GEFRAN

PRESSURE SENSORS FOR HIGH TEMPERATURE IO-Link IMPACT

Cod. *80618D edit.* ***08/2024*** *- ENG*

INDEX

1. GENERAL INFORMATION

1.1. General information

This manual refers to the following products:

ILI and must be kept near the equipment for easy reading and consultation.

It must be read, understood, and strictly follow in order to avoid and prevent accidents and/or malfunctions.

Gefran will not be liable for any injury to people and/or damage to property deriving from disregard of this manual.

1.2. Copyright

1.3. Correct use

Gefran Melt pressure sensors are designed and built to measure the pressure and temperature variable of melted plastic at different temperatures according to the filling fluid used.

The correct temperature range is:

- Up to 350°C

If the sensors are used as a safety component in accordante with the Machinery Directive, the equipment builder must take all necessary precautions to ensure that any malfunctions of the Melt pressure sensor do not injury to people and/or damage to property.

Installation and maintenance must only be carried out by suitably skilled and qualified personnel.

2. MELT IO-LINK

2.1. Impact IO-link models

IMPACT "ILI" series of Gefran, are pressure transmitters, without transmission fluid, for using in High temperature process environment (up to 350°C). Pressure is transduced by a micro-worked silicon structure (MEMS) and the operating principle is "piezoresistive". **"IMPACT"** is Gefran's exclusive series of high-temperature pressure sensors that use the piezoresistive principle.

This new series "**ILI**" with **"IO-Link"** digital output is a Smart device specifically designed to meet the requirements of "**Industry 4.0**" environment, with auxiliary information suitable to prevent machine downtime.

The main characteristic of "**IMPACT**" sensors is that they do not contain any transmission fluid.

The sensitive element, directly positioned behind the contact membrane, is realised in silicon through microprocessing techniques.

The micro structure includes the measurement membrane and piezoresistors.

The minimum deflection required by the sensitive element makes it possible to use very robust mechanics.

The process contact membrane can be up to **15 times** thicker than the membrane used in traditional Melt sensors.

Supplied in 2 different configurations, rigid stem, and rigid + flexible and 4 mechanics, single and modular fixed and single and modular floating, the Melt sensors of GEFRAN are able to meet all installation requirements in the field.

The coverage relative to the pressures that can be detected by the sensor is almost total; we start from the probe with a minimum range of 0-10 bar to arrive at a version with a scale of 0-1000bar. All models in the catalogue can be supplied in two different accuracy classes; in particular class M, with accuracy 0.5%FS and class H, with 0.25%FS accuracy.

Thanks to **PLd** and **SIL2** approvals, this product is suitable for Functional Safety applications.

2.2. Transducer General Information

IO-Link transducer offers different options related to process data configuration and functional features (see datasheet for selection of ordering codes):

- Standard transducer with only IO-Link pressure data available
- T integrated transducer with IO-Link pressure + tip temperature measurement data available
- SIL 2 / PL d certified transducer with IO-Link output + Analog output (Voltage or Current output), available in standard and T integrated version
- SIL 2 / PL d certified transducer with IO-Link output + Relay output, available in standard and T integrated version

2.3. Models

DIGITAL IO-LINK OUTPUT

ILI0

ILI1

3. TECHNICAL DATA

MELT IMPACT PRESSURE TRANSDUCERS
ILI series

Table 1

Accuracy (1)	H <±0.25%FS (100...1000 bar) M <±0.5%FS (10...1000 bar)
Thermal drift in compesated range: Zero / Calibration / Sensibility	< 0.02% FS/°C
Measuring ranges	0…10 to 0…1200 bar 0…150 to 0...15000 psi
Maximum overpressure (without degrading performances)	1.5 x FS (up to 1200 bar/ 17400 psi max)
Measurement principle	Piezoresistive
Power supply	18...30 Vdc
Maximum current absorption	1W (1,2W with optional relay)
Zero offset	< ± 0.25% FS
Zero adjustment	“Autozero” function
Communication interface	IO-Link
Min Cycle time	2,7 ms (2 bytes PDI) 3,5 ms (4 bytes PDI)
IO-Link version	1.1
Transmission type	COM2 (38.4 kB)
Profile	Smart Sensor Generic Profile
SIO mode	Yes
Required class for Master port	A
Pressure process data resolution	14 bit
Temperature process data resolution	16 bit
Analog output resolution	16 bit
Rangeability	3:1 (Analog output option)
Calibration signal	80% FS
Reverse polarity protection on power supply	YES
Compensated temperature range (housing)	0...+85°C
Operating temperature range (housing)	-30...+85°C
Storage temperature range (housing)	-40...+125°C
Diaphragm maximum temperature	23…350 °C / 660 °F
Zero drift on process temp. 20 to 350°C	< ± 1.2%FS
Span drift on process temp. 20 to 350°C	< ± 1%FS
Integral temperature (optional)	Accuracy ± 2 °C
Standard material in contact with process medium	Diaphragm: • 15-5PH with GTP+ coating Stem: • 17-4 PH
Protection degree (5 pole female connector)	IP65 with suitable mating connector
Insulation resistance (at 50Vdc)	>1000 Mohm
Electromagnetic compatibility – Emission	EN 61326-1 EN 61326-2-3 EN61326-3-1
Electromagnetic compatibility – Immunity	EN 61326-1 EN 61326-2-3 EN61326-3-1
FS = Full scale output : (1) BFSL method (Best Fit Straight Line): includes combined effects of Non-Linearity, Hysteresis and Repeatability (according to IEC 62828-2).	
Sensors are manufactured in compliance with: - EMC compatibility directive - RoHS directive - Machinery directive Electrical installation requirements and Conformity certificate are available on our web site: www.gefran.com	

4. MECHANICAL DIMENSIONS

For the mechanical dimensions keep as reference the product datasheets or Gefran website www.gefran.com

5. INSTALLATION AND POSITIONING ON THE MACHINE

TECHNICAL DATA

Extrusion processes require very high temperatures. Extrusion pressure can be checked by means of especially designed transducers. The IMPACT series sensors are suitable for pressure measurements with high temperature and are based on the piezoresistive technology.

Following advice for extending the sensors lifetime:

a) Avoid shocks and abrasions to the in contact diaphragm. Protect the transducer with its cover each time you remove it from its seat.

b) The seat must be prepared perfectly and with appropriate tools in order to respect the depth and axiality of the holes and tapping. Pay particular attention to the coaxiality of the holes to the thread, because diaxialities greater than 0.2 mm will break the transducer during assembly. It is essential that hole depth guarantee the absence of chambers or air pockets in which extrusion material may be trapped. To prevent contact with the extrusion screw or with tools used to clean the extrusion chamber, the front diaphragm must not extend from the inner wall of the extruder.

c) Before assembling the transducer in machines already in operation, make sure that the housing is clean. Remove any residual with the suitable cleaning device.

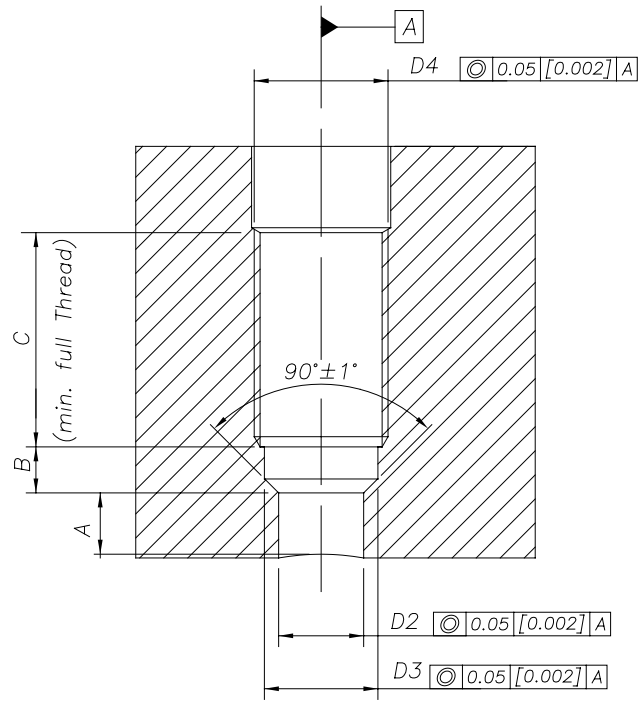
d) The transducer should be removed only with the machine empty (without pressure) but still hot.

e) The transducer should be cleaned with solvents for the material being processed.

Any mechanical action on the contact diaphragm modifies its operation and could break it.

5.1. Installation seat

The installation seat has to be realized:



D1	1/2-20UNF	M18x1.5
D2	.313 ±.001” [7.95 ±0.02mm]	.398 ±.001” [10.10 ±0.02mm]
D3	.454 ±.004” [11.53 ±0.1mm]	.634 ±.004” [16.10 ±0.1mm]
D4	.515” [13mm] minimum	.790” [20mm] minimum
A	.225” [5.72mm] minimum	.240” [6.10mm] minimum
B	.17” [4.3mm] maximum	.16” [4.0mm] maximum
C	.75” [19mm]	.99” [25mm]

Incorrect working or shape of the side can result in properties out of specification, bad behaviour or damage to the sensor.

The side should be clean and without any polymer residual.

Drilling kit

A drilling kit with formed tools for drilling, reaming and tapping is available to facilitate correct preparation of the assembly seat. The assembly seat must be perfect to assure proper transducer function and long lifetime. Drilling kits are available in the following versions: **KF12, KF18**.

Drilling procedure

1) To drill hole (D4) up to a distance from the hole equal to the sum of (A+B+C) (tool 3).
2) Make the pass through hole (D2) by the tool 1.
3) To create the seal seat at a distance from the hole equal to dimension (A) (tool 4).
4) With a roughing tap, create threading 1/2-20UNF-2B (recognizable from the greater number of threads beveled at the mouth) (tool 5).
5) With a finishing tap, go over threading 1/2-20UNF-2B up to a distance from the bottom equal to the sum of (A+B) (tool 6).
6) To ream the hole (D2) with reamer (tool 2).

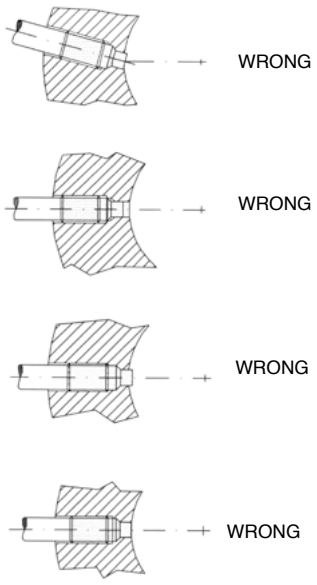
Installation seat check

The dimensions of the assembly seat have to be checked after preparation and before the transducer installation.
Use dummy plug SC 12/18 as follows:
1) Coat the end of the rod with the appropriate ink.
2) Lubricate the threaded part to prevent friction.
3) Insert the dummy plug and screw it fully down.
4) Remove the rod and examine it.
With the exception of 45° surfaces, the ink should be intact on the entire surface.

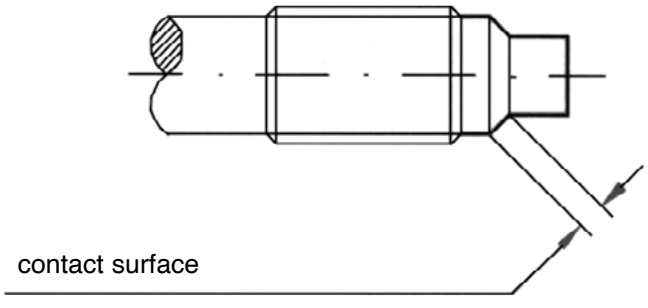
5.2. Drilling tool kit

VERSION CODE		KF12	KF18
THREADING TYPE		1/2-20UNF-2B	M18x1.5
1		Ø 7.6	Ø 9.75
2		Ø 7.95	Ø 10.1
3		Ø 13	Ø 20
4		Ø 11.5 with pilot guide	Ø 16 with pilot guide
5		1/2-20UNF-2B roughing	M18x1.5 roughing
6		1/2-20UNF-2B finishing	M18x1.5 finishing

CORRECT INSTALLATION



CORRECT SEAL



Transducer installation

Installation procedure

1) Make sure the drilling procedure has been realized correctly. If the sensor is installed in a previously used hole, make sure the hole is completely clean and free of any plastic residual.
2) Remove the protective cap from the sensor top.
3) Lubrificate the thread with non-grip grease such as Neverseez (Bostik), or C5A (Felpro), or equivalent.
4) Insert firmly the sensor into the hole, first by hand and then with a wrench, 1/4 turn at a time.

Recommended torque: 40 Nm.

NOTE: Please pay particular attention to the sensor installation when it's provided in its fixed mechanis configuration.
In this case, during the clamping phase any misalignment. Has tube avoided, otherwise a possible interference of the sensor mechanical coupling can occur.

Calibration procedure (Analog output option)

Bring the system to work temperature with the transducer installed and connected to the measurement instrument without any pressure applied.

The measurement chain connected to the transducer is calibrated as follows:

1) Reset the indication on the instrument to reset the temperature variation zero shift. Use the Autozero function to run the reset (see par. 7).
   a) For correct zero resetting, run Autozero only after work temperature has been completely reached.
2) Calibrate the instrument and have it display the calibration value (80% of full scale) (see par. 7).
3) If the instrument does not exactly indicate zero, repeat points 1 and 2. In this way, the instrument is calibrated to give the exact indication in the chosen engineering unit.

Calibration procedure (IO-Link output)

Bring the system to work temperature with the transducer installed and connected to the measurement instrument without any pressure applied.

The measurement chain connected to the transducer is calibrated as follows:

1) Use the Autozero function to run the reset (see par. 7) ; run Autozero only after work temperature has been completely reached.
2) Calibrate the instrument and have it display the calibration value (80% of full scale). (see par. 7)
3) If the instrument does not exactly indicate zero, repeat points 1 and 2. In this way, the instrument is calibrated to give the exact indication in the chosen engineering unit.

Removal (Figure 1)
To remove the transducer from its seat and carry on the working process, dummy plugs with identical mechanical dimensions are available.
The dummy plugs differ by type of threading; max pressure range is 2000 bar for all rods.
The dummy plugs are available in the following versions: **SC12** 1/2-20UNF seat - **SC18** M18x1,5 seat

Brackets (Figure 2)
Models with flexible sheaths require the housing precise fixing. Suitable fastening brackets (SF18) are recommended.
Remember that the fastening point must be vibration-free (vibrations affect the measurement) and that temperatures must not exceed the maximum temperature range for the strain gauge housing (as stated on the sensor technical sheet).

Extruder starting
Bring the system to working temperature with the transducer installed and without any pressure applied.
Wait until all the material is at the same temperature to prevent the transducer damage by semi-solid material.

Seat cleaning & Cleaning tool
As mentioned in the notes, the seat must be cleaned before the transducer installation.
The cleaning tool is a hard metal cutting tool specially designed to remove working materials residuals.

Recommended procedure (Figure 3)
The following procedure must be implemented with the material in a fluid condition.

1) Insert the tool in the seat and screw down the cutting rod (normally a 1/4 turn at a time).
2) Turn the pilot cutter clockwise until there is no resistance to cutting.
3) Repeat the procedure until the seat is completely clean.

For constructive reasons, the maximum torque applicable to the cutter is 15 Nm (1.5 Kgm).
If the hole occlusion requires higher torque for removal, use the drilling kit and follow the recommended procedure.
The cleaning tool is available in the following versions: **CT12** 1/2-20UNF seat - **CT18** M18x1,5 seat.

Figure 1

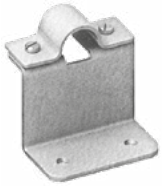


Figure 2

Figure 3

Order codes for tools and accessories

MOUNTING BRACKET	SF 18

CLEANING TOOL KIT	CT
1/2-20UNF	12
M18x1,5	18

DUMMY PLUG	SC
1/2-20UNF	12
M18x1,5	18

DRILL KIT	KF
1/2-20UNF	12
M18x1,5	18

5.3. Torquing the sensor

Screw the sensor after checking the correct shape of the side.
Hold the flexible part while screwing the jam bushing.

For safety operations at least 6 pitch of the jam bushing must be screwed into the hole.

The torque must be 40 Nm.

5.4. Connecting amplifier (only for modular versions)

The electronics must be connected to the primary part by aligning the 2 red points on each connector.
Take care not to force the connectors together: check the correct aligning of the 2 red points.

Screw the sensor after checking the correct shape of the side.
Hold the flexible part while screwing the jam bushing.
flexible sheath to the machine. Take care not to fix the sheath to parts heated at over than 220°C.

Screw the electrical cable connector to the electronics and switch on the sensor.
Wait 60 seconds before starting to operate the transducer.

To disconnect the electronics from the primary sensor, take care to handle the two connectors next to the red points and not to force the disconnection.

Remark:
In modular versions the decoupling between the electronics and the primary element is not allowed.

6. INSTALLATION AND ELECTRICAL CONNECTIONS

6.1. General precautions

The system must be used only in accordante with the required protection level.

The sensor must be protected against accidental knocks and used in accordante with the instrument's ambient characteristics and performance levels.

The sensors must be powered with non-distributed networks and always at lengths of less than 30 mt.

*In case of safety applications see further limitations in par. 9.

6.2. Electrical installation

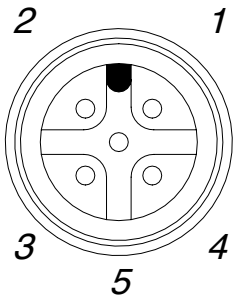
The transducer must be grounded (normally through the machine body or equipment it is installed on).

To prevent interference, separate the power cables from signal cables

The IL transducer has a male M12 5 pole connector for power supply and output signal. According to the ordering code these are the different connection configurations available, where:

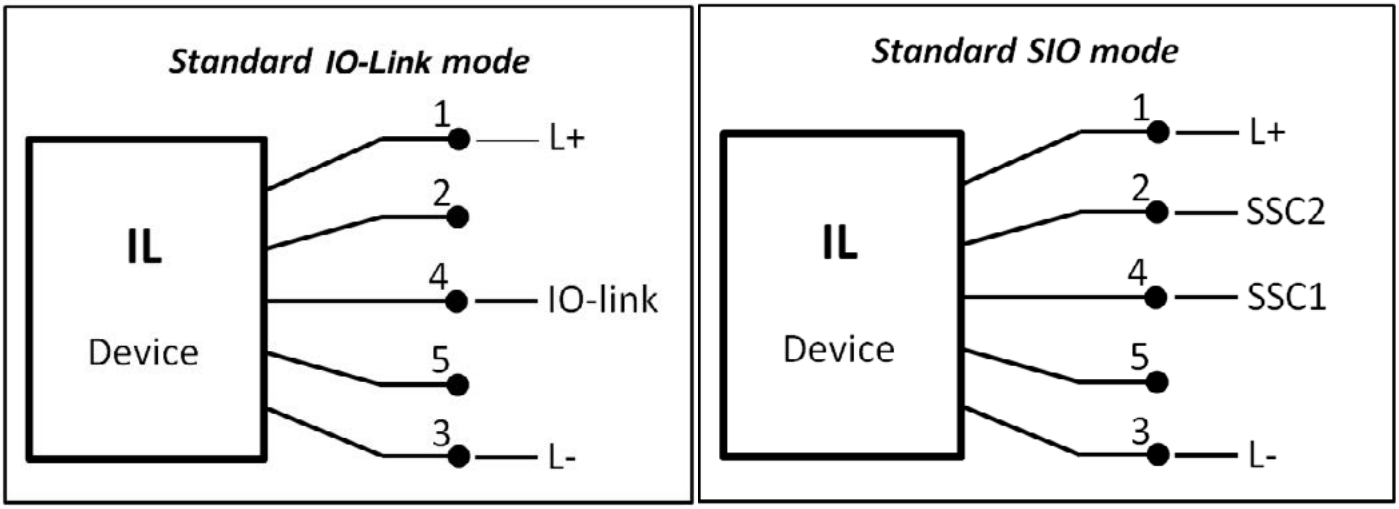
- L+ = Power supply + (nominal 24 Vdc)
- L- = Power supply - (0 Vdc)
- IO-Link = Digital communication pin
- SSC1/2 = Switching signal channel 1 and 2 (output current limit = 200mA), active only in SIO mode
- An Out = SIL 2 / PL d Analog output voltage or current (reference is L-)
- Relay contact 1/2 = SIL 2 / PL d Relay contact

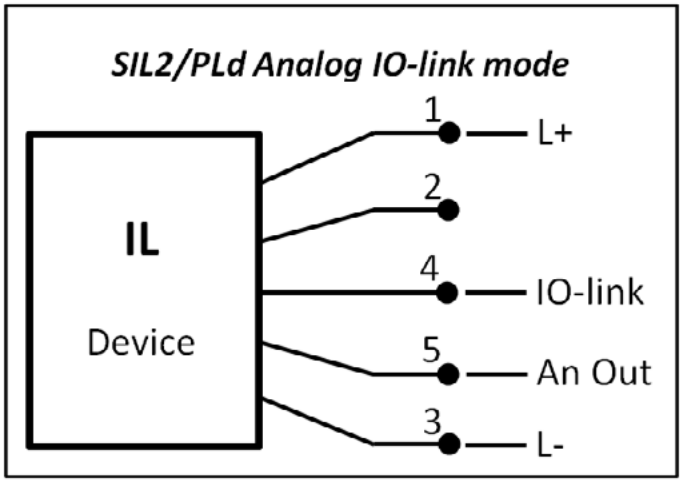
5 pin M12x1 connector

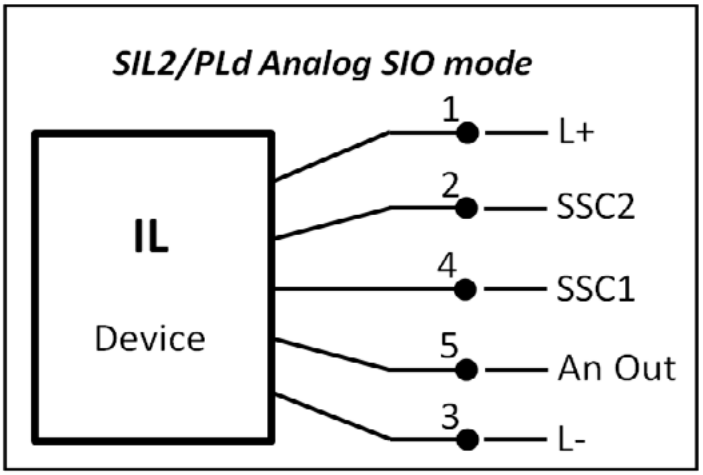


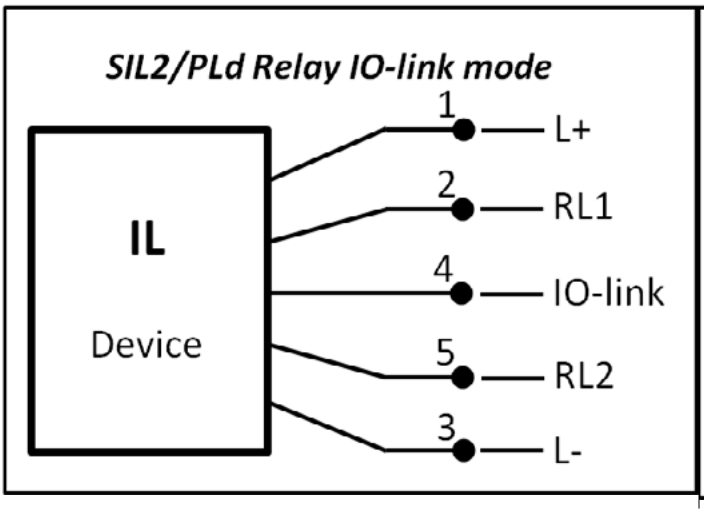
M12x1 5 pin Connector	IO-LINK Output	Relay Output Option	Analogue Output Option
1	V+	V+	V+
2	DO (*)	Relay Contact 1	DO (*)
3	V-	V-	V-
4	IO-LINK	IO-LINK	IO-LINK
5	N.C.	Relay Contact 2	Analogue Output

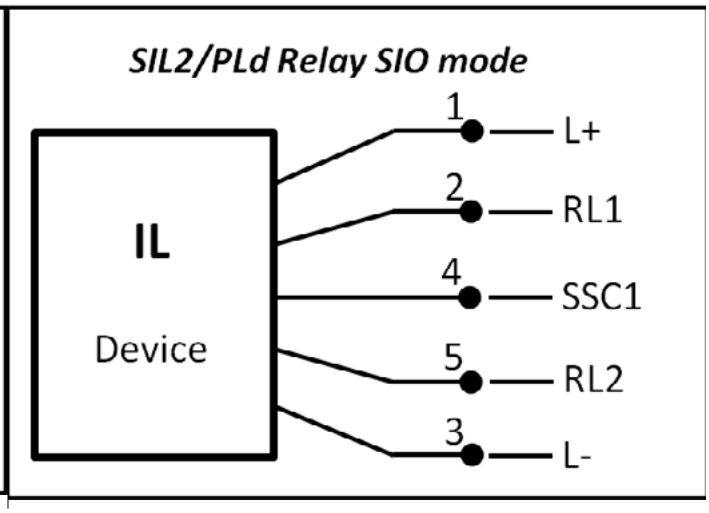
(*) DO = digital output only active in SIO mode





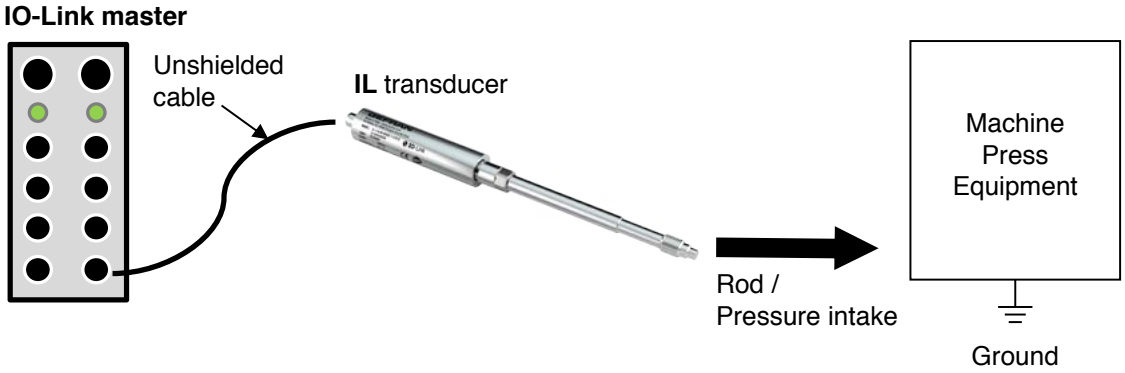






Notes:

- For IO-Link only version connect the transducer to a standard IO-Link master through a standard unshielded M12 cable (max length 20m according to IO-Link specification)

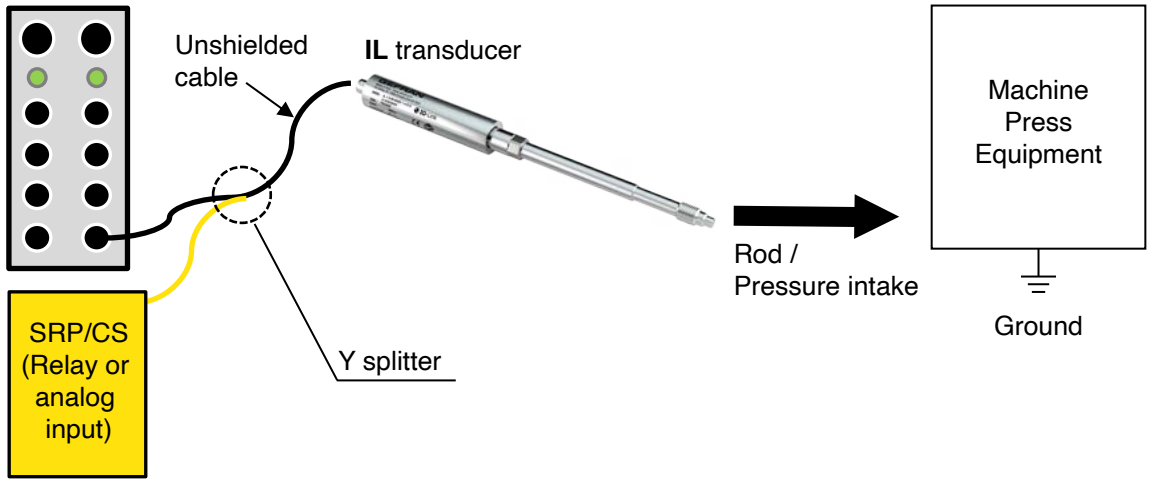


- For SIL 2 / PL d versions a splitting of signals is needed in order to connect:
  - L+, L- and IO-Link to standard IO-Link master
  - Safety signal: Analog out and reference (L-) or RL1/2 to a SRP/CS*

Please see below a couple of possible configurations:

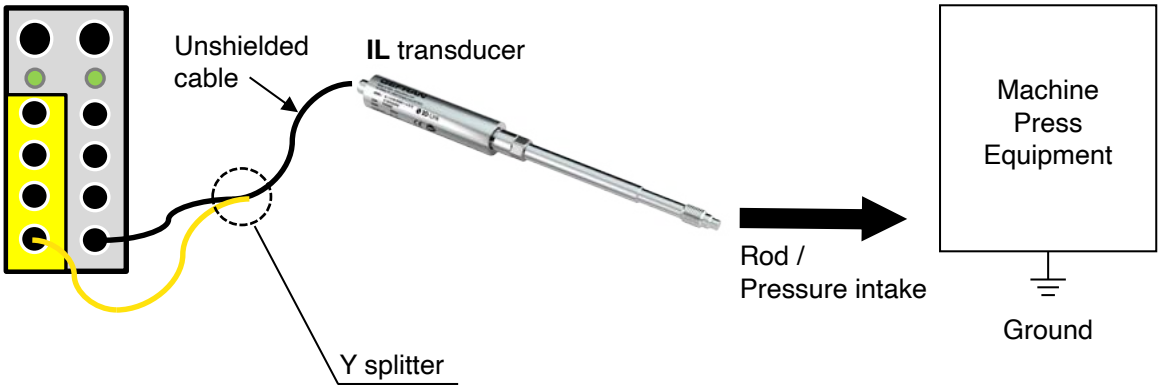
Conf 1

IO-Link standard master



Conf 2

IO-Link hybrid master, acts as SRP/CS (IO-link master + Safety input, Relay only)



*Y splitter is available on catalog in order to separate standard signal from safety signals.

6.3. Standard reference

Gefran products, described in this manual, are compliant to the European Directive 2014/30/EU.

They are tested according to the standard EN 61326-1 “Electrical equipment for measurement, control and laboratory use - EMC requirements”, Part 1 “general requirements and EN 61326-2-3 “Electrical equipment for measurement, control and laboratory use - EMC requirements”, Part 2-3: Particular requirements - Test configuration, operational conditions and performance criteria for transducers with integrated or remote signal conditioning.

Note

In accordance with IEC/EN 62061, IEC/EN 61508 and ISO/EN 13849, ILI series transducers also comply with EN 61326-3-1 “Electrical equipment for measurement, control, and laboratory use - immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) - General industrial applications”.

6.4. EMC and RoHS Requisites

Gefran Melt transducers and transmitters are built in conformity with the following EMC directives: EMC 2014/30/EU and RoHS 2011/65/EU

7. COMMAND MODES

7.1. IO-Link Information

Table 2 *IO-Link information*

Port Class	A
Baud rate	COM2 (38.4 kB)
IO-Link version (1)	1.1
Profile	Generic Smart Sensor
Process data input length	2 Bytes (Pressure + SSCs) : mapping A (*) 4 Bytes (Pressure + SSCs) : mapping C (*) 4 Bytes (Temperature + Pressure + SSCs) : mapping B and D (*)
Process output data length	0
Min Cycle Time	2,7 ms: mapping A (*) 3,5 ms: mapping B, C, D (*)
SIO mode	Supported
ISDU	Supported
Data storage	Supported

Compliant to IO-Link interface specification v1.1.2 (Jul13)

(*) see par. 7.3

7.2. SIO mode and IO-Link mode

The IL transducer supports both SIO mode and IO-Link mode:

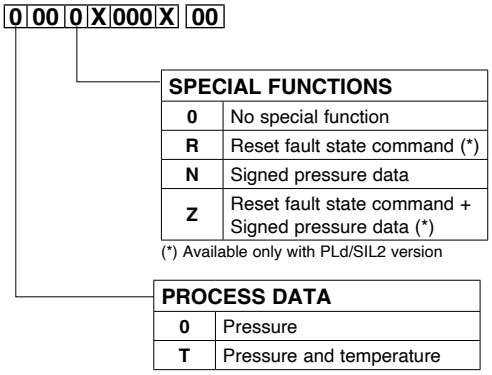
- In SIO mode the transducer behaves like a digital sensor: on pin 4 and 2 of M12 connector two digital thresholds are available and programmable (replicating the same behavior configured for SSCs, see par. 7.6)
- In IO-Link mode the transducer communicates with a standard IO-Link master on pin 4 of M12 connector

7.3. Process Data mapping (IO-Link)

The IL transducer offers different Input Data mappings, according to the following variables selected in the ordering code.

- Transmitted sensor data: only Pressure (0) or Pressure and Temperature (T)
- Special function available: no special function (0), Reset fault state command (R), Signed pressure data (N), Reset fault state command and Signed pressure data (Z)

These variables can be found inside the ordering code as shown below.



The four available mappings are the following:

- **Mapping A**: Pressure version (0), special functions 0 or R

15..2	1	0
Pressure	SSC2	SSC1

- **Mapping B**: Pressure + Temperature version (T), special functions 0 or R

31..16	15..2	1	0
Temperature	Pressure	SSC2	SSC1

- **Mapping C**: Pressure version (0), special functions N or Z

31..16	15..2	1	0
Pressure	All 0s	SSC2	SSC1

• **Mapping D**: Pressure + Temperature version (T), special functions N or Z

31..16	15..2	1	0
Pressure	Temperature	SSC2	SSC1

Where:

- Temperature is the value of temperature taken at the tip of transducer (behind the membrane), given with 0,5°C resolution.
- Pressure is the value of pressure given in the unit selected according to ordering code and decimal digits according to the following table:

Measuring range [bar]	Decimal Digits
17<= bar <=100	2
100< bar <=1000	1

Measuring range [psi]	Decimal Digits
250<= psi <=1450	1
1450 < psi <=15000	0

- SSC1: switching signal 1 is a on/off bit changing its value according to the overtaking of a pressure threshold that can be programmed by the user; several configurations are available (see par.7.6)
- SSC2: switching signal 2 is a on/off bit changing its value according to the overtaking of a pressure threshold that can be programmed by the user; several configurations are available (see par.7.6)

7.4. Parameterization data

Parameterization data

This paragraph includes list and explanation of relevant available parameters for IL transducer, listed according to IO-Link specification

- ***Predefined parameters - System***

Index	Subindex	Object name	Access			Length	Data Type	Value (example)	Description
			U	M	S				
0x0002	0x00	System Command	W	W	W	1	Uint8	See Table 3	

U=User, M=Maintenance, S=Specialist

Table 3 *System command values-*

Value	Access			Command	Data Type	Description
	U	M	S			
0x01	W	W	W	ParamUploadStart	Uint8	
0x02	W	W	W	ParamUploadEnd	Uint8	
0x03	W	W	W	ParamDownloadStart	Uint8	
0x04	W	W	W	ParamDownloadEnd	Uint8	
0x05	W	W	W	ParamDownloadStore	Uint8	
0x06	W	W	W	ParamBreak	Uint8	
0x41	-	W	W	TeachSP1	Uint8	It allows to teach “Setpoint 1” (SP1) for the selected Switching Signal Channel(s). SP1 is defined by one “TeachPoint” (“Single value teach-in” mode)
0x42	-	W	W	TeachSP2	Uint8	It allows to teach “Setpoint 2” (SP2) for the selected Switching Signal Channel(s). SP2 is defined by one “TeachPoint” (“Single value teach-in” mode)
0x82	-	W	W	RestoreFactorySettings	Uint8	Recall the settings stored during factory calibration
0xA0	-	W	W	Autozero	Uint8	Set to zero the offset of transducer (see limits in Table 4)
0xA1	-	W	W	ResetAutozero	Uint8	Reset the Autozero effect command
0xA2	-	W	W	RelayThresholdConfirmation*	Uint8	Confirm the change of value of the Relay Threshold
0xA4	-	W	W	ResetPressureMaxValue	Uint8	Reset the Peak of pressure measured from last power on
0xA6	-	W	W	ResetPressurePeaksCounter	Uint8	Reset the Counter of peaks of pressure (stored in EEprom)
0xA7	-	W	W	ResetTemperatureMaxValue***	Uint8	Reset the Peak of temperature measured from last power on
0xA9	-	W	W	ResetTemperaturePeaksCounter***	Uint8	Reset the Counter of peaks of temperature (stored in EEprom)
0xAA	-	W	W	ResetOperatingTimeCounters	Uint8	Reset the Time counter and Time in pressure counter
0xC8	-	W	W	ResetFaultState****	Uint8	Try to reset the fault State. If there is actually no active error the device will resume its normal operation state.

U=User, M=Maintenance, S=Specialist, - : command not available

*Available only in SIL 2 / PL d Relay output version

** Available only in SIL 2 / PL d Analog output version

*** Available only in T integrated version

**** Available only in SIL 2 / PL d

Table 4 *Autozero command application limits-*

Transducer FS	Percentage limit for autozero application [%FS]
FS ≤ 35 bar (500psi)	100%
36 bar ≤ FS ≤ 199 bar (3000psi)	40%
200 bar ≤ FS ≤ 349 bar (5000psi)	20%
FS ≥ 350 bar	10%

According to the different FS, the Autozero command can be applied only if the offset is within the percentage allowed by Table 4.

- ***Predefined parameters – Identification***

Index	Sub Index	Object name	Access			Length	Data Type	Value (example)	Description
			U	M	S				
0x0010	0x00	VendorName	RO	RO	RO	10	String	GEFRAN spa	
0x0011	0x00	VendorText	RO	RO	RO	14	String	www.gefran.com	
0x0012	0x00	ProductName	RO	RO	RO	Max 64	String	ILI1-S-5-M-B07C-1-4-D-P T000A000X00	Full description of product
0x0013	0x00	ProductID	RO	RO	RO	7	String	F080186	Model (F code)
0x0014	0x00	ProductText	RO	RO	RO	Max 64	String	IMPACT Melt Sensor	User friendly description according to model: Nak Melt Sensor or Mercury Melt Sensor or Oil Melt Sensor or IMPACT Melt Sensor
0x0015	0x00	SerialNumber	RO	RO	RO	8	String	19400102	Unique serial number for product
0x0016	0x00	HardwareRevision	RO	RO	RO	3	String	1.0	
0x0017	0x00	FirmwareRevision	RO	RO	RO	3	String	1.1	(0, R)
						5		1.1.A	(N, Z)
0x0018	0x00	ApplicationSpecificTag	RO	R/W	R/W	Min16 Max32	String	*** (Default)	User specifies a tag which defines functionality, position of the transducer in the system
0x0019	0x00	FunctionTag	RO	R/W	R/W	Min16 Max32	String	Empty (Default)	User specifies a tag which defines functionality, position of the transducer in the system
0x001A	0x00	LocationTag	RO	R/W	R/W	Min16 Max32	String	Empty (Default)	User specifies a tag which defines functionality, position of the transducer in the system

U=User, M=Maintenance, S=Specialist

- ***Predefined parameters – Diagnosis***

Index	Sub Index	Object name	Access			Length	Data Type	Value (example)	Description
			U	M	S				
0x0020	0x00	ErrorCount	RO	RO	RO	2	Uint16	0	Incremental counter of errors since power-on
0x0024	0x00	DeviceStatus	RO	RO	RO	1	Uint8	See Table 5	Defines the status of Device
0x0025	0x01 0x02 0x03 0x04	DetailedDeviceStatus	RO	RO	RO	Variable	(Array of 3 bytes Record)	See Table 6	Specifies detailed status of the Device Octet 1=EventQualifier Octet 2,3=EventCode
0x0028	0x00	ProcessDataInput	RO	RO	RO	PD length	PD	0	Read last valid Process Data from PDin channel

Table 5 *Device Status Values*

Value	Description
0	Device is operating properly (no errors/warnings)
1	Maintenance required
2	Out of specification
3	Functional check
4	Failure

Table 6 *Error and Warnings in Detailed Device Status*

Event Code	Event Type	Device Status	Possible failure	Output behavior			Reset Mode	Note
				IO-Link Pressure value	Relay	Analog		
Functional Safety Related								
-	-	-	Power supply cable broken	-	Open	LOW	Remove failure	Valid for SIL 2 / PL d Diagnostic
-	-	-	Device not connected	-	Open	LOW	Remove failure	Valid for SIL 2 / PL d Diagnostic
-	-	-	Broken Power supply	-	Open	LOW	Remove failure	Valid for SIL 2 / PL d Diagnostic
0x5000	Error	Failure	Broken primary element or not connected primary element	16000	Open	HIGH	Send device to factory for repair	
0x8C10	Warning	Out of Specification	Pressure above 150% of Span respect to factory zero at room temperature	16000	Open	HIGH	Switch off and on; if error persists send to factory for repair	
0x8C30	Warning	Out of Specification	Pressure below -50% of Span respect to factory zero at room temperature	16000	Open	HIGH	Switch off and on; if error persists send to factory for repair	
0x5100	Error	Failure	Overvoltage	16000	Open	LOW	Switch off and on; if error persists send to factory for repair	
0x5100	Error	Failure	Undervoltage	16000	Open	LOW	Switch off and on; if error persists send to factory for repair	
0x5100	Error	Out of specification	Voltage variations	16000	Open	LOW	Switch off and on; if error persists send to factory for repair	
0x8CA0	Error	Failure	Error in program sequence	16000	Open	LOW	Switch off and on; if error persists send to factory for repair	
0x4210	Error	Out of specification	Electronics overtem-perature	16000	Open	LOW	Switch off and on (leave temperature cool down); if error persists send to factory for repair	
0x8C00	Error	Failure	Error in input stage	16000	Open	LOW	Switch off and on; if error persists send to factory for repair	Only for SIL 2 / PL d certified transducer
0x8CA5	Error	Failure	Error in RAM Memory	16000	Open	LOW	Switch off and on; if error persists send to factory for repair	Only for SIL 2 / PL d certified transducer
0x8CA6	Error	Failure	Error in ROM Memory	16000	Open	LOW	Switch off and on; if error persists send to factory for repair	Only for SIL2/ PLd certified transducer
0x8CA7	Error	Failure	Error in CPU	16000	Open	LOW	Switch off and on; if error persists send to factory for repair	Only for SIL 2 / PL d certified transducer
0x18A4	Error	Failure	The Relay did not open/close when required	16000	-	-	Switch off and on; if error persists send to factory for repair	Only for SIL 2 / PL d Relay version
Not Functional Safety Related								
0x8CA1	Warning	Maintenance required	Zero drift excessive	-	-	-	Send device to factory for maintenance	
0x8CA2	Warning	Out of specification	Process temperature over limit allowed	-	-	-	Switch off and on (leave temperature cool down); if error persists send to factory for repair	
0x8CA3	Warning	Out of specification	Process temperature below -30°C	-	-	-	Switch off and on (leave temperature increase); if error persists send to factory for repair	
0x8CA4	Error	Failure	Process temperature sensor broken	Temperature = 10000	-	-	Send device to factory for repair	(0, R)
				Temperature = 8000	-	-		(N, Z)

Table 7 *Other Events*

Event Code	Event Type	Device Status	Description	Note
0x8DFD	Error	Failure	Test event type “Error”	
0x8DFE	Warning	OK	Test event type “Warning”	
0x8DFF	Notification	OK	Test event type “Notification”	
0x189C	Notification	OK	event for Autozero command successfully completed	
0x189D	Notification	OK	event for Autozero command failed due to value (autozero) out of range	
0x189E	Notification	OK	event for Autozero command failed due to function temporarily not available	
0x189F	Notification	OK	event for Autozero command reset	
0x18A0	Warning	OK	event for Relay opened	

Event Code	Event Type	Device Status	Description	Note
0x18A1	Notification	OK	event for Relay Threshold Changed, required confirmation*	
0x18A2	Notification	OK	event for Relay Threshold Changed, value confirmed	
0x18A3	Notification	OK	event for Relay Threshold Changed, abort	

*In case of Block Parameterization (not Write Direct) this event happens each time one of any parameter is written; this behavior is required for IO-Link certification test; do not care.

Table 8 *Error codes*

Error Code	Description
0x8000	Device application error – no details
0x8011	Index not available
0x8012	Subindex not available
0x8022	Service not available – Device control
0x8023	Access denied
0x8030	Parameter value out of range
0x8031	Parameter value above limit
0x8032	Parameter value below limit
0x8033	Parameter length overrun
0x8034	Parameter length underrun
0x8035	Function not available
0x8036	Function temporarily unavailable
0x8040	Invalid parameter set
0x8041	Inconsistent parameter set

- **Predefined parameters – Profile specific parameters**

Index	Sub Index	Object Name	Access			Length	Data Type	VALUE (example)	Value Range	Gradient	Offset	Unit	Description
			U	M	S								
0x003A	0x00	TeachIn Channel	-	R/W	R/W	1	UInt8	0x00: SSC1 (default) 0x01: SSC1 0x02: SSC2	0…2	-	-	-	Defines the channel to which address teach-in
0x003B	0x00	TeachIn Result	-	RO	RO	1	Boolean	0: not OK 1...255: OK	0...255				Show the result of teach-in procedure
	0x01	State	-	RO	RO	4 bit	UInt4	0 See Table 9	0…15	-	-	-	
	0x02	FlagSP1TP1	-	RO	RO	1 bit	Boolean	0: SP1TP1 not taught 1...255: SP1TP1 taught	0...255	-	-	-	
	0x03	FlagSP1TP2	-	RO	RO	1 bit	Boolean	0: SP1TP2 not taught 1...255: SP1TP2 taught	0...255	-	-	-	
	0x04	FlagSP2TP1	-	RO	RO	1 bit	Boolean	0: SP2TP1 not taught 1...255: SP2TP1 taught	0...255	-	-	-	
	0x05	FlagSP2TP2	-	RO	RO	1 bit	Boolean	0: SP2TP2 not taught 1...255: SP2TP2 taught	0...255	-	-	-	
0x003C	0x00	SSC1Param	RO	R/W	R/W	4	Record						Defines the Switch-points for Channel 1 (see par. 7.6)
	0x01	SP1	RO	R/W	R/W	2	(0, R): Uint16 (N, Z): Int16	FS	(0, R): min 0... max FS (N, Z): min: -1bar or equivalent max: FS	According to MU See Table 10	0	MU	From Specification: SP1=SP “High” SP2=SP “Low”
	0x02	SP2	RO	R/W	R/W	2	(0, R): Uint16 (N, Z): Int16	0	(0, R): min 0... max FS (N, Z): min: -1bar or equivalent max: FS	According to MU See Table 10	0	MU	
0x003D	0x00	SSC1Config	RO	R/W	R/W	4	Record						Defines the config-uration of Channel 1 (see par. 7.6)
	0x01	Logic	RO	R/W	R/W	1	UInt8	0x00: High active 0x01: Low active	0…1	-	-	-	

Index	Sub Index	Object Name	Access			Length	Data Type	VALUE (example)	Value Range	Gradient	Offset	Unit	Description
			U	M	S								
	0x02	Mode	RO	R/W	R/W	1	UInt8	0x00: Deactivated 0x01: single point 0x02: window 0x03: two point	0…3	-	-	-	
	0x03	Hyst	RO	R/W	R/W	2	UInt16	0x0000: no hysteresis Other values: hysteresis in pressure unit	0…10%FS	According to MU See Table 10	0	MU	
0x003E	0	SSC2Param	RO	R/W	R/W	4	Record						Defines the Switch-points for Channel 2 (see par. 7.6)
	0x01	SP1	RO	R/W	R/W	2	(0, R): Uint16 (N, Z): Int16	FS	(0, R): min 0... max FS (N, Z): min: -1bar or equivalent max: FS	According to MU See Table 10	0	MU	From Specification: SP1=SP “High” SP2=SP “Low”
	0x02	SP2	RO	R/W	R/W	2	(0, R): Uint16 (N, Z): Int16	0	(0, R): min 0... max FS (N, Z): min: -1bar or equivalent max: FS	According to MU See Table 10	0	MU	
0x003F	0x00	SSC2Config	RO	R/W	R/W	4	Record						Defines the configuration of Channel2 (see par. 7.6)
	0x01	Logic	RO	R/W	R/W	1	UInt8	0x00: High active 0x01: Low active	0…1	-	-	-	
	0x02	Mode	RO	R/W	R/W	1	UInt8	0x00: Deacti-vated 0x01: single point 0x02: window 0x03: two point	0…3	-	-	-	
	0x03	Hyst	RO	R/W	R/W	2	UInt16	0x0000: no hysteresis Other values: hysteresis in pressure unit	0…10%FS	According to MU See Table 10	0	MU	

U=User, M=Maintenance, S=Specialist

MU = measure unit

Table 9 *Teach-in state*

Value	Description
0	IDLE
1	Set point 1 OK
2	Set point 2 OK
3	Set point 1 and 2 OK
4	WAIT
5	BUSY
7	ERROR

Table 10 *Gradient and Display format for data in pressure unit*

Sensor ordered in BAR unit		**Configured measure unit for data display**		
		bar	**psi**	**MPa**
1 decimal digit*	gradient	0.1	1.45038	0.01
	Display format	Dec.1	Dec.0	Dec.2
2 decimal digit*	gradient	0.01	0.14504	0.001
	Display format	Dec.2	Dec.1	Dec.3

Sensor ordered in PSI unit		**Configured measure unit for data display**		
		bar	**psi**	**MPa**
0 decimal digit*	gradient	0.0689476	1	0.00689476
	Display format	Dec.1	Dec.0	Dec.2
1 decimal digit*	gradient	0.0068948	0.1	0.00068948
	Display format	Dec.2	Dec.1	Dec.3

*see paragraph 7.3 (Process Data Mapping)

- ***Device parameters – Extended Index***

Index	**Sub Index**	**Object Name**	**Access**			**Length (Bytes)**	**Data Type**	**Value (example)**	**Value Range**	**Gradient**	**Offset**	**Unit**	**Description**
			U	**M**	**S**								
0x0100	0x00	Calibration Date	RO	RO	RO	8	String	20190825		-	-	-	Calibration date (yyyymmdd)
0x0101	0x00	Cal Mode Enable	RO	R/W	R/W	1	Boolean	0: false (default) 1...255: true	0...255	-	-	-	Enable/Disable the Calibration function
0x0102	0x00	Relay Status*	RO	RO	RO	1	Boolean	0: Opened 1...255: Closed (default)	0...255	-	-	-	Opened/Closed state of the relay
0x0103	0x00	Lin error (%FS)	RO	RO	RO	1	Int8	25	1…100	0,01	0	%	Linearity error at factory in %FS
0x0104	0x00	Zero calibration	RO	RO	RO	1	Uint16	0	0…65535	According to MU See Table 10	0	MU	Zero calibration value at factory in MU
0x0105	0x00	Span calibration	RO	RO	RO	1	Uint16	FS	0…65535	According to MU See Table 10	0	MU	Span calibration value at factory in MU
0x0106	0x00	Relay Activation Threshold*	RO	RO	RO	1	Uint8	80	10…100	1	0	%	Threshold of relay opening in %FS
0x0107	0x00	PressurePeaksCounterTh	RO	R/W	R/W	1	(0, R): Uint16 (N, Z): Int16	1000	(0, R): min: 0 max: 120%FS (N, Z): min: -1bar or equivalent max: 120%FS	1	0	MU	Pressure peaks counter threshold in MU
0x0108	0x00	UseAutozeroCorrection	RO	R/W	R/W	1	Boolean	0: off 1...255: on (default)	0...255	-	-	-	Enable/disable autozero correction
0x0109	0x00	RelayOutEnabled*	RO	RO	RO	1	Boolean	0: Relay output disabled 1...255: Relay output enabled	0...255	-	-	-	Defines if the transducer has Relay output (enabled) or not (disabled)
0x010A	0x00	PressureDataUnit	RO	R/W	R/W	1	Uint8	0x00: bar 0x01: psi 0x02: MPa	0…2	-	-	-	Measure Unit used for pressure expressed parameters. IT DOES NOT AFFECT PROCESS DATA
0x010B	0x00	FullScaleValue	RO	RO	RO	2	Uint16	FS	0...FS	According to MU See Table 10	0	MU	Factory full scale value, expresses in MU
0x010C	0x00	OperatingTimeCounter	RO	RO	RO	4	UInt32	0	0...4294967295	0,1	0	h	Operating hours from first power on, stored in non volatile memory

Index	Sub Index	Object Name	Access			Length (Bytes)	Data Type	Value (example)	Value Range	Gradient	Offset	Unit	Description
			U	M	S								
0x010D	0x00	OperatingTimeInPressureCounter	RO	RO	RO	4	UInt32	0	0...4294967295	0,1	0	h	Operating hours since Pressure > 0, stored in non volatile memory
0x010E	0x00	PressurePeaksCounter	RO	RO	RO	4	UInt32	0	0...4294967295	1	0	-	Count of times pressure goes above PeakPressureThreshold
0x010F	0x00	PressureMaxValue	RO	RO	RO	2	(0, R): Uint16 (N, Z): Int16	0	(0, R): 0...65535 (N, Z): -32768..32767	According to MU See Table 10	0	MU	Max value registered from last power on, stored in non volatile memory
0x0111	0x00	TemperaturePeaksCounter***	RO	RO	RO	4	UInt32	0	0...4294967295	1	0	-	Count of times pressure goes above PeakTemperatureThreshold
0x0112	0x00	TemperatureMaxValue***	RO	RO	RO	2	Int16	1000	-32768...32767	0,1	0	°C	Max value registered from last power on, stored in non volatile memory
0x0114	0x00	TemperaturePeaksCounterTh	RO	RO	RO	2	Int16	2500	-400...max (Temp Range)	0,1	0	°C	Threshold of temperature peaks counter
0x0115	0x00	Special Execution Tag	RO	RO	RO		String	1AA	-	-	-	-	String for special execution versions
0x0116	0x00	AutozeroCorrection	RO	RO	RO	2	Int16	0	-32768...32767	According to MU See Table 10	0	MU	Actual zero Offset value. Useful to monitor the “zero drifting” in time.
0x0117	0x00	Lower Range Value (LRV)**	RO	RO	RO	2	UInt16	0	0	According to MU See Table 10	-	MU	Rangeability functionality, specifies the initial value of range for Analog output
0x0118	0x00	Upper Range Value (URV)**	RO	R/W	R/W	2	UInt16	FS	33%FS…FS	According to MU See Table 10	0	MU	Rangeability functionality, specifies the end value of range for Analog output (limited from 33 to 100% FS)
0x0119	0x00	SSC1 Set Delay	RO	R/W	R/W	2	UInt16	0	0…500	0,1	0	s	SSC1 Delay time set (see par. 7.6)
0x011A	0x00	SSC1 Reset Delay	RO	R/W	R/W	2	UInt16	0	0…500	0,1	0	s	SSC1 Delay time reset (see par. 7.6)
0x011B	0x00	SSC2 Set Delay	RO	R/W	R/W	2	UInt16	0	0…500	0,1	0	s	SSC2 Delay time set (see par. 7.6)
0x011C	0x00	SSC2 Reset Delay	RO	R/W	R/W	2	UInt16	0	0…500	0,1	0	s	SSC2 Delay time reset (see par. 7.6)
0x011D	0x00	AmbientTemp	RO	RO	RO	2	Int16	0	-40…125	1	0	°C	Temperature of electronics
0x011E	0x00	AnalogOutEnabled**	RO	RO	RO	1	Boolean	0: disabled 1...255: enabled	0...255	1	0	-	Defines if the transducer has Analog output (enabled) or not (disabled)
0x011F	0x00	AnalogOutType**	RO	R/W	R/W	1	Uint8	0x00--> no analog 0x01--> 4…20 mA 0x02--> 0,5…10,5 V	0…2	1	0	-	Selects type of analog output. Need restart to be effective
0x0120	0x00	Damping filter	RO	R/W	R/W	2	Uint16	0	0…1000	0,001	0	s	Process data (pressure) filter; it affects both Digital and Analog output Limited to 1s (user have to consider it for safety function reaction) 0 = disabled 1 ms = not accepted
0x0200	0x00	RelayThresholdConfigurationValue	-	R/W	R/W	1	UInt8	80	10…100	1	0	%	Defines value of Relay threshold inserted by user (needs confirmation through sys command) (see par. 7.8)

U=User, M=Maintenance, S=Specialist

MU= Measure Unit

*Available only in SIL 2 / PL d Relay output version

** Available only in SIL 2 / PL d Analog output version

*** Available only in T integrated version

7.5. LED behavior

The IL transducer has an RGB led on board used to show the status and functionalities of the device:

Table 11 *Led behavior*

Status/Event	Led Color	Mode	Timing	Note
OFF	-	Fixed	OFF	
SIO mode	Green	Fixed	ON	
IO-Link	Green	Blinking	100ms OFF 900ms ON	
Autozero command	Blue	Fixed	1s ON Then OFF	If autozero command is accepted
Cal Mode	Yellow	Fixed	ON	Until Cal mode disabled
Safety related Error/Warning	Red	Blinking	500ms OFF 500ms ON	
Non Safety related Error/Warning	Yellow	Blinking	500ms OFF 500ms ON	
Relay threshold overtaking	Pink	Blinking	500ms OFF 500ms ON	

7.6. Switching signal channels (SSCs) configuration

The IL transducer offers two digital ouput (SSCs):

- Logical, inside process data (bit0 and bit1), during IO-Link mode communication
- Physical, on pin 4 and pin 2 (*) of M12 connector, during SIO mode.

SSCs commute according to the overtaking (high or low) of threshold value(s) based on the main process data, that is pressure.

Logical and physical SSCs behave in the same way, according to different configuration possibilities.

(*) Physical SSC2 is not available in SIL 2 / PL d relay output version.

Each channel has its own sets of parameters:

- SP1: point of switch HIGH, defined in MU (it must be higher than SP2)
- SP2: point of switch LOW, defined in MU (it must be lower than SP1)
- LOGIC:
  - High Active
  - Low Active
- MODE:
  - Deactivated: SSC is not enabled
  - Single Point: only SP1 is used to determine the commutation of SSC (it's important to set Hysteresis)
  - Two Point: SP1 and SP2 are used to determine commutation and contemporarily the hysteresis (no need to set parameter Hyst)

Window: SSC commutes both during ramp up and ramp down, when pressure overtakes SP2 and SP1 threshold in both directions

- HYST: the hysteresis, always espressed in MU, is useful for:
  - -Single Point Mode: hysteresis value is all below SP
  - -Window Mode: hysteresis value is half above SP, half below SP
- SET_DELAY: filter on SSC activation; if the pressure spike/movement is faster than the time interval defined in set_delay parameter (0,1s resolution) the SSC does not activate
- RESET_DELAY: filter on SSC deactivation; if the pressure spike/movement is faster than the time interval defined in reset_delay parameter (0,1s resolution) the SSC does not deactivate

For better understanding of SSCs configurations, see following figures:

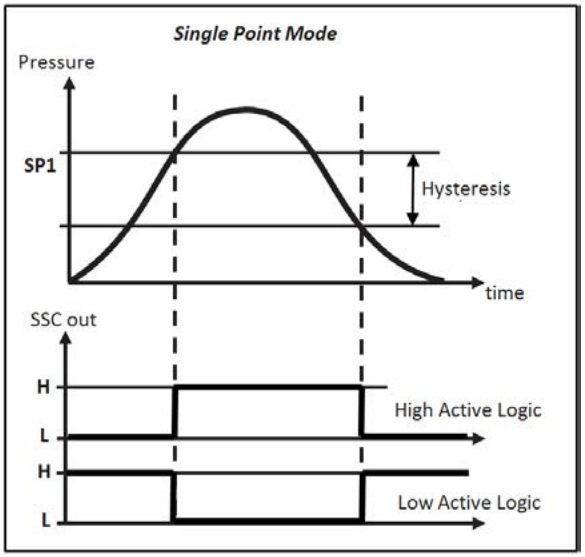


Figure 4 *Single Point Mode*

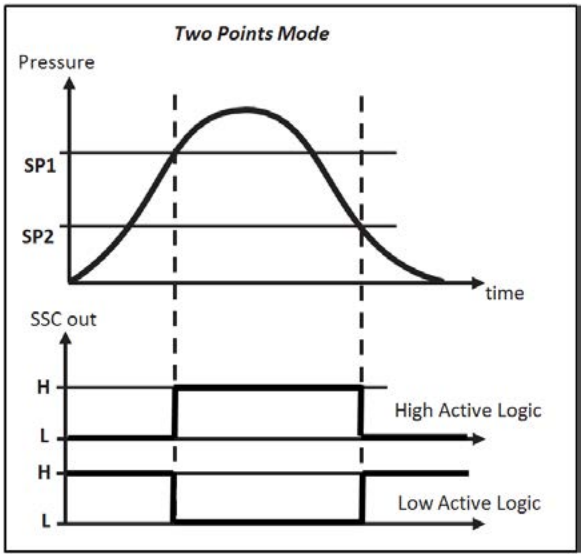


Figure 5 *Two Points Mode*

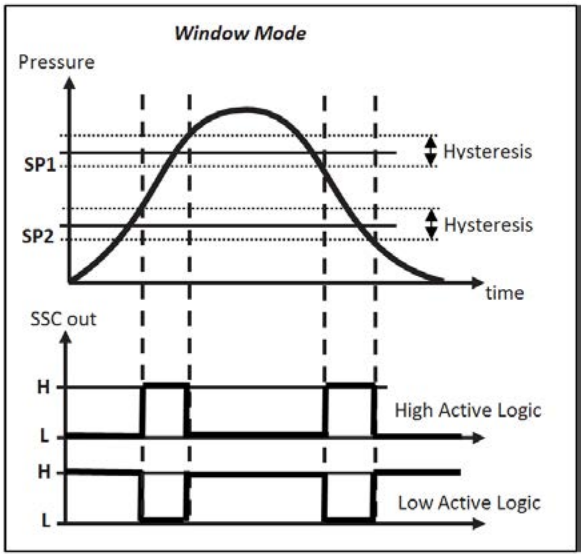


Figure 6 *Window Mode*

SP1 and SP2 points can be set in two ways:

- through direct setting of the value of objects:
  - SSC1Param.SP1 (Index 0x003C, sub-index 1)
  - SSC1Param.SP2 (Index 0x003C, sub-index 2)

- SSC2Param.SP1 (Index 0x003E, sub-index 1)
- SSC2Param.SP2 (Index 0x003E, sub-index 2)

• through Teach-in procedure applied to SSC1, to SSC2 or both SSC1 and SSC2, using system commands 0x41 (TeachSP1) and 0x42 (Teach SP2). SSC1 is the default channel set for the Teach-in procedure.

• Teach-in procedure

1) Connect input pressure to the transducer
2) Select the SSC number (1/2/all) to which address SPs through TeachInChannel (Index 0x003A)
3) Bring (Higher)the input pressure to the SP1 desired value
4) Launch System command 0x41 for setting SP1 value
5) Bring (Lower) the input pressure to the SP2 desired value
6) Launch System command 0x42 for setting SP2 value
7) Repeat procedure for SSC2 if needed

7.7. Reranging (LRV/URV) – only for SIL 2 / PL d analog output version

The IL transducer has an optional analog output on pin 5 with reference on pin 3 of M12 connector (only for SIL 2 / PL d analog output version).

This output can be used as safety function for safety related applications up to SIL 2 / PL d.

The analog outputs available are:

• 0,5…10,5 Vdc (voltage output)

• 4…20 mA (current output)

For the analog output is also possible to remap the FS (4…20 mA or 0,5…10,5 Vdc) on a reduced FS input up to a 3:1 range; for instance a 100 bar nominal FS transducer can be downranged up to 33 bar:

• LRV (Lower range value) = value in MU at which the transducer shall output 4 mA or 0,5 Vdc (it's set equal to 0 bar/psi by default)

• URV (Upper range value) = value in MU at which the transducer shall output 20 mA or 10,5 Vdc

LRV value is not allowed to be changed by customer (it's a read only parameter set by default to zero)

URV value can be changed under the following conditions:

• being a Specialist / Maintenance user

• LRV < URV

• 33%FS ≤ URV ≤ FS

Reranging does not affect at all IO-Link Process Data

Accuracy error is always referred to nominal Full Scale

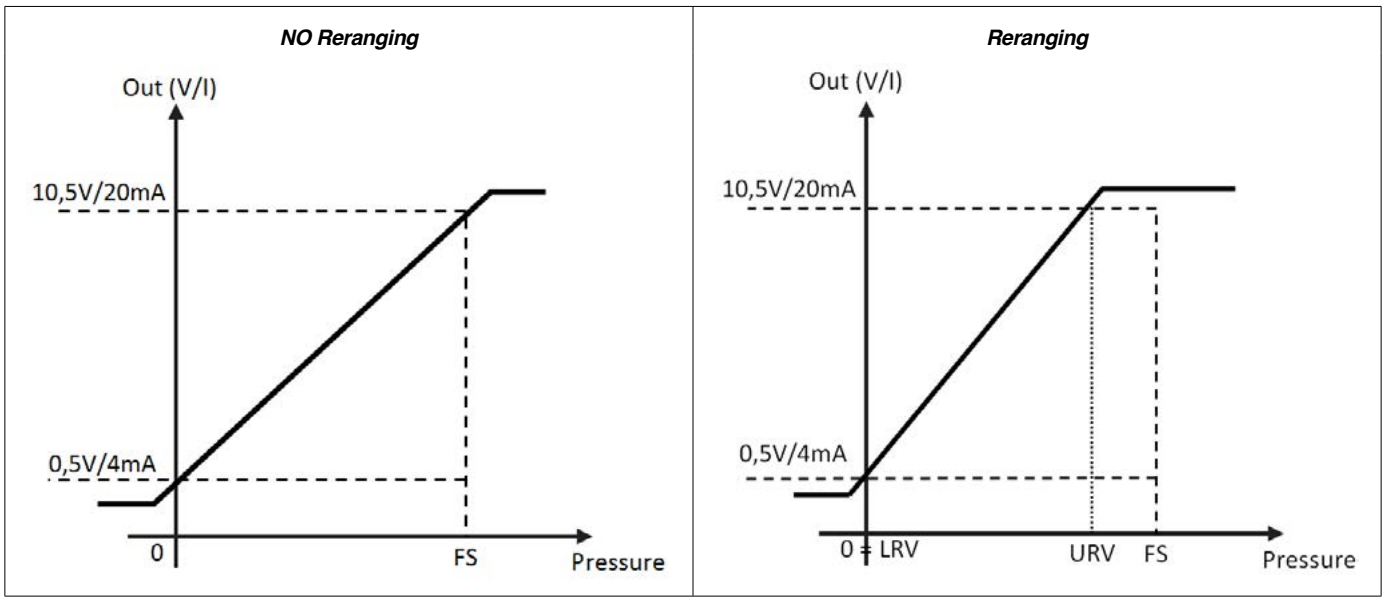


Figure 7 *Input-Output function without reranging applied and with reranging applied*

7.8. Relay Threshold change – only for SIL 2 / PL d relay output version

The IL transducer has an optional relay output contact on pin 2 and 5 of M12 connector (only for SIL 2 / PL d relay output version).

This contact can be used as Safety function for safety related application up to SIL 2 / PL d.

The relay contact is normally closed during standard working of the transducer.

It opens due to one of the following causes:

- The input pressure goes above a determined threshold
- An internal error, related to safety function, happens

If the pressure goes below the threshold (plus hysteresis) the relay contact closes again

If an internal error happens (for SIL 2 / PL d versions), the device blocks its function until a power cycle is made and the error cause removed.

The threshold at which the relay contact will open is selected through ordering code.

During IO-Link parameterization, only with Specialist or Maintenance credentials, it is possible to change the threshold through the following procedure:

1) Write the new desired value in %FS at Index 0x200 subindex 0 (values accepted between 10 and 100 % FS)
2) An event of “Event for Relay Threshold Changed, required confirmation” (0x18A1) is launched by the Device
3) Within 30s from writing of new value a Sys Command of “Relay Threshold Confirmation” (value 0xA2) must be launched
4) If the procedure worked fine an event of “Event for Relay Threshold Changed, value confirmed” (0x18A2) is launched by the Device
5) Read back the new value changed and confirmed at Index 0x0106 Subindex 0 (Relay Activation Threshold)
6) From now on the new threshold is saved and used
7) If:
   a) The procedure stops for any reason
   b) The confirmation command is not launched within 30s

The new value is rejected and the old one restored.

Action on this parameter must be done by skilled and trained personnel only.

7.9. Damping filter parameter

The Process Value, represented by both analog output pressure (where available) and IO-Link pressure data, can be filtered by a digital filter with the aim of smoothing the output value in front of noise and peaks on input value.

The time duration of this filter is driven by the Damping Filter parameter (par. 7.4 – Device parameters - index 0x0120); its value is expressed in seconds and represents the step response time from 10% to 90% of step value.

This filter applies both to analog output and IO-Link digital value.

The value of Damping Filter can be changed under these constraints:

- It can be modified only by Specialist and Maintenance users
- It is limited in the range 2 ms … 1s

Writing of this parameter has immediate effect on output.

Modification of this parameter must take into account that it will add delay to the response time of Safety function, both for analog and relay ouput. For this reason Action on this parameter must be done by skilled and trained personnel.

7.10. Autozero command

The Autozero command (see par. 7.4, Table 3 – System command values – value 0xA0) allows the user to put to zero the offset of pressure reading of transducer due to thermal drift at working temperature, as described in calibration procedure at par. 5.2

Action on this command must be done by skilled and trained personnel, under these constraints and procedure:

- It can be acted only by Specialist and Maintenance users
- It is limited in range according to Table 4
- It must be acted at 0 barg pressure in the plant
- It cannot be acted at a time interval shorter than 20 s
- After the application of command the user shall verify the output, both analog (if available) and IO-Link, in order to confirm that the pressure offset has gone to zero.
- Writing of this parameter has immediate effect on output.

Application of command has immediate effect on output.

The value of offset measured and stored by the device is visible at parameter AutozeroCorrection (see par. 7.4, - Device parameters – Extended index – index 0x0116).

With Specialist and Maintenance credentials the Autozero effect can be cancelled (reset) through the Autozero Reset command (see par. 7.4, Table 3– System command values – value 0xA1).

With Specialist and Maintenance credentials The Autozero effect can also be disabled through the UseAutozeroCorrection parameter (see par. 7.4, - Device parameters – Extended index – index 0x0108).

7.11. Enable CAL parameter

The Enable CAL parameter (see par 7.4 – Extended index – index 0x0101) allows the user to bring the output value, both analog (where available) and IO-Link, to the 80% of Full Scale; this option is used during calibration procedure as described at par. 5.2. Action on this parameter must be done by skilled and trained personnel, can be acted only by Specialist and Maintenance users and should be executed only during installation procedure or maintenance, according to following procedure:

- Bring the system to work temperature with the transducer installed and connected to the measurement instrument without any pressure applied
- Execute Autozero command if needed
- Set to “TRUE” the Enable CAL parameter
- The transducer output will go to 80% FS, the led will turn to fixed yellow
- Verify the reading on instrument / controller of transducer output, calibrate it if needed
- Set to “FALSE” the Enable CAL parameter
- The transducer output will go back to 0% FS, the led will turn to blinking green
- Verify the reading on instrument / controller of transducer output

Application of command has immediate effect on output.

7.12. Analog Out Type parameter

As already described in 7.7 the IL transducer has an optional analog output (only for SIL 2 / PL d analog output version).

The analog outputs available are:

- 0,5…10,5 Vdc (voltage output)
- 4…20 mA (current output)

The user has to select one of this option in ordering code; this will be the default configuration.

The Analog Out Type parameter (see par 7.4 – Extended index – 0x011F), allows the user to switch from Voltage to Current output and viceversa, under following constraints and procedure:

- It can be acted only by Specialist and Maintenance users
- It is limited to only the two values allowed: 0x01 (Current), 0x02 (Voltage); other values will be rejected
- A power cycle is needed in order to make the new configuration active

Note: reading a current output transducer with a voltage meter or reading a voltage output transducer with a current meter will bring the output to an out of range and for this reason it must be considered as a fault condition by the controller.

7.13. Autocompensation effect on impact series

Impact series sensors work on a piezoresistive principle by a silicon chip. All the components need about an accurate thermal compensation either of the zero signal or of the span signal.
This compensation eliminates the sensor drift effects and is realized by the temperature signal digital reading through the silicon chip. The components thermal inertia can generate signal over/under elongations (<15% FSO) during fast thermal gradients. In steady state the signal is correctly compensated.

8. MAINTENANCE

8.1. Maintenance

Melt pressure sensors must be installed and electrically connected by trained people, following all applicable recommendations, with zero pressure and voltage, and with the machine switched off.
The sensor must be removed with the plastic in melt state and the machine in hot conditions.
Always remove the sensor before cleaning the machine, using steel brushes or similar tools.
Always wear protective gloves and always take adequate ESD precautions to prevent electrostatic discharges that could damage the sensor.Always use the wrench for the hexagonal nut when installing and removing the sensor.
DO NOT force the electronics housing.
Once the sensor is removed, clean it gently with a soft cloth while the material is still malleable.

8.2. Transport, storage and disposal

The melt pressure sensors Impact series are realized with piezoresistive silicon technology completely “fluid free”.
Even if these are designed with a thick diaphragm, they must be always transported and stocked with the protection cap and with the package.
Gefran allows melt pressure sensors of own production, also defective units or damage by the use, for the disposal.

9. FUNCTIONAL SAFETY NOTES (FOR SIL 2 / PL d CERTIFIED VERSIONS ONLY)

9.1. Application

The pressure sensors ILI SIL 2 / PL d perform the following safety function:

The safety function performed by the sensor is the correct measurement and transduction of pressure value, read according to accuracy specification defined in the datasheet and in this user manual, to be compared with a determined safety threshold (high threshold), or de-energizing of a relay contact normally energized, at the overcoming of a set safety threshold.

The designated category to which are limited the use of safety related parts is Category 2.

The SIL/PL parameters of the transducer are shown in the table below:

Table 12

Parameter	Value	Measuring Unit
Architecture	1oo1 (1oo2 for relay output block)	--
HFT	0 (1 for relay output block)	--
Category	2 (3 for relay output block)	--
β, β_D factors	0,02	--
λ_{DD}		
Analog output	4,61E-07	1/h
Relay output	4,44E-07	1/h
λ_{DU}		
Analog output	6,73E-08	1/h
Relay output	3,72E-08	1/h
DC_{avg}		
Analog output	90	%
Relay output	90	%
SFF		
Analog output	94,1	%
Relay output	96,7	%
$MTTF_D$		
Analog output	216	years
Relay output	237	years
PFH/PFH_D		
Analog output	6,73E-08	1/h
Relay output	3,72E-08	1/h
Systematic Capability	2	--
SILCL (IEC/EN 62061) SIL (IEC/EN 61508)	2	--
PL (EN ISO 13849)	d	--

In the evaluation three different failure types have been excluded:

- Wearing/corrosion of the mechanical parts at the process front end [EN ISO 13849-2:2012 prospect A.4]
- Break of the mechanical parts at the process front end [EN ISO 13849-2:2012 prospect A.4]
- Plastic deformation due to excessive loads of the mechanical parts at the process front end [EN ISO 13849-2:2012 prospect A.4]

The pressure sensors of the ILI SIL 2 / PL d series can be part of a pressure detection system which, when a threshold value is exceeded, deactivates all the pressure generation elements through the control system.

In following figures some possible applications are shown:

1) the IL transducer has analog output and is power supplied through an IO-Link master; IO-Link communication can be on or not; the transducer detects the pressure and gives in output an analog electrical value proportional to the pressure itself; SRP/CS compares the signal with its internal alarm threshold: if the threshold is exceeded the SRP/CS will stop the pressure generation systems.

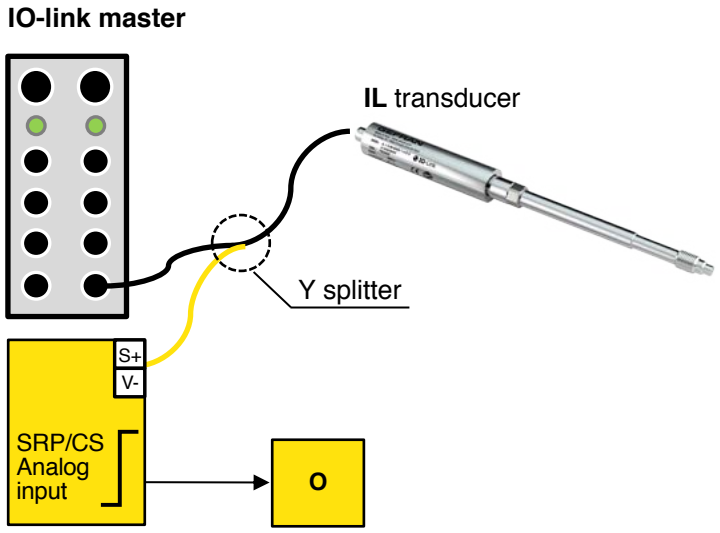


Figure 8

2) the IL transducer has analog output and is powered directly through the SRP/CS; the transducer detects the pressure and gives in output an analog electrical value proportional to the pressure itself; SRP/CS compares the signal with its internal alarm threshold: if the threshold is exceeded the SRP/CS will stop the pressure generation systems.

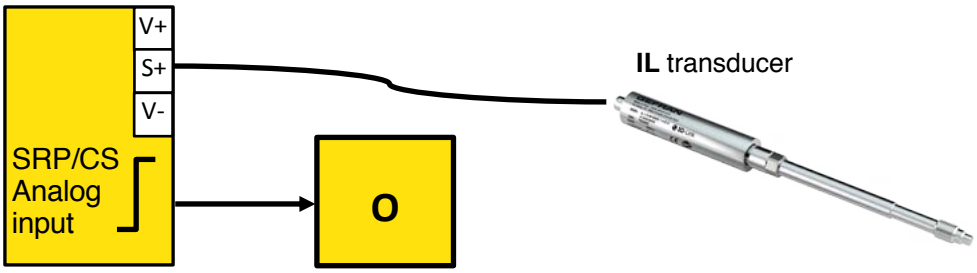


Figure 9

3) the IL transducer has relay output and is power supplied through an IO-Link master; IO-Link communication can be on or not; the sensor detects the pressure and compares it with a determined threshold; if the threshold is exceeded, the relay will open; the relay output is interfaced with an enable input of the pressure generating system motor drive; when the threshold is exceeded, the open state of the relay stops the pressure generating systems.

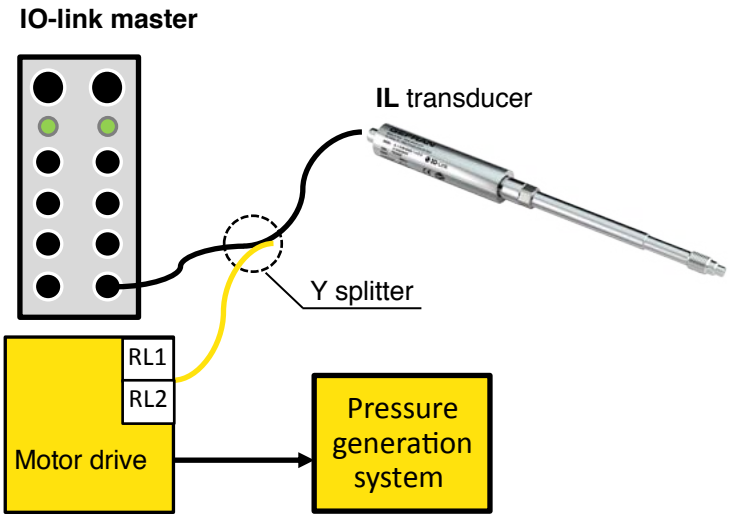


Figure 10

4) the IL transducer has relay output and is power supplied externally; the sensor detects the pressure and compares it with a determined threshold; if the threshold is exceeded, the relay will open; the relay output is interfaced with an enable input of the pressure generating system motor drive; when the threshold is exceeded, the open state of the relay stops the pressure generating systems.

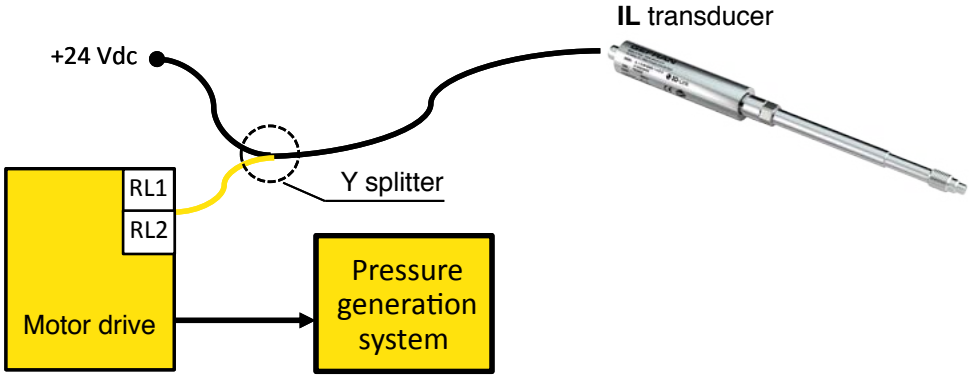


Figure 11

9.2. Restrictions of use

The device must only be used in accordance with these operating instructions for mechanical installation, electrical connection, environmental conditions and use in order to maintain the declared SIL and PL degree. The sensors must be powered by non-distributed networks and in any case with a length of less than 30 m.

9.3. Maintenance and periodic checks

The periodic maintenance to be carried out to ensure the permanence over time of the declared Failure Rates are:

- Visual inspection of the state of electrical and mechanical connections

  Maintenance is aimed at assessing any problems due to situations of incorrect assembly over time or particular aggressiveness of the processed material.

  Periodicity: every two years

  Visual inspection of the condition of the process membrane and stem threads.

  Maintenance is aimed at assessing any abnormal abrasions or wear due to incorrect assembly situations over time. (see par. 5)

  Periodicity: every year

- Checking the sensor installation seat

  Maintenance is aimed at assessing the correctness of the profile and dimensions and the absence of material residues or occlusions of the pressure channel.

  Periodicity: every two years.

- Electronic calibration test (**Reduced Proof Test**)

  The purpose of the test is to verify the correct functioning of the electronics.
  It is carried out by performing the CAL procedure

  Periodicity: every **6 months**

- Sensor calibration test (**Proof Test**)

  The purpose of the test is to verify the correctness of the transduction curve of the sensor.
  It is carried out by applying known pressure points to the transducer and checking the values reported by the probe.

  Periodicity: every two years

- For each new installation or re-installation use anti-seize paste on the thread of the stem.

9.4. Mean Time to Restoration

The MTTR (mean time of restoration) is calculated considering travel time, device location, maintenance contracts, environmental restrictions, warehouses and the technical time of replacement of the device (not its repairing).

In particular in the MTTR is included:

- The time required to replace and reset the device
- Travel time and any maintenance contracts
- The time to detect the failure (considered negligible in respect to the previous ones)

The MTTR calculation does NOT include:

- Any administrative delays on the part of the end user
- The unavailability of spare parts

Under these conditions the MTTR will be equal to 5 working days.

Considering instead only the technical time for replacement and restoration of the device (i.e. the spare part is already available from the user) the MTTR is equal to approx. 4h

9.5. Indication on response times

The response time to pressure transduction is 4 ms (Analog Out response).

The response time of relay version is 250 ms.

These response times are measured considering the value of Damping Filter value set to 0s (see par. 7.4 index 0x120 and par 7.9 for setting and limitations)

9.6. Effects on the safety function of deviations in performance

The limit of acceptability in deviations of metrological performance in order not to induce loss of the safety function is ± 5 % of the value of span at room temperature.

9.7. Inhibition and suspension of the safety function

With the ILI SIL 2 / PL d series sensors, it is not possible to bypass the safety function of transducer.

9.8. Indications and alarms

The sensors of the ILI SIL 2 / PL d series can have two different electrical output: analog amplified (0,5..10,5 V o 4..20 mA) or a relay output.

IO-Link communication cannot be considered a safety channel, even if:

- it gives indication and events through process data and diagnostic, related to the status and failures of the device
- parameterization through IO-Link can affect safety function; safety relevant parameter changes are allowed only according to procedures described at paragraphs 7.7 - 7.12

In Figure 12 are shown the significant value of the outputs in case of analog signal:

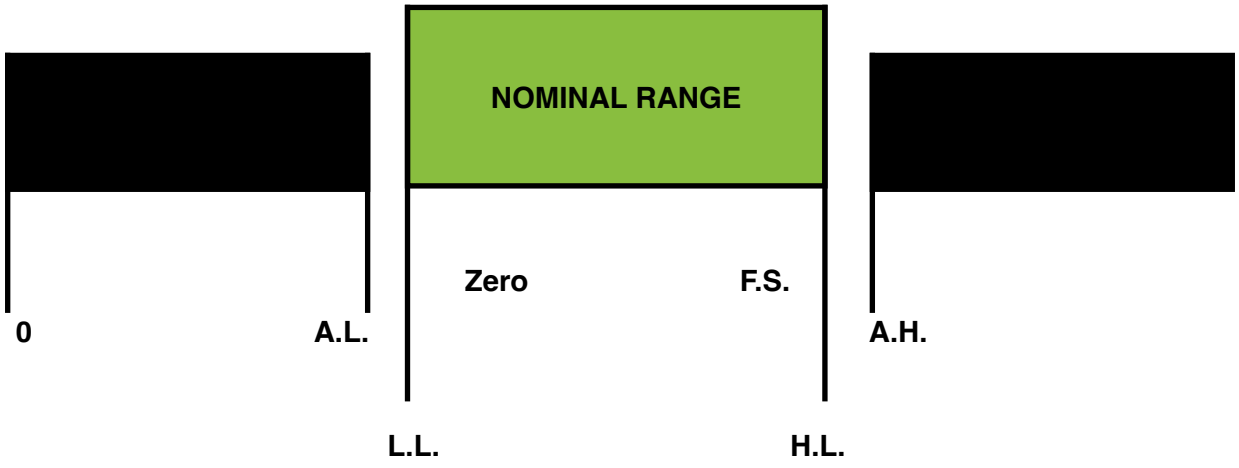


Figure 12

Table 13

TABLE VALUES OUTPUTS	OUTPUT 4-20 mA	OUTPUT 0,5-10,5 V
A.L. = Alarm Low	< 3,600 mA	< 0,250 V
L.L . = Low Limit	= 3,68 mA	= 0,300 V
H.L. = High Limit	= 20,55 mA	= 10,85 V
A.H. = Alarm High	> 21,000 mA	> 10,95 V

In case of relay output, the relay is closed except when:

- a failure is detected
- the % of F.S. set as the alarm threshold has been exceeded

The failures, their effects on the output signal, on the relay output and how to reset are described at par. 7.4 (IO-Link parameterization – diagnostics)

Note: Out of range values and relay opened signal must be handled by the downstream controller, which must take appropriate action.

10. RELAY APPLICATION NOTES

Contacts

Relay manufacturers assume you will be using resistive loads when they rate their relays.

The load is a simple resistive element, and it is assumed that the current flow through the contacts will be fairly constant, although some increase may occur due to arcing during “make” or “break.” Ideally, a relay with a purely resistive load can be operated at its stated voltage and current ratings and attain its full lifetime.

Precautions for the Contacts

Contacts are the most important elements of relay construction. Contact life is influenced by contact material, voltage and current value applied to the contacts, the type of load, switching frequency, ambient atmosphere, form of contact and the contact bouncing etc.

The material transfer, welding, abnormal usage and the increase in contact resistance bring about the failure of the contacts. Please pay attention to them in application.

In order to better apply the relay, please refer to the following precautions of the contacts.

Inductive loads

Switching inductive loads is difficult, primarily because current tends to continue to flow in inductors, even as contacts are being broken.

The stored energy in inductors induces arcing; arc-suppression schemes are frequently used.

When you are switching inductive loads, you typically will want to derate relay contacts to 40 percent of the resistive load rating.

Capacitive loads

Capacitors resemble short circuits when they are charging, so the in-rush current from a capacitive load can be very high. Series resistors are often used to limit in-rush current; without a limiting resistor, contact welding may occur.

When you are switching capacitive loads, you typically will want to derate relay contacts to 75 percent of the resistive load rating.

Motor loads

When an electric motor starts up, it has very low impedance and requires a large in-rush current to begin building a magnetic field and begin rotating. Once it is running, it generates a back electromagnetic force (emf), which can cause a large inductive spike when the switch is opened. The result is a large in-rush current at “turn-on” and arcing at “turn-off.”

When you are switching a motor load, typical industry practice is to derate to 20 percent of the resistive rating.

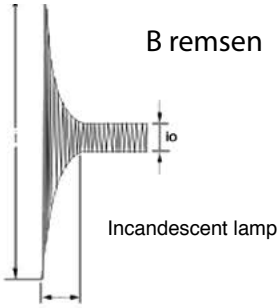
Type of load and inrush current

The type of load and its inrush current characteristics, together with the switching frequency, are important factors which cause contact welding.

The table shows the relationship between typical loads and their inrush currents.

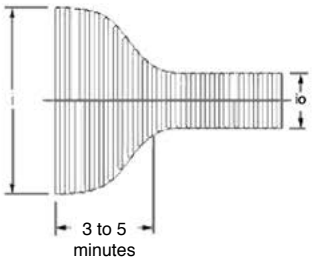
Type of load	Inrush current
Resistive load	Steady state current
Solenoid load	10 to 20 times the steady state current
Motor load	5 to 10 times the steady state current
Incandescent lamp load	10 to 15 times the steady state current
Mercury lamp load	Approx. 3 times the steady state current
Sodium vapor lamp load	1 to 3 times the steady state current
Capacitive load	20 to 40 times the steady state current
Transformer load	5 to 15 times the steady state current

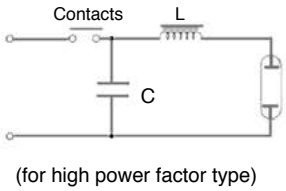
(1) Incandescent Lamp Load



Approx. 1/3 second
Inrush current/rated current:
$i/i_o \approx 10$ to 15

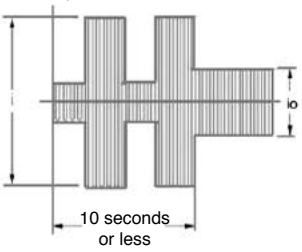
(2) Mercury Lamp Load $i/i_o \approx 3$





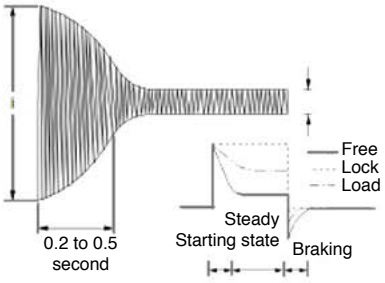
(for high power factor type)

(3) Fluorescent Lamp Load $i/i_o \approx 5$ to 10



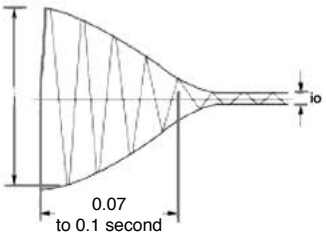
The discharge tube, transformer, choke coil, capacitor, etc, are combined in common discharge lamp circuits. Note that the inrush current may be 20 to 40 times, especially if the power supply impedance is low in the high power factor type.

(4) Motor Load $i/i_o \approx 5$ to 10



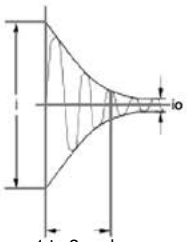
- Conditions become more harsh if plugging or inching is performed since state transitions are repeated.
- When using a relay to control a DC motorand brake, the on time inrush current, steadystate current and off time brake current differ depending on whether the load to the motor is free or locked.

(5) Solenoid Load $i/i_o \approx 10$ to 20



Note that since inductance is great, the arc lasts longer when is cut. The contact may easily burn.

(6) Electromagnetic Contact Load $i/i_o \approx 3$ to 10



(7) Capacitive Load $i/i_o \approx 20$ to 40

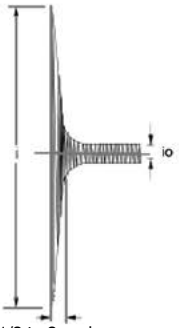


Figure 13

Inrush Current And The Reverse Voltage

When the motor, capacitance, solenoid and lamp load make, the inrush current is generated, which is several multiple steady state currents.

When the inductive load such as solenoid, the motor, contactor, the reverse voltage which are from hundreds of to thousands of volts.

Generally in the normal temperature and atmospheric pressure the critical insulation destruction voltage of the air is 200 to 300V.

Therefore if the reverse voltage exceeds this value, the discharge phenomena between contacts will happen.

Both inrush current and the reverse voltage will greatly damage the contacts and obviously shorten the relay life.

Therefore the proper use of the contact protection circuit may increase the life of the relay.

Material Transfer Of Contacts

Material transfer of contacts occurs when one contact melts or boils and the contact material transfers to the other contact.

This often occurs in circuits where electrical arcs are produced at the moment the contacts “make” such as when the DC current is large for inductive or capacitive loads or when the inrush current is large (several amperes or several tens of amperes).

When material transfer becomes serious, the deformation of the contact surface can be seen by eyes, as shown in Figure 14.

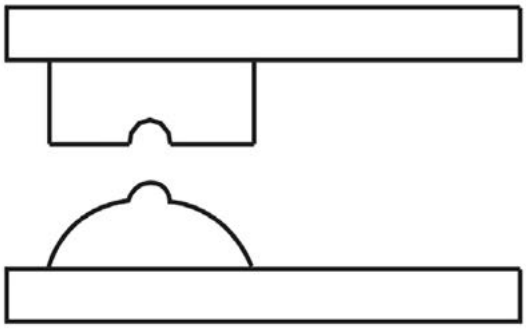


Figure 14

Generally, a concave formation appears on the cathode and a convex formation appears on the anode.

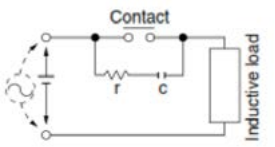
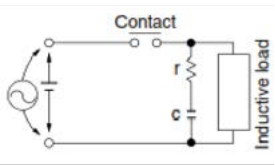
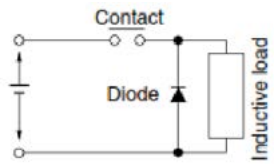
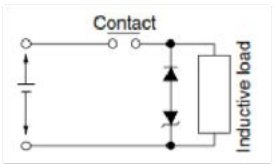
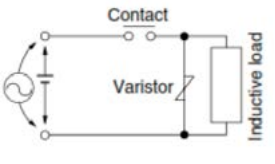
Contact protection circuit

Use of contact protective devices or protection circuits can suppress the counter emf to a low level.

However, note that incorrect use will result in an adverse effect.

Typical contact protection circuits are given in the table below.

Contact protection circuit: Inductive load

Circuit		Voltage		Features/Others	Devices Selection
		CA	CD		
CR circuit		C*	G	If the load is a timer, leakage current flows through the CR circuit causing faulty operation. * If used with AC voltage, be sure the impedance of the load is sufficiently smaller than that of the CR circuit	As a guide in selecting “c” and “r”, **c : 0.5 µF to 1µF for 1A contact current** **r : 0.5 Ω to 1 Ω per 1V contact voltage** Values vary depending on the properties of the load and variations in relay characteristics. Capacitor “c” acts to suppress the discharge the moment the contacts open. Resistor “r” acts to limit the current when the power is turned on the next time. Use a capacitor “c” with a breakdown voltage of 200 to 300V. Use AC type capacitors (non polarized) for AC circuits.
		G	C	If the load is a relay or solenoid, the release time lengthens. Effective if the power supply voltage is 24 or 48V.	
Diode circuit		NG	G	The diode connected in parallel causes the energy stored in the coil to flow to the coil in the form of current and dissipates it as joule heat at the resistance component of the inductive load. This circuit further delays the release time compared to the CR circuit. (2 to 5 times the release time listed in the catalog)	Use a diode with a reverse breakdown voltage at least 10 times the circuit voltage and a forward current at least as large as the load current. In electronic circuits where the circuit voltages are not so high, a diode can be used with a reverse breakdown voltage of about 2 to 3 times the power supply voltage.
Diode and zener circuit		NG	G	Effective when the release time in the diode circuit is too long.	Use a zener diode with a zener voltage about the same as the power supply voltage.
Varistor circuit		G	G	Using the stable voltage characteristics of the varistor, this circuit prevents excessively high voltages from being applied across the contacts. This circuit also slightly delays the release time.	-
(G: Good, NG: No Good, C: Care)					

Mounting the protective device

In the actual circuit, it is necessary to locate the protective device (diode, resistor, capacitor, varistor, etc.) in the immediate vicinity of the load or contact.

If located too far away, the effectiveness of the protective device may diminish. As a guide, the distance should be within 50cm.

Switching Capacitive Loads

Using relays to switch capacitive loads requires special care. When a switch closes, a transient current flows to charge the capacitance. This inrush current may be substantially higher than the steady-state current through the system.

Relay's contact welding may occur because of this high inrush current, even though the voltage and steady-state currents are within the switch specifications.

Any capacitance in the system can contribute to inrush currents, whether it is in a reactive device or from a shielded cable.

Inrush currents can be controlled with series impedance, such as a resistor (about 30 Ω to 50 Ω), between the switch and the capacitance, as shown in Figure 15.

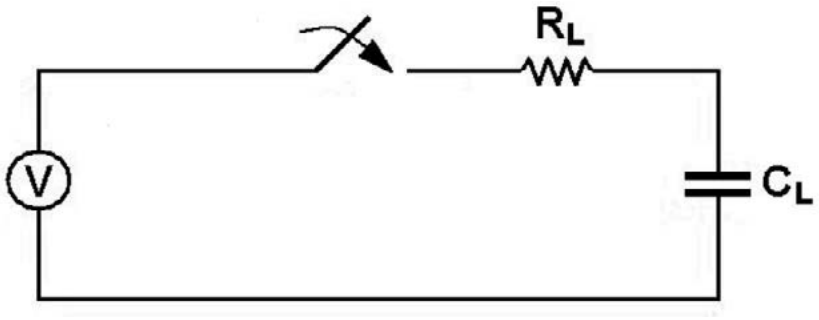


Figure 15

Precautions for using the long lead wire

If long wires (> 10 m) are to be used in a relay contact circuit, inrush current may become a problem due to the stray capacitance existing between wires.

Please connect in series the resistance **(10 Ω to 50 Ω)** in the contact circuit, as shown in Figure 16.

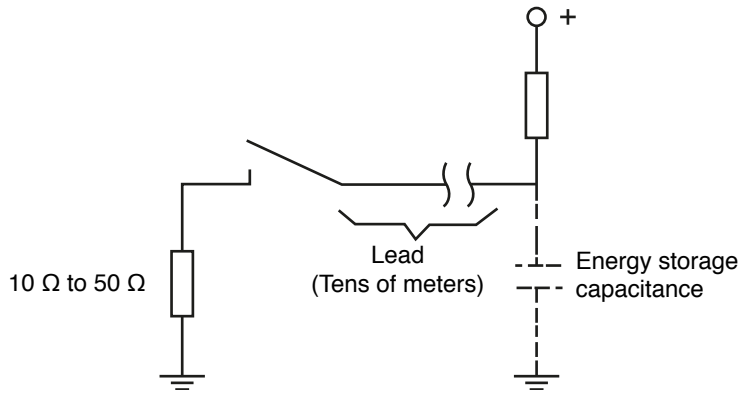


Figure 16

Riferimenti:

National Instruments: *http://www.ni.com/white-paper/4197/en/*

Panasonic Corporation: *General application Guidelines ASCTB250E 201402-T*

Hongfa Relay: Explanation of terminology and guidelines of relay

Fujitsu Components: *Engineering Reference Relays*

Agilent Technologies Inc : *Application Note 1399*

11. RESOLUTION PROBLEMS

All Gefran sensors are built in conformity to UNI EN ISO 9001: 2000

In case of malfunction, you can run a series of simple checks to identify the type of fault. If the problem is caused by a sensor malfunction, the sensor MUST be returned to Gefran.

Only Gefran personnel are permitted to open the sensor.

Any repair attempted without Gefran's authorization will cause the warrantee expiry.

ELECTROMECHANICAL PROBLEMS

MALFUNCTION	POSSIBLE CAUSE	POSSIBLE SOLUTION
NO SIGNAL	NO POWER SUPPLY CONNECTION FAILED	CHECK POWER SUPPLY / CONNECTIONS
NO SIGNAL VARIATION	BROKEN DIAPHRAGM PLUG FORMED	CHECK HOUSING AND DIAPHRAGM
EXCESSIVE SIGNAL IMBALANCE	OVERPRESSURE ELECTRONICS MALFUNCTION CALIBRATION ON	CHECK CALIBRATION
SIGNAL VARIATION AT TIGHTENING	INCORRECT INSTALLATION POINT	CHECK INSTALLATION HOLE
NO TEMPERATURE READ	BROKEN THERMOCOUPLE BROKEN TC WIRE	SEND IT TO THE FACTORY FOR REPAIR

FUNCTIONAL PROBLEMS

FAILURE	POSSIBLE CAUSES	MEANS OF RESEARCH
The sensor does not feel pressure and no alarm signal is activated	Pressure channel occlusion Output stage failure	1. Power down and remove the sensor 2. Verify eventual occlusion of the channel under pressure. Clean any residues and material caps 3. Reduce the process pressure below the F.S. value 4. Power the probe off-line and press gently with the finger on the membrane; if the probe does not change output, send it to the Factory for repair
The sensor is in alarm mode type "HIGH"	Bridge broken Detachment of pins Failure on primary element Pressure value above threshold (2x FS)	1. Power down and remove the sensor 2. Power the probe again, if the problem persists, you should send back the probe to the Factory for repair.
The sensor is in alarm mode type "LOW"	Power supply cable /connector broken Sensor not connected Sensor not powered Bridge broken Overvoltage Undervoltage Floating power supply Program sequence error Overtemperature on electronics RAM, Flash, CPU error	1. Power down and remove the sensor 2. Check that the power supply is connected. If necessary, restore the power supply. 3. Check for continuity between the pins of the connector and the power supply. If necessary, replace the cable and the connector. 4. Check if the power values are within the specifications indicated in this manual. If necessary, replace the power supply. 5. Check for overheating of electronics housing. Remove the causes of overheating, wait until it cools down and power the sensor 6. If the problem persists, you should send back the probe to the Factory for repair.
It's not possible to carry out the operation of AUTOZERO	Input pressure out of range of AUTOZERO activation Broken electronics	1. Stop the machine and make sure the pressure is near zero or at least within the limits reported in Table 4 2. Run RESET factory settings; if the read value is outside limits reported in Table 4, remove the sensor, check and clean its seat, reinsert the sensor and rerun AUTOZERO. 3. If the AUTOZERO is not executed, wait at least 20 seconds, then retry 4. If the problem persists, you should send back the probe to the Factory for repair

12. APPENDIX B: IP PROTECTION

IP protection indexes indicate the protection level of a device against outside agents.

It consists of two numbers after the prefix IP: the first is the index of protection against solids and dust; the second is the index of protection against liquids.

Three numbers are used in some countries. In this case, the third number is the mechanical index of protection.

Example: the protection index IP45 indicates a protection level of 4 against solids and a protection level of 5 against liquids.

Attention: these indexes are valid under standard ambient conditions.

Gefran Melt transducers and transmitters are built with protection index IP65.

Protection against solid objects

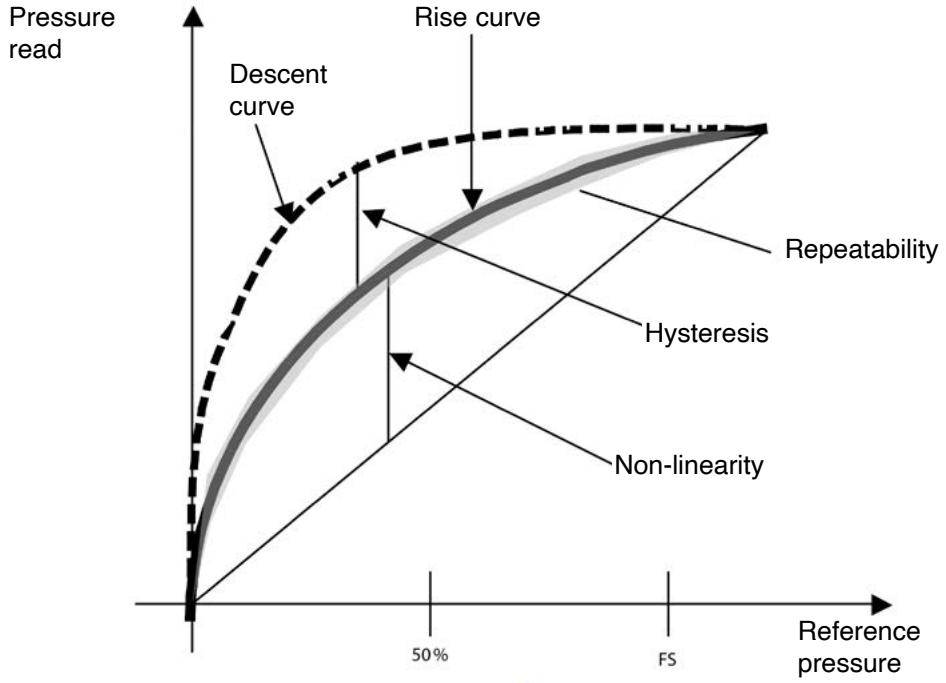
1st number	Description	Definition
0	No protection	No special protection
1	Protection against solid objects larger than 50mm	A part of the body with large surface, such as a hand (protection does not include intentional access). Solid objects with diameter exceeding 50mm.
2	Protection against solid objects larger than 12mm	Finger or similar objects less than 80mm in length. Solid objects with diameter exceeding 12mm.
3	Protection against solid objects larger than 2.5mm.	Tools, wires, etc., with diameter or thickness exceeding 2.5mm. Solid objects with diameter exceeding 2.5mm.
4	Protection against solid objects larger than 1.0mm	Wires or strips with thickness exceeding 1.0mm. Solid objects with diameter exceeding 1.0mm
5	Protection against dust	**Dust is not completely blocked, but does not enter in amounts sufficient to prevent good operation of the device.**
6	High protection against dust	No entry of dust.

Protection against liquids

1st number	Description	Definition
0	No protection	No special protection
1	Protection against drops of water.	Vertically dripping water must not have harmful effects.
2	Protection against drops of water at angle up to 15°.	Vertically dripping water must not have harmful effects when the device is rotated vertically up to 15°.
3	Protection against water vapor.	Sprays of vapor that fall at an angle up to 60° from vertical must not have harmful effects.
4	Protection against sprays of water.	Water sprayed on the housing from any direction must not have harmful effects.
5	Protection against jets of water.	**A jet of water pumped from any direction must not have harmful effects.**
6	Protection against waves.	Water from sea waves or a strong jet of water from any direction must not have harmful effects.
7	Protection against immersion.	Entry of water in an amount sufficient to damage the device must not be possible when the device is immersed in water for a defined length of time under defined pressure conditions.
8	Protection against continuous immersion	The device may be immersed in water for an extended length of time under conditions specified by the manufacturer.

13. APPENDIX C: ACCURACY CLASS

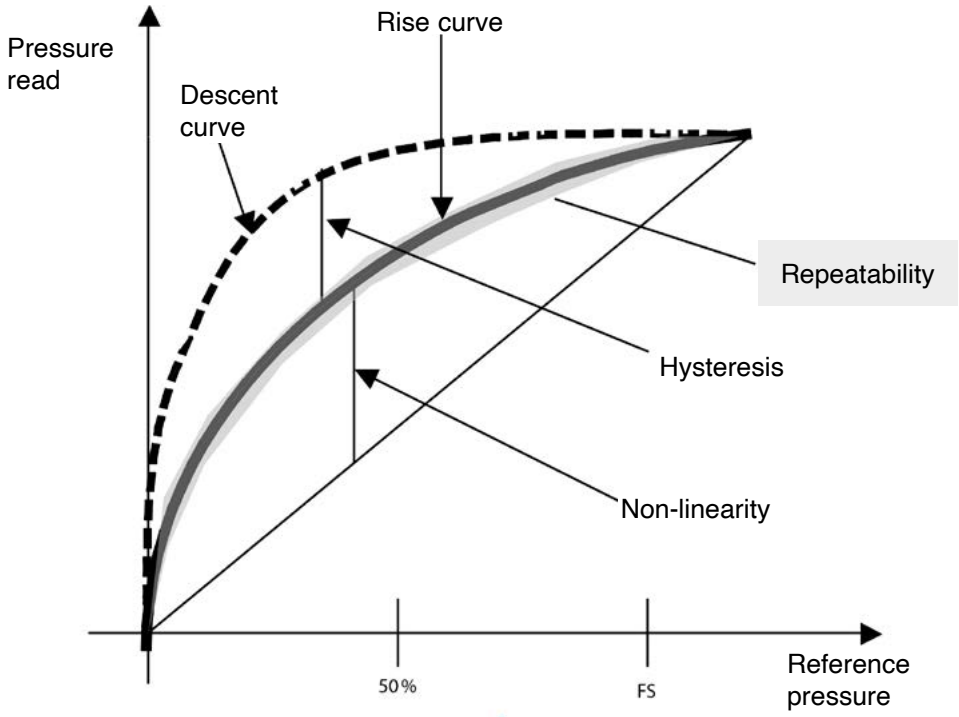
13.1. Calibration curve



13.2. Repeatability

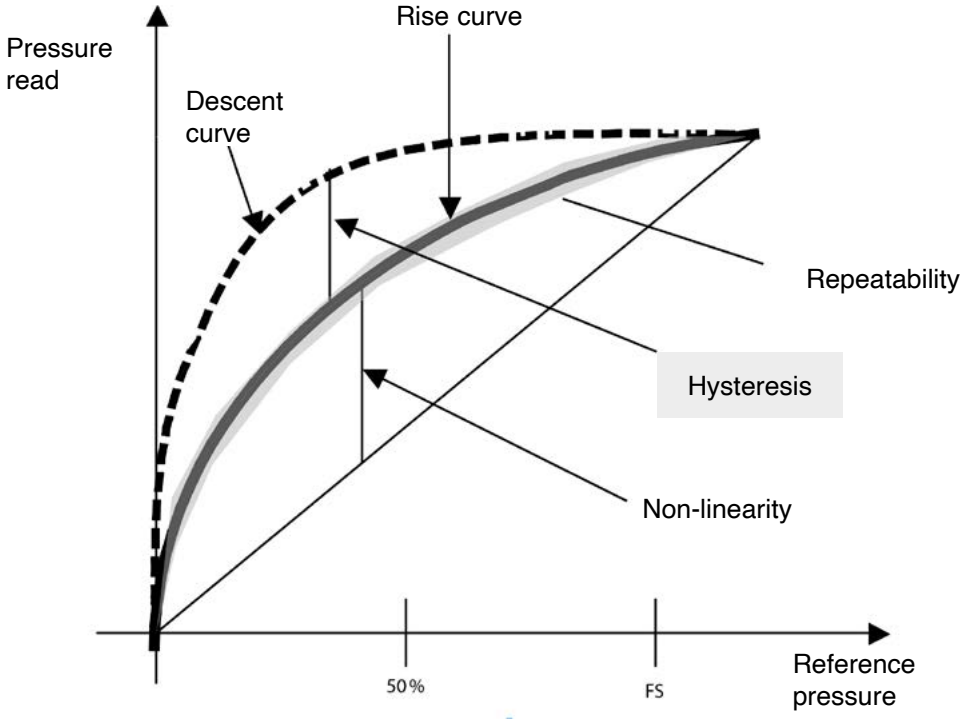
Repeatability is defined as the ability to reproduce reads in the same direction and under the same conditions when the same pressure is applied consecutively.

The maximum repeatability error of every Gefran sensor is 0.1% FS



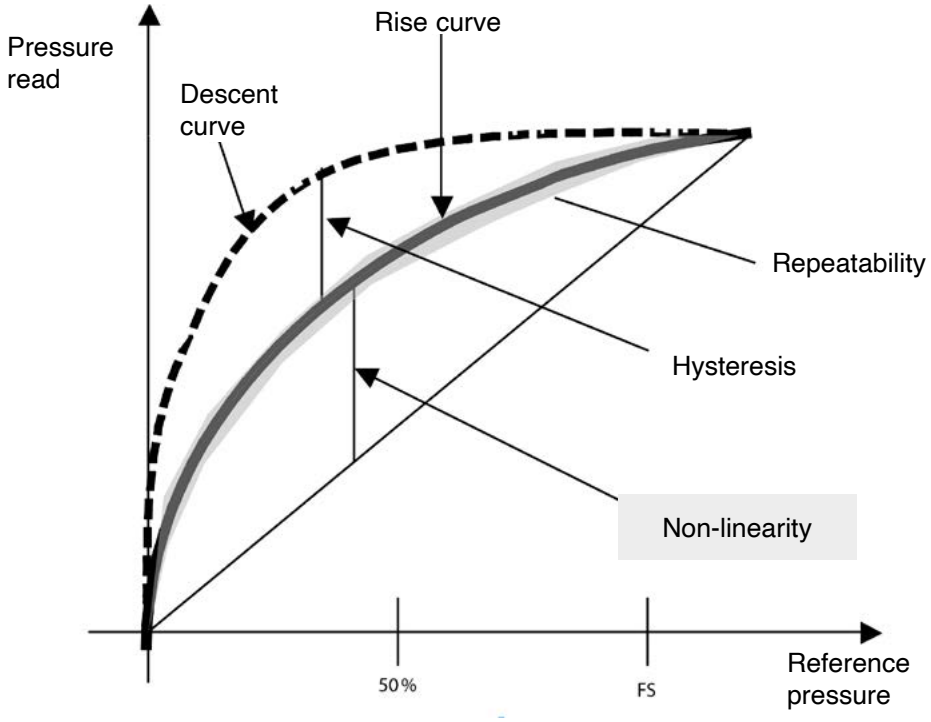
13.3. Hysteresis

The maximum read difference for each reading in a specific range when the value is reached, first in rise and then in descent.
The maximum hysteresis for every Gefran sensor is 0.1% F



13.4. Linearity

TThe maximum deviation of the calibration read curve for each calibration value, obtained by comparison to an ideal read curve.
Gefran uses the “BSFL” (best straight fit line) method.



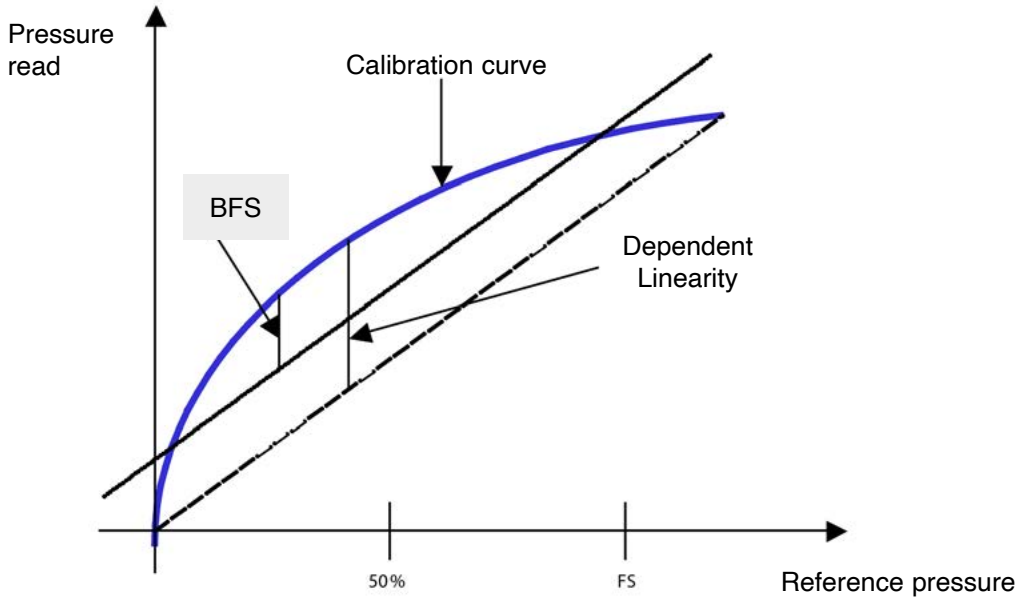
Dependent linearity error (End point)

Dependent linearity error is the deviation between the real characteristic of the transducer and the straight line passing through the two ends; expressed in % of FS.

Independent linearity error (BFSL)

Independent linearity error (BFSL) is the deviation between the real characteristic of the transducer and the straight line of minimum squares.

In practice, a straight line is formed that best approximates the real curve.



14. APPENDIX D: REGISTRATION MAINTENANCE

Date	DUT (model/SN)	Maintenance Done	Result	Pass/Fail	Operator	Notes

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