

# Process protection

## Acoustic sensors for pump monitoring

SITRANS DA400

### Overview



SITRANS DA400 acoustic diagnostic unit and sensor

The SITRANS DA400 acoustic diagnostic unit acoustically measures the structure-borne noise

- in the version for pump monitoring; on oscillating displacement pumps
- in the version for material flow monitoring; on pipes, conveying equipment or channels.

It comprises an electric diagnostic unit and up to four acoustic sensors.

### Benefits

#### Benefits when pump monitoring

- Increased availability of the system through:
  - Advanced maintenance planning thanks to early recognition of defective components
  - Reduced downtimes (no fault locating necessary)
  - Increased maintenance intervals
  - Greater pump reliability
- Prevention of expensive consequential damage
- Increased safety of critical applications
- Early recognition of a reduction in power
- Increased productivity

#### Benefits when material flow monitoring

- Detection of insufficient or excessive inflow of material in a liquid or gas flow
- Detection of blockages or clogging
- Reduction of down times
- Increased product quality
- Increased availability
- Guaranteed operational safety
- Increased productivity

### Application

In the version for pump monitoring, the SITRANS DA400 allows continuous, simultaneous and independent monitoring of up to four flow control valves in a pump for leaks. In addition, another four inputs are available for monitoring standard signals (e.g. diaphragm and temperature monitoring). This means that the con-

dition of an oscillating displacement pump is monitored in every phase of its operation.

The SITRANS DA400 is used in all industries where an oscillating displacement pump is used.

The version for material flow monitoring monitors the material flow in liquids or gases that is usually as a result of impact or friction, e.g. against the pipe or channel wall.

If the acoustic diagnostic unit is used in potentially explosive areas, the sensors as well as the acoustic diagnostic unit can be installed in the Ex-zone.

If using the unit in potentially explosive areas, you have two options:

- Operation of the sensors over the safety barriers or
- Operation of the sensors over the SITRANS DA400 with explosion protection.

### Function

#### Product features

Continuous and independent status monitoring:

- of the flow control valves, for leaks
- of the membranes, for material fatigue
- of the temperature loading of the hydraulic oil
- of flowing bulk solids in pipes, conveying equipment or channels

Communication of the status to superordinate control systems:

- via digital outputs
- digitally, via PROFIBUS DP or PROFIBUS PA

Simple to operate and parametrize:

- locally, via digital display and keys
- PROFIBUS DP and PROFIBUS PA

#### Mode of operation

##### Principle of measurement

Leaks in the flow control valves of oscillating displacement pumps are flows in which cavitation occurs. This results in sound waves that are transmitted to the valve housing, where they are recorded by the structure-borne sound sensor in the SITRANS DA400 on the outside.

The SITRANS DA400 utilizes the fact that with both an open valve and a closed intact valve, no cavitation occurs and the measured sound level thus corresponds to the operating noise of the pump. By contrast, with a closed defective valve cavitation does occur, which can be identified by a period increase in the sound level (see figures). The measured value from the SITRANS DA400 corresponds exactly to this increase in the sound level.

In the version for material flow monitoring, SITRANS DA400 continuously detects high-frequency acoustic oscillations by means of structure-born noise sensors.

These oscillations are created by:

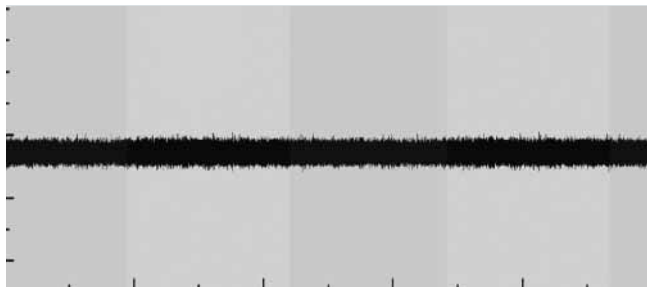
- Friction and impact of bulk solids in:
  - pipes, raceways or channels
  - chutes
  - conveyors
- Friction and impact of mechanical parts
- Bursting of bubbles
- Cavitation
- Turbulence in gas and liquid flows

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The following shows an example of signal levels at an oscillating displacement pump.



Signal from structure-borne sound sensor with intact valve



Signal from structure-borne sound sensor with defective valve

#### Sensor operation

The structure-borne sound sensor works on the piezoelectric principle. The structure-borne sound is injected into the sensor via the sensor base (mounting surface) and inside it is converted into an electrical voltage by a piezo-ceramic element. This is amplified in the sensor and transmitted via the cable.

The sensor frequency range lies in the ultrasonic range (> 20 kHz). The sensor is non-directional, i.e. the angle at which the sound wave impacts on the sensor base is not important.

#### Mode of operation of the safety barrier

The safety barrier comprises intrinsically-safe circuits. These circuits serve to operate intrinsically-safe components such as sensors and to isolate safety from the non-hazardous area with the SITRANS DA400 diagnostic unit.

#### Technical specifications

SITRANS DA400	Without Ex protection	With Ex protection
<b>Input</b>		
Acoustic channels		4
• Cycle time		10 ms
Only for connection to intrinsically safe sensors with:		
• Max. voltage $U_o$	-	≤ 5.5 V
• Max. current $I_o$	-	≤ 70 mA
• Max. power $P_o$	-	≤ 100 mW
• Internal capacitance $C_i$	-	≤ 1.2 μF
• Internal inductance $L_i$	-	Negligible
<u>Universal inputs</u>		
		4
• Cycle time		80 ms
• Low pass filter time		1 s

SITRANS DA400	Without Ex protection	With Ex protection
<u>Universal analog current input</u>		
• Load	< 105 Ω	< 12 Ω
• Resolution		0.1 %
• Accuracy		0.5 %
• Fault signal	> 21 mA or < 3.6 mA (at 4 ... 20 mA)	
• Alarm monitoring hysteresis	0.5 %	
• Static destruction limit	40 mA, 4 V	-
For connection with approved intrinsically safe circuits with:		
• Max. supply voltage $U_i$	-	≤ 30 V
• Max. short-circuit current $I_i$	-	≤ 100 mA
• Max. power $P_{oi}$	-	≤ 1 W
• Internal capacitance $C_i$	-	≤ 11 nF
• Internal inductance $L_i$	-	≤ 70 μH
<u>Universal input 24 V digital signal</u>		
• Input resistance		> 19 kΩ
• Signal level Low		< 4.5 V or open
• Signal level High		> 7 V
• Hysteresis		> 1 V
• Static destruction limit	± 40 V	-
For connection with approved intrinsically safe circuits with:		
• Max. supply voltage $U_i$	-	≤ 30 V
• Max. short-circuit current $I_i$	-	≤ 100 mA
• Max. power $P_{oi}$	-	≤ 1 W
• Internal capacitance $C_i$	-	≤ 11 nF
• Internal inductance $L_i$	-	≤ 70 μH
<u>Universal input closing contact</u>		
For connection to closing contact with the maximum values:		
• Max. voltage $U_o$	-	≤ 10 V
• Max. current $I_o$	-	≤ 1 mA
• Max. power $P_o$	-	≤ 5 mW
• Internal capacitance $C_i$	-	≤ 11 nF
• Internal inductance $L_i$	-	≤ 70 μH
<u>8.2 V source for NAMUR signal (DIN EN 60947-5-6)</u>		
• Open circuit voltage	8.2 V ± 0.3 V, short-circuit proof	-
• Input resistance	< 950 Ω	-
• Static destruction limit for incorrect wiring	+20 V/-10 V	-
<b>Output</b>		
<u>Digital outputs</u>		
	6	6 (applicable for NAMUR switch hardener)
• Semiconductor relay	Individually isolated, short circuit-proof	-
• Switching voltage	24 V AC/36 V DC, any polarity	-
• Destruction limit	35 V AC, 50 V DC	-
• Max. switching current	100 mA	-
• Signal status Low (no response)	-	≤ 1.2 mA (source to DIN 19234)
• Signal status High (response)	-	≥ 2.1 mA (source to DIN 19234)

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SITRANS DA400	Without Ex protection	With Ex protection
For connection with an intrinsically safe switching amplifier to DIN 19234 with:		
• Max. supply voltage $U_i$	-	≤ 15.5 V
• Max. short-circuit current $I_i$	-	≤ 25 mA
• Max. power $P_{oi}$	-	≤ 64 mW
• Internal capacitance $C_i$	-	≤ 5.2 nF
• Internal inductance $L_i$	-	Negligible
<b>Conditions of use</b>		
Installation conditions	Vertical wall mounting, cables fed in from below	
Climatic class	Class 4K4 according to EN 60721-3-4	
Mounting location	-	Zone 1 or zone 2
Permissible ambient temperature	-20 ... +60 °C (-4 ... +140 °F)	-
• Temperature class T5 – T1		-20 ... +60 °C (-4 ... +140 °F)
• Temperature class T6		-20 ... +50 °C (-4 ... +122 °F)
Mechanical load	Class 4M3 according to EN 60721-3-4	
Degree of protection to EN 60529	IP65	
Electromagnetic Compatibility	To EN 61326 and NAMUR NE 21	
Usage limits for water		
• Delivery side	≥ 10 bar a	
• Number of strokes	min. 4 min <sup>-1</sup> , max. 10 ... 500 min <sup>-1</sup>	
<b>Design</b>		
Weight (without options)	approx. 2.5 kg	
Dimensions (W x H x D) in mm (inch)	172 x 320 x 80 (6.8 x 12.6 x 3.2)	
Enclosure material	Macrolon (polycarbonate + 20 % glass fiber)	Makrolon (Polycarbonate + 20 % glass fibers), surface attenuated with CrNi layer and painted
Electrical connection via screw terminals	<ul style="list-style-type: none"> <li>• Rigid 2.5 mm (0.984 inch)</li> <li>• Flexible 1.5 mm (0.59 inch)</li> <li>• Flexible with connector sleeves 1.5 mm (0.59 inch)</li> </ul>	
Cable inlet via plastic cable joints	<ul style="list-style-type: none"> <li>• 2 x Pg 13.5</li> <li>• 5 x Pg 11</li> </ul>	
<b>Power supply</b>		
Rated voltage	24 V DC	16 V DC
Operating range	19 to 36 V DC	15 to 17 V DC
Current consumption	< 100 mA	< 40 mA
For connection with approved intrinsically safe circuits with:		
• Max. supply voltage $U_i$	-	≤ 17.4 V
• Max. short-circuit current $I_i$	-	≤ 191 mA
• Max. power $P_{oi}$	-	≤ 1.35 W
• Internal capacitance $C_i$	-	≤ 33 nF
• Internal inductance $L_i$	-	≤ 28 μH

SITRANS DA400	Without Ex protection	With Ex protection
<b>Certificates and approvals</b>		
Explosion protection to EN 50014, EN 50020 and EN 50021		
• Intrinsic safety "i"	-	TÜV (German Technical Inspectorate) 06 ATEX 2952
• Marking	-	II 2(1) G EEx is [ia] IIC T6
<b>Communication</b>		
PROFIBUS DP	RS485, switchable terminating resistor	
Protocol	Cyclic with Master C1 and acyclic with Master C2	
Power supply	-	Bus-supplied
Bus voltage	-	9 ... 24 V
Current consumption	-	10.5 mA ± 10 %
Bus connection with FISCO supply unit, ia/ib group IIC or IIB	-	Yes
Layer 1 and 2 from PROFIBUS PA, transfer technology from IEC 1158-2		
• C2 connections	-	4 connections are supported in master class 2
• Device profile	-	PROFIBUS PA Profil V3.0 Rev. 1, Class B
• Device address	-	1 ... 126 (126 factory-set)
PC parameterization software	SIMATIC PDM (not included in the scope of delivery)	
<b>Sensor for SITRANS DA400</b>		
<b>Setup</b>		<ul style="list-style-type: none"> <li>• Piezoceramic sensor with pre-amplifier</li> <li>• Encapsulated electronics</li> <li>• 4-wire cable with anti-kink sleeve</li> </ul>
<b>Conditions of use</b>		
Permissible Ambient Temperature	-40 ... +110 °C (-40 ... +230 °F)	
Degree of protection to EN 60529	IP66/IP68	
Mechanical load	Class 4M7 according to EN 60721-3-4	
Climatic class	Class 4K4 according to EN 60721-3-4	
<b>Design</b>		
Housing material	Stainless steel 1.4571 (316Ti SST)	
Cable	Ends with wire protectors and cable shoe for connection to the SITRANS DA400	
Weight	125 g (0.276 lb)	
Mounting location	Zone 0/1 or zone 20/21/22	
Dimensions (W x H x D) in mm (inch)	26 x 29 x 40 (1.02 x 1.14 x 1.57)	

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#### Sensor for SITRANS DA400

<b>Power supply</b>	Power fed from device
<b>Certificates and approvals</b>	
Explosion protection	
Intrinsic safety "i"	TÜV 2005 ATEX 2876 X
Marking	II 1 G EEx ia IIC T6/T5/T4 or II 1 D EEx ia D 20/21/22 T160
Permissible ambient temperature	
• Category 1G	
- Temperature class T4, T5	-20 ... +60 °C (-4 ... 140 °F)
- Temperature class T6	-20 ... +50 °C (-4 ... 122 °F)
• Category 2G	
- Temperature class T4	-40 ... +110 °C (-40 ... 230 °F)
- Temperature class T5	-40 ... +80 °C (-40 ... 176 °F)
- Temperature class T6	-20 ... +65 °C (-4 ... 149 °F)
• Category 1D or 2D	
- Temperature class T160	-40 ... +110 °C (-40 ... 230 °F)

#### Ex barriers for sensors

<b>Application area</b>	For the intrinsically safe supply of the acoustic sensors in zone 1; the safety barriers must be installed between the SITRANS DA400 acoustic diagnostic unit and the sensor if only the sensors are being operated in the Ex zone.
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<b>Input</b>	A maximum of two sensors can be connected.
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#### Conditions of use

Degree of protection to EN 60529	IP20
Permissible Ambient Temperature	-20 ... +60 °C (-4 ... +140 °F)

#### Design

Weight	115 g (0.254 lb)
Housing material	Plastic, polyamide
Type of installation	Installation on mounting rail NS 32 or NS 35/7.5. The acoustic diagnostic unit SITRANS DA400 and the safety barrier must be operated outside the Ex zone.

Dimensions (W x H x D) in mm (inch)	68 x 77 x 42 (2.68 x 3.03 x 1.65)
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#### Certificates and Approvals

Explosion protection	
• Intrinsic safety "i"	TÜV 05 ATEX 2917 X
• Marking	II (2) G [EEx ib] IIC

#### Selection and Ordering data

<b>Acoustic diagnostics unit SITRANS DA400</b> with local programming and display	Order-No. <b>7MJ2400-1A0</b>
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#### Communication

• PROFIBUS DP	<b>1 A</b>
• PROFIBUS PA	<b>2 B</b>

#### Explosion protection

• without	<b>A</b>
• with EEx ia/ib to ATEX <sup>1)</sup>	<b>B</b>

#### Application software

for continuous condition monitoring of positive displacement pumps	<b>1</b>
for material flow monitoring in pipes, raceways and conveyors	<b>2</b>

#### Acoustic sensors for diagnostics unit SITRANS DA400

Order-No. **7MJ2000-1B00**

#### Explosion protection

• without	<b>A</b>
• with EEx ia to ATEX	<b>B</b>

#### Cable

(incl. pin and allen screw M6)	
20 m	<b>B</b>
40 m	<b>C</b>
100 m	<b>F</b>

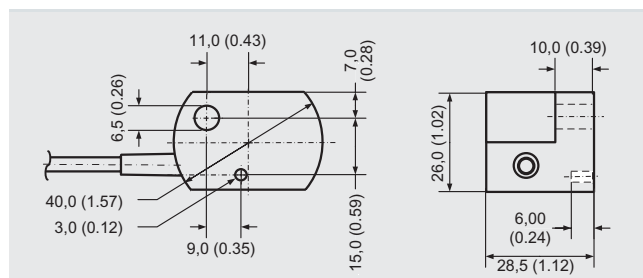
#### Safety barriers for sensors

**7MJ2010-1AA**

for rail mounting NS 32 and NS35/7.5 in non hazardous areas  
Explosion-protected output circuit EEx ib

1) Not in combination with trigger sensor.

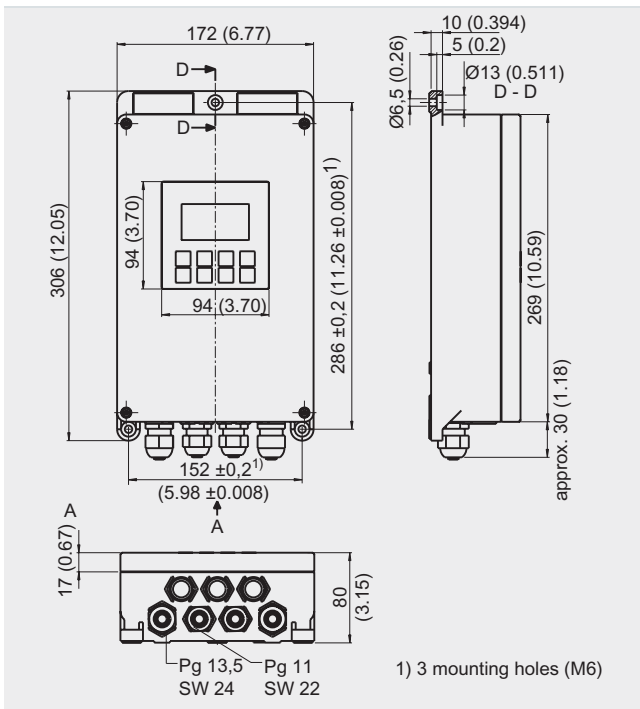
#### Dimensional drawings



Sensor for SITRANS DA400, dimensions in mm (inch)

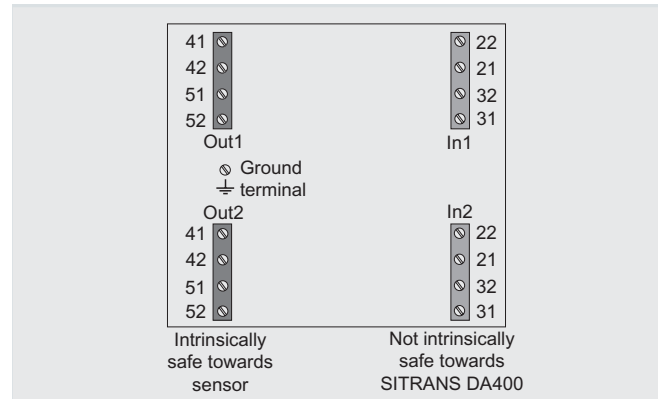
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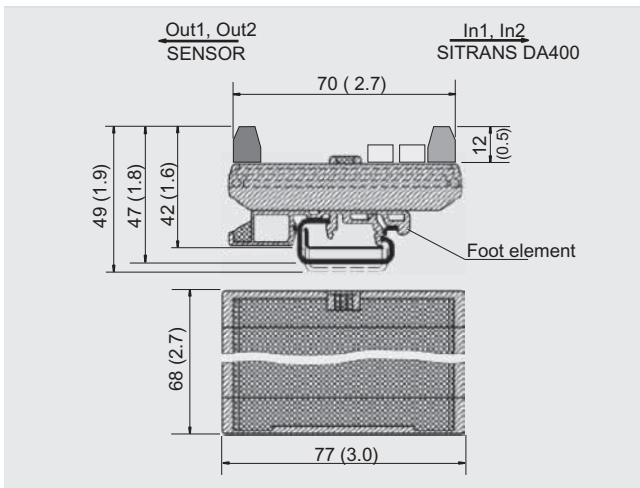


SITRANS DA400, dimensions in mm (inch)

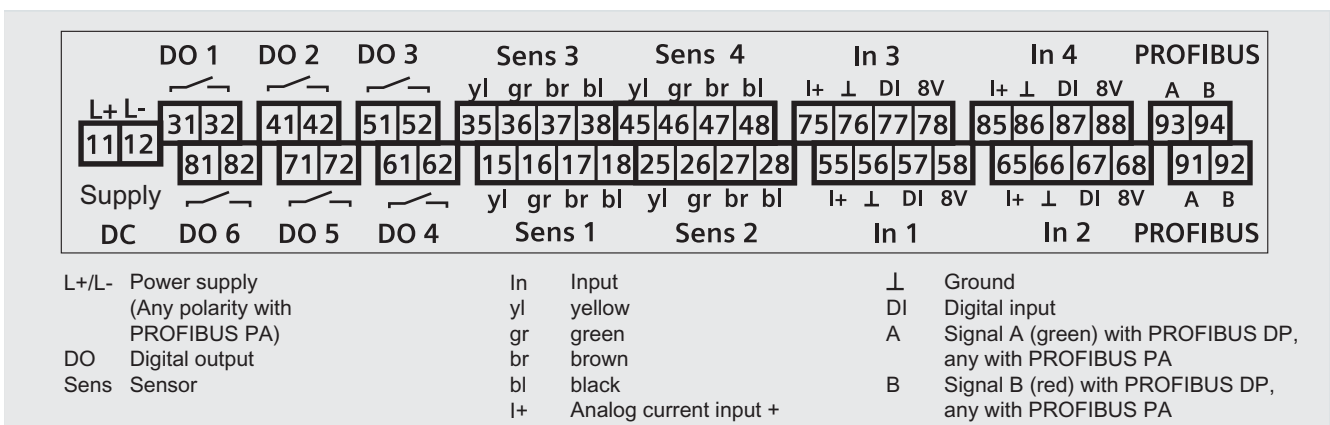
## Schematics



Safety barrier for SITRANS DA400, terminal assignment



Safety barrier for SITRANS DA400, dimensions in mm (inch)



SITRANS DA400, terminal assignment