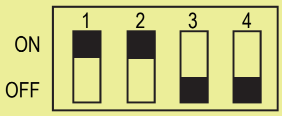


Input configuration selection via internal Dip-Switch



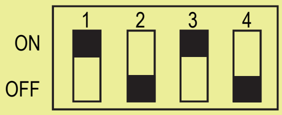
2 wires transducers (4 mA)

1 = ON, 2 = OFF, 3 = OFF, 4 = OFF.



2 wires transducers (6 mA)

1 = ON, 2 = ON, 3 = OFF, 4 = OFF.

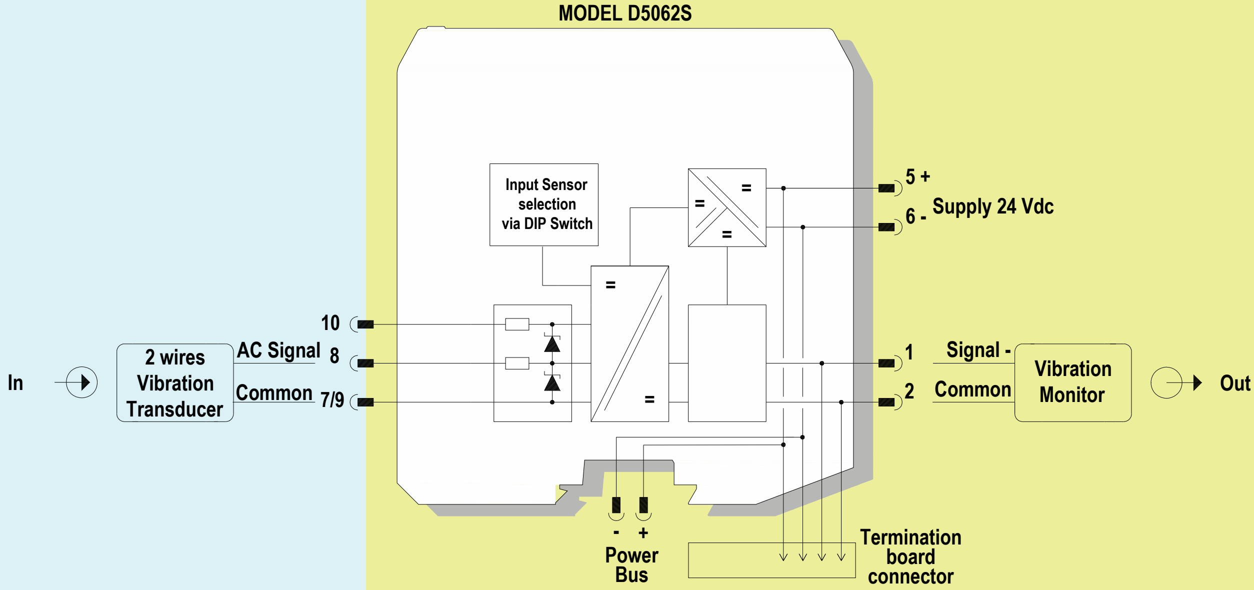


2 wires transducers (10 mA)

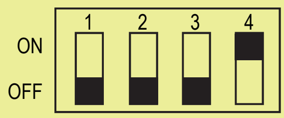
1 = ON, 2 = OFF, 3 = ON, 4 = OFF.

Function Diagram

HAZARDOUS AREA ZONE 0 (ZONE 20) GROUP IIC.	SAFE AREA, ZONE 2 GROUP IIC T4.



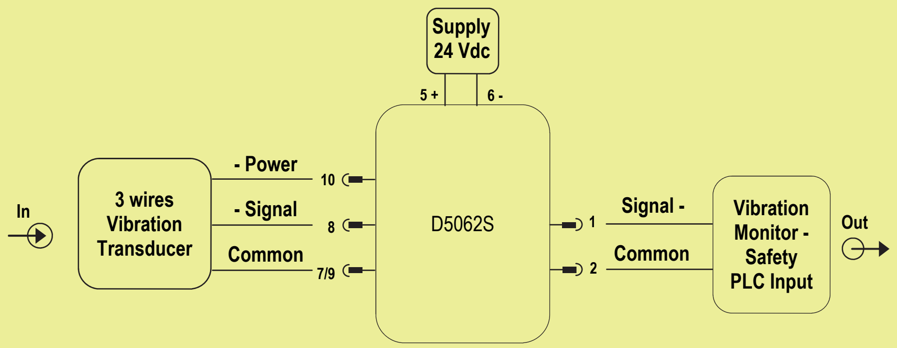
Input configuration selection via internal Dip-Switch



2 wires AC transducers

1 = OFF, 2 = OFF, 3 = OFF, 4 = ON.

1st Application for D5062S, with 3 wires powered transducer input



Description:

For this application, set the internal dip-switches in the following mode (see page 11 for more information):

Dip-switch position (D5062S)	1	2	3	4
3 wires transducer	OFF	OFF	OFF	OFF

The D5062S module is supplied (with 18 to 30Vdc supply voltage) at Pins 5 (+) – 6 (-). The green LED is lit in presence of supply power.
The input transducer supply current is applied between Pins 7/9-10 (Common, -Power) and the input transducer signal (DC or AC) is applied between Pins 8-7/9 (-Signal, Common). When a DC input transducer is used, a 0 to -20Vdc input signal is applied. For AC transducers, a sinusoidal signal is applied (0 to 20Vpp, DC to 20kHz) together with a -10Vdc offset. For DC signals, the input signals (0 to -20Vdc) is identically repeated at output Pins 1-2 (-Signal, Common); for AC signals, the AC component of the input signal (0 to 20Vpp, DC to 20kHz) is identically repeated at output Pins 1-2, while the -10Vdc offset is not repeated at the output pins.

Safety Function and Failure behavior:

D5062S is considered to be operating in Low Demand mode, as a Type A module, having Hardware Fault Tolerance (HFT) = 0.
The failure behaviour is described by the following definitions:

- □ Fail-Safe State: is defined as the output going Low or High, considering that the safety logic solver can convert the Low or High fail (dangerous detected) to the fail-safe state.
- □ Fail Safe: a failure mode that causes the module / (sub)system to go to the defined fail-safe state without a demand from the process.
- □ Fail Dangerous: failure mode that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state) or deviates the output voltage by more than 5 % of full span (> ± 1 Vdc).
- □ Fail High: a failure mode that causes the output signal to go below the maximum negative voltage (< -20 Vdc). Assuming that the application program in the safety logic solver is configured to detect High failure and does not automatically trip on this failure, this failure has been classified as a dangerous detected (DD) failure.
- □ Fail Low: a failure mode that causes the output signal to go above the minimum negative voltage (> -0.5 Vdc). Assuming that the application program in the safety logic solver is configured to detect Low failure and does not automatically trip on this failure, this failure has been classified as a dangerous detected (DD) failure.
- □ 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 because the output voltage is deviated by less than 5 % of full span (< ± 1 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 date: taken from Siemens Standard SN29500.

Failure rate table:

Failure category	Failure rates (FIT)
λ_{dd} = Total Dangerous Detected failures	160.84
λ_{du} = Total Dangerous Undetected failures	71.56
λ_{sd} = Total Safe Detected failures	0.00
λ_{su} = Total Safe Undetected failures	0.00
$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = $\lambda_{dd} + \lambda_{du} + \lambda_{sd} + \lambda_{su}$	**232.40**
MTBF (safety function, single channel) = (1 / $\lambda_{tot\ safe}$) + MTTR (8 hours)	**491 years**
$\lambda_{no\ effect}$ = “No Effect” failures	269.70
$\lambda_{not\ part}$ = “Not Part” failures	22.70
$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe} + \lambda_{no\ effect} + \lambda_{not\ part}$	**524.80**
MTBF (device, single channel) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)	**217 years**

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

λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF	DC_D
0.0 FIT	0.00 FIT	160.84 FIT	71.56 FIT	69.21%	69.21%

PFDavg vs T[Proof] table (assuming Proof Test coverage of 99%), with determination of SIL supposing module contributes ≤10% of total SIF dangerous failures:

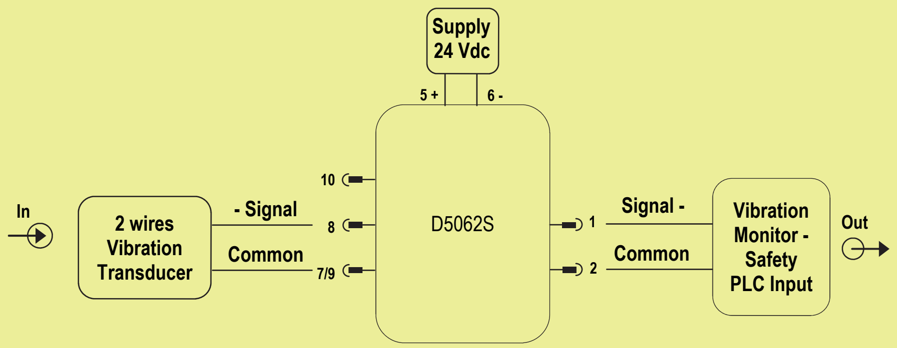
T[Proof] = 1 year	T[Proof] = 3 years
PFDavg = 3.15E-04 Valid for **SIL 2**	PFDavg = 9.46E-04 Valid for **SIL 2**

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] = 20 years
PFDavg = 6.31E-03 Valid for **SIL 2**

Systematic capability SIL 3.

2nd Application for D5062S, with 2 wires powered transducer input



Description:

For this application, set the internal dip-switches in the following mode (see page 11 for more information):

Dip-switch position(D5062S)	1	2	3	4
2 wires transducer (4 mA)	ON	OFF	OFF	OFF
2 wires transducer (6 mA)	ON	ON	OFF	OFF
2 wires transducer (10 mA)	ON	OFF	ON	OFF

The D5062S module is supplied (with 18 to 30Vdc supply voltage) at Pins 5 (+) – 6 (-). The green LED is lit in presence of supply power.
The input transducer voltage signal (0 to -20Vdc) is applied between Pins 8-7/9 (-Signal, Common). The input transducer supply current is imposed to 4, 6 or 10mA by means of the internal DIP-switches, as shown above.
The input signal (0 to -20Vdc) is identically repeated at output Pins 1-2 (-Signal, Common).

Safety Function and Failure behavior:

D5062S is considered to be operating in Low Demand mode, as a Type A module, having Hardware Fault Tolerance (HFT) = 0.
The failure behaviour is described by the following definitions:

- □ Fail-Safe State: is defined as the output going Low or High, considering that the safety logic solver can convert the Low or High fail (dangerous detected) to the fail-safe state.
- □ Fail Safe: a failure mode that causes the module / (sub)system to go to the defined fail-safe state without a demand from the process.
- □ Fail Dangerous: failure mode that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state) or deviates the output voltage by more than 5 % of full span (> ± 1 Vdc).
- □ Fail High: a failure mode that causes the output signal to go below the maximum negative voltage (< -20 Vdc). Assuming that the application program in the safety logic solver is configured to detect High failure and does not automatically trip on this failure, this failure has been classified as a dangerous detected (DD) failure.
- □ Fail Low: a failure mode that causes the output signal to go above the minimum negative voltage (> -0.5 Vdc). Assuming that the application program in the safety logic solver is configured to detect Low failure and does not automatically trip on this failure, this failure has been classified as a dangerous detected (DD) failure.
- □ 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 because the output voltage is deviated by less than 5 % of full span (< ± 1 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 date: taken from Siemens Standard SN29500.

Failure rate table:

Failure category	**Failure rates (FIT)**
λ_{dd} = Total Dangerous Detected failures	161.96
λ_{du} = Total Dangerous Undetected failures	75.95
λ_{sd} = Total Safe Detected failures	0.00
λ_{su} = Total Safe Undetected failures	0.00
$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = $\lambda_{dd} + \lambda_{du} + \lambda_{sd} + \lambda_{su}$	**237.91**
MTBF (safety function, single channel) = (1 / $\lambda_{tot\ safe}$) + MTTR (8 hours)	**479 years**
$\lambda_{no\ effect}$ = “No Effect” failures	274.79
$\lambda_{not\ part}$ = “Not Part” failures	12.10
$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe} + \lambda_{no\ effect} + \lambda_{not\ part}$	**524.80**
MTBF (device, single channel) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)	**217 years**

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

λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF	DC_D
0.0 FIT	0.00 FIT	161.96 FIT	75.95 FIT	68.08%	68.08%

PFDavg vs T[Proof] table (assuming Proof Test coverage of 99%), with determination of SIL supposing module contributes ≤10% of total SIF dangerous failures:

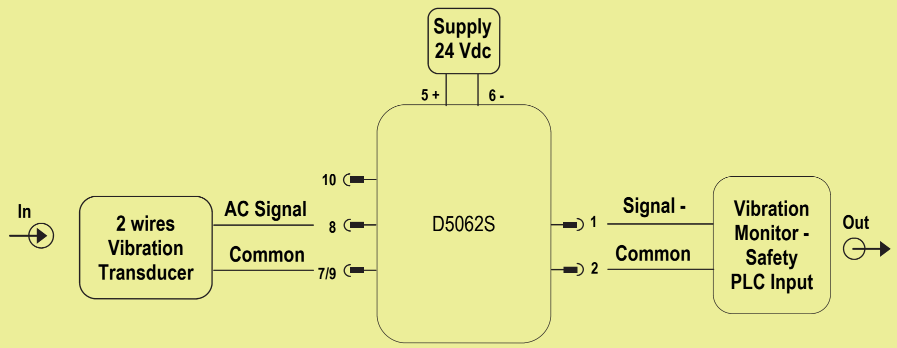
T[Proof] = 1 year	T[Proof] = 3 years
PFDavg = 3.35E-04 Valid for **SIL 2**	PFDavg = 1.00E-04 Valid for **SIL 2**

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] = 20 years
PFDavg = 6.69E-03 Valid for **SIL 2**

Systematic capability SIL 3.

3rd Application for D5062S, with 2 wires AC (unpowered) transducer input



Description:

For this application, set the internal dip-switches in the following mode (see page 11 for more information):

Dip-switch position (D5062S)	1	2	3	4
2 wires AC transducer	OFF	OFF	OFF	ON

The D5062S module is supplied (with 18 to 30Vdc supply voltage) at Pins 5 (+) – 6 (-). The green LED is lit in presence of supply power.
The input transducer AC signal (0 to 20Vpp, DC to 20kHz) is applied between Pins 8-7/9 (-Signal, Common). No DC offset must be applied.
The input signal (0 to 20Vpp, DC to 20kHz) is identically repeated at output Pins 1-2 (-Signal, Common).

Safety Function and Failure behavior:

D5062S is considered to be operating in Low Demand mode, as a Type A module, having Hardware Fault Tolerance (HFT) = 0.
The failure behaviour is described by the following definitions:

- □ Fail-Safe State: is defined as the output going Low or High, considering that the safety logic solver can convert the Low or High fail (dangerous detected) to the fail-safe state.
- □ Fail Safe: a failure mode that causes the module / (sub)system to go to the defined fail-safe state without a demand from the process.
- □ Fail Dangerous: failure mode that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state) or deviates the output voltage by more than 5 % of full span (> ± 1 Vdc).
- □ Fail High: a failure mode that causes the output signal to go below the maximum negative voltage (< -20 Vdc). Assuming that the application program in the safety logic solver is configured to detect High failure and does not automatically trip on this failure, this failure has been classified as a dangerous detected (DD) failure.
- □ Fail Low: a failure mode that causes the output signal to go above the minimum negative voltage (> -0.5 Vdc). Assuming that the application program in the safety logic solver is configured to detect Low failure and does not automatically trip on this failure, this failure has been classified as a dangerous detected (DD) failure.
- □ 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 because the output voltage is deviated by less than 5 % of full span (< ± 1 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 date: taken from Siemens Standard SN29500.

Failure rate table:

Failure category	Failure rates (FIT)
λ_{dd} = Total Dangerous Detected failures	160.84
λ_{du} = Total Dangerous Undetected failures	71.96
λ_{sd} = Total Safe Detected failures	0.00
λ_{su} = Total Safe Undetected failures	0.00
$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = $\lambda_{dd} + \lambda_{du} + \lambda_{sd} + \lambda_{su}$	**232.80**
MTBF (safety function, single channel) = (1 / $\lambda_{tot\ safe}$) + MTTR (8 hours)	**490 years**
$\lambda_{no\ effect}$ = "No Effect" failures	269.70
$\lambda_{not\ part}$ = "Not Part" failures	22.70
$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe} + \lambda_{no\ effect} + \lambda_{not\ part}$	**525.20**
MTBF (device, single channel) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)	**217 years**

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

λ_{sd}	λ_{su}	λ_{dd}	λ_{du}	SFF	DC_D
0.0 FIT	0.00 FIT	160.84 FIT	71.96 FIT	69.09%	69.09%

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] = 3 years
PFDavg = 3.17E-04 Valid for **SIL 2**	PFDavg = 9.51E-04 Valid for **SIL 2**

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] = 20 years
PFDavg = 6.34E-03 Valid for **SIL 2**

Systematic capability SIL 3.

T– proof

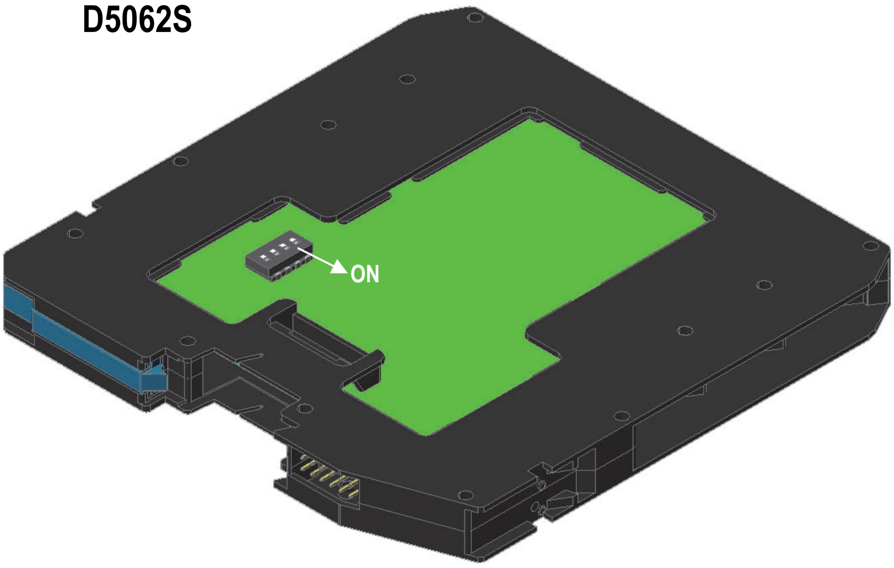
The proof test shall be performed to reveal dangerous faults which are undetected by diagnostic. This means that it is necessary to specify how dangerous undetected fault, which have been noted during the FMEDA, can be revealed during proof test.
The **Proof test** consists of the following steps:

Steps	Action
1	Bypass the safety-related Vibration Monitor/PLC or take any other appropriate action in order to avoid a false trip.
2	Connect a calibrated DC input voltage to the interface (terminals 7/9 and 8); in the 0 to -20 Vdc range, check with a 1 Vdc step that the output voltage corresponds to each input step with a deviation smaller than 1%. This test detects any failure in the basic DC loop transfer function.
3	Connect a frequency generator to the interface (terminals 7/9 and 8); impose a 1 kHz square wave input signal with amplitude in the 0 to -20 Vpp range and -10 Vdc offset, then check with an oscilloscope that the output waveform maintains the peak-to-peak value with a deviation smaller than 1%. In addition, impose a zero input signal and verify that the output ripple is ≤ 20 mVrms. This test detects any other possible failure in the loop transfer function.
4	Connect a current sinking source (i.e.: 0 ÷ 20 mA current calibrator) between terminals 10 (negative supply) and 7/9 (common) and connect a DVM across the calibrator terminals. Set the current sink at 1 mA and check if the voltage measure is ≤ -21 Vdc at terminal 10, referred to terminal 7/9. Then, set the current sink at 15 mA and check if the voltage measure is ≤ -16 Vdc at terminal 10, referred to terminal 7/9. This test detects any failure in the input channel circuit.
5	Restore the loop to full operation.
6	Remove the bypass from the safety-related Vibration Monitor/PLC or restore normal operation.

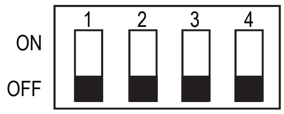
This test will reveal around 99% of the possible Dangerous Undetected failures.

Configuration

D5062S



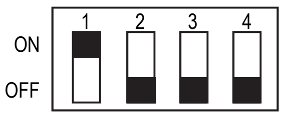
DIP switch configurations (all valid for SIL applications):



3 wires transducers

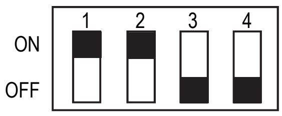
1 = OFF, 2 = OFF, 3 = OFF, 4 = OFF.

This mode is factory settings



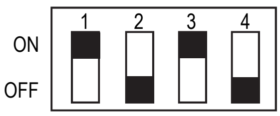
2 wires transducers (4 mA)

1 = ON, 2 = OFF, 3 = OFF, 4 = OFF.



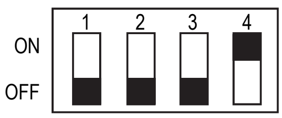
2 wires transducers (6 mA)

1 = ON, 2 = ON, 3 = OFF, 4 = OFF.



2 wires transducers (10 mA)

1 = ON, 2 = OFF, 3 = ON, 4 = OFF.



2 wires AC transducers

1 = OFF, 2 = OFF, 3 = OFF, 4 = ON.

Warning

The D5062S series devices are isolated Intrinsically Safe Associated Apparatus installed into standard EN50022 T35 DIN-Rail located in Safe Area or Zone 2, Group IIC, 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 D5062 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.

Operation

The D5062S module provides a fully floating DC supply for energizing vibration transducers, accelerometers or 2-3 wires sensors located in Hazardous Area and repeats the sensor input voltage in a totally isolated circuit located in Safe Area to drive vibration monitors or analyzers for rotating machinery control and supervision purposes.
The module provides 3 port isolation (input / output / supply) and a “POWER ON” green led is lit when the unit is supplied.

Installation

The D5062 series devices are vibration transducer interfaces housed in a plastic enclosure suitable for installation on T35 DIN-Rail according to EN50022, with or without Power Bus, or on customized Termination Boards.
The D5062 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 and configurations with 2 or 3 wires sensors.
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 “5” (positive pole) and “6” (negative pole).
For 3 wires powered sensors (such as eddy current probes, piezo-ceramic accelerometers and similar sensors), connect the sensor negative supply wire to terminal “10”, the sensor signal wire to terminal “8” and the sensor common wire (identical for both signal and supply) to terminal “7” or “9”.
For 2 wires powered sensors (such as position, velocity or acceleration sensors, operating in constant current mode), connect the sensor signal wire to terminal “8” and the sensor common wire to terminal “7” or “9”.
The sensor constant current supply mode is enabled selecting the appropriate DIP switch configurations (see the “Function Diagram” of “Configuration” section).
The sensor supply current is selectable between the three different values of 4 mA, 6 mA and 10 mA. Each supply current value corresponds, as shown in the “Function Diagram” and “Configuration” sections, to a different DIP switch configuration.
For 2 wires unpowered sensors (such as suspended mass “seismic” accelerometers or other magnetic pick-up sensors), connect the sensor signal wire to terminal “8” and the sensor common wire to terminal “7” or “9”.
This type of sensor generates AC signals only; therefore, the D5062 input must be biased in order to provide a half scale output value with 0 Vdc input, by selecting the appropriate DIP switch configuration for 2 wires AC transducers (see the “Function Diagram” of “Configuration” section).
Connect the output signal wire to terminal “1” and the output common wire to terminal “2” (output port for the vibration monitor interface).

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 D5062 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, the D5062 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 input 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.
For 3 wires powered sensors, the sensor negative supply voltage (referred to common terminals “7” / “9”) must be more negative than -17 Vdc (supposing a 15 mA maximum value for the transducer current consumption).
In addition, for 2 or 3 wires powered sensors, the output signal should be corresponding to the input sensor signal, verifying that the output signal is kept within the 0 to - 20 V range (supposing a 10 KΩ output load). Instead, for 2 wires unpowered sensors, the AC output signal should be corresponding to the AC input sensor signal, considering that the output signal also comprises a -10 Vdc component (absent in the input signal) because of the offset introduced by the DIP switch configuration for 2 wires AC transducers shown in the “Configuration” section.