



Vibration equipment division

TR-PRO

High Performance Vibration Sensor with integrated 4-20mA power loop

User and Maintenance Manual



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Note: the pictures and the images in the present document are for reference only; CEMB reserve the rights to modify the content of this manual without preliminary note.

1 GENERAL DESCRIPTION



TR-PRO is a high performance vibration transmitter that can measure the vibration and protect any type of rotational machine.

TR-PRO is designed to fulfill the needs of rotors that have advanced requirements in terms of dynamic range (e.g. crusher, alternative motors, high performance process pumps and compressors), operational thermal cycles or extended vibration bands (e.g. High speed machines).

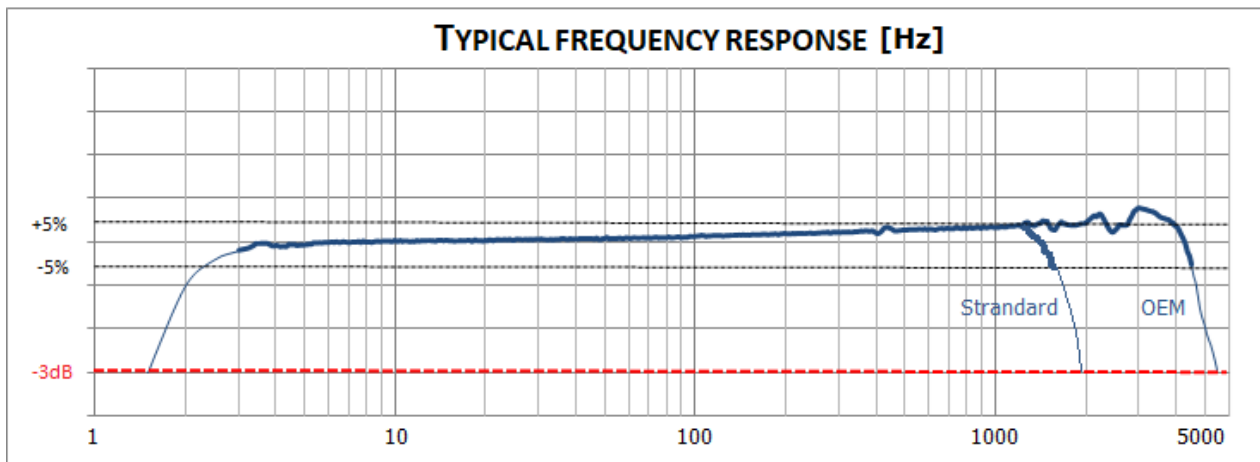
TR-PRO is perfect for rugged industrial applications, with its AISI 316L stainless steel body with general purpose ¼" 28 UNF Female hole.

TR-PRO is available with different electrical connections, from standard 2 poles MIL-C connector or integral cable, either standard, armoured or ETFE to resist chemical or severe environmental situations.

It measures the absolute vibration of the bearing support where the accelerometer is installed, and the vibration is measured along the axis of the accelerometer.

2 TECHNICAL SPECIFICATION

Material	Stainless steel AISI 316L
Type of measure	Sismic vibrations along axis (any mounting direction)
Dynamic Range	+/- 50g
Dynamic performance (See picture below)	-3db / 1.5Hz – 1kHz (for standard version) OEM/Customized Versions are available up to 5KHz
Operating conditions	- 60°C ÷ + 120°C IP 68 - EN 60529/10.91
Power supply	24Vdc nominal (10-35Vdc) current loop 4-20mA - 2 wires
Electrical connection (See also Chapter 4)	Mil-C 2 poles integrated connector (B=0) Integral ETFE cable (B=1) Integral STANDARD Cable (B=2) Integral ARMOUR cable (B=3)
Transversal sensitivity	< 5 %
Linearity	± 2% - 75 Hz
Insulation	≥10 ⁸ Ω between signal and case
Screwing torque	6÷8 Nm
Storage conditions	- 60°C ÷ + 150°C non condensing
Shock resistance	1000 g
Periodic Maintenance	Not required



3 ORDERING CODES

TR-PRO / A / B / C / DD - XXX

A: MEASURING FIELD [RMS]

- 0 10 mm/s
- 1 20 mm/s
- 2 50 mm/s
- 3 100 mm/s
- 4 1 g
- 5 5 g
- 7 10 g
- 8 25.4 mm/s (1 inch/s)
- 9 12.7 mm/s (0.5 inch/s)

B: CONNECTION

- 0 MilC-2 poles
- 1 Integral ETFE cable – Blue: 2 wires + shield + armour (internal)
- 2 Integral STANDARD cable – gray: 2 wires + shield
- 3 Integral ARMoured cable – gray: 2 wires + shield + armour (external)

C: CERTIFICATION

- 0 Safe Area
- 2 ATEX for Gas and Dust: Zone1: Ex-ia (to be installed with barriers)
Zone2: Ex-tc & Ex-tc (barriers NOT required)

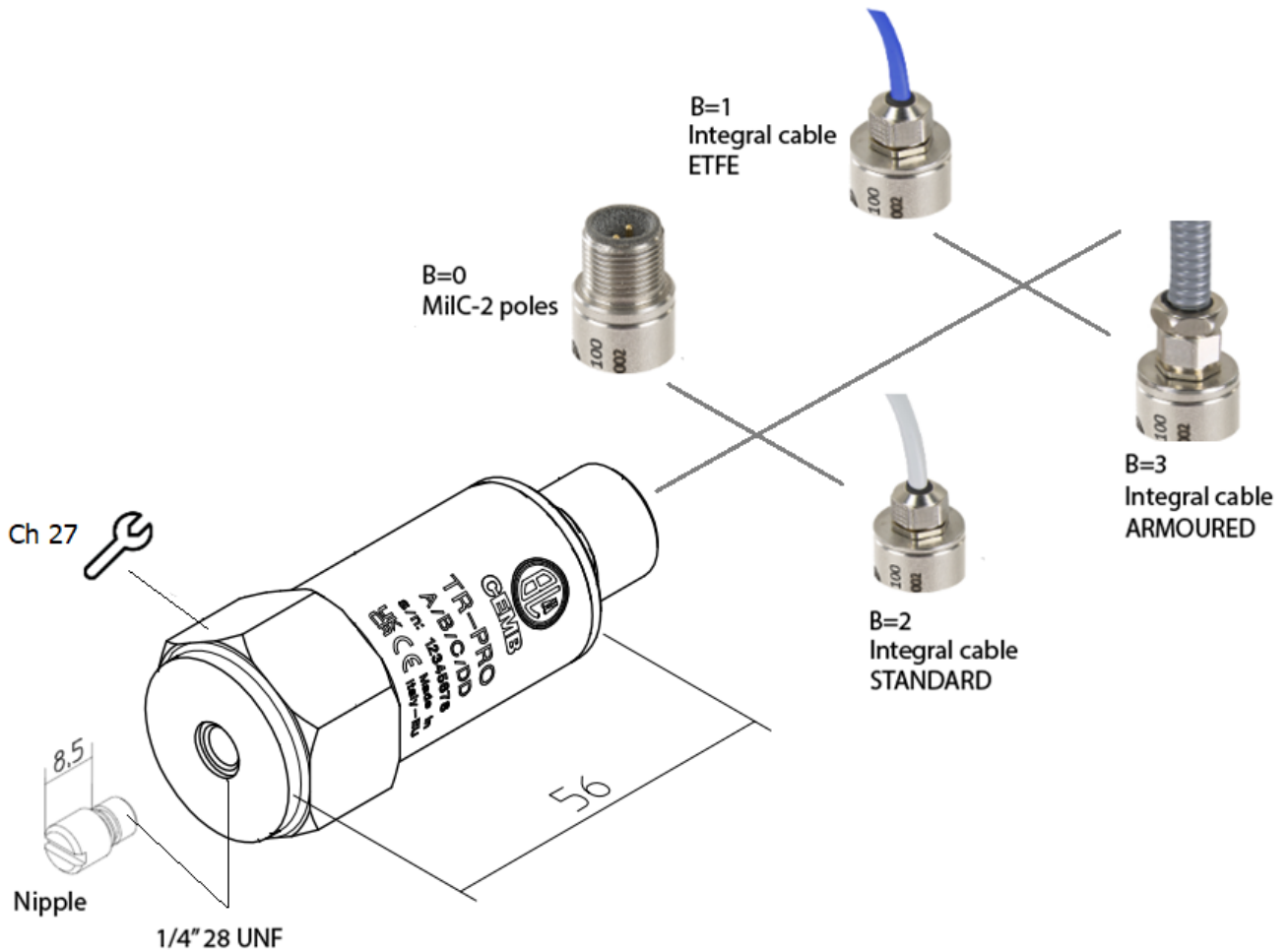
D: CABLE LENGTH

- 0 No Cable (mandatory if **B** = 0)
- XX 1 to 29 m (default = 5 m)

-XXX: optional customization code for special configurations or OEM

4 COMPOSITION

The picture below describes the standard composition of TR-PRO, showing also the various electrical connections that are available for the sensor.



4.1 THREAD ADAPTER NIPPLES

The following thread adapter nipples shall be ordered depending on the threaded hole on the machine support.

Nipple Ordering code	Thread	Reference picture
440315770	1/4" – 28 UNF	
440315760	M8 x 1.25	
440315750	M6 x 1	
440814330	M10 x 1.5	
440A008780	M10 x 1	
440A042669	M8 x 1	

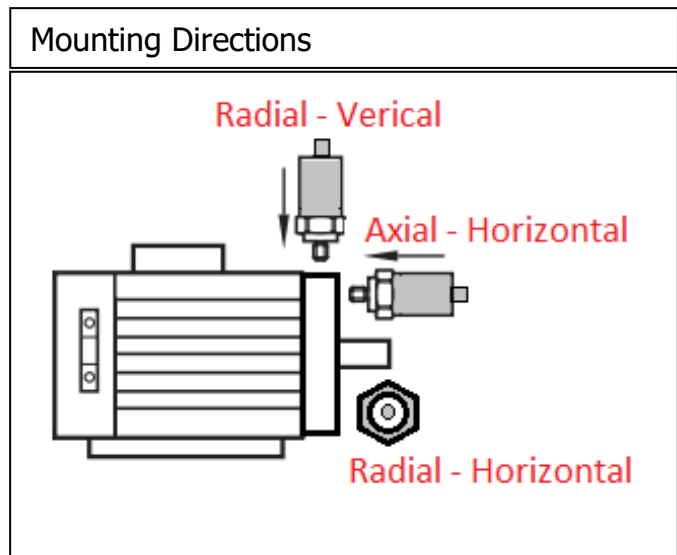
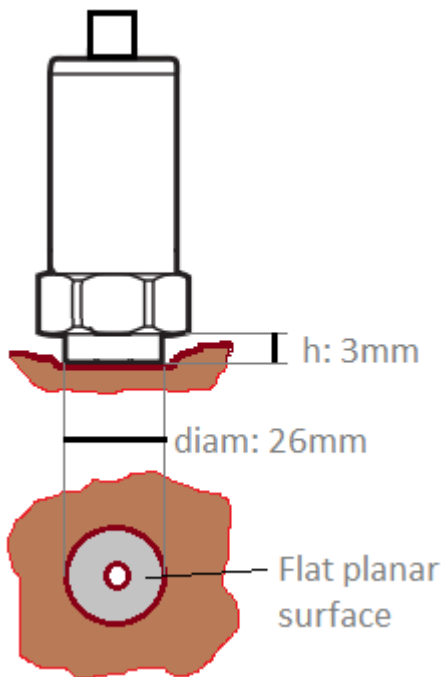
5 HOW TO INSTALL THE DEVICE

The device need to be screwed on the machine in the area where the vibration need to be measured; typically on the bearing support of the machine.

It can be mounted either vertically, horizontally (either radially or axially) or at any angular position on the support.

The vibration measured by the device is along the axial direction of the transmitter.

In order to grant the best coupling between the machine and the device, prepare a flat surface of at least 26mm diameter (max depth 3mm) around the screw hole as per picture below.

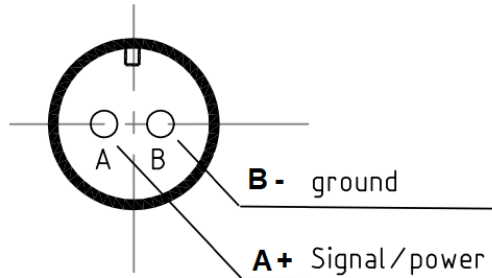


Use a Key 27 to screw the device with a coupling torque of approximately 7Nm.

6 ELECTRICAL CONNECTION

6.1 MIL-C 2 POLES CONNECTOR (B=0)

The picture below shows the pinout of the MIL-C connector onboard to TR-PRO (ordering version: **B** = 0).





If you purchase TR-PRO with B=0, in order to connect the device you have to separately purchase either:




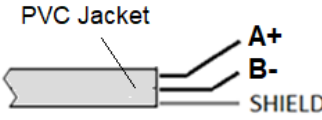
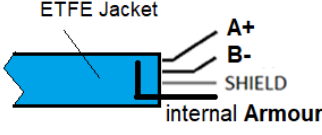
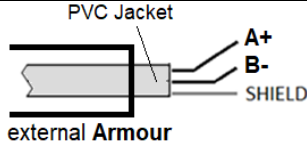
- the flying connector (to assemble any cable of your choice that fits your requirements),
or
- the cable with preassembled connector offered by CEMB as described below

6.1.1 Flying Connectors

Here below the flying connectors that can be purchased together with TR-PRO in situations where you need to assemble your own custom cable.

CEMB Code	Picture	Size	Direction	Cable OD
597023104		50mm +bending radius	straight	4 – 8 mm
597A23108		50 x 50mm	90°	4 – 8 mm

6.1.2 Cables with preassembled connector

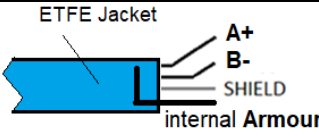
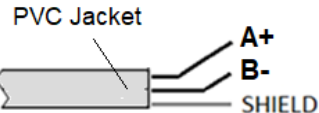
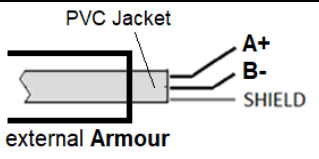
CEMB Code:	CBL/TRPRO/S/0/xx	CBL/TRPRO/E/0/xx	CBL/TRPRO/A/0/xx
Picture			
Cable type	Standard	ETFE	ARMOURED
Armoured	No	YES (internal)	YES (external)
Shielded	Yes	Yes	Yes
Connector type	2 Poles MilC Stright		
Length [m]	See ordering code xx (0 to 30)		
Pinout			
Jacket colour	PVC/Gray	ETFE/Blue	PVC/Gray
Wire Colours	A+: Brown B-: White	A+: Blue/white B-: White	A+: Brown B-: White
Out Diameter (OD) [mm]	5.7 (max 6.0)	4.7 (max 5.0)	Cable 5.7 (max 6.0) Armour 11.0
Wire section (mm ² /AWG)	1.00 / 17	0.37/22	1.00 / 17
Bending Radius	7x OD	7x OD	10x OD
Chemical resistance	Good	Excellent	Very good
UV Resistance	No	Yes	Yes (armour)
Operating Temperature	-20°C +80°C	-60°C +150°C	-20°C +80°C
Fire Retardant	Yes	Yes (Fire resistant)	Yes

Note: all the 3 types above are also available with execution with 90° connector with free angular position.

Just write **1** instead of **0** in the ordering code: e.g. CBL/TRPRO/S/**1**/xx

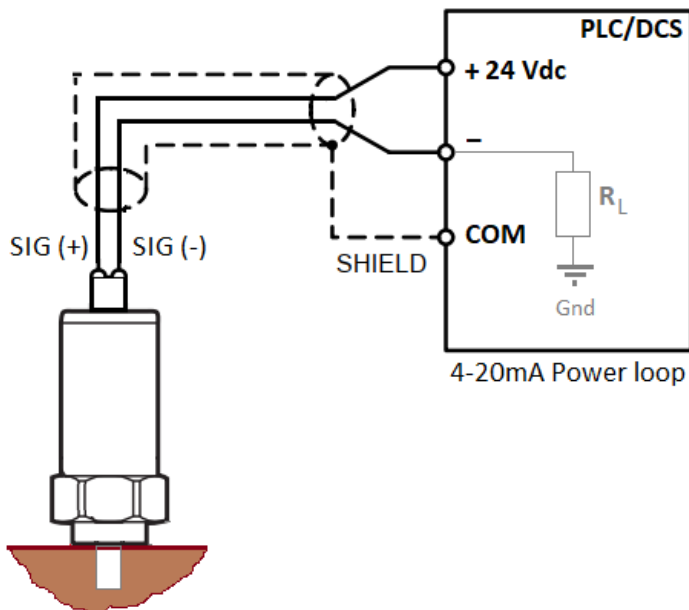
6.2 INTEGRAL CABLE (B = 1,2,3)

The table below shows the pinout and the main characteristics of the integral cables available for TR-PRO (ordering version: **B** = 1,2,3).

	B=1 ETFE	B=2 STANDARD	B=3 ARMOURED
Pinout			
Armoured	YES (internal)	No	YES (external)
Shielded	YES	YES	YES
Colours	A+: Blue/white B-: White	A+: Brown B-: White	A+: Brown B-: White
Jacket colour	ETFE/Blue	PVC/Gray	PVC/Gray
Out Diameter (OD) [mm]	4.7 (max 5.0)	5.7 (max 6.0)	Cable: 5.7 (max 6.0) Armour 11.0
Wire section (mm ² /AWG)	0.37/22	1.00 / 17	1.00 / 17
Bending Radius	10x OD	10x OD	10x OD
Chemical resistance	Excellent	Good	Very good
UV Resistance	Yes	No	Yes (armour)
Temperature limitation due to integral cable	No	Yes (-20°C +80°C)	Yes (-20°C +80°C)

6.3 WIRING DIAGRAM

The picture below shows the wiring diagram of the device with PLC/DCS



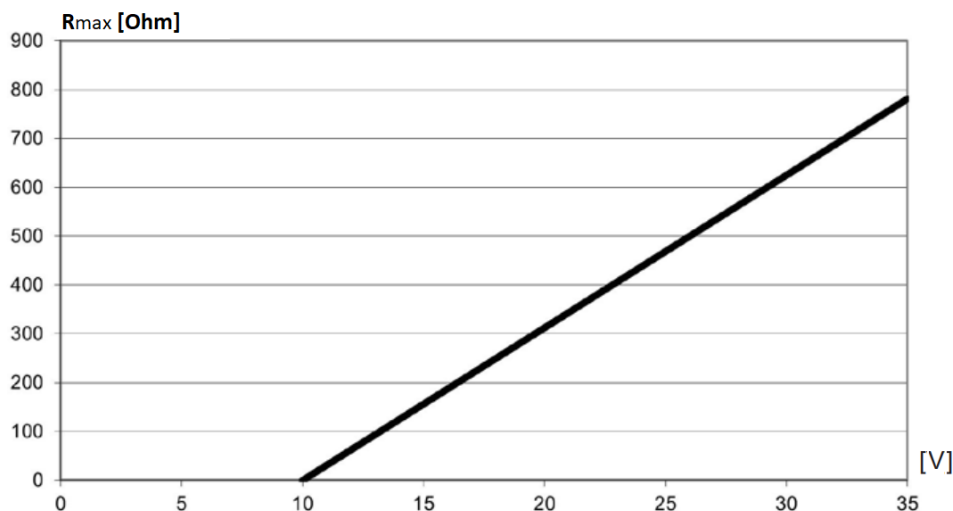
Note: the inversion of SIG (+) and (-), even if it does NOT causes permanent damages to the transmitter, still might have the following undesired side effects:

- increase the vibration reading (usually higher 4-20mA signal than real vibration);
- reduce EMI/EMC performance of the device causing EMI noise to disturb the measure;
- both of the above.

Make sure that the shield is not connected to the Sig(-) nor it is in contact with the body of the transmitter.

6.4 POWER SUPPLY

The nominal power supply of the transmitter is 24Vdc. Indeed the device can also operate in a wider range of power, from 10 to 35V while granting a max load on the current loop as per graphic below.



Please note that the Max Load R_{max} is the sum of R_L (internal measurement load of PLC) + C_L (Cable load).

Due to the relation $R_{max} = R_L + C_L$ the max length of the cable between the device and PLC can reach very high distances, mainly depending on the wiring section (the bigger the section the longer the distance) and R_L (internal measurement load of PLC).

6.5 GOOD PRACTICES FOR RELIABLE CONNECTION

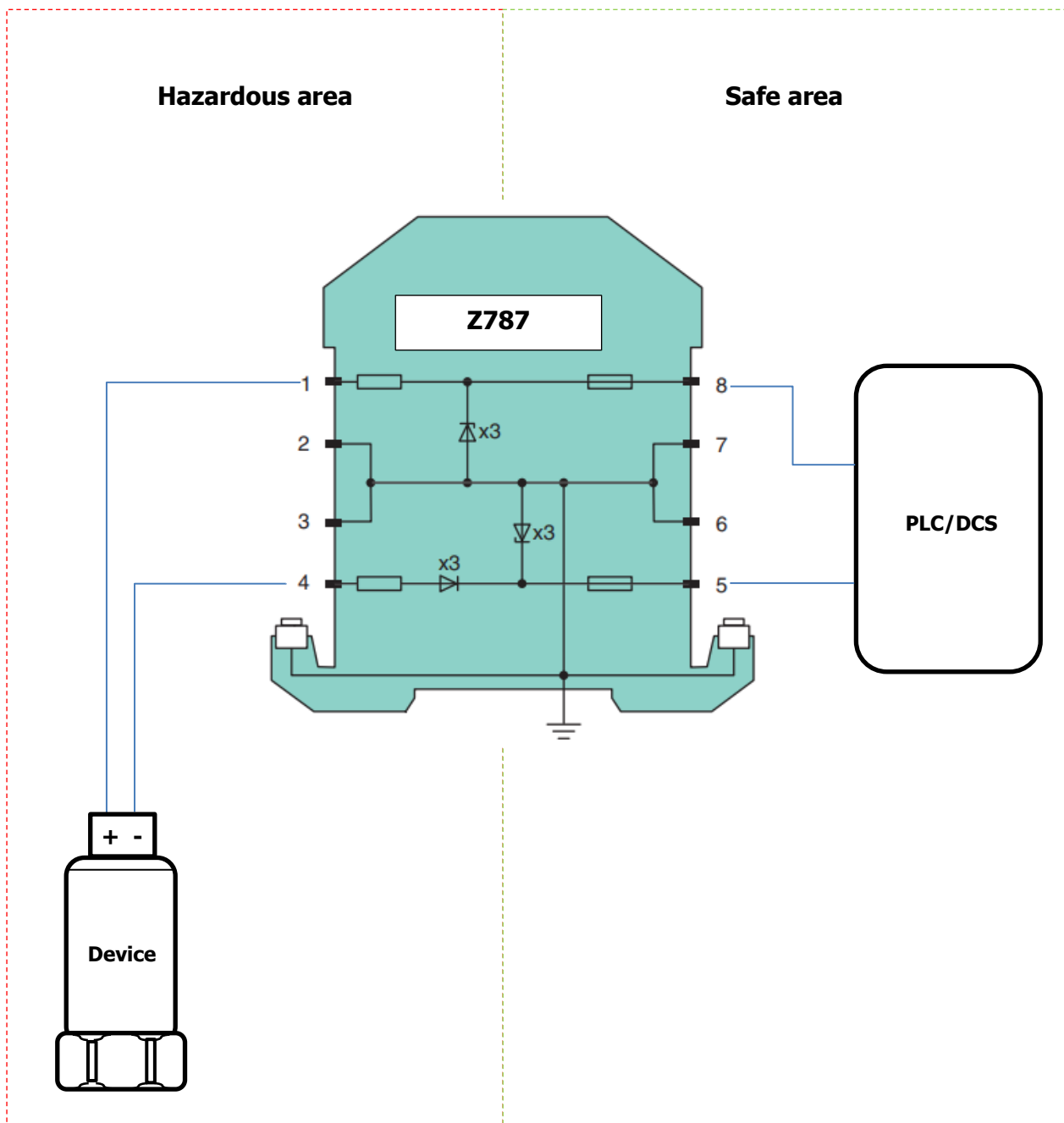
- Properly connect the shield as explain in chapter 6.4 .
- Make sure that, for very long distances, the cables are properly shielded, the shield is properly connected, and the cables does not cross nor share the same conduit of power lines.
- Make sure that the cables are lay-outed as far as possible from EMI/EMC noise sources, like power inverters or power switches.

6.6 WIRING DIAGRAM WITH ZENER BARRIER (FOR HAZARDOUS AREAS)

In case the device need to be installed in Hazardous areas according to EX-ia protection mode, a certified barrier to limit the current according to the limits described into the certification is required.

An example of the connection with the Zener barrier Z787 by P+F is described in the picture below as reference only.

Other barriers (e.g. Galvanic insulation barriers instead of Zener) or other barrier manufacturers might be selected too. In any case, the selection of the barrier is under the responsibility of the installer.



7 FUNCTIONAL SAFETY

The Vibration Transmitter, meets the requirements with regard to the following functions in accordance with IEC 61508.

- **Safety vibration measure:** **SIL2**

The safety function is to repeat current within $\pm 2\%$ and the logic solver will diagnose currents above 24mA and below 3 mA as faults and take appropriate action.

The failure modes shown above can then be defined as:

Failure mode	Category
Output current >24mA (upscale)	Dangerous detected, λ_{dd}
Output current <3 mA (downscale)	Dangerous detected, λ_{dd}
Output current within range but >2% in error	Dangerous undetected, λ_{du}
Output current correct within $\pm 2\%$	Safe undetected, λ_{su}

The hardware assessment shows that Vibration Transmitters:

- has a hardware fault tolerance of 0
- is classified as Type A devices ("non-complex" component with well-defined failure modes)
- there are no internal diagnostic elements of these products.

The Vibration Transmitter is suitable for the safety related use under continuous supervision of the user.

It fulfils the requirements of the basis of tests, see section 3, in particular the relevant requirements of EN ISO 61508.

Failure mode	Failure rate (FIT)
Output current >24mA (upscale)	35
Output current <3 mA (downscale)	25
Output current within range but >2% in error	83
Output current correct within $\pm 2\%$	18

(FITs means failures per 10⁹ hours or failures per thousand million hours).

8 TROUBLESHOOTING

This chapter describes actions to be taken in case of anomalous behavior or problem observation.

Item	Description of the observed problem	Actions to be taken
1	The output of the device is always at 0 mA	Verify the cable and the power supply from the PLC/DCS. Replace the cable
2	The output of the device is always at 4 mA	The machine is not vibrating. Shake manually the device along its axis to simulate the vibration and see if the current increases above 4 mA. Replace the device.
3	The device has occasional spikes that trip the machine	Verify that the device is strongly mechanically fixed on the machine and the thread is not loose; Verify that the device is mechanically installed in the proper way as described in Chapter 5. Verify the cable or connector is not deteriorated over time. Verify that the cable and the shield is properly connected and verify that the device is electrically installed in the proper way as described in Chapter 6. Verify that the Machine is properly working, and that there are no mechanical resonances or mechanical issues in the rotating elements. You can better analyze mechanical and vibrational behavior of your rotating machine by using portable vibration analyzer with FFT capability (e.g. CEMB N130). Replace the device.

9 MAINTENANCE, REPAIR, DISPOSAL

The device is maintenance free and does not require periodical calibration.

In case of malfunctioning it is not possible to repair the device.

Dispose the device in accordance with the national environmental regulation.