FMC Technologies

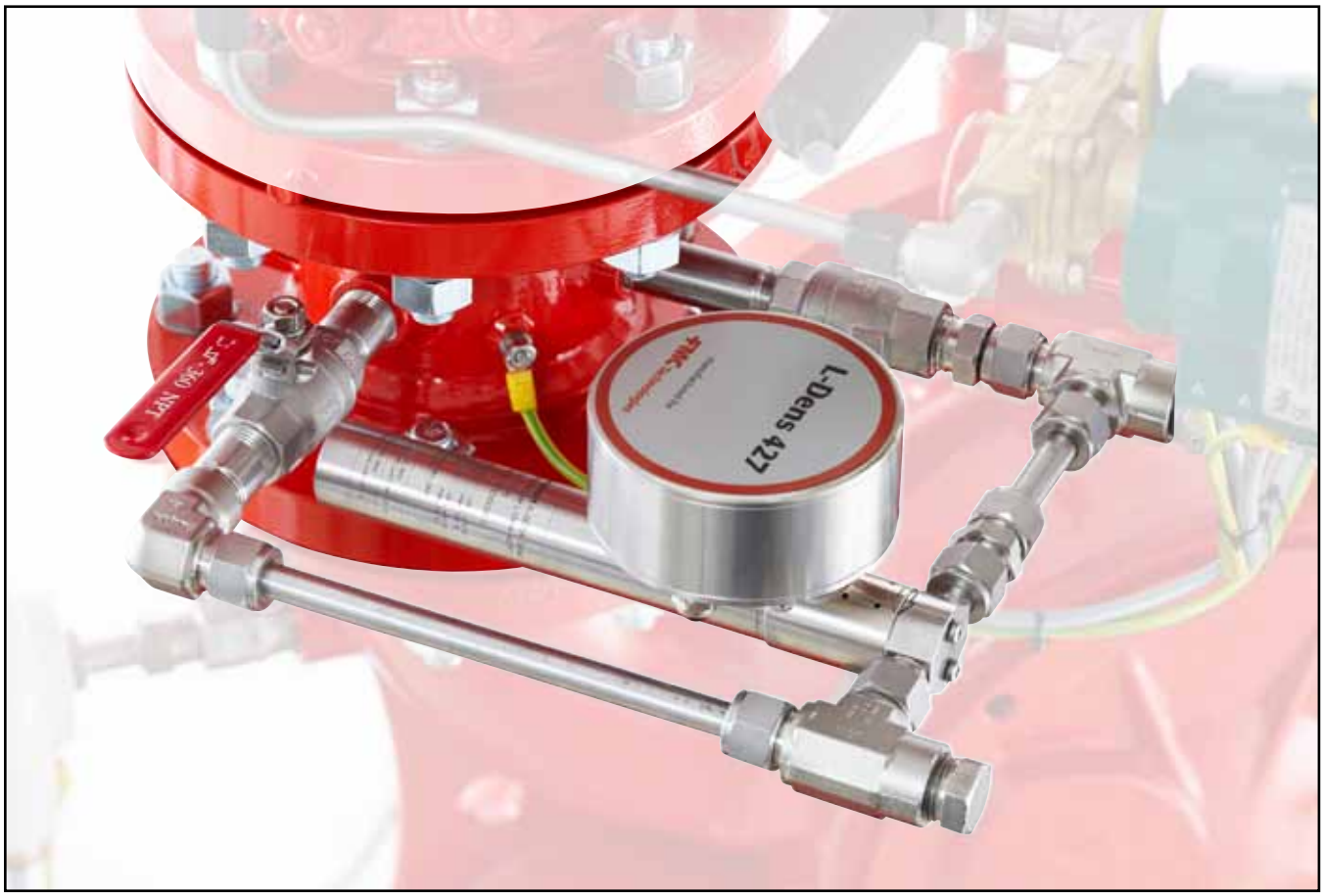
Densitometers

L-Dens 427

Instruction

Issue/Rev. 0.0 (6/12)

Bulletin MN04001E



Valid for

FMC Technologies

L-Dens 427F Ex 2/18mA OEM

Anton Paar

Measure,
what is measurable,
and make measurable
that which is not.

Galileo Galilei (1564–1642)

Instruction Manual

L-Dens 427

Density Sensors

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Density Sensors

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Contents

1 About the Instruction Manual

This instruction manual informs you about the installation and the safe handling and use of the product. Pay special attention to the safety instructions and warnings in the manual and on the product.

The instruction manual is a part of the product. Keep this instruction manual for the complete working life of the product and make sure it is easily accessible to all people involved with the product. If you receive any additions or revisions to this instruction manual from Anton Paar GmbH, these must be treated as part of the instruction manual.

Conventions for safety messages

The following conventions for safety messages are used in this instruction manual:

DANGER
Danger indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING
Warning indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION
Caution indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

Hot surface
This symbol calls attention to the fact that the respective **surface can get very hot**. Do not touch this surface without adequate protective measures.

NOTICE
Notice indicates a situation which, if not avoided, could result in damage to property.

TIP *Tip gives extra information about the situation at hand.*

Typographical conventions

The following typographical conventions are used in this instruction manual:

Convention	Description
<key>	The names of keys and buttons are written inside angle brackets.
"Menu Level 1 > Menu Level 2"	Menu paths are written in bold, inside straight quotation marks. The menu levels are connected using a closing angle bracket.

2 Safety Instructions

- Read the instruction manual before using the L-Dens 427.
- Follow all hints and instructions contained in this instruction manual to ensure the correct use and safe functioning of the L-Dens 427.

2.1 General Safety Instructions

Liability

- The instruction manual at hand does not claim to address all safety issues associated with the use of the instrument and samples. It is your responsibility to establish health and safety practices and determine the applicability of regulatory limitations.
- Anton Paar GmbH only warrants the proper functioning of the L-Dens 427 if no adjustments have been made to the mechanics, electronics, and software.
- Only use the L-Dens 427 for the purpose described in this instruction manual. Anton Paar GmbH is not liable for damages caused by the improper use of the L-Dens 427.

Installation and Use

- Mechanical knocks and vibrations may damage the L-Dens 427. Use caution when handling the sensor.
- The installation procedure should only be carried out by authorized personnel who are familiar with the installation instructions.
- Do not use any accessories or consumables other than those supplied or approved by Anton Paar GmbH.

- Make sure all operators are trained to use the instrument safely and correctly before starting any applicable operations.
- In case of damage or malfunction, do not continue operating the L-Dens 427. Do not operate the instrument under conditions which could result in damage to properties, injuries or loss of life.
- Check the L-Dens 427 for chemical resistance to the samples and cleaning agents.

Maintenance and Service

- The results delivered by the L-Dens 427 not only depend on the correct function of the instrument, but also on various other factors. We therefore recommend to have the results checked (e.g. plausibility tested) by skilled personnel before consequential actions are taken based on the results.
- L-Dens 427 sensors are typically subject to harsh process conditions such as shock pressure, sudden temperature changes, aggressive samples, vibrations, etc. This may cause sudden drifts or malfunctions. Check the measuring results regularly and carry out readjustments if required.
- Installation, start-up, maintenance and service work should only be carried out by trained and authorized personnel.

Returns

- For repairs send the cleaned L-Dens 427 to your Anton Paar representative. Only return the instrument together with the completed „Maintenance/Error Report“ and the „Safety declaration for repairs“. Find the applicable formsheets on the Anton Paar homepage:
  http://www.anton-paar.com/Safetydeclaration/Safetydeclaration.zip
- Make sure you pack the L-Dens 427 securely to prevent further damage during transport. This is especially important if you are returning an instrument under warranty. If possible, use the original packaging.

Disposal

- Concerning the disposal of L-Dens 427 observe the legal requirements in your country.

2.2 Special Safety Instructions for L-Dens 427

Operation in Hazardeous Area/Location

- In hazardous areas with risk of explosion only operate instruments identified by the Ex rating.
- Instruments for use in areas with the risk of explosion must be either the intrinsically safe sensors L-Dens 427F I according to ATEX, or the explosionproof and flameproof devices L-Dens 427F EX, L-Dens 427F EX 2/ 18mA, L-Dens 427E EX and L-Dens 427T EX according to ATEX and FM.
- Anton Paar GmbH confirms that all sensors identified by the ATEX lable, meets the requirements of the EC type examination certificate according to ATEX (guideline 94/9/EG).
- By attaching the Class I, Division 1 type plate according to FM, Anton Paar GmbH confirms that the sensor meets the requirements of the type examination certificate from FM.
- Before using the L-Dens 427 read this instruction manual, the EC type examination Certificates (ATEX), the type examination certificate from FM and the CE Declarations of Conformity.
- Do not repair and/or change components of an L-Dens 427 identified by the Ex lable.
- For installation and operation of the L-Dens 427 refer to national standards and regulations and the respective type examination certificate. It is the plant operator's responsibility to ensure the approval ratings listed on the instrument comply with these standards.
- The Ex lable and the EC approval certificate contain the following identification:
  -  II 2G Ex d IIC T4/T5 ... flameproof acc. to ATEX
  - Class I, Division 1, Groups A, B, C, D (US) ... explosionproof acc. to FM
  - Class I, Division 1, Groups B, C, D (CA) ... explosionproof acc. to FM

  or

  -  II 1/2G Ex ia IIC T4/T5 ... intrinsically safe acc. to ATEX

2.3 Safety Symbols on the Instrument

Warning symbol – sample connection:

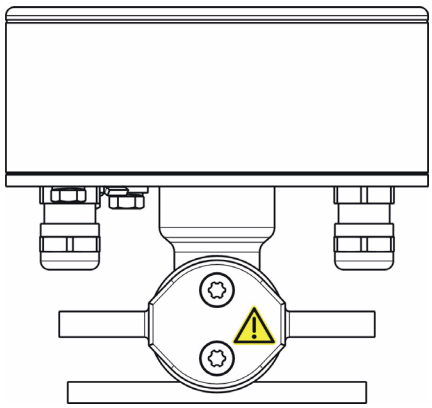


Fig. 2 - 1 Warning symbol at the sample connection

WARNING
The density sensor as well as the process connection is designed for a max. pressure and a max. sample temperature according to Appendix D.

Hot surface
Risk of injury! The sample connections, the flange plate and the sensor heat up to the temperature of the sample after a period of time.

Warning symbol on the rear side of the electronics housing:

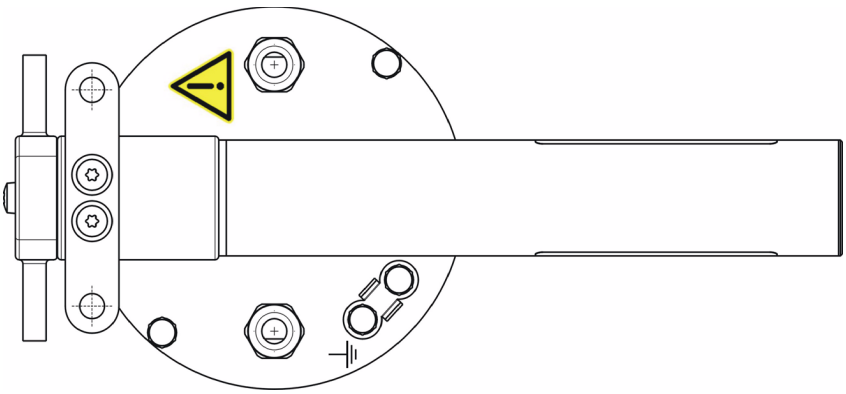


Fig. 2 - 2 Warning symbol on the rear side of the electronics housing:

WARNING
- For your safety follow all instructions for cable and connection, shielding and grounding given in Chapter 8.
- Do no open when an explosive atmosphere may be present.

3 L-Dens 427 – An Introduction

Small and compact with great accuracy: L-Dens 427 family

The L-Dens 427 density sensor continuously measures the density and temperature of a sample liquid flowing through the sensor.

Density is an important liquid material parameter and can be used for material characterization. For many liquid solutions and mixtures the density is directly proportional to the concentration. Therefore, a density measurement can also be used to determine the concentration.

Straight to the flow computer:
L-Dens 427FI, L-Dens 427F EX and L-Dens 427F EX 2/18mA

A signal proportional to the density as well as the measuring temperature are directly transferred to a flow computer via a frequency output and a Pt100 interface. The density is calculated using sensor constants in the flow computer. The sensor constants are compatible with the formulas which are already implemented in many flow computer models. In combination with a volumetric flow measurement, the mass flow rate can be easily determined with great accuracy.

Straight to the Anton Paar Evaluation Unit:
L-Dens 427E and L-Dens 427E EX

The mPDS evaluation unit calculates the temperature-compensated density, concentration values or further deduced properties and makes them available at standard interfaces for monitoring and controlling purposes. The combination of the L-Dens 427E (EX) and the evaluation unit opens up a huge range of new applications. The application determines the selection of process connections and user programs.

Straight to the PLC: L-Dens 427T EX

The L-Dens 427T EX completes the family. The supported interfaces Modbus, HART and the 4 – 20 mA analog signal enable the simple connection to your measuring and control center. Beside the actual measurement values such as line density and temperature, the output can be set to many different calculated values like compensated density, API gravity and concentration.

Model Overview:

Model	Interfaces	Hazardous area rating
L-Dens 427F I	Frequency and Pt100	ATEX Ex ia IIC T4/5
L-Dens 427F EX	Frequency and Pt100	ATEX Ex d IIC T4/5 FM Class I, Division 1, Groups A,B,C,D (US) Groups B,C,D (CA)
L-Dens 427F EX 2/18mA	Frequency and Pt100	ATEX Ex d IIC T4/5 FM Class I, Division 1, Groups A,B,C,D (US) Groups B,C,D (CA)
L-Dens 427E	Connection to AP evaluation unit (mPDS)	----------
L-Dens 427E EX	Connection to AP evaluation unit (mPDS)	ATEX Ex d IIC T4/5 FM Class I, Division 1, Groups A,B,C,D (US) Groups B,C,D (CA)
L-Dens 427T EX	4-20 mA, HART, Modbus, Concentration and Petroleum programs	ATEX Ex d IIC T4/5 FM Class I, Division 1, Groups A,B,C,D (US) Groups B,C,D (CA)

Fig. 3 - 1 Density sensor – front

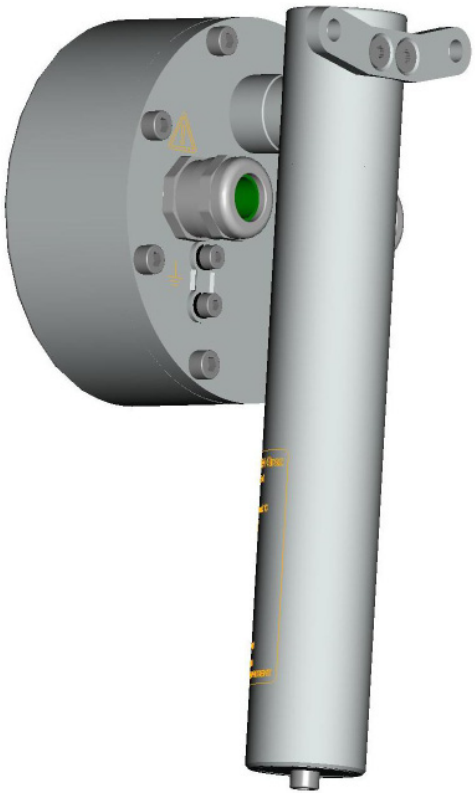


Fig. 3 - 2 Density sensor – back

Applications:

- Online measurement of density (at measuring temperature) and temperature-compensated density
- Determination of mass flow is possible by upgradeing an existing flow meter with a density sensor (mass flow = density * volume flow).
- Online concentration measurement
- Product differentiation and/or phase separation
- Product blending
- Fiscal measurement

Liquids to be measured:

- Fuels (regular-grade petrol, premium, diesel, extra light heating oil, Jet-A1…)
- Other low-viscous petroleum products, by-products and end products of refineries, LPG
- Ethanol
- All low-viscous liquids to which the oscillator is resistant

The L-Dens 427 density sensor is either installed in the bypass to the main line or directly mounted in the main line if the flow rates are suitable.

Features and Benefits:

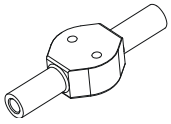
- High-precision, fast-response measurement (oscillating U-tube principle) without moving parts
- Robust housing made of stainless steel for operation under harsh process conditions in interior and exterior areas
- High-resolution temperature measurement in the instrument
- Low pressure-dependency, irrelevant for minor pressures, option of compensation
- Suited for Fiscal measurement
- Suitable for continuous density measurement according to national and international standards, such as MID, OIML R117, API etc.
- All wetted parts are made of certified raw materials and can be traced to these certifications.
- Maintenance-free, long life

4 Checking the Supplied Parts

The L-Dens 427 was tested and packed carefully before shipment. However, damage may occur during transport.

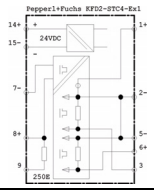
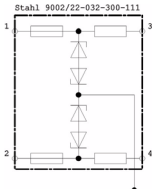
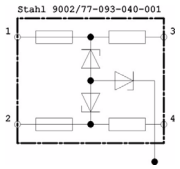
- Keep the packaging material (box, foam piece, transport protection) for possible returns and further questions from the transport- and insurance company.
- Check the delivery for completion by comparing the supplied parts to those noted in the following tables.
- If a part is missing, contact your Anton Paar representative.
- If a part is damaged, contact the transport company and your Anton Paar representative.

4.1 Supplied Parts for L-Dens 427F I

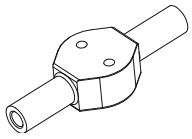
Symbol	Pcs.	Article Description	Mat. No.
	1	**L-Dens 427F I Online density sensor** including: • Factory adjustment protocol for standard temperature range -10 ... 50 °C • Cable glands	40555
	1	Instruction manual	
	1	**Connection kit:** • for Swagelok 12 mm or • for Flange DIN 2633 or • for Flange ANSI 1/2" 300 or • Tri-Clamp 1/2"	 45285 88950 89115 89411

Optional Parts:

Symbol	Pcs.	Article Description	Mat. No.
	1	Special adjustment (adjustment constants "K") in defined temperature range	63487
	1	Calibration constants BEV 0.001 g/cm^3 (for BEV calibration certificate)	19748
	1	Special adjustment (adjustment constants "P") in defined pressure range	97025

Symbol	Pcs.	Article Description	Mat. No.
	1	Buffer amplifier* Pepperl & Fuchs KFD2-STC4-Ex1	46104
	1	Safety barrier 1 Stahl 9002/22-032-300-111	46109
	1	Safety barrier 2 Stahl 9002/77-093-040-001	46108

4.2 Supplied Parts for L-Dens 427F EX and L-Dens 427T EX

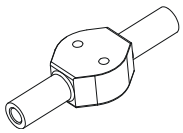
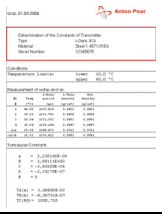
Symbol	Pcs.	Article Description	Mat. No.
	1 or 1 or 1	**L-Dens 427F EX Online density sensor** or **L-Dens 427T EX Online density sensor** or **L-Dens 427F EX 2/18m Online density sensor** Including Factory adjustment protocol for standard temperature range -10 ... 50 °C	90102 92034 97471
	1	Instruction manual	
		**Connection kit:** • for Swagelok 12 mm or • for Flange DIN 2633 or • for Flange ANSI 1/2" 300 or • Tri-Clamp 1/2"	 45285 88950 89115 89411

Optional Parts:

Symbol	Pcs.	Article Description	Mat. No.
	1	Special adjustment (adjustment constants "K") in defined temperature range	63487

Symbol	Pcs.	Article Description	Mat. No.
	1	Set of cable glands HSK-M-Ex–d NPT 1/2" and one blanking plug (all ATEX rated)	93678
	1	Special adjustment (adjustment constants "P") in defined pressure range	97025

4.3 Supplied Parts for L-Dens 427E and L-Dens 427E EX

Symbol	Pcs.	Article Description	Mat. No.
	1 or 1	**L-Dens 427E Online density sensor** including two cable glands or **L-Dens 427E EX Online density sensor**	80926 89541
	1	Instruction manual	
	1	**Connection kit:** • for Swagelok 12 mm or • for Flange DIN 2633 or • for Flange ANSI 1/2" 300 or • Tri-Clamp 1/2"	 45285 88950 89115 89411
	1	Factory adjustment protocol*, "constants K" (please specify temperature range on order) **Adjustment protocol corresponds to the serial number of the density sensor*	63487

Optional Parts:

Symbol	Pcs.	Article Description	Mat. No.
	1	Set of cable glands HSK-M-Ex–d NPT 1/2" and one blanking plug (all ATEX rated)	93678
	1	Calibration constants BEV 0.001 g/cm^3 (for BEV calibration certificate)	19748
	1	Special adjustment (adjustment constants "P") in defined pressure range	97025

5 Measuring Principle and Design

The L-Dens 427 continuously monitors product quality and product specifications during production.

For many liquid solutions and mixtures, the density is directly proportional to the concentration. The measured density value can therefore be used to determine the concentration. The density also can be used for material characterization.

5.1 Measuring Principle

The L-Dens 427 uses the reliable oscillating U-tube measurement principle to measure the density.

A U-shaped tube, where the sample flows through oscillates at its natural frequency. The natural frequency depends on the density of the sample. It is measured and used for the density calculation together with the measured temperature.

Temperature influence:

The temperature dependency of the sensor is determined during the factory adjustment and is compensated in the respective temperature range.

Sudden temperature changes need a short equalization time. Temperature changes faster than 1 °C/min can cause deviations in the density result.

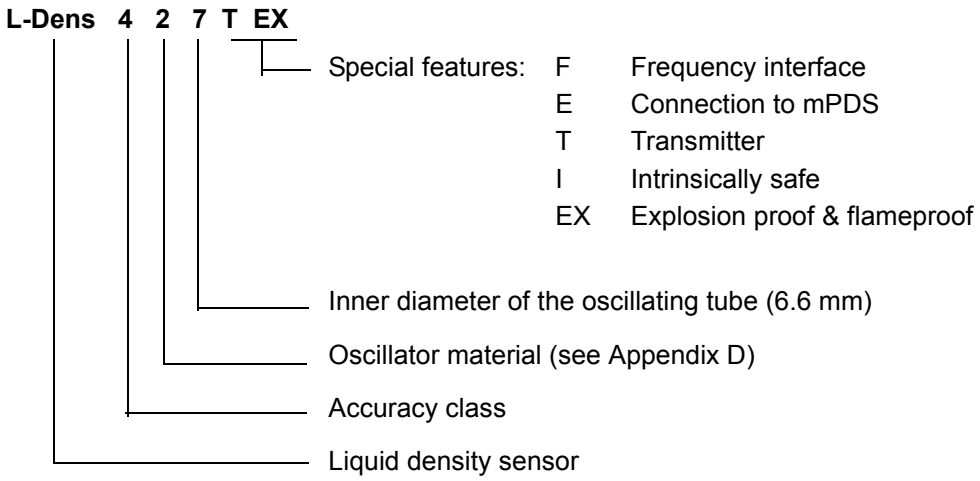
Pressure influence:

Small pressure fluctuations can be eliminated by adjusting the results on-site under process and pressure conditions.

The sensor’s pressure dependency can be determined during the factory adjustment and can be accordingly compensated. For a pressure compensation, the pressure must be continuously measured with an external pressure sensor. The PLC, flow computer or Anton Paar Evaluation Unit, calculates the compensated density.

5.2 Design Features

The designation of the L-Dens 427 density sensor describes the following properties:



The L-Dens 427 consists of a robust sensor housing which contains the oscillator, the electromagnetic excitation system and the temperature sensor.

The sensor electronics are built into a separate housing. The cable glands for the interface cables and a ground terminal for optional use are located at the back of the electronics housing.

5.2.1 Serial Number and Material Certificates

The serial number and the material certificates' numbers of all the sensor's wetted parts are engraved on the sensor housing of the L-Dens 427:

Example inscription of serial number and material certificates:

Sn. 14936173	... Oscillator serial number
Mc. 855	... Oscillating tube material certificate (Hastelloy)
Mc. 722	... Material certificate of baffle part 1 (stainless steel)
Mc. 722	... Material certificate of baffle part 2 (stainless steel)

Fig. 5 - 1 Serial number and material certificates

Another inprint of the according material certificates' numbers is located on the connection kit.

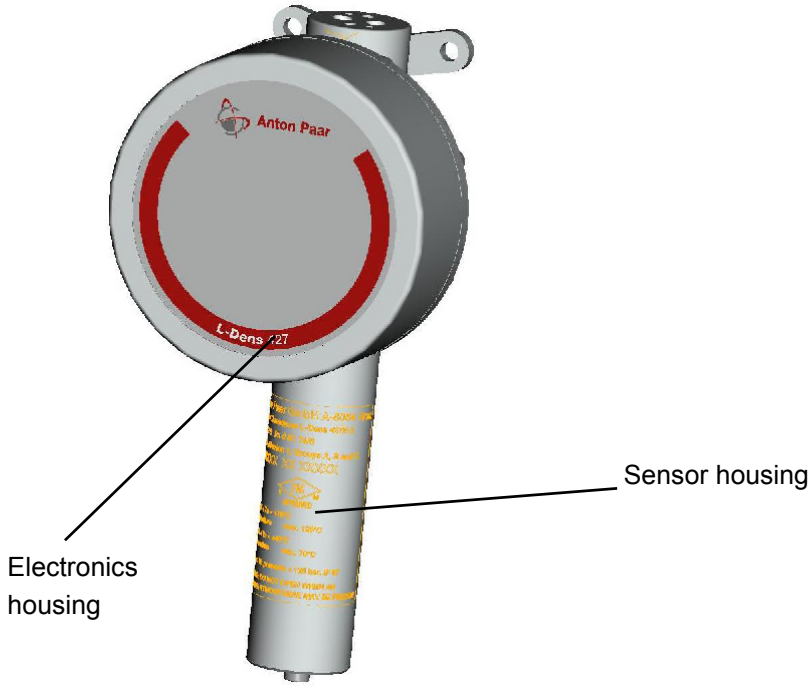


Fig. 5 - 2 Front side

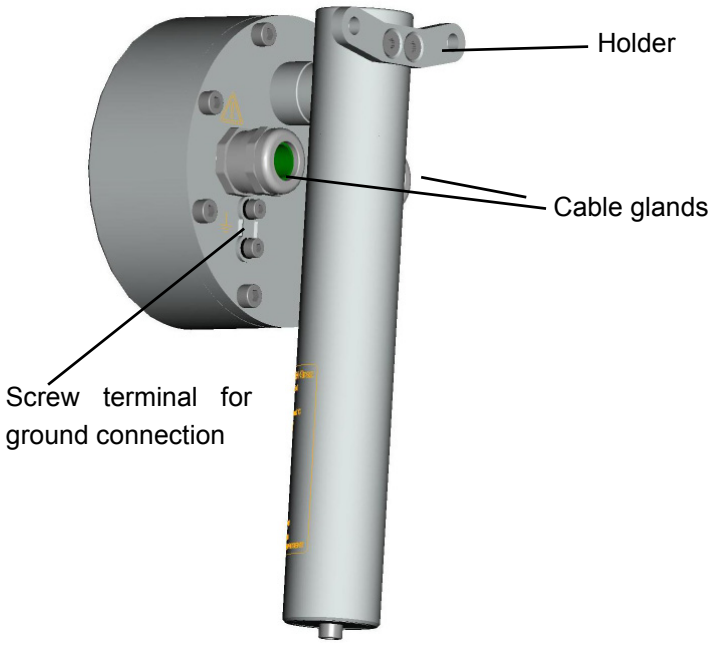


Fig. 5 - 3 Rear side

6 Installation Checklist

1. Install the L-Dens 427 in the production line, refer to Chapter 7.
2. Make sure that the connections are secure and leak-tight.
3. Perform electrical cabling of the L-Dens 427 and set-up, refer to Chapter 8.
4. Cleaning:
   Before you use the system to measure products, it is essential to clean the instrument in the production line (to remove any deposits or other dirt which has accumulated during the installation process), refer to Chapter 10.
5. Start the measuring system:
   Make sure that the main line is filled and free of bubbles.
6. Make a performance check of the L-Dens 427, refer to Chapter 9.

7 Mechanical Installation of the L-Dens 427

WARNING

- Installation, start-up, maintenance and service work should only be carried out by trained and authorized personnel.
- Make sure that the main line is empty and unpressurized before mounting or dismounting the L-Dens 427.
- Observe the operating and ambient conditions permitted for the L-Dens 427 (refer to Appendix D).
- Pay attention to warning signs on the sensor, also refer to Chapter 2.
- Before filling the sensor with sample or cleaning agent, check the chemical resistance of the wetted parts (see Appendix D).

WARNING

- **Hot surface, risk of burns!** The sample connections and sensor heat up to the temperature of the sample after a period of time. The operator is responsible for ensuring protection from burns.

WARNING

- Before installation, read the instruction manual carefully. Incorrect installation can lead to damage to the L-Dens 427.
- Mechanical knocks and vibrations may damage the sensor. Take care when handling the sensor.
- When connecting the L-Dens 427 to the process line, regard the hints in the following chapters concerning mounting position and installation type.

7.1 Direction of Flow

NOTICE

The flow rate through the L-Dens 427 must be at a sufficient rate in order to ensure temperature stability throughout the entire oscillator. The recommended maximum flow rate should not be exceeded either, in order to prevent cavitation (refer to Appendix D).

NOTICE

- Handle the L-Dens 427 carefully and avoid impacts.
- Regard the flow specifications and ensure continuous, pulsation-free flow.
- If there is a risk of gas bubbles forming, the line pressure must be higher than P_{min}. The according definition:
  P_{min} = 2 x partial pressure of the dissolved gas and/or
  P_{min} = 2 x vapor pressure of the volatile liquid component.
  P_{min} for LPG = vapour pressure + 1 bar
- Do not bend the connecting tubes of the L-Dens 427.

The direction of flow is marked on the sensor and needs to be considered during the installation.

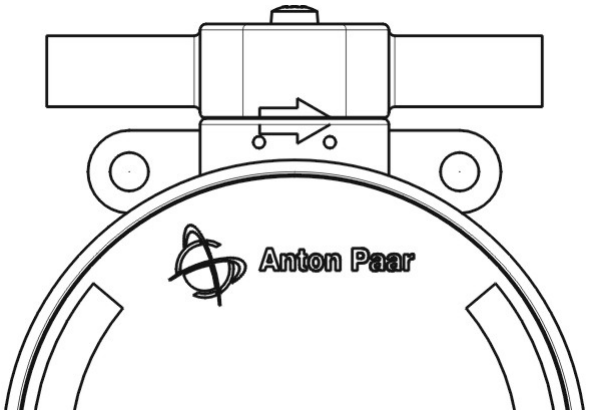


Fig. 7 - 1 Designation of flow direction

The L-Dens 427 is mounted on the holder provided. The sensor is mounted with 2 M6 screws.

Different sample connections can be connected to the L-Dens 427 (Appendix D).

7.2 Installation Position

Installation position at a horizontal main line:

The L-Dens 427 can be mounted in various positions, e.g. on the wall, on a rack or directly at the main line.

The sensor is normally mounted horizontally:

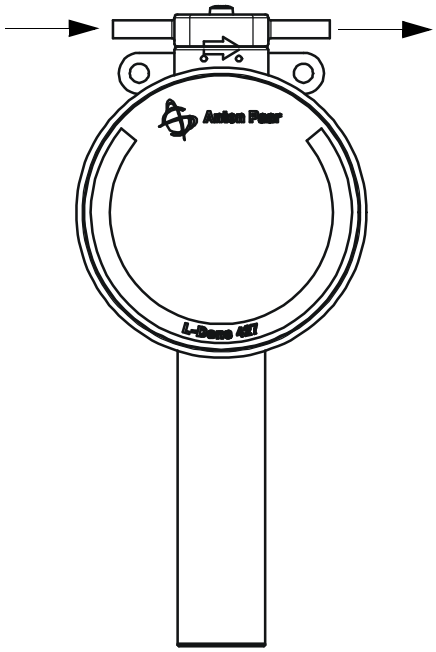


Fig. 7 - 2 Installation position at a horizontal main line

Installation position at a vertical main line:

For special applications the following installation positions are preferable:

- If there is a risk of solid deposits:

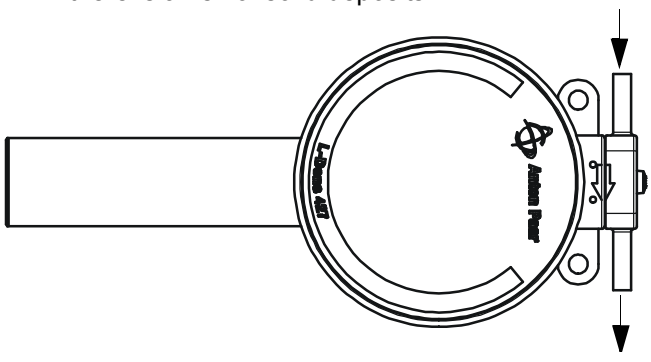


Fig. 7 - 3 Installation position at a vertical main line (risk of solid deposits)

- If there is a risk of gas bubbles:

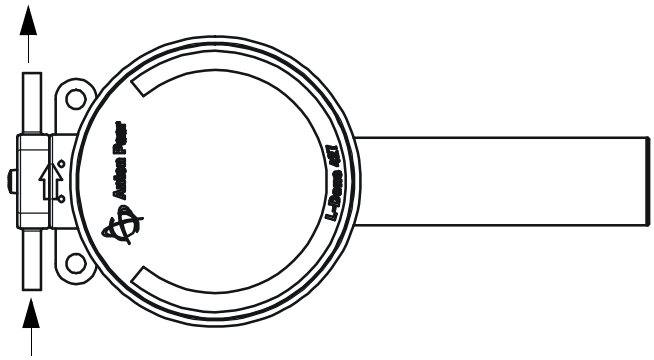


Fig. 7 - 4 Installation position at a vertical main line (risk of gas bubbles)

7.3 Protection from Vibrations

The sensor should be mounted on a rigid, vibration-free base. If this is not possible, it is recommended to use vibration dampers made of e.g. rubber between the sensor and the mounting base. It is also important to prevent vibrations from being transferred to the sensor via the connection lines. If necessary, use flexible connection lines or mechanically support them.

7.4 Protection against Ambient Temperature Influence

If there are major fluctuations of the ambient temperature or large differences between the ambient temperature and the sample temperature, the sensor and the bypass installation need to be insulated in order to avoid measuring deviations due to the influence of ambient temperature. Avoid directly exposing the sensor to sunlight.

7.5 Types of Installation

The L-Dens 427 is mostly installed in a bypass to the main line, but can also be installed directly in the main line (inline) depending on the flow rate (refer to Appendix D). In case of larger flow rates, fluctuating flow rates or measurements from containers, a bypass installation is recommended.

7.5.1 Installation in a Bypass

If the flow volume in the main line exceeds the recommended upper limit for the density sensor, install the L-Dens 427 in a bypass off the main line.

NOTICE

- Hold the bypass tubes short and free of unnecessary bends.
- Locate the sensor in the main line at the same level as the bypass connections. This prevents the formation of gas-filled cavities, which may restrain the necessary flow through the sensor, and enables self-emptying.
- Vent the lines during installation.

NOTICE

- For applications with bypass installation we recommend using valves at the inlet and outlet for flow regulation, a sample valve for taking reference samples and valves for cleaning the bypass lines.

NOTICE

- The tube between the pump and the sensor should have a minimum of 1 m.
- The diameter of the bypass tubes should be at least 12 mm.
- The distance between the inlet and the outlet of the bypass at the main line should be at least 1 m.

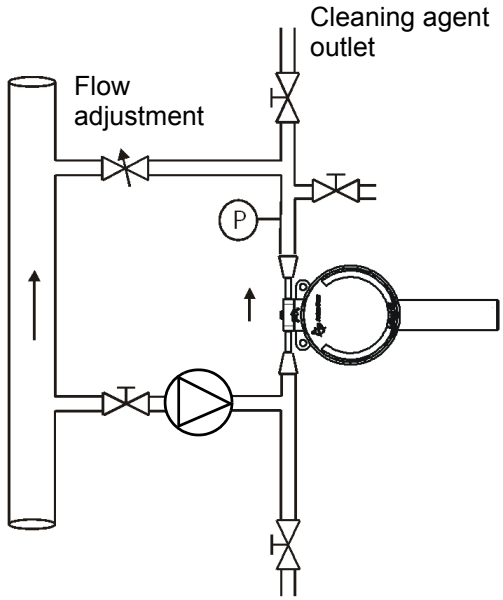


Fig. 7 - 5 Installation with valves for flow adjustment, cleaning and sampling

There are several options for generating the pressure difference necessary to force a sufficient flow of sample through the bypass:

7.5.1.1 Bypass with pump

This is used if there are insufficient or fluctuating flow conditions. A bypass pump is also necessary if increased pressure is necessary in the L-Dens 427, e.g. to prevent the formation of gas bubbles.

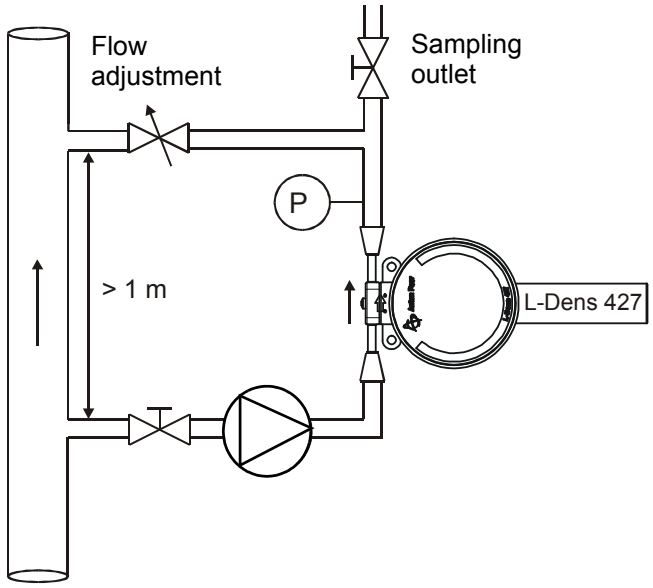


Fig. 7 - 6 Bypass with pump

7.5.1.2 Bypass across a pump

This is used if a bypass across a pump in the main line is possible and the pump provides a stable pressure difference. Pumps built into the main line often generate a much higher pressure than required for a reasonable flow rate through the bypass. Therefore it is very important to adjust the flow through the bypass properly using the outlet valve.

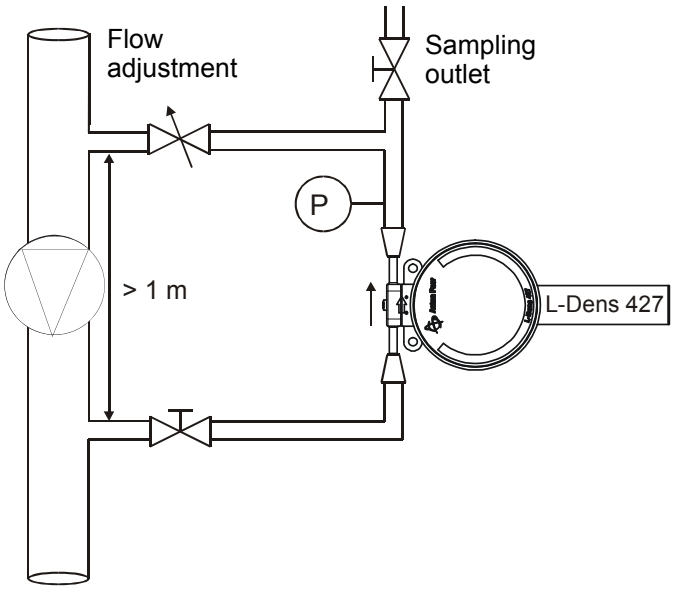


Fig. 7 - 7 Bypass across a pump

7.5.1.3 Bypass over a reduction in the main line

This is used if there is a constant main line flow.

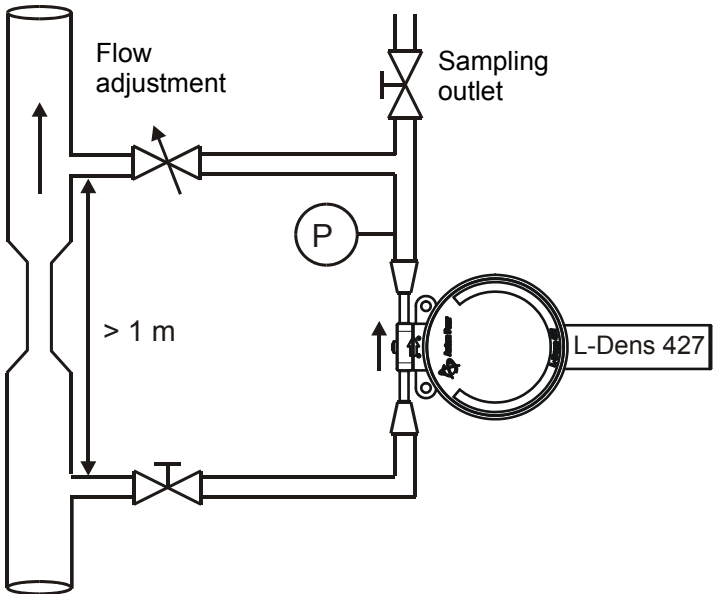


Fig. 7 - 8 Bypass over a reduction in the main line

7.5.1.4 Bypass with an orifice in the main line

This is used if there is a constant main line flow.

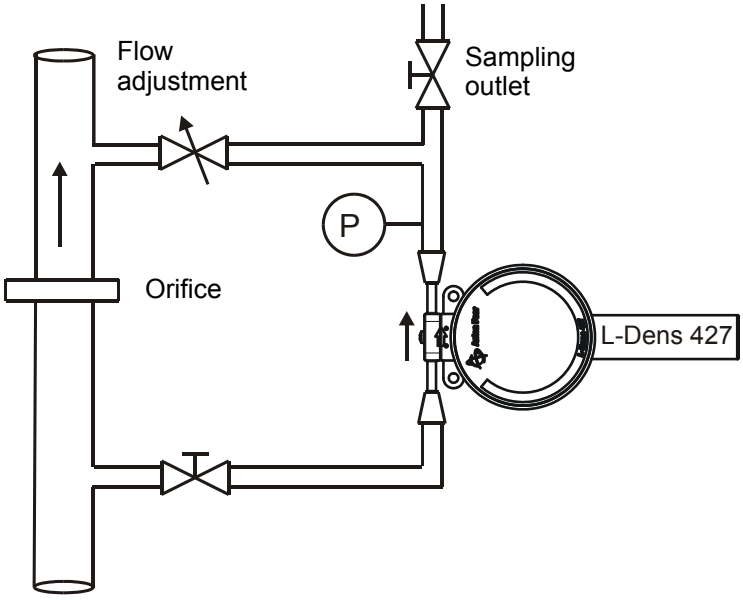


Fig. 7 - 9 Bypass with an orifice in the main line

7.5.1.5 Bypass with a Pitot tube in the main line

This is used if there is a constant main line flow.

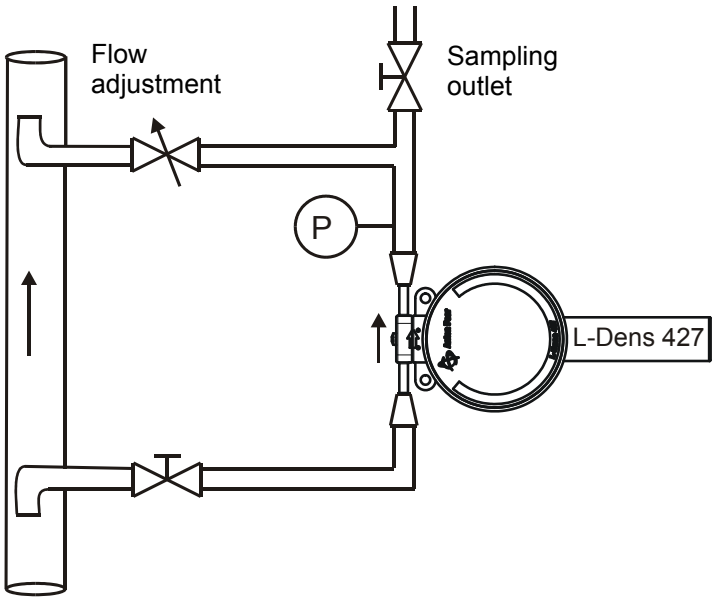


Fig. 7 - 10 Bypass with a Pitot tube in the main line

7.5.2 Installation Directly in the Main Line

The L-Dens 427 can be installed directly in the main line if the flow rate in the main line is within the specified limits of the sensor (refer to Appendix D).

8 Electrical Installation and Set-up

WARNING

- The devices have a functional insulation. Protection against potentially hazardous touch current has to be ensured by the customer in accordance to local regulations.
- Installation, maintenance and service work should only be carried out by trained and authorized personnel.
- Installations shall comply with the intended area of use and the relevant national regulations and requirements.

8.1 Explosion Protection

8.1.1 Intrinsically Safe Density Sensors

The L-Dens 427F I is an intrinsically safe device. It is marked with an Ex type plate and features an EC type examination certificate according to 94/9/EG (ATEX).

WARNING

- Observe the hints in the instruction manual, the certificate and the signs on the instrument during installation and service. Also observe the corresponding national standards and regulations.
- Connect evaluation units or flow computers to the L-Dens 427F I sensor using accessories (buffer amplifier for frequency interface/barrier for temperature measurement). These must be mounted outside the area with risk of explosion. Observe the producers' instructions.
- When selecting the cable and cable length, take into account the max. allowed electrical ratings stated on the EC type examination certificates.
- The sensor's housing has a ground terminal which must be connected to ground and with the ground terminals of the barriers and flow computer. A cross-section of at least 1.5 mm^2 is specified for this line. If there is the possibility of major potential differences between the parts of a station, the potential equalization cable has to be dimensioned accordingly

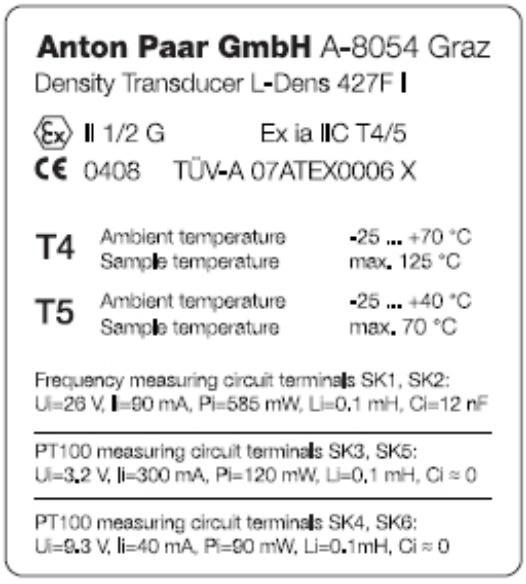


Fig. 8 - 1 Example for Ex type plate

8.1.2 Explosionproof and Flameproof Density Sensors

The L-Dens 427F EX, L-Dens 427F EX 2/18 mA, the L-Dens 427E EX and the L-Dens 427T EX are explosionproof and flameproof devices and marked with an Ex type plate on the sensor housing.

WARNING

- For installation, operation, maintenance and service observe the hints in the instruction manual of the instrument, the type examination certificate and the signs on the instrument.
- Installations shall comply with the national regulations and requirements.
- Cable glands or conduits, which comply with the national regulations for hazardous areas, must be used.
- If a cable gland or conduit entry part is not used, it must be blanked off using the appropriate flameproof / explosionproof blanking plug whith the plug entered to a depth of at least five threads.
- Do not open when an explosive atmosphere may be present.

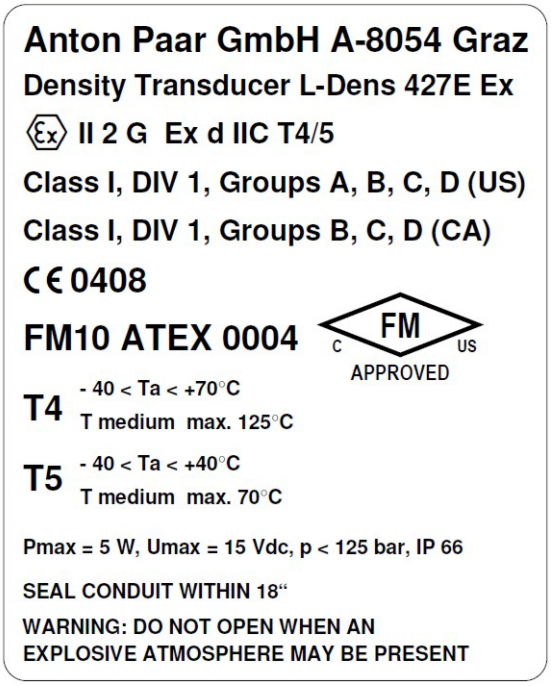


Fig. 8 - 2 Example for Ex type plate

8.2 Electrical Cabling

WARNING

- The connecting cables must correspond to the local ambient conditions and the national regulations.
- Take mechanical stress into consideration when choosing the connecting cables.
- Choose the cables' diameters to ensure optimal sealing at the cable gland.
- Strain relief is provided by the correct assembly of the cable gland.

Recommended cables L-Dens 427F I and L-Dens 427E:

- 2-pole and/or 4-pole shielded cable, diameter 3 - 6.5 mm
- Insulation resistance/test voltage 4000 V_{eff}, 50/60 Hz
- Recommended cable type: LiYCY

Recommended cables L-Dens 427E EX, L-Dens 427F EX, L-Dens 427T EX, L-Dens 427F EX 2/18mA :

- 2-pole and/or 4-pole shielded cable, diameter 7 - 12 mm
- Insulation resistance/test voltage 4000 V_{eff}, 50/60 Hz
- Recommended cable type: LiYCY

The connecting cables are not included in the delivery.

Procedure:

1. Open the cover of the electronics housing to connect the cables to the connection terminals on the circuit board. Find detailed descriptions of the interface connections and pin assignment in Chapter 8.3 and Chapter 8.4 for the respective instruments.
2. Unscrew the screws at the rear and open the electronics housing.
3. Loosen the cable glands and insert the interface cables.
4. Connect the cables to the connection terminals.
5. Close the electronics housing and tighten the cable glands. Pay attention to leak-tightness.

8.3 Grounding

WARNING
Installations must meet the relevant national regulations and requirements.

On the rear of the electronics housing there is a ground terminal provided.

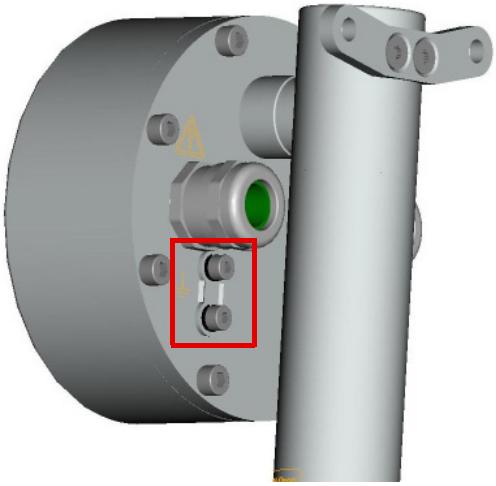


Fig. 8 - 3 Screw terminal for ground connection

For explosionproof and flameproof instruments there is an additional ground terminal inside the electronics housing.

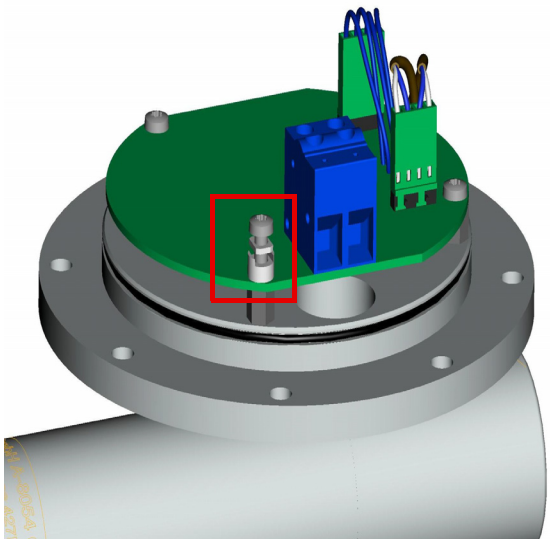


Fig. 8 - 4 Ground terminal inside the electronics housing for the L-Dens 427E EX

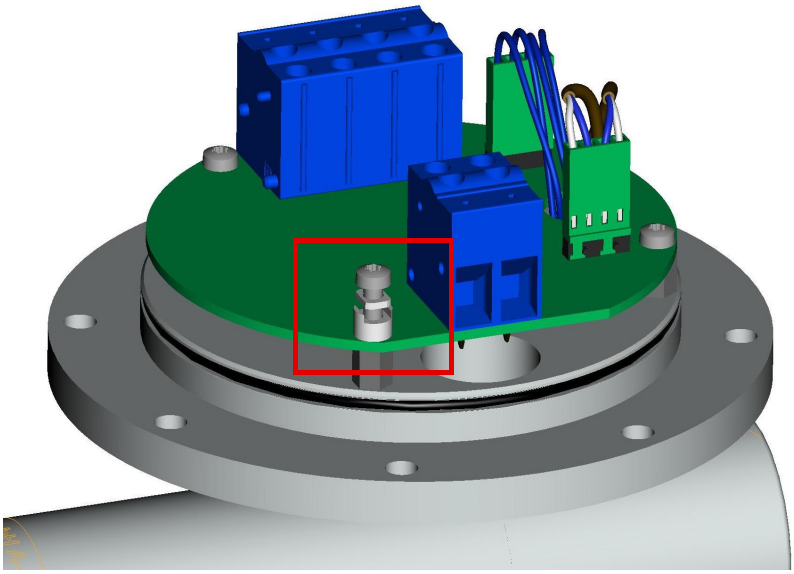


Fig. 8 - 5 Ground terminal inside the electronics housing for the L-Dens 427F EX, L-Dens 427F EX 2/18 mA

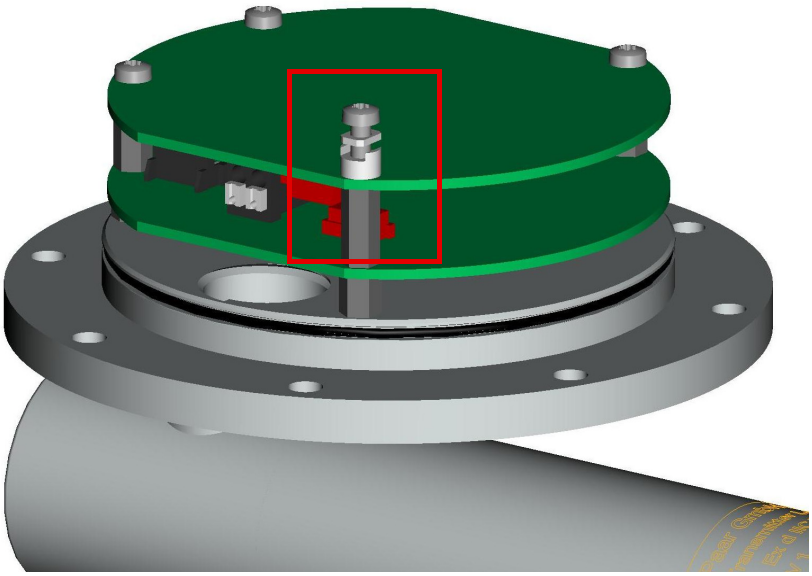


Fig. 8 - 6 Ground terminal inside the electronics housing for LL-Dens 427T EX

8.4 Electrical Installation and Setup

Find the wiring schemes and installation instructions for the different density sensor models of L-Dens 427 in the subsequent chapters.

8.4.1 Electrical Installation of L-Dens 427F I, L-Dens 427F EX and L-Dens 427F EX 2/18 mA

8.4.1.1 Wiring Scheme

The L-Dens 427F I, L-Dens 427F EX and L-Dens 427F EX 2/18mA sensors have to be supplied with a voltage according to Appendix D in 2-wire technology. The oscillation frequency is transferred on the same wires and modulated on the supply current. Additionally a temperature signal (Pt100 4-wire) is provided.

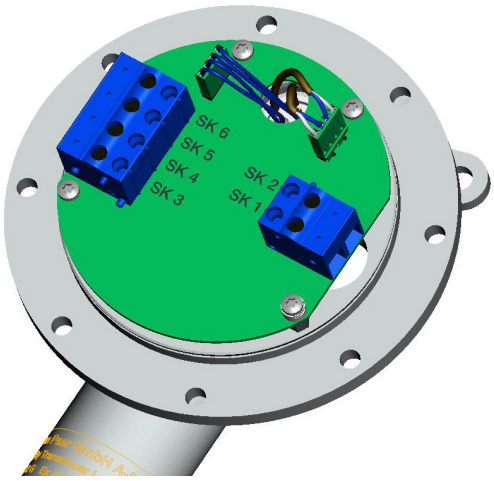


Fig. 8 - 7 Screw terminals of the L-Dens 427F I, L-Dens 427F EX and L-Dens 427F EX 2/18mA

Cable terminal	Function	Connection
SK1	Supply voltage and frequency-interface	DC +
SK2	Supply voltage and frequency-interface	DC -
SK3	Pt100 interface	Measuring circuit
SK4	Pt100 interface	Measuring current
SK5	Pt100 interface	Measuring circuit
SK6	Pt100 interface	Measuring current

L-Dens 427F I

Following accessories must be used for the electrical connection of the intrinsically safe L-Dens 427F I sensor with a flow computer, PLC or an evaluation unit. Use the equipment stated in the following table or equipment with matching electrical data, as referred to the EC type examination certificate:

Instrument	to connect to
Buffer amplifier Pepperl & Fuchs KFD2-STC4-Ex1	Frequency interface
Safety barrier 1 Steel 9002/22-032-300-111	Pt100 interface (measuring circuit)
Safety barrier 2 Steel 9002/77-093-040-001	Pt100 interface (measuring current)

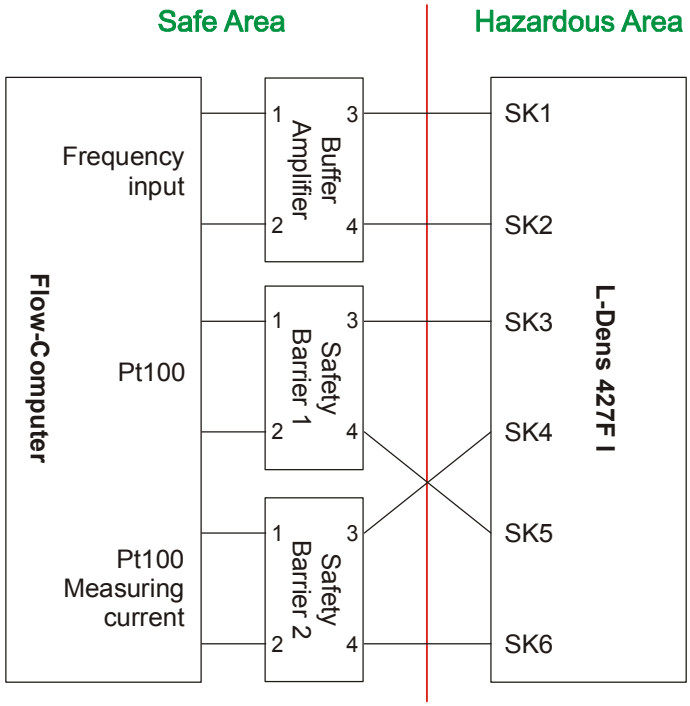


Fig. 8 - 8 Mounting the instruments in areas with risk of explosion – frequency circuit and Pt100 circuit

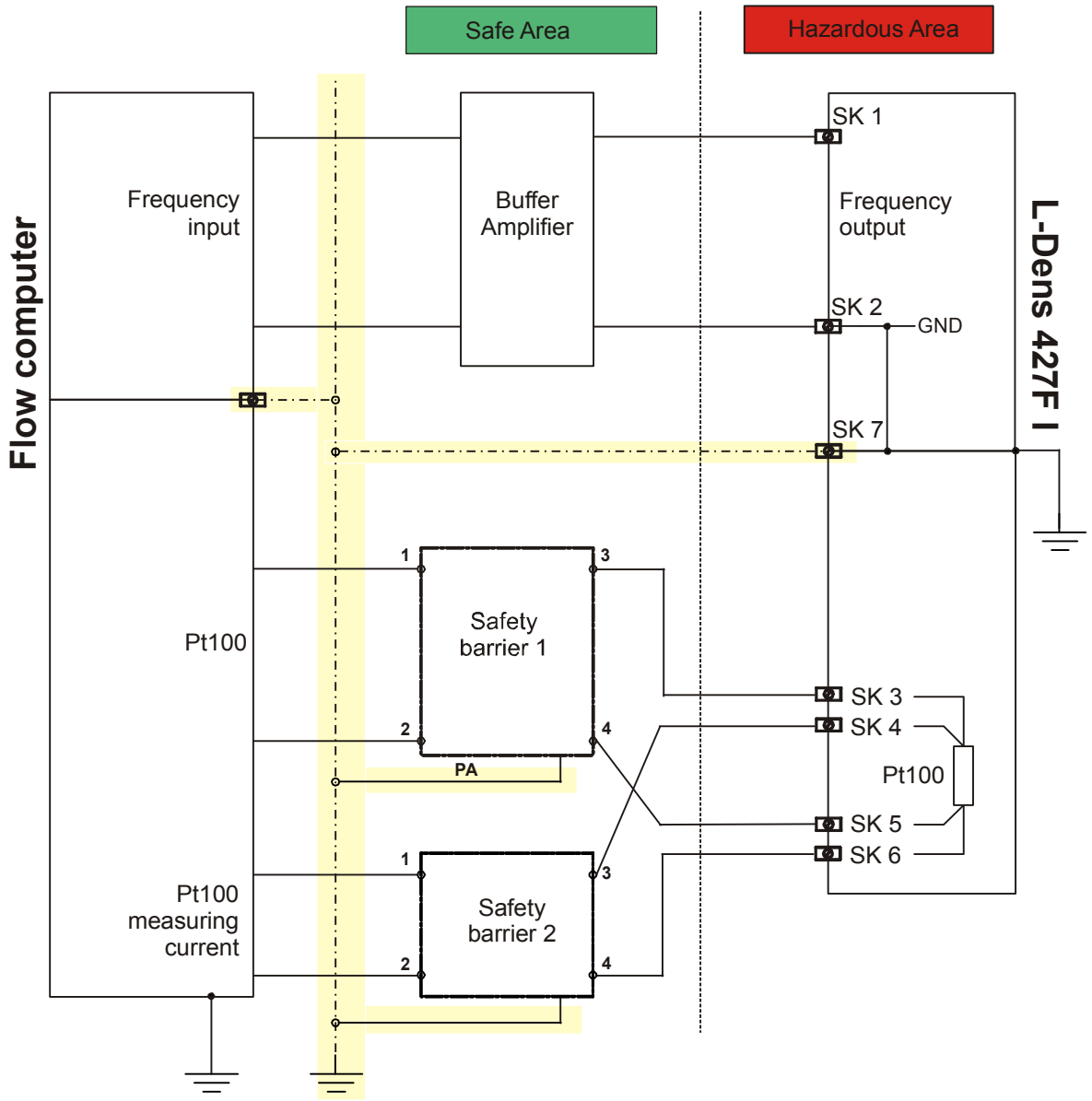


Fig. 8 - 9 Diagram of potential equalization and ground cables

L-Dens 427F EX and L-Dens 427F EX 2/18mA:

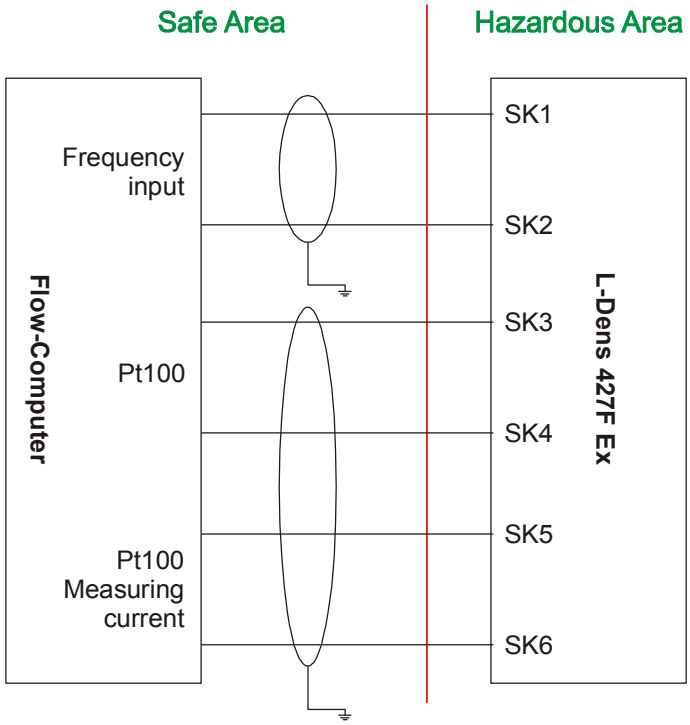


Fig. 8 - 10 Wiring diagram L-Dens 427F EX and L-Dens 427F EX 2/18mA

8.4.1.2 Pt100 Interface

The Pt100 of L-Dens 427F I, L-Dens 427F EX, L-Dens 427F EX 2/18mA have a 4-wire terminal. The evaluation electronics supplies the Pt100 and measures at the other two terminals the voltage that is proportional to the temperature.

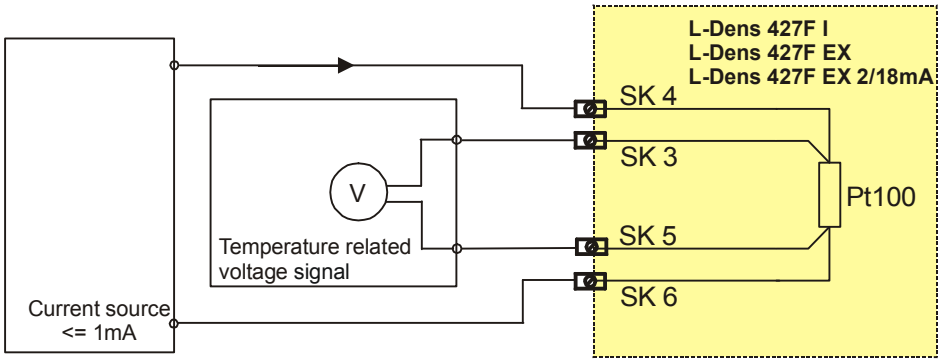


Fig. 8 - 11 Pt100 interface

For specifications of Pt100, temperature circuit supply and temperature measuring signal please refer to Appendix D.

8.4.1.3 Power Supply and Frequency Interface

The density sensor's power is supplied by the flow computer. The flow computer's current is modulated with the resonant frequency of the density sensor. In the evaluation electronics this is used to determine the frequency again and to calculate the density.

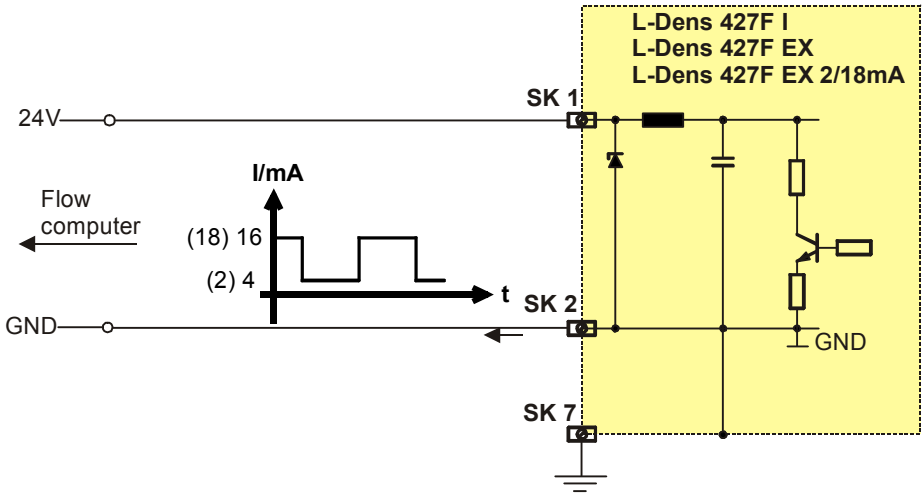


Fig. 8 - 12 Power supply and frequency interface

For supply voltage and current specifications please refer to Appendix D.

8.4.1.4 Configuration and Set-up

Enter the adjustment constants from the adjustment protocol (example in Appendix B) into the evaluation unit or the flow computer. Observe the following instructions. Depending on the evaluation unit or flow computer the adjustment constants may also have other names.

NOTICE

- The density can only be correctly calculated from the oscillation frequency and temperature if the right adjustment constants are applied. Pressure influences can only be compensated if the right adjustment constants are applied.
- Compare the sensor's serial number with the serial number on the adjustment protocol. Each sensor is assigned individual adjustment data.
- Enter adjustment constants correctly. The density is caluclated in the flow computer with the constants stated on the adjustment protocol. It is caluclated from the period of oscillation, the temperature and an optional pressure signal using the formulas described below.
- If some units or calculation formulas used in the evaluation unit differ from this example, the according factors have to be considered.

Density Calculation with Frequency Adjustment Constants

The density is calculated in the flow computer with the constants stated on the adjustment protocol. It is calculated from the period of oscillation, the temperature and an optional pressure signal using the following formulas:

For the flow computer Accuload III from FMC:

$D = K0 + K1*T + K2 *T^2$
$Dt = D (1+ K18 (t - tk)) + K19 (t - tk)$
$Dp = Dt (1+ K20 (p - pk)) + K21 (p - pk)$

K20 and K21 are calculated from:

$K20 = K20A + K20B (p - pk)$
$K21 = K21A + K21B (p - pk)$

D	Density at measuring temperature [kg/m^3], not corrected
Dt	Density at measuring temperature [kg/m³], corrected for temperature effects
Dp	Density at measuring temperature [kg/m³], corrected for temperature and pressure effects
T	Period of time of the oscillation frequency [s]
t	Measuring temperature [°C]
tk=T_{cal}	Reference temperature = **20 °C**
p	Measured absolute pressure in the line [bar]
pk=P_{cal}	Reference pressure = **1 bar**

K0, K1, K2	Adjustment constants
K18, K19	Adjustment constants for temperature compensation
K20A,K20B	Adjustment constants for pressure compensation
K21A,K21B	Adjustment constants for pressure compensation

For the flow computer type MFX 4 following adjustment constants are used:

Kb0	=	K0
Kb1	=	$K1 * 10^2$
Kb2	=	$K2 * 10^4$
Kbt1	=	K18
Kbt0	=	K19

$D = Kb0+Kb1*10000/f+Kb2*10000/f*10000/f$

D	Density at measuring temperature [kg/m³], not corrected
f	Frequency of oscillating tube [Hz]
Kb0, Kb1,Kb2	Adjustment constants, refer to adjustment protocol

A Pt100 sensor is mounted on the oscillator for continuously recording the measuring temperature. The following equation is used for compensating the temperature dependency of the sensor:

$$Dt = D + (Kbt0 + Kbt1*D)*(t - tk)$$

Dt	Density at measuring temperature [kg/m³], corrected for temperature effects
t	Measuring temperature [°C]
tk=T	Reference temperature = **20 °C**
Kbt0, Kbt1	Adjustment constants for temperature compensation

An external pressure sensor is required for optional pressure compensation. The pressure effect is compensated using the following formula:

$$Dp = Dt * [1 + [K20A + K20B(p - pk)] (p - pk)] + [K21A + K21B(p - pk)] (p - pk)$$

Dp	Density at measuring temperature [kg/m³], corrected for temperature and pressure effects
p	Measured absolute pressure in the line [bar]
pk	Reference pressure = **1 bar**
Kbt0, Kbt1	Adjustment constants for pressure compensation

NOTICE
The adjustment constants of the L-Dens 427F I, L-Dens 427F EX, L-Dens 427F EX 2/18mA sensors are provided on an enclosed adjustment protocol. They are only valid for the sensor with the corresponding serial number and the temperature range described in the datasheet.

The optional pressure sensor has to provide the absolute pressure in bar.

8.4.2 Electrical Installation of L-Dens 427E and L-Dens 427E EX

8.4.2.1 Wiring Scheme

The sensor is connected to an mPDS evaluation unit. This 2-wire connection serves as power supply to the sensor and is simultaneously used for transferring data to the evaluation unit.

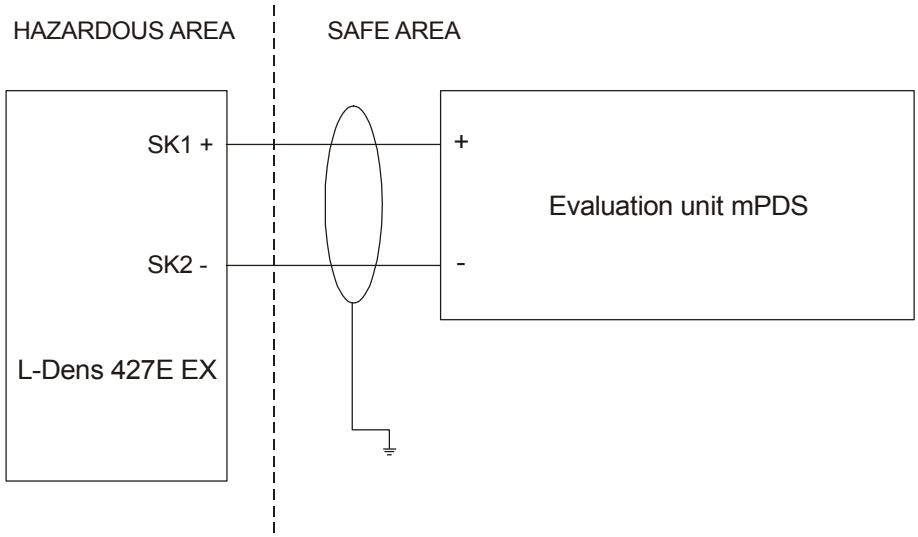


Fig. 8 - 13 Wiring diagram of the L-Dens 427E EX to mPDS

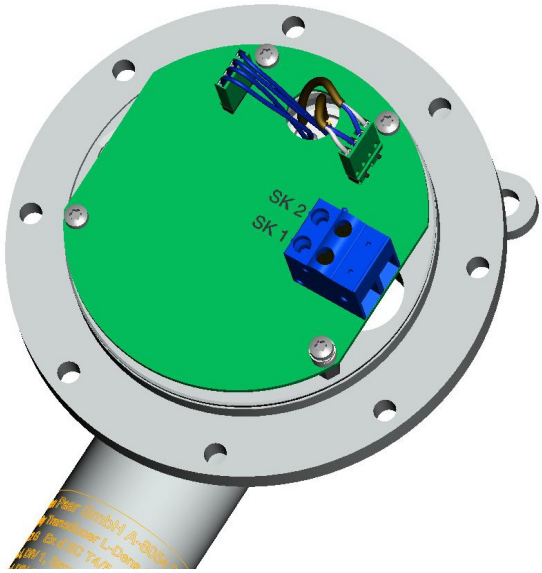


Fig. 8 - 14 Screw terminals on the L-Dens 427E and L-Dens 427E EX

Cable terminal	Connection
SK1	mPDS +
SK2	mPDS -

8.4.2.2 Density Calculation

The evaluation unit calculates the density from period of oscillation and temperature in the following way:

$$\rho = DA \times P^2 \times (1 + DA1 \times t + DA2 \times t^2) - DB \times (1 + DA3 \times t)$$

ρ	density [g/cm^3]
P	period of oscillation [µs]
t	temperature [°C]
DA, DB, DA1, DA2, DA3	DPRn density transducer constants

8.4.2.3 Configuration and Set-up

The adjustment data, selection of measuring program and all related set-up is done with the mPDS evaluation unit. Refer to the respective manual.

8.4.3 Electrical Installation of the L-Dens 427T EX

8.4.3.1 Wiring Scheme

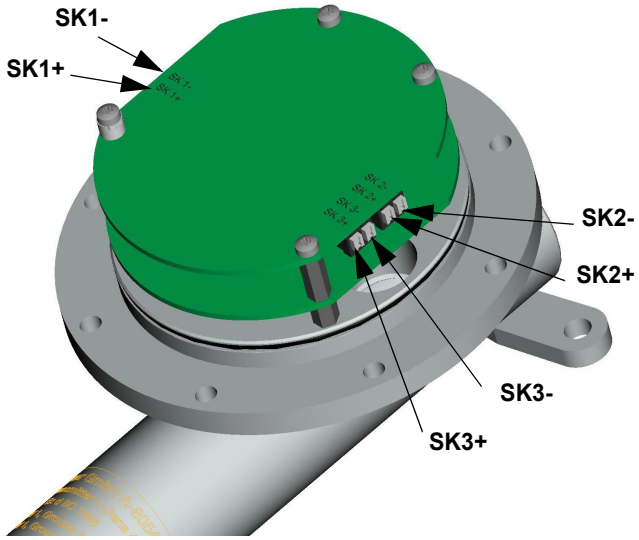


Fig. 8 - 15 Terminals at the L-Dens 427T EX

Cable terminal	Function	Connection to
SK1+	4-20 mA/HART Interface	4-20 mA/HART +
SK1-	4-20 mA/HART Interface	4-20 mA/HART -
SK2+	Modbus/RS485 Interface	Modbus/RS485 +
SK2-	Modbus/RS485 Interface	Modbus/RS485 -
SK3+	Supply voltage	DC +
SK3-	Supply voltage	DC -

8.4.3.2 Density Calculation

The L-Dens 427T EX calculates the density from period of oscillation and temperature in the following way:

$\rho = DA \times P^2 \times (1 + DA1 \times t + DA2 \times t^2) - DB \times (1 + DA3 \times t)$

ρ	....	density [g/cm^3]
P	....	period of oscillation [µs]
t	....	temperature [°C]
DA, DB, DA1, DA2, DA3	....	L-Dens 427 sensor constants

If required, calculate the pressure compensated density in your PLC.

$\rho_P = \rho + DA4 \times (p\text{-}pk)$

ρ_p	....	pressure compensated density [g/cm^3]
DA4	....	pressure adjusting constante
p	....	pressure [bar]
pk	....	reference pressure = 1 bar

8.4.3.3 Operation Modes of the L-Dens 427T EX

The L-Dens 427T EX can transmit signals via analog interface 4-20 mA, HART and Modbus. To use the respective interfaces following connections must be wired:

HART:	4-20 mA (loop-powered)
Modbus:	RS 485 & Supply voltage
Analog interface 4-20mA:	4-20 mA (loop-powered)

8.4.3.4 Analog Output 4-20 mA

NOTICE
The analog output is a passive output which supplies a 4 to 20 mA signal. Connect it to an active input. E.g.: PLC input with auxiliary voltage.

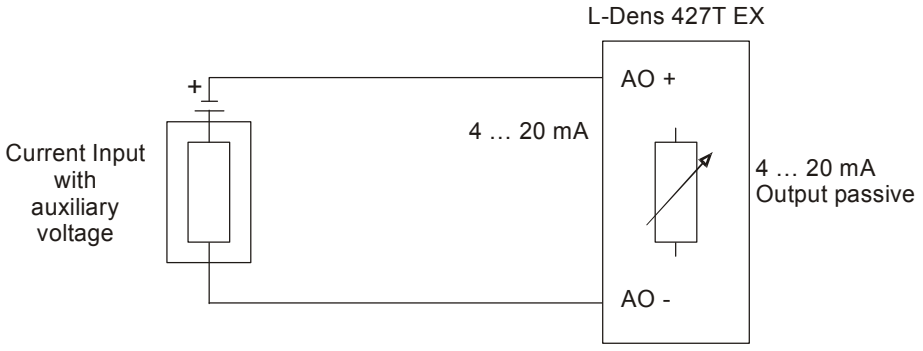


Fig. 8 - 16 Analog outpout 4-20 mA

8.4.3.5 HART Protocol

HART is a bi-directional communication protocol for data transfer and configuration between the L-Dens 427T EX sensor and host systems. The digital information is simultaneously sent with the 4-20 mA signal over the same wires. For detailed information read the instruction manual "L-Dens 427T EX, Modbus - HART - Analog Output".

NOTICE

- Use the HART protocol when you connect the device to a flow computer or PLC with HART interface. The HART interface of the L-Dens 427T EX is automatically enabled after a HART protocol is connected.
- The power of the L-Dens 427T EX is supplied over the current loop from the HART protocol.

8.4.3.6 Modbus/RS485

For detailed information read the instruction manual "L-Dens 427T EX, Modbus - HART - Analog Output".

NOTICE

- You can use the Modbus by connecting the power supply.
  The L-Dens 427T EX will automatically enable the Modbus.
- The power supply should have an output voltage of 8 to 30 V.
- The Modbus is using the RS485 interface specifications.
- The RS485 interface is a half duplex interface. The master (e.g. PLC) can only send the next request after L-Dens 427T EX has sent the response to the previous request.
- The interface settings on the master and L-Dens 427T EX must be identical.
- It is neither possible to use the Modbus together with the analog output nor with HART

WARNING

Connect the shielding on both sides.

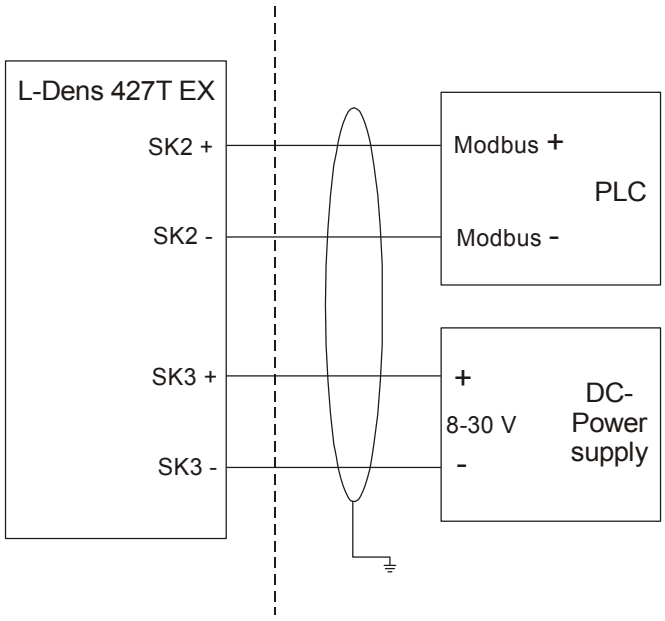


Fig. 8 - 17 RS485 interface

9 Calibration and On-site Adjustment

Each L-Dens 427 has been factory-adjusted, the sensor constants have been calculated, and an adjustment protocol has been compiled. The adjustment protocol is enclosed with the instrument.

Installation, changed process conditions, deposits or corrosion can result in a change to measuring values.

This requires checking the measuring accuracy with a comparison measurement (calibration) after installation and then periodically, and possibly also requires intensive cleaning and/or an on-site adjustment.

On-site calibration:

In an on-site calibration the sample density determined in the process measurement and the same sample density determined by a measuring instrument recognized as a standard (e.g. digital laboratory density meter) are compared.

It is vital that both measurements are performed at the same temperature, or that the result of one measurement is converted to the temperature of the other measurement.

If the results of this comparative measurement show the desired measuring accuracy, the calibration is concluded and no further activities are necessary.

Cleaning and exclusion of other error sources:

If the two measuring results diverge, an intensive cleaning of the L-Dens 427 should be first performed in order to remove possible deposits on the oscillator surface (see Chapter 10).

If cleaning has not solved the error, see also Chapter 12.

On-site adjustment:

If the two measuring results continue to diverge, adjust the measurement of L-Dens 427.

Use an offset parameter if it is available in the evaluation unit or flow computer at hand.

The offset parameter is set/reset until the result of the process measurement matches the result of the comparative measurement.

Example Diesel measurement:

D = 835.6 kg/m³	Density measured online with L-Dens 427
D = 835.0 kg/m³	Density measured with a reference method at the same temperature
△D = 0.6 kg/m³	Density difference between reference density and online density
⟶	Offset parameter new = Offset parameter old – 0.6
D = 835.0 kg/m³	Adjusted density measured online with L-Dens 427

NOTICE

- Deviations can be the result of measuring irregularities, sedimentation or less than optimal process conditions. Thus check the process conditions always first, whether there are deposits in the oscillating tube. Perform a cleaning procedure if necessary.
- Only trained personnel should perform calibrations and adjustments based on a standardized method, and the results should be tested thoroughly.
- Use only a measuring instrument recognized as a standard for a comparative measurement. Depending on the user's regulations, it is possible to only permit a standardized measuring instrument traceable to national standards.
- To achieve the best accuracy, do not carry out an offset adjustment after every comparison with a reference value. Use the average deviation of several comparison measurements to make the offset adjustment.
- Perform the process measurement and the comparative measurement in close succession, since the sample medium and the process conditions may change with time.
- Write down the old as well as the new adjustment parameters and measuring results, in order to recreate the original process conditions if possible.
- Readjustment is only recommended if the deviations are small. If the deviations are large, send the L-Dens 427 to the factory for a check.

10 Cleaning the L-Dens 427

Open the bypass valves to clean the sensor during the standard cleaning procedure in the main line. Since even slight residues on the oscillator surface can cause density deviations, in some cases additional cleaning connections and the regular rinsing of the L-Dens 427 may be necessary.

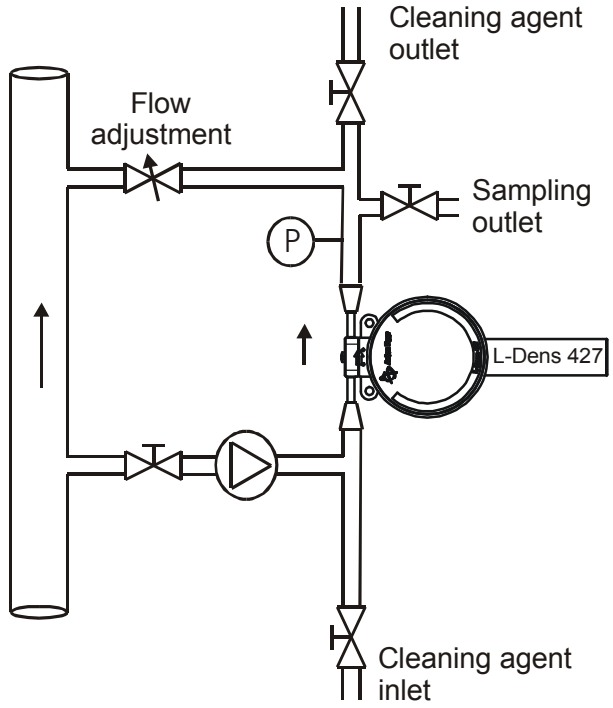


Fig. 10 - 1 Cleaning

11 Preventive Maintenance

WARNING

- Maintenance and service work should only be carried out by trained and authorized personnel.
- Do not repair and/or change components of an explosion proof, flameproof or intrinsically safe L-Dens 427.
- Make sure that the main line is empty and unpressurized before mounting or dismounting the sensor.
- The lines and instruments can be hot. Wait for the entire station to cool down.
- Never open the L-Dens 427 in an explosive atmosphere.

To ensure trouble-free operation and operational safety, check and clean the L-Dens 427 sensor regularly. The service and maintenance interval for L-Dens 427 depends on the operating conditions.
We recommend the following maintenance steps:

Daily:

- Check the flow computer, evaluation unit or PLC for error messages.

Once a week:

- Clean the L-Dens 427 in case of contamination.
- Check the L-Dens 427 and the entire bypass for leaks.

Once a year:

- Cleaning
- Optical check of damages
- Optical check of corrosion

Customer specified intervals:

- Verify the validity of the measurement results in order to identify any malfunction or deterioration in sensor performance.
- Check the measuring results regularly, clean the sensor and/or carry out readjustments if required, because the L-Dens 427 is typically subject to harsh process conditions such as shock pressure, sudden temperature changes, vibrations, etc. Deposits may also form in the oscillating tubes. This may cause sudden drifts or malfunctions.

Cleaning the housing of the sensor:

- It is important to clean the sensor and remove deposits.
- For external cleaning use a mild rinsing agent that agrees with the material, depending on the type of contamination.

12 Troubleshooting and Service

WARNING

- Maintenance and service work should only be carried out by trained and authorized personnel.
- Do not repair and/or change components of an explosion proof, flameproof or intrinsically safe L-Dens 427.
- Make sure that the main line is empty and unpressurized before mounting or dismounting the sensor.
- The lines and instruments can be hot. Wait for the entire station to cool down.
- Never open the L-Dens 427 in an explosive atmosphere.

Problems such as incorrect or fluctuating measuring values, no measuring values and error messages on the evaluation unit can be the result of malfunctions of the L-Dens 427 or may be caused by certain process conditions.

12.1 Troubleshooting

To help to identify the problem, see the following list:

Problem	Checks and solution
Incorrect density displayed	The error source may be found in the process conditions. Common error sources are: • Too small, too large or pulsating flow; gas bubbles, foam, deposits or abrasions in the oscillating tube; change of oscillator properties by short-term sensor overload (pressure blow, over-temperature etc.); vibration transfer to sensor. • Through checks with regard to the hints in Chapter 7, these error sources should be excluded.
Constant deviation between the displayed density and the reference value	• Compare the stored sensor constants with the constants from the adjustment protocol with the same serial number. • Compare the temperature measurement results of the sensor with an external temperature measuring device. If the deviation is bigger than 0.5 °C, then the sensor needs to be repaired. • Calibrate the measurement, clean and adjust the sensor if necessary (refer to Chapter 9).

Drift of the measuring values	• Compare the temperature measurement results of the sensor with an external temperature measuring device: If the deviation is more than 0.5 °C, send the sensor for repair to your Anton Paar representative. • If the temperature measurement is correct, the following errors may cause the drift: - Deposits on the oscillator: clean the sensor and calibrate / adjust it afterwards. - Corrosion of the oscillator due to aggressive or abrasive samples: Check the corrosion resistance of the sensor materials to the liquids you measure and the cleaning agents. - If the deviation is small, perform an adjustment. - If the deviations is large, severe corrosion could be the reason and the sensor might not suite for your application. •
No signal from the L-Dens 427F I or L-Dens 427F EX L-Dens 427F EX 2/18mA	• Open the cover of the sensor's electronic box and measure the voltage between the "+" and "-" terminals: - If there is not a DC voltage according to the specifications, check the connecting cable to the flow computer. If there is still no voltage, send the sensor for repair to your Anton Paar representative. - Check the rectangular pulse (frequency signal) with an oscilloscope. If there is no rectangular signal despite a correct supply, the electronics unit of the L-Dens 427 is defective. Send the sensor for repair to your Anton Paar representative.
• No signal from the L-Dens 427E or L-Dens 427E EX L-Dens 427 EX 2/18mA Error message on the mPDS: CELL DROP OUT or TRANS. DROPOUT	• Open the cover of the sensor's electronic box and measure the voltage between the "+" and "-" terminals: If there is no DC voltage of approx. 12-15 V, check the connecting cable to the evaluation unit. If there is also no voltage on it, send the sensor for repa

12.2 Disconnecting the Process Connections of the L-Dens 427

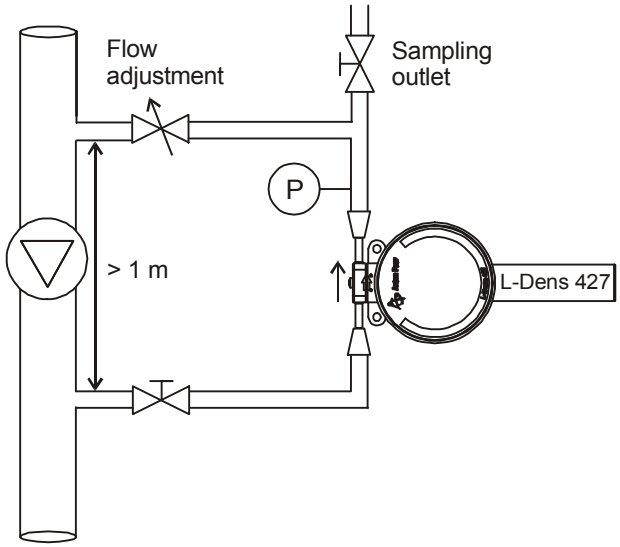


Fig. 12 - 1 Disconnecting the process connections of L-Dens 427in a bypass

Disconnecting the process connections of L-Dens 427:

1. The lines and instruments can be hot. Wait for the entire station to cool off. Make sure that the line is empty and unpressurized before dismounting the sensor.
   If the sensor is in a bypass, close the bypass valves. Then open the sample valve and make sure that there remains no pressure in the bypass.

2. Open the connections of L-Dens 427.

CAUTION

When reconnecting the sensor, ensure that

- the flow direction is correct
- the system is tight

12.3 Exchanging the O-Rings

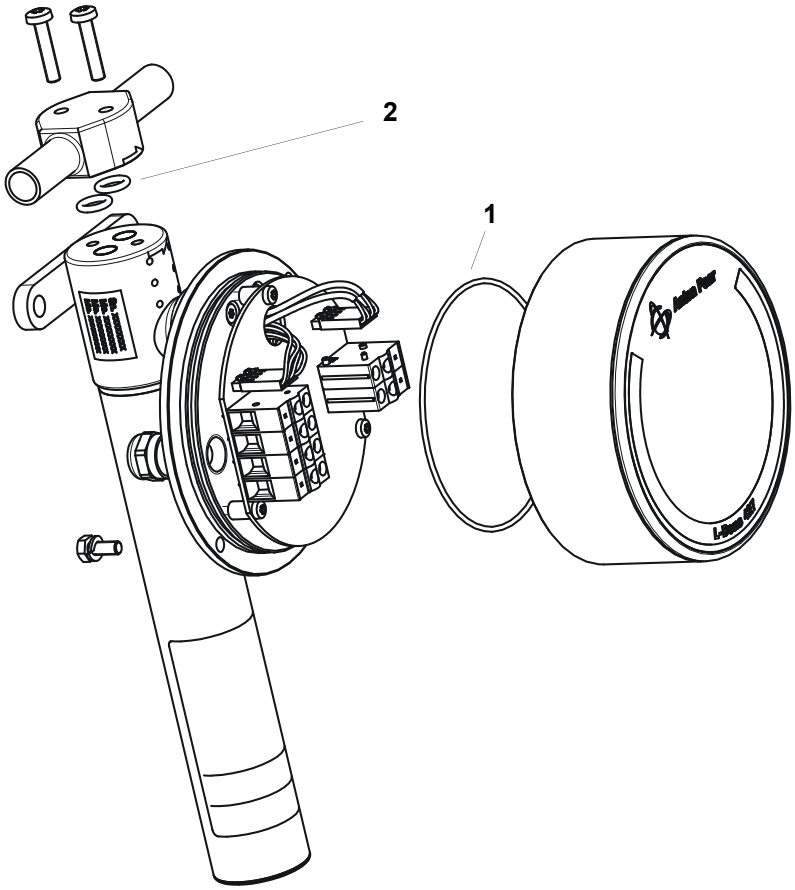


Fig. 12 - 2 Exchanging the O-rings

1 ... 1 O-ring 80x1.5 (Ground plate electronics housing)
2 ... 2 O-rings 7x2 (Connecting adapter 12 mm)

CAUTION
When you exchange the O-rings, make sure that you do not damage the sealing surface of the oscillator.

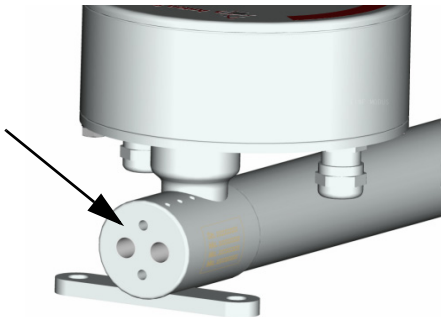


Fig. 12 - 3 Sealing surface of the oscillator

12.4 Further Error Analysis

WARNING
Never open the L-Dens 427 in an explosive atmosphere.

12.4.1 Checking the L-Dens 427F I and L-Dens 427F EX and L-Dens 427F EX 2/18mA

12.4.1.1 Wiring Check

Check the loop resistance of the cable for frequency interface.
The cables' loop resistance must be <100 Ohm.

12.4.1.2 Power Supply

1. Open the electronics housing and measure the voltage between the terminals SK1 and SK2.
2. The voltage must be between DC 12 V and 26 V.

12.4.1.3 Frequency Signal with Water

1. Connect the ground connection of the oscilloscope with the housing of L-Dens 427.
2. Open the electronic's housing.
3. Fill the L-Dens 427 oscillator with water and measure the frequency signal at terminal SK1.
4. The frequency has to be about 1250 Hz (period 800 µs). The displayed value is a guiding value and may deviate slightly.

Frequency signal with water (approx. 23 °C)

Oscilloscope settings:	500 mV / DIV
	250 µs / DIV
	AC coupling

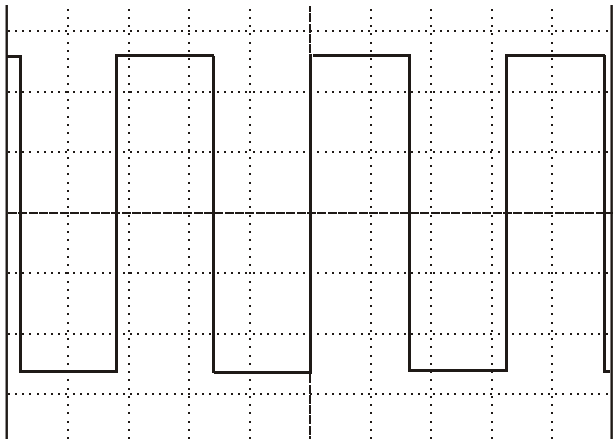


Fig. 12 - 4 Frequency signal with water (approx. 1250 Hz)

12.4.1.4 Frequency Signal with Air

1. Dry the L-Dens 427 oscillator with pressurized air.
2. Connect the ground connection of the oscilloscope with the housing of the L-Dens 427.
3. Open the electronics housing and measure the frequency at terminal SK1.
4. The frequency must be about 1715 Hz (period 583 µs). The displayed value is a guiding value and may deviate slightly.

Frequency signal with air (room temperature)

Oscilloscope settings:	500 mV / DIV
	250 µs / DIV
	AC coupling

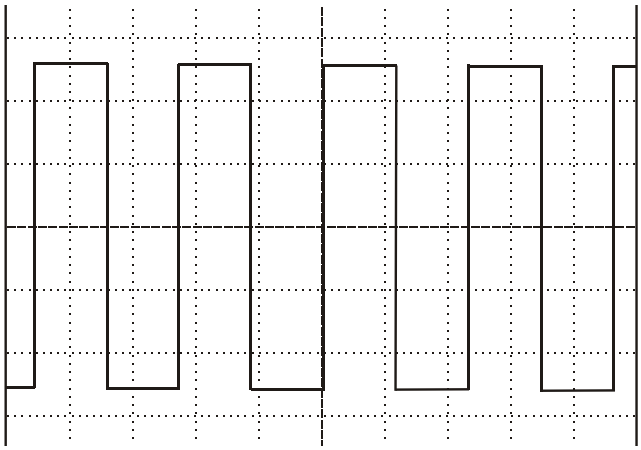


Fig. 12 - 5 Frequency signal with air (approx. 1715 Hz)

12.4.1.5 Pt100

If the wrong temperature values are displayed, either the Pt100 temperature sensor or the evaluation unit is defective. If the evaluation unit is fully functional, the resistance of the temperature sensor needs to be measured.

1. Open electronics housing.
2. The following resistance values have to be measured (see screw terminals in Fig. 12 - 6):

Terminal		Resistance
SK3	SK4	approx. 0 Ohm
SK5	SK6	approx. 0 Ohm
SK3	SK6	approx. 100 Ohm (refer to table)
SK4	SK5	approx. 100 Ohm (refer to table)

Resistance values Pt100:

Temperature (°C)	-10	0	10	20	30	40	50	60	70
Resistance (Ω)	96	100	104	108	112	116	119	123	127

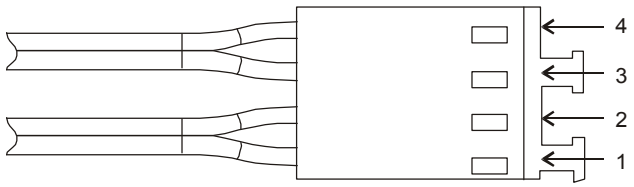


Fig. 12 - 6 Connector pin assignments

12.4.2 Checking the L-Dens 427E and L-Dens 427E EX

12.4.2.1 Checking the Cabling Between Sensor and Evaluation Unit

Check the loop resistance of the cable for frequency interface.
The cables' loop resistance must be <100 Ohm.

12.4.2.2 Power Supply

1. Open electronics housing and measure the voltage between the terminals SK1 and SK2.
2. The voltage has to be between DC 12 V and 15 V.

Appendix A: Certifications, Accreditations and Standards

CE-Certification

The L-Dens 427 density sensors meet all the basic requirements in design and type of the applicable sections of the relevant EU directives. This is certified by Anton Paar by CE labelling on the product. You can download a written declaration of conformity from our website or request it from your sales office

Electromagnetic Compatibility 2004/108/EC

Following standard is applied at the L-Dens 427 density sensors:

EN 61326-1:2006	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements The product is classified as a class B equipment and is intended for the use in industrial area.

Low Voltage Directive 2006/95/EC

Following standard is applied at the L-Dens 427 density sensors:

EN 61010-1:2001	Safety requirements for electrical equipment for measurement, control and laboratory use Part 1: General requirements

Equipment in potentially explosive atmospheres ATEX (94/9/EC)

- Following standards are applied at L-Dens 427F Ex, L-Dens 427E Ex, L-Dens 427F Ex 2/18mA and L-Dens 427T Ex density sensor:

EN 60079-0:2006	Explosive atmospheres - Part 0: Equipment - General requirements
EN 60079-1:2007	Explosive atmospheres - Part 1: Equipment protection by flameproof enclosures "d"
EN 60529:1991 + A1:2000	Degrees of protection provided by enclosures (IP Code)

  Notified body: TÜV Austria / A-1015 Wien, Krugerstraße 16 / Identification no. 0408 EC-type-examination certificate: FM 10 ATEX 0004, FM Approvals Ltd., Identification no. 1725

- Following standards are applied at L-Dens 427F I density sensor:

EN 60079-0:2004	Electrical apparatus for explosive gas atmospheres - Part 0: General requirements
EN 60079-11:2007	Electrical apparatus for explosive gas atmospheres - Part 11: Intrinsically safety "i"
EN 60079-26:2004	Electrical apparatus for explosive gas atmospheres - Part 26: Construction. test and marking of Group II Category 1G electrical apparatus

Notified body: TÜV Austria / A-1015 Wien, Krugerstraße 16 / Identification no. 0408 EC-type-examination certificate: TÜV-A 07 ATEX 0006 X

Anhang B: Example of an Adjustment Protocol

Graz, 11.03.2008

Factory Adjustment Protocol
Determination of the Constants of Transducer
Type: **L-Dens 427F I**
Material: **Hastelloy C 276**
Serial Number: **14384332**

Conditions:

Temperature Limits:	lower	-10 °C
	upper	+50 °C

Measurement of water and air

No #	Temp [°C]	L-Dens peri [µs]	L-Dens dens [g/cm³]	Ref. density [g/cm³]
1	29,67	1616,748	0,99575	0,99574
2	25,00	1616,177	0,99704	0,99704
3	20,02	1615,485	0,99820	0,99820
4	15,01	1614,688	0,99910	0,99910
5	10,01	1613,780	0,99970	0,99970
6	5,02	1612,742	0,99996	0,99996
air	23,80	1167,288	0,00114	0,00114
calib	17,50	1615,098	0,99869	0,99869

Transducer Frequency Constants

Kb0 = -1,085718E3
Kb1 = 0
Kb2 = 3,1940131E1
Kbt0 = -3,01924E-1
Kbt1 = -2,89432E-4

R0 = 1,0001700E2
A = 3,895280E-3
B = -5,97631E-7

K20A = 0
K20B = 0
K21A = -3,01306E-2
K21B = 3,099140E-5

Constants verified for: MFX4

Appendix C:Document Numbers

Document number	Date	Comment
C77IB11A	24.02.2010	First version
C77IB11B	30.03.2010	Correction: FM Class I, Division 1 groups (US, CA)
C77IB11C	19.04.2010	Ex type plates
C77IB011EN-D	February 2011	Reorganization of the manual All instruments of the L-Dens 427 family included Change of document number

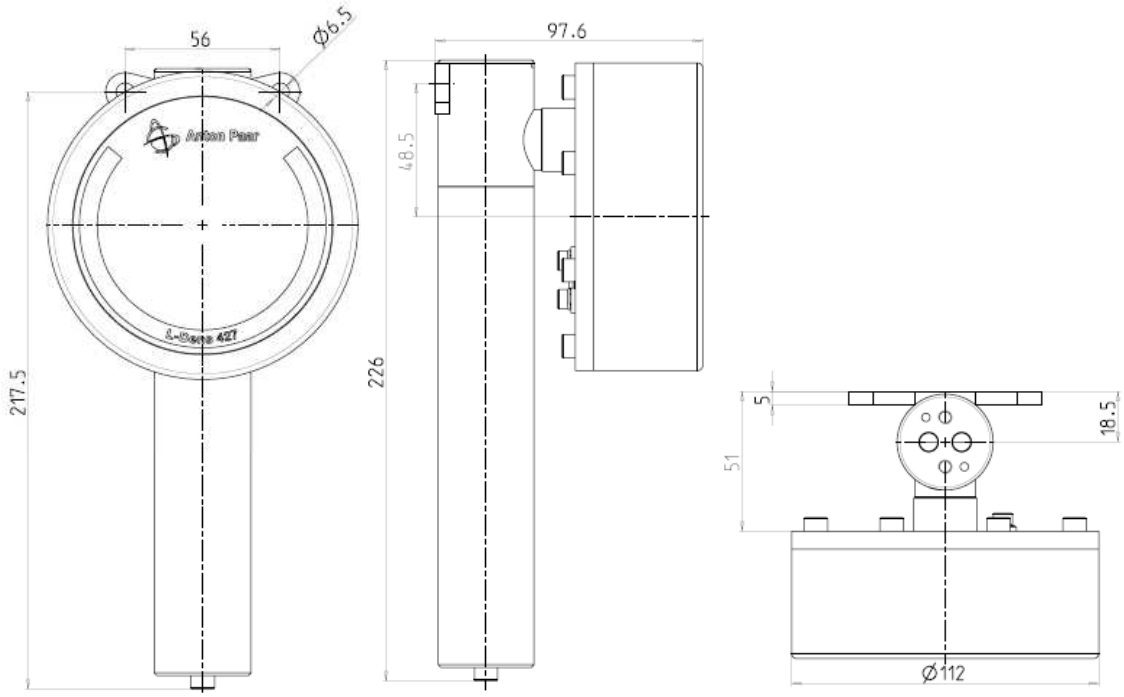
Appendix D:Technical Data

Find on the following pages the technical data for the following density sensors:

- L-Dens 427F I
- L-Dens 427F EX
- L-Dens 427F EX 2/18mA
- L-Dens 427E
- L-Dens 427E EX
- L-Dens 427T EX

90102 L-Dens 427F Ex
Density Sensor

Density sensor with a frequency output.
Flame proof and explosion proof version.



Accuracy and operating conditions

Density	
Measuring range	0 to 3 g/cm^3
Accuracy in the adjusted range*	1 x 10^{-4} g/cm^3
Repeatability*	2 x 10^{-5} g/cm^3
Temperature	
Temperature range - sample	-40 to +125 °C (T5: to +70 °C)
Temperature measurement	Pt100 integrated (1/10 DIN IEC 751 CL.B)
Accuracy in the adjusted range*	Better 0,1 °C
Factory adjustment	
Standard	-10 to +50 °C, without pressure adjustment
Pressure	ATTENTION: consider the specification of the process connection
Pressure range	0 to 125 bar (0 to 1800 psi)
Pressure influence	ca. 0,0001 g/cm³ /bar (can be compensated)
Flow rate	100 to 500 L/h (recommended range)

* All specifications are valid for constant measuring conditions and correct installation.

90102 L-Dens 427F Ex
Density Sensor

Anton Paar

Material, dimensions and weight

Inner diameter of oscillator	6,6 mm
Wetted materials	Hastelloy C276 Stainless steel 1.4571, 1.4404 Silver solder (Ag 54 % / Cu 21% / Pd 25%)
Housing material	Stainless steel 1.4571, 1.4404
Dimensions	226 x 112 x 97,6 mm
Weight	approx. 3400 g

Ambient conditions

Temperature range - ambient	-40 to +70 °C (T5: to +40°C)
Degree of Protection	IP66, NEMA 4X
ATEX	EC type-examination certificate according to 94/9/EG Ⓔx II 2 G Ex d IIC T4/5
FM	Class I, DIV 1, Groups A, B, C, D (US) Class I, DIV 1, Groups B, C, D (CA)

Electrical connections

Supply voltage**	DC 12 to 26 V
Frequency signal*	Frequency, density- proportional from 750 to 2000 Hz 2-wire current loop with 4 to 16 mA Rectangular signal with duty cycle approx. 1:1 Passive, grounded circuit (open collector)
Temperature measurement*,**	4-wire Pt 100 integrated, 4-wire connection, Temperature circuit Uimax = 10 V Temperature measuring signal Uimax = 5 V measuring current: ≤ 1mA Pt 100 characteristics according to DIN IEC 751, 1/10 DIN Class B, R0=100 Ω, A=3.9083E-3, B=-5.775E-7 Galvanically isolated: min. creepage path ≥ 0.5 mm
Insulation resistance between: Frequency and Pt 100 circuits Pt 100 circuit and housing	In accordance with EN 60079-11, separation distances Table 5 30V 30V

* Linearization and temperature compensation in the connected evaluation unit/flow computer

** The device has functional isolation for max. DC 30 V. Protection against potentially hazardous touch current must be ensured by the customer in accordance with local regulations.

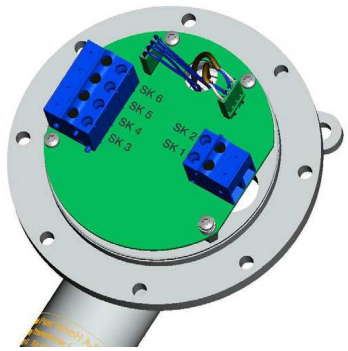
90102 L-Dens 427F Ex
Density Sensor

Anton Paar

Electrical connections

Electrical connection	Screw terminals
Cable glands (supplied optionally)	Recommended type ATEX: HSK-M-Ex–d NPT 1/2"
Cable (not supplied) Frequency interface / Supply Pt 100 interface	Recommended cable type: LiYCY, diameter 7 to 12 mm 2 cores twisted in pairs, screened, double insulation Insulation resistance/test voltage 4000 Veff, 50/60 Hz Twin-core Four-wire

Terminal connections



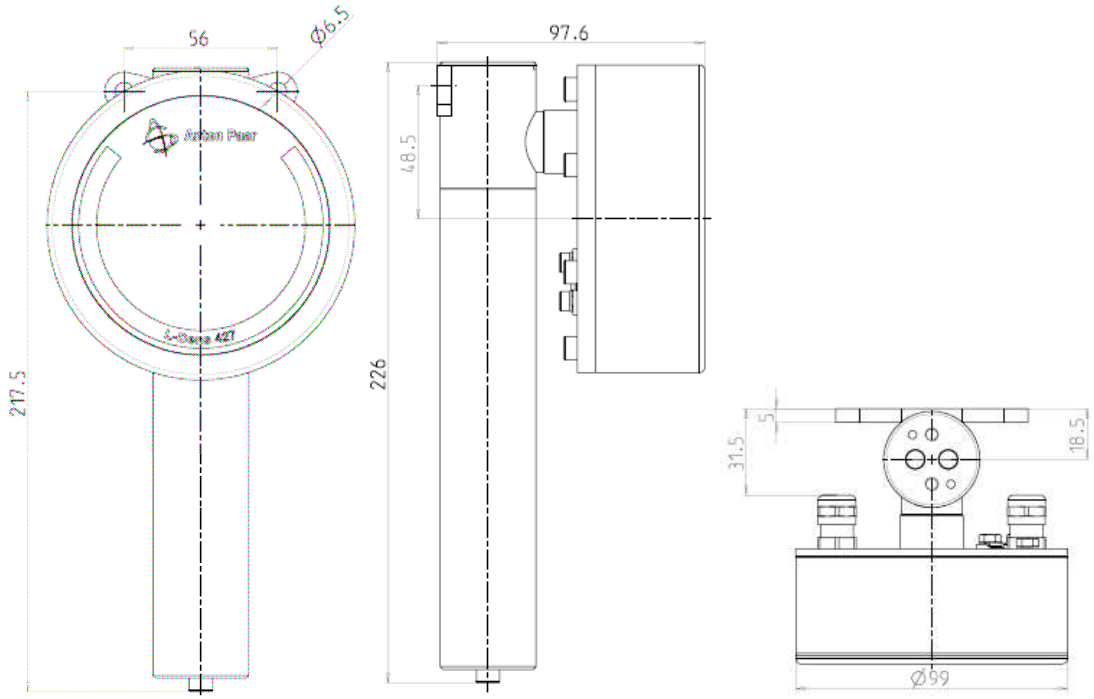
Cableterminal	Function	Connection
SK1	Supply voltage and frequency interface	DC +
SK2	Supply voltage and frequency interface	DC -
SK3	Pt 100 interface	Measuring circuit
SK4	Pt 100 interface	Measuring current
SK5	Pt 100 interface	Measuring circuit
SK6	Pt 100 interface	Measuring current

Hazardous Areas

Observe the hints in the instruction manual, the EC type examination certificate or type examination certificate from FM and the type plates for installation and service in hazardous areas.

40555 L-Dens 427F I
Density Sensor

Density sensor with a frequency output.
Intrinsically safe version.



Accuracy and operating conditions

Density	
Measuring range	0 to 3 g/cm^3
Accuracy in the adjusted range*	1 x 10^{-4} g/cm^3
Repeatability*	2 x 10^{-5} g/cm^3
Temperature	
Temperature range - sample	-25 to +125 °C (T5: to +70 °C)
Temperature measurement	Pt100 integrated (1/10 DIN IEC 751 CL.B)
Accuracy in the adjusted range*	Better 0,1 °C
Factory adjustment	
Standard	-10 to 50 °C, without pressure adjustment
Pressure	ATTENTION: consider the specification of the process connection
Pressure range	0 to 125 bar (0 to 1800 psi)
Pressure influence	ca. 0,0001 g/cm³ /bar (can be compensated)
Flow rate	100 to 500 L/h (recommended range)

* All specifications are valid for constant measuring conditions and correct installation.

40555 L-Dens 427F I
Density Sensor

Anton Paar

Material, dimensions and weight

Inner diameter of oscillator	6,6 mm
Wetted materials	Hastelloy C276 Stainless steel 1.4571, 1.4404 Silver solder (Ag 54 % / Cu 21% / Pd 25%)
Housing material	Stainless steel 1.4571, 1.4404
Dimensions	226 x 99 x 93 mm
Weight	approx. 1870 g

Ambient conditions

Temperature range - ambient	-25 to +70 °C (T5: to +40°C)
Degree of Protection	IP66, NEMA 4X
ATEX	EC type-examination certificate according to 94/9/EG Ⓔx II 1/2 G Ex ia IIC T4/5

Electrical connections

Supply voltage**	DC 12 to 26 V
Frequency signal*	Frequency, density-proportional from 750 to 2000 Hz 2-wire current loop with 4 to 16 mA Rectangular signal with duty cycle approx. 1:1 Passive, grounded circuit (open collector)
Temperature measurement*,**	4-wire Pt 100 integrated, 4-wire connection, measuring current: ≤ 1mA Pt 100 characteristics according to DIN IEC 751, 1/10 DIN Class B, R0=100 Ω, A=3.9083E-3, B=-5.775E-7 Galvanically isolated: min. creepage path ≥ 0.5 mm
Insulation resistance between: Frequency and Pt 100 circuits Pt 100 circuit and housing	In accordance with EN 60079-11, separation distances Table 5 30V 30V

* Linearization and temperature compensation in the connected evaluation unit/flow computer

** The device has functional isolation for max. DC 30 V. Protection against potentially hazardous touch current must be ensured by the customer in accordance with local regulations.

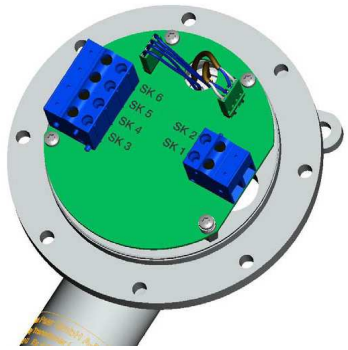
40555 L-Dens 427F I
Density Sensor

Anton Paar

Electrical connections

Electrical connection	Screw terminals
Cable glands	HSK-M-EMV-Ex M12x1,5
Cable (not supplied) Frequency interface / Supply Pt 100 interface	Recommended cable type: LiYCY, diameter 3,0 to 6,5mm twisted in pairs, screened, double insulation Insulation resistance/test voltage 4000 Veff, 50/60 Hz Twin-core Four-wire

Terminal connections



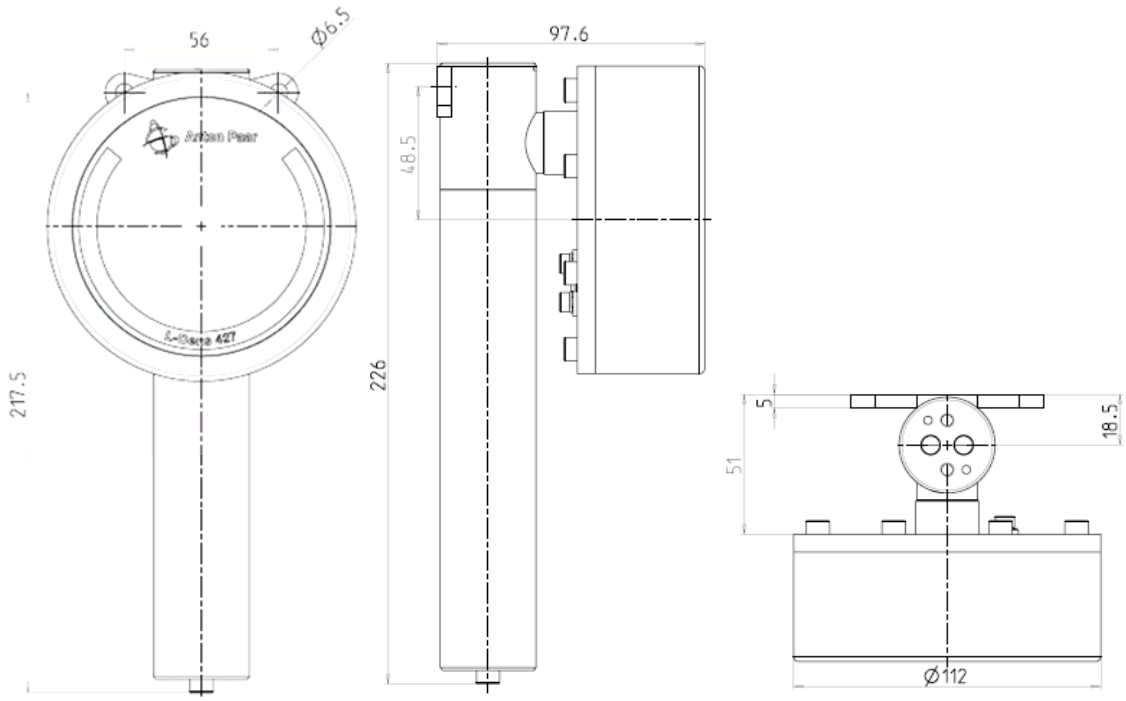
Cableterminal	Function	Connection
SK1	Supply voltage and frequency interface	DC +
SK2	Supply voltage and frequency interface	DC -
SK3	Pt 100 interface	Measuring circuit
SK4	Pt 100 interface	Measuring current
SK5	Pt 100 interface	Measuring circuit
SK6	Pt 100 interface	Measuring current

Intrinsic Safety (ATEX)

Outside the risk area, accessories (buffer amplifier for frequency interface and/or barrier for temperature measurement) have to be connected. Observe the hints in the instruction manual, the EC type examination certificate and the type plates during installation and service in hazardous areas.

97471 L-Dens 427F Ex 2/18mA

Density sensor with a frequency output.
Flame proof and explosion proof version



Accuracy and operating conditions

Density	
Measuring range	0 to 3 g/cm^3
Accuracy in the adjusted range*	1 x 10^{-4} g/cm^3
Repeatability*	2 x 10^{-5} g/cm^3
Temperature	
Temperature range - sample	-40 to +125 °C (T5: to +70 °C)
Temperature measurement	Pt100 integrated (1/10 DIN IEC 751 CL.B)
Accuracy in the adjusted range*	Better 0,1 °C
Factory adjustment	
Standard	-10 to +50 °C, without pressure adjustment
Pressure	ATTENTION: consider the specification of the process connection
Pressure range	0 to 125 bar (0 to 1800 psi)
Pressure influence	ca. 0,0001 g/cm³ /bar (can be compensated)
Flow rate	100 to 500 L/h (recommended range)

* All specifications are valid for constant measuring conditions and correct installation.

Material, dimensions and weight

Inner diameter of oscillator	6.6 mm
Wetted materials	Hastelloy C276 Stainless steel 1.4571, 1.4404 Silver solder (Ag 54 % / Cu 21% / Pd 25%)
Housing material	Stainless steel 1.4571, 1.4404
Dimensions	226 x 112 x 97,6 mm
Weight	approx. 3400 g

Ambient conditions

Temperature range - ambient	-40 to +70 °C (T5: to +40 °C)
Degree of Protection	IP66, NEMA 4X
ATEX	EC type-examination certificate according to 94/9/EG ⟨Ex⟩ II 2 G Ex d IIC T4/5
FM	Class I, DIV 1, Groups A, B, C, D (US) Class I, DIV 1, Groups B, C, D (CA)

Electrical connections

Supply voltage**	DC 12 to 26 V
Frequency signal*	Frequency, density-dependent from 750 to 2000 Hz 2-wire current loop with 2/18 mA Rectangular signal with duty cycle approx. 1:1 Passive, grounded circuit (open collector)
Temperature measurement*,**	4-wire Pt 100 integrated, 4-wire connection, Temperature circuit Uimax = 10 V Temperature measuring signal Uimax = 5 V measuring current: ≤ 1mA Pt 100 characteristics according to DIN IEC 751, 1/10 DIN Class B, R0=100 Ω, A=3.9083E-3, B=-5.775E-7 Galvanically isolated: min. creepage path ≥ 0.5 mm

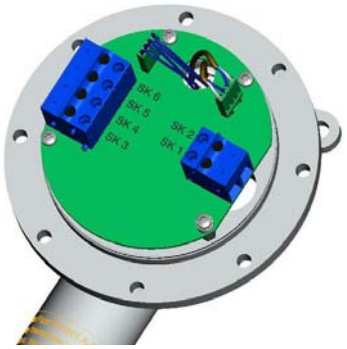
* Linearization and temperature compensation in the connected evaluation unit/flow computer.

** The device has a functional insulation for DC 28V. Protection against potentially hazardous touch current has to be ensured by the customer in accordance with local regulations.

Electrical connections

Electrical connection	Screw terminals
Cable glands (supplied optionally)	Recommended type ATEX: HSK-M-Ex–d NPT 1/2"
Cable (not supplied) Frequency interface / Supply Pt 100 interface	Recommended cable type: LiYCY, diameter 7 to 12 mm 2 cores twisted in pairs, screened, double insulation Insulation resistance/test voltage 4000 Veff, 50/60 Hz Twin-core Four-wire

Terminal connections



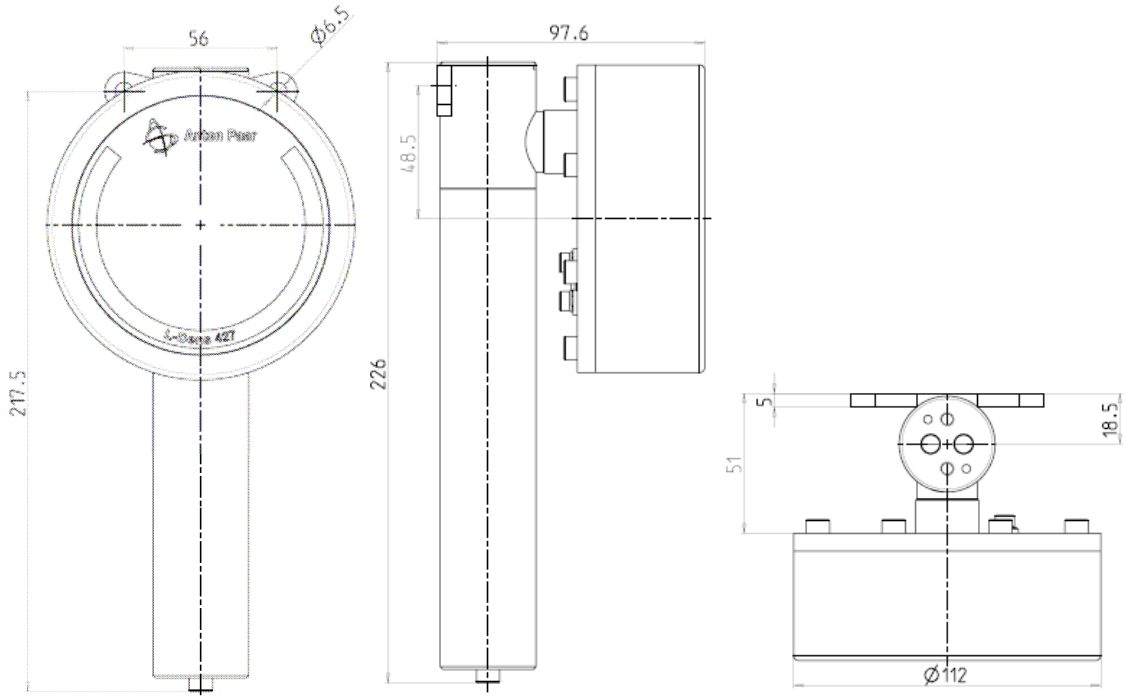
Cableterminal	Function	Connection
SK1	Supply voltage and frequency interface	DC +
SK2	Supply voltage and frequency interface	DC -
SK3	Pt 100 interface	Measuring circuit
SK4	Pt 100 interface	Measuring current
SK5	Pt 100 interface	Measuring circuit
SK6	Pt 100 interface	Measuring current

Hazardous Areas

Observe the hints in the instruction manual, the EC type examination certificate or type examination certificate from FM and the type plates for installation and service in hazardous areas.

89541 L-Dens 427E Ex
Density Sensor

Density sensor with an interface to an Anton Paar evaluation unit.
Flame proof and explosion proof version.



Accuracy and operating conditions

Density	
Measuring range	0 to 3 g/cm^3
Accuracy in the adjusted range*	1 x 10^{-4} g/cm^3
Repeatability*	2 x 10^{-5} g/cm^3
Temperature	
Temperature range - sample	-40 to +125 °C (T5: to +70 °C)
Temperature measurement	Pt1000 integrated
Accuracy in the adjusted range*	Better 0,1 °C
Factory adjustment	In accordance with the temperature and pressure range defined in the order.
Adjustment constants „K“	
Pressure	ATTENTION: consider the specification of the process connection
Pressure range	0 to 125 bar (0 to 1800 psi)
Pressure influence	ca. 0,0001 g/cm³ /bar (can be compensated)
Flow rate	100 to 500 L/h (recommended range)

* All specifications are valid for constant measuring conditions and correct installation.

89541 L-Dens 427E Ex
Density Sensor

Anton Paar

Material, dimensions and weight

Inner diameter of oscillator	6,6 mm
Wetted materials	Hastelloy C276 Stainless steel 1.4571, 1.4404 Silver solder (Ag 54 % / Cu 21% / Pd 25%)
Housing material	Stainless steel 1.4571, 1.4404
Dimensions	226 x 112 x 97,6 mm
Weight	approx. 3400 g

Ambient conditions

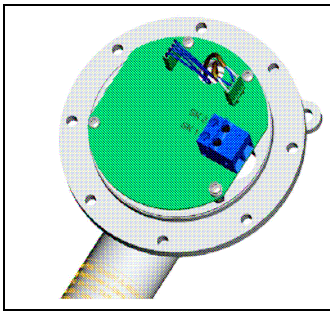
Temperature range - ambient	-40 to +70 °C (T5: to +40°C)
Degree of Protection	IP66, NEMA 4X
ATEX	EC type-examination certificate according to 94/9/EG Ⓔx II 2 G Ex d IIC T4/5
FM	Class I, DIV 1, Groups A, B, C, D (US) Class I, DIV 1, Groups B, C, D (CA)

Electrical connections

The transducer is powered by the connected evaluation unit mPDS

Supply voltage	DC 12 to 15 V
Current consumption	< 20 mA
Electrical connection	Screw terminals
Cable glands (supplied optionally)	Recommended type ATEX: HSK-M-Ex–d NPT 1/2"
Cable (not supplied)	Recommended cable type: LiYCY, diameter 7 to 12 mm 2 cores twisted in pairs, screened, double insulation Insulation resistance/test voltage 4000 Veff, 50/60 Hz

Terminal connections



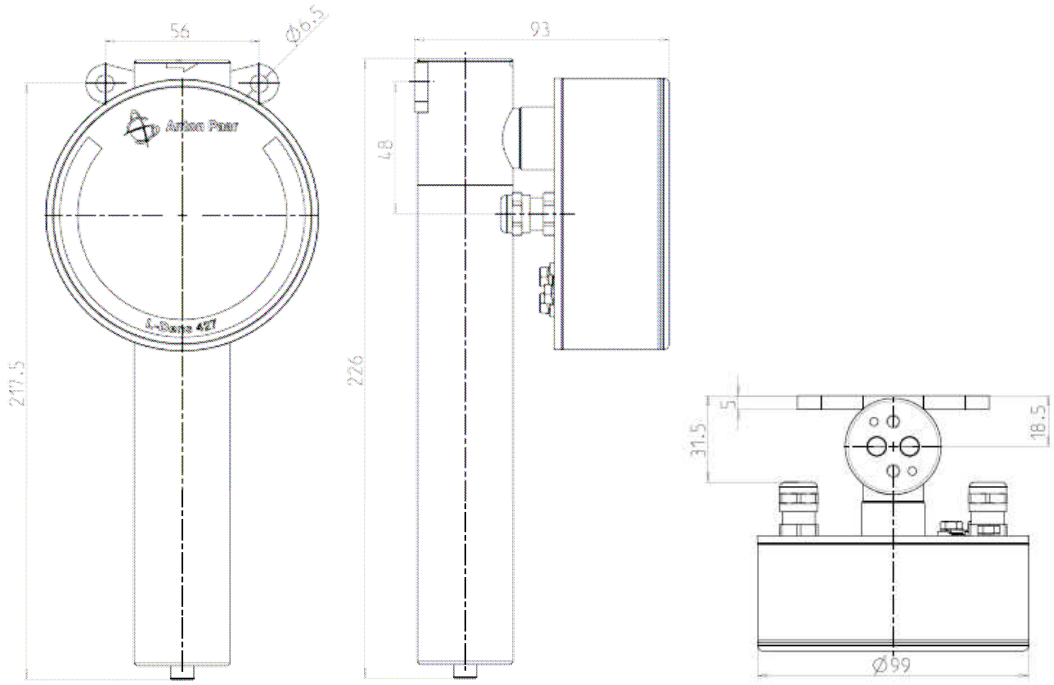
Cable terminal	Function	Connection
SK1	Supply voltage and evaluation unit interface	Transd. or DPR/SPR "+"
SK2	Supply voltage and evaluation unit interface	Transd. or DPR/SPR "-"

Hazardous Areas

Observe the hints in the instruction manual, the EC type examination certificate or type examination certificate from FM and the type plates for installation and service in hazardous areas.

80926 L-Dens 427E
Density Sensor

Density sensor with an interface to an Anton Paar evaluation unit.



Accuracy and operating conditions

Density	
Measuring range	0 to 3 g/cm^3
Accuracy in the adjusted range*	1 x 10^{-4} g/cm^3
Repeatability*	2 x 10^{-5} g/cm^3
Temperature	
Temperature range - sample	-40 to +125 °C
Temperature measurement	Pt1000 integrated
Accuracy in the adjusted range*	Better 0,1 °C
Factory adjustment	In accordance with the temperature and pressure range defined in the order.
Adjustment constants „K“	
Pressure	ATTENTION: consider the specification of the process connection
Pressure range	0 to 125 bar (0 to 1800 psi)
Pressure influence	ca. 0,0001 g/cm³ /bar (can be compensated)
Flow rate	100 to 500 L/h (recommended range)

* All specifications are valid for constant measuring conditions and correct installation.

80926 L-Dens 427E
Density Sensor

Anton Paar

Material, dimensions and weight

Inner diameter of oscillator	6,6 mm
Wetted materials	Hastelloy C276 Stainless steel 1.4571, 1.4404 Silver solder (Ag 54 % / Cu 21% / Pd 25%)
Housing material	Stainless steel 1.4571, 1.4404
Dimensions	226 x 99 x 93 mm
Weight	approx. 1870 g

Ambient conditions

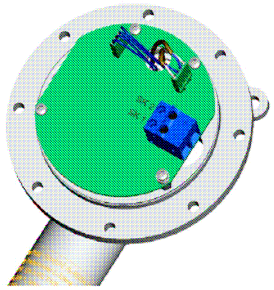
Temperature range - ambient	-40 to +70 °C
Degree of Protection	IP66, NEMA 4X

Electrical connections

The transducer is powered by the connected evaluation unit mPDS

Supply voltage	DC 12 to 15 V
Current consumption	< 20 mA
Electrical connection	Screw terminals
Cable glands	Type: HSK-M-EMV-Ex M12x1,5
Cable (not supplied)	Recommended cable type: LiYCY, diameter 3 to 6,5 mm 2 cores twisted in pairs, screened, double insulation, Insulation resistance/test voltage 4000 Veff, 50/60 Hz

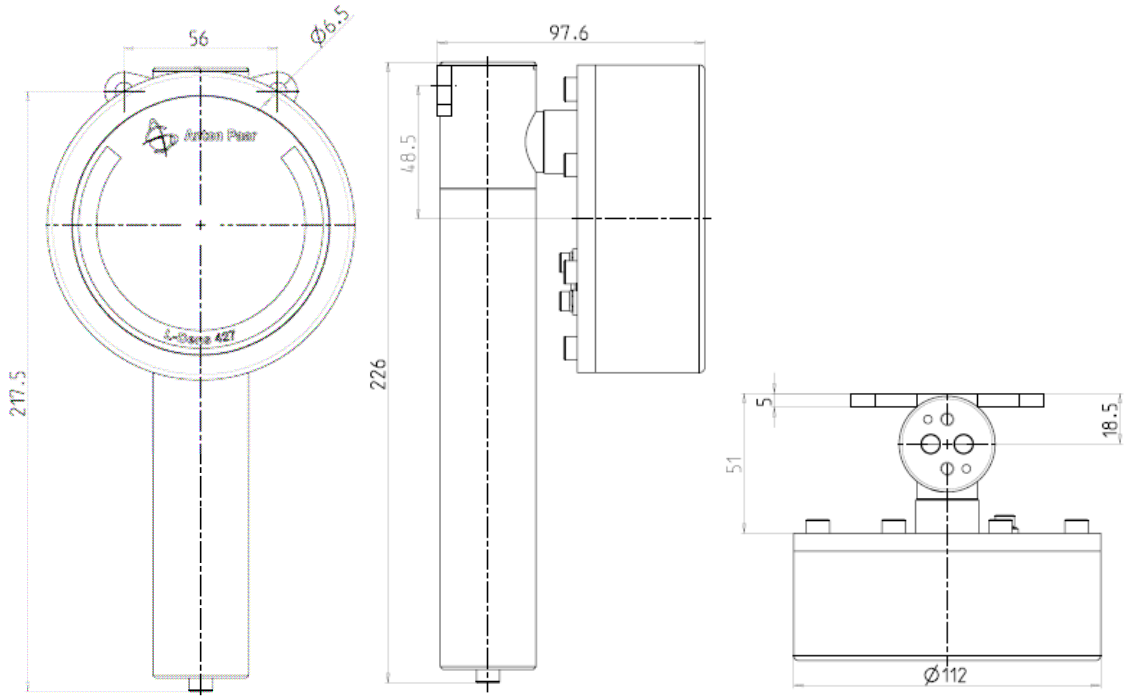
Terminal connections



Cable terminal	Function	Connection
SK1	Supply voltage and evaluation unit interface	Transd. or DPR/SPR "+"
SK2	Supply voltage and evaluation unit interface	Transd. or DPR/SPR "-"

92034 L-Dens 427T Ex
Density Sensor

Density sensor with Modbus, HART und 4 – 20 mA analog output.
Flame proof and explosion proof version.



Accuracy and operating conditions

Density	
Measuring range	0 to 3 g/cm^3
Accuracy in the adjusted range*	1 x 10^{-4} g/cm^3
Repeatability*	2 x 10^{-5} g/cm^3
Temperature	
Temperature range - sample	-40 to +125 °C (T5: to +70 °C)
Temperature measurement	Pt1000 integrated
Accuracy in the adjusted range*	Better 0,1 °C
Factory adjustment	In accordance with the temperature and pressure range defined in the order.
Adjustment constants „K“	
Pressure	ATTENTION: consider the specification of the process connection
Pressure range	0 to 125 bar (0 to 1800 psi)
Pressure influence	ca. 0,0001 g/cm³ /bar (can be compensated)
Flow rate	100 to 500 L/h (recommended range)

* All specifications are valid for constant measuring conditions and correct installation.

92034 L-Dens 427T Ex
Density Sensor

Anton Paar

Material, dimensions and weight

Inner diameter of oscillator	6,6 mm
Wetted materials	Hastelloy C276 Stainless steel 1.4571, 1.4404 Silver solder (Ag 54 % / Cu 21% / Pd 25%)
Housing material	Stainless steel 1.4571, 1.4404
Dimensions	226 x 112 x 97,6 mm
Weight	approx. 3400 g

Ambient conditions

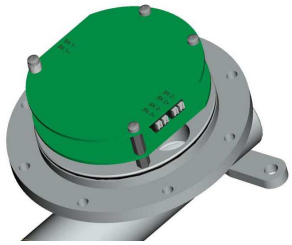
Temperature range - ambient	-40 to +70 °C (T5: to +40°C)
Degree of Protection	IP66, NEMA 4X
ATEX	EC type-examination certificate according to 94/9/EG Ⓔx II 2 G Ex d IIC T4/5
FM	Class I, DIV 1, Groups A, B, C, D (US) Class I, DIV 1, Groups B, C, D (CA)

Electrical connections

Modbus*	RS 485, externally powered DC 8 to 30 V
HART*	Modulated on the 4-20 mA interface, 2-wire connection (loop powered) DC 11 to 30 V
Analog output*	4-20 mA (loop powered), according to NAMUR NE43 DC 11 to 30 V
Current consumption	< 200 mA
Electrical connection	Spring type terminals, clamping range 0,13 – 1,5 mm²
Cable glands (supplied optionally)	Recommended type ATEX: HSK-M-Ex–d NPT 1/2"
Cable (not supplied)	Recommended cable type: LiYCY, diameter 7 to 12 mm 2 cores twisted in pairs, screened, double insulation Insulation resistance/test voltage 4000 Veff, 50/60 Hz

* The device has functional isolation for max. DC 30 V. Protection against potentially hazardous touch current must be ensured by the customer in accordance with local regulations.

Terminal connections



Cable terminal	Function	Connection
4-20mA / HART +	4-20 mA / HART Interface	4-20mA / HART +
4-20mA / HART -	4-20 mA / HART Interface	4-20mA / HART -
Modbus / RS485 A/+	Modbus / RS485 Interface	Modbus / RS485
Modbus / RS485 B/-	Modbus / RS485 Interface	Modbus / RS485
Supply 8-30V +	Modbus Supply voltage	DC +
Supply 8-30V -	Modbus Supply voltage	DC -

Hazardous Areas

Observe the hints in the instruction manual, the EC type examination certificate or type examination certificate from FM and the type plates for installation and service in Ex areas.

Contact information is subject to change. For the most current contact information, visit our website at www.fmctechnologies.com/measurementsolutions and click on the "Contact Us" link in the left-hand column.

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