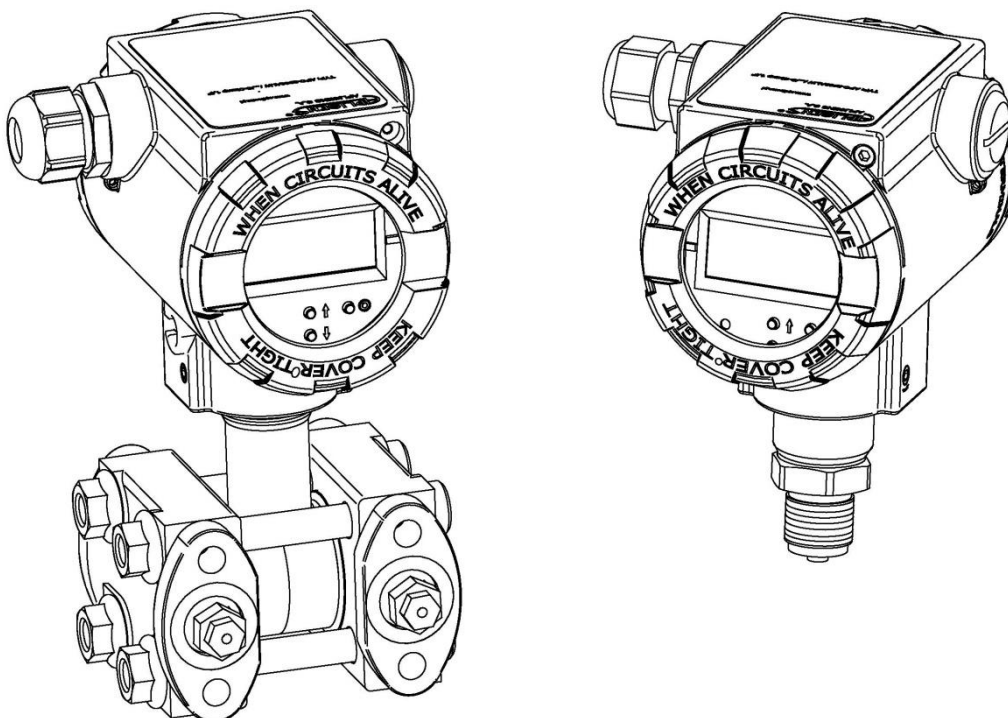




TECHNICAL INFORMATION

PRESSURE AND DIFFERENTIAL PRESSURE TRANSMITTERS

APC-2000ALW Safety
APR-2000ALW Safety

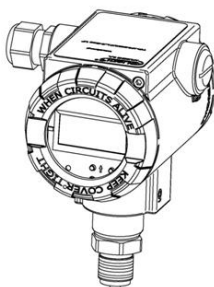


The QR code enables to identify a product and quickly access the user documentation.

APC-2000ALW Safety

ID: 0001 0004 0002 0000 0000 0000 0001 88

<https://aplisens.pl/ID/00010004000200000000000000000188/00000000>



APR-2000ALW Safety

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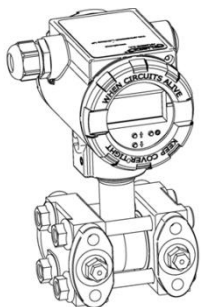


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1. Document information

1.1. Purpose of the document

The purpose of the Technical Information is to provide broader knowledge about the design, application, installation and parameterisation of transmitters APC(R)-2000ALW Safety.

1.2. Symbols used





Symbol	Description
	Warning to proceed strictly in accordance with the information contained in the documentation in order to ensure the safety and full functionality of the device.
	Information particularly useful during installation and operation of the device.
	Information particularly useful during installation and operation of an Ex type device.
	Information on disposal of used equipment.

Table 1. Symbols used.

1.3. Trademarks

HART® is a registered trademark of FieldComm Group.

Windows® is a registered trademark of Microsoft Corporation.

Google Play® is a service registered and managed by Google® Inc.

Varivent® is a registered trademark of GEA Tuchenhausen GmbH.

Tri-Clamp® is a registered trademark of Alfa Laval Corporate AB.

Teflon® is a registered trademark of E. I. du Pont de Nemours and Company.

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1.4. Definitions and abbreviations

APC(R)-2000ALW Safety. Definitions and abbreviations.		
ITEM NO	Abbreviation	Meaning
1	LRV	“Lower Range Value” – the value of the set range expressed in physical units corresponding to the current of 4.000 mA, i.e. 0% of the output setpoint. The set range cannot exceed the set range limits. The minimum width of the set range (URV-LRV) is limited to 10% of the base range (URL-LRL) .
2	URV	“Upper Range Value” – the value of the set range expressed in physical units corresponding to the current of 20.000 mA, i.e. 100% of the output setpoint. The set range cannot exceed the set range limits. The minimum width of the set range (URV-LRV) is limited to 10% of the base range (URL-LRL) .
3	LRL LSL	“Lower Range Limit” or “Lower Sensor Limit” – lower limit of set range expressed in physical units. Value (URL-LRL) or (USL-LSL) is referred to as the base transmitter range.
4	URL USL	“Upper Range Limit” or “Upper Sensor Limit” – upper limit of set range expressed in physical units. Value (URL-LRL) or (USL-LSL) is referred to as the base transmitter range.
5	LPL	“Lower Processing Limit” – lower limit of digital processing of measured value. The transmitter processes a digital measurement up to 50% of the base range width below the lower limit of set range LRL (LSL) . After reaching the LPL and when below this value up to LSAL , the transmitter freezes the refreshing of digital value of the measurement. In this situation, error number E0128 will be displayed on the display and diagnostic alarm mode I_AL< 3.600 mA will be set. Additionally, collective status PV_OUT_OF LIMITS and status PV_LOW_LIMITED in the Transmitter Block will be set, which can be read out in the diagnostic tab via HART communication.
6	UPL	“Upper Processing Limit” – upper limit of digital processing of measured value. The transmitter processes a digital measurement up to 50% of the base range width above the upper limit of set range URL (USL) . After reaching the UPL and when above this value up to USAL , the transmitter freezes the refreshing of digital value of the measurement. In this situation, error number E0128 will be displayed on the display and diagnostic alarm mode I_AL< 3.600 mA will be set. Additionally, collective status PV_OUT_OF LIMITS and status PV_HIGH_LIMITED in the Transmitter Block will be set, which can be read out in the diagnostic tab via HART communication.
7	LSAL	“Lower Saturation Limit” – lower limit of the ADC transmitter processing range. The lower limit of the ADC transmitter saturation is on the pressure/differential pressure scale below the LPL point and is associated with the minimum pressure, at which the analog-digital pressure measurement transmitter reaches the lower limit of the processing capacity. The exact determination of this pressure is not possible, however usually the pressure does not exceed the pressure corresponding to 200% of the base range width (URL-LRL) below the lower limit of the digital processing of measured LPL value. After reaching LSAL and when below this value, error number E0136 will be displayed on the display and the diagnostic alarm mode I_AL<3.600 mA will be activated. Additionally, collective status SENSOR_FAULT , PV_OUT_OF LIMITS , status NOREF+ERR@AIN1_AD7794 in the Sensor Block and PV_LOW_LIMITED in the Transmitter Block will be set, which can be read out in the diagnostic tab via HART communication.
8	USAL	“Upper Saturation Limit” – upper limit of the ADC transmitter processing range. The upper limit of the ADC transmitter saturation is on the pressure/differential pressure scale above the UPL point and is associated with the maximum pressure, at which the analog-digital pressure measurement transmitter reaches the upper limit of the processing capacity. The exact determination of this pressure is not possible, however usually the pressure does not exceed the pressure corresponding to 200% of the base range width (URL-LRL) above the upper limit of the digital processing of measured UPL

		value. After reaching USAL and when above this value, error number E0136 will be displayed on the display and diagnostic alarm mode I_AL < 3.600 mA will be activated. Additionally, collective status SENSOR_FAULT, PV_OUT_OF LIMITS, status NOREF+ERR@AIN1_AD7794 in the Sensor Block and PV_HIGH_LIMITED in the Transmitter Block will be set, which can be read out in the diagnostic tab via HART communication.
9	MSV	“Minimum Span Value” – a value of the minimum set range width [URV - LRV] that possible to be set in the transmitter. This value is entered into the transmitter at the manufacturing stage and cannot be changed by the user. It is used to limit the application of the scaling of the MSF set range.
10	MSF	“Minimum Span Factor” – scaling coefficient of set range. Specifies the ratio of the base range to the minimum set range that can be set in the transmitter. This coefficient is usually x 10. The parameter defining the minimum set range width can be read-out using HART communications.
11	FSO	“Full Scale Output” – this term refers to full scale of setpoints (range of setpoints). For setpoints expressed as percentage values, it corresponds to 100% of the range value.
12	ADC	“Analog to Digital Converter”, an analog-digital transmitter used to change the analog value of voltage or current to a digital value.
13	DAC	“Digital to Analog Converter”, a digital-analog transmitter used to change the digital value to an analog value of voltage or current.
14	LCD1, LCD2, LCD3	LCD information fields. The exact description is included in (→13.2.1).
15	I_AL	Alarm current. For non-critical safe diagnosable damages, the diagnostic alarm current is: I_AL < 3.600 mA (nominal 3.440 mA). For critical safe diagnosable failures, the diagnostic alarm current value is: I_AL << 3.600 mA (nominal 0.240 mA). For safe non-diagnosed failures, the assumed alarm current value may be I_AL < 3.600 mA or I_AL > 20.660 mA.
16	PV SV TV FV	First process variable (pressure or differential pressure). Second process variable (pressure sensor temperature). Third process variable (ADC transmitter temperature). Fourth process variable (temperature of main CPU microcontroller).

Table 2. Definitions and abbreviations.

2. Selection of transmitter version depending on application

2.1. Principle of pressure and differential pressure measurement

The measurement principle is based on the measurement of the output voltage from the piezoelectric bridge proportional to the process pressure acting on the sensor diaphragm. The external pressure is fed through the flexible diaphragm of the sensor and the gauge fluid filling the sensor to the piezoresistive diaphragm of the measuring bridge, causing its deflection and changing the resistance of the bridge piezoresistors. Depending on the purpose, the measuring sensor may be installed in simple pressure heads or in more complex differential pressure heads. Additionally, pressure or differential pressure heads may be equipped with hydraulic separators. The electrical signal from the pressure sensor is transmitted to the ADC analog-digital transmitter where it is converted to a digital value. The digital value of the measurement signal with diagnostic measurements and the temperature measurement of the structure and the ADC transmitter via an optoelectrical galvanic barrier is transmitted to the main CPU microcontroller that manages the calculations and control of the transmitter modules. Here the analysis of the correctness of measurements, normalization of measurements to physical pressure values, compensation of temperature impacts on measurements, conversion of units, conversion of the characteristics and output setpoint ranges are performed depending on the client's settings. As a result, the standardized, calibrated and configured measurement controls the output current controller 4 ... 20 mA, ensuring that a user will obtain a precise and stable read-out of the measured input value of the process variable.

2.2. Selection of the transmitter version

Transmitter APC(R)-2000ALW Safety is manufactured in an intrinsically safe N version, in an intrinsically safe Exia version and a flameproof Exd version.

The following versions are available:

- low pressure measurement with an ultra-stable HS header;
- measurement of medium and high pressures;
- measurement of low pressure differences with the ultra-stable HS head;
- measurement of medium and high differential pressure.

The transmitters are available with several types of process connections and various versions of separators. The list of parameters is presented in the table below.

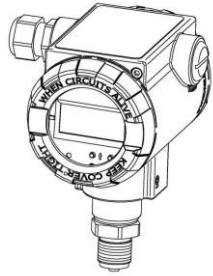
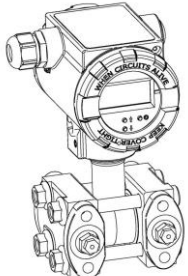
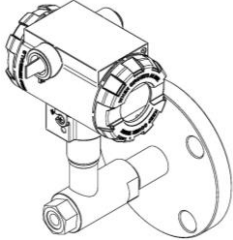
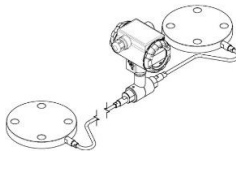
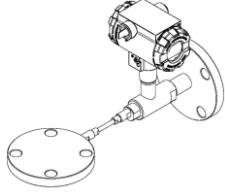
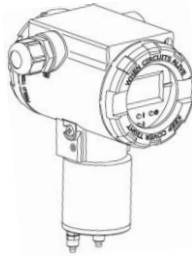
Smart transmitters						
	Pressure APC-2000ALW Safety	Differential pressure APR-2000ALW Safety				
Version		APR-2000ALW Safety 	With one direct or distance separators 	With two distance separators 	With direct and distance separators. 	For low gas pressure measurement. 
Application in measurements	<ul style="list-style-type: none"> - Level measurement - Pressure measurement - Negative pressure measurement - Absolute pressure measurement 	<ul style="list-style-type: none"> - Level measurement - Differential pressure measurement - Flow measurement 	<ul style="list-style-type: none"> - Level measurement 	<ul style="list-style-type: none"> - Level measurement in closed tanks - Density measurement - Phase limit measurement - Differential pressure measurement 	<ul style="list-style-type: none"> - Level measurement - Density measurement - Phase limit measurement - Differential pressure measurement (at varied height of pulse collection points) 	<ul style="list-style-type: none"> - Pressure measurement - Negative pressure measurement - Differential pressure measurement
Housing	Normal version:					
	<ul style="list-style-type: none"> - high pressure aluminium alloy casting, varnished or acid resistant steel 1.4401 (316) 					
Special version (Exd, Exi):						
<ul style="list-style-type: none"> - high pressure aluminium alloy casting, varnished or acid resistant steel 1.4401 (316) 						

Table 3. Transmitter versions, used in measurements.

	APC-2000ALW Safety	APR-2000ALW Safety	With one direct or distance separators	With two distance separators	With direct and distance separator	For low gas pressure measurement
Process connections	<ul style="list-style-type: none"> - M (M20x1.5, Ø4) - P (M20x1.5, Ø12) - 1/2NPT(ext. 1/2" NPT, inner G1/4") - G1/2 (G1/2, Ø4) - GP (G1/2, Ø12) - CM30x2(M30x2) - CG1(G1") - G1/4 (G1/4" Ø4) - CG1/2(G1/2") - RM(M20x1.5 Ø4) - RG radiator with G1/2 stub <p>Specification of process connections for APC-2000ALW Safety</p>	<ul style="list-style-type: none"> - P(M20x1.5, Ø9) - C - CR <p>Specification of process connections for APR-2000ALW Safety</p>	<p>For APR-2000ALW Safety:</p> <ul style="list-style-type: none"> - 1/4 NPT (for impulse tube welding) <p>For APC(R)-2000ALW Safety:</p> <ul style="list-style-type: none"> - Flanged flat S-P - Flanged tubular S-T - Separator S-TK-P with built-in diaphragm flushing unit - Chemical resistant flanged S-Ch - Compact S-Comp - Compact distance separators S-Comp10MPa, S-Comp25MPa, S-Comp60MPa - Compact chemical resistant S-CompCh - Hygiene - S-Mazut - S-RC 	<ul style="list-style-type: none"> - Flanged flat S-P - Flanged tubular S-T - Separator S-TK-P with built-in diaphragm flushing unit - Chemical resistant flanged S-Ch - Compact S-Comp - Compact distance separators S-Comp10MPa, S-Comp25MPa, S-Comp60MPa - Compact chemical resistant S-CompCh - Hygiene - S-Mazut - S-RC 	<ul style="list-style-type: none"> - PCV (stubs with clamping end for Ø6 tube) - P (M20 x 1.5) - GP (G1/2" Ø12) - Block valve adapter (1/4NPT) <p>Process connections for measuring low gas pressure</p>	
			Separators and their application			

Table 4. Transmitter versions, process connections.

	<p>APC-2000ALW Safety</p>	<p>APR-2000ALW Safety</p>	<p>With one direct or distance separators</p>	<p>With two distance separators</p>	<p>With direct and distance separator</p>	<p>For low gas pressure measurement</p>
Measuring ranges ¹	-100 kPa to 100 MPa	from 50kPa to 7 MPa Static pressure up to 41.3 MPa	According to the relevant separator data sheet ² .	-160kPa to 1600kPa		-10 to 10 kPa Static pressure up to 100 kPa
Overload*	Up to 120 MPa	With type C connection: 25 MPa – normal version. 41.3 MPa – special version. With type P connection: 7 MPa	According to the relevant separator data sheet ² .			Overload depending on the measurement range and the head used.
Operating temperature ⁶	-40°C ... 85°C		-40°C ... 85°C		-25°C ... 85°C	
Ambient temperature ⁶	-40°C ... 85°C		-40°C ... 85°C		-25°C ... 85°C	
Measurement error ⁵	Basic error 0.05%... 0.1%	Basic error ≤ ± 0.075%	Basic error ≤ ± 0.1% Please note! Measurement errors depending on the effect of separation			Basic error from ± 0.075% to ± 1,6% Please note! Measurement errors depending on the measurement range.

Table 5. Transmitter versions, measurement ranges, overload, operating temperature, measurement error.

	<p>APC-2000ALW Safety</p>	<p>APR-2000ALW Safety</p>	<p>With one direct or distance separator</p>	<p>With two distance separators</p>	<p>With direct and distance separator</p>	<p>For low gas pressure measurement</p>
Power supply voltage	<p>For N, Exd versions: 11.5 V – 36 V DC For Exi versions: 11.5 V – 30 V DC For transmitter with LCD backlight + 3V</p> <p>Note: backlighting on request, provided at the manufacturing level</p>					
Output	<p>4 ... 20 mA with HART protocol</p>					
Options ⁴	<ul style="list-style-type: none"> • KAL – factory calibration certificate; • WZ – calibration certificate issued by Accredited Laboratory; • AU – gold-plated diaphragm; • 2.1, 3.1 – material certificate acc. to PN-EN10204; 2006 (wetted parts); • NACE – material certificate NACE MR0175/ISO 15156 (wetted parts); • PZH – Certificate of the National Institute of Hygiene; • TH – hydrostatic test; • filling with edible oil, silicone oil, chemically neutral liquid for oxygen measurement versions and clean gases. 					
Special versions	<ul style="list-style-type: none"> • IP67 – housing protection rating – special version; • MR – version for marine applications; • Hastelloy – diaphragm made of Hastelloy C 276 (not for HS version); • Oxygen – transmitter adapted for measurement of oxygen and pure gases³; • SS – housing made of steel 316L (stainless steel – maximum vibrations up to 1 g); • HS – Ultra stable measuring element; • Other – to be agreed with Aplisens consultants. 					

Table 6. Transmitter versions, supply voltages, output, options, special versions.

* Limit value of the device pressure depends on the measuring system component with the lowest rated pressure.

¹ Measurement ranges of pressure and differential pressure transmitters and transmitters with the connection for low gas pressure measurement are shown in:

➔ **Table 13**, ➔ **Table 14**, ➔ **Table 15**, ➔ **Table 16** of Technical Information.

² Scope of applicability according to the relevant separator data sheet. The data are included in section (➔ **Separators and their application**).

³ For selected ranges.

⁴ Special versions with regard to separators according to the relevant separator data sheet.

⁵ Measurement error depending on the measurement range.

⁶ Range of storage temperature and operating temperature is depends on the measuring system components see ➔ **Table 22**, ➔ **Table 23**.

2.3. Flow measurement, methods of mounting and mechanical connection of transmitters

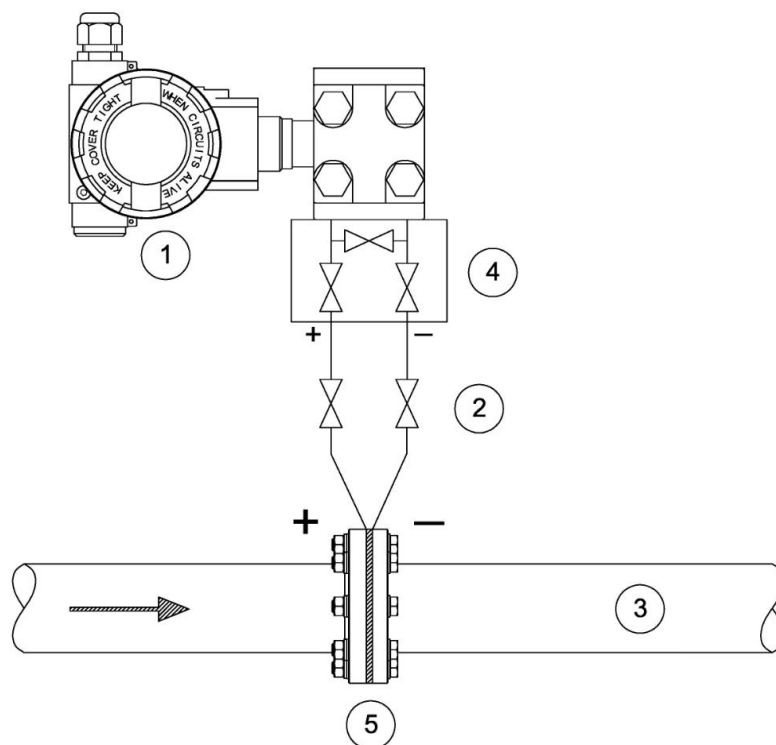
Transmitter APR-2000ALW Safety enables to perform the measurement of gas, steam and liquid flow. In order to obtain the output current proportional to the flow, the transmitter should be set to the output setpoint root characteristics mode (→ 4.4). The transmitter configuration allows for selection of one of 3 types of root characteristics. These characteristics differ from each other in the method of controlling the current output below the root dead band. The selection of characteristics is possible via HART communication and the corresponding software, e.g. Raport 2 manufactured by Aplisens S.A. or other using DD or DTM libraries.

In transmitters APR-2000ALW Safety, the following characteristics are available:

- second-stage root characteristics with relay characteristics and 0.2% hysteresis in the dead band (→ 4.5);
- manufacturer's dual linear characteristics No 1 + second-stage root characteristics for constant dead band = 0.6% ... 0.8% of setpoints (→ 4.6);
- manufacturer's single linear characteristics No 2 + second-stage root characteristics and 0.2% hysteresis in the dead band (→ 4.7);
- square characteristics;
- special characteristics based on user-modified table.

2.3.1. Measurement of gas flow rate

Transmitter APR-2000ALW Safety must be installed above the measuring point so that the condensate can flow from the capillaries to the process pipe.



1. APR-2000ALW Safety.
2. Shut-off valves.
3. Pipeline.
4. Three-way valve.
5. Orifice or Pitot tube.

Figure 1. Gas flow rate measurement system using APR-2000ALW Safety.

2.3.2. Measurement of steam flow rate

Transmitter APR-2000ALW Safety must be installed below the measuring point.

Traps (siphons) should be located at the same level as the sampling points and at the same distance from the transmitter.

Before turning the device on fill the impulse tubes up to the height of condensate traps.

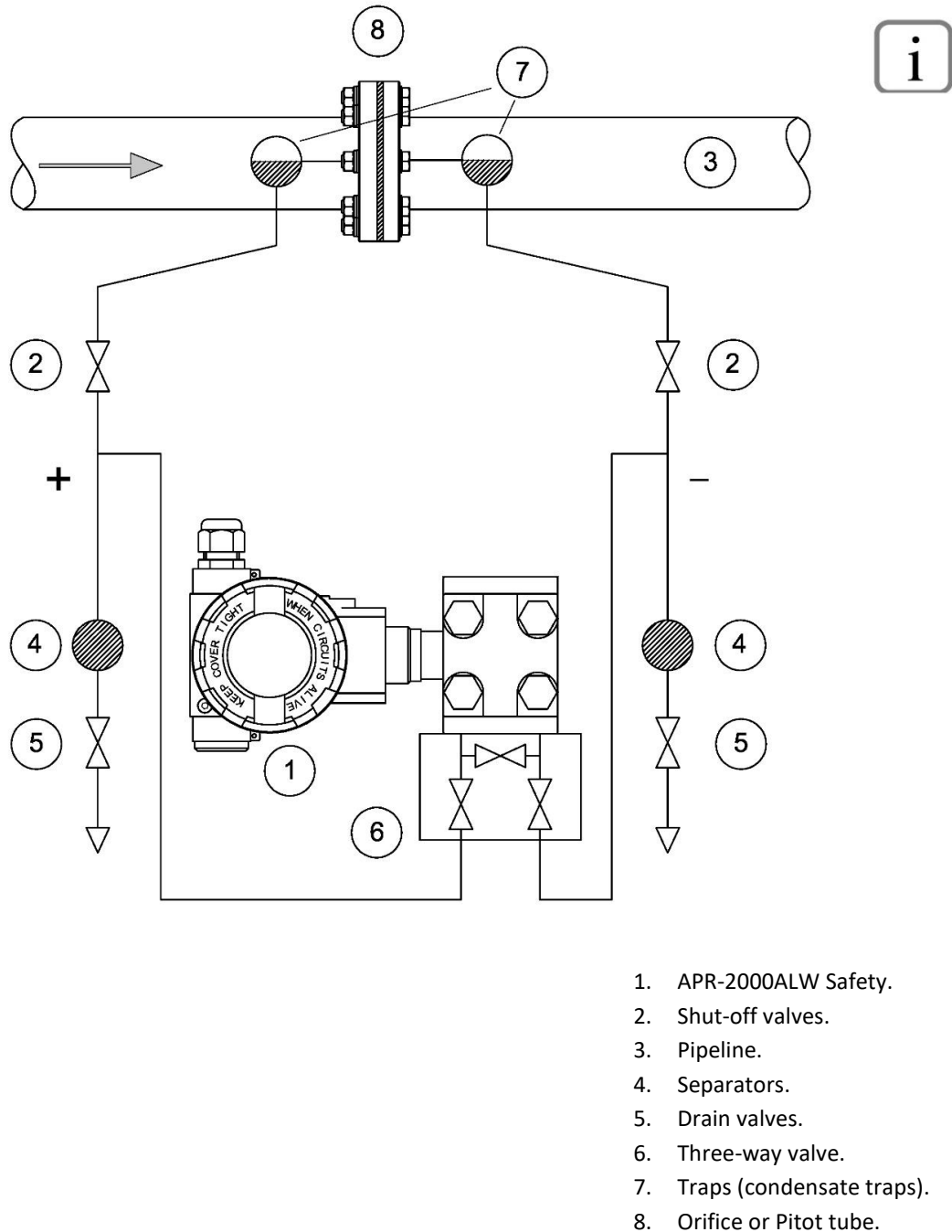
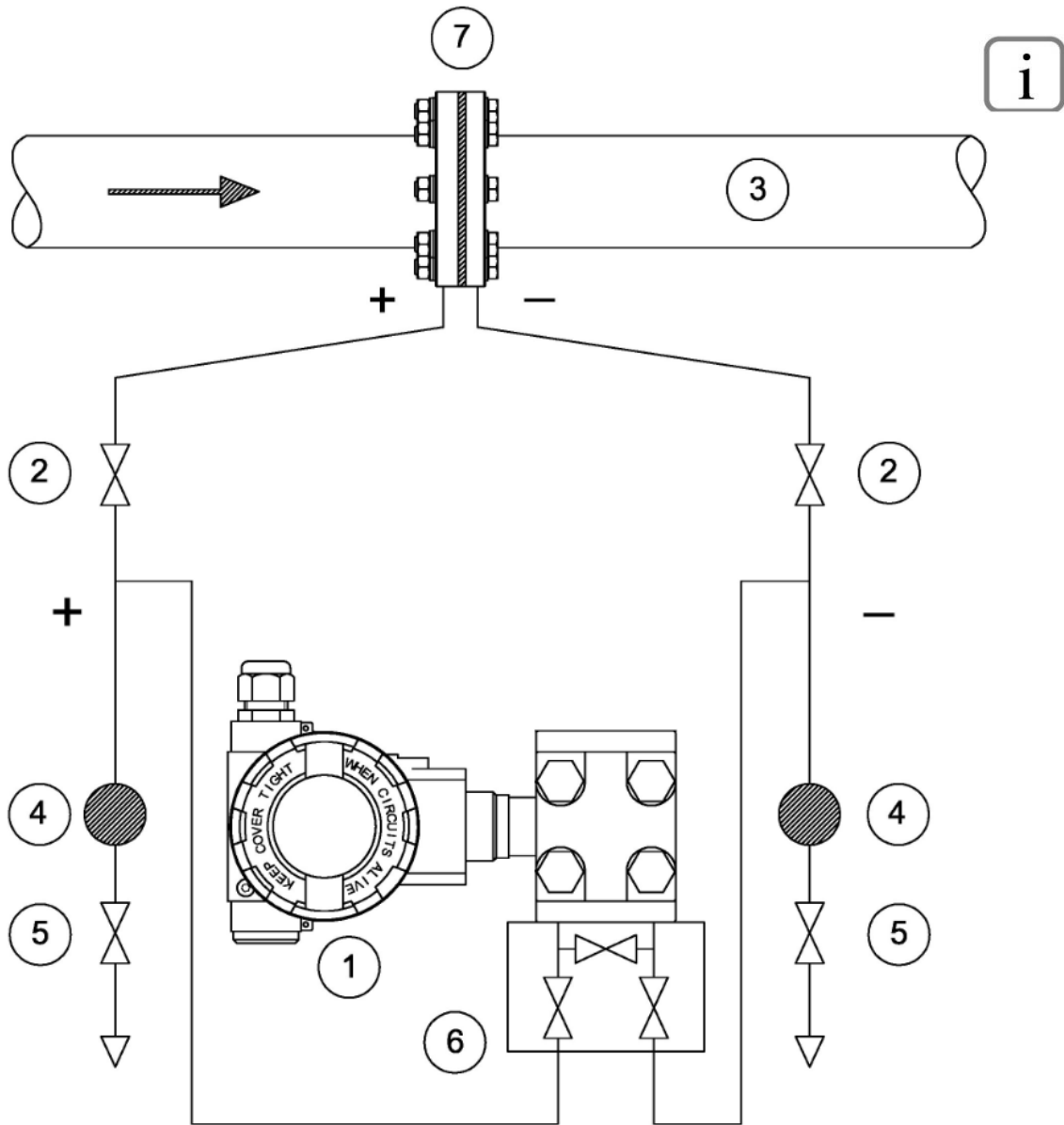


Figure 2. Steam flow rate measurement system using APR-2000ALW Safety.

2.3.3. Liquid flow measurement

Transmitter APR-2000ALW Safety must be mounted below the measuring point so that the impulse tubes are always filled with liquid and the gas bubbles can freely escape to the process pipe.

If the measured medium contains particles, it is useful to install separators and drain valves to remove deposits.



1. APR-2000ALW Safety.
2. Shut-off valves.
3. Pipeline.
4. Separators.
5. Drain valves.
6. Three-way valve.
7. Orifice or Pitot tube.

Figure 3. Liquid flow rate measurement system using APR-2000ALW Safety.

2.4. Level measurement

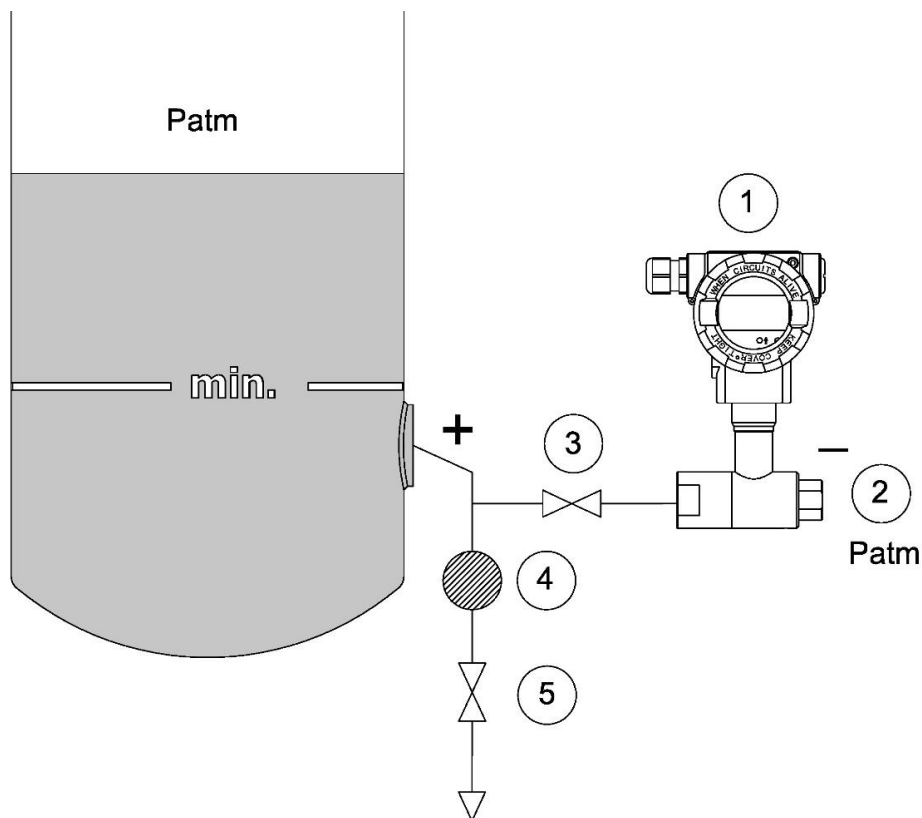
Transmitter APC-2000ALW Safety or APR-2000ALW Safety enables to measure the level of liquids. In order to obtain the output current proportional to the liquid column, the transmitter should be set to the linear output setpoint characteristics mode (→ 4.4). The transmitter configuration also enables to select a 21-point user characteristics and define the user's own unit and scaling the output setpoint. In this way, it is possible, for example, to measure the volume/weight of liquid in the tanks with irregular shapes.

2.4.1. Liquid level measurement system in open tanks

Transmitter APR-2000ALW Safety must be mounted below the measuring point so that the impulse tubes are always filled with liquid.

The negative side of pressure connection is open to the atmosphere.

If the measured medium contains particles, it is useful to install separators and drain valves to remove deposits.

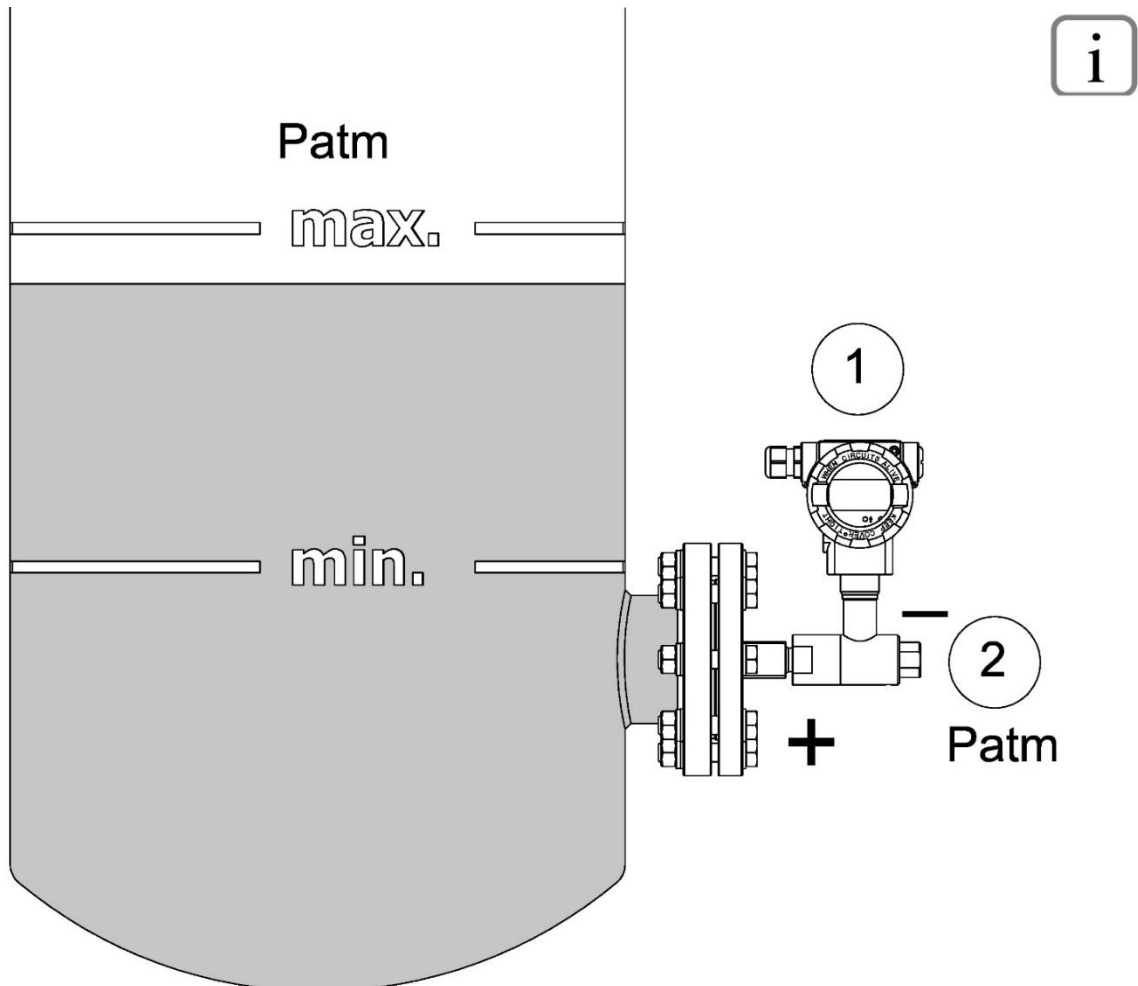


1. APR-2000ALW Safety.
2. The negative side of pressure connection is open to atmosphere.
3. Shut-off valve.
4. Separators.
5. Drain valves.

Figure 4. System of liquid level measurement in open tanks using APR-2000ALW Safety.

2.4.2. Liquid level measurement system in open tanks with the use of direct separator and differential pressure transmitter APR-2000ALW Safety

Transmitter APR-2000ALW Safety shall be mounted directly into the tank using an integrated separator always below the minimum liquid level.

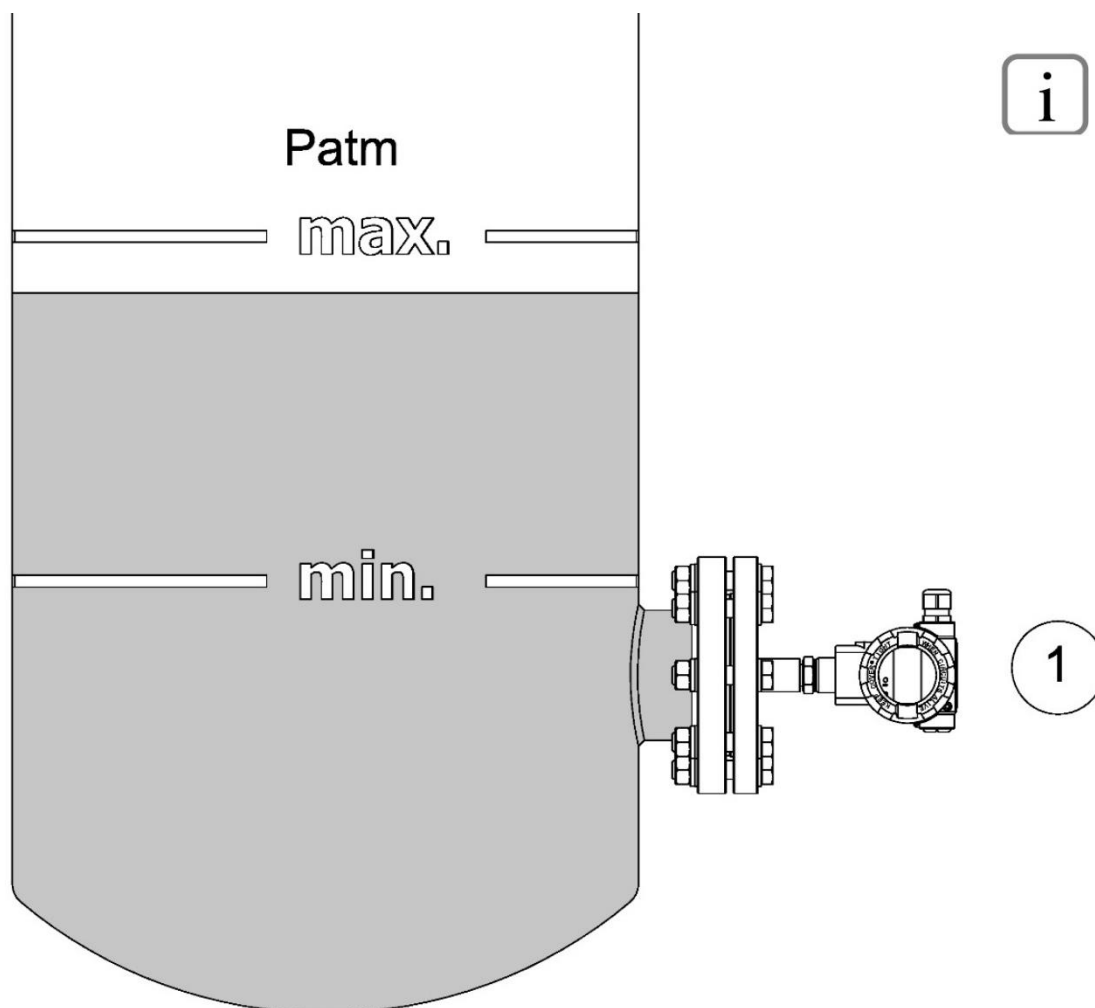


1. APR-2000ALW Safety.
2. The negative side of pressure connection is open to the atmosphere.

Figure 5. Liquid level measurement system in open tanks using APR-2000ALW Safety with direct separator.

2.4.3. Liquid level measurement system in open tanks with the use of direct separator and pressure transmitter APC-2000ALW Safety

Transmitter APC-2000ALW Safety shall be mounted directly into the tank using an integrated separator always below the minimum liquid level.



1. APC-2000ALW Safety.

Figure 6. Liquid level measurement system in open tanks using APC-2000ALW Safety with direct separator.

2.4.4. Liquid level measurement system in closed tanks

Transmitter APR-2000ALW Safety must be mounted below the measuring point so that the impulse tubes are always filled with liquid.

The negative side of pressure connection must be connected through a capillary tube always above the maximum liquid level.

If the measured medium contains particles, it is useful to install separators and drain valves to remove deposits.

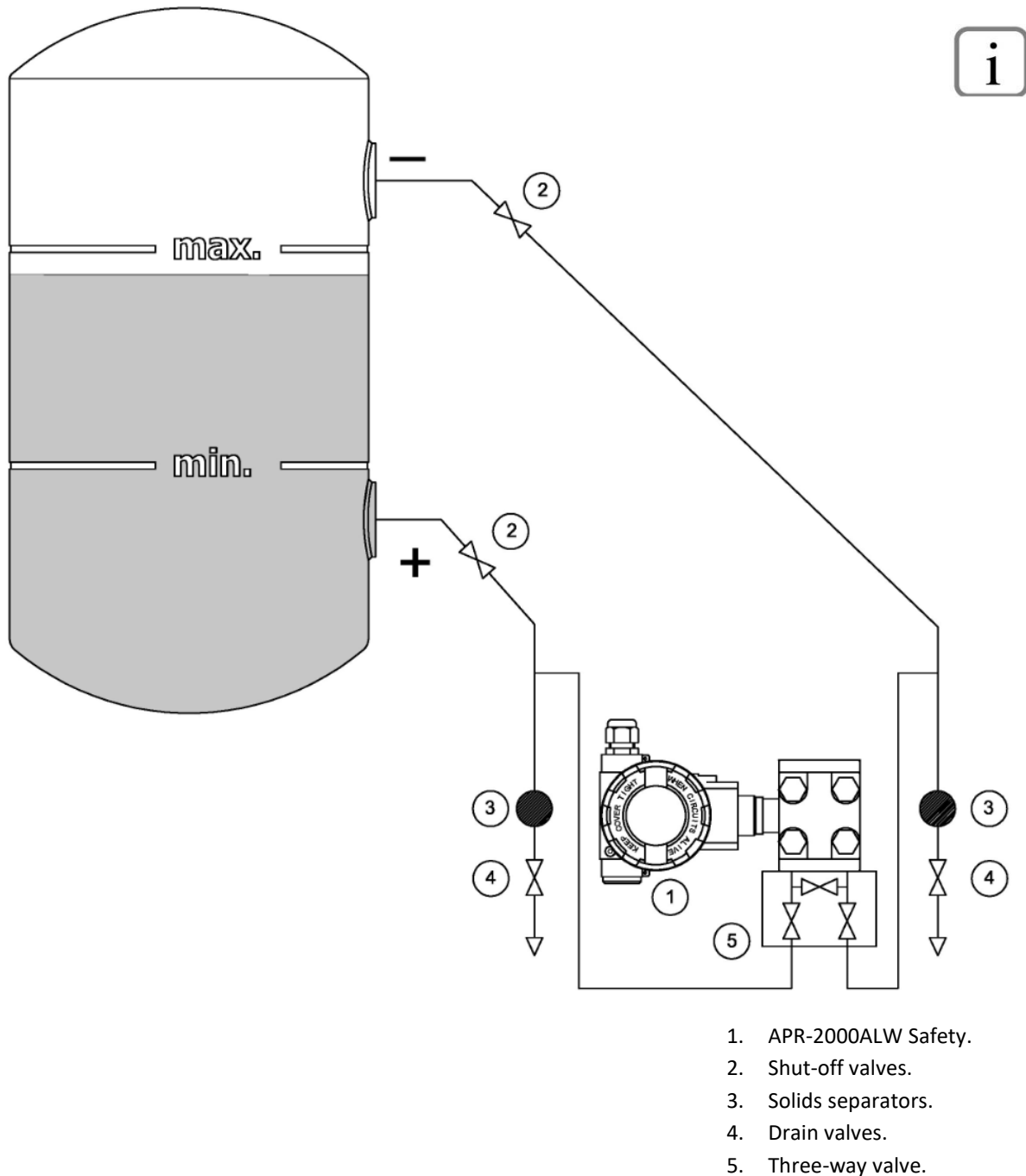


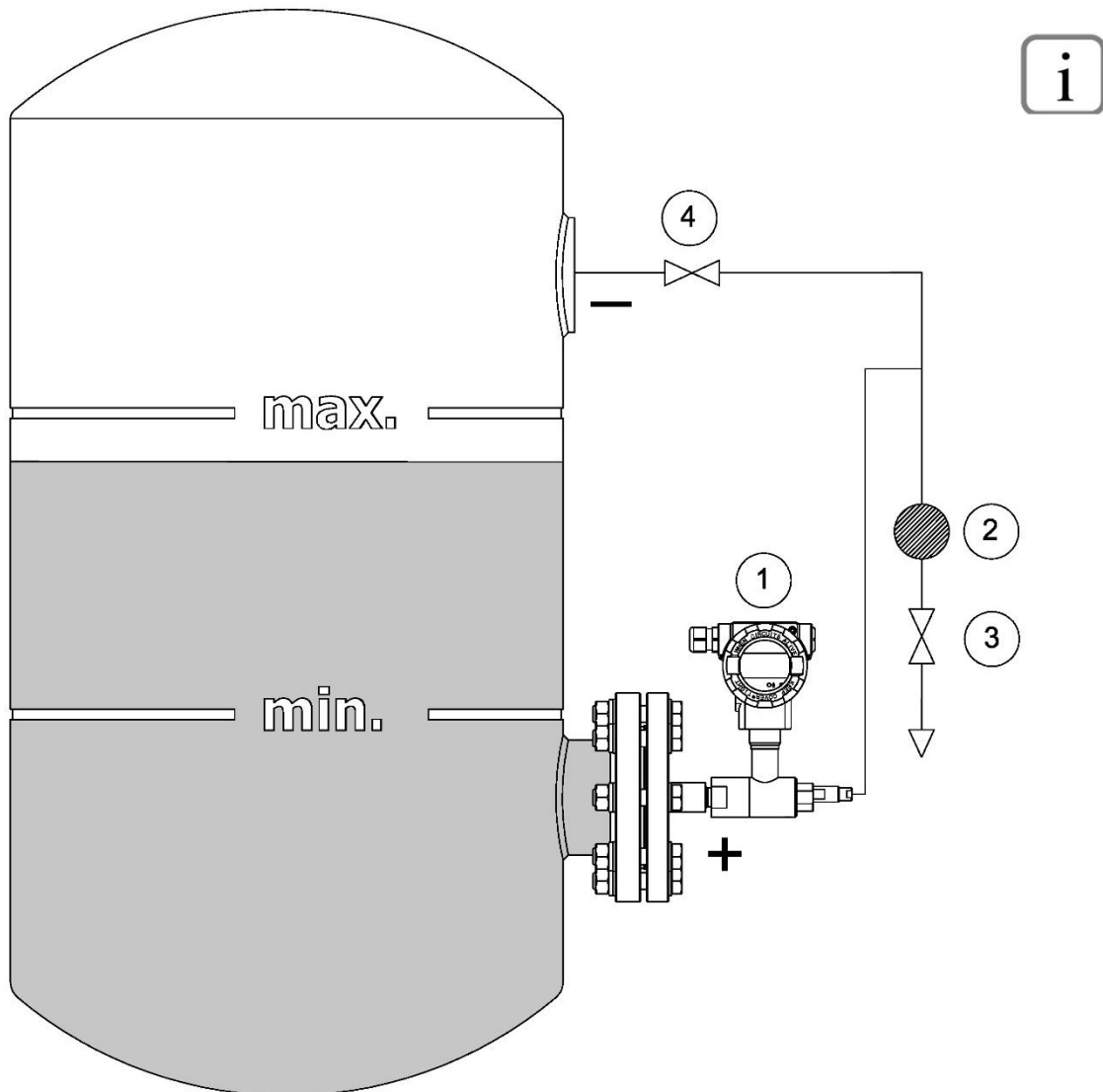
Figure 7. Liquid level measurement system in closed tanks using APR-2000ALW Safety.

2.4.5. Liquid level measurement system in closed tanks with the use of direct separator

Transmitter APR-2000ALW Safety must be mounted directly into the tank using an integrated separator.

The negative side of pressure connection must be connected through a capillary tube always above the maximum liquid level.

If the measured medium contains particles, it is useful to install separators and drain valves to remove deposits.



1. APR-2000ALW Safety.
2. Solids separators.
3. Drain valve.
4. Shut-off valve.

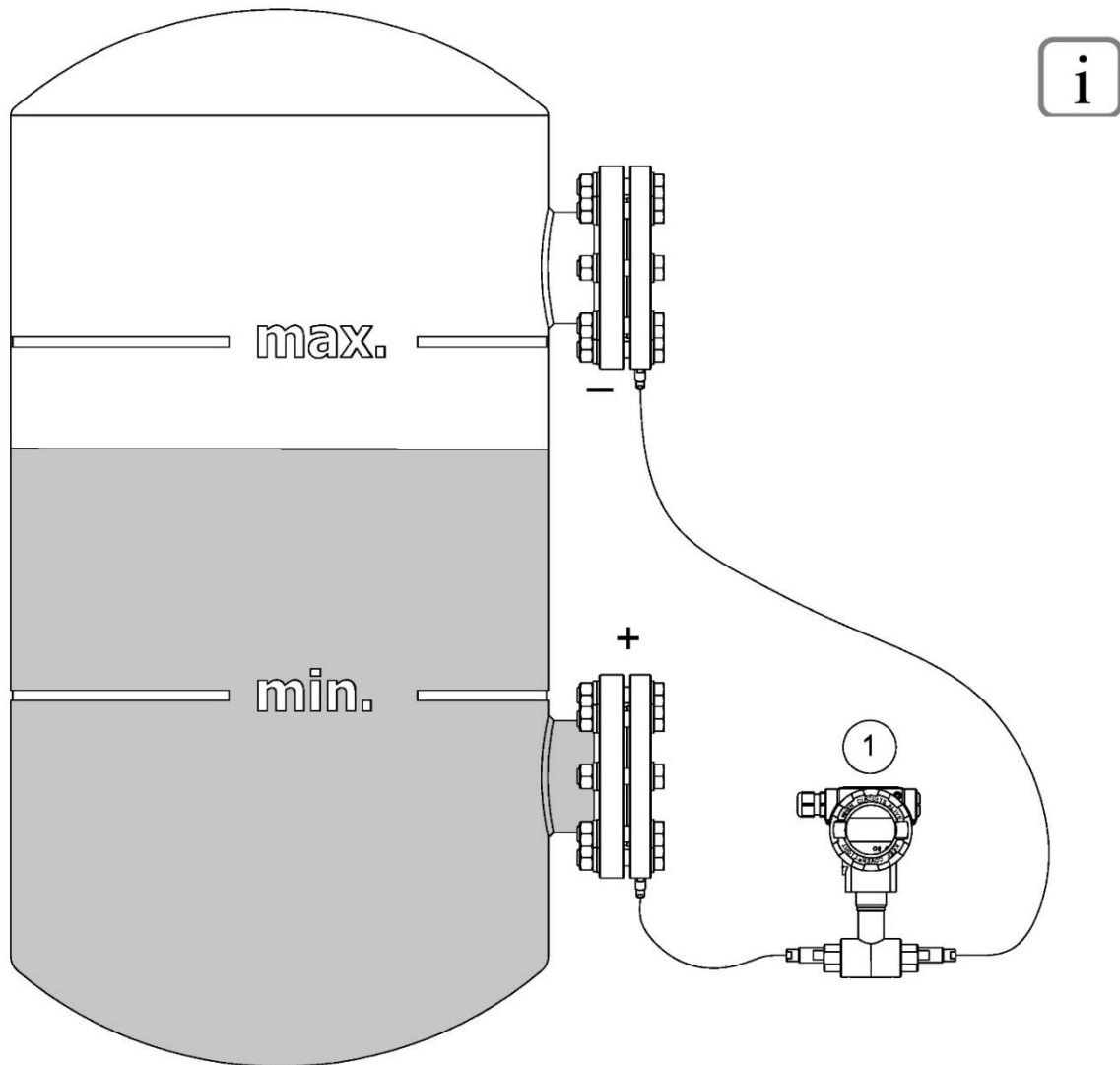
Figure 8. Liquid level measurement in closed tanks using APR-2000ALW Safety and direct separator.

2.4.6. Liquid level measurement system in closed tanks with the use of distance separators

Transmitter APR-2000ALW Safety must be installed below the mounting points of distance separators.

Approximate ambient temperature in both capillaries connecting the transmitter with separators must be ensured.

The correct measurement is ensured only between the upper edge of the lower separator and the lower edge of the upper separator.



1. APR-2000ALW Safety with distance separators.

Figure 9. Liquid level measurement in closed tanks using APR-2000ALW Safety and distance separators.

2.4.7. Liquid level measurement system in closed tanks with the use of direct and distance separator

Transmitter APR-2000ALW Safety must be mounted directly into the tank using an integrated separator. The negative side of pressure connection must be connected through a distance separator always above the maximum liquid level.

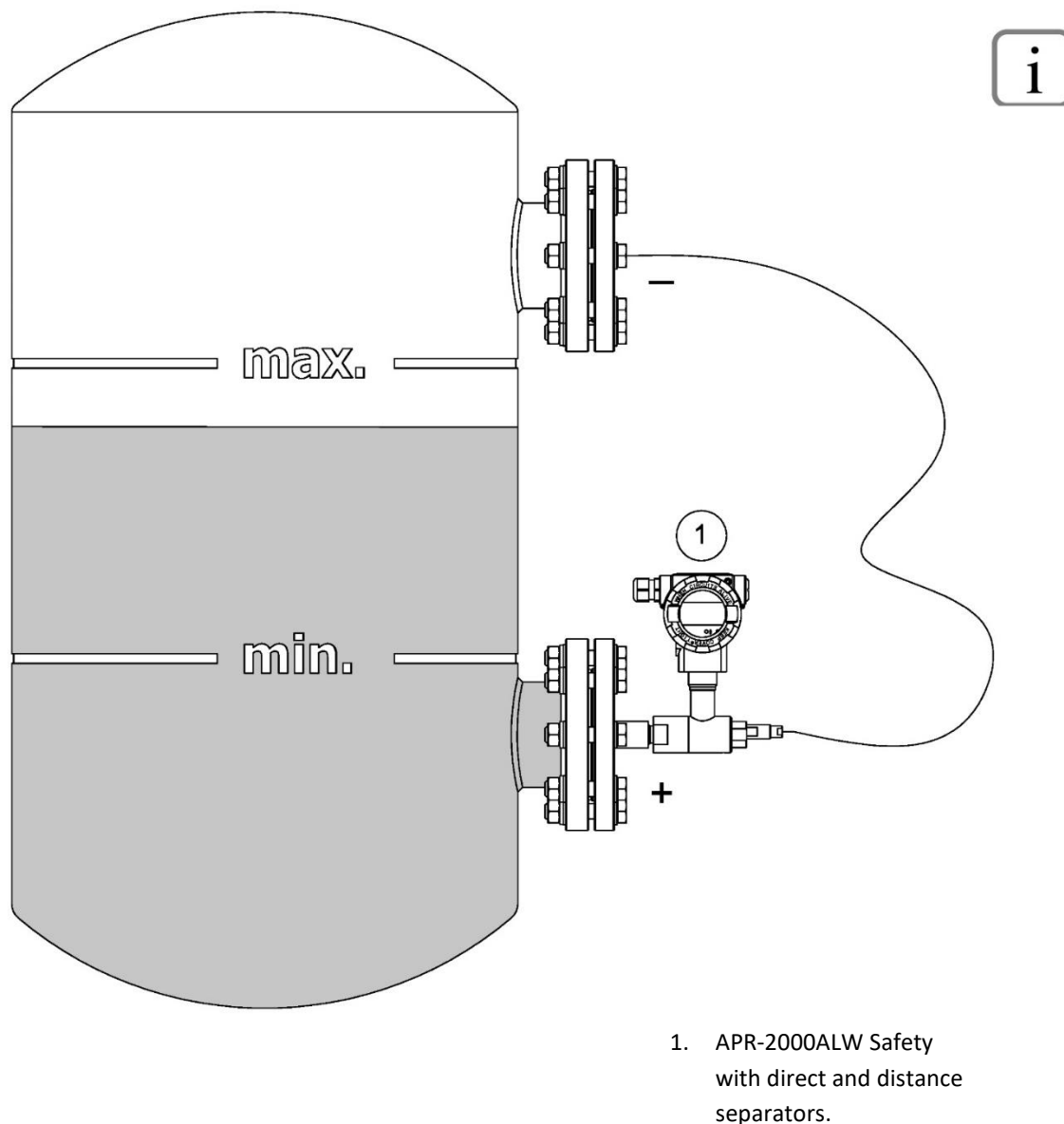


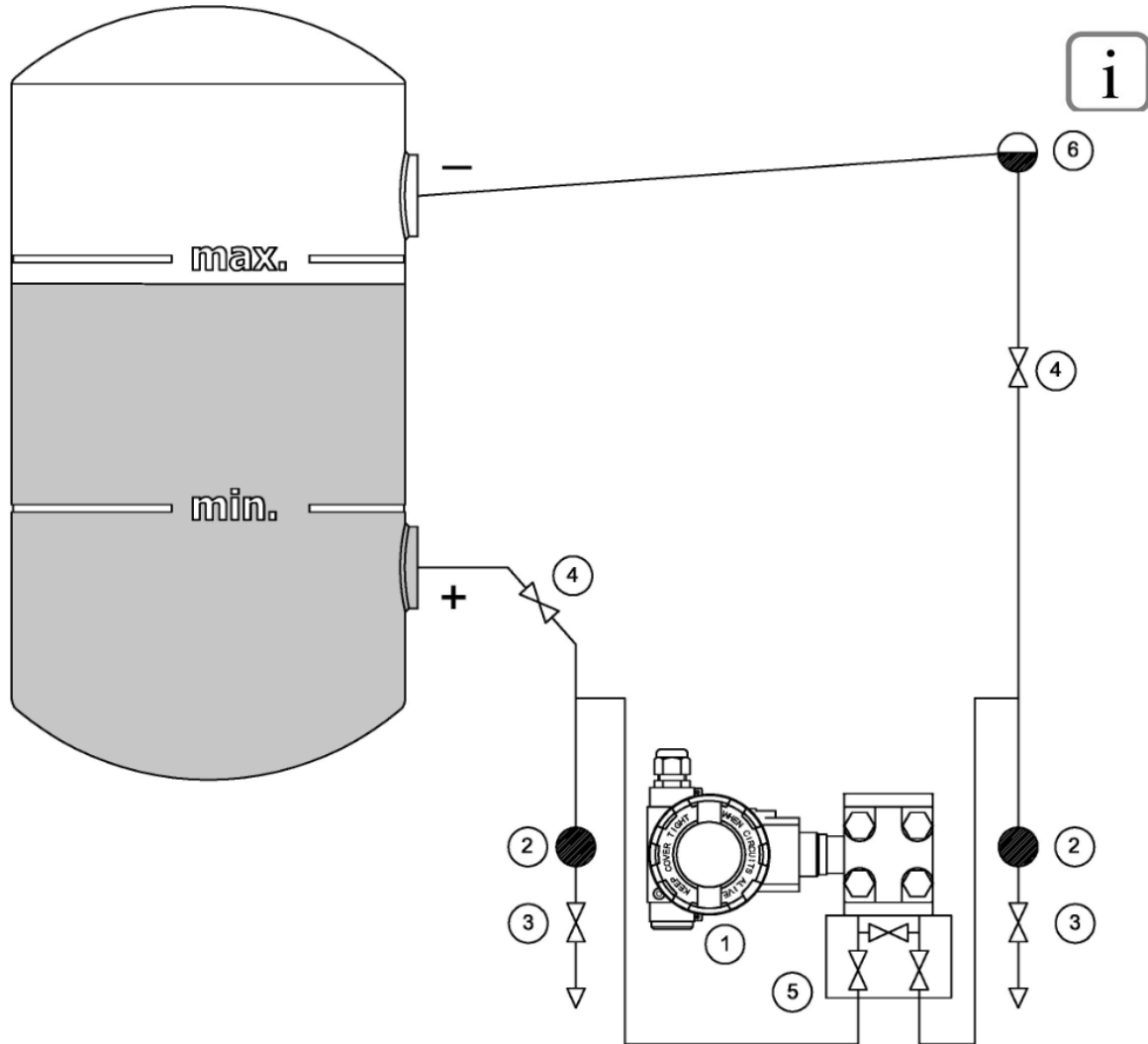
Figure 10. Liquid level measurement in closed tanks using APR-2000ALW Safety with direct and distance separators.

2.4.8. Liquid level measurement system in closed tanks with steam pillow

Transmitter APR-2000ALW Safety must be mounted below the measuring point so that the impulse tubes are always filled with liquid.

The negative side of pressure connection must be connected through a capillary tube always above the maximum liquid level.

If the measured medium contains particles, it is useful to install separators and drain valves to remove deposits.



1. APR-2000ALW Safety.
2. Solids separators.
3. Drain valves.
4. Shut-off valves.
5. Three-way valve.
6. Condensate trap.

Figure 11. Liquid level measurement system in closed tanks with steam cushion using APR-2000ALW Safety.

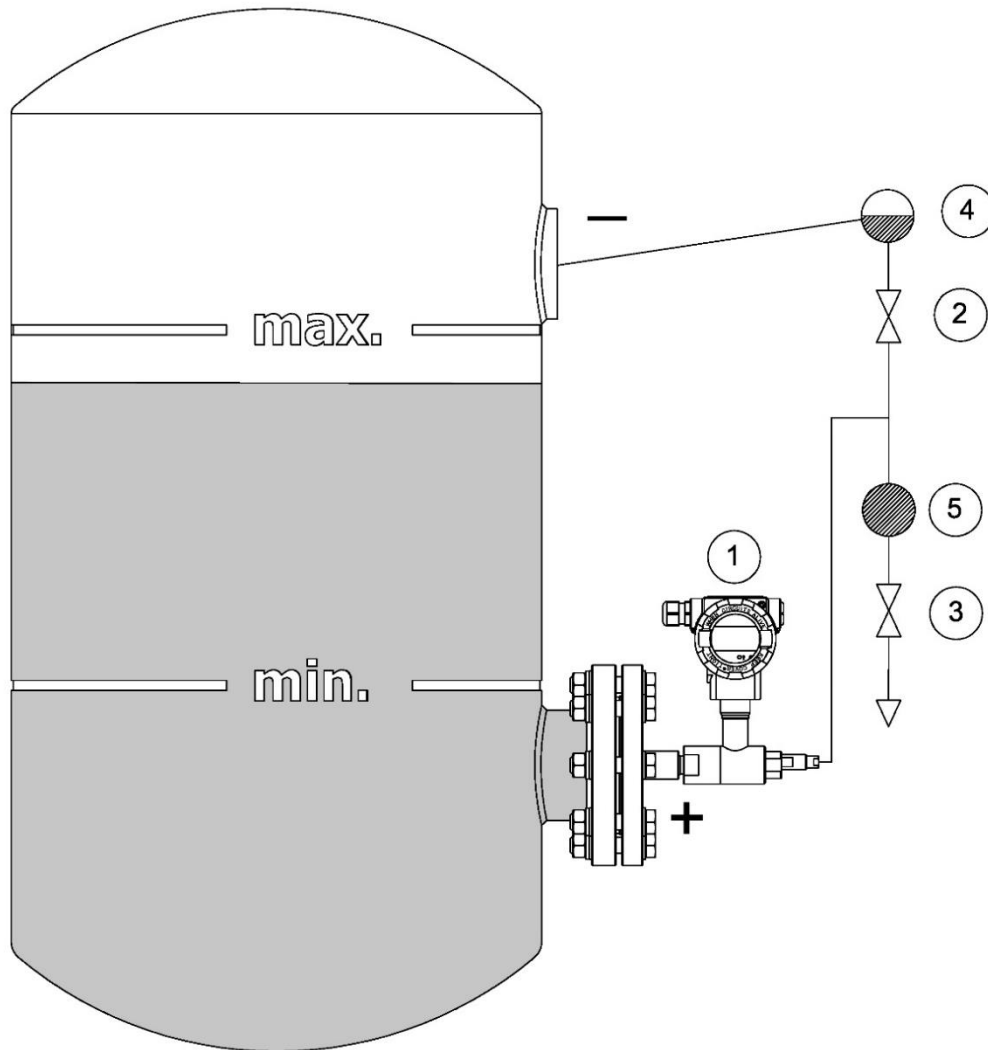
2.4.9. Liquid level measurement system in closed tanks with steam cushion with the use of direct separator

Transmitter APR-2000ALW Safety must be mounted directly into the tank using a direct separator.

The negative side of pressure connection must be connected through a capillary tube always above the maximum liquid level.

Condensate trap ensures constant pressure from the negative process pressure side.

When measuring medium contains solid particles, it is useful to install a separator and drain valve to remove deposits.



1. APR-2000ALW Safety with direct separator.
2. Shut-off valve.
3. Drain valve.
4. Condensate trap.
5. Solids separator.

Figure 12. Liquid level measurement system in closed tanks with steam cushion using APR-2000ALW Safety with direct separator.

2.5. Pressure measurement

Transmitter APC-2000ALW Safety or APR-2000ALW Safety enables to measure pressure. A range of process connections with separators and a large number of standard process ranges of the measured pressures are available. The transmitter configuration also allows for pressure presentation in many physical units (→ 13.2.2) or the user's own units (→ 13.2.6).

2.5.1. Gas pressure measurement system

Transmitter APC-2000ALW Safety must be installed above the measuring point so that the condensate can flow into the piping.

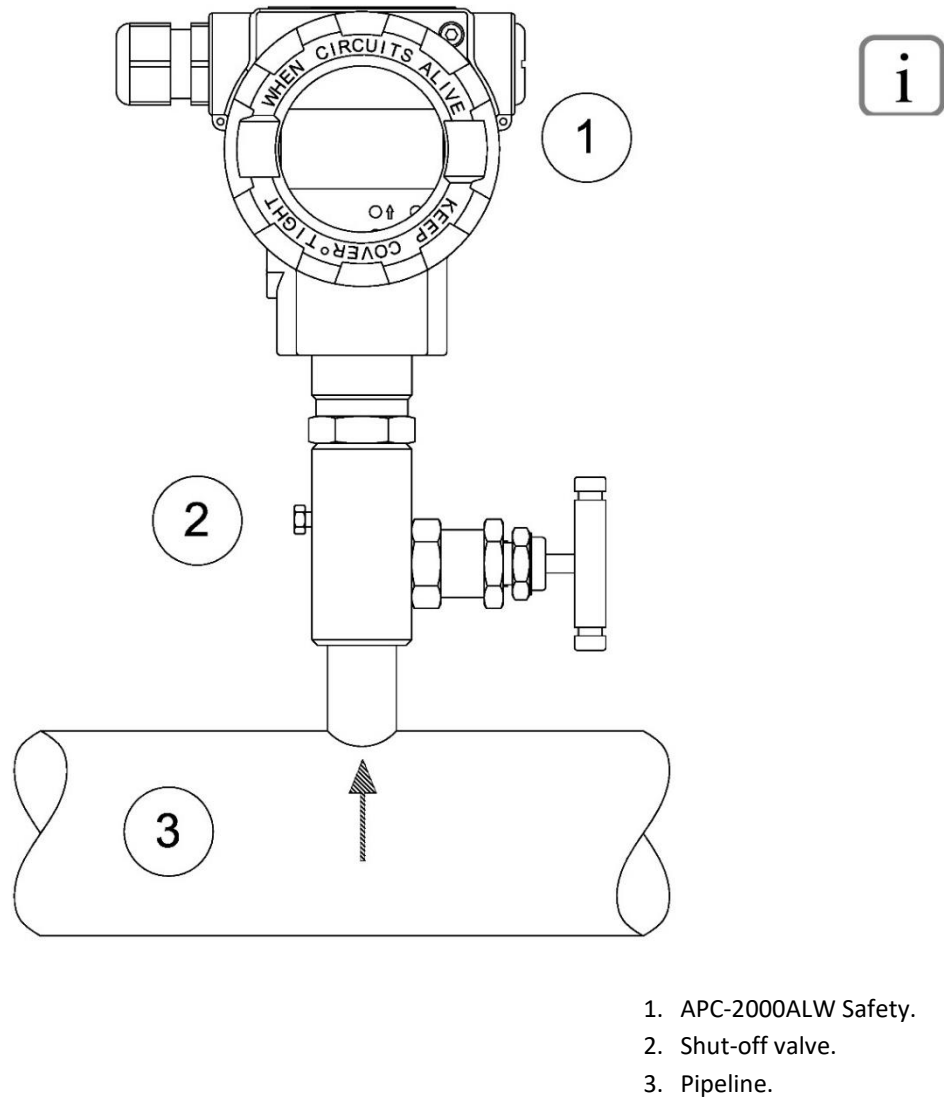
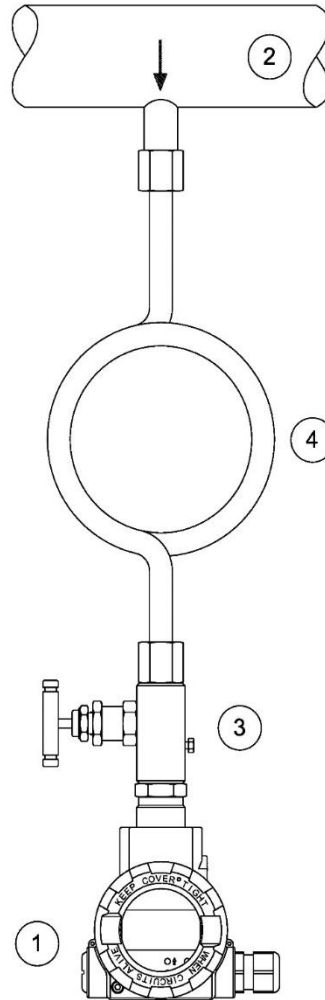


Figure 13. Gas pressure measurement system using APC-2000ALW Safety.

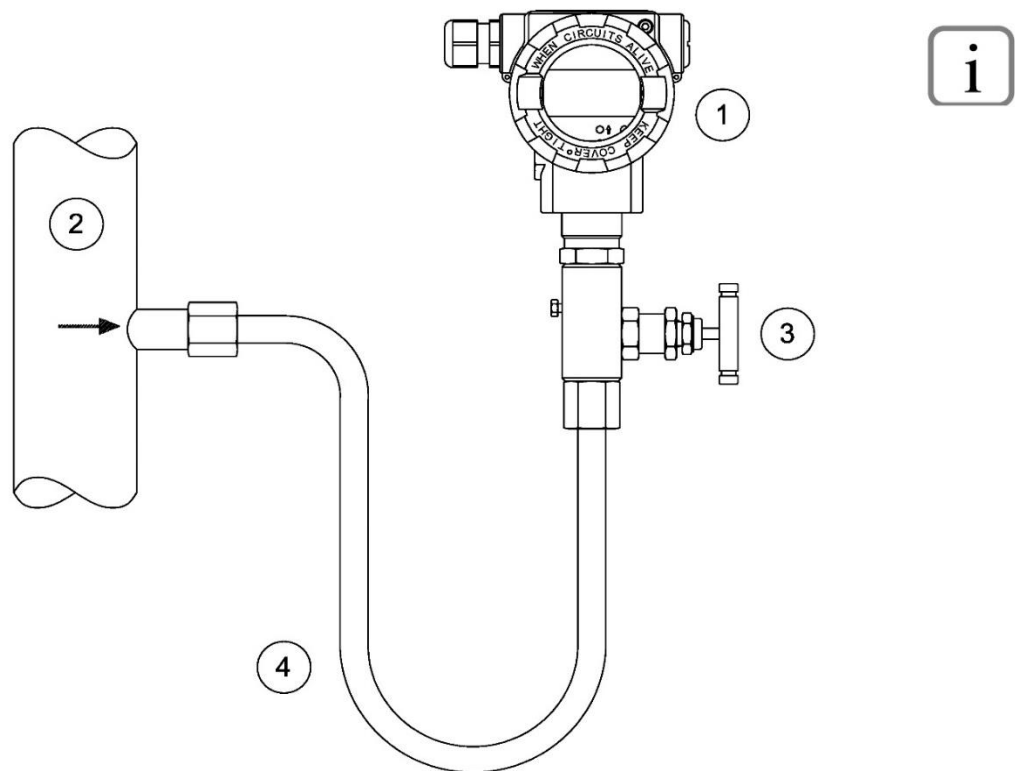
2.5.2. Steam pressure measurement system

Steam temperature reducing water-seal tubes should be used to measure the steam pressure. Preferably transmitter APC-2000ALW Safety should be installed below the measuring point. Before starting the water-seal tubes must be filled with liquid.



1. APC-2000ALW Safety.
2. Pipeline.
3. Shut-off valve.
4. Loop water-seal tube.

Figure 14. Steam pressure measurement system on horizontal pipeline using APC-2000ALW Safety.

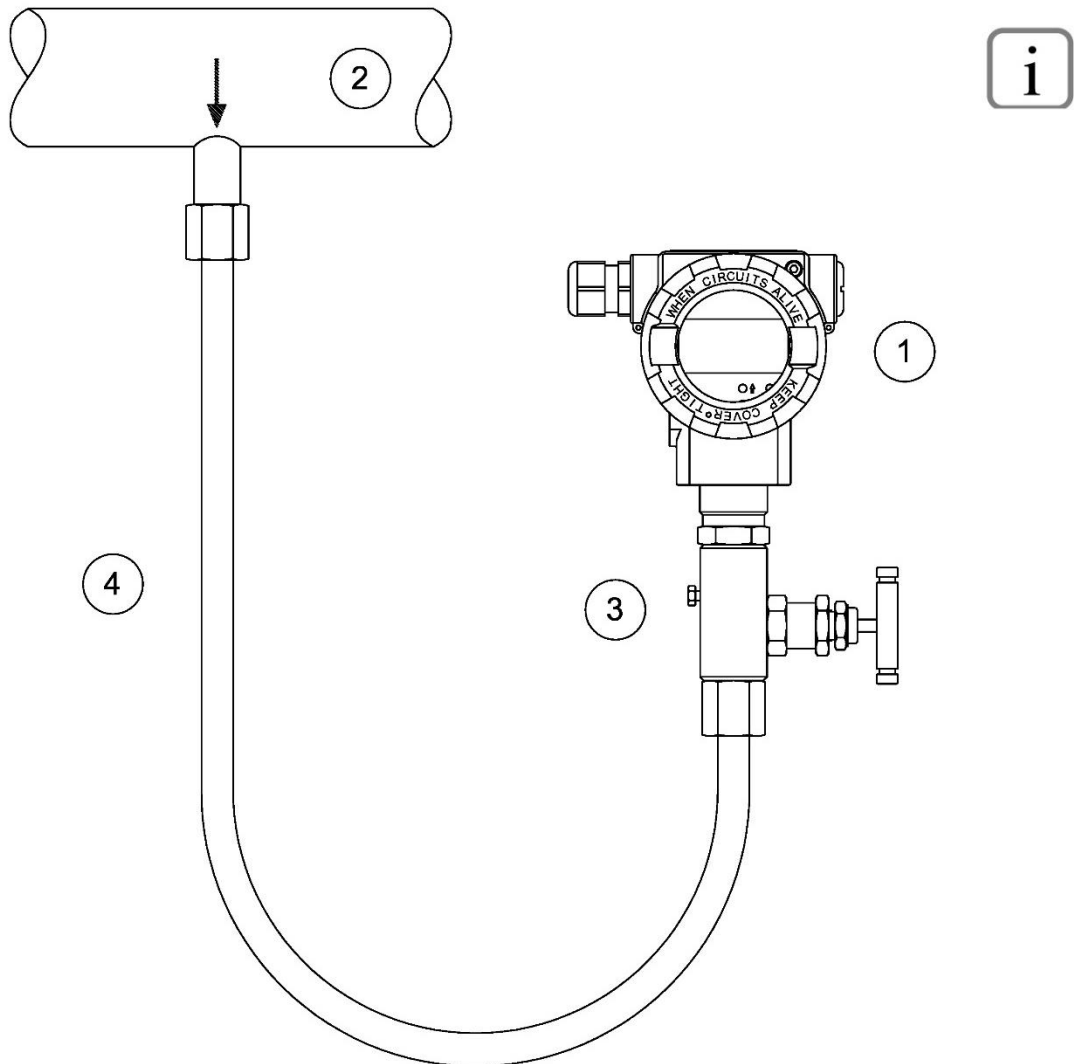


1. APC-2000ALW Safety.
2. Pipeline.
3. Shut-off valve.
4. Water-seal tube.

Figure 15. Steam pressure measurement system on vertical pipeline using APC-2000ALW Safety.

2.5.3. Liquid pressure measurement system

Transmitter APC-2000ALW Safety must be mounted below the measuring point or at the same level as the measuring point.



1. APC-2000ALW Safety.
2. Pipeline.
3. Shut-off valve.
4. Water-seal tube.

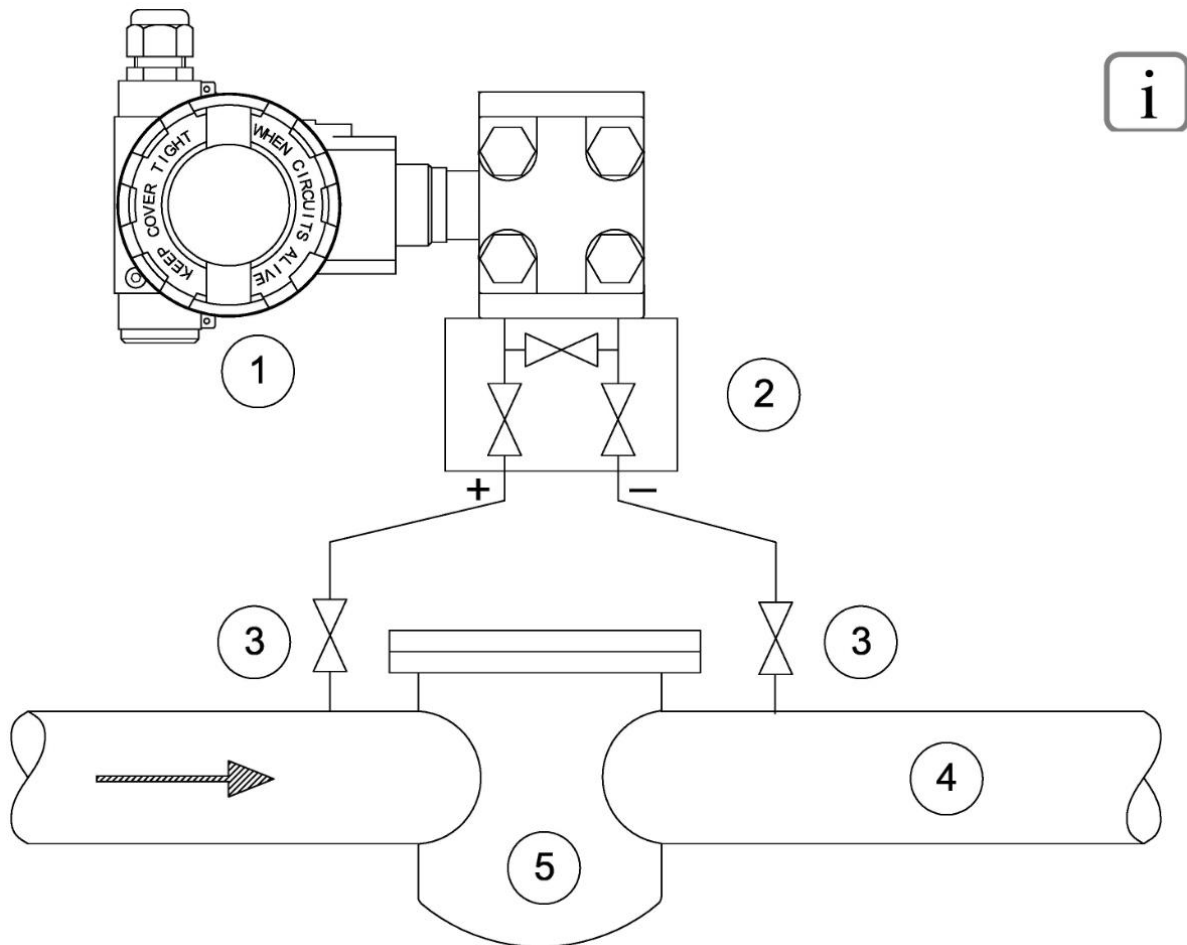
Figure 16. Liquid pressure measurement system using APC-2000ALW Safety.

2.6. Differential pressure measurement

Transmitter APR-2000ALW Safety makes it possible to measure differential pressure at high static pressures. A range of valve manifolds with separators and a large number of standard process ranges of the measured differential pressures are available. The transmitter configuration also allows for differential pressure presentation in many physical units (→ 13.2.2) or the user's own units (→ 13.2.6).

2.6.1. Gas and steam differential pressure measurement system

Transmitter APR-2000ALW Safety must be installed above the measuring point so that the condensate can flow through impulse tubes into the process pipes.



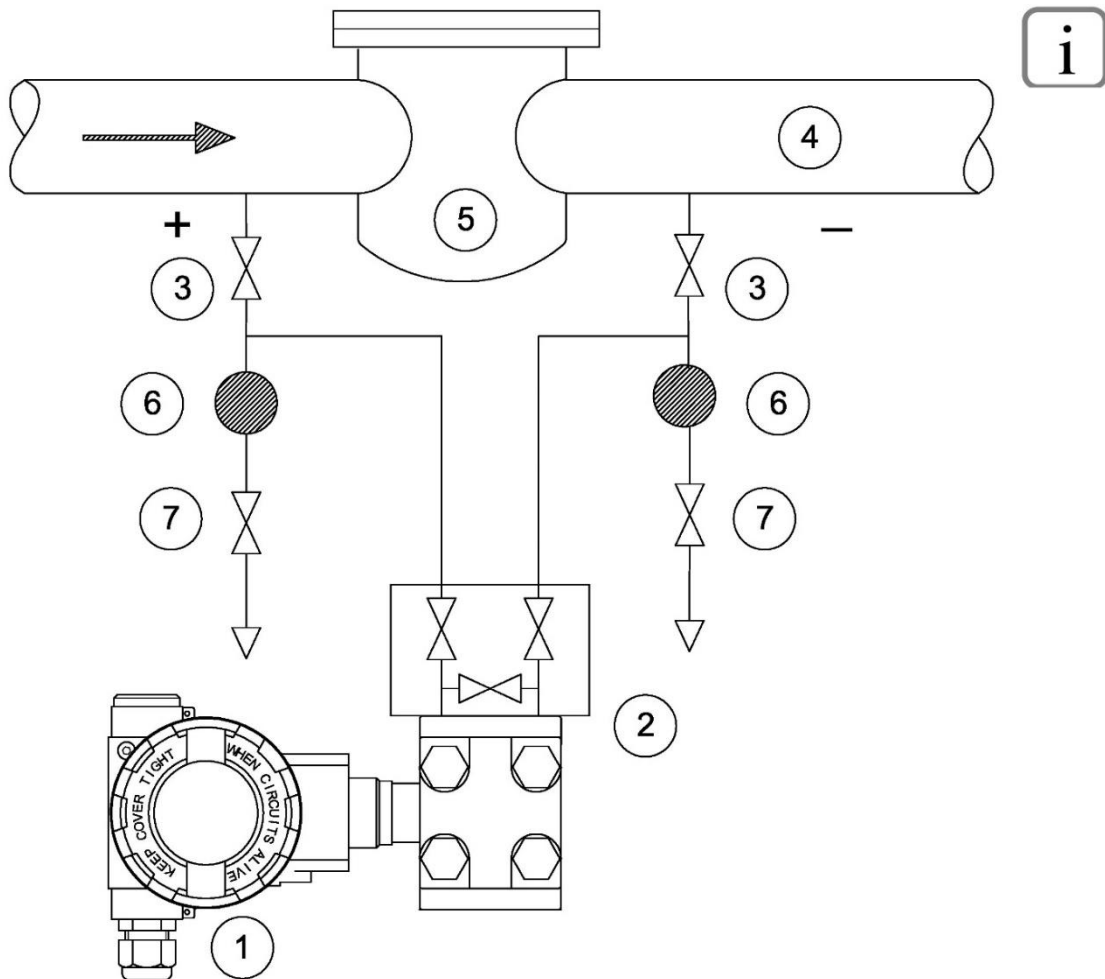
1. APR-2000ALW Safety.
2. Three-way valve.
3. Shut-off valves.
4. Pipeline.
5. Filter or other element.

Figure 17. Gas and steam differential pressure measurement system using APR-2000ALW Safety.

2.6.2. Liquid differential pressure measurement system

Transmitter APR-2000ALW Safety must be mounted below the measuring point so that the impulse tubes are always filled with liquid and the gas bubbles can freely escape to the process pipe.

If the measured medium contains particles, it is useful to install separators and drain valves to remove deposits.



1. APR-2000ALW Safety.
2. Three-way valve.
3. Shut-off valves.
4. Pipeline.
5. Filter or other element.
6. Solids separators.
7. Drain valves.

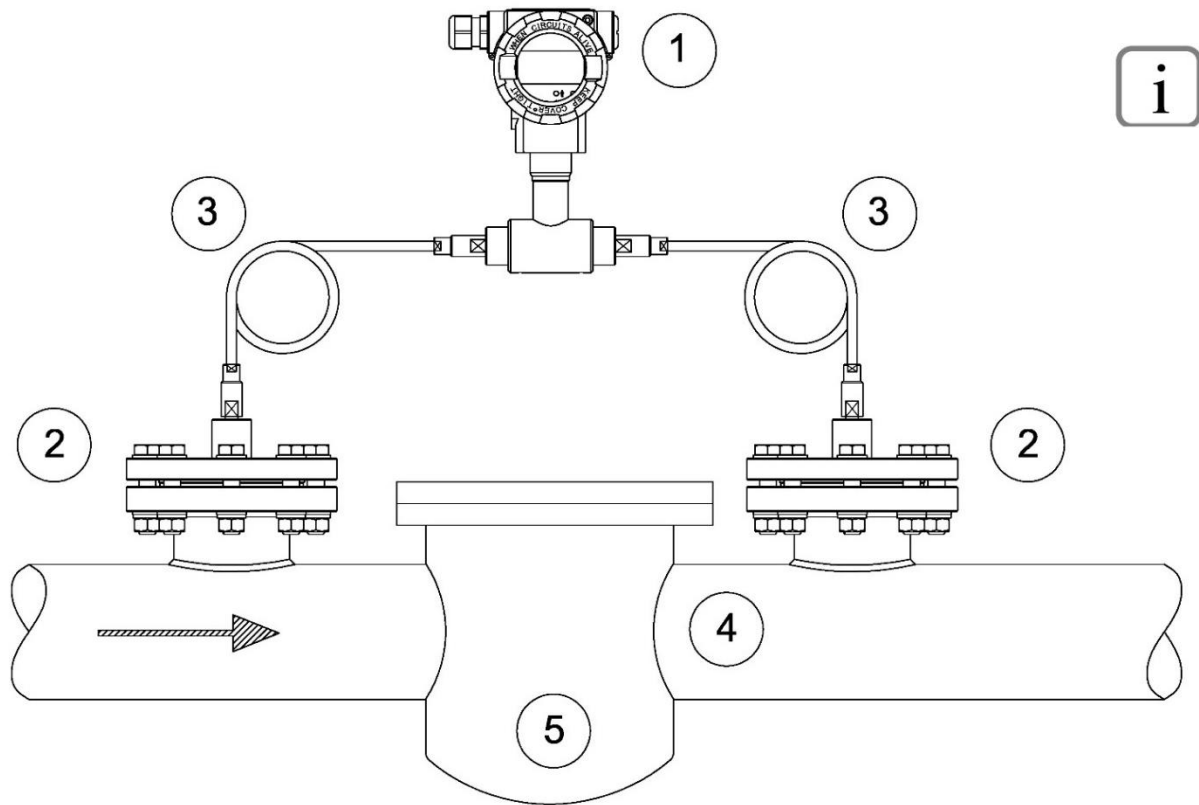
Figure 18. Liquid differential pressure measurement system using APR-2000ALW Safety.

2.6.3. Gas, steam and liquid differential pressure measurement system with the use of distance separators

The separators must be mounted on the top or side of the pipeline.

For vacuum measurements, transmitter APR-2000ALW Safety must be installed below the measuring point.

Approximate ambient temperature in both capillaries connecting the transmitter with separators must be ensured.



1. APR-2000ALW Safety.
2. Separators.
3. Capillary tubes.
4. Pipeline.
5. Filter or other element.

Figure 19. Gas, steam and liquid differential pressure measurement system using APR-2000ALW Safety with two distance separators.

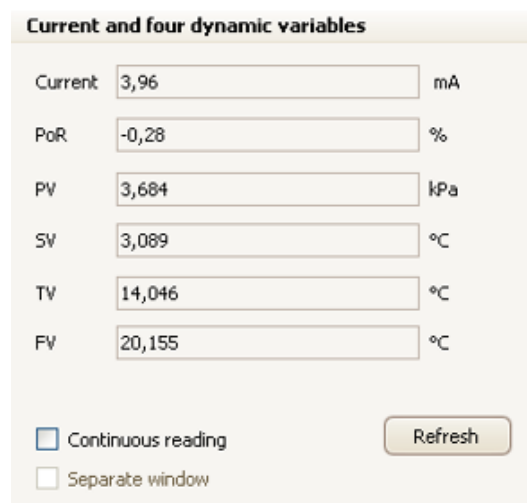
3. Characteristics of process measurement input

3.1. Measurement process variables

The basic input variable of the measuring process is pressure or differential pressure (PV). They are used to measure derivative values such as level (liquid column, volume, weight) or flow. Additionally, further process variables related to temperature are measured. These are:

- temperature of the pressure measuring module in the measuring head (SV);
- temperature of the structure of an ADC analog-digital transmitter used to perform pressure measurements (TV);
- temperature of the main microcontroller CPU (FV).

Temperature measurement process variables are used to adjust the temperature impact on the transmitter measuring elements to ensure high measurement accuracy. Process variables can be read out through Raport 2, Aplisens Mobile Configurator or other software using DD or DTM library – example below.



Variable	Value	Unit
Current	3,96	mA
PoR	-0,28	%
PV	3,684	kPa
SV	3,089	°C
TV	14,046	°C
FV	20,155	°C

Continuous reading
 Separate window

Refresh

Figure 20. Example of process variables read-out window in Raport 2.

3.2. Measurement input diagnostics

The input measurement circuits are subject to continuous diagnostics, providing the CPU with data on the correctness of the measurement process. The monitoring covers, inter alia, the sensor measuring bridge, ADC transmitter, EEPROM of sensor parameters, sensor power supply systems, connections between sensor components, digital data transfer via sensor galvanic insulation barrier. The detected failures are analysed by the software and in the event of a threat to the safety function, the current output is set to alarm mode (→ 4.8), (→ 4.9).

4. Characteristics of process measurement output

4.1. Basic unit and user's unit

The transmitter allows for setting one of many available physical units of pressure, level or force (→ 13.2.2). After changing the physical unit, the conversion to a newly selected unit occurs automatically. Using HART communication, the user can configure his/her own 6-character description of the unit displayed on LCD3 (→ 13.2.6). It is possible to display ASCII characters from the range (32...96 dec) or (20 ... 60 hex), i.e.: !"#%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNPOQRSTUVWXYZ[\]^_` Lowercase letters are exchanged automatically to uppercase ones; other unsupported characters are displayed as *.

When a user-defined unit is used, it is required to enter its name and scaling parameters. The scaling of the user's unit involves entry of a digital value for 0% setpoint of the set range width and 100% setpoint of set range width. The user's unit is used to visualize the value displayed on LCD and does not affect the process variable of the measurement expressed in the basic unit and the process value of the current setpoint in the current loop.

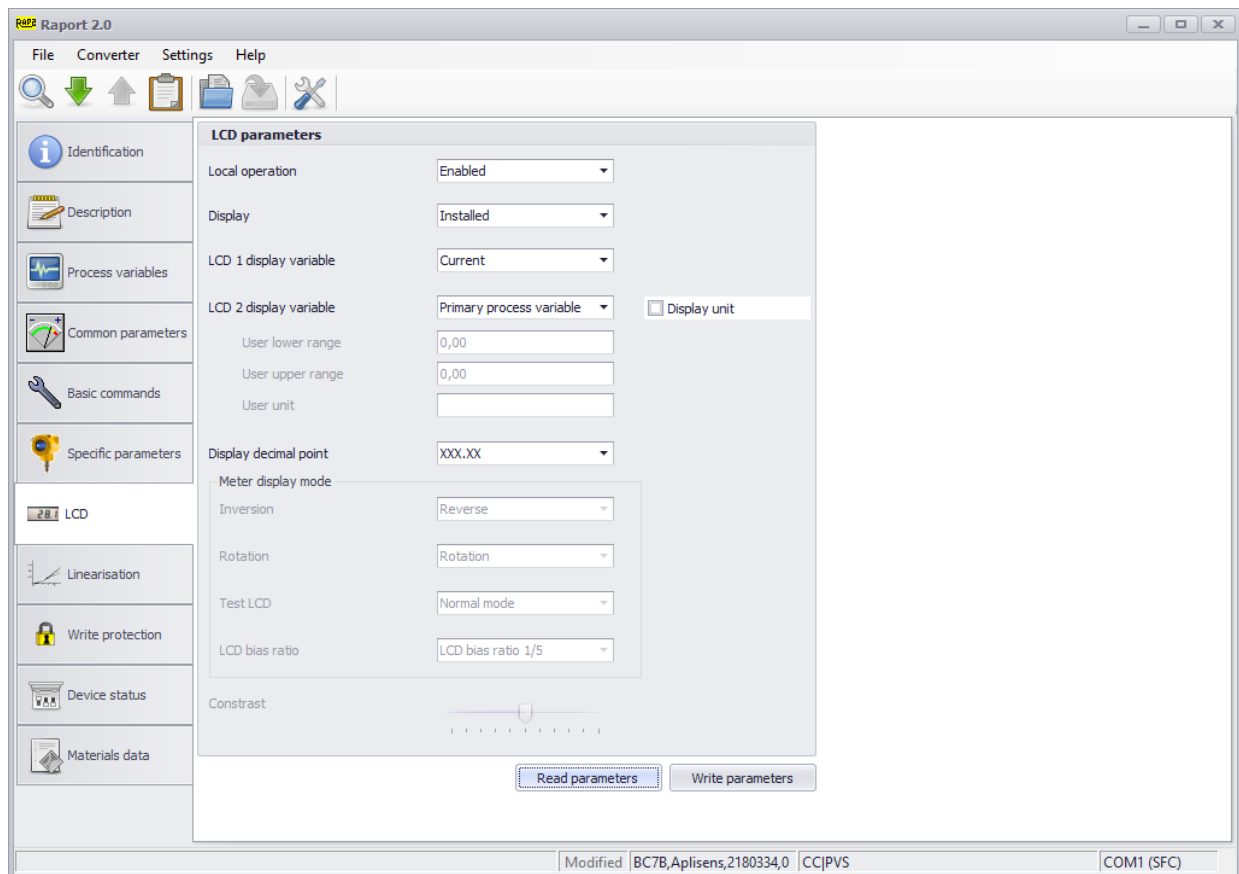


Figure 21. Exemplary settings of the start of range, end of range and user's unit name in Raport 2.

4.2. Set range

The set range refers to the setpoints of the process current output. The setpoint of the process output can be presented in percent or in milliamperes. The LRV point of the set range corresponds to the current of 4.000 mA, whereas the URV point corresponds to the current of 20.000 mA. The LRV and URV points can be assigned to different pressures from the transmitter's base range while maintaining the condition for minimum range width of the set MSV. The reversal characteristics can also be set where the LRV point is assigned to the pressure higher than the URV point, while maintaining the minimum MSV set range width.

The figure below shows the transmitter set range and limits related to the permissible set range, digital processing range and saturation limits of A/D pressure measurement transmitter. As standard, values of 4 mA/20 mA currents are assigned to LRV/URV points. In order to obtain reverse characteristics, it is possible to reverse the assignment so that the LRV/URV points are assigned to 20 mA/4 mA currents.

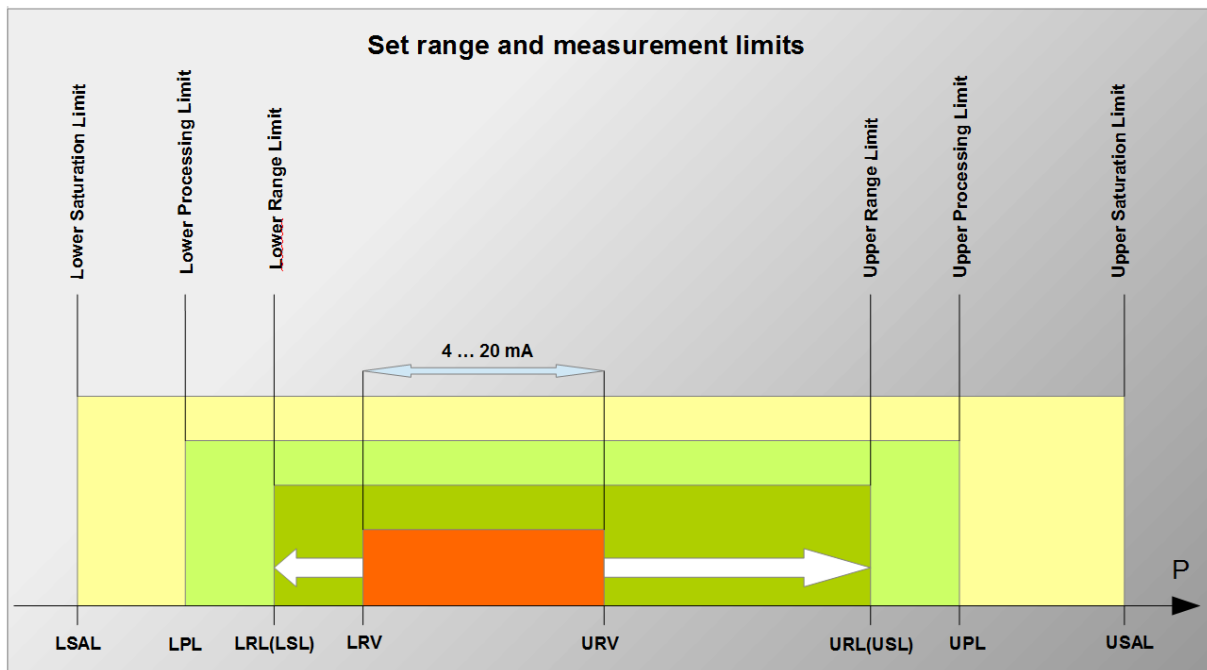


Figure 22. Set range and measurement limits.

4.3. Digital damping time constant

The transmitter allows for adjusting the damping of the measurement process value. The standardized measurement process variable can be suppressed by a digital inertial element of the first order for time constant parameterised in the range of $\tau = 0 \dots 30$ s. Entry of a parameter in a floating-point format is available via software using HART communication (→ 6), e.g. Raport 2 by Aplisens S.A. It is also possible to set in the local MENU (→ 13.2.11) one of the six predefined fixed damping time constants $\tau = 0, 2, 5, 10, 30, 60$ s. The pressure process variable subjected to damping in the inerting unit is:

- converted to the selected unit and presented on the display (→ 13.2.1) or available for reading via HART communication (→ 13.1);
- converted according to the set range and presented as output setpoint percentage (0... 100%) or output current setpoint (4 ... 20 mA).

4.4. Linear characteristics transfer functions

In some applications it is recommended to convert the linear process variable of the output control setpoint with a specific function. The following mathematical control signal transformation functions are available:

- linear, i.e. no transformation;
- second-stage root characteristics with relay characteristics and 0.2% hysteresis of the setpoint value in the dead band;
- manufacturer’s dual linear characteristics No 1 + second-stage root characteristics for constant dead band = 0.6% of setpoint value;
- manufacturer’s single linear characteristics No 2 + second-stage root characteristics and 0.2% hysteresis of the setpoint value in the dead band;
- square characteristics;
- special multi-point linearization based on user-modified table.

In addition to the linear characteristics used in the measurements of level, force, pressure and differential pressure, the root characteristics is often used for flow measurements. Therefore, transmitter APC(R)-2000ALW Safety allows the user to select 3 types of root characteristics as described below.

4.5. Basic root characteristics

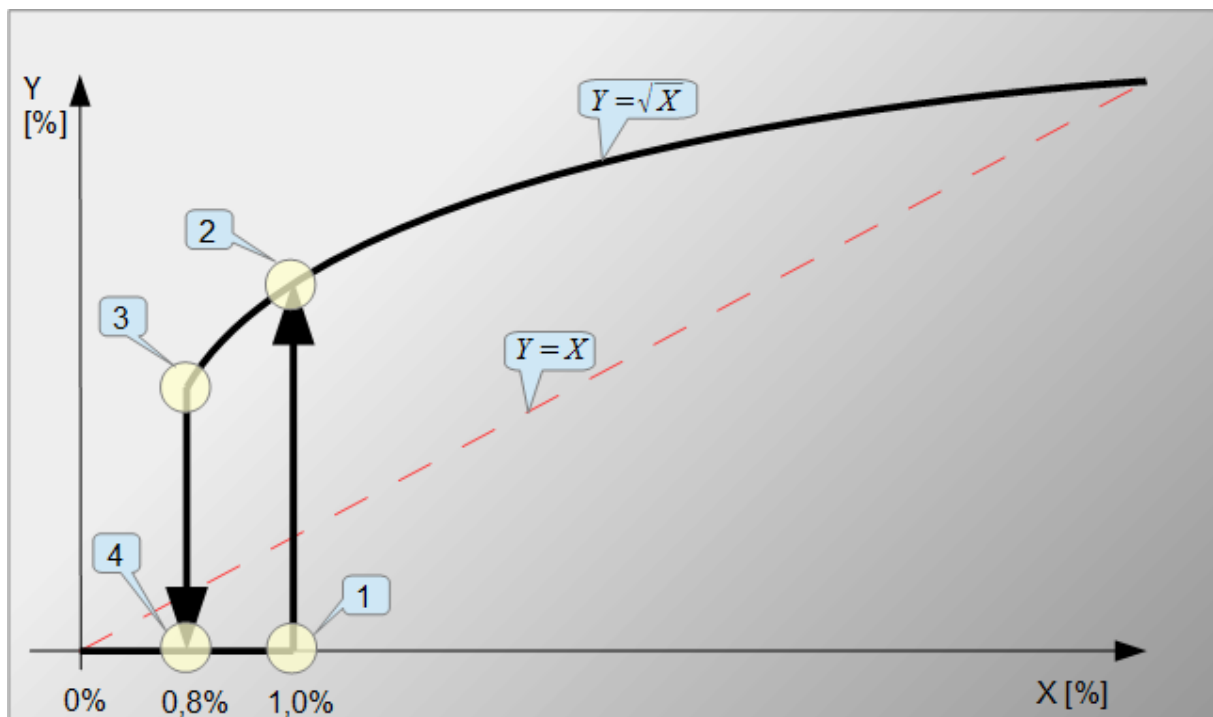


Figure 23. Root characteristics with adjustable dead band.

“Relay” characteristics below the dead band. The figure shows exemplary values for the set dead band of 1%.

① – ② In the case of pressure/flow increase in point [1]–[2], the hysteresis of 0.2% is activated and function $Y = 0$ is converted to root function $Y = \sqrt{X}$. The pressure measured above point [3] will be converted to the root function.

③ – ④ In the case of pressure/flow drop in point [3]–[4], root function $Y = \sqrt{X}$ is converted to function $Y = 0$. The pressure below point [1] will be converted to $Y = 0$. The dead band of the root characteristics is configurable in the full range of 0-100% using HART communication or in a limited range of pre-defined values using the local MENU. In on-site applications the values are typically set to approx. 1% of the output setpoint.

4.6. Manufacturer's root characteristics 1

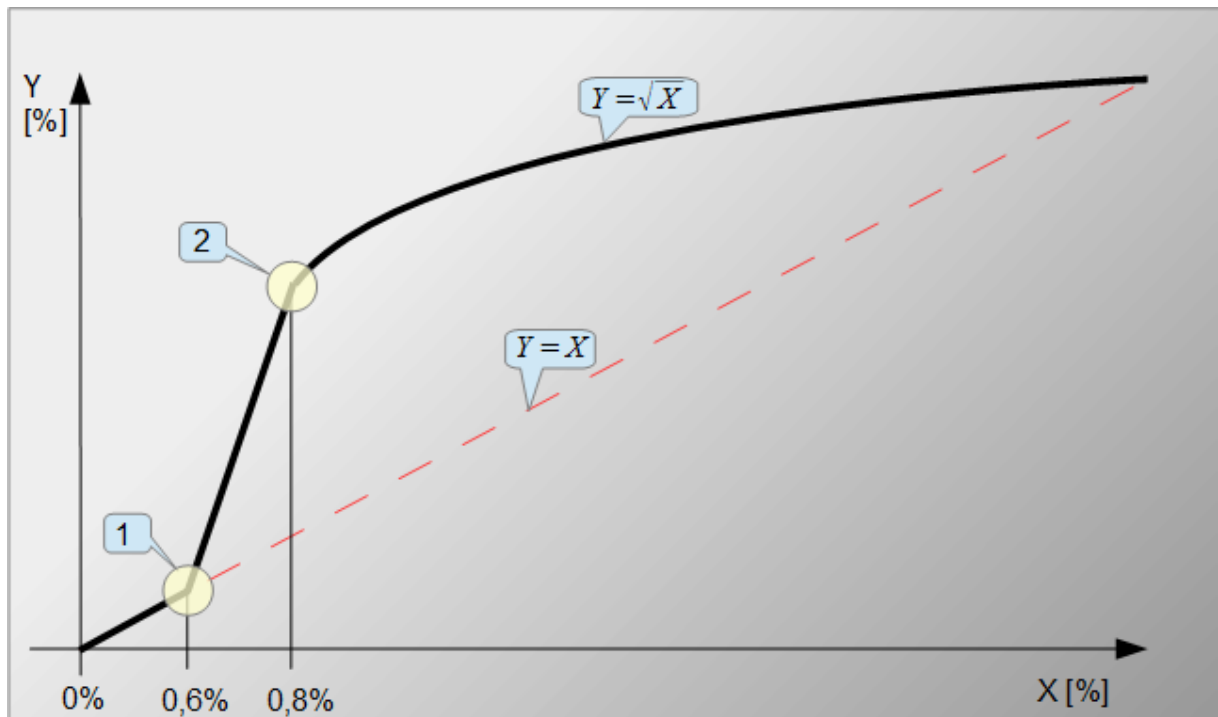


Figure 24. The manufacturer's characteristics 1 with fixed points of the characteristic change at points 0.6% and 0.8%.

① – Point [1] of the 0.6% setpoint of the X output (4.096 mA on linear characteristic) in which linear function $Y = X$ is converted to linear function with a larger slope $Y = X_n$.

② – In point [2] of the 0.8% setpoint of the X output (4.128 mA on linear characteristics), linear function $Y = X_n$ is converted to root function \sqrt{X} . Unlike the base root characteristics, this characteristics allows for monitoring of small flows below the dead band, e.g. when the valve closes or is unscrewed. The “stroke” effect of the measurement at the limit of the function concatenation is also significantly smaller. The values of concatenation points are fixed and cannot be modified.

4.7. Manufacturer's root characteristics 2

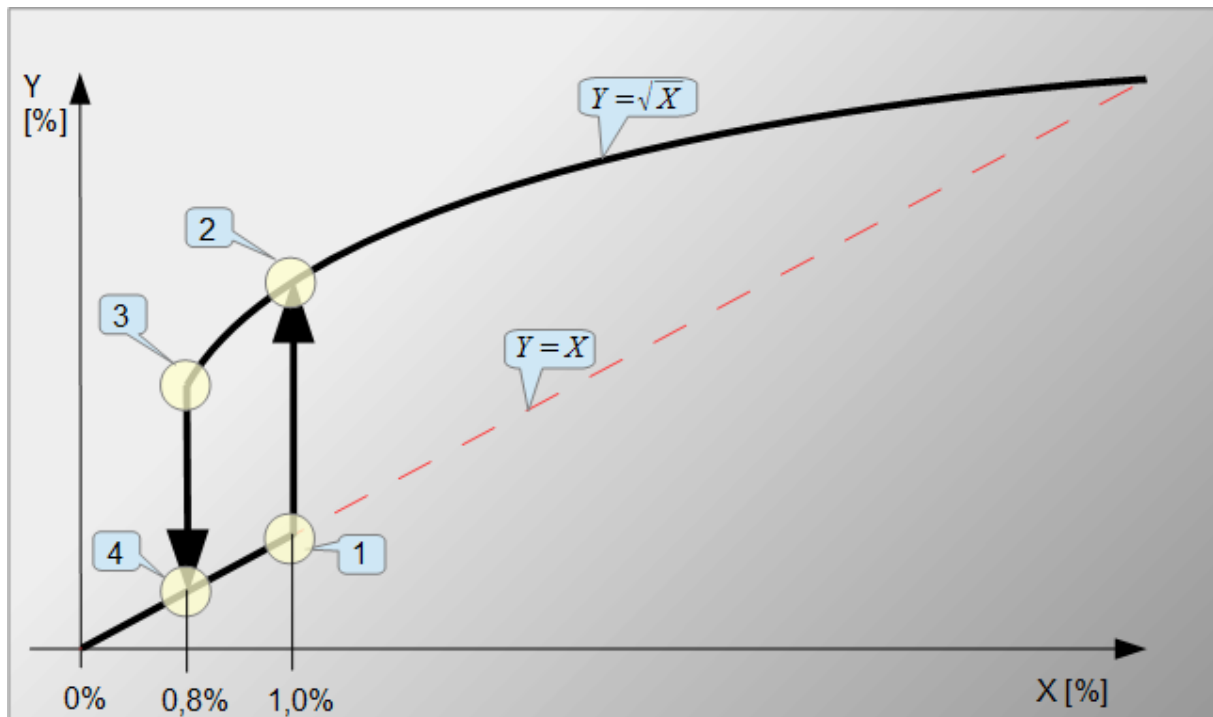


Figure 25. Manufacturer's root characteristics 2 with adjustable dead band and hysteresis 0.2%.

The figure shows exemplary values for the set dead band of 1%.

① – ② In the case of pressure/flow increase in point [1]–[2], the hysteresis of 0.2% is activated and linear function $Y = X$ is converted to root function $Y = \sqrt{X}$. The pressure measured above point [1]–[2] will be converted to the root function.

③ – ④ In the case of pressure/flow drop in point [3]–[4], root function $Y = \sqrt{X}$ is converted to linear function $Y = X$. The pressure below point [3]–[4] will be converted to linear function. The dead band of the root characteristics can be configured in a limited range of pre-defined values using the local MENU or in the full range of 0-100% using HART communications. In on-site applications the values are typically set to approx. 1% of the output setpoint. Unlike the base root characteristics, this characteristics allows for monitoring of small flows, e.g. when the valve closes or is unscrewed, simultaneously reducing the “ringing” of the input signal on the limits when the linear function concatenates with the root function.

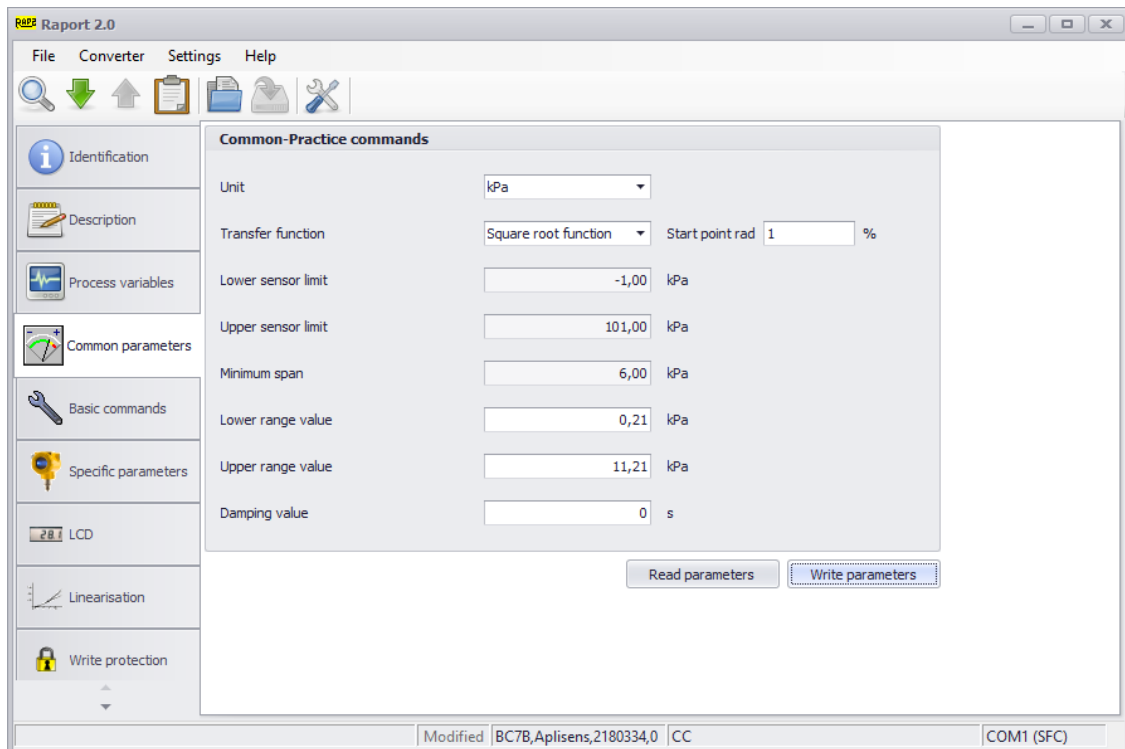


Figure 26. Example of a tab in Raport 2, in which the type of processing characteristics and the dead band of the root characteristics are configured.

4.8. Output signal 4 ... 20 mA HART

Transmitter APC(R)-2000ALW Safety provides a process variable of the measurement referenced to the set range of pressure via the value of current in current loop 4 ... 20 mA. For practical reasons, the transmitter's current controller lower saturation point is below the 0% setpoint and is -0.64% (3.900 mA) for the NORMAL mode and -1.25% (3.800 mA) for the NAMUR mode. For the same reasons, the upper saturation point of the setpoint is 103.13% (20.500 mA).

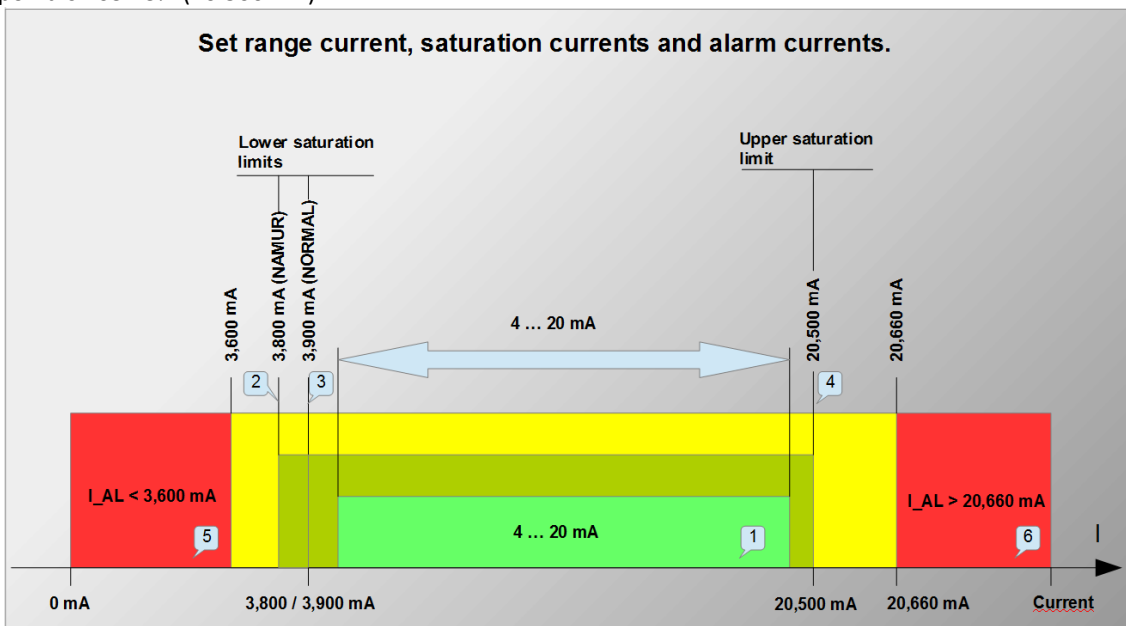


Figure 27. Set range current, saturation currents, alarm currents.

- ① – Area of current set to 4 ... 20 mA corresponding to the 0 ... 100% setpoint of the process output.
- ② – Lower saturation current of 3.800 mA for NAMUR mode.
- ③ – Lower saturation current of 3.900 mA for NORMAL mode.
- ④ – Upper saturation current of 20.500 mA for NAMUR and NORMAL mode.
- ⑤ – Alarm current area $I_{AL} < 3.600$ mA for internal diagnostic alarms or alarms related to safe failures with external diagnostics.
- ⑥ – Alarm current area $I_{AL} > 20.660$ mA for alarms related to safe failures with external diagnostics.

The measurement process variable expressed in the basic unit of pressure, force or level is also available via HART communication using a current loop as a physical layer. Digital HART communication is based on FSK modulation of BELL202 type with frequencies of 2200 Hz and 1200 Hz respectively for “0” and “1”. Transmitter APC(R)-2000ALW Safety has an implemented communication stack with an application layer consistent with HART 5.1 (→ 13.1).

4.9. Alarm signal levels

Below the lower saturation thresholds there is an alarm current setting area covering the range < 3.600 mA. Due to the specificity of the Safety transmitter, a safe error referenced to the output setpoint of $E = \pm 1\%$ was assumed for the FMEDA calculations. For this reason, the transmitter in the diagnostic alarm mode sets the following current at the current output:

$$I_{AL} = 3600 - \frac{E [\%]}{100 [\%]} * 16 \text{ [mA]}$$

Therefore the nominal diagnostic current alarm is 3.440 mA. In addition to the diagnostic alarm supported by the transmitter current controller, there is also a critical diagnostic alarm. This is an alarm mode supported by an additional independent watchdog system and is triggered in the following cases:

- error of floating-point mathematical calculations;
- error in RAM dynamic memory;
- error in the coefficient memory or FLASH memory;
- error in main CPU logs;
- inconsistency of 8 successive values of the current setpoint with the measured current value in the current loop;
- disturbance of the programme automatic system resulting in exceeding the watchdog refresh time window of the critical alarm mode WDT_SIL.

The critical alarm mode is used due to the need of immediate disconnection of the transmitter from the current loop (associated process current drop below the alarm threshold). The specified causes of the errors are critical due to the inability to guarantee in such conditions the correct course of numerical calculations and consequently the reliability of the output process variable.



Occurrence of a critical alarm usually indicates a serious damage to the transmitter and the necessity to repair it at the manufacturer's plant.

However, there are two exceptions.

The first one is too low power voltage inconsistent with the technical conditions, causing shortage of supply voltage on the transmitter terminals when the output current is high.

The other one is a very high excessive interruption level in the current loop line supplying the transmitter. Excessive interference may destabilize the operation of the transducer systems responsible for the control measurement of current flowing in the current loop. The difference between the value of the set current for the controller and the measured value, which lasts for a longer period of time may also cause the critical alarm

to be set. In case of a critical alarm, the transmitter display goes out, the alarm current is much lower than 3.440 mA and is below 0.300 mA.

APC(R)-2000ALW Safety. Types of diagnostic alarms with comment		
Alarm type	Alarm current [mA]	Comment
Diagnostic alarm	< 3,600	Nominal alarm current = 3.440 mA. This is an alarm current caused by non-critical events or failures in terms of the process and operation of the transmitter. In case of a hazardous event the transmitter internal diagnostics always applies alarm current < 3.600 mA.
Critical alarm	<< 3,600	The rated alarm current is 0.2 ... 0.3 mA. This is an alarm current caused by critical events or failures in terms of the process and operation of the transmitter. The critical alarm latches its condition, which means that it is necessary to disconnect power supply from the transmitter and then to reconnect it in order to restore the transmitter to operation.
Alarm of safe defects with external diagnostics	> 20,660	The internal diagnostics does not use alarm current > 20.660 mA (this is the maximum value of the current setpoint increased by a maximum safe error 1%). This current may, however, appear in the current loop in the case of occurrence of the so-called safe failure, i.e. the failure which results in the increase of current in the current loop above 20.660 mA without the participation of the transmitter internal diagnostics. If the supporting PLC is configured to detect a dangerous condition for currents above 20.660 mA, such errors may be detected as safe diagnosable. Some of the safe failures that are not diagnosed by internal diagnostics also result in the current value < 3.600 mA.

Table 7. Types of diagnostic alarms with comment.

4.10. Loading of current loop 4 ... 20 mA with serial resistance

The power line resistance, power source resistance and other additional serial resistances increase the voltage drops between the power source and the transmitter terminals. The maximum transmitter current under normal operation conditions is defined as:

$$I_{\max} = 20.500 \text{ mA} + E$$

where E is a permissible safe error which is ± 0.160 mA. The maximum resistance value in the power circuit (along with the power cables resistance) is defined by the formula:

$$R_{L_{\max}} [\Omega] \leq \frac{(U - 11.5) [V]}{0.02066 [A]}$$

where:

U – voltage of 4 ... 20 mA current loop power supply unit in [V];

$R_{L_{\max}}$ – maximum power supply line resistance in [Ω].

The above formula may be used to describe the indicative dependency of the maximum load resistance on the power supply voltage:

In applications where the supply voltage is lower than the nominal supply voltage (24 V DC), it is necessary to pay particular attention to the voltage drop on the resistance incorporated in series into the power supply line in order to use the local HART communication (→ Figure 30). After removing the jumper mounted on the electrical connection terminals, the resistor 240 [Ω] shunted by the jumper, integrated with the transmitter is switched in series to the current line, causing additional voltage drop. It can be up to approx. 5 VDC, increasing the minimum supply voltage by this value. After performing configuration or local HART read-outs, it is recommended to reassemble the jumpers (→ Figure 30).

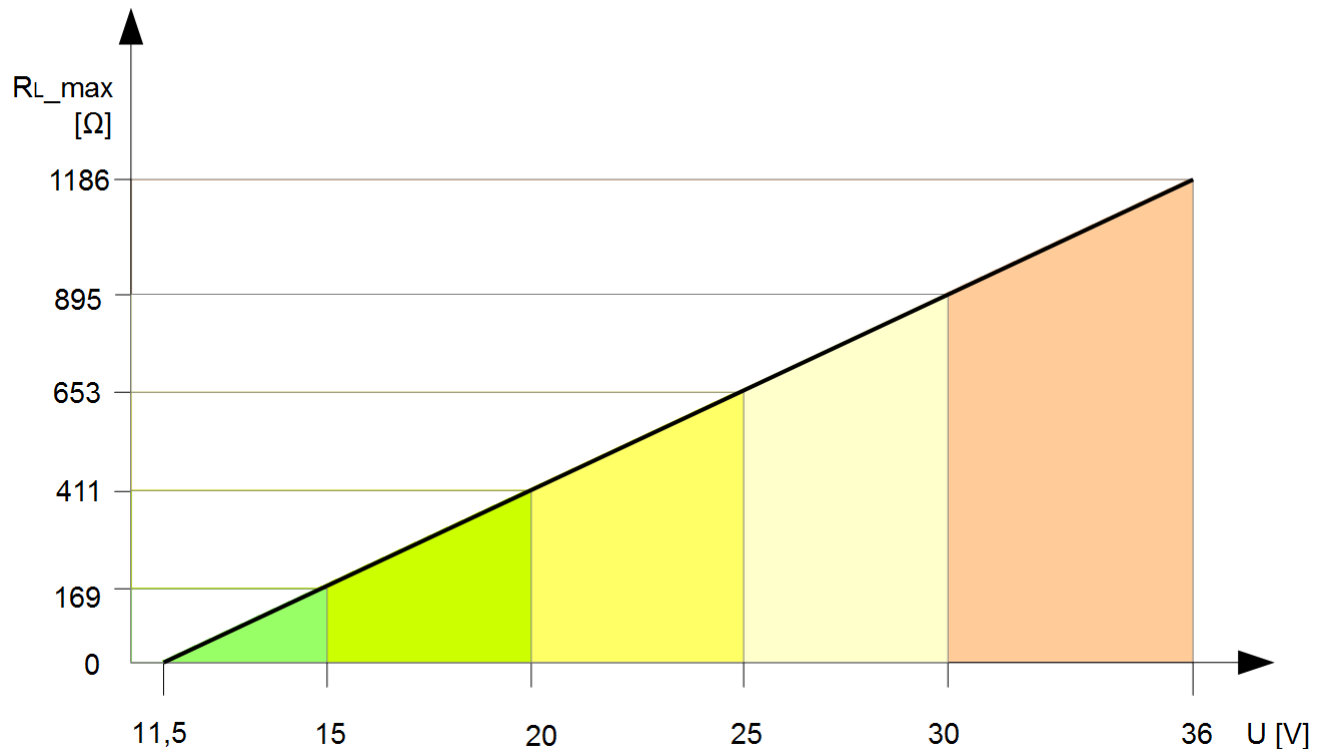


Figure 28. The maximum load resistance R_{L_MAX} [Ω] in the supply line of transmitter depending on the power supply voltage U [V].

HART local communication jumper (→ Figure 30) mounted.

4.11. Current controller resolution 4...20 mA

The current controller used to control the output current of the transmitter operates on the basis of a 16-bit DAC digital-analog transmitter. Effective controller current resolution is approximately 1.0 μA (→ 8.3).

4.12. Dynamic parameters of digital measurement

In the full measurement cycle the transmitter performs the measurements of basic input pressure values and temperatures and measurements of additional diagnostics-related variables. The full measurement cycle related to the refreshing of the process output with a successive value lasts 330 ms (3 measurement cycles per second).

4.13. Dynamic parameters of current output

The process current output is refreshed every 330 ms. Time constant τ of analog output path damping entered by the hardware low-pass filter is approx. 66 ms.

4.14. Process measurement output diagnostics

The transmitter diagnostic systems control the process variable of the current measurement output for compliance with the calculated current set value. If the measured value of current in the current loop is different by more than 1% of the set range (160 μA) than the set value, the transmitter diagnostics will activate alarm $I_AL < 3.600$ mA. If the alarm current is also affected by the error greater than 1% of the set range (160 μA), the diagnostic system will activate the critical alarm by enabling an additional protection module WDT_SIL. In this case the alarm current will be lower than 0.300 mA. The critical alarm will last until the power supply is disconnected and then reconnected to the transmitter. For more information on diagnostic alarms, see (→ 4.9).

5. Software version of the main microcontroller CPU

APC(R)-2000ALW Safety. Software version of the main microcontroller CPU		
Major/minor version number	Date of entry	Comments
2.2	02-2019	First certified version of software.

Table 8. Software version of the main microcontroller CPU.

6. HART – specific data related to the protocol application layer

Universal commands and general-purpose commands are implemented in the transmitter according to the requirements of HART standard rev. 5.1. The manufacturer's specific commands meet the requirements of the HART standard, but have a structure not described in the standard. Data with the structure of the manufacturer's specific commands are not available in this documentation. However, they may be made available in specific cases. The following commands and associated parameters and methods are available:

APC(R)-2000ALW Safety. Specific data related to the protocol application layer		
HART Command No	Type	Function
Universal commands		
0	READ	Read unique identifier
1	READ	Read primary variable
2	READ	Read current and percent of range
3	READ	Read current and four dynamics variables
6	WRITE	Write pooling address
11	READ	Read unique identifier associated with TAG
12	READ	Read message
13	READ	Read TAG, DESCRIPTOR, DATE
14	READ	Read PV sensor information
15	READ	Read output information
16	READ	Read final Assembly Number
17	WRITE	Write message
18	WRITE	Write tag, descriptor, date
19	WRITE	Write final assembly number
General-purpose commands		
34	WRITE	Write PV damping value
35	WRITE	Write PV unit code and upper and lower range values
36	WRITE	Set PV upper range value URV by PV value
37	WRITE	Set PV lower range value LRV by PV value
38	WRITE	Reset " configuration changed " flag
40	WRITE	Enter/exit PV current mode
42	WRITE	Perform master reset
43	WRITE	Set PV zero
44	WRITE	Write PV unit
45	WRITE	Trim PV current DAC zero
46	WRITE	Trim PV current DAC gain
47	WRITE	Write PV transfer function
48	READ	Read additional transmitter status
59	WRITE	Set numbers of response preambles
Manufacturer's specific commands		
128	READ	Read static data materials
129	READ	Read device variable trim points
130	WRITE	Trim upper sensor calibration

131	WRITE	Trim lower sensor calibration
132	WRITE	LCD1 variable, LCD2 variable, decimal points, LCD operation, keyboards operation - set local control modes
133	READ	Read local control modes
135	WRITE	Write user's characteristic coefficients
136	READ	Read user's characteristic coefficients
138	WRITE	Return to factory settings
141	WRITE	Write Analog Input function block configurations
142	READ	Read Analog Input function block configurations
230	READ	Read CPU, Master, Slave, HART firmware revision
231	READ	Read product codes
233	READ	Read separator codes
235	READ	Read manifold codes
237	READ	Read operational limits
240	WRITE	Write long TAG
241	READ	Read long TAG
242	WRITE	Write start point rad
243	READ	Read start point rad
244	WRITE	Write User's unit name and rearrange coefficients
245	READ	Read User's unit name and rearrange coefficients
246	WRITE	Write customer's security code
247	WRITE	Set write protect code

Table 9. Specific data related to the HART application layer.

7. Power supply

7.1. Cabling specification

Aplisens S.A. recommends using two-wire screened twisted pair cable. The recommended external diameter of the cable for the glands sold with the product is from 5 to 10 mm. In the case of using glands purchased by the customer, the outer diameter of the conductor shall be selected according to the gland specifications so as to ensure tightness of the cable gland.

7.2. Electric connection terminals functions

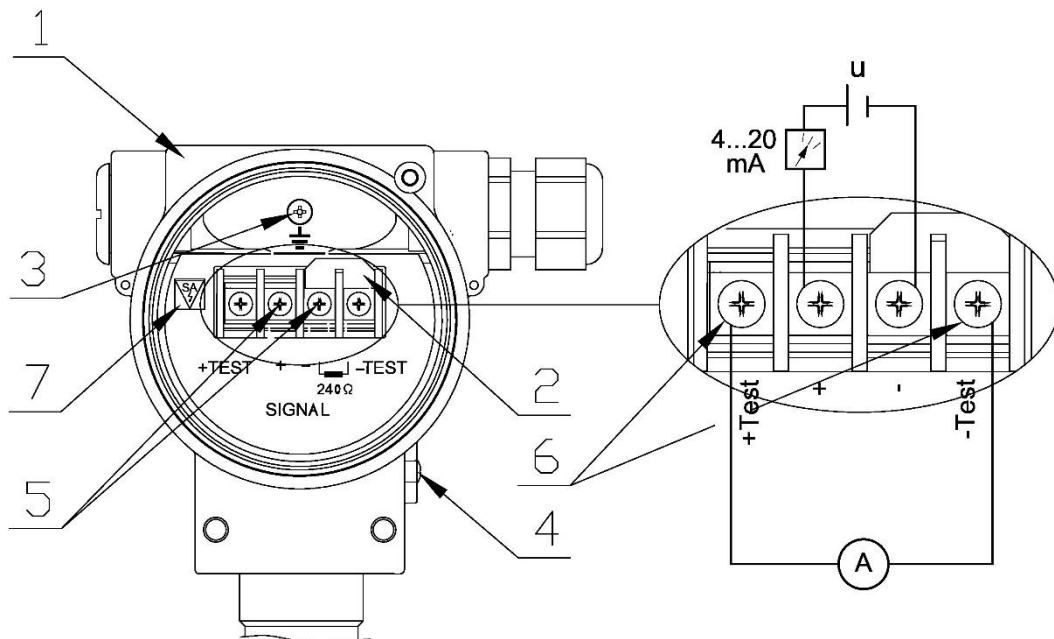


Figure 29. APC(R)-2000ALW Safety. Electrical connection compartment, electrical terminals and their functions.

- 1 - Housing.
- 2 – Local HART communication jumper.
- 3 – Internal ground terminal.
- 4 – External ground terminal.
- 5 – Transmitter power terminals, current loop 4 ... 20 mA.
- 6 – Ammeter connection terminals for uninterruptible current measurement.
- 7 – Designation of a transmitter version (SA) with integrated lightning protection.



Internal electrical switching terminals are suitable for conductors with the cross-section from 0.5 to 2.5 mm². The internal and external electrical ground terminal of the body is suitable for conductors with cross-section from 0.5 to 5 mm².



7.3. Electrical connection of power supply



Warning!

Power cables may be live!

There is a risk of electric shock and/or explosion!

- When using the transmitter in explosion-risk atmospheres, the system must comply with local national standards and regulations, with intrinsic safety instructions and installation drawings.
- All explosion protection data is given in separate documentation which is available on request (→ 16.2). The Ex documentation is typically supplied with all transmitters approved for use in explosion-risk atmospheres.

Power supply from cable line 4 ... 20 mA should be connected to terminals **[SIGNAL +]** and **[SIGNAL -]** according to the figure (→ Figure 29).

7.4. Shielding, equipotential bonding

Optimal protection against interference is provided by the earthing of the screen on both sides (in the cabinet and equipment). In case of potential difference between earthing points of devices which may result in the flow of equipotential currents, the screen shall be earthed on one side – preferably at the transmitter.

When used in potentially explosive environments, the applicable regulations must be observed. Separate Ex documentation with additional technical data and instructions is attached to all Ex transmitters.

7.5. Electrical connection of uninterruptible current measurement in the current loop

The transmitter enables uninterruptible current measurement in the current loop using a milliammeter. In order to maintain the measurement error $\leq 0.05\%$, the internal resistance of the milliammeter shall be $\leq 10 \Omega$.

The milliammeter must be connected to terminals **[+ Test]** and **[- Test]**. The milliammeter connection diagram is shown in Figure (→ Figure 29).

7.6. Electrical connection of local and remote HART communication

7.6.1. Connection of transmitter with the option of using local HART communication.

Transmitter APC(R)-2000ALW Safety allows to use the local HART communication. To do this you can use a HART communicator unit or modem interoperating with a computer or a smartphone.

In order to establish the local communication, it is necessary to:

- unscrew the transmitter's electrical connection cover;
- remove HART communication jumper ②;
- connect the communicator or modem to terminals and carry out the planned operations;
- after completing the communication, install the HART communication jumper ② on the correct position according to (→ Figure 30);
- close the cover of the transmitter electrical connection, paying attention to its correct tightening.

Please note!

Opening of the HART jumper results in applying resistance of 240Ω in series in line $4 \dots 20 \text{ mA}$. This resistance reduces voltage on transmitter supply terminals by approximately 5 V DC for the maximum current, which can be set by the transmitter. Therefore, when the jumper is removed, the minimum power supply voltage increases by 5 VDC . When using power supplies with supply voltages below 17 V DC , to avoid the supply voltage deficit on the transmitter terminals during operation, the HART jumper must be dismantled only for the time of performing the HART local communication. Connection diagram of the communicator or modem to energized transmitter APC(R)-2000ALW Safety is shown in the figure below.

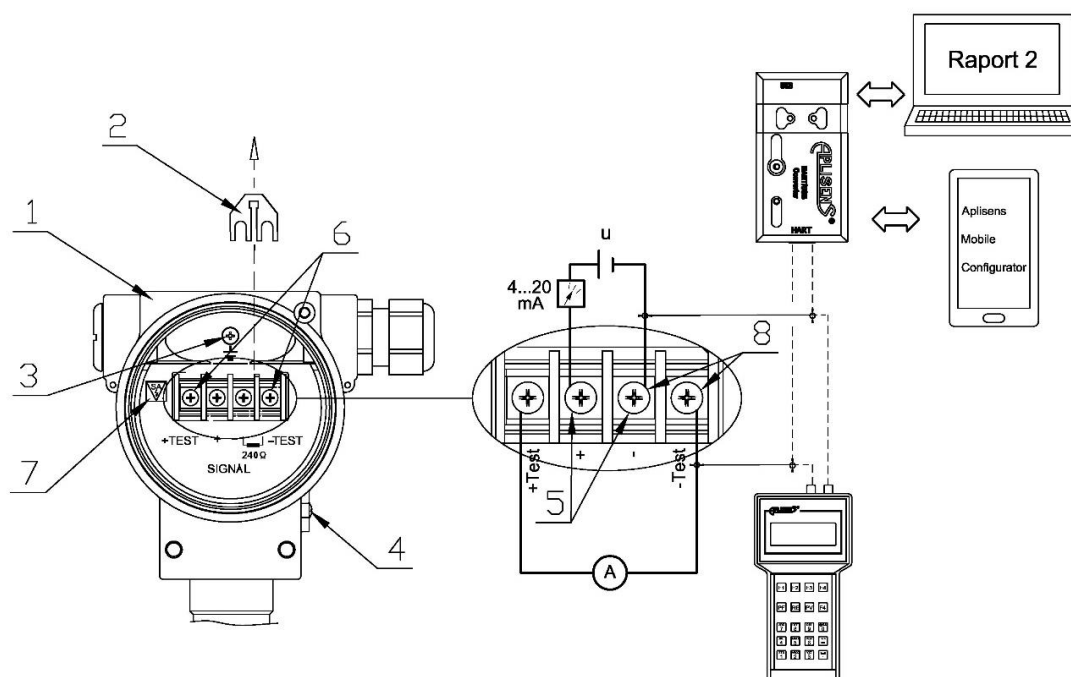


Figure 30. Local electrical connection of the communicator or HART modem to transmitter APC(R)-2000ALW Safety.

- 1 - Housing.
- 2 – Removed local HART communication jumper.
- 3 – Internal ground terminal.
- 4 – External ground terminal.
- 5 – Transmitter power terminals, current loop $4 \dots 20 \text{ mA}$.
- 6 – Ammeter connection terminals for uninterruptible current measurement.
- 7 – Designation of a transmitter version (SA) with integrated lightning protection.
- 8 – Terminals – point of connection of the communicator or HART modem.

7.6.2. Connection of transmitter with the option of using remote HART communication

For remote communication, where the connection point of Master HART is not local as for the transmitter, it is necessary to ensure the resistance of $\geq 240 \Omega$ between the power supply and the communicator/modem connection point. In the case when the transmitter is supplied from smart cards of measuring systems equipped with HART communication, such resistance is usually not required. Its function is fulfilled by the active impedance on the system measurement card provided with HART communications module. In case of measurement cards with HART communication, the manufacturer's recommendations shall be adhered to.

7.7. Lightning protections (optional)

Transmitters APC(R)-2000ALW Safety may be optionally, at the customer's request, equipped with lightning protection (SA). Presence of the protection in the transmitter is confirmed by the mark (SA) on the plastic cover of the power supply connection terminals.

Parameters of lightning protection:

- discharge threshold voltage: 230 V DC;
- discharge threshold impulse voltage: 450 V (pulse 100 V/ μ s);
- discharge threshold impulse voltage: 600 V (pulse 1000 V/ μ s);
- discharge current for 1 surge: 20 kA, 8/20 μ s;
- discharge current for 10 surges: 10 kA, 8/20 μ s;
- discharge current for 300 surges: 200 A, 10/1000 μ s.

Transmitter APC(R)-2000ALW Safety has an internal and external earthing terminal. Transmitters with integrated lightning protection (SA) must be grounded. The method of earthing and the type of conductors used are defined by local regulations.

7.8. Supply voltages



APC(R)-2000ALW Safety. Minimum and maximum supply voltage		
Electronics version	Minimum supply voltage	Maximum supply voltage
4 ... 20 mA HART, N version (to be used in non-explosive environments)	11.5 V DC	36 V DC
4 ... 20 mA HART, Exi version *	11.5 V DC	30 V DC
4 ... 20 mA HART, Exd version *	11.5 V DC	36 V DC
* For details on intrinsically safe and flameproof version see Exi and Exd documentation (→ 16.2).		

Table 10. Minimum and maximum supply voltage.



Check that for the maximum possible current setpoint (20.660 mA) the voltage on the transmitter's supply terminals complies with the requirements set out in the table and on the transmitter nameplate.

7.9. Impact of supply voltage on ADC transmitter (supply voltage range from minimum to maximum under reference conditions)

Any noticeable impact of voltage change within the range from the minimum to maximum on digital readings of the process variable value of the measurement was not found.

7.10. Impact of supply voltage on DAC transmitter

It was found that the supply voltage variation has negligible impact on the value of process current. This effect results from the flow of the shunt current of overvoltage elements used in the transmitter input power supply system. The maximum impact of the supply voltage referenced to the current range width of 16 mA does not exceed 0.0005%/V.

7.11. Total impact of supply voltage on measurement (ADC + DAC)

The total impact of the supply voltage covering the impact on ADC +DAC referenced to the current range width of 16 mA does not exceed 0.0005%/V.

7.12. Permissible levels of ripple and differential interruptions in power supply line

Transmitter APC(R)-2000ALW Safety complies with the requirements of PN-EN 61326-1, PN-EN 61326-2-1, PN-EN 61326-2-3, PN-EN 61326-3-1 and PN-EN 61000 referenced therein.

With regard to voltages dips and failures for the I/O control connections, the standards do not determine the levels and duration of the tests. However, using the approach where loop 4 ... 20 mA is regarded as DC supply port, resistance measurements were performed.

Maximum permissible duration of supply voltage failure < 1 ms when the DS criterion is met in terms of continuous performance of the safety function.

Maximum permissible duration of voltage dip up to 40% of the rated voltage of 24 V DC on the transmitter terminals < 3 ms, when the DS criterion is met in terms of continuous performance of the safety function.

Maximum permissible duration of voltage dip up to 70% of the rated voltage of 24 V DC on the transmitter terminals < 3 ms, when the DS criterion is met in terms of continuous performance of the safety function.

A separate issue is the permissible interruption level required to ensure the correct HART communication. In order to ensure a low error rate, it is required to provide the power supply that meets the following criteria:

APC(R)-2000ALW Safety. Permissible supply interruption level required for correct HART communication		
Item No	Maximum interruption voltage	Voltage value, characteristics
1	Maximum interruption voltage in band 0... 63 Hz	138 mV RMS
2	Maximum interruption voltage in band 63... 500 Hz	138 mV ... 2.2 mV RMS with decrement of 40 dB/decade
3	Maximum interruption voltage in band 500 ... 10 kHz	2.2 mV RMS
4	Maximum interruption voltage in band 10 kHz ... 3.2 MHz	2.2 mV ... 707 mV RMS with increment of 20 dB/decade

Table 11. Permissible supply interruption level required for correct HART communication.

The above-mentioned conditions are illustrated in the following figure:

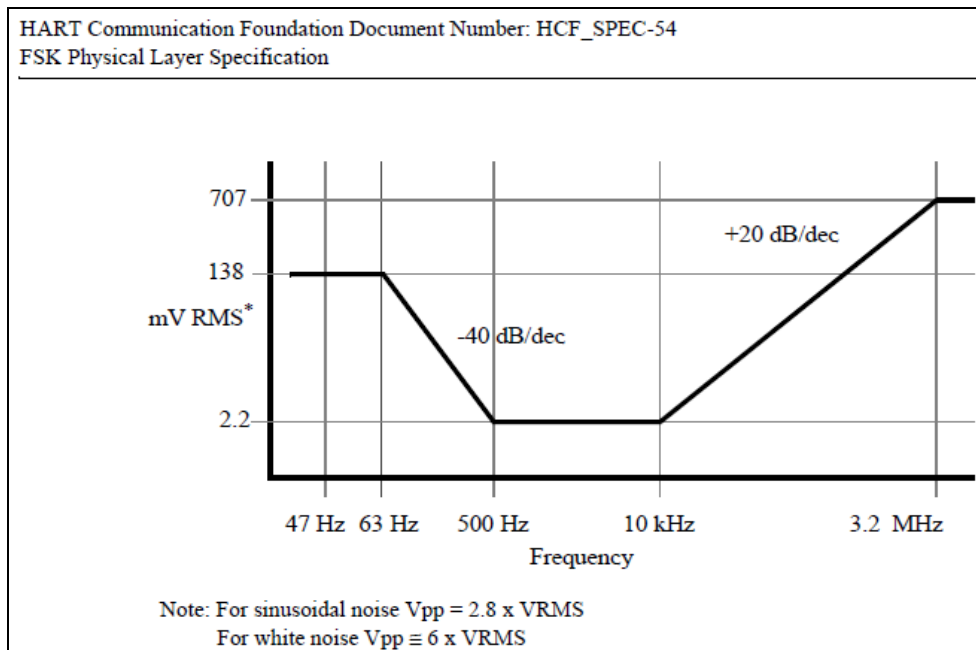


Figure 31. Requirements for the maximum interruption level in the transmitter power supply approved for correct HART communication.

8. Transmitter parameters related to process measurement

8.1. Reference climatic conditions

Constant reference temperature of 22°C (± 5)°C.

Constant relative humidity in the range of: 10... 80% rH.

8.2. Impact of mounting position on measurement

During installation of the transmitter on site it may be required to correct the effect of the position on the measurement. This impact applies to the transmitter “zero” offset, which is connected to the gravitational impact on the silicon measuring diaphragm and is greater, the lower base measurement range of the transmitter is. To perform the pressure resetting after installation, use the local MENU (→ 13.2.11) and perform a **PVZERO** function in it or perform this operation using HART communication using a communicator, PC or smartphone. It should be noted that the transmitters with ABS ranges do not enable resetting operations. However, ABS ranges due to the use of higher pressure ranges are less sensitive to the impact of the mounting position.

8.3. Measurement resolution

The resolution of the digital measurement value depends on the measuring range of the transmitter and is slightly different for each base range. A 24-bit ADC analog-digital transmitter is used for pressure/differential pressure measurements. Approximately 25% of the range is used out of the transmitter full range of processing voltage, which reduces the theoretical resolution to about 22 bits. Therefore, the theoretical resolution of the digital measurement is approximately 0.000024% of the base range. The effective resolution of digital measurement taking into account the stable number of measurement bits is however lower and amount to approximately 0.0015% of the base range. Since, simply speaking the entire pressure process variable processing path basically consists of a serial connection of the ADC stage and the DAC stage, the final resolution will be determined by the module with the smallest processing resolution. It is an analog-digital DAC transmitter module based on a 16-bit transmitter. The measurement resolution referenced to the process current output is therefore approx. 1.0 µA.

APC(R)-2000ALW Safety. Pressure measurement resolution		
Type of measurement	Measurement resolution	Comments
ADC	0.000024%	Refers to the total resolution of the analog-digital module for the base range.
ADC	0.0015%	Refers to the effective resolution of the analog-digital module for the base range.
DAC	0.005% ≈ 1 µA	Refers to total resolution of the analog-digital and digital-analog module referenced to the current output.

Table 12. Pressure measurement resolution.

8.4. Impact of vibration on measurement

During the tests of transmitters APC(R)-2000ALW Safety in aluminium housing (→ 10.5) vibrations have slight impact on the process variable measurement. The maximum impact of vibrations was observed in resonance frequencies, the variation amplitude of the current process variable for the transmitter's base range did not exceed 0.032% of the measurement range (5 µA). Tests were performed in 3 transducer axes in accordance with PN-EN 60068-2-6: 2008 for the range of 10 Hz ... 60 Hz with displacement amplitude of ± 0.35 mm, and for a range of 60 Hz ... 1000 Hz with constant acceleration of 50 m/s². During the tests of transmitters APC(R)-2000ALW Safety in the stainless steel housing (→ 10.5) vibrations have slight impact on the process variable measurement. The maximum impact of vibrations was observed in resonance frequencies, the varia-

tion amplitude of the current process variable for the transmitter's base range did not exceed 0.032% of the measurement range (5 μ A). The tests were performed in 3 transmitter axes in accordance with PN-EN 60068-2-6:20 08 for the range 10 Hz ... 60 Hz with displacement amplitude of \pm 0.15 mm, and for a range of 60 Hz ... 1000 Hz with constant acceleration of 20 m/s².

8.5. Measuring ranges

8.5.1. APC-2000ALW Safety

APC-2000ALW Safety. Measuring ranges.				
No.	Base range	Minimum adjustable width of the measuring range	Option of changing the start of the measuring range	Permissible overload (without hysteresis)
1	0 ... 100 MPa	1 MPa	0 ... 99 MPa	120 MPa
2	0 ... 60 MPa	600 kPa	0 ... 59,4 MPa	120 MPa
3	0 ... 30 MPa **	300 kPa	0 ... 29,7 MPa	45 MPa
4	0 ... 16MPa**	160 kPa	0 ... 15,84 MPa	45MPa
5	0 ... 7 MPa **	70 kPa	0 ... 6,93 MPa	14 MPa
6	-0,1 ... 7 MPa**	71 kPa	-0,1 ... 6,929 MPa	14 MPa
7	0 ... 2,5 MPa **	25 kPa	0 ... 2,475 MPa	5 MPa
8	-0,1 ... 2,5 MPa**	26kPa	0 ... 2,474 MPa	5 MPa
9	0 ... 0,7 MPa **	7 kPa	0 ... 693 kPa	1,4 MPa
10	-100 ... 700 kPa**	8 kPa	0 ... 692 kPa	1,4 MPa
11	-100 ... 150 kPa **	12 kPa	-100 ... 138 kPa	400 kPa
12	0 ... 200 kPa **	10 kPa	0 ... 190 kPa	400 kPa
13	0 ... 100 kPa **	5 kPa	0 ... 95 kPa	200 kPa
14	-50 ... 50 kPa **	5 kPa	-50 ... 45 kPa	200 kPa
15	0 ... 25 kPa **	2,5 kPa	0 ... 22,5 kPa	100 kPa
16	-10 ... 10 kPa **	2 kPa	-10 ... 8 kPa	100 kPa
17	-1,5 ... 7 kPa */**	0,5 kPa	-1,5 ... 6,5 kPa	50 kPa
18	-2,5 ... 2,5 kPa * (only for HS)	0,2 kPa	-2,5 ... 2,3 kPa	50 kPa
19	-0,7 ... 0,7 kPa * (only for HS)	0,1 kPa	-0,7 ... 0,6 kPa	50 kPa
20	0 ... 130 kPa (ABS)	10 kPa	0 ... 120 kPa (ABS)	200 kPa
21	0 ... 700 kPa (ABS)	10 kPa	0 ... 690 kPa (ABS)	1,4 MPa
22	0 ... 2,5 MPa (ABS)	25 kPa	0 ... 2,475 MPa (ABS)	5 MPa
23	0 ... 7 MPa (ABS)	70 kPa	0 ... 6,93 MPa (ABS)	14 MPa
24	0 ... 30 MPa (ABS)	300 kPa	0 ... 29,7 MPa (ABS)	45 MPa
25	0 ... 10 MPa**	100 kPa	0 ... 9,90 MPa	45 MPa
26	0 ... 10 MPa (ABS)	100 kPa	0 ... 9,90 MPa (ABS)	45 MPa
* – only for transmitters without separator. ** – range available in standard and HS versions. HS – Ultra stable measuring element. ABS- absolute pressure				

Table 13. APC-2000ALW Safety. Measuring ranges.

8.5.2. APR-2000ALW Safety

APR-2000ALW Safety. Measuring ranges				
No.	Base range	Minimum adjustable width of the measuring range	Option of changing the start of the measuring range	Permissible overload / Permissible static pressure.
1	0 ... 7 MPa	700 kPa	0 ... 6300 kPa	C type connection: 25 MPa 32 MPa – special execution 41,3 MPa – special execution
2	0 ... 1,6 MPa **	160 kPa	0 ... 1440 kPa	
3	0 ... 250 kPa **	20 kPa	0 ... 230 kPa	
4	0 ... 100 kPa **	5 kPa	0 ... 93 kPa	
5	0 ... 25 kPa **	1 kPa	0 ... 24 kPa	
6	-50 ... 50 kPa **/**	10 kPa	-50 ... 40 kPa	P type connection: 4 MPa 7MPa (for the first range)
7	-10 ... 10 kPa	0,4 kPa	-10 ... 9,6 kPa	
8	-0,5 ... 7 kPa **	0,4 kPa	-0,5 ... 6,6 kPa	
9	-2,5 ... 2,5 kPa (only for HS)	0,2 kPa	-2,5 ... 1,8 kPa	20 MPa 4 MPa for P type connection.
10	-0,7 ... 0,7 MPa (only for HS)	0,1 kPa	-0,7 ... 0,6 kPa	2 MPa
* – recommended for level measurement with direct separator and flooded (or empty) impulse tube. ** – range available in standard and HS versions. HS – Ultra stable measuring element.				

Table 14. APR-2000ALW Safety. Measuring ranges.

APR-2000ALW Safety. Measuring ranges with distance separator or with distance and direct separator.					
No.	Base range	Minimum adjustable width of the measuring range	Distance between vertical separators	The maximum adjustable measuring range (taking into account actual spacing of sep., vertically)	Permissible static pressure.
1	-16 ... 16 kPa	0,1m H ₂ O	≤ 1,7m	[1,6 + (distance between sep. vertical x 0,94)]m H ₂ O	4 MPa
2	-50 ... 50 kPa	0,5m H ₂ O	≤ 6 m	[5 + (distance between sep. vertical x 1,04)]m H ₂ O	4 MPa
3	-160 ... 200 kPa	1,5m H ₂ O	≤ 15m	[20 + (distance between sep. vertical x 1,04)]m H ₂ O	4 MPa
4	-160 ... 1600 kPa	100 kPa	≤ 15m	1600 kPa	4 MPa
Please note! Presented in the table maximum spacing of vertical separators applies to level measuring, the ability to reset the transmitter with an empty tank. For measuring the density or the phase boundary (sugar industry, chemical industry, refineries) spacing of vertical separators can be larger.					

Table 15. APR-2000ALW Safety. Measuring ranges with distance separator or distance and direct separators.

APR-2000ALW Safety. Measurement ranges of the version with the connection for low pressure measurement gases.					
No.	Base range	Minimum adjustable width of the measuring range	Option of changing the start of the measuring range	Permissible overload	Permissible static pressure.
1	0 ... 2500 Pa	100 Pa	0 ... 2400 Pa	100 kPa	35 kPa
2	-250 ... 250 Pa	20 Pa	-250 ... 230 Pa	35 kPa	35 kPa
3	-700 ... 70 Pa	100 Pa	-700 ... 600 Pa	35 kPa	35 kPa
4	-2500 ... 2500 Pa	500 Pa	-2500 ... 2000 Pa	100 kPa	100 kPa
5	-10 ... 10 kPa	2 kPa	-10 ... 8 kPa	100 kPa	100 kPa

Table 16. APR-2000ALW Safety. Measurement ranges of the version with the connection for low pressure measurement gases.

8.6. Basic measurement error

8.6.1. Basic measurement error of pressure transmitter APC(R)-2000ALW Safety

The basic measurement error of APC(R)-2000ALW Safety	
Transmitter	Declared error
APC-2000ALW Safety	<ul style="list-style-type: none"> – $\leq \pm 0,075\%$; – $\leq \pm 0,1\%$ (for the range 19); – $\leq \pm 0,05$ (special execution).
APR-2000ALW Safety	– $\leq \pm 0,075\%$;

Table 17. Basic measurement error of APC(R)-2000ALW Safety.

8.6.2. Basic measurement error of differential pressure transmitter APR-2000ALW Safety with connection for low pressure gases measurement.

Basic measurement error of APR-2000ALW Safety with connection for low gas pressure measurement					
Basic range	0 ... 2500 Pa	-250 ... 250 Pa	-700 ... 700 Pa	-2500 ... 2500 Pa	-10 ... 10 kPa
Basic error	$\leq \pm 0,075\%$	$\leq \pm 0,25\%$	$\leq \pm 0,1\%$	$\leq \pm 0,1\%$	$\leq \pm 0,075\%$
Basic range	0 ... 250 Pa	-50 ... 50 Pa	-50 ... 50 Pa	-250 ... 250 Pa	-1 ... 1 kPa
Basic error	$\leq \pm 0,4\%$	$\leq \pm 1,6\%$	$\leq \pm 1,6\%$	$\leq \pm 0,4\%$	$\leq \pm 0,4\%$

Table 18. Basic measurement error of APR-2000ALW Safety with connection for low pressure gases measurement.

8.7. Temperature error

Temperature error	
Transmitter	Declared error
APC-2000ALW Safety	<ul style="list-style-type: none"> – $< \pm 0,05\% \text{ (FSO)}/10^{\circ}\text{C}$ (0,1% for ranges: 16, 17, 18, 19); – Max $\pm 0,25\% \text{ (FSO)}$ entire range of compensation (0,4% for ranges: 16, 17, 18, 19).
APR-2000ALW Safety	<ul style="list-style-type: none"> – $< \pm 0,05\% \text{ (FSO)}/10^{\circ}\text{C}$ (for ranges: 1, 2, 3, 4, 5, 6, 7, 8, 9); – $< \pm 0,08\% \text{ (FSO)}/10^{\circ}\text{C}$ (for range 10; – Max $\pm 0,25\% \text{ (FSO)}$ entire range of compensation.
APR-2000ALW Safety (with low pressure gases measurement connection)	<ul style="list-style-type: none"> – $\pm 0,1\% \text{ (FSO)}/10^{\circ}$; – Max $\pm 0,4\% \text{ (FSO)}$ entire range of temperature compensation.

Table 19. Temperature error of pressure and differential pressure transmitter.

8.8. Static pressure error

8.8.1. Measurement error due to static pressure of differential pressure transmitter APR-2000ALW Safety

APR-2000ALW Safety. Measurement error due to static pressure		
Base range No. (FSO)	Maximum declared measurement error referenced to the base range	Comments
3, 4, 5, 6, 7, 9;	– $\pm 0,01\% \text{ (FSO) / 1 MPa}$	
8	– $\pm 0,03\% \text{ (FSO) / 1 MPa}$	
1, 2	– $\pm 0,06\% \text{ (FSO) / 1 MPa}$	
2, 8 (HS)	– $\pm 0,01\% \text{ (FSO) / 1 MPa}$	Version HS
10	– $\pm 0,02\% \text{ (FSO) / 1 MPa}$	
HS - Ultra stable measuring element.		

Table 20. Measurement error due to static pressure of differential pressure transmitter APR-2000ALW Safety.

8.9. Total measurement error

When calculating the total measurement error, the square average of the sum of errors shall be assumed, taking into account the conditions such as the base range, set range, range of ambient temperature variations, range of static pressure variations, long-term stability. Other parameters, such as supply voltage variation or humidity, have a negligible impact on the measurement and may be omitted in calculations.

8.10. Long-term stability

APC(R)-2000ALW Safety. Long-term stability	
Transmitter type.	Maximum declared measurement error referenced to the base range
APC-2000ALW Safety	<ul style="list-style-type: none"> - for base range \leq base error for 3 years (FSO) or $\leq 2 \times$ base error for 5 years (FSO); - special execution HS \leq (ranges 3 ...15) base error for 6 years (FSO) $\leq 2 \times$ base error for 10 years (FSO).
APR-2000ALW Safety	<ul style="list-style-type: none"> - for base range \leq base error for 3 years (FSO) $\leq 2 \times$ base error for 5 years (FSO); - special execution HS \leq (ranges 2,4,5,8,9) base error for 10 years (FSO).
HS — Ultra stable measuring element.	

Table 21. Long-term stability.

8.11. Time from switch-on to first measurement

The start-up of the transmitter from the activation to the end of the first measurement lasts approx. 5 seconds. It is the time of performing basic programme tests and pressure and temperature measurements which constitute a complete process variable measurement chain.

8.12. Measurement thermal stabilization time

Thermal stabilization of the measurement is related to the determination of thermal equilibrium of measurement elements warmed with power supply energy. The transmitter is equipped with mechanisms compensating the impact of temperature on the measurement. After the transmitter is energized, the measurements performed are within the tolerance limits of the errors described in the Technical Information, but in order to perform calibration or adjustment it is recommended to stabilize the temperature conditions. If the transmitter has already been located in a stable temperature, the recommended stabilization time of the transmitter to perform these operations is approximately 15 minutes. When in the transmitter there is a significant difference between the body temperature and the ambient temperature, at which the measurement is to be performed, the temperature stabilization time shall be at least 2 hours.

9. Installation

9.1. General mounting instructions

During installation of transmitter APC(R)-2000ALW Safety on site it may be required to correct the effect of the position on the measurement. This impact applies to the transmitter zero offset (→ 8.2).

Pressure resetting can be performed by the following methods:

- in the transmitter's local **MENU**, select and accept the **PV ZERO** function with the buttons (→ 13.2.12);
- using the KAP03 communicator manufactured by Aplisens S.A. or other communicator using DD and DTM libraries;
- using a PC, Raport 2 and HART/USB communicator.

The transmitter with ABS ranges is not capable of performing a pressure resetting operation.

The ABS ranges due to the use of larger pressure ranges are less sensitive to the influence of the mounting position.

The body of transmitter APC(R)-2000ALW Safety can be rotated by max. 330° (→ 9.5).

Transmitter APC(R)-2000ALW Safety gives the possibility of adjusting the display position to the mounting position of the body. The display may be rotated in total by an angle of 345° with a step of 15° (→ 9.6).

Transmitters APC(R)-2000ALW Safety may be mounted on a pipe or wall using special brackets and clamps. Exact mounting method is described in (→ 9.3). Specification of mounting brackets is included in (→ 12.3).

The method of mounting the transmitter and the configuration of impulse tubes used to feed pressure shall be based on the following conditions:

- impulse tubes should be as short as possible and with a sufficiently large cross section, run without sharp bends;
- impulse tubes must have a constant slope, e.g. 10 cm/m, unless they are looped;
- if the impulse pipes are installed in open air, they must be adequately protected against freezing;
- in the case of gaseous medium, the transmitter must be installed above the measuring point so that the condensate can flow from capillary tubes to the process pipe;
- for liquid and steam, the transmitter must be installed below the measuring point;
- if the measured medium contains particles, it is useful to install separators and drain valves to remove deposits;
- keep the same liquid level or constant level difference in the impulse tubes. It is necessary to ensure the same temperature of both tubes and correct the error due to the impact of the position and filling of impulse tubes by pressure resetting;
- avoid installation of a measuring orifice at high points of a process system for liquids and at low points for gases;
- the configuration of impulse tubes and three- or five-way valve connection system shall be selected taking into account the measurement conditions and such functions as "pressure resetting" of transmitters on site. In addition, it is necessary to take into account the impulse routes during degassing, dewatering and flushing.

The transmitter parts must be selected according to chemical (corrosive) properties of the process medium. Pay particular attention to the diaphragm material. For more information on wetted parts materials in item (→ 12.5).

9.2. Measuring system

Flow measurement.

Transmitter **APR-2000ALW Safety** enables to perform the measurement of gas, steam and liquid flow (→ 2.3). In case of gas flow measurement, the transmitter must be installed above the measuring point (→ 2.3.1). For measurement of steam and liquid flow, the transmitter should be installed below the measuring point (→ 2.3.2; → 2.3.3). Additionally, when measuring the steam flow, condensate traps must be installed at the level of the measuring point and at the same distance from transmitter **APR-2000ALW Safety**.

Level measurement.

Transmitters APC(R)-2000ALW Safety enable the liquid level measurement in open and closed tanks (→ 2.4).

- *Level measurement system in open tanks*
 - APR-2000ALW Safety:** Install the transmitter below the measuring point; the negative side of the pressure connection remains open to the atmosphere (→ 2.4.1).
 - APR-2000ALW Safety:** Install the transmitter directly on the tank; the negative side of the pressure connection remains open to the atmosphere (→ 2.4.2).
 - Install transmitter **APC-2000ALW Safety** directly into the tank below the minimum liquid level (→ 2.4.3).

- *Level measurement system in closed tanks, also with steam pillow*
 - APR-2000ALW Safety:** Install the transmitter below the measuring point; the negative side of the pressure connection should be connected via capillary tube to the tank above the maximum liquid level (→ 2.4.4).
 - APR-2000ALW Safety:** Install the transmitter directly on the tank using an integrated separator; the negative side of the pressure connection must be connected via the capillary tube to the tank above the maximum liquid level (→ 2.4.5).
 - APR-2000ALW Safety:** Install the transmitter below the mounting points of distance separators (→ 2.4.6).
 - APR-2000ALW Safety:** Install the transmitter directly on the tank using an integrated separator; the negative side of the pressure connection must be connected via the distance separator above the maximum liquid level (→ Figure 10).
 - APR-2000ALW Safety:** Install the transmitter below the measuring point; the negative side of the pressure connection must be connected via the capillary tube above the maximum liquid level (→ 2.4.8).
 - APR-2000ALW Safety:** Install the transmitter directly on the tank using a direct separator; the negative side of the pressure connection must be connected via the capillary tube above the maximum liquid level (→ 2.4.9).

Pressure measurement.

Transmitters APC(R)-2000ALW Safety enable to measure pressure and differential pressure of gases, steam and liquids (→ 2.5; → 2.6).

- Gas pressure measurement:

APC-2000ALW Safety: Install the transmitter above the measuring point (→ 2.5.1).

Steam pressure measurement:

APC-2000ALW Safety: Install the transmitter below the measuring point (→ 2.5.2).

Liquid pressure measurement:

APC-2000ALW Safety: Install the transmitter below the measuring point (→ 2.5.3).

- Differential pressure measurement.

Gas and steam differential pressure measurement:

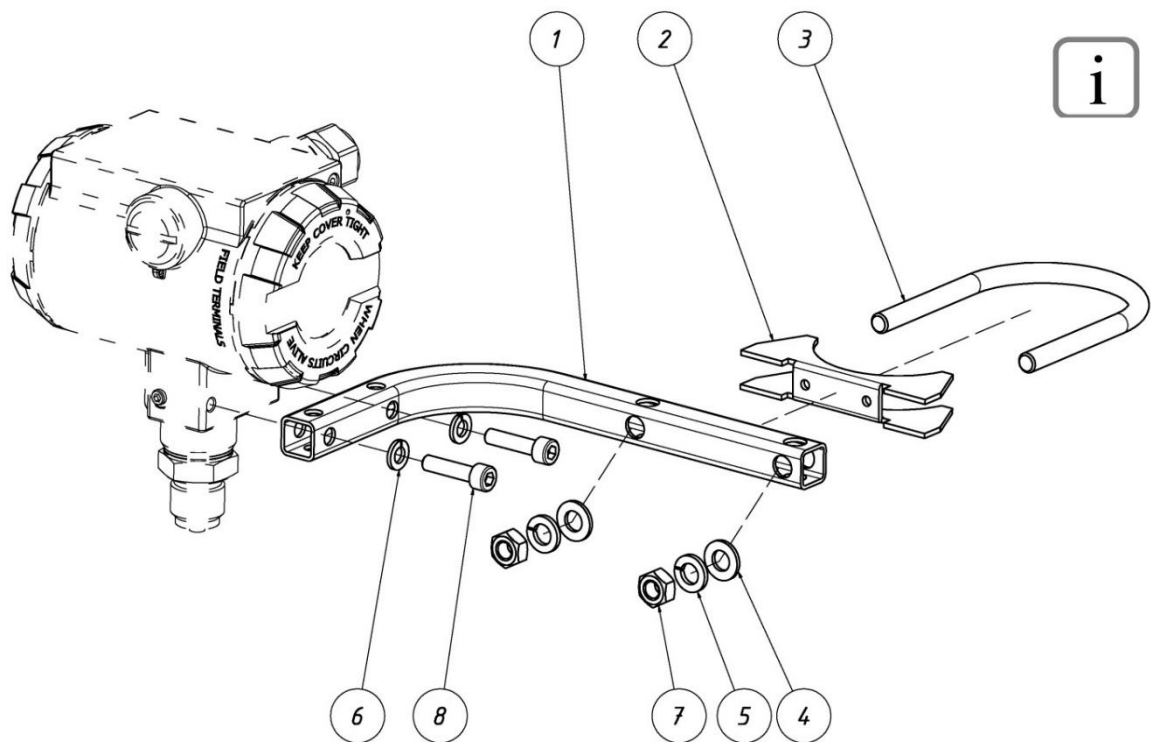
Transmitter **APC-2000ALW Safety** must be installed above the measuring point (→ 2.6.1).

Liquid differential pressure measurement:

Transmitter **APC-2000ALW Safety** must be installed below the measuring point (→ 2.6.2).
 Gas, steam and liquid differential pressure measurement with the use of distance separators:
 Transmitter **APR-2000ALW Safety** must be installed below the measuring point (→ 2.6.3).

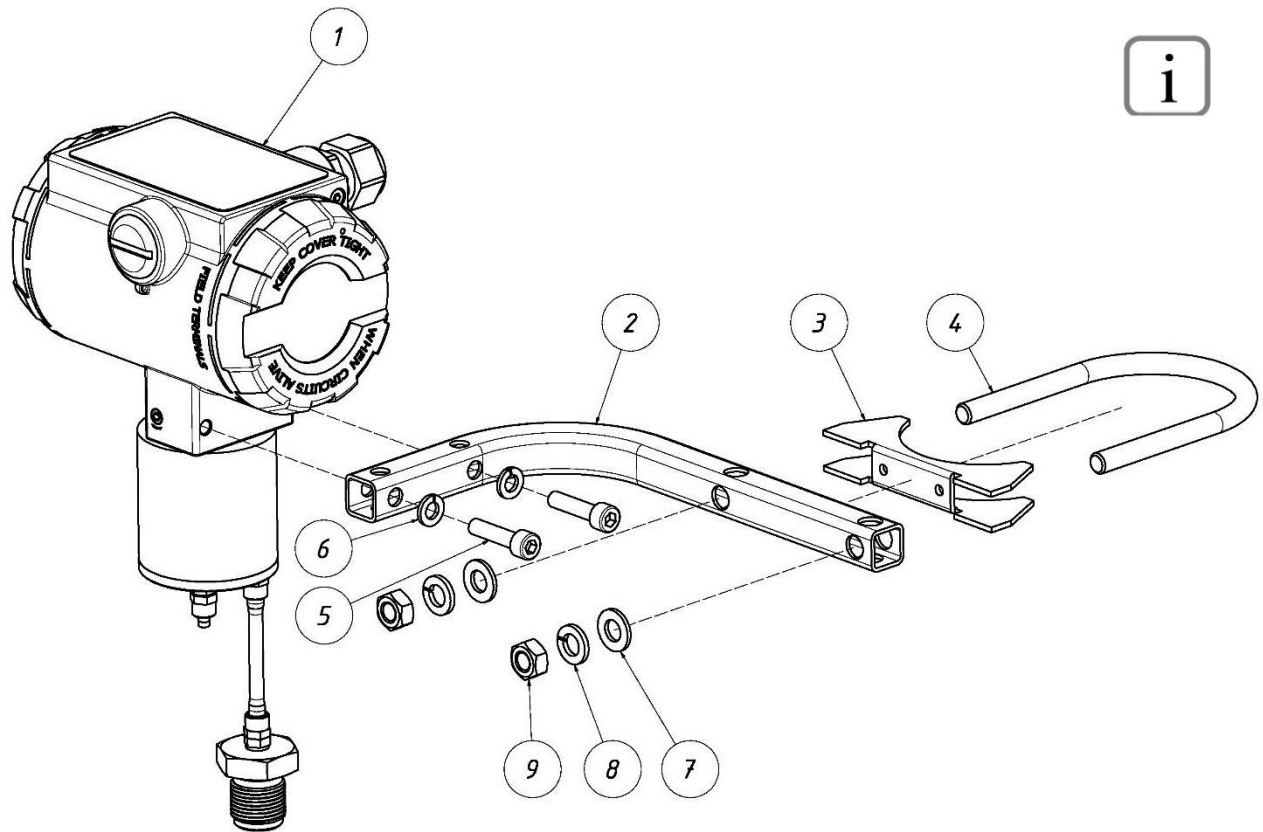
9.3. Pipe and wall mounting

Transmitter APC(R)-2000ALW Safety can be mounted on the wall by means of an AL mounting arm (item 1) or to the pipe using the components as shown below:



1. AL mounting arm.
2. C2 clamp V-block.
3. Pipe mounting lug.
4. Flat washer \varnothing 8.4 acc. to DIN 125 (2 pcs).
5. Spring washer \varnothing 8.1 acc. to DIN 127 (2 pcs).
6. Spring washer \varnothing 6.1 acc. to DIN 127 (2 pcs).
7. M8 nut acc. to DIN 934 (2 pcs).
8. Hex socket head cap screw M6x25 acc. to DIN 912 (2 pcs).

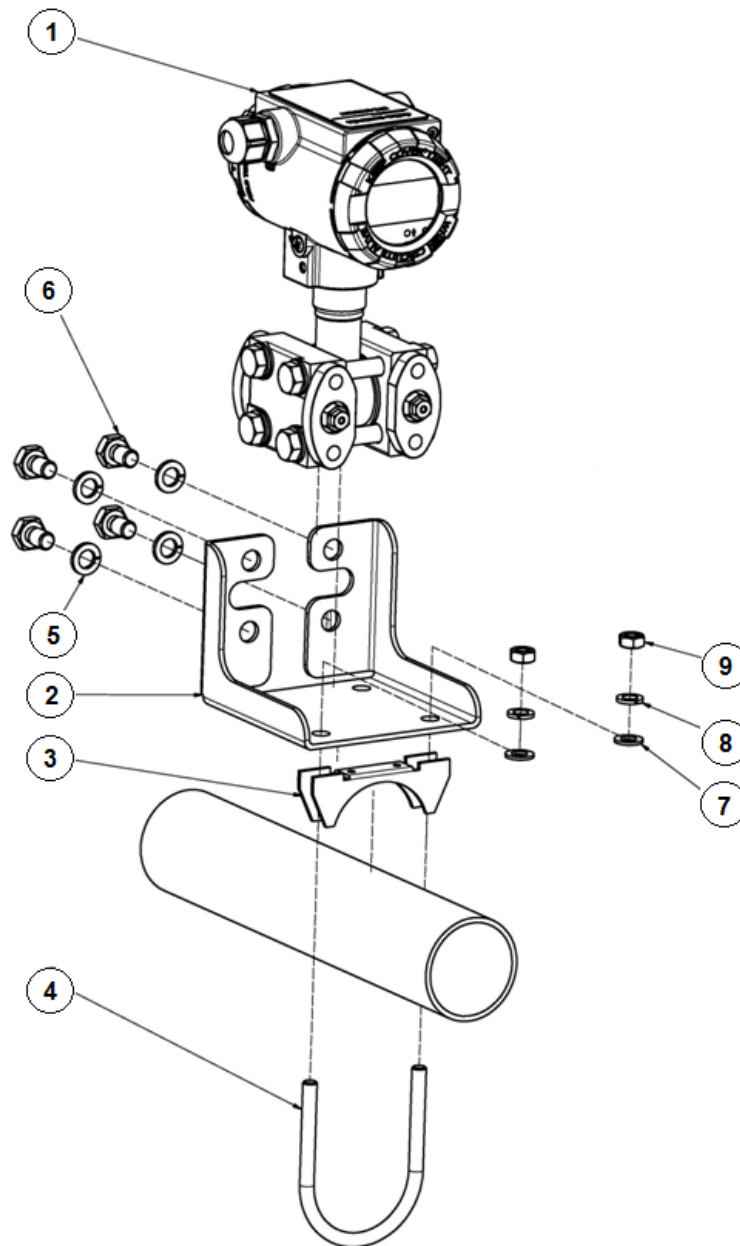
Figure 32. Transmitter APC-2000ALW Safety. Wall and pipe mounting.



1. APR-2000ALW Safety with PCV process connection.
2. AL mounting arm.
3. C2 clamp V-block.
4. Pipe mounting lug.
5. Hex socket head cap screw M6x25 acc. to DIN 912 (2 szt.).
6. Spring washer $\varnothing 6,1$ acc. to DIN 127 (2 szt.).
7. Flat washer $\varnothing 8,4$ acc. to DIN 125 (2 szt.).
8. Spring washer $\varnothing 8,1$ acc. to DIN 127 (2 szt.).
9. M8 nut acc. to DIN 934 (2 szt.).

Figure 33. Transmitter APR-2000ALW Safety with PCV process connection. Wall and pipe mounting.

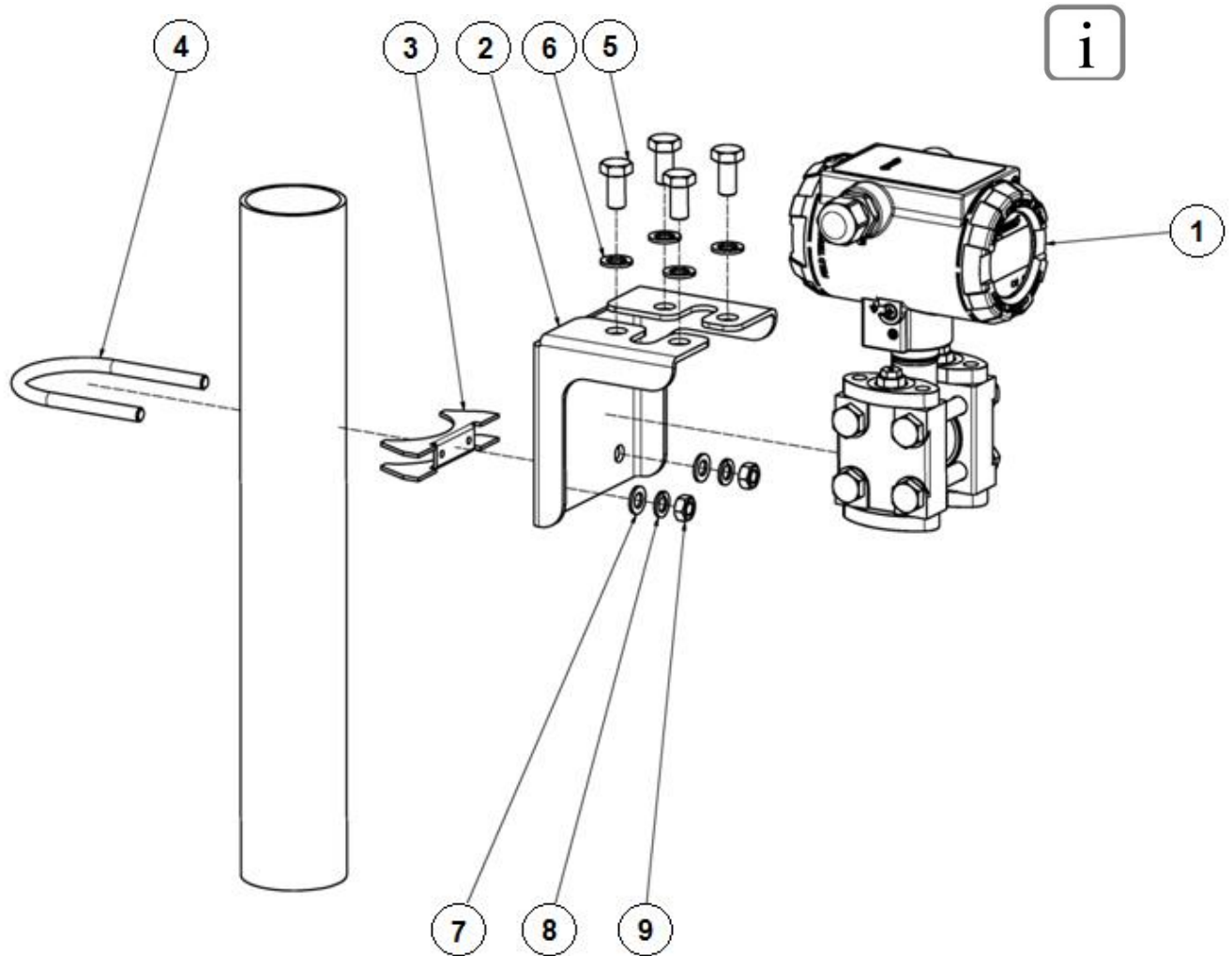
Differential pressure transmitters APR-2000ALW Safety with process connection of C type can be mounted to the pipe using the mounting bracket C2 in the following way:



1. APR-2000ALW Safety with process connection C.
2. C2 bracket.
3. V-block.
4. Pipe mounting lug.
5. Spring washer \varnothing 10.2 acc. to DIN 127A (4 pcs).
6. Screw M10x16 acc. to DIN 933 (4 pcs).
7. Flat washer \varnothing 8.4 acc. to DIN 125 (2 pcs).
8. Spring washer \varnothing 8.1 acc. to DIN 127 (2 pcs).
9. M8 nut acc. to DIN 934 (2 pcs).

Figure 34. Transmitter APR-2000ALW Safety with C type process connection. Mounting on pipe.

Differential pressure transmitters APR-2000ALW Safety with process connection of CR type can be mounted to the pipe using the mounting bracket C2 in the following way:



1. APR-2000ALW Safety with process connection CR.
2. C2 bracket.
3. V-block.
4. Pipe mounting lug.
5. Screw M10x16 acc. to DIN 933.
6. Spring washer $\varnothing 10.2$ acc. to DIN 127A (4 pcs).
7. Flat washer $\varnothing 8.4$ acc. to DIN 125 (2 pcs).
8. Spring washer $\varnothing 8.1$ acc. to DIN 127 (2 pcs).
9. M8 nut acc. to DIN 934 (2 pcs).

Figure 35. Transmitter APR-2000ALW Safety with CR process connection. Mounting on pipe.

9.4. Version with distance separator

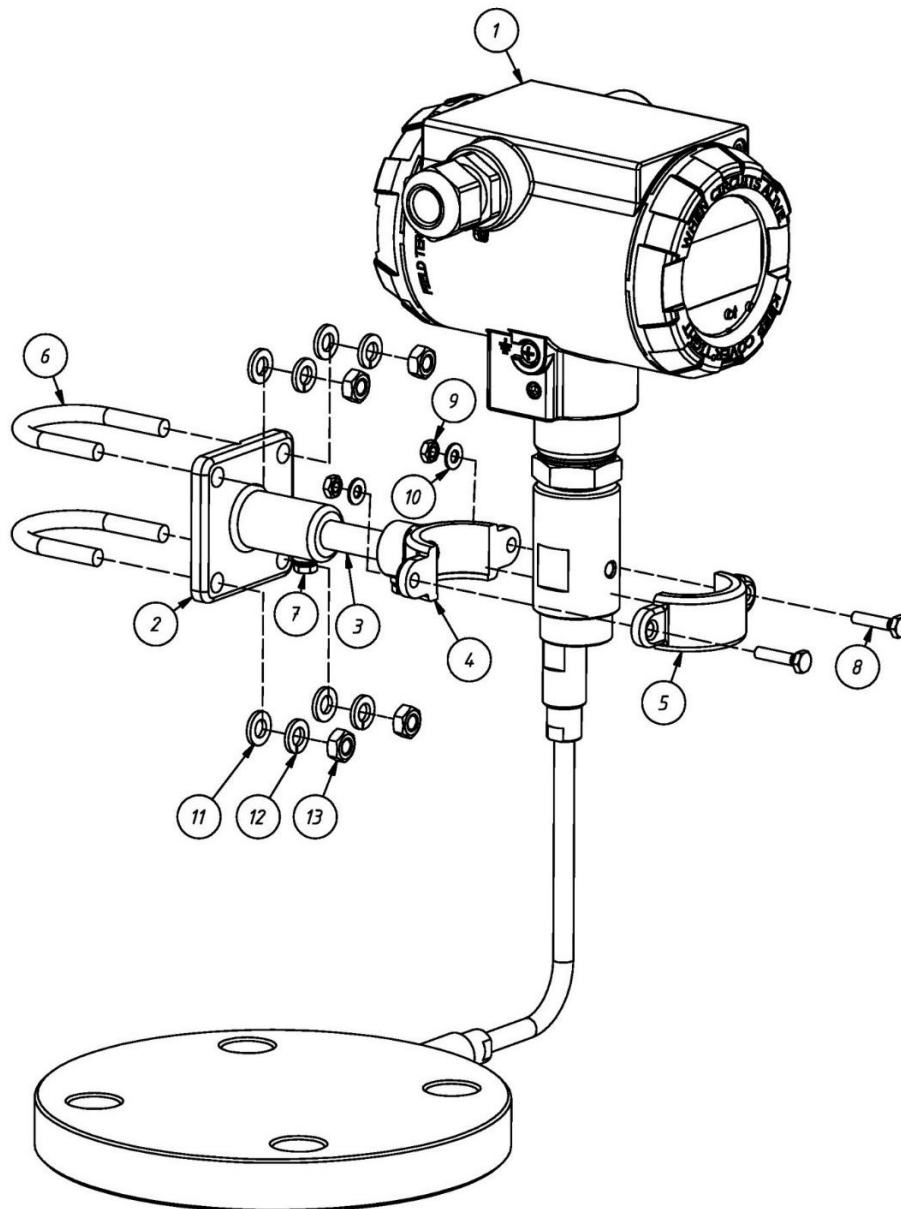


Figure 36. Assembly and mounting of the variant with distance separator.

List of parts for the PCR version bracket (pipe mounting):

1. APC-2000ALW Safety with distance separator.
2. Bracket body.
3. Bracket pin.
4. Bracket clamp (bottom).
5. Bracket clamp (top).
6. Pipe mounting lug (2 pcs).
7. Screw M5x10 acc. to DIN 933 (2 pcs).
8. Screw M5x18 acc. to DIN 933 (2 pcs).
9. M5 nut acc. to DIN 934 (2 pcs).
10. Flat washer $\varnothing 5.3$ acc. to DIN 433 (2 pcs).
11. Flat washer $\varnothing 6.4$ acc. to DIN 125 (4 pcs).
12. Spring washer $\varnothing 6.1$ acc. to DIN 127 (4 pcs).
13. M6 nut acc. to DIN 934 (4 pcs).

List of parts for the PC version bracket (wall mounting):

1. APC-2000ALW Safety with distance separator.
2. Bracket body.
3. Bracket pin.
4. Bracket clamp (bottom).
5. Bracket clamp (top).
7. Screw M5x10 acc. to DIN 933 (2 pcs).
8. Screw M5x18 acc. to DIN 933 (2 pcs).
9. M5 nut acc. to DIN 934 (2 pcs).
10. Flat washer $\varnothing 5.3$ acc. to DIN 433 (2 pcs).

9.5. Rotation of transmitter body

Transmitters APC(R)-2000ALW Safety can be rotated by 330° .

In order to do so:

- loosen the screw (item 1) to allow the housing to be rotated;
- position the transmitter housing as required (item 2);
- tighten the screw (item 1).

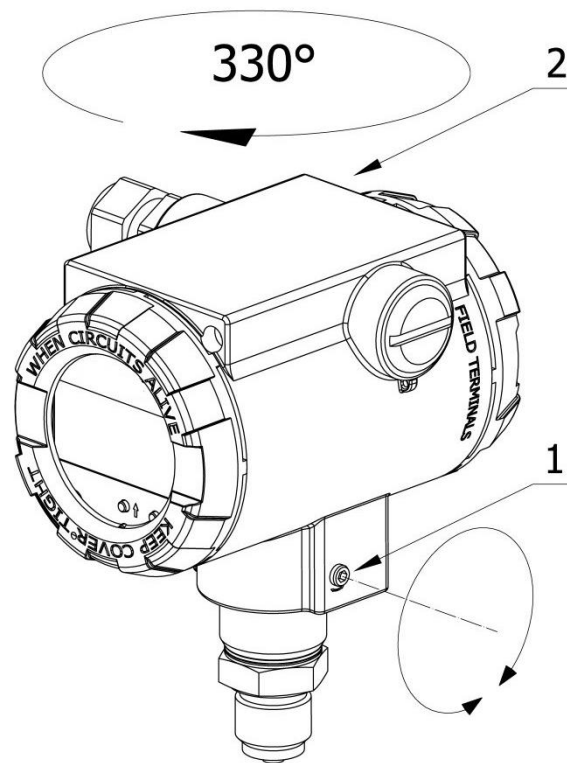


Figure 37. Rotation of APC(R)-2000ALW Safety transmitter housing.

9.6. Rotation of display

The transmitter gives the possibility of adjusting the display position to the mounting position of the body. Access to the brackets (item 2) used to rotate the display is provided after opening the front cover (item 1). The display may be rotated by an angle of 345° with a step of 15°.

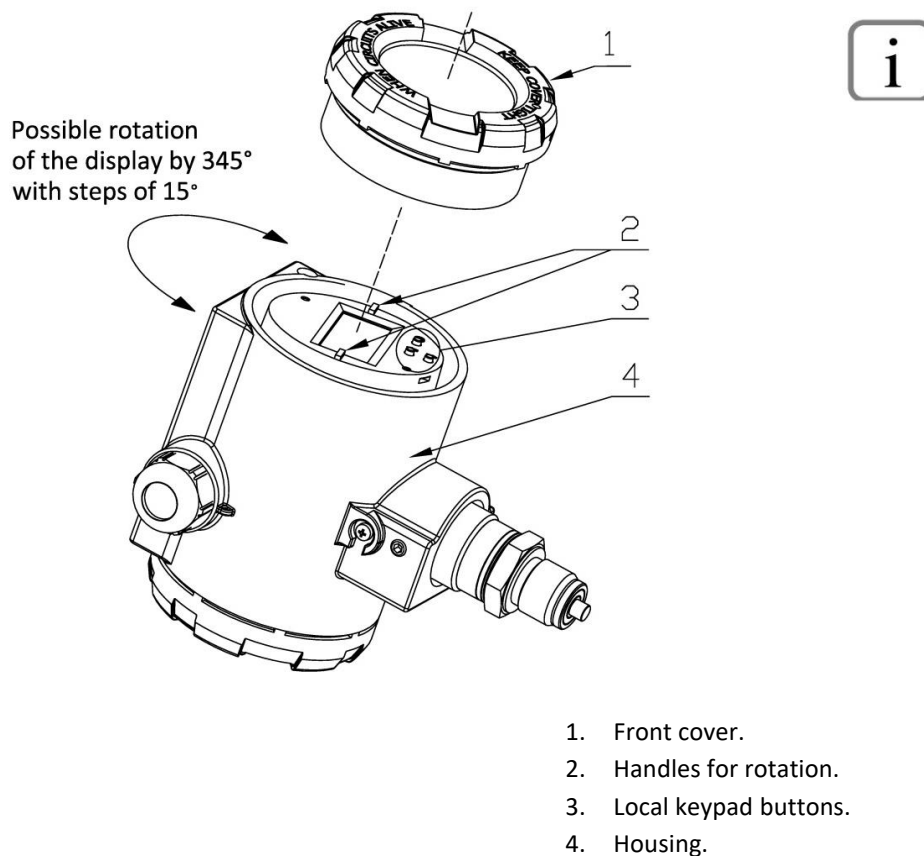


Figure 38. Change of display position and access to buttons.

9.7. Oxygen applications

Oxygen and some other gases are highly explosive when they come into contact with oil, any fats and plastics, therefore it is necessary to take the following measures:

- all components of the measuring system must be cleaned and degreased.

Transmitters APC(R)-2000ALW Safety are available in the version suitable for oxygen measurements. At the user's request, a washing certificate (→ 16.8.7) may be issued to confirm the possibility of using pressure and differential pressure transmitters in oxygen systems, and the interior of the measurement heads is filled with a chemically inert liquid.

9.8. Hydrogen applications

For applications where the process medium contains hydrogen, there is a risk that the hydrogen atoms will penetrate through the metal and diaphragm into the sensor chamber. This phenomenon causes false measurement results and, in some cases, it may result in the damage to the sensor.

For this type of application Aplsens S.A. offers diaphragms coated with Au layer, designed for the measurement of the hydrogen-containing media pressure.

More information in item (→ 12.5) "Specification of materials coming into contact with the process".

10.Environment

10.1. Operating temperature range

APC(R)-2000ALW Safety. Operating temperature range	
Transmitter type.	Operating temperatures
APC-2000ALW Safety	- 40°C ... + 85°C
APR-2000ALW Safety	- 40°C ... + 85°C
APC(R)-2000ALW Safety with separators	- 25°C ... + 85°C
APR-2000ALW Safety with connection for low pressure gases measurement.	- 25°C ... + 85°C
Ex	
APC-2000ALW Safety Exd	- 40°C ... + 75°C
APR-2000ALW Safety Exd	- 40°C ... + 75°C
APC(R)-2000ALW Safety Exd with separators	- 25°C ... + 75°C
Exi	
APC-2000ALW Safety Exi	- 40°C ... + 80°C
APR-2000ALW Safety Exi	- 40°C ... + 80°C
APC(R)-2000ALW Safety Exi with separators	- 25°C ... + 80°C
APR-2000ALW Safety Exi with connection for low pressure gases measurement.	- 25°C ... + 80°C
Special version	From -50°C
* Please note! Exd transmitters APC(R)-2000ALW Safety have a thermal fuse which trips at +87 ± 2°C. The exceeding of temperature exceeding of +85°C may result in permanent disconnection of the transmitter power supply circuit and the need to repair the transmitter in the service centre.	

Table 22. Operating temperature range.

10.2. Storage temperature range

APC(R)-2000ALW Safety. Storage temperature range	
Transmitter type.	Storage temperatures
APC-2000ALW Safety	- 40°C ... + 85°C
APR-2000ALW Safety	- 40°C ... + 85°C
APC(R)-2000ALW Safety with separators	- 25°C ... + 85°C
APR-2000ALW Safety with connection for low pressure gases measurement.	- 40°C ... + 85°C
Ex	
APC-2000ALW Safety Exd	- 40°C ... + 75°C
APR-2000ALW Safety Exd	- 40°C ... + 75°C
APC(R)-2000ALW Safety Exd with separators	- 25°C ... + 75°C
Exi	
APC-2000ALW Safety Exi	- 40°C ... + 80°C
APR-2000ALW Safety Exi	- 40°C ... + 80°C
APC(R)-2000ALW Safety Exi with separators	- 25°C ... + 80°C
APR-2000ALW Safety Exi with connection for low pressure gases measurement.	- 25°C ... + 80°C
Special version	From - 50°C
* Please note! Exd transmitters APC(R)-2000ALW Safety have a thermal fuse which trips at +87 ± 2°C. The exceeding the temperature exceeding of +85°C may result in permanent disconnection of the transmitter power supply circuit and the need to repair the transmitter in the service centre.	

Table 23. Storage temperature range.

10.3. IP protection rating

APC(R)-2000ALW Safety. IP protection rating	
Transmitter type.	IP
APC-2000ALW Safety	IP66 IP67 special version
APR-2000ALW Safety	IP66 IP67 special version
APR-2000ALW Safety with two separators	IP66 IP67 special version
APR-2000ALW Safety with connection for low pressure gases measurement.	IP66

Table 24. IP protection rating.

10.4. Climatic class

APC(R)-2000ALW Safety. Climatic class	
Test basis, standard title	Conditions
EN 60068-2-2:2007, item 3.7 DNV, Dry heat	Test B, T = +70°C, RH = max 55%
EN 60068-2-1:2007, item 3.9 DNV, Cold	Test A, T = -25°C
EN 60068-2-30:2008, item 3.8 DNV, Damp heat, cyclic	Db test, (T = +55°C, RH = min. 95%, 24 h) x 2 cycles
EN 60068-2-52:2001, item 3.10 DNV, Salt mist, cyclic (sodium chloride solution)	Kb test (spraying for 2 h, T = +25°C, storage for 7 days, T = +40°C, RH = 93%) x 4 cycles, together 28 days

Table 25. Climatic class.

10.5. Vibration and surge resistance

APC(R)-2000ALW Safety. Vibration and surge resistance.			
Type of disturbance	Standard	Type of housing	Exposure parameters
Surges	EN 60068-2-27	Stainless steel	20g/10ms; 18 surges (3 per each direction of axle)
		AL	50g/10ms; 600 surges (100 per each axle direction)
Sinusoidal vibrations	EN 60068-2-6, Fc test	Stainless steel	± 15mm, 10...60Hz ±20m/s ² , 60...1000Hz
		AL	± 35mm, 10...60Hz ±50m/s ² , 60...1000Hz

Table 26. Vibration and surge resistance.

10.6. Electromagnetic compatibility

Electromagnetic compatibility acc. to EN 61326-1, EN 61326-2-3 for industrial applications		
Type of disturbance	Standard	Level
Electrostatic discharge (ESD)	EN 61000-4-2	contact ± 6 kV air ± 8 kV
Radiated electromagnetic field	EN 61000-4-3	80...1000 MHz – 10 V/m 1.4...2 GHz – 3 V/m 2...2.7 GHz – 1 V/m
Fast electrical transients (burst)	EN 61000-4-4	± 2 kV, I/O
Surges	EN 61000-4-5	± 2 kV, line – earthing
Conducted interruptions induced by radio-frequency fields:	EN 61000-4-6	0.15...80 MHz, 3 V
Emission	EN 55011	30 ... 1000 MHz (group 1, class A)

Table 27. Electromagnetic compatibility.

11. Process

11.1. Process temperature limits (applies to the temperature of transmitter components)

Components of transmitter APC(R)- 2000ALW Safety		Temperature limits of	
		Process	Medium
Separators	1.4404 (316L) Hastelloy C 276 Teflon® Nickel Titanium Tantalum Monel	from -40°C to +85°C from -25°C to +85°C ²⁾	from -40°C to +120°C in direct measure- ments. Above 120°C in distance measure- ments.
Diaphragms	1.4404/1.4435 (316L) Hastelloy C 276 Nickel Titanium Tantalum Monel Teflon ¹⁾ Gold ¹⁾		
Process connections	1.4404 (316L) Hastelloy C 276		
1) Layer sprayed on 316L steel diaphragm.			
2) APR-2000ALW Safety with connection for low pressure gases measurement.			

Table 28 Temperature limit for individual transmitter components.

- The temperature of the measured medium cannot cause an increase in the temperature of the transmitter housing above the temperatures specified in the table;
- measurement of the medium with temperature above 120°C is possible only with the use of a separator, stub with a radiator or impulse tube;
- the temperature ranges of the measured medium should be observed due to the applied gauge fluid in the process connection. Information on gauge fluids is given in section (→ 14.2);
- for oxygen measurement applications, the guidelines given in item (→ 9.7) “Oxygen application” shall be observed;
- observe the permissible temperature range for gaskets, given in item (→ 11.2) “Operating temperature ranges of gaskets”.

11.2. Operating temperature ranges of the used gaskets

Sealing material	Permissible ranges of operating temperatures*
NBR	from -40°C to +85°C
HNBR	from -40°C to +85°C
PTFE	from -40°C to +85°C
EPDM	from -40°C to +85°C
Silicone	from -40°C to +85°C
FPM	from -20°C to +85°C
Copper	from -30°C to +85°C
* The permissible operating temperature range depends on the transmitter configuration.	

Table 29. Temperature ranges for the transmitter sealing elements.

11.3. Specification of allowable pressures

The maximum pressure value for transmitters APC(R)-2000ALW Safety is dependent on the measuring system component with the lowest nominal pressure. The relevant data are included in section (→ 8.5) “Measurement ranges”.

The maximum static pressure is specified on the transmitter nameplate APR-2000ALW Safety.

For oxygen measurement applications, it shall be necessary to follow the instructions and the values provided in section (→ 9.7) “Oxygen applications”.

12. Mechanical design

Housing:

normal version:

- varnished housing of AL 164 type made of high pressure casting of aluminium alloy AK11B1c, or YZA1Sil2, or ZL 102.
- stainless steel housing: acid resistant steel 1.4401 (316).

Special version:

- high pressure aluminium alloy casting, varnished;
- stainless steel 1.4401 (316).

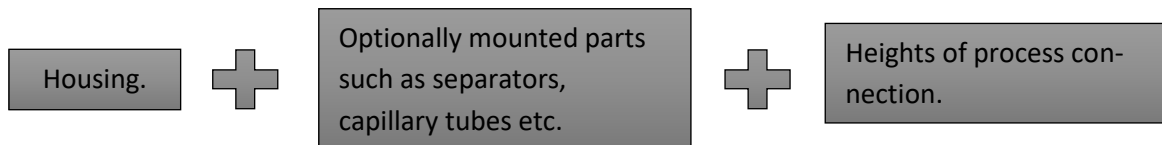
Housing protection rating (acc. to PN-EN60529:2003):

- IP66;
- IP67.

The main component of the transmitter is a measuring head with the installed silicon diaphragm. The measuring heads may be equipped with different pressure connections. Inside the head there is a “pressure chamber” filled with gauge fluid. On the side of the measured medium, it is limited by a separating diaphragm welded tightly to the head body (differential pressure transmitters have two separating diaphragms for inputs: “+” and “-”).

12.1. Dimensions of body with pressure process connection

The transmitter height is calculated as a sum of heights of the following elements:



Please note!

If necessary, the mounting distances essential for installation of the transmitter must be considered.

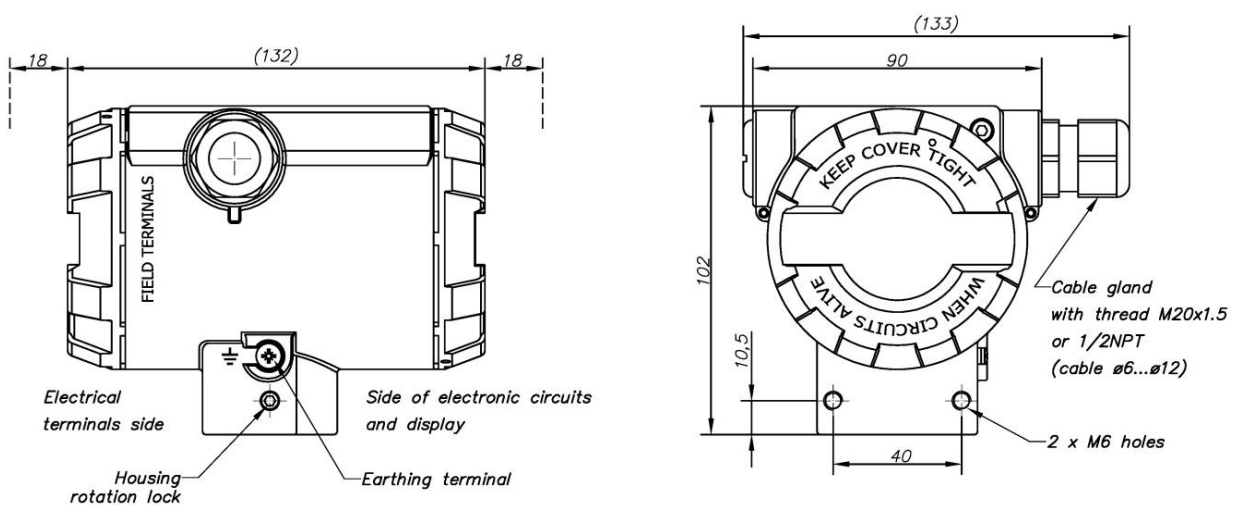
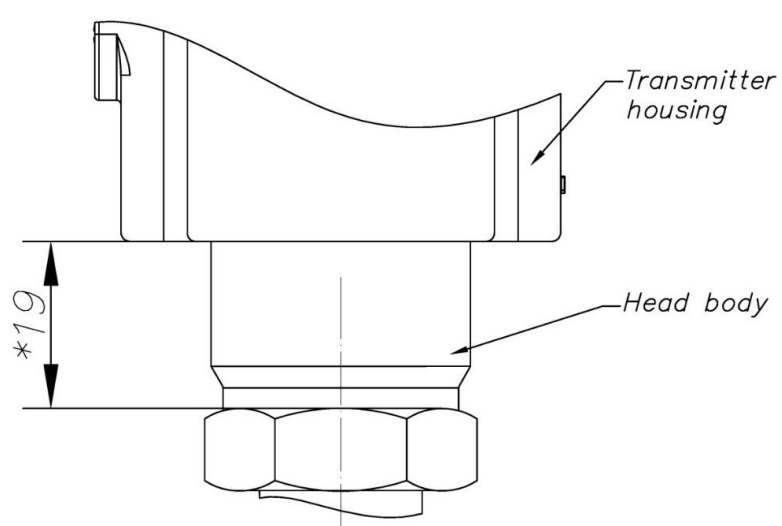


Figure 39. Overall dimensions of APC(R)-2000ALW Safety.



***33 mm for EXD version**

Figure 40. Diversification of the head body dimensions due to the versions.

12.2. Process connections

12.2.1. Specification of process connections for APC-2000ALW Safety

Type M (M20x1.5, $\varnothing 4$)

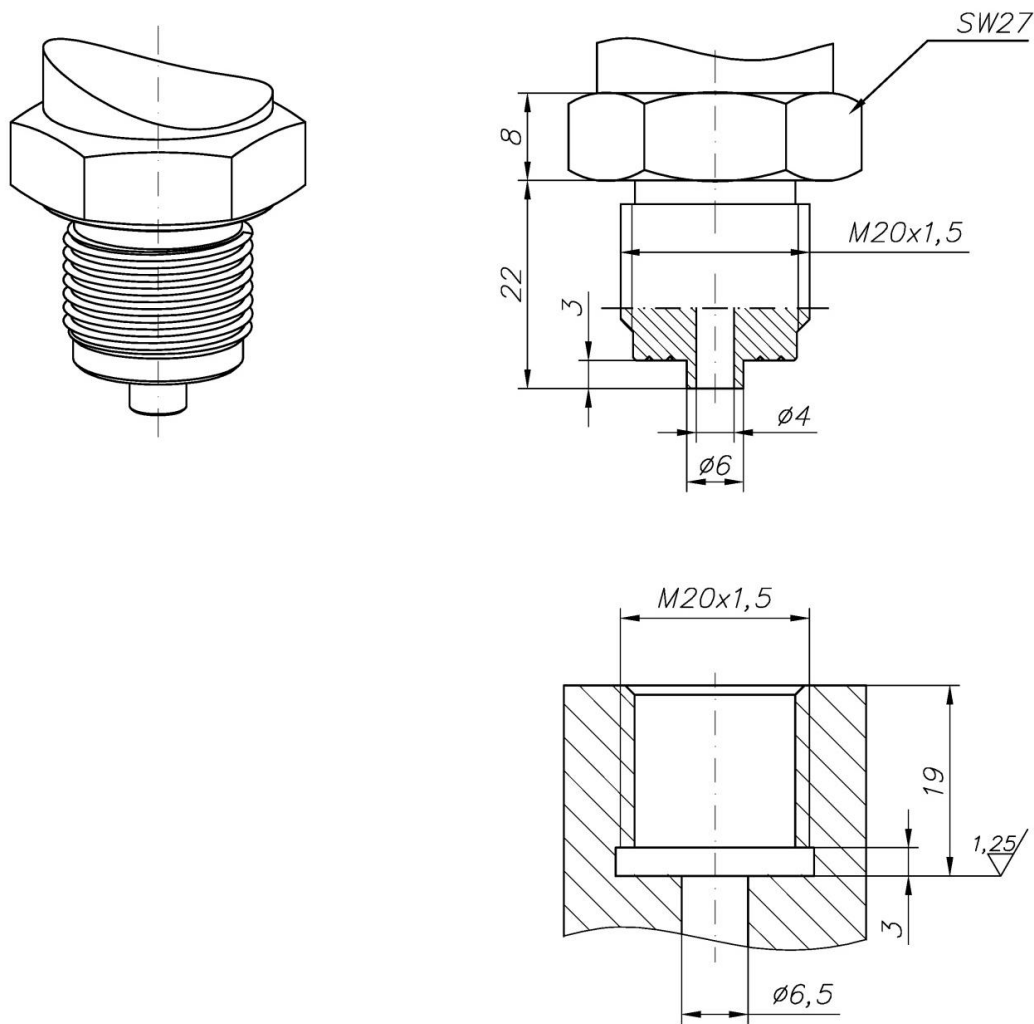


Figure 41. Type M connection (M20x1.5, $\varnothing 4$) with socket.

Material:

- standard version: steel 316L;
- special version: **Au** – gold-plated diaphragm; **Oxygen** – head suitable for oxygen measurement.

Return → Table 4. Transmitter versions, process connections.

Type P (M20x1.5, Ø12)

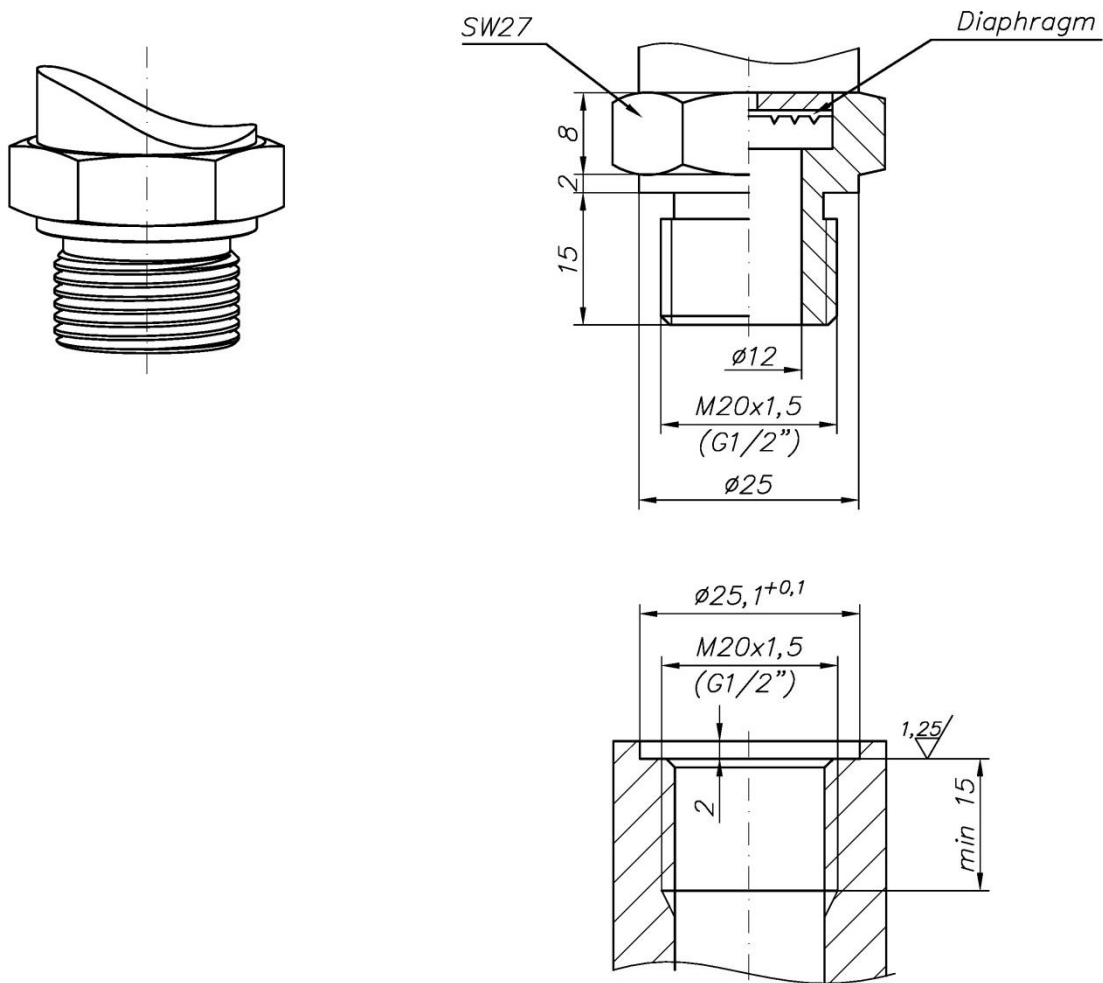


Figure 42. Type P connection (M20x1.5, Ø12) with socket.

Material:

- standard version: steel 316L;
- special version: **Hastelloy C 276**; **Oxygen** – head suitable for oxygen measurement.

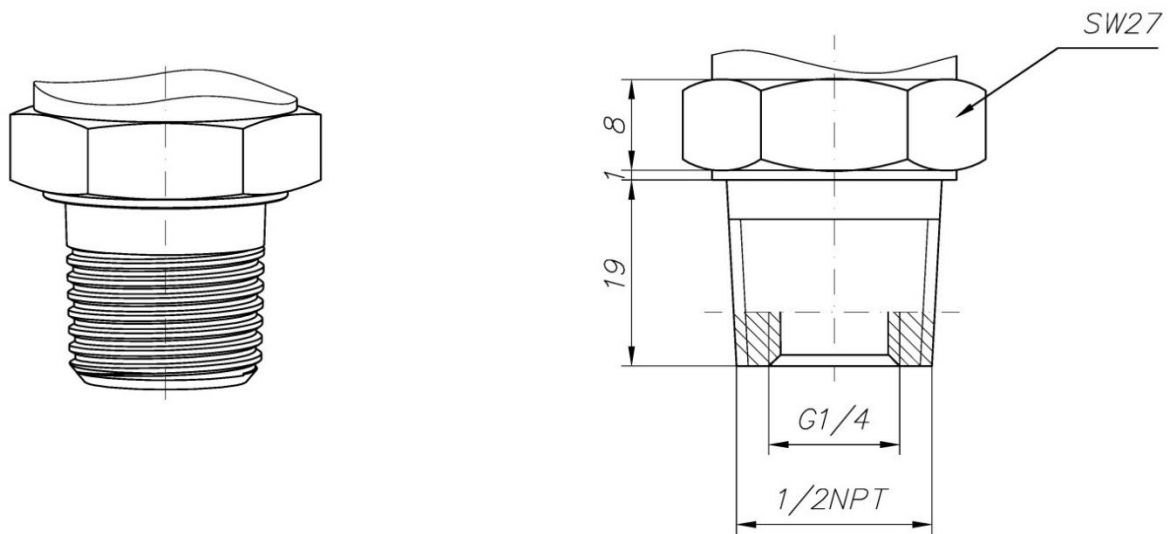
Type ½ NPT (ext. ½ NPT, inner G ¼")

Figure 43. Type ½ NPT connection (ext. ½ NPT, inner G ¼").

Material:

- standard version: steel 316L;
- special version: **Hastelloy C 276**.

Type G 1/2" (G 1/2", Ø4)

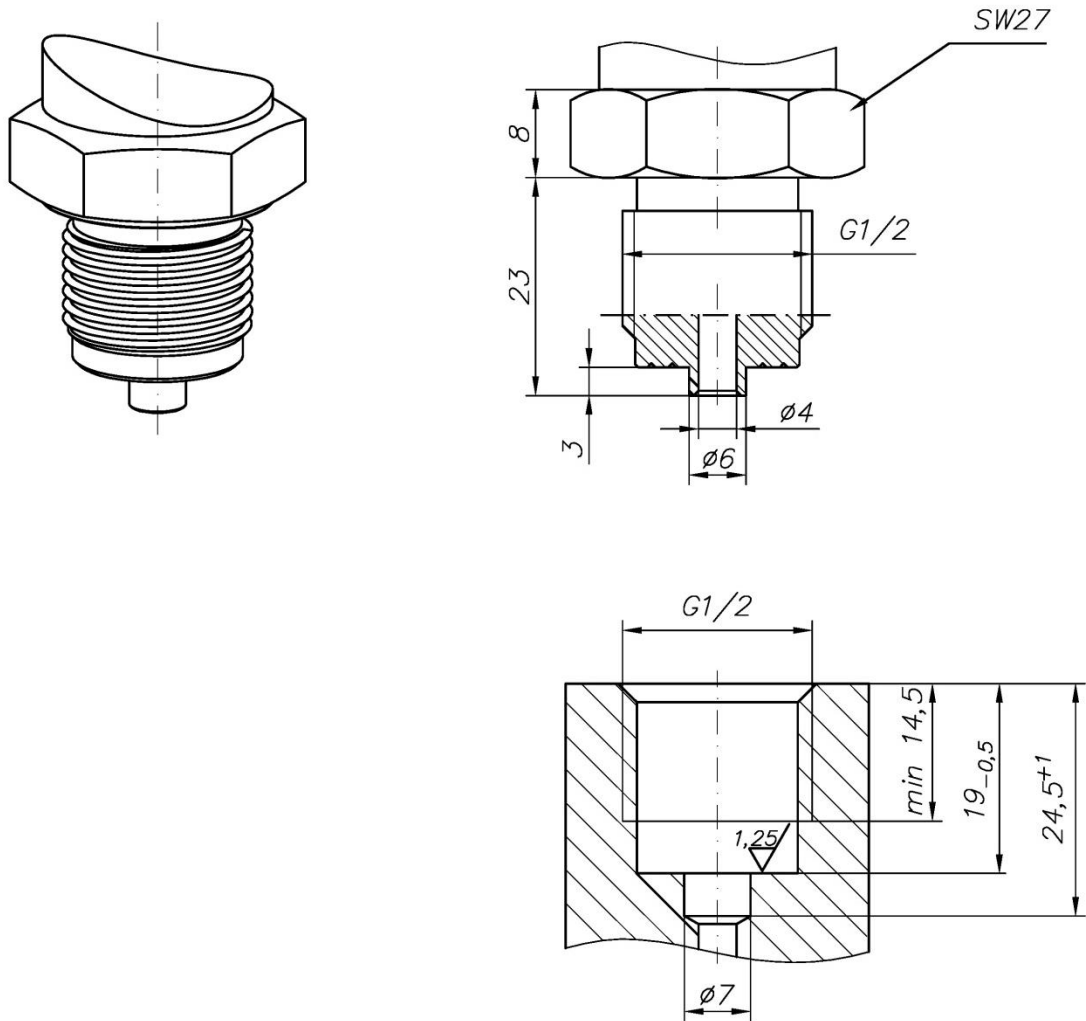


Figure 44. Type G 1/2" connection, Ø4 with socket.

Material:

- standard version: steel 316L;
- special version: **Au** – gold-plated diaphragm; **Oxygen** – head suitable for oxygen measurement.

Type GP (G ½, Ø12)

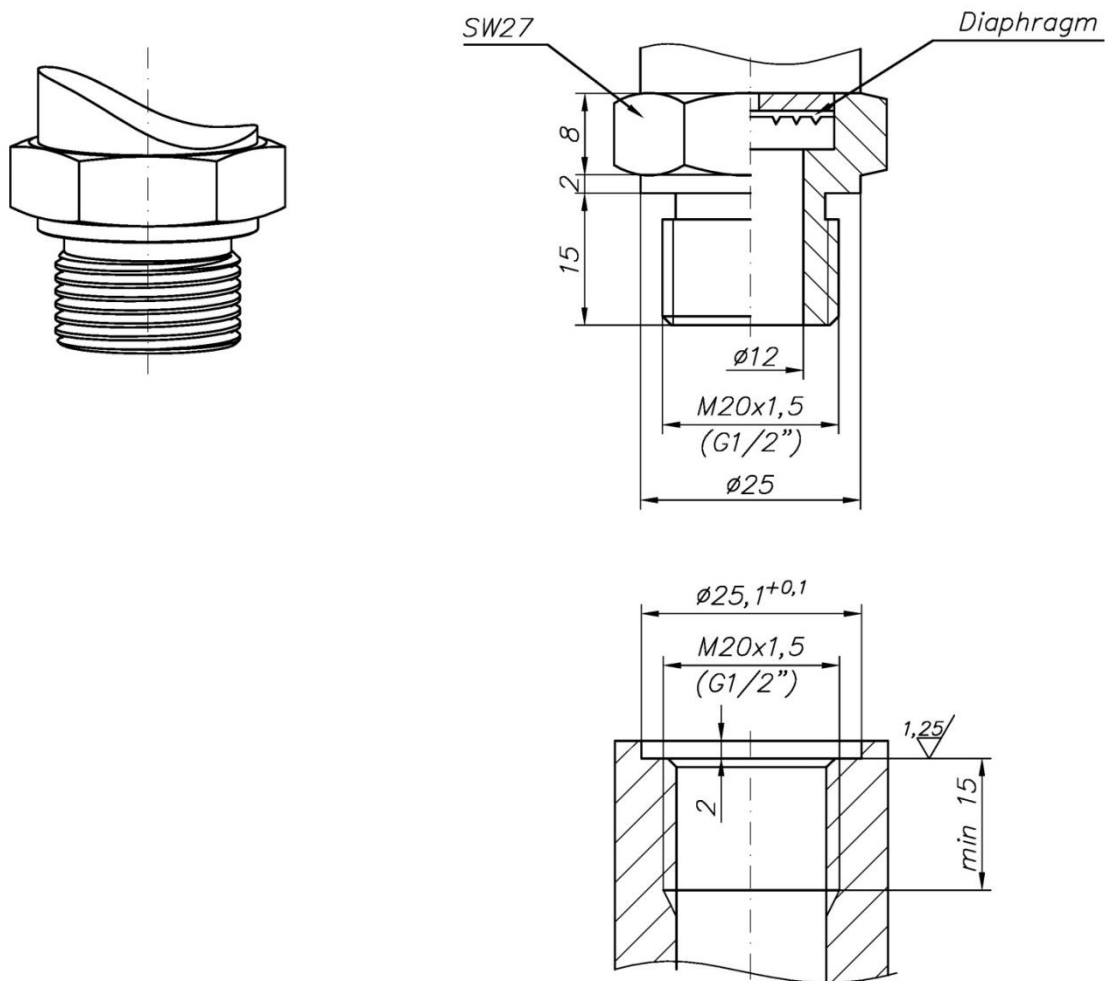


Figure 45. Type GP connection (G ½ , Ø12) with socket.

Material:

- standard version: steel 316L;
- special version: **Hastelloy C 276**; **Oxygen** – head suitable for oxygen measurement.

Type CM30x2 (M30x2)

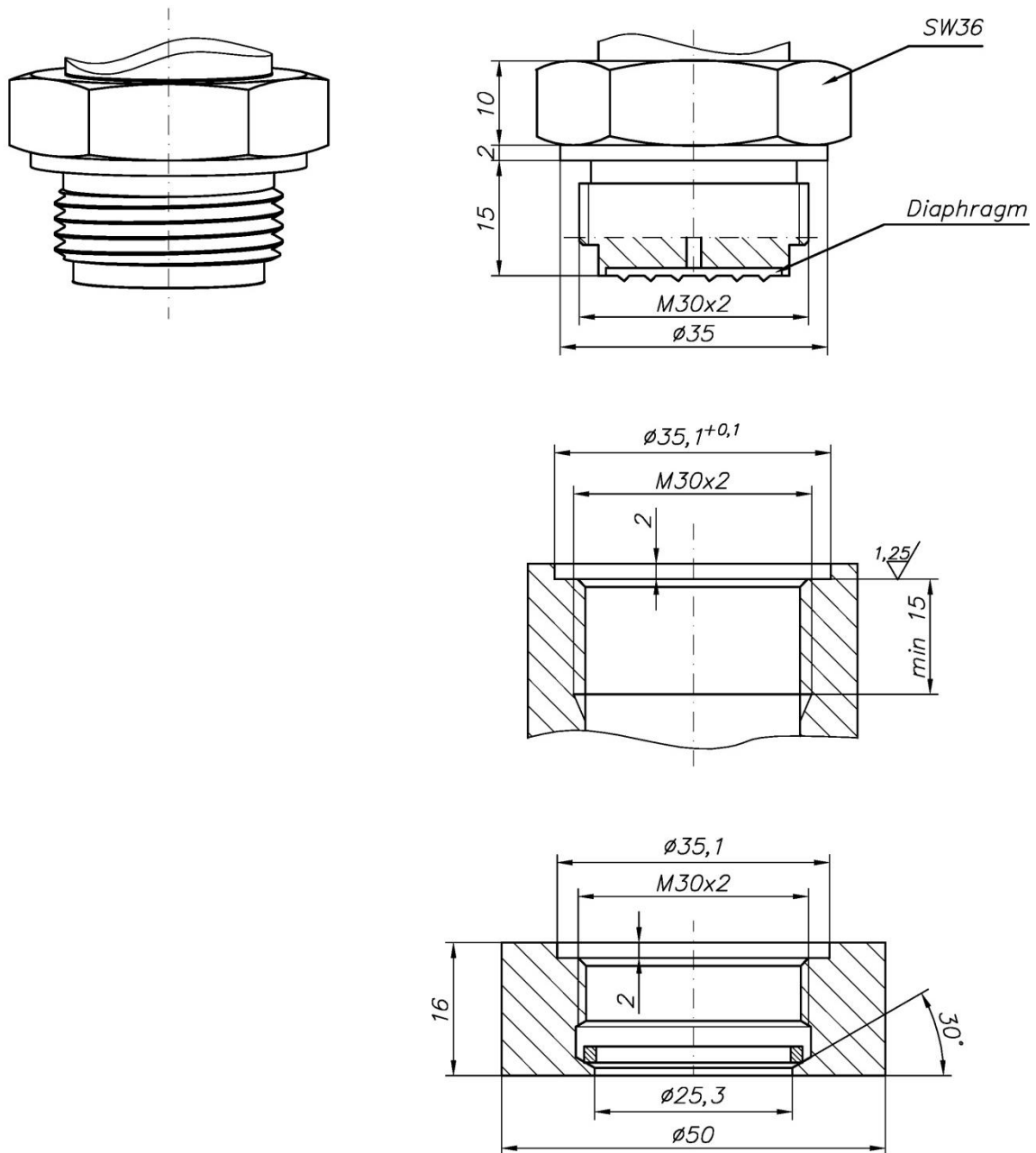


Figure 46. Type CM30x2 connection (M30x2) with socket and ring.

Material:

- standard version: steel 316L;
- special version: **Hastelloy C 276; Au** – gold-plated diaphragm;
- sealing: PTFE.

Type CG1 (G1")

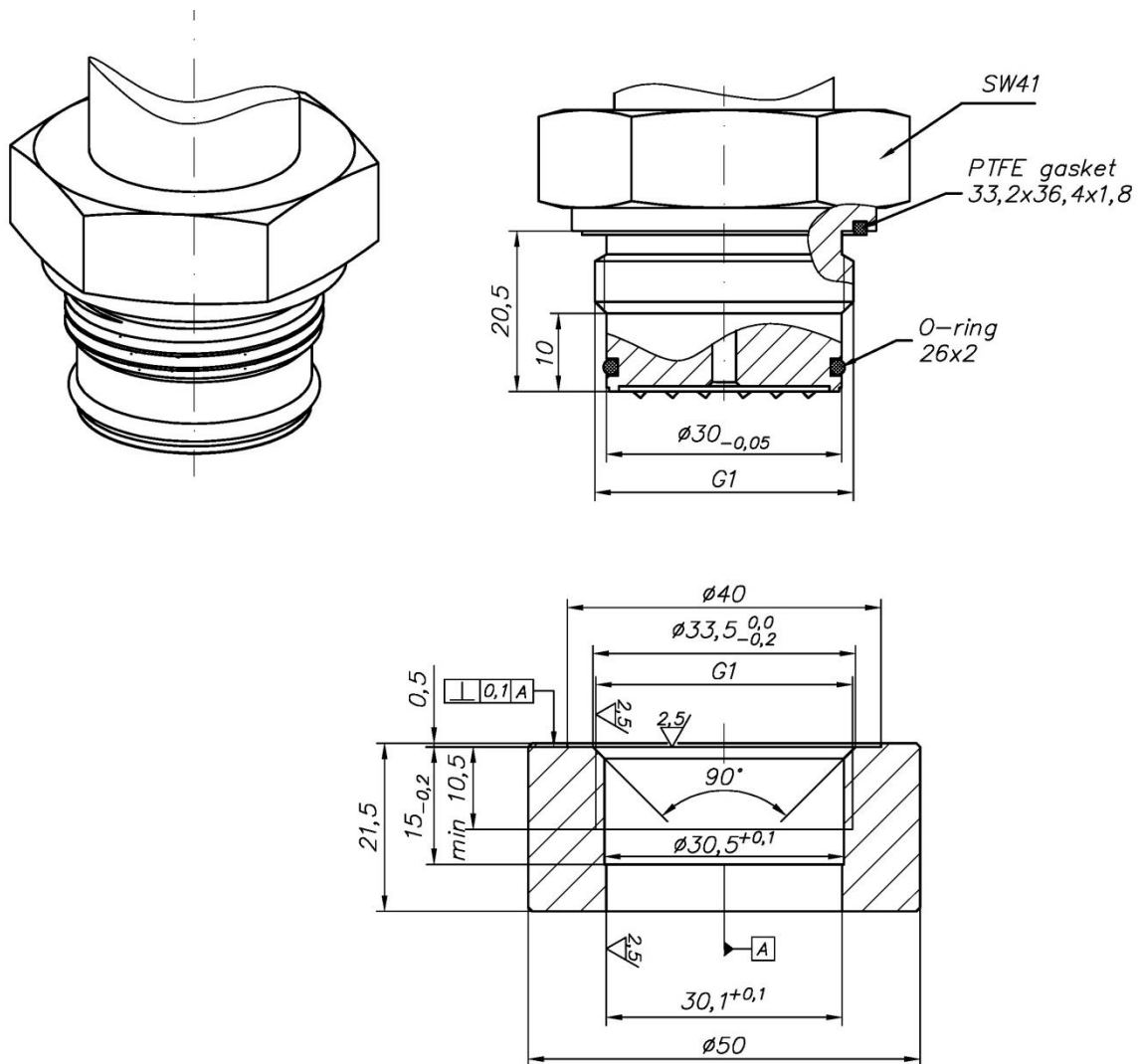


Figure 47. Type CG1 connection (G1") with socket.

Material:

- standard version: steel 316L;
- special version: **Au** – gold-plated diaphragm.

Type G ¼ (G ¼" Ø4)

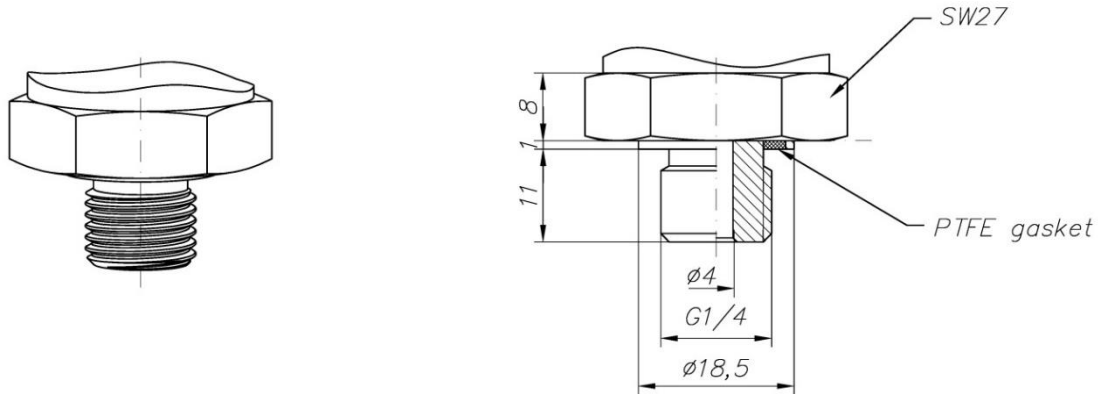


Figure 48. Type G ¼ connection Ø4.

Material – standard version: steel 316L.

Type CG ½ (G ½")

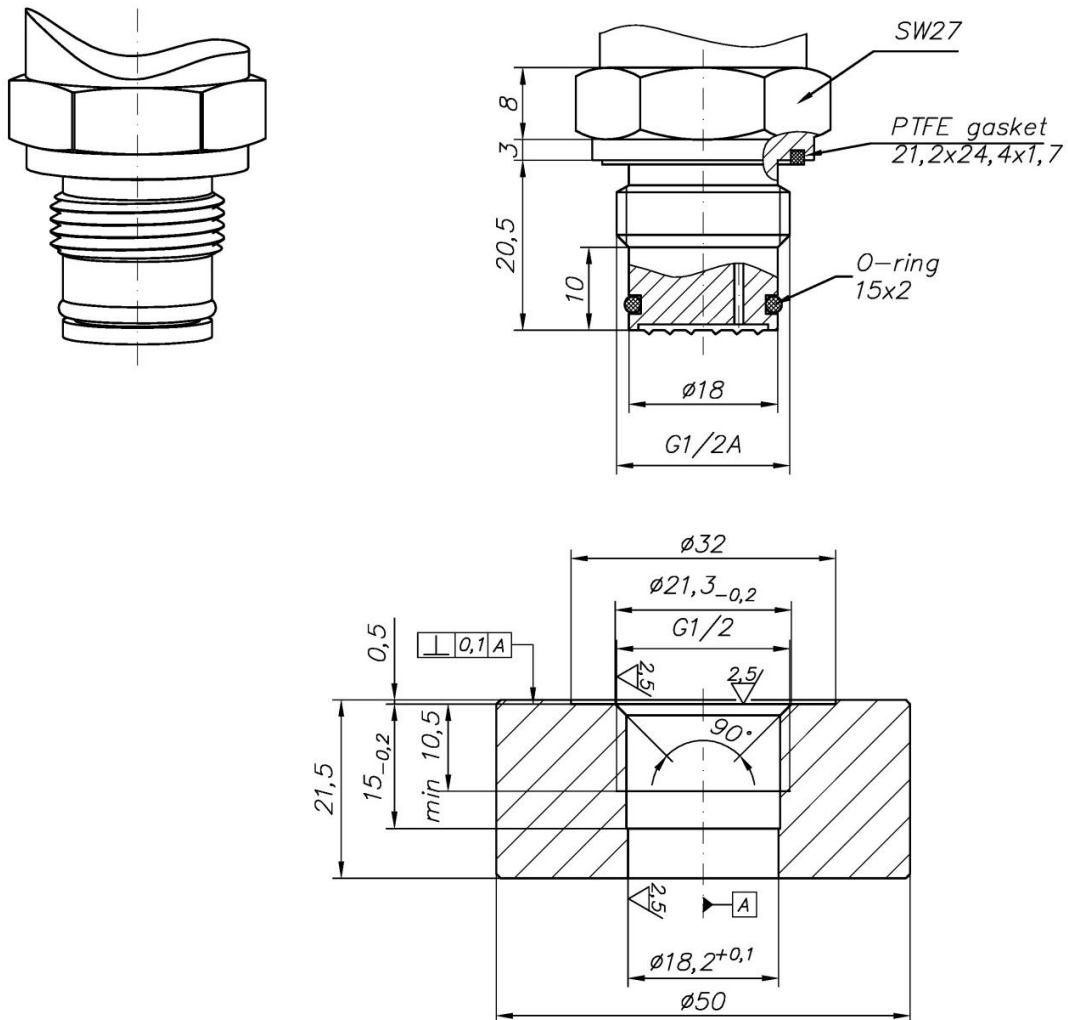


Figure 49. Type CG½ (connection G ½") with socket.

Material:

- standard version: steel 316L;
- special version: **Au** – gold-plated diaphragm.

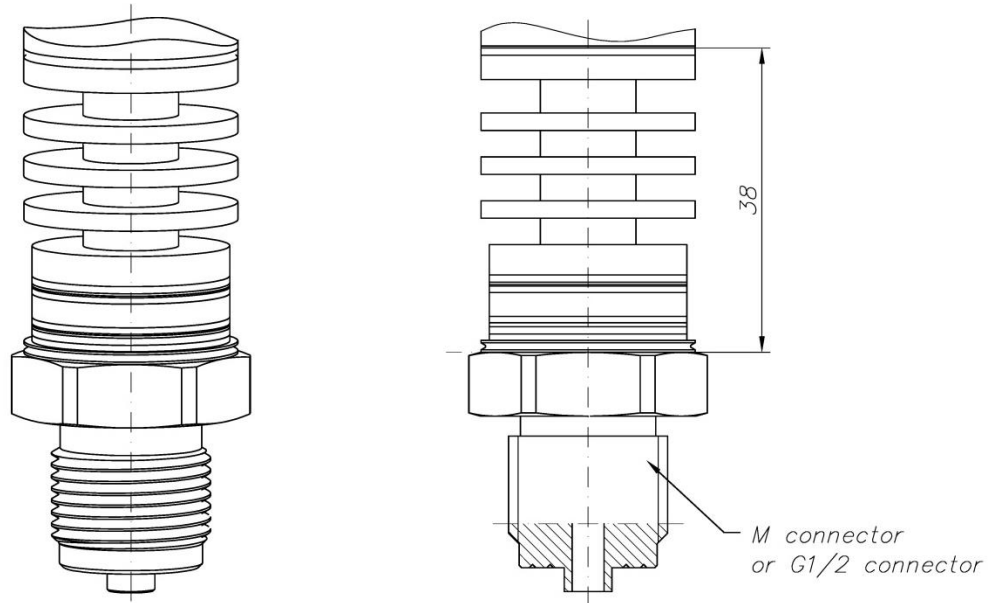
Type: RM radiator with M stub M20x1,5 / RG radiator with G ½ stub

Figure 50. Radiator with M20x1,5 or G ½ stub.

Material – standard version: steel 316L.

12.2.2. **Adapters**

Material:

- Steel 316L
- Brass

- **G ½"**

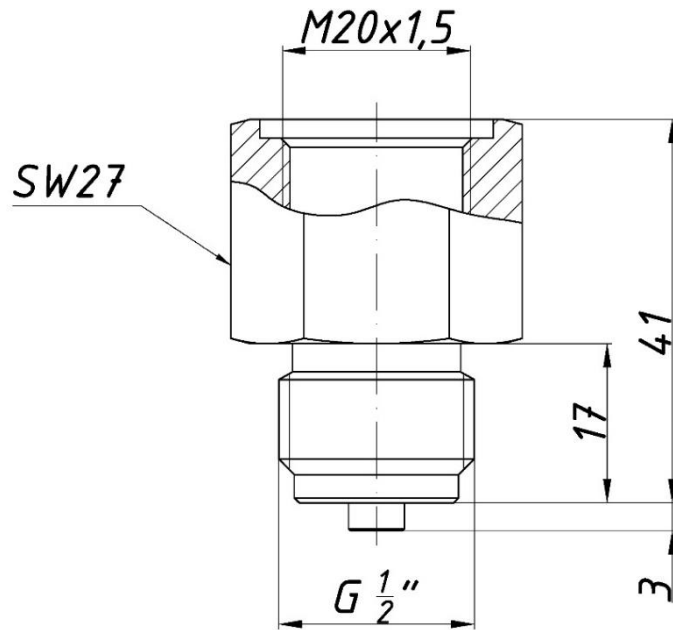


Figure 51. Adapter G ½".

- **R ½"**

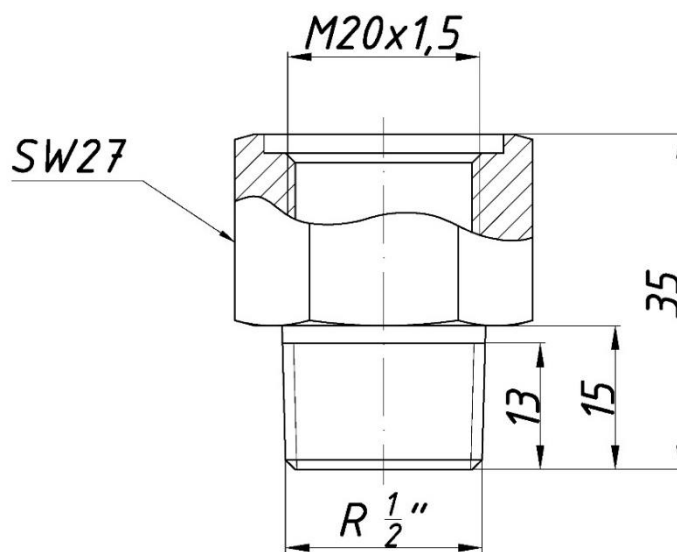


Figure 52. Adapter R ½".

- ¼ NPT

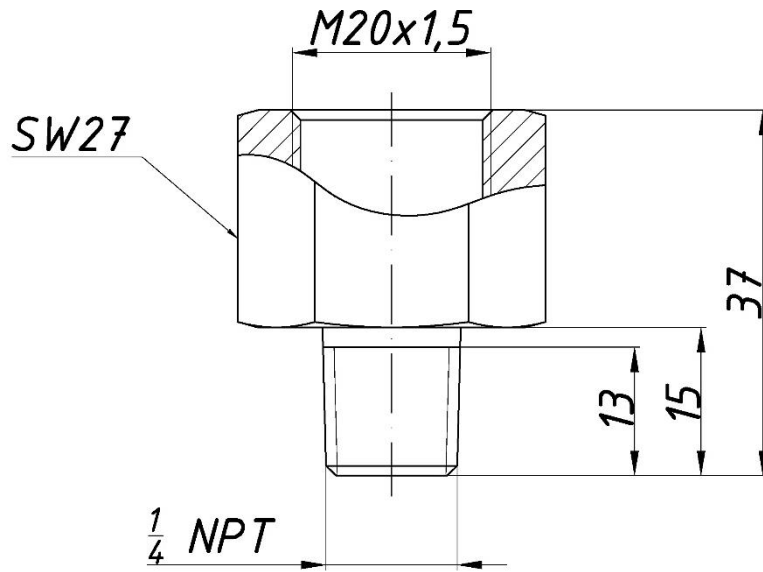


Figure 53. Adapter ¼ NPT.

- G ¼"

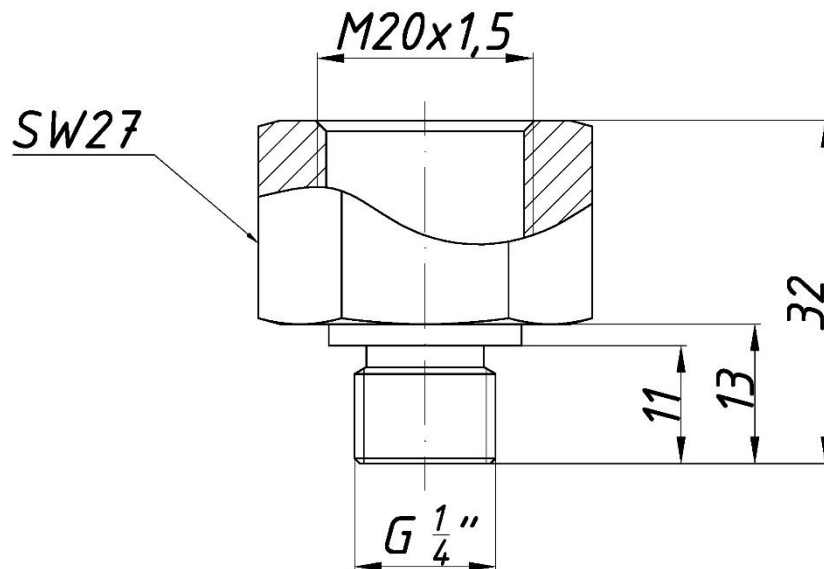


Figure 54. Adapter G ¼".

- ½ NPT F

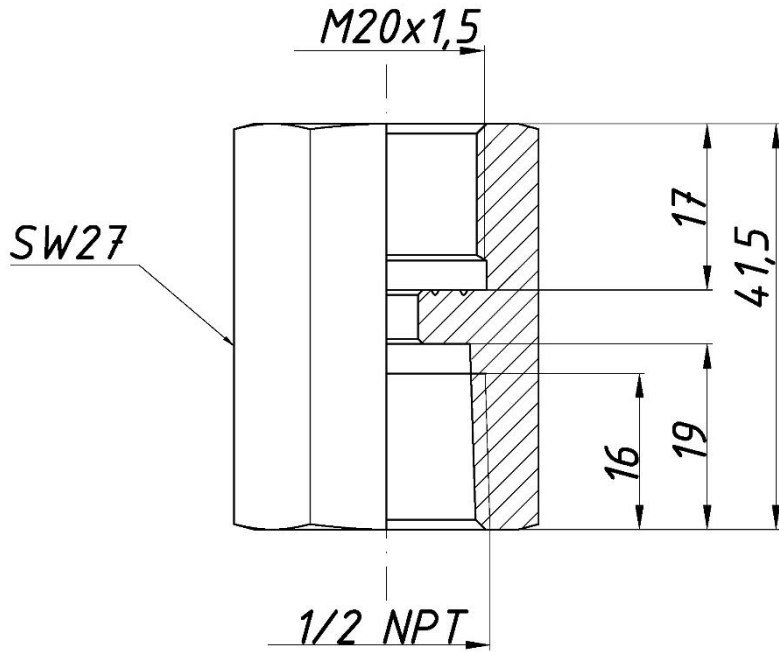


Figure 55. Adapter ½ NPT F.

- ¼ NPT F

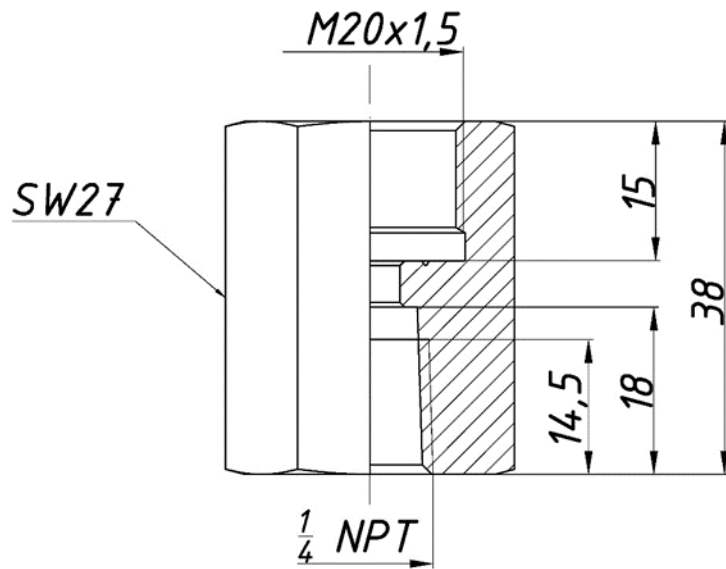
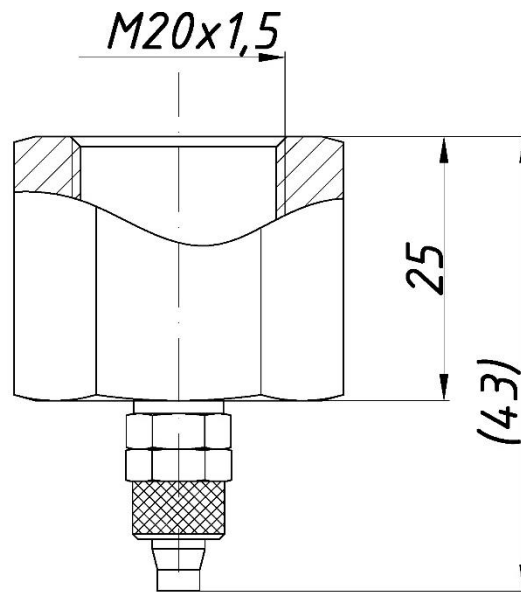


Figure 56. Adapter ¼ NPT F.

- Elastic tube

Figure 57. Elastic tube $\varnothing 6 \times 1$.

12.2.3. Specification of process connections for APR-2000ALW Safety

Type P

Process connector
with female thread 1/4 NPT



Process connector
with male thread M20x1.5

Process connector
with male thread G1/2



Process connector
with male thread 1/2 NPT

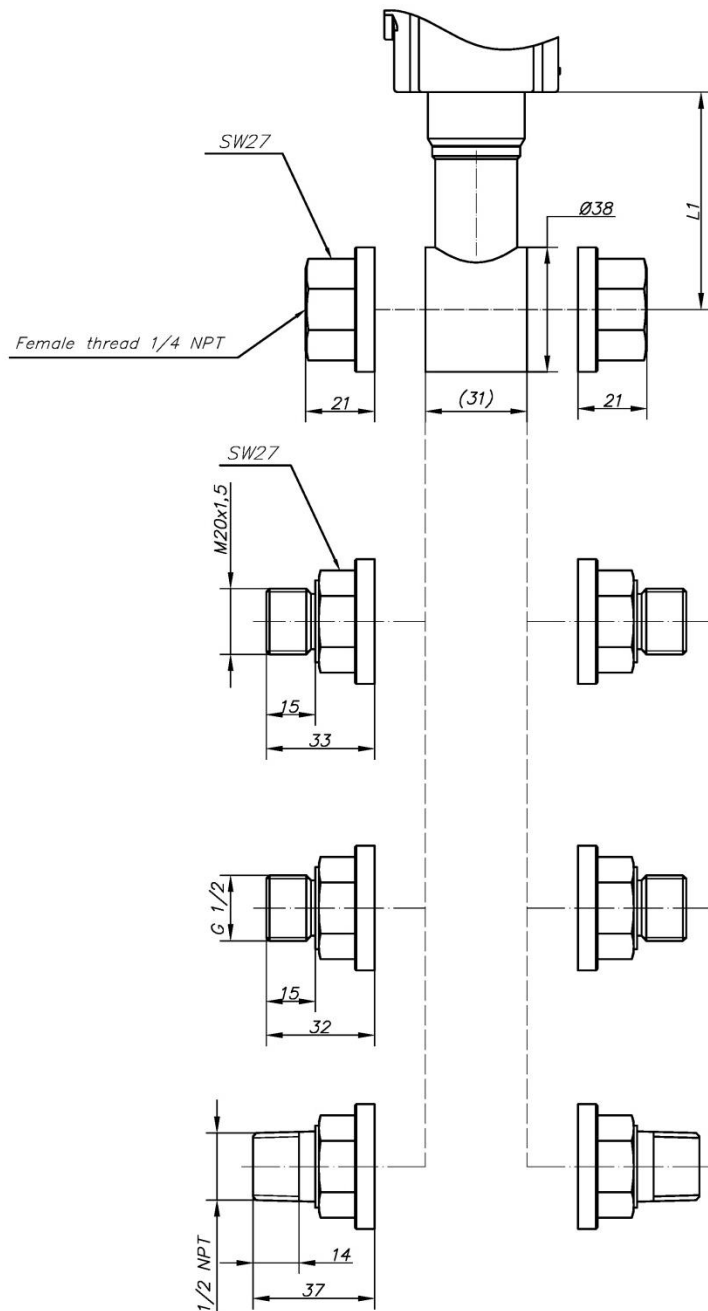


Figure 58. Type P connection for APR-2000ALW Safety.

* L1 dimension due to different values depending on the version is shown in [Table 30.](#)

Material:

- standard version: steel 316L;
- special version: Au.

Return [→ Table 4. Transmitter versions, process connections.](#)

Type C

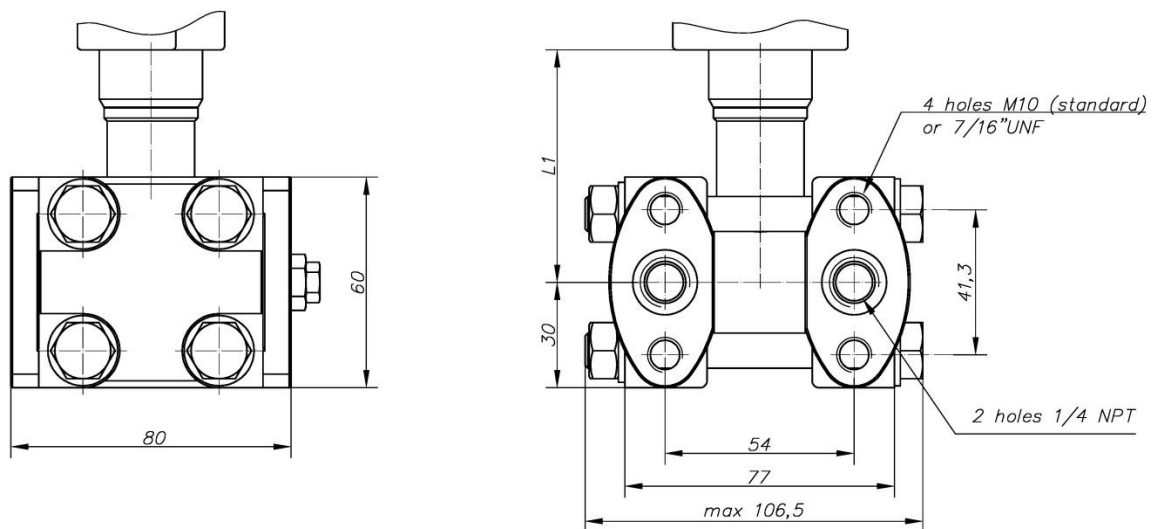


Figure 59. Overall dimensions of type C connection.

* L1 dimension due to different values depending on the version is shown in [Table 30](#).

Material – standard version: steel 316L.

Type CR

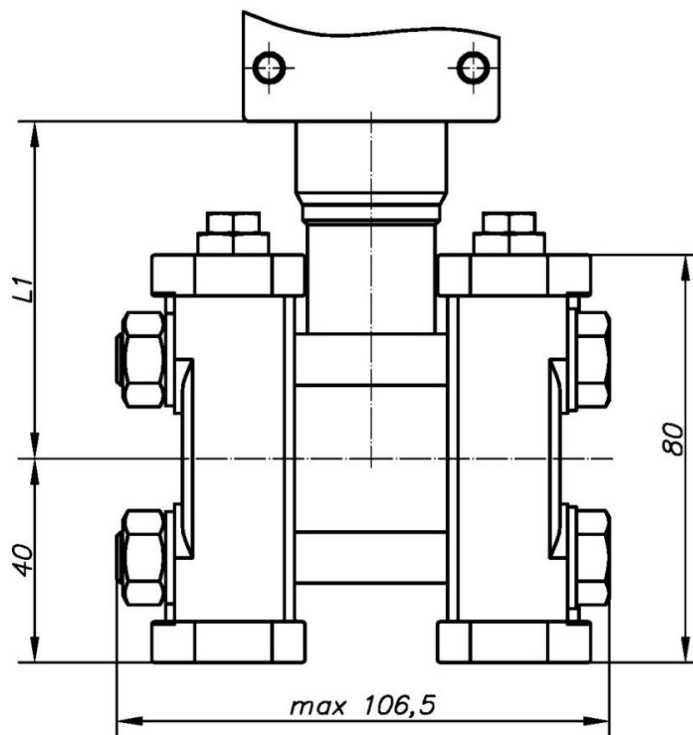
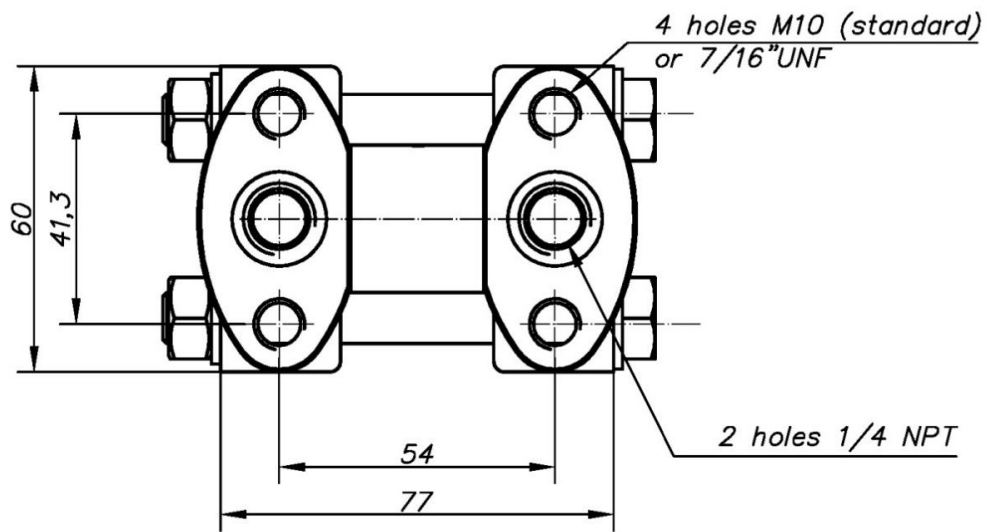


Figure 60. Overall dimensions of CR type connection.

* L1 dimension due to different values depending on the version is shown in [Table 30](#).

Material – standard version: steel 316L.

Connection	Size	Version N	Version Exd	Version HS	HS Exd version
C	L1 [mm]	66.5	80.5	78.5	92.5
CR					
Two-side process connection:					
P (M20x1.5) G ½ ¼ NPT F ½ NPT M					

Table 30. Diversification of the head height depending on the type of connection and version.



12.2.4. Process connections for measuring low gas pressure

PCV

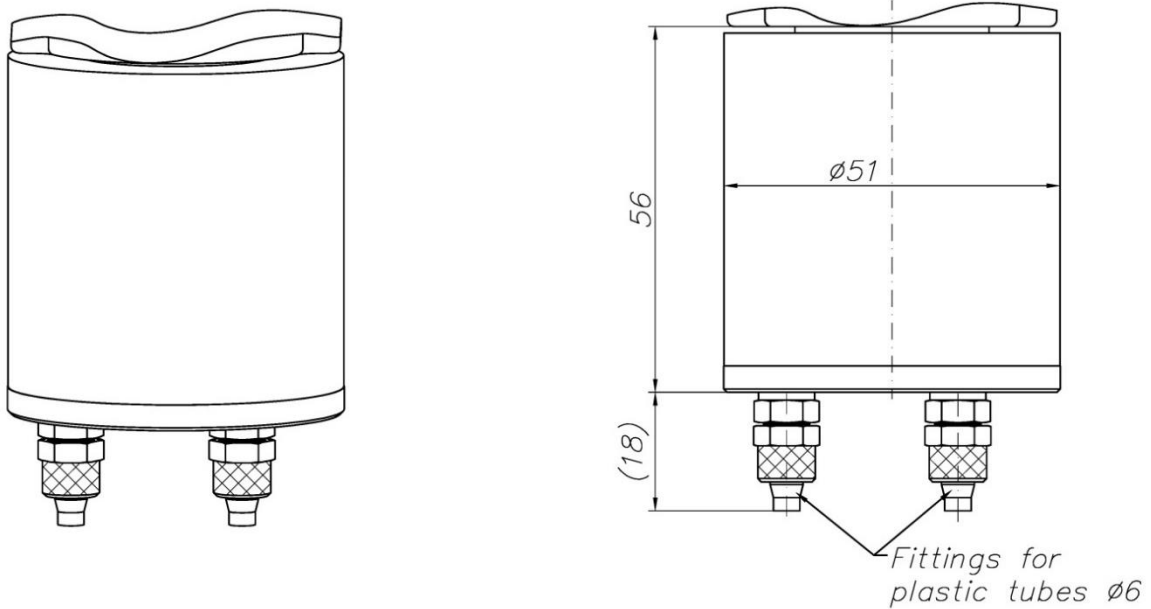


Figure 61. Process connection PCV type.

Return → Table 4. Transmitter versions, process connections.

P GP

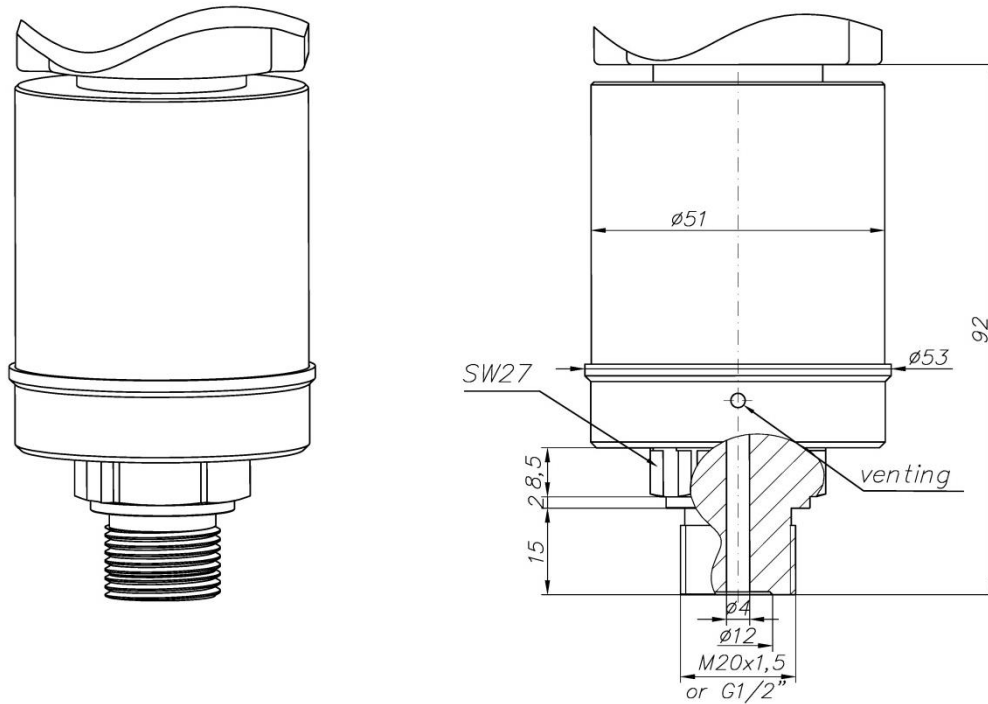


Figure 62. Process connection P or GP for measuring low pressure gases.

HS

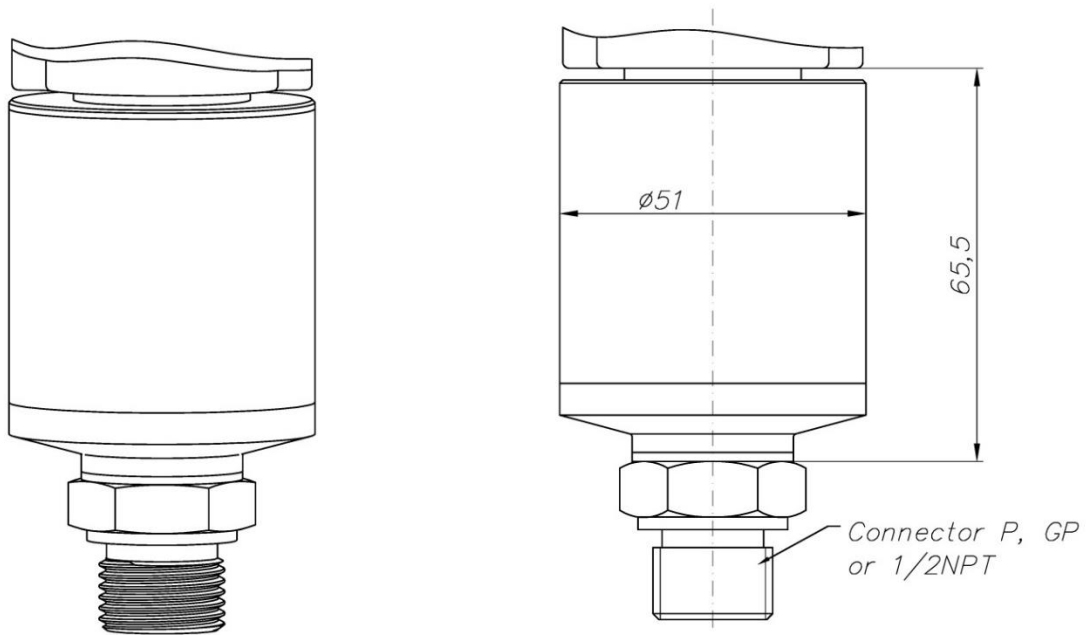


Figure 63. Process connection HS.

Adapter for block valve ¼ NPT

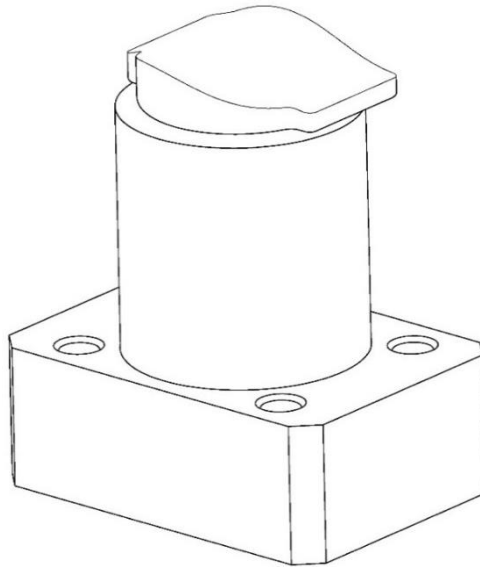


Figure 64. Block valve adapter ¼ NPT for low pressure gases measurement- view in isometry.

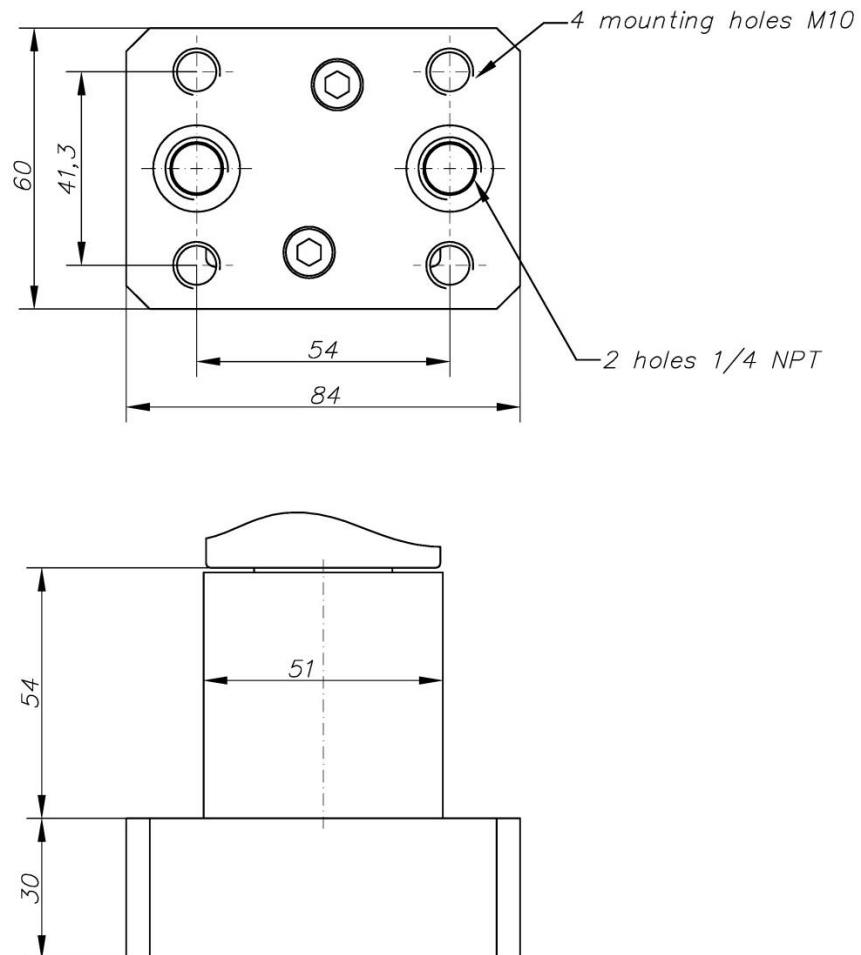
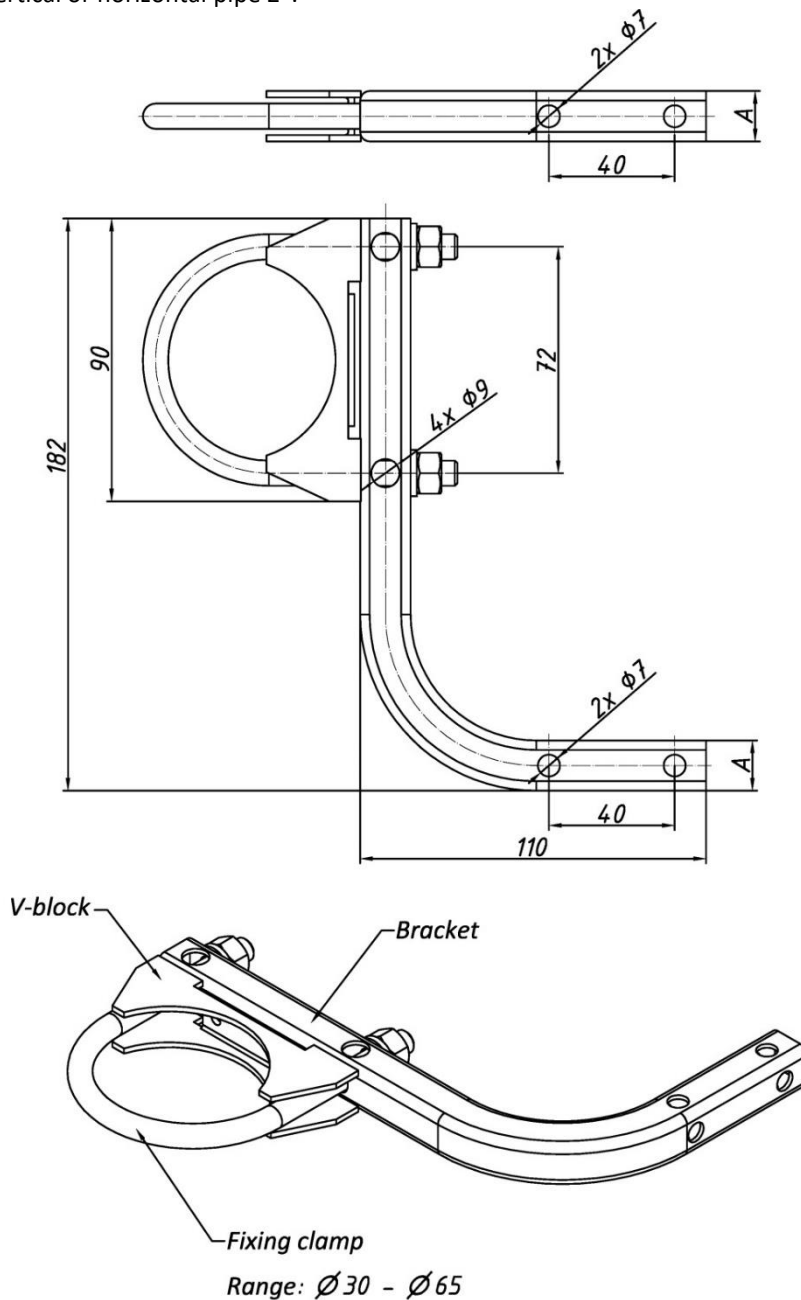


Figure 65. Overall dimension of block valve adapter ¼ NPT for low pressure gases measurement.

12.3. Specification of mounting brackets

“AL” bracket for transmitters APC-2000ALW Safety.

A universal bracket for transmitters APC-2000ALW Safety allows to mount them in any position on the construction and vertical or horizontal pipe 2”.



A = 16 Bracket AL (galvanized)
A = 15 Bracket AL (stainless steel)

Figure 66. Overall dimensions of the “AL” mounting bracket in galvanized and stainless steel versions.

Bracket C-2 for transmitters APR-2000ALW Safety

Bracket for fixing of differential pressure transmitters with type C connection to pipe 2" or walls.

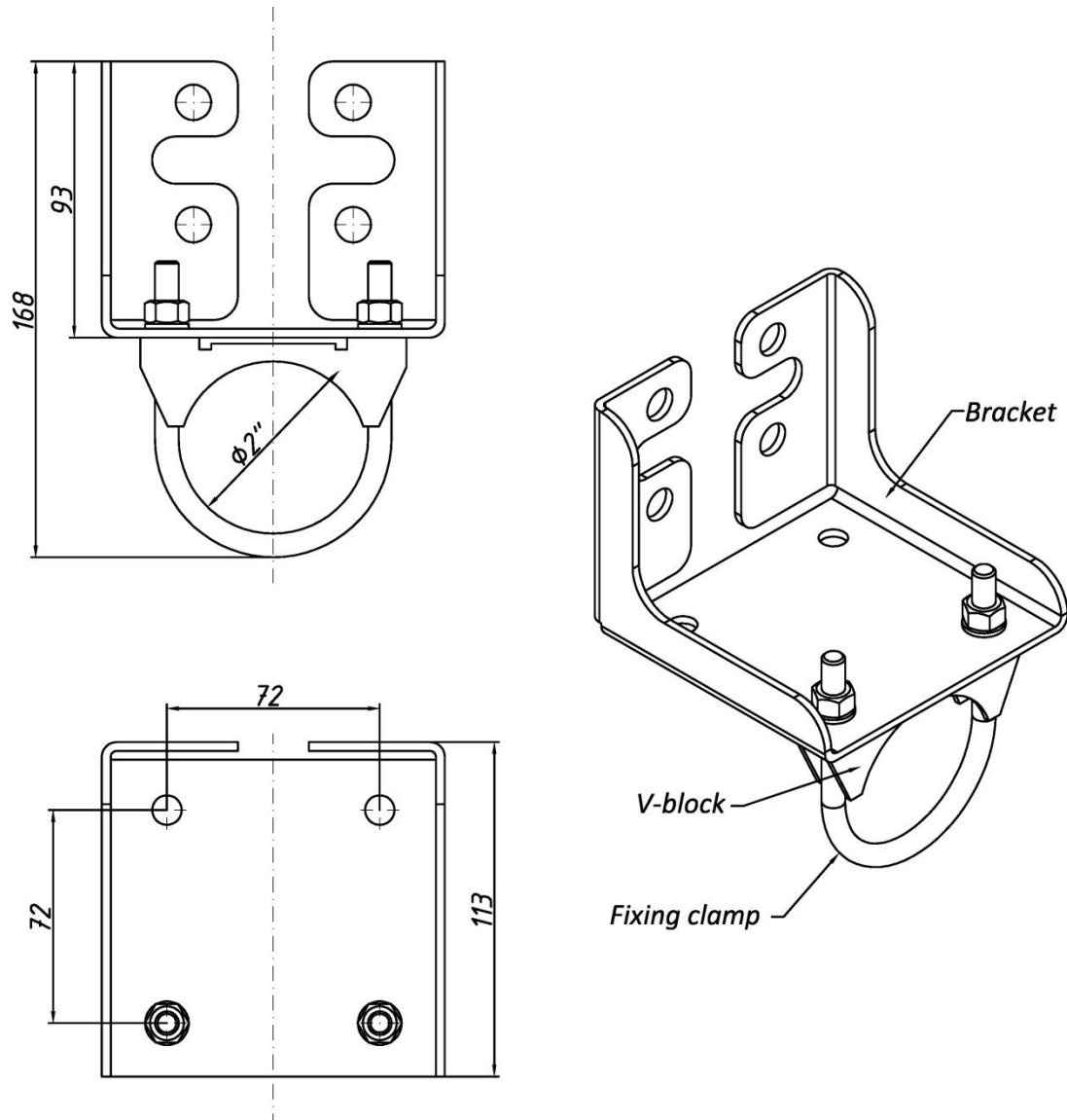


Figure 67. Mounting bracket C-2 for transmitters APR-2000ALW Safety.

Bracket $\varnothing 25$ for transmitters APR-2000ALW Safety.

A set for fixing differential pressure transmitters APR-2000ALW Safety with type P stub on a vertical or horizontal pipe $\varnothing 25$.

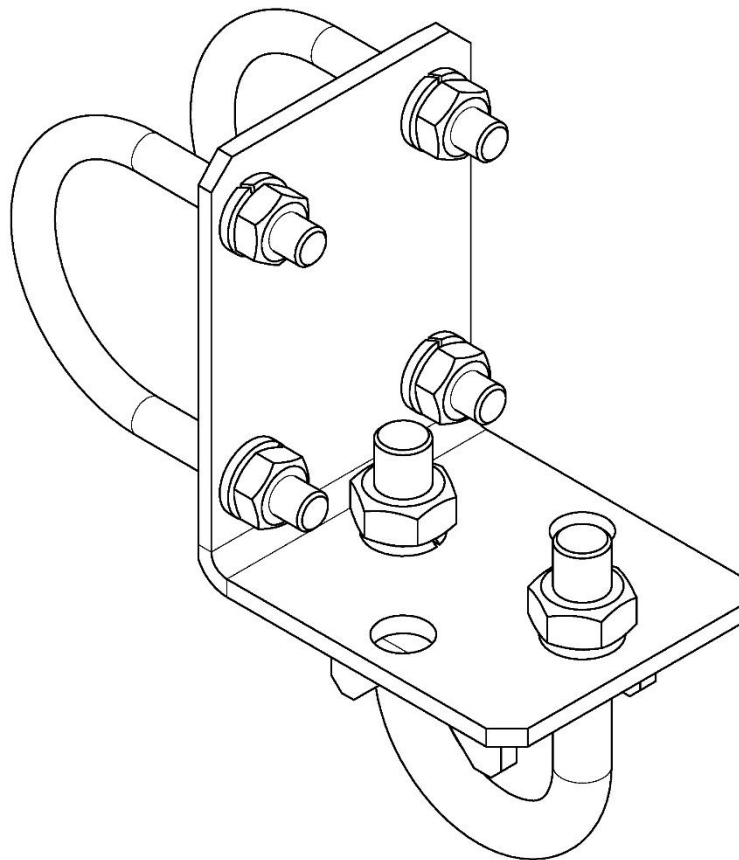


Figure 68. Mounting bracket $\varnothing 25$.

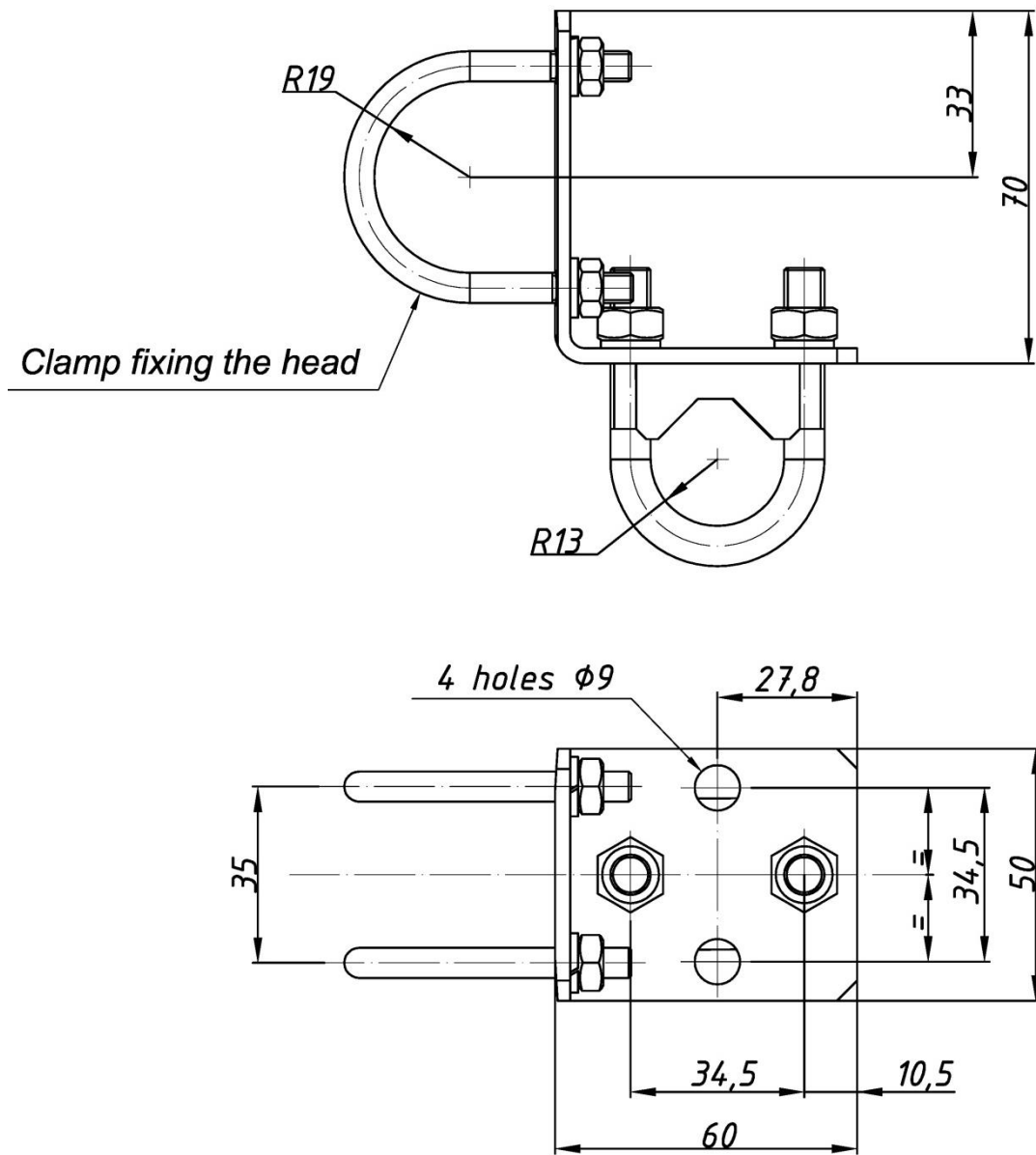


Figure 69. Overall dimensions of the mounting bracket $\phi 25$.

12.4. Specification of materials not coming into contact with the process

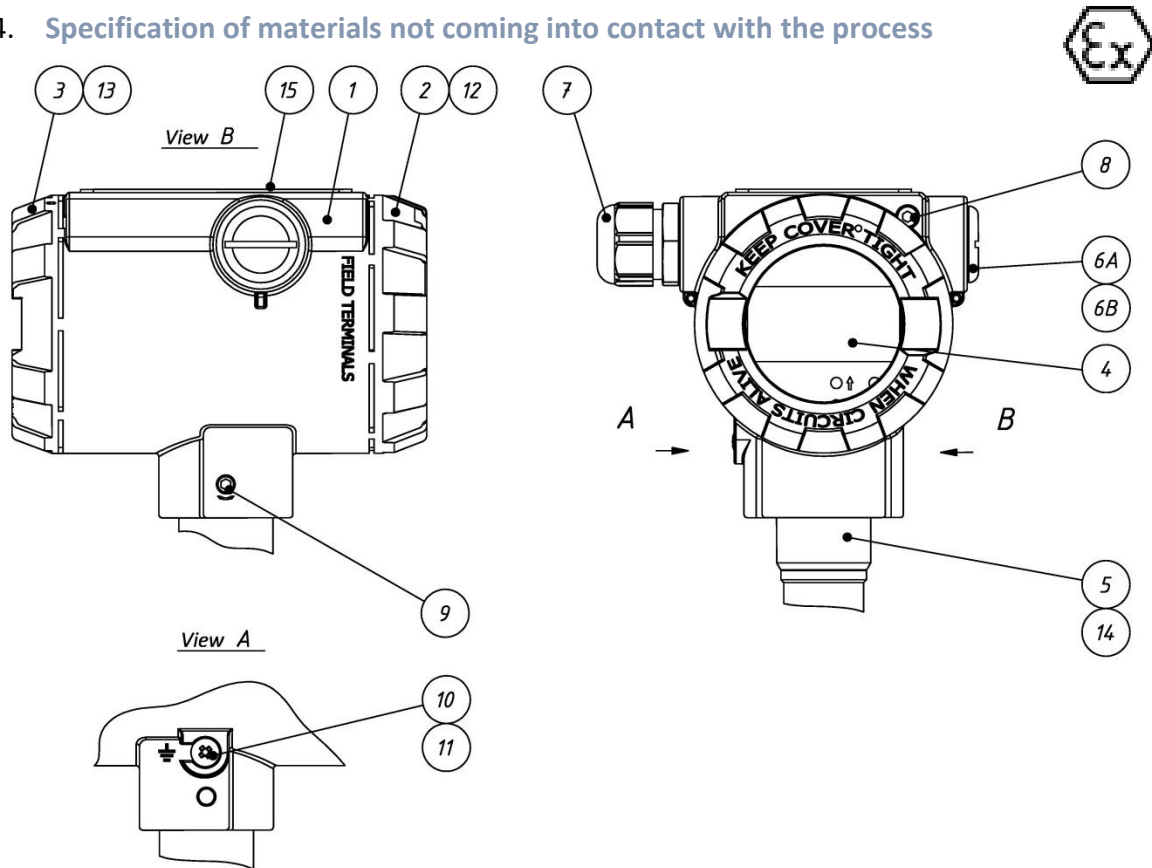


Figure 70. Specification of materials not coming into contact with the process.

1. Transmitter housing.
2. Full cover.
3. Cover with sight glass.
4. Glass window.
5. Head body.
6. A. Plug.
B. Plug (EXD).
7. Gland.
8. Cover locking bolt.
9. Housing rotation locking screw.
10. Earthing bolt.
11. Earthing washer.
12. Full cover O-ring.
13. Sight glass cover O-ring.
14. Head body O-ring.
15. Nameplate.

12.5. Specification of materials coming into contact with the process

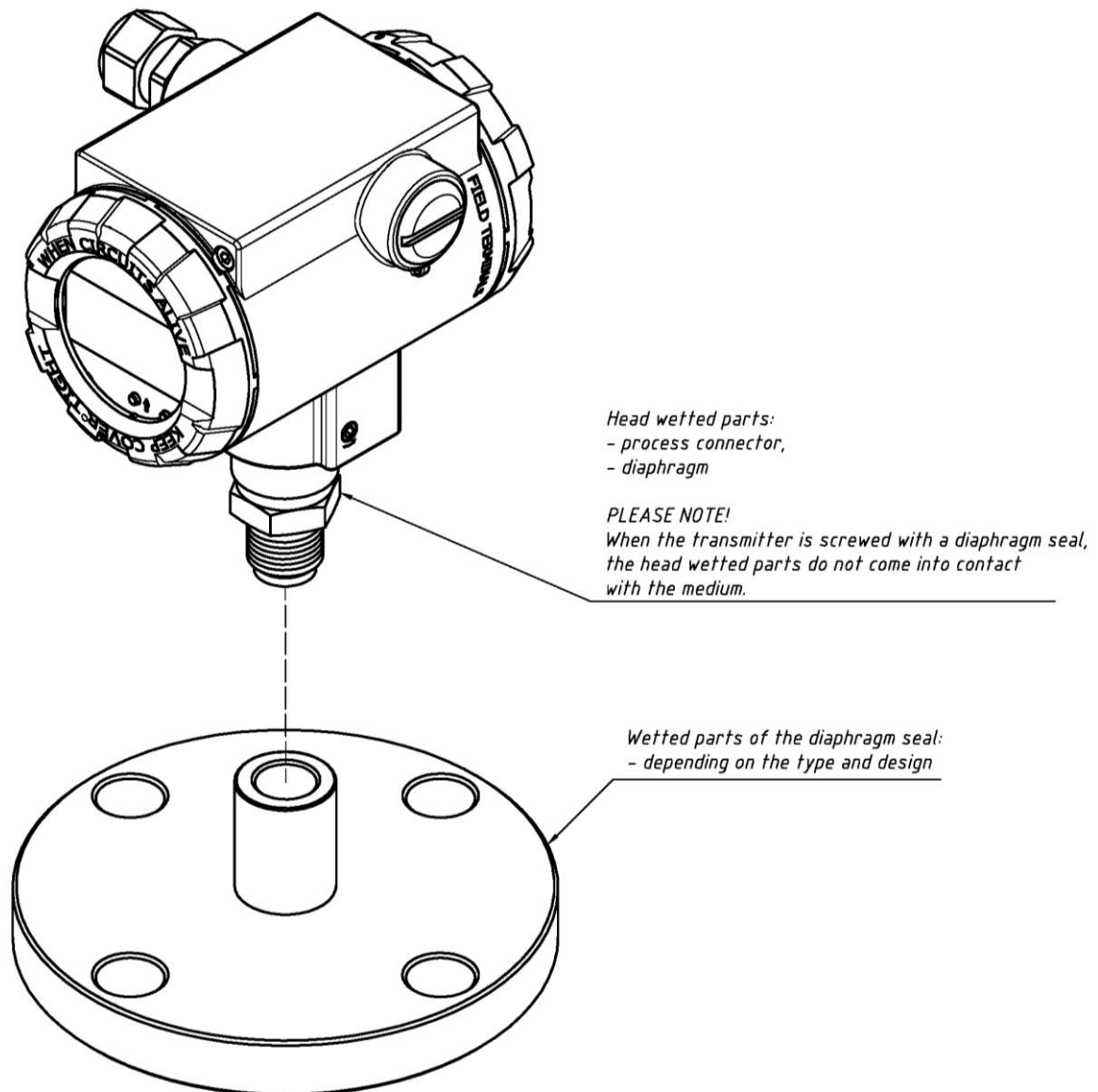


Figure 71. Specification of materials coming into contact with the process for APC-2000ALW Safety.

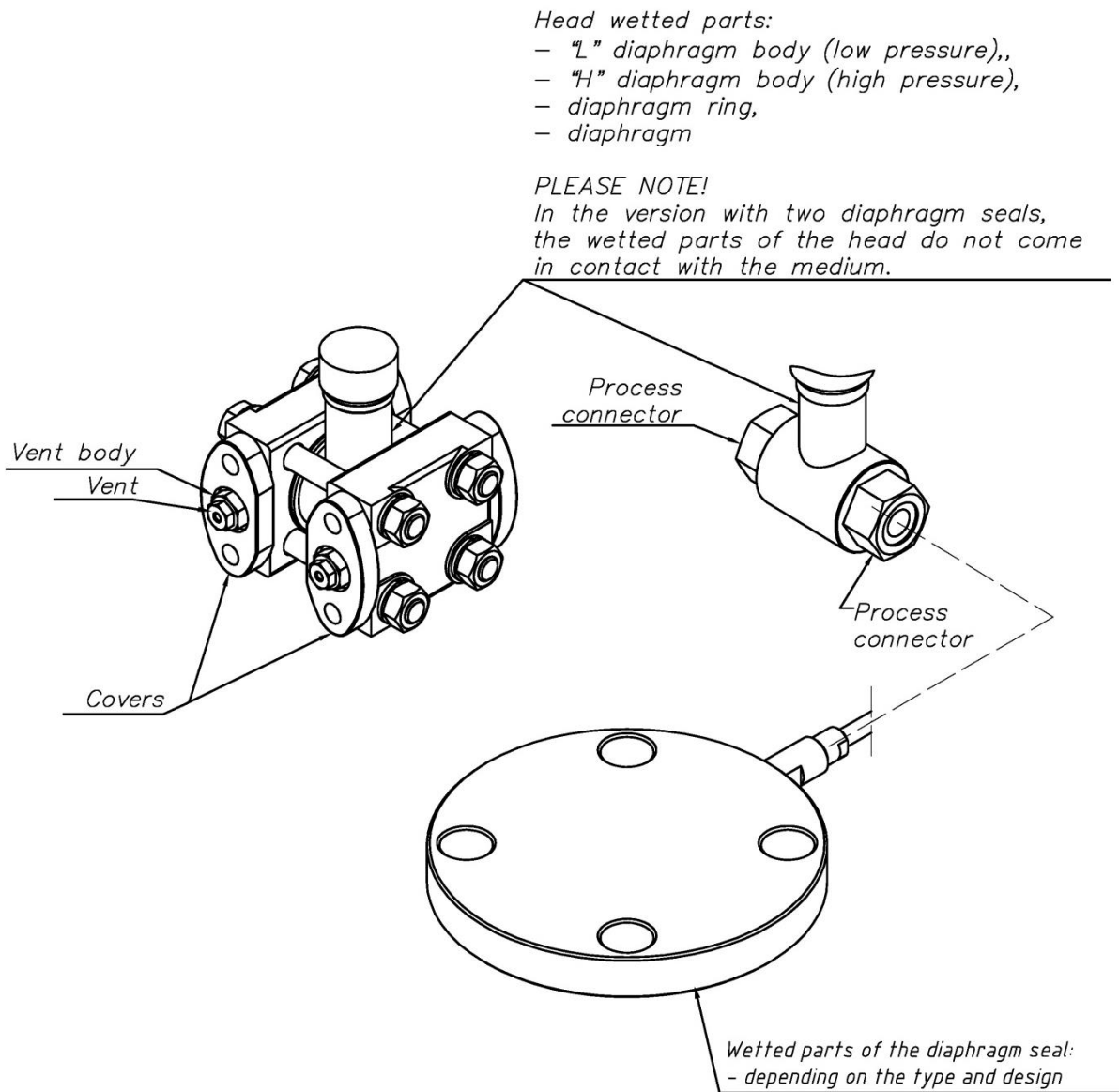


Figure 72. Specification of materials coming into contact with the process for APR-2000ALW Safety.

13. Operation

13.1. Change of setpoints, parameterisation, read-out of variables, diagnostics

The scope of the transmitter's operations include read-out of the settings, change of the settings, diagnostic read-outs. Some of the setpoint change functions (parameterisation) are available in local MENU with the use of the local keyboard. Almost all the functions (except for activation and deactivation of the MID mode) are available via digital HART communications. The following table describes the functions available in local MENU supported by local keypad and functions available via digital HART communications.

APC(R)-2000ALW Safety. Change of setpoints, parameterisation, read-out of variables, diagnostics		
HART Command No/Function	Local keypad	HART communication
CMD_0 Unique identifier read-out. <i>Read unique identifier.</i>	No.	Yes.
CMD_1 Read-out of basic process variable. <i>Read primary variable.</i>	Yes (LCD2).	Yes.
CMD_2 Read-out of current and setpoints percentage. <i>Read current and percent of range.</i>	Yes (LCD1)	Yes.
CMD_3 Read-out of current and 4 variables: PV, SV, TV, FV. <i>Read current and four dynamics variables.</i>	Yes (LCD2). Except for ADC temperature.	Yes.
CMD_6 Call address entry. <i>Write pooling address.</i>	No.	Yes.
CMD_11 Read-out of unique TAG-related identifier. <i>Read unique identifier associated with TAG.</i>	No.	Yes.
CMD_12 Message read-out. <i>Read message.</i>	No.	Yes.
CMD_13 Read-out of Tag, Descriptor, Date. <i>Read Tag, Descriptor, Date.</i>	No.	Yes.
CMD_14 Read-out of information related to the PV sensor. <i>Read PV sensor information.</i>	No.	Yes.
CMD_15 Read-out of output parameters. <i>CMD_15 Read output information.</i>	No.	Yes.
CMD_16 Read-out of device installation number. <i>Read final Assembly Number.</i>	No.	Yes.
CMD_17 Message entry. <i>Write message.</i>	No.	Yes.

APC(R)-2000ALW Safety. Change of setpoints, parameterisation, read-out of variables, diagnostics		
HART Command No/Function	Local keypad	HART communication
CMD_18 Entry of Tag, Descriptor, Date. <i>Write tag, descriptor, date.</i>	No.	Yes.
CMD_19 Entry of device installation number. <i>Write final assembly number.</i>	No.	Yes.
CMD_34 Damping value entry. <i>Write PV damping value.</i>	Yes (DAMPING). Predefined values 0, 2, 5, 10, 30, 60 s.	Yes. Floating-point value from the range 0 ... 30 s.
CMD_35 Entry of PV unit for URV and LRV, and URV and LRV values via the value. <i>Set PV unit code for upper and lower range value. Set URV and LRV by value.</i>	Yes, (SETURV → BYVALU), (SETLRV → BYVALU).	Yes.
CMD_36 Entry of URV set range through the set pressure. <i>Set PV upper range value.</i>	Yes (SETURV → BYPRES).	Yes.
CMD_37 Entry of LRV set range through the set pres- sure. <i>Set PV lower range value.</i>	Yes (SETLRV → BYPRES).	Yes.
CMD_38 Resetting of configuration change flag. <i>Reset "configuration changed" flag.</i>	No.	Yes.
CMD_40 Forced current mode. <i>Enter/exit PV current mode.</i>	No.	Yes.
CMD_42 Program reset. <i>Perform master reset.</i>	Yes (RESET).	Yes.
CMD_43 Pressure resetting. <i>Set PV zero.</i>	Yes (PVZERO).	Yes.
CMD_44 Basic unit entry. <i>Write PV unit.</i>	Yes (UNIT).	Yes.
CMD_45 4mA DAC calibration. <i>Trim PV current DAC zero.</i>	No.	Yes.
CMD_46 20 mA DAC calibration. <i>Trim PV current DAC gain.</i>	No.	Yes.
CMD_47 Transfer function entry. <i>Write PV transfer function.</i>	Yes (TRANSF). Linear; root; ; ; Square; special user-defined.	Yes. Linear; root; manufacturer's root 1; manufacturer's root 2; square; special user-defined.
CMD_48 Read-out of additional diagnostic statuses. <i>Read additional transmitter status</i>	No.	Yes.

APC(R)-2000ALW Safety. Change of setpoints, parameterisation, read-out of variables, diagnostics		
HART Command No/Function	Local keypad	HART communication
CMD_59 Entry of the number of recitals in the reply. <i>Set numbers of response preambles.</i>	No.	Yes.
CMD_128 Material data read-out. <i>Read static data materials.</i>	No.	Yes.
CMD_129 Pressure calibration points read-out. <i>Read device variable trim points.</i>	No.	Yes.
CMD_130 Calibration of upper pressure point. <i>Trim upper sensor calibration.</i>	No.	Yes.
CMD_131 Calibration of lower pressure point. <i>Trim lower sensor calibration.</i>	No.	Yes.
CMD_132 Selection of variable displayed on LCD2. <i>LCD2 variable, Set local control modes.</i>	Yes (LCD2VR).	Yes.
CMD_132 Selection of the decimal point position in LCD2. <i>LCD2 variable decimal point, Set local control modes.</i>	Yes (LCD2DP).	Yes.
CMD_132 Enabling/disabling of LCD display. <i>LCD operation, Set local control modes.</i>	No.	Yes.
CMD_132 Local keypad activation/interlock. <i>Keyboard operation, Set local control modes.</i>	No.	Yes.
CMD_132 Selection of variable displayed on LCD1. <i>LCD1 variable, Set local control modes.</i>	Yes (LCD1VR).	Yes.
CMD_133 Read-out of keypad and display operation mode configuration. <i>Read local control modes.</i>	No.	Yes.
CMD_135 User's characteristics entry. <i>Write user's characteristic coefficients.</i>	No.	Yes.
CMD_136 User's characteristics read-out. <i>Read user's characteristic coefficients.</i>	No.	Yes.
CMD_138 Return to factory settings. <i>Return to factory settings.</i>	Yes (FACTOR).	Yes.
CMD_141 Entry of AI function block configuration. <i>Write AIFB Configuration.</i>	No.	Yes.

APC(R)-2000ALW Safety. Change of setpoints, parameterisation, read-out of variables, diagnostics		
HART Command No/Function	Local keypad	HART communication
CMD_142 Read-out of AI function block configuration. <i>Read AIFB Configuration.</i>	No.	Yes.
CMD_230 Read-out of the CPU, Master, Slave, HART revisions. <i>Read CPU, Master, Slave, HART firmware revision.</i>	No.	Yes.
CMD_231 Product code read-out. <i>Read product codes.</i>	No.	Yes.
CMD_233 Separator code read-out. <i>Read separator codes.</i>	No.	Yes.
CMD_235 Manifold code read-out. <i>Read manifold codes.</i>	No.	Yes.
CMD_237 Read-out of limit parameters. <i>Read operational limits.</i>	No.	Yes.
CMD_240 Write long TAG <i>Write long TAG.</i>	No.	Yes.
CMD_242 Read long TAG. <i>Read long TAG.</i>	No.	Yes.
CMD_242 Entry of the root characteristics start point. <i>Write sqrt start point.</i>	Yes (%SQRT). Predefined 0%, 0.2%; 0.4%; 0.6%; 0.8%; 1%.	Yes. Floating-point value from the range (0... 100%).
CMD_243 Read-out of the root characteristics start point. <i>Read sqrt start point.</i>	No.	Yes.
CMD_244 Entry of the user's unit and scaling coefficients. <i>Write User's unit name and rearrange coefficients.</i>	No.	Yes.
CMD_245 Read-out of the user's unit and scaling coefficients. <i>Read User's unit name and rearrange coefficients.</i>	No.	Yes.
CMD_246 Access code entry. <i>Write customer's security code.</i>	No.	Yes.
CMD_247 Write lock setting (setpoint changes). <i>Set write protect code.</i>	No.	Yes.

APC(R)-2000ALW Safety. Change of setpoints, parameterisation, read-out of variables, diagnostics		
HART Command No/Function	Local keypad	HART communication
MID Selection of MID interlock mode. <i>MID write protect.</i>	Yes (MID_WP).	No.

Table 31. APC(R)-2000ALW Safety. Change of setpoints, parameterisation, read-out of variables, diagnostics.

13.2. Local setpoints selected with keypad

13.2.1. Local LCD display

The transmitter is equipped with a local LCD used to illustrate process variables, parameters during local configuration, error messages or failures. When the front cover is opened, the display module can be rotated by any angle in the range of 345° to adjust it to the mounting position of the body. The rotation of the module is possible due to the protrusions in the module's moulding. Rotation of display (→ 9.6.)

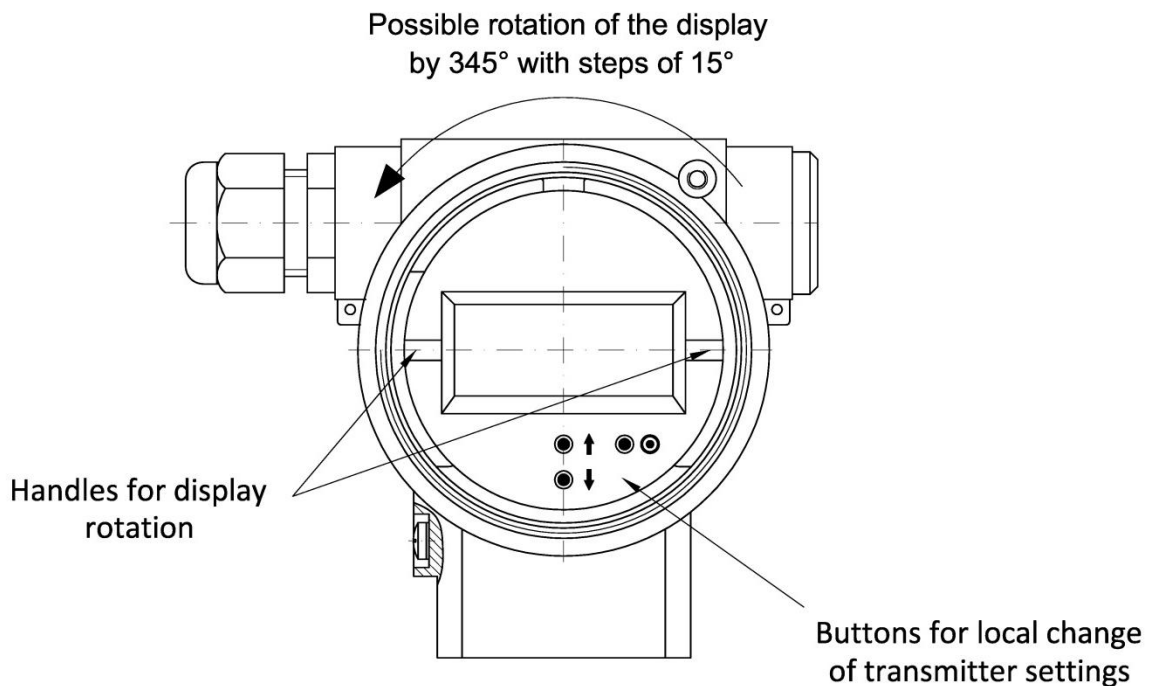


Figure 73. Display module of transmitter APC(R)-2000ALW Safety.

The LCD has three primary information fields identified in the figure below as LCD1, LCD2, LCD3.

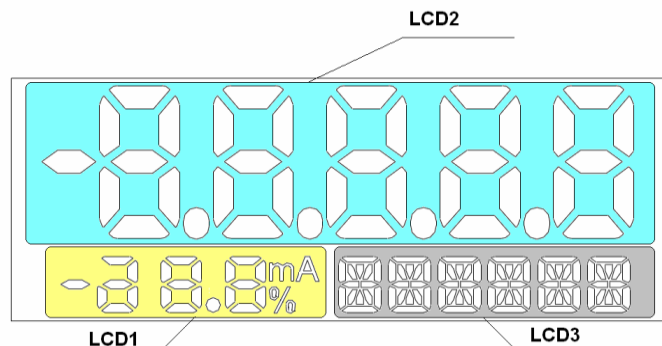


Figure 74. LCD display.

Depending on the configuration **LCD1** field is used to display:

- values of process variable for current in [mA] with 0.1 mA resolution;
- values of the set range of current output in percent [%] with 1% resolution.

[mA] – value (milliamperes) of process current in line 4 ... 20 mA, proportional to the measured pressure.

[%] – value (percentage) of the setpoint $Y(t)$ of current controller in current loop 4 ... 20 mA. This value is the ratio of the process current $I_p(t)$ to the current range width according to the following formula:

$$\%Y(t) = \frac{I_p(t) - 4 \text{ [mA]}}{16 \text{ [mA]}} * 100 \text{ [%]}$$

Depending on the configuration **LCD2** field is used to display:

- values of pressure / differential pressure in physical units;
- values of pressure / differential pressure in the user's units and scaling;
- value of temperature of the pressure sensor body;
- value of CPU temperature;
- values of the set range when changing the range by entering a number;
- information on error or failure number;
- information on exceeding the range of displayed values;
- information about exceeding the set range limits (only in MID mode).

The LCD2 field is used mainly to display floating point decimal values in the unit displayed on LCD3. In some cases, other messages may be displayed:

- **ERROR** in case of some operating errors or failure diagnosed in the transmitter, error / failure number **E□□□** will appear on LCD2, the **ERROR** message will be displayed on LCD3. The image will blink to attract the operator's attention. The transmitter will set the current output to alarm status $I_{AL} < 3.600 \text{ mA}$.
- **undEr** if the limit below LRV of the set range (only in MID mode) is exceeded by the process, **undEr** (under) message will appear on LCD1. The image will blink to attract the operator's attention. The transmitter will set the current output to alarm status $I_{AL} < 3.600 \text{ mA}$.
- **ouEr** if the limit above URV of the set range (only in MID mode) is exceeded by the process, **ouEr** (over) message will appear on LCD1. The image will blink to attract the operator's attention.
- ● ● ● ● when the set position of comma (point) on LCD2 does not allow for the correct display of the process variable, four dots ● ● ● ● will appear on LCD. The image will blink to draw the operator's attention. In this situation, change the decimal point position in the local setpoint change MENU or via HART communications.

Depending on the configuration **LCD3** field is used to display:

- physical unit of pressure displayed on LCD2;
- user's unit when displaying values of pressure/differential pressure on LCD2 in the units and scaling of the user;
- option of selecting a setpoint using the local setpoint change MENU;
- numbers of errors related to the execution of commands of the local setpoint change MENU.

The display configuration is possible by means of a local keypad/local MENU or via HART communication.

The local LCD has a limited number of character fields. For this reason, the majority of the messages are given in an abbreviated form. Below you will find a list of abbreviations used for each character field.

13.2.2. Abbreviations of physical units of pressures and levels and their description

INH20	inch of water column.
INGH	inches of mercury column with temperature of 0°C.
FTH20	feet of water column with temperature of 20°C (68°F).
MMH20	millimeters of water column with temperature of 20°C (68°F).
MMHG	millimeters of mercury column with temperature of 0°C.
PSI	pounds per square inch.
BAR	bars.
MBAR	millibars.
GSQCM	grams per square centimeter.
KGSQCM	kilograms per square centimeter.
PA	pascals.
KPA	kilopascals.
TORR	torrs.
ATM	atmosphere.
MH204	metres of water column with temperature of 4°C.
MPA	megapascals.
INH204	inches of water column with temperature of 4°C.
MMH204	millimeters of water column with temperature of 4°C.
NOUNIT	the shortcut displayed when a unit not implemented in the transmitter is configured via HART communication.

13.2.3. Abbreviations of temperature measurement point name

SENS °C	temperature of pressure/differential pressure sensor measurement structure expressed in degrees Celsius.
CPU °C	temperature of the main CPU structure expressed in degrees Celsius. This temperature refers to temperature of the main electronic components and is similar to transmitter body temperature.

13.2.4. Abbreviations displayed during configuration via local MENU and their descriptions

<-BACK	return to one level above in local MENU.
EXIT	going out of the local MENU.
UNIT	pressure and level unit selection menu.
SENS_T	option of measuring the temperature of pressure or differential pressure sensor measurement structure.
CPU_T	option of measuring the main CPU structure temperature.
DAMPIN	menu of selecting damping time constant of process variable.
TRANSF	menu of selecting the current output transfer function.
%SQRT	menu of selecting the dead band percentage of the root characteristics of the current output transfer function.
PVZERO	pressure transmitter resetting menu and option.
SETURV	URV setting menu (upper pressure of the set range).
SETLRV	LRV setting menu (lower pressure of the set range).
BYPRES	option of setting the range according to pressure.
BYVALU	option of setting the set range by entering a value.
RESET	transmitter hot restart software menu.
LCD1VR	menu for selection of the type of measurement displayed on LCD1.
LCD2VR	menu for selection of the type of measurement displayed on LCD2.
LCD2DP	menu for selecting position of comma / decimal point.

FACTOR	return to factory values menu.
RECALL	option of return to factory settings. Factory pressure/differential pressure calibrations, zero setpoints of pressure and current will be restored.
LINEAR	option of linear function of current output setpoint transfer.
SQRT	option of root function of current output setpoint transfer.
SPECIA	option of the user's special characteristics of current output setpoint transfer.
SQUARE	option of square function of current output setpoint transfer.
CURREN	option of selecting the display of set current on LCD1.
PERCEN	option of selecting the display of set percentage on LCD1.
PRESS	option of selecting the display of pressure/differential pressure on LCD1.
USER	option of selecting user's units and scaling to be displayed on LCD1.
MID_WP	MID mode setting menu. In this mode, the option of changing the setpoints related to the transmitter metrology is disabled. Additionally, the exceeding of LRV and URV limits results in displaying the undEr or ovEr message, blinking of the display and setting of the process output to the current alarm mode I_AL < 3.600 mA.
ON	MID mode activation option.
OFF	MID mode deactivation option.
X.XXXX	option of selecting position of comma / decimal point.
XX.XXX	option of selecting position of comma / decimal point.
XXX.XX	option of selecting position of comma / decimal point.
XXXX.X	option of selecting position of comma / decimal point.
XXXXX.	option of selecting position of comma / decimal point.
0 [S]	option of selecting damping time constant.
2 [S]	option of selecting damping time constant.
5 [S]	option of selecting damping time constant.
10 [S]	option of selecting damping time constant.
30 [S]	option of selecting damping time constant.
60 [S]	option of selecting damping time constant. The 60-second damping constant is only available from the local keypad; the configuration via HART in Revision 5 does not allow a damping value greater than 30 seconds. Other damping values are possible to be set via HART communication.
0.0 %	option of selecting root characteristics dead band point.
0.2 %	option of selecting root characteristics dead band point.
0.4 %	option of selecting root characteristics dead band point.
0.6 %	option of selecting root characteristics dead band point.
0.8 %	option of selecting root characteristics dead band point.
1.0 %	option of selecting root characteristics dead band point. Other dead band values are possible to be set via HART communication.
DONE	message about the acceptance and implementation of the set-point change.

13.2.5. Abbreviations of local configuration errors and description of abbreviations

ER_L07	message displayed on LCD3. It is displayed if a user tries to change the setpoint in the transmitter protected against entry (change of setpoints) or in active MID mode.
ER_L09	message displayed on LCD3. It is displayed if: <ul style="list-style-type: none"> – a user tries to change the set range by set pressure which is not within the allowable upper URL pressure. – A user tries to reset pressure when the pressure exceeds the allowable upper limit.
ER_L10	message displayed on LCD3. It is displayed if: <ul style="list-style-type: none"> – a user tries to change the set range by set pressure which is not within the allowable lower LRL pressure. – A user tries to reset pressure when the pressure exceeds the allowable lower limit.

- ER_L14** message displayed on LCD3. It is displayed if:
- the adopted URV value through the set pressure or entry of a value cannot be accepted because it causes a reduction of the set pressure range set below the allowable limit.
- ER_L16** message displayed on LCD3. It is displayed if:
- A user tried to perform an operation that is disabled or unavailable. It may be caused by:
 - attempting to access the local setpoint change MENU when the access to the local MENU is disabled;
 - attempting to reset pressure in the absolute pressure measurement transmitter.
- WG_L14** the message will appear if the assumed LRV value through the set pressure or entry of a value causes a decrease of the current set range. Entry of LRV automatically results in the transmitter's attempt to set URV in such a way that the current width of the set range is maintained. If this is not possible due to exceeded URL, the transmitter automatically adopts the URV = URL and a new LRV. Since the set range width and URV deviate from previous values, a message is displayed.

13.2.6. ASCII characters displayed on LCD3 in user's unit

Using HART communication, the user can configure its own 6-character unit displayed on LCD3. It is possible to display ASCII characters from the range (32... 96 dec) or (20 ... 60 hex), i.e.:

!"#\$%&'()*+,-./0123456789;:<=>?@ABCDEFGHIJKLMN OPQRSTUVWXYZ[\]^_`

13.2.7. Local keypad

The local keypad is used to enable the configuration mode of some transmitter parameters and to navigate through MENU and accept MENU options. The MENU can be accessed by pressing and holding any of the keys for at least 4 seconds. After this time, the LCD3 field of the local display will show an **EXIT** message. This means entering into the MENU navigation mode.

13.2.8. Local configuration of setpoints

Transmitter APC(R)-2000ALW Safety Transmitter enables local configuration of some of the most common setpoints via local keypad and local LCD.

13.2.9. Navigation in local setpoints MENU

The MENU can be accessed by pressing and holding any of the keys for at least 4 seconds. After this time, the LCD3 field of the local display will show an **EXIT** message. This means entry into the local configuration MENU. Pressing the buttons with arrows [↑] [↓] for at least 1 second you can move up or down MENU.

13.2.10. Acceptance of local setpoints

The key marked with symbol [●] is used to accept the selection. The acceptance of setpoint change is confirmed by a **DONE** message displayed on LCD3. After changing the setpoint, the transmitter leaves the local configuration change MENU. If in MENU mode, we do not make any choice, after 2 minutes the transmitter automatically returns to display of standard messages. The MENU can also be left by selecting and accepting the **EXIT** option.

13.2.11. List of local setpoints MENU messages

EXIT →	[↓][scroll down]	[↑][scroll up]	→	▣ [set]
PVZERO →	[↓][scroll down] ←BACK PVZERO	[↑][scroll up] ←BACK PVZERO	→	▣ [set]
SETLRV →	[↓][scroll down] ←BACK SETLRV	[↑][scroll up] ←BACK SETLRV	→	▣ [set]
SETURV →	[↓][scroll down] ←BACK SETURV	[↑][scroll up] ←BACK SETURV	→	▣ [set]
UNIT →	[↓][scroll down] ←BACK INH2O INHG FTH2O MMH2O MMHG PSI BAR MBAR GSQCM KGSQCM PA KPA TORR ATM MH2O4 MPA INH2O4 MMH2O4	[↑][scroll up] ←BACK MMH2O4 INH2O4 MPA MH2O4 ATM TORR KPA PA KGSQCM GSQCM MBAR BAR PSI MMHG MMH2O FTH2O INHG INH2O	→	▣ [set]
DAMPIN →	[↓][scroll down] ←BACK 60 [S] 30 [S] 10 [S] 5 [S] 2 [S] 0 [S]	[↑][scroll up] ←BACK 0 [S] 2 [S] 5 [S] 10 [S] 30 [S] 60 [S]	→	▣ [set]
TRANSF →	[↓][scroll down] ←BACK LINEAR SQRT SPECIA SQUARE	[↑][scroll up] ←BACK SQUARE SPECIA SQRT LINEAR	→	▣ [set]

%SQRT →	[↓][scroll down] ←BACK 1.0 % 0.8 % 0.6 % 0.4 % 0.2 % 0.0 %	[↑][scroll up] ←BACK 0.0 % 0.2 % 0.4 % 0.6 % 0.8 % 1.0 %	→	▣ [set]
LCD1VR →	[↓][scroll down] ←BACK CURREN PERCEN	[↑][scroll up] ←BACK PERCEN CURREN	→	▣ [set]
LCD2VR →	[↓][scroll down] ←BACK PRESS USER SENS_T CPU_T	[↑][scroll up] ←BACK CPU_T SENS_T USER PRESS	→	▣ [set]
LCD2DP →	[↓][scroll down] ←BACK XXXXX● XXXX●X XXX●XX XX●XXX X●XXXX	[↑][scroll up] ←BACK X●XXXX XX●XXX XXX●XX XXXX●X XXXXX●	→	▣ [set]
FACTOR →	[↓][scroll down] ←BACK RECALL	[↑][scroll up] ←BACK RECALL	→	▣ [set]
RESET →	[↓][scroll down] ←BACK RESET	[↑][scroll up] ←BACK RESET	→	▣ [set]
MID_WP →	[↓][scroll down] ←BACK ON OFF	[↑][scroll up] ←BACK OFF ON	→	▣ [set]

13.2.12. Structure of local setpoints MENU

(Press and hold any of 3 buttons for 4 s.)

If you navigate through the active local MENU area, you should hold the button for at least 1 s to trigger the action. The pushing and holding of button ↑ or ↓ replaces single holding for min. 1 s. If you leave the Local Menu inactive for more than 2 minutes, the transmitter will automatically leave the Local Menu and begins displaying the process variable.

|
|
EXIT
|
|
|

(The first message you will see when Local Menu is enabled. If you accept this option, you will leave the Local Menu and return to the process variable display.)

PVZERO

←BACK

(Return to Local Menu. If you approve this option, you will return to the main tree of the Local Menu.)

PVZERO

(Pressure resetting. If you approve this option, the transmitter will confirm that it received the command using "DONE" message or will display a relevant error number.)

SETLRV

(Setting of the beginning of set LRV range.)

←BACK

(Return to Local Menu. If you approve this option, you will return to the main tree of the Local Menu.)

BYPRESsure

(Setting of LRV through set pressure. After parameter acceptance the transmitter will confirm that it received the command using "DONE" message or will display a relevant error number.)

BYVALUe

(Setting of LRV by entering a digit.)

(When approved, the current LRV value will be displayed before going to the edit mode.)

↓

↓

+/-

(Select and confirm the character of the parameter you entered.)

↓

00000

(Enter a 5-digit number, digit by digit, with or without a decimal point. After accepting the last 5th digit of the parameter, the transmitter will confirm that it received the command by displaying the following message "DONE" or will display a relevant error number. The parameter is entered in "UNITS".)

SETURV

(Setting of the end of set URV range.)

←BACK

(Return to Local Menu. If you approve this option, you will return to the main tree of the Local Menu.)

BYPRESsure

(Setting of URV through set pressure. After parameter acceptance the transmitter will confirm that it received the command using "DONE" message or will display a relevant error number.)

BYVALUe

(Setting of URV by entering a digit.)

(After accepting, the current URV value will be displayed before going to the edit mode.)

↓

↓

+/-

(Select and confirm the character of the parameter you entered.)

↓

00000

(Enter a 5-digit number, digit by digit, with or without a decimal point. After accepting the last 5th digit of the parameter the transmitter will confirm that it received the command by displaying the following message "DONE" or will display a relevant error number. The parameter is entered in "UNITS".)

<p>UNIT</p> <p>←BACK</p> <p>INH2O INHG FTH2O MMH2O MMHG PSI BAR MBAR GSQCM KGSQCM PA KPA TORR ATM MH2O4 MPA INH2O4 MMH2O4</p>	<p>(Return to Local Menu. If you approve this option, you will return to the main tree of the Local Menu.)</p> <p>(Accept one of the following units by pressing ● button. After accepting the parameter, the transmitter will confirm that it received the command by displaying the following message „DONE“.)</p>
<p>DAMPINg</p> <p>←BACK</p> <p>0 [s] 2 [s] 5 [s] 10 [s] 30 [s] 60 [s]</p>	<p>(Setting of damping time constant of process variable.)</p> <p>(Return to Local Menu. If you approve this option, you will return to the main tree of the Local Menu.)</p> <p>(Accept one of the following values of time constant by pressing and holding ● button. After accepting the parameter, the transmitter will confirm that it received the command by displaying the following message „DONE“.)</p>
<p>TRANSFer</p> <p>←BACK</p>	<p>(Setting of transfer type for current output characteristics.)</p> <p>(Return to Local Menu. If you approve this option, you will return to the main tree of the Local Menu.)</p> <p>(Accept one of the following values of time by pressing and holding ● button. After accepting the parameter,</p>

		scaled in user units.)
	SENS_T	(LCD2 display will display the current temperature of pressure sensor – head in °C.)
	CPU_T	(LCD2 display will not display the current temperature of transducer CPU – electronic elements in °C.)
	LCD2DP	(Position of decimal point of the variable displayed on LCD2.)
	←BACK	(Return to Local Menu. If you approve this option, you will return to the main tree of the Local Menu.)
		(Accept one of the following options by pressing ● button. After accepting the parameter, the transmitter will confirm that it received the command by displaying the following message „DONE“.)
	XXXXX●	
	XXXX●X	
	XXX●XX	
	XX●XXX	
	X●XXXX	
	FACTORY	(Removal of pressure and current sub-calibration. Return to factory settings.)
	←BACK	(Return to Local Menu. If you approve this option, you will return to the main tree of the Local Menu.)
		(Accept the following command by pressing and holding ● button. After accepting the parameter, the transmitter will confirm that it has received the command with “DONE” message.)
	RECALL	
	RESET	(Software forcing of transmitter reset.)
	←BACK	(Return to Local Menu. If you approve this option, you will return to the main tree of the Local Menu.)
		(Accept the following command by pressing and holding ● button. After accepting the parameter, the transmitter will perform hot restart.)
	RESET	

14. Separators and their application

The separator is a diaphragm pressure relay. The signal is transmitted to the associated pressure gauge, pressure transmitter, manometer via gauge fluid filling the space between the separator diaphragm and the pressure gauge. The function of the separator is to separate the pressure gauge from adverse parameters of the medium, such as:

- low or high temperature, increased viscosity, contamination;
- system vibrations (distance separation).

The basic metrological problem when using the separators is an absolute “zero” temperature error resulting from the effects of thermal expansion of gauge fluid, which must be compensated by the flexibility of the separating diaphragm.

In order to minimize this impact, it is recommended to:

- use of as short capillaries as possible, which reduces the volume of the gauge fluid in the system;
- use of larger DN's to maximize diaphragm flexibility;
- location of capillary tubes in such a way to minimize the changes of their temperatures.

14.1. Design and operation modes

The separator is a diaphragm device used in situations where the measuring medium or installation structure does not allow for direct connection of a pressure transmitter. This is the case when:

- the process temperature is outside the temperature range acceptable for the pressure gauge (and it is not possible to use an impulse tube);
- the medium is corrosive;
- the medium is characterised by increased viscosity, solidification or forms slurries;
- the application requires the use of hygienic connection;
- there are vibrations in the installation.

The separator transfers a pressure signal of the measured medium to the associated transmitter via a pressure gauge fluid that fills the space between the separator diaphragm and the transmitter.

The measuring sets of the separator and transmitter are available in the following configurations:

- pressure transmitter – direct separator;
- pressure transmitter – distance separator;
- differential pressure transmitter – direct separator;
- differential pressure transmitter – distance separator;
- differential pressure transmitter – two separators, including at least one distance separator.

The following drawings show possible separator configurations along with the application of process connections.

Return → Table 4. Transmitter versions, process connections.

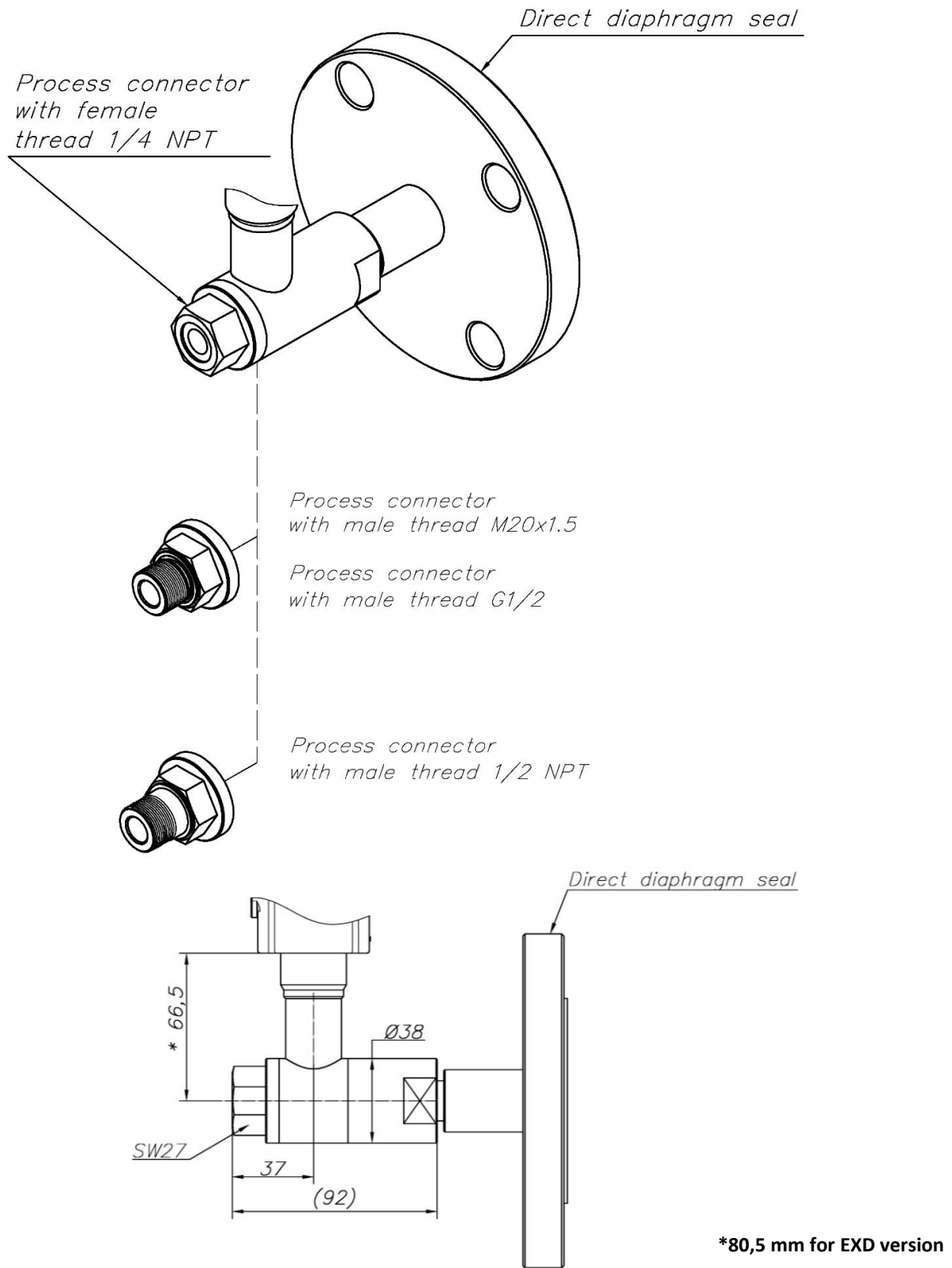


Figure 75. Direct separator and possible process connections.

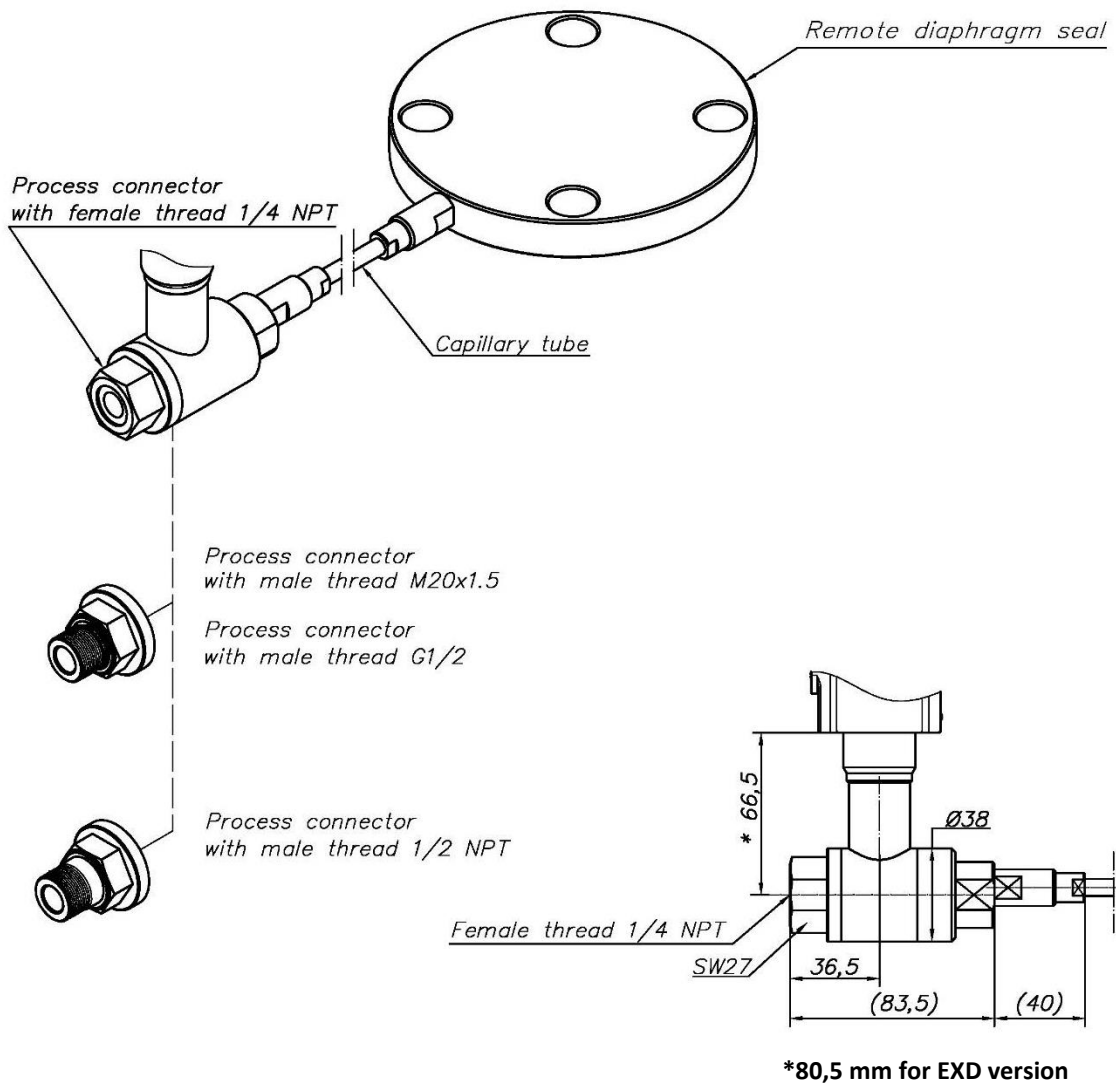
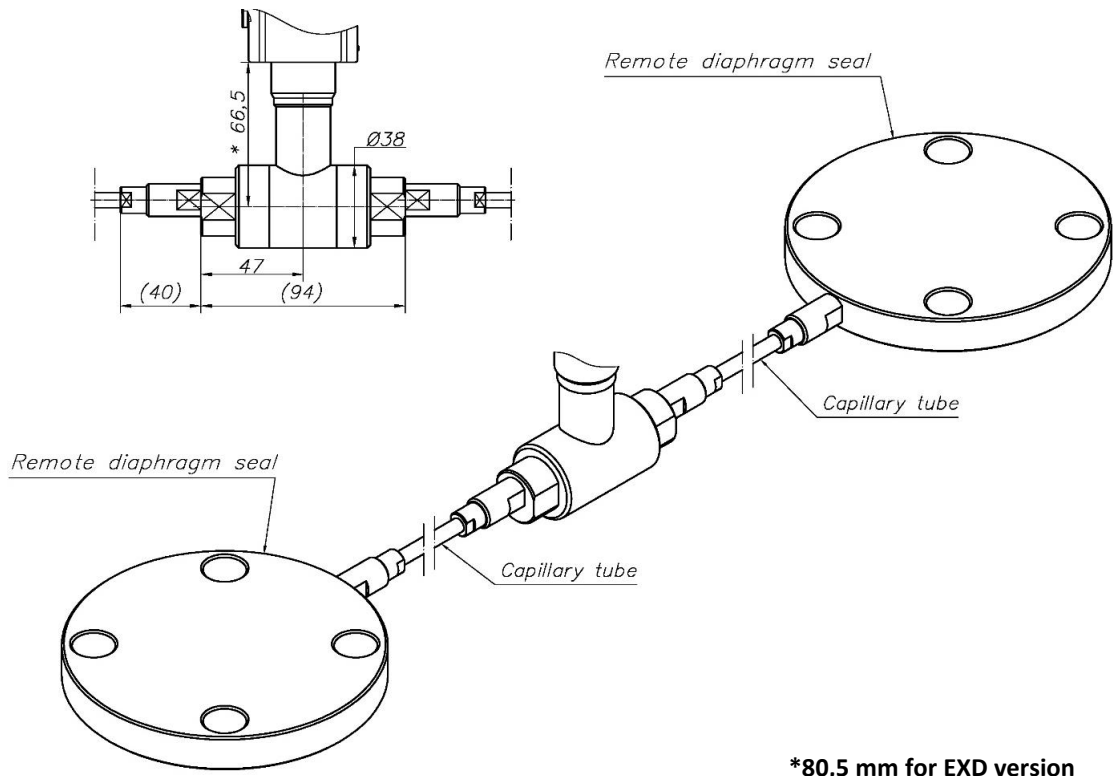
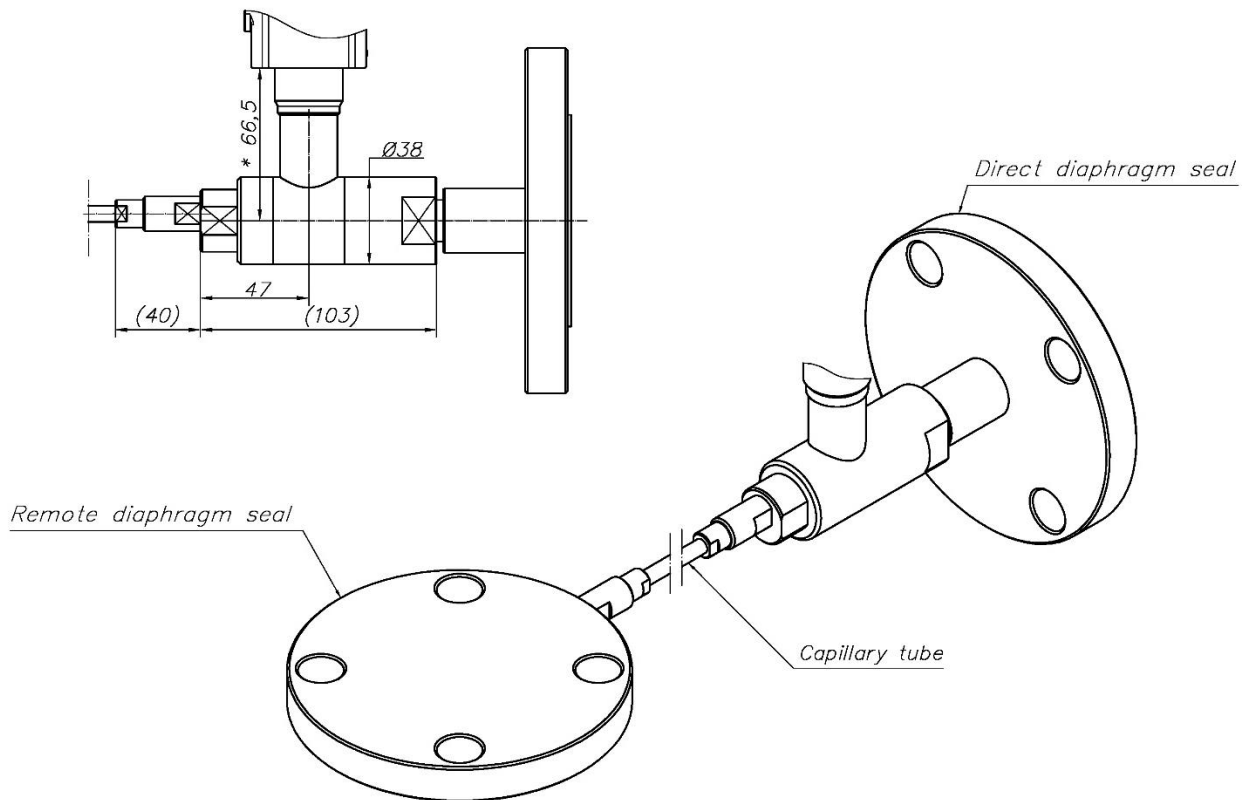


Figure 76. Distance separator and possible connections.



***80,5 mm for EXD version**

Figure 77. Example of connection using two distance separators.



***80,5 mm for EXD version**

Figure 78. Example of connection using distance and direct separator.

Distance separators, unlike the direct separators, have a capillary tube that allows the transmitter to be moved from the pressure measuring point. This allows media measurements in the range from 150°C to 380°C. Capillary tubes have an inner diameter of 1 mm and are made of material 316Ti. Capillary tubes are available in two versions:

- in flexible conduit 304;
- in flexible conduit 304 coated with white PVC.

Hygienic separators of S-DIN type; S-CLAMP; S-POZIOM are equipped with standard hygienic connections and enable to perform the measurements in the food and pharmaceutical industry.

The separators are also designed with flanged connections according to international flange standards: ASME B16.5; EN1092-1; JIS B2220.

The tubular flange separators have a protruded diaphragm, which may reach into a multi-shell container close to its inner wall.

Distance flange separators with acid-resistant steel diaphragm are made in a standard with a radial capillary tube. Whereas the version of these separators with diaphragm made of materials other than acid-resistant steel or with (Teflon®, gold) plated diaphragm typically has a capillary tube outgoing in the separator axis.

14.1.1. Flanged seals with flush diaphragm S-P

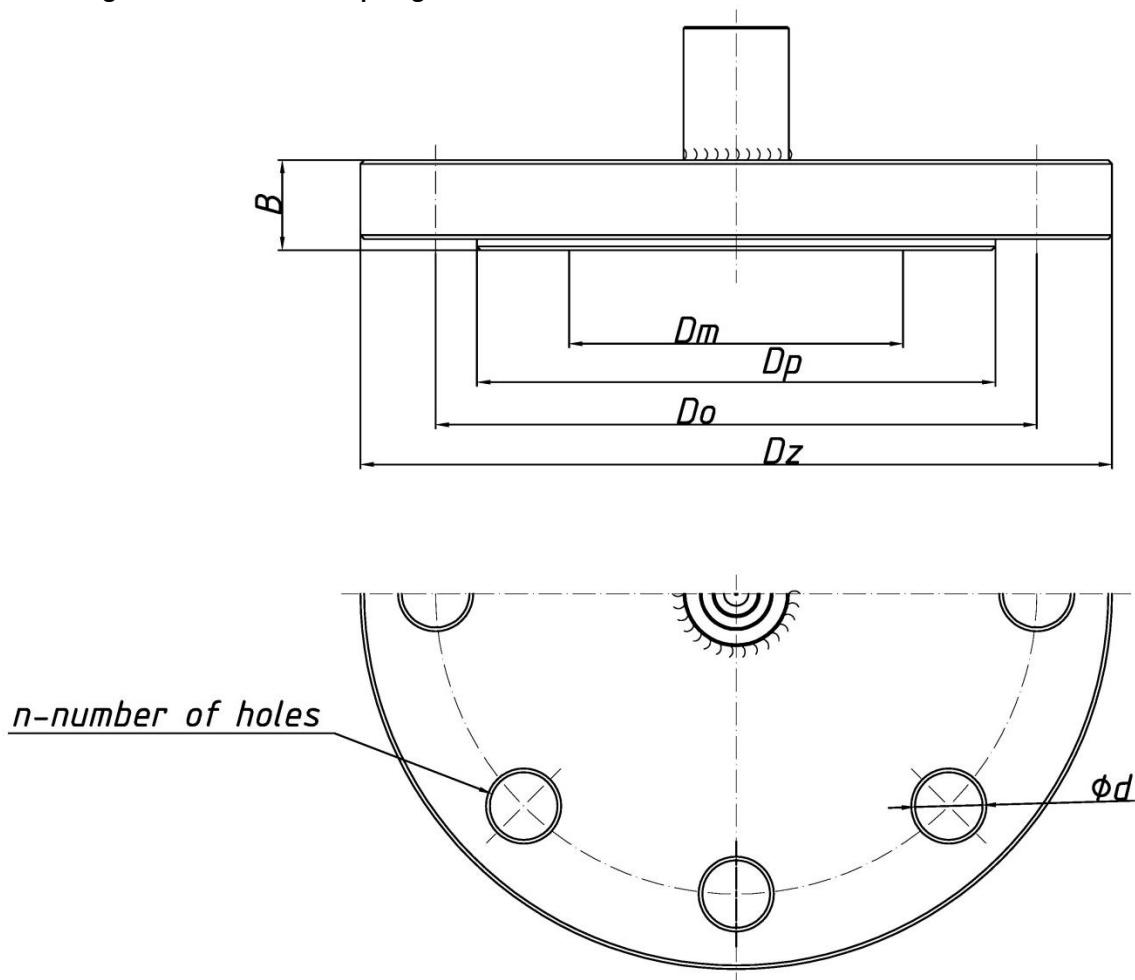


Figure 79. Flanged seals with flush diaphragm S-P.

Using in each type of separation				
	Direct (S-P)	Distance (S-PK)	With distance separators (S-PK)	With direct and distance separators (S-P/S-PK)
Transmitter				
APC-2000ALW Safety	✓	✓	✗	✗
APR-2000ALW Safety	✓	✓	✓	✓

Version	Diaphragm diameter Dm	Rabbit diameter Dp	Pitch diameter Do	Outer diameter Dz	Thickness B	Holes diameter d	Number of holes n
DN50 PN40	59	102	125	165	22	18	4
2" ANSI PN40	59	92	120.5	150	20	20	4
DN80 PN40	89	138	160	200	24	18	8
3" ANSI 150	89	127	152.5	190	24	20	4
DN100 PN40	89	162	190	235	24	22	8
4" ANSI 150	89	158	190.5	230	24	20	8

Table 32. Dimensions of S-P separators.

Pressure gauge	Type of separation	Separator version		
		DN50 / 2"	DN80 / 3"	DN100 / 4"
APC(R)-2000ALW Safety	Direct	10	2.5	2.5
	Distance	100	25	25

*The ranges listed in the table for the variable range transmitter APC(R)-2000ALW Safety shall be understood as set ranges.

Table 33. Recommended minimum measurement range width (kPa).

Maximum pressure for PN40: 4 MPa.

Type of separation	Absolute "zero" error per 10°C for the separator		
	DN50 / 2"	DN80 / 3"	DN100 / 4"
Direct	0.05 kPa	0.04 kPa	0.04 kPa
Distance (capillary tube 2 m)	0.3 kPa	0.1 kPa	0.1 kPa

Table 34. Additional absolute "zero" error due to the ambient temperature changes.



Please note!

Additional "zero" error due to the changes of temperature in the oil separation system and in each case is considerably smaller than the errors given in the table.

Distance separation			Direct separation
Gauge fluid	Negative pressure measurements	Overpressure measurements	-30 ... 150°C
High temperature (DC)	Max. 200°C - $p \geq 5$ kPa ABS	-10°... 315°C	
High temperature (DH)	Max. 250°C - $p \geq 10$ kPa ABS	+15°... 380°C	
Low temperature (AK)	Not recommended for pressure measurements < 20 kPa ABS	-60°... 200°C	

Table 35. Range of the measured medium temperature.

ABS- absolute pressure**Please note!**

For ambient temperature < -15°C it is recommended to warm up the capillary tubes with DC fluid.

Diaphragm and separator flange material: 1.4404 (steel 316L).

Special versions:

- other standard ANSI or DIN;
- filled with edible oil (medium temp. -10° ... 150°C);
- direct diaphragm seal for medium temp. over 150°C;
- other to be agreed with Aplisens consultants.

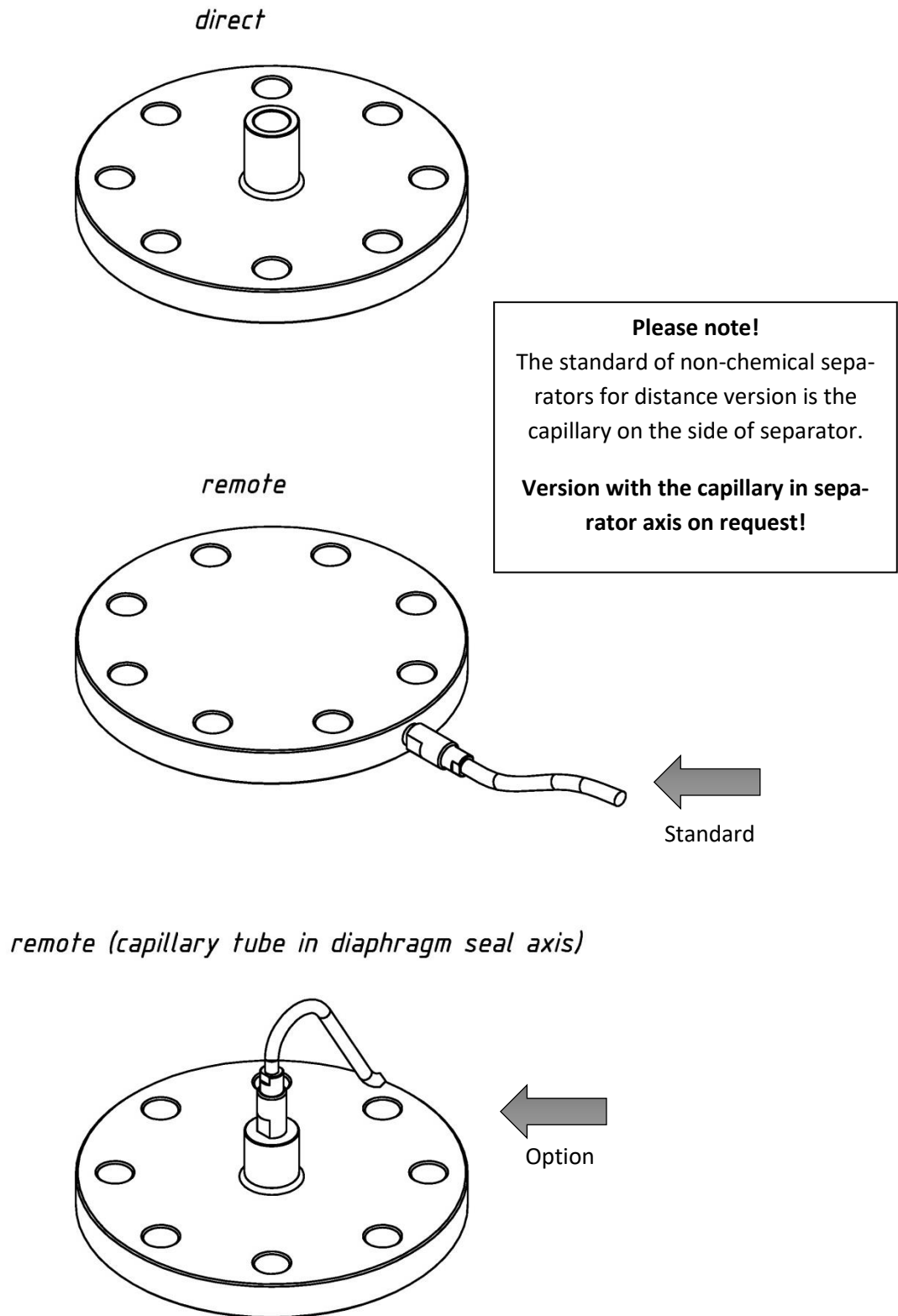


Figure 80. Types of flange separators S-P.

14.1.2. Flanged seals with extended diaphragm S-T

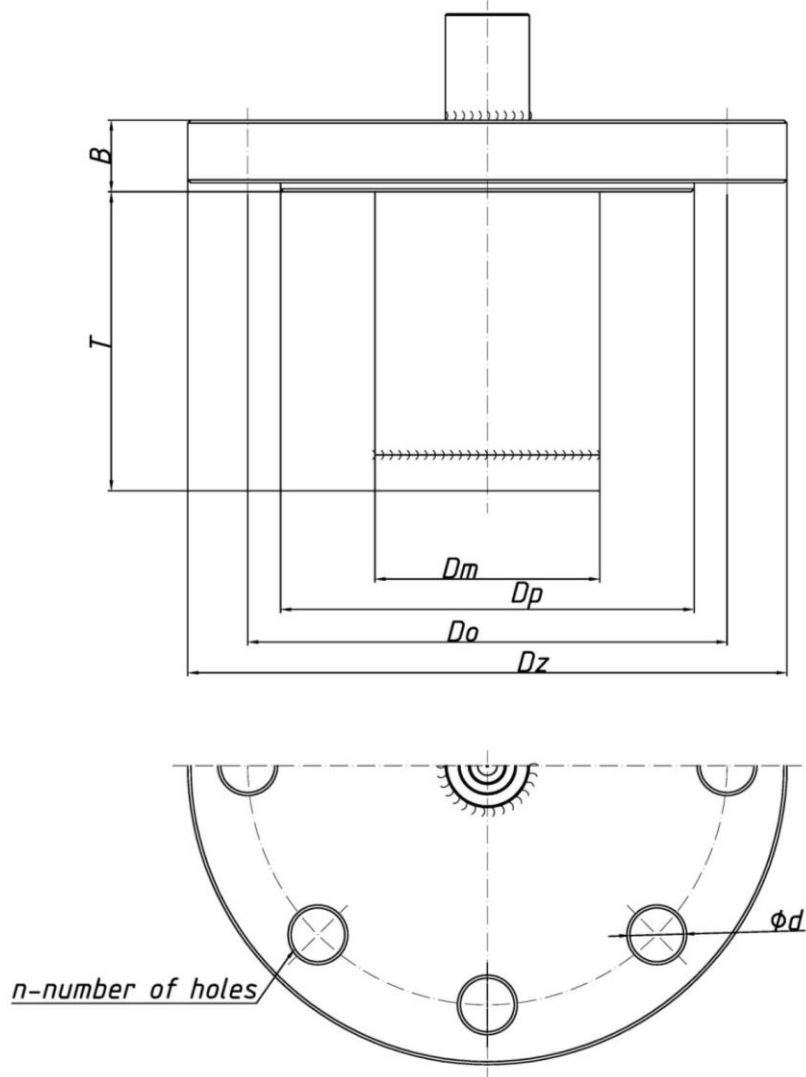


Figure 81. Flanged seals with extended diaphragm S-T.

	Using in each type of separation			
	Direct (S-T)	Distance (S-TK)	With distance separators (S-TK)	With direct and distance separators (S-T/S-TK)
Transmitter				
APC-2000ALW Safety	✓	✓	✗	✗
APR-2000ALW Safety	✓	✓	✓	✓

A typical use of a tubular separator is a pressure or level measurement in a multi-shell tank where it is advisable that the diaphragm is located close to the inside of the tank.

Version	Diaphragm diameter Dm	Rabbit diameter Dp	Pitch diameter Do	Outer diameter Dz	Thickness B	Holes diameter d	Number of holes n	Tube length T
DN50 PN40	48	102	125	165	22	18	4	50, 100, 150, 200
2" ANSI PN40	48	92	120.5	150	20	20	4	
DN80 PN40	75	138	160	200	24	18	8	50, 100, 150
3" ANSI 150	75	127	152.5	190	24	20	4	
DN100 PN40	89	162	190	235	24	22	8	50, 100, 150
4" ANSI 150	89	158	190.5	230	24	20	8	

Table 36. Dimensions of S-T separators.

Pressure gauge	Type of separation	Separator version		
		DN50 / 2"	DN80 / 3"	DN100 / 4"
APC(R)-2000ALW Safety*	Direct	10	10	10
	Distance	600	50	25

*The ranges listed in the table for the variable range transmitter APC(R)-2000ALW Safety shall be understood as set ranges.

Table 37. Recommended minimum measurement range width (kPa).

Maximum pressure for PN40: 4 MPa.

Type of separation	Absolute "zero" error per 10°C for the separator		
	DN50 / 2"	DN80 / 3"	DN100 / 4"
Direct	0.2 kPa	0.06 kPa	0.04 kPa
Distance (capillary tube 2 m)*	1 kPa	0.2 kPa	0.1 kPa

*For separator with a 100mm of tube.

Table 38. Additional absolute "zero" error due to the ambient temperature changes.



Please note!

Additional "zero" error due to changes of the temperature of the medium depends on the temperature gradient in the oil separation system and in any case it is significantly lower than the errors given in the table.

Gauge fluid	Distance separation		Direct separation
	Negative pressure measurements	Overpressure measurements	
High temperature (DC)	Max. 200°C - $p \geq 5$ kPa ABS	-10°... 315°C	-30 ... 150°C
High temperature (DH)	Max. 250°C - $p \geq 10$ kPa ABS	+15°... 380°C	
Low temperature (AK)	Not recommended for pressure measurements < 20 kPa ABS	-60°... 200°C	

Table 39. Range of the measured medium temperature.



Please note!

For ambient temperature < -15°C it is recommended to warm up the capillary tubes with DC fluid.

Special versions:

- other separators acc. to DIN or ANSI;
- direct diaphragm seal for medium temp. over 150°C.
- other to be agreed with Aplisens consultants.

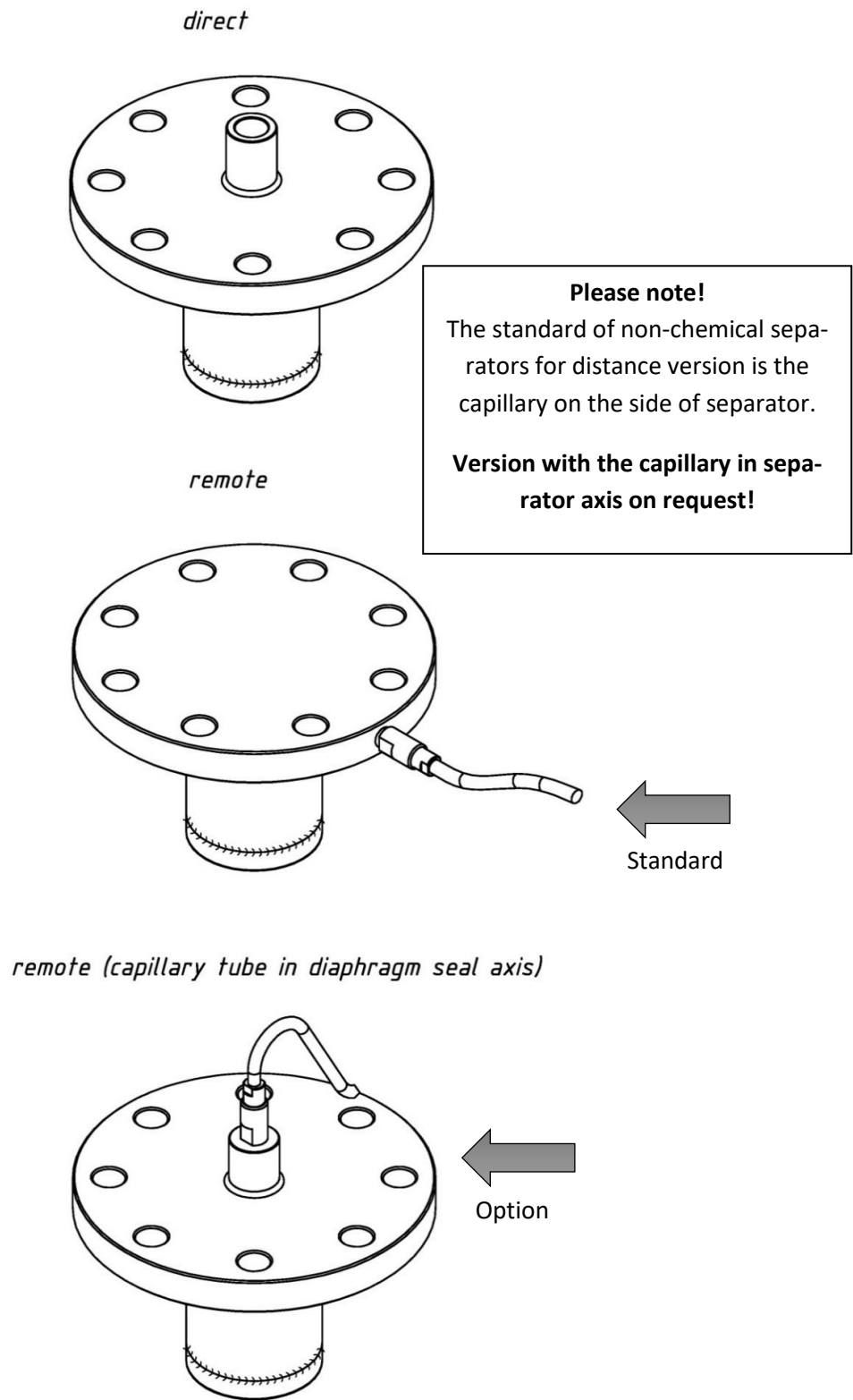


Figure 82. Types of flanged tubular separators S-T.

14.1.3. Flanged seals with extended diaphragm and direct diaphragm cleaning system S-TK-P

Separator S-TK-P is a special version of tubular distance separator S-TK-DN100/T=100mm, which is equipped with a diaphragm flushing unit. It is used for the measurements of extremely dense and viscous media with tendency to cover the diaphragm. The user can clean the diaphragm without dismantling the separator. The cleaning medium, e.g. water is supplied through two ducts located inside the separator.

Flushing shall be carried out periodically, in intervals depending on the properties of the measured medium. Connection of water to the flushing ducts is possible via two ball valves G ½" located at the rear part of the separator.

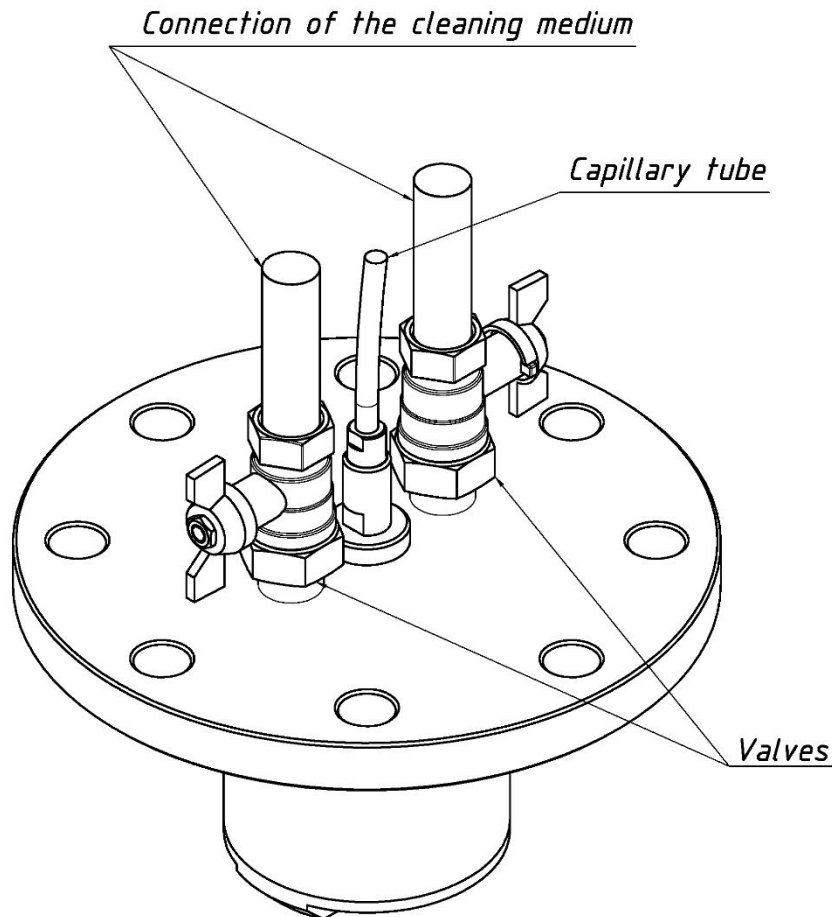


Figure 83. Separator S-TK-P with a built-in diaphragm rinsing unit, view in isometry.

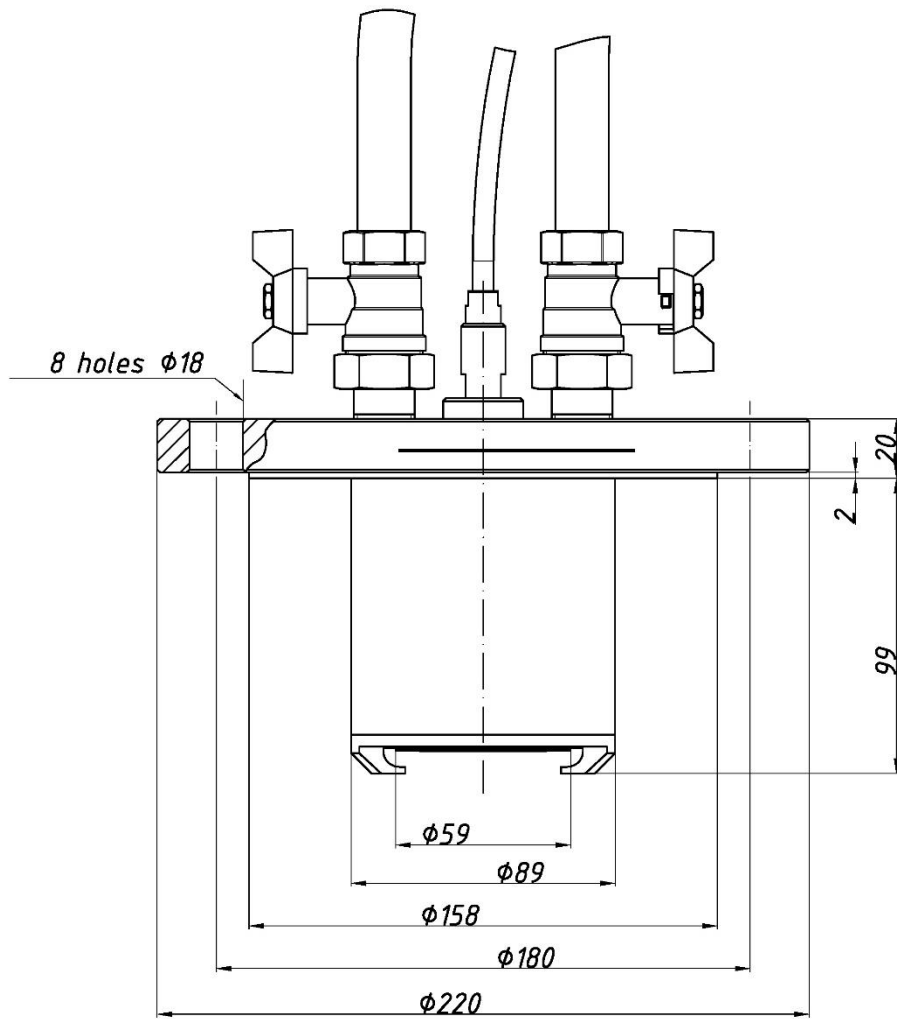


Figure 84. Overall dimensions of the separator S-TK-P with a built-in diaphragm rinsing unit.

Using in each type of separation				
	Direct	Distance (S-TK-P)	With distance separators (S-TK-P)	With direct and distance separators (S-TK-P)
Transmitter				
APC-2000ALW Safety	✗	✓	✗	✗
APR-2000ALW Safety	✗	✓	✓	✓*
*S-TK-P separator is intended to distance mounting only.				

14.1.4. Chemical flanged seals with flush diaphragm S-Ch

Chemical flanged seals separate the transmitter from adverse parameters characterising the medium, such as:

- high corrosivity;
- low or high temperature, increased viscosity, contamination;
- system vibrations.

Diaphragms and rabbets of chemical-resistant separators are made of selected materials resistant to corrosive effect of the medium, taking into consideration the chemical composition, the expected range of concentrations and the range of temperatures.

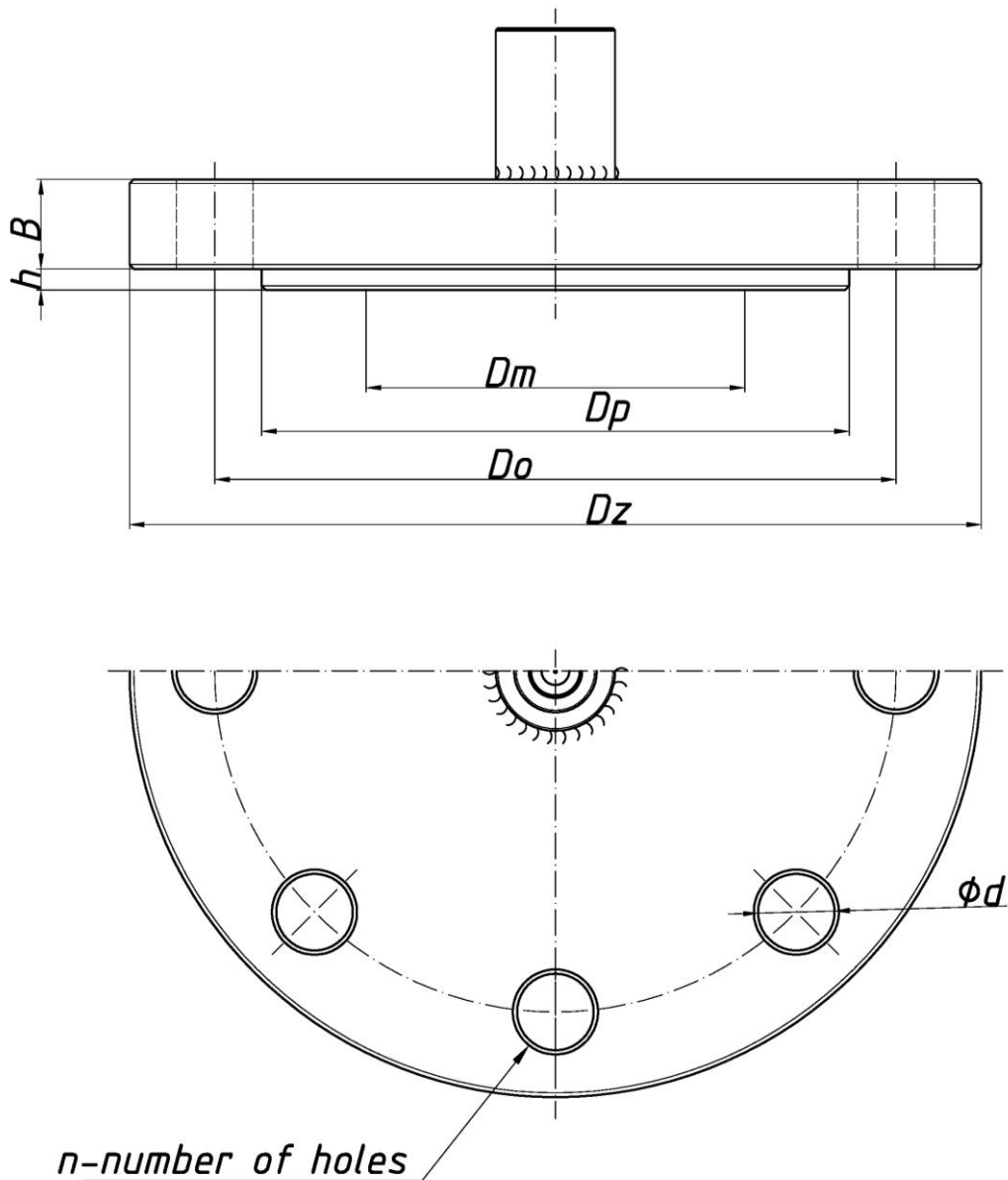


Figure 85. Overall dimensions of S-Ch separator with flush diaphragm.

Using in each type of separation				
	Direct (S-Ch)	Distance (S-ChK)	With distance separators (S-ChK)	With direct and distance separators (S-Ch/S-ChK)
Transmitter				
APC-2000ALW Safety	✓	✓	✗	✗
APR-2000ALW Safety	✓	✓	✓	✓

Material of wetted parts.	Version	Diaphragm diameter Dm	Rabbit diameter Dp	Pitch diameter Do	Outer diameter Dz	Thickness B	Thickness h	Holes diameter d	Number of holes n
Hastelloy, nickel, Monel	DN50 PN10/40	59	98	125	165	18	7	18	4
	DN80 PN25/40	89	132	160	200	22	7	18	8
Titanium	DN50 PN10/40	59	98	125	165	24	6	18	4
	DN80 PN25/40	89	138	160	200	22	6	18	8
Tantalum-Tantalum	DN50 PN10/40	59	102	125	165	18	3	18	4
	DN80 PN25/40	89	138	160	200	22	3	18	8
Tantalum-Teflon Titanium-Teflon	DN50 PN16	59	102	125	165	18	8	18	4
	DN80 PN10/16	89	138	160	200	22	8	18	8
Teflon	DN50 PN10/40	59	102	125	165	18	7	18	4
	DN80 PN25/40	89	138	160	200	22	7	18	8

Table 40. The dimensions of the Aplisens separators are similar to those specified in DIN EN1092-1.

Material of wetted parts.	Version	Diaphragm diameter Dm	Rabbit diameter Dp	Pitch diameter Do	Outer diameter Dz	Thickness B	Thickness h	Holes diameter d	Number of holes n
Hastelloy, nickel, Monel	2" ANSI 150	59	92	120.5	150	18	7	20	4
	3" ANSI 150	89	123	152.5	190	22	7	20	4
Tantalum-Tantalum	2" ANSI 150	59	92	120.5	150	18	2	20	4
	3" ANSI 150	89	127	152.5	190	22	2	20	4
Tantalum-Teflon Titanium-Teflon	2" ANSI 150	59	92	120.5	150	18	8	20	4
	3" ANSI 150	89	127	152.5	190	22	8	20	4
Teflon	2" ANSI 150	59	92	120.5	150	18	7	20	4
	3" ANSI 150	89	127	152.5	190	22	7	20	4

Table 41. The dimensions of the Aplisens separators are similar to those specified in ANSI ASME 16.5.

Pressure gauge	Type of separation	Separator version	
		DN50 PN16	DN80 PN40
APC(R)-2000ALW Safety	Direct	40	10
	Distance	100	40

Table 42. Recommended minimum measurement range width (kPa).

**Please note!**

Diaphragms and rabbits of chemical-resistant separators are made of selected materials resistant to corrosive effect of the medium, taking into account the chemical composition, the expected range of concentrations and the temperature range.

Type of separation	Absolute "zero" error per 10°C for the separator	
	DN50	DN80
Direct	0.5 kPa	0.2 kPa
Distance (capillary tube 2 m)	1 kPa	0.4 kPa

Table 43. Additional absolute "zero" error due to the ambient temperature changes.

Diaphragm material	Rabbit material	Permissible pressure	Some restrictions for use
Hastelloy	Hastelloy	4 MPa	Measurement of hot concentrated hydrochloric acid
Monel	Monel	4 MPa	Acid measurement
Nickel	Nickel	4 MPa	Acid measurement
Tantalum	Tantalum	1.6 MPa	Hydrofluoric acid measurement, soda lye measurement
Tantalum	Tantalum	1.6 MPa	Presence of gaseous chlorine or fluorine; temperature of medium greater than 95°C
Titanium	Titanium	4 MPa	Presence of dry chlorine, measurements in Ex zones
Teflon*	Teflon*	4 MPa	Measurements of negative pressure, measurements of abrasive media, additionally limitation of Teflon application



Table 44. Offered chemical-resistant materials with the major application limits.

* Diaphragm material — Hastelloy with sprayed-on Teflon layer, rabbit material – steel 316L with sprayed-on Teflon layer.

Medium temperature range:

- -30 ... 180°C for distance separation;
- -30 ... 150°C for direct separation.

Special versions:

- filling with FLUOROLUBE fluid;
- direct diaphragm seal for medium temp. over 150°C;
- gold plated wetted parts material- after consulting with Aplisens.

14.1.5. Threaded seals with large diaphragm S-Comp

Separators S-Comp are equipped with a large separating diaphragm (ø70) while maintaining an economic, compact design of the unit. Advantages of S-Comp type separators:

- possibility of performing measurements with low range width;
- ease of assembly.

	Using in each type of separation			
	Direct (S-Comp)	Distance (S-CompK)	With distance separators (S-CompK)	With direct and distance separators (S-Comp/S-CompK)
Transmitter				
APC-2000ALW Safety	✓	✓	✗	✗
APR-2000ALW Safety	✓	✓	✓	✓

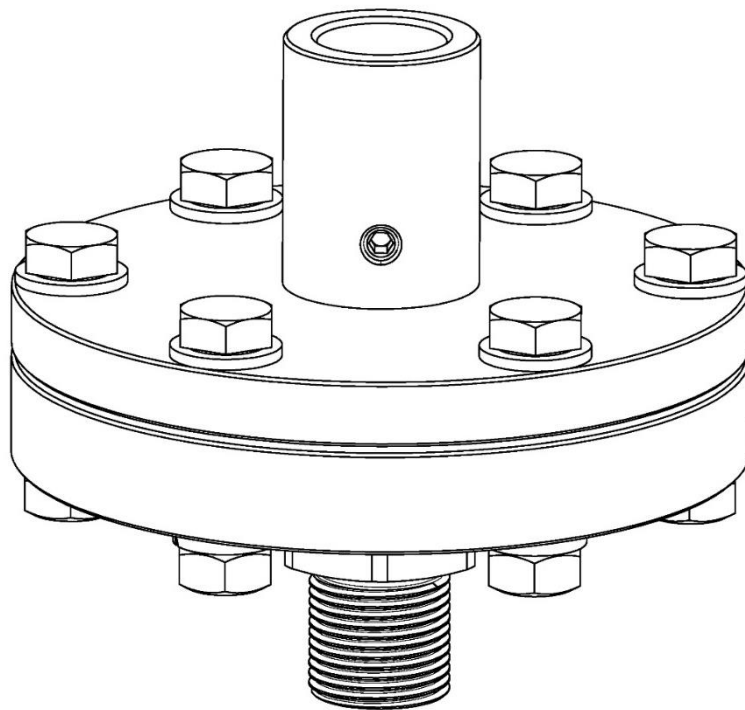


Figure 86. S-Comp separator- view in isometry.

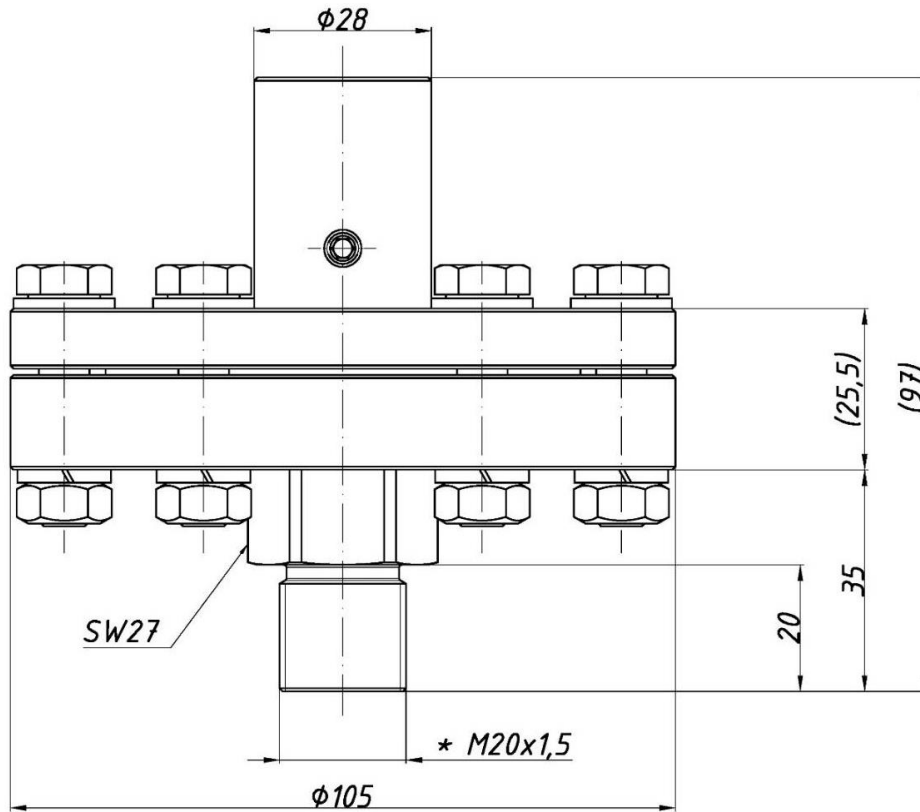


Figure 87. S-Comp separator - overall dimensions.

***Optionally G ½**

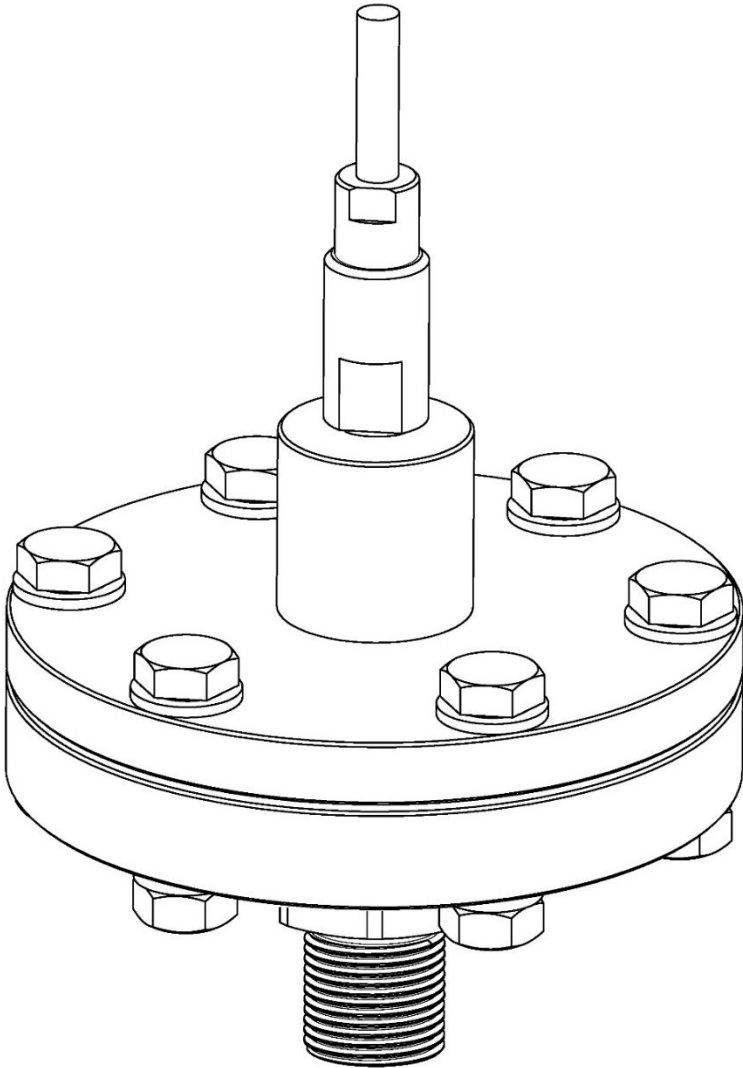


Figure 88. S-CompK distance separator with capillary in axis.

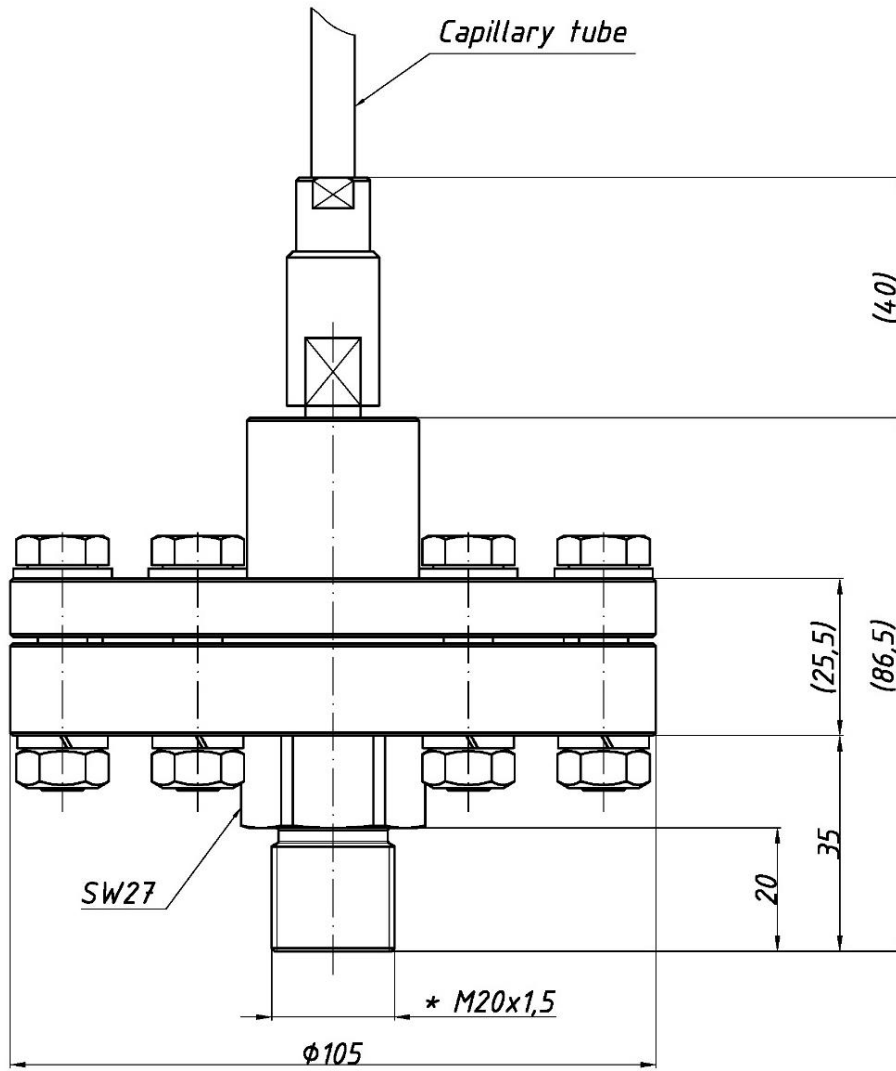
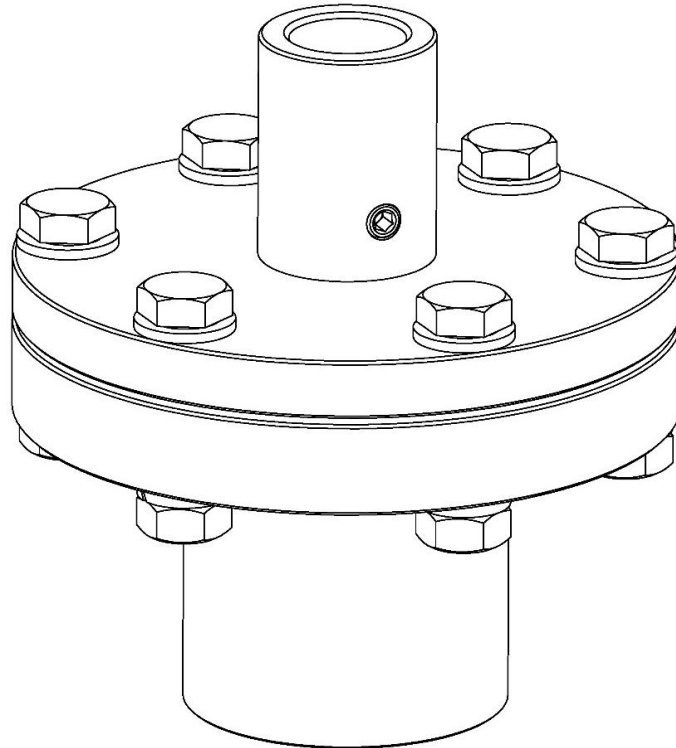
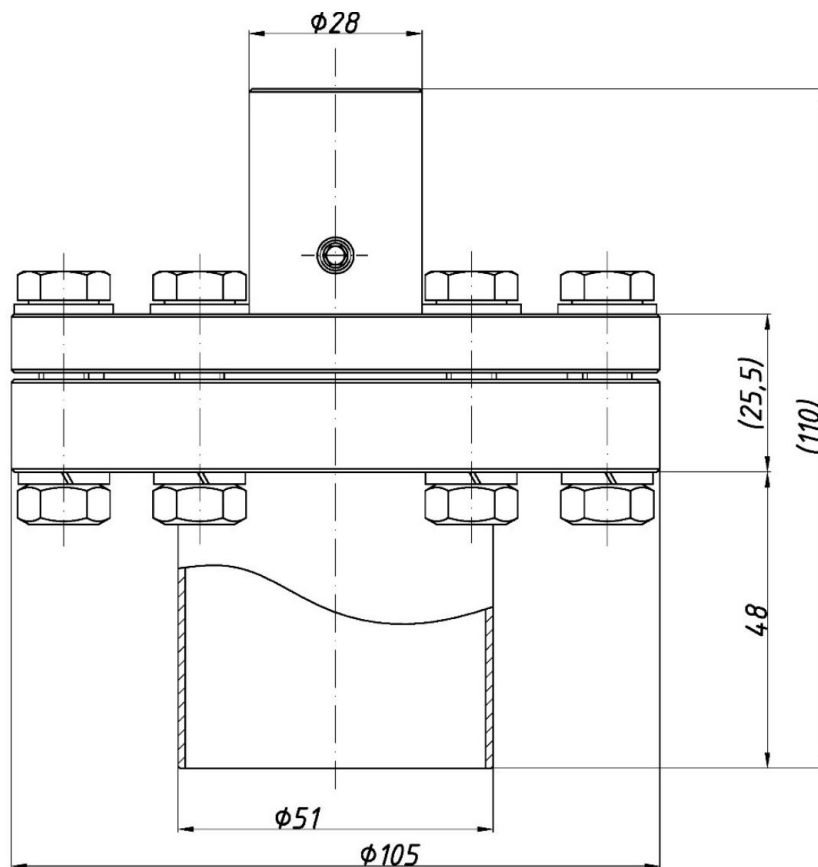


Figure 89. S-CompK separator - overall dimensions.

***Optionally G ½**

S-Comp $\phi 51$ separatorFigure 90. S-Comp $\phi 51$ separator, view in isometry.Figure 91. S-Comp $\phi 51$ separator - overall dimensions.

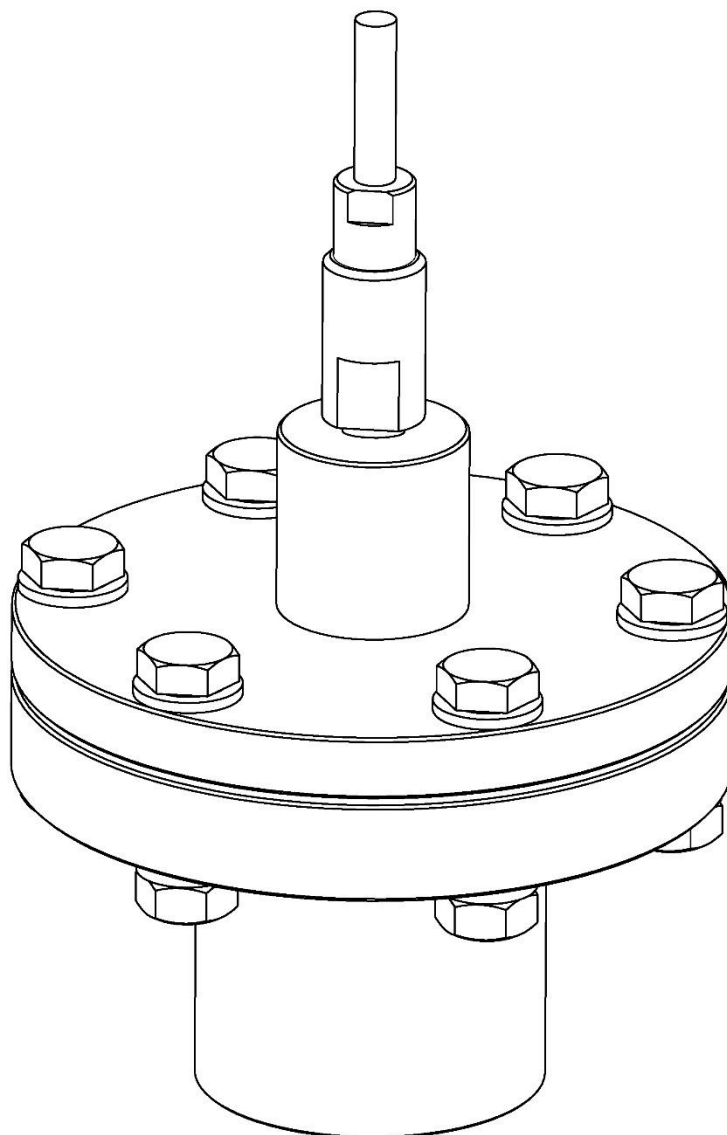


Figure 92. S-CompK ø51 separator, view in isometry.

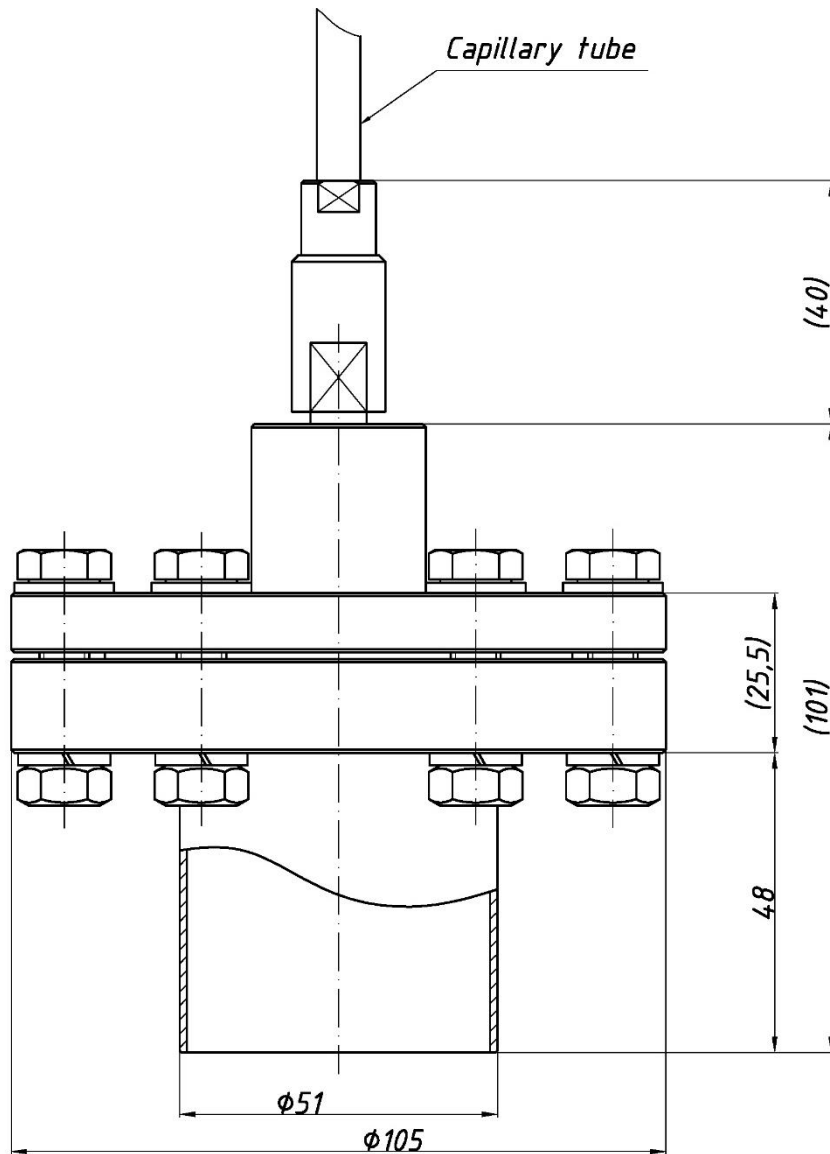


Figure 93. S-CompK ø51 - overall dimensions.

Pressure gauge	Type of separation	Minimum measurement range width
APC(R)-2000ALW Safety*	Direct	20
	Distance	50

*The ranges listed in the table for the variable range transmitter APC(R)-2000ALW Safety shall be understood as set ranges.

Table 45. Recommended minimum measurement range width of separator S-Comp/K (kPa).

Max. measuring range: 0 ... 1,6MPa

Type of separation	Absolute "zero" error
Direct	0.06 kPa/10°C
Distance capillary tube 2 m	0.2 kPa/10°C

Table 46. Additional absolute "zero" error due to the ambient temperature changes.

**Please note!**

Additional “zero” error due to the changes of the medium temperature depends on the temperature gradient in the oil separation system and in each case it is considerably smaller than the errors given in the table.

Medium temperature range:

- -30 ... 200°C for distance separation;
- -30 ... 150°C for direct separation.

Special versions:

- diaphragm made of Hastelloy C 276;
- capillary outlet at the side of the diaphragm seal;
- direct diaphragm seal for medium temp. over 150°C;
- other to be agreed with Aplisens consultants.

Separator diaphragm, flange and counter flange material: 1.4404 (steel 316L).

14.1.6. Threaded seals with large diaphragm S-Comp10/25/60 MPa

Separators S-Comp are equipped with a large separating diaphragm ($\varnothing 70$) while maintaining an economic, compact design of the unit. Advantages of S-Comp type separators:

- possibility of performing measurements with low range width;
- ease of assembly.

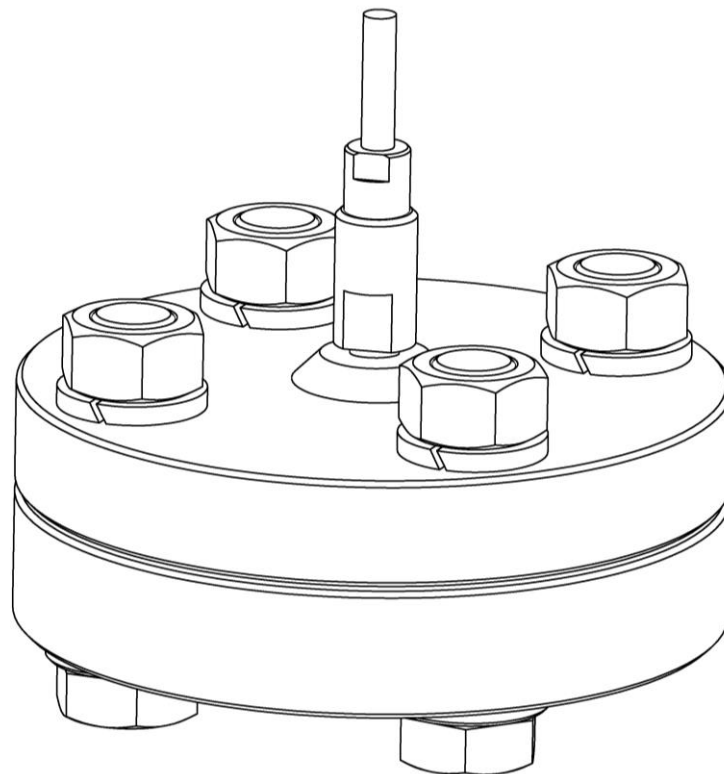


Figure 94. S-Comp10MPa separator - view in isometry.

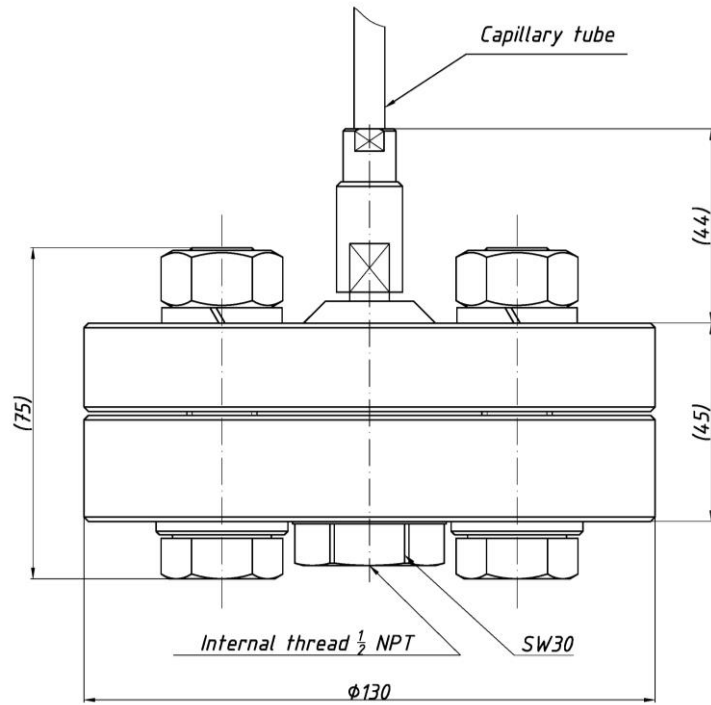


Figure 95. S-Comp10MPa separator - overall dimensions.

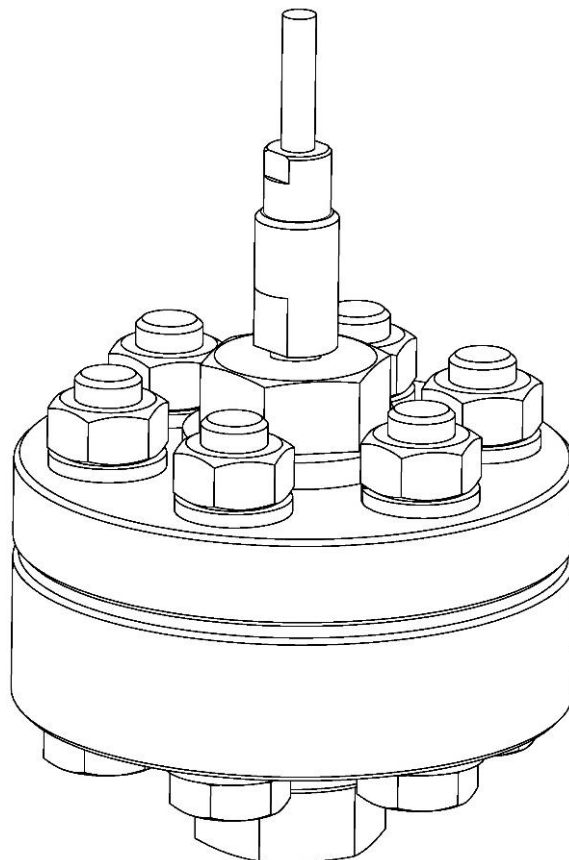


Figure 96. S-Comp25MPa separator- view in isometry.

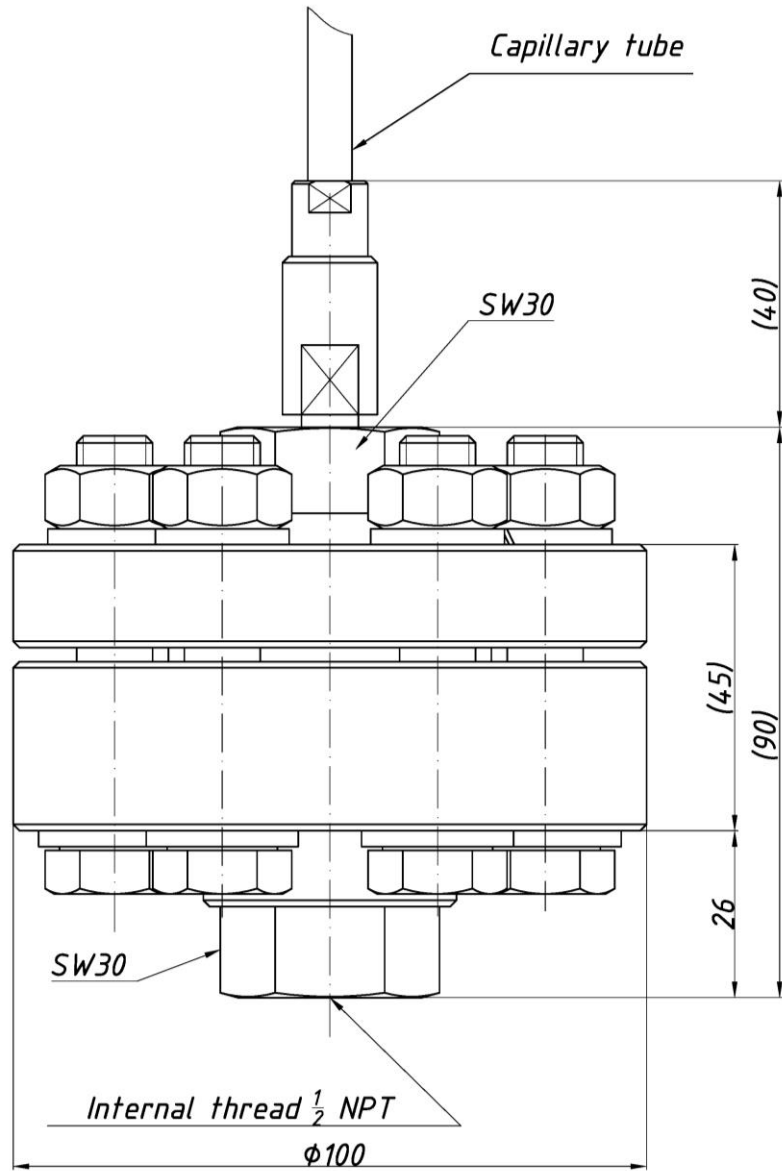


Figure 97. S-Comp25MPa separator - overall dimensions.

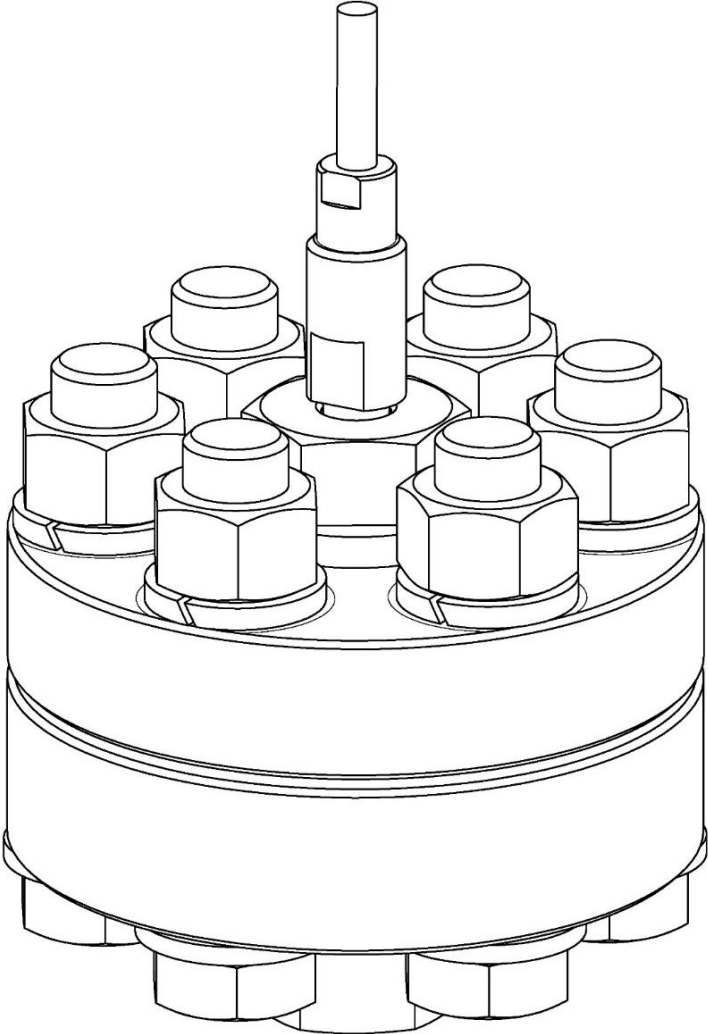


Figure 98. S-Comp60MPa separator - view in isometry.

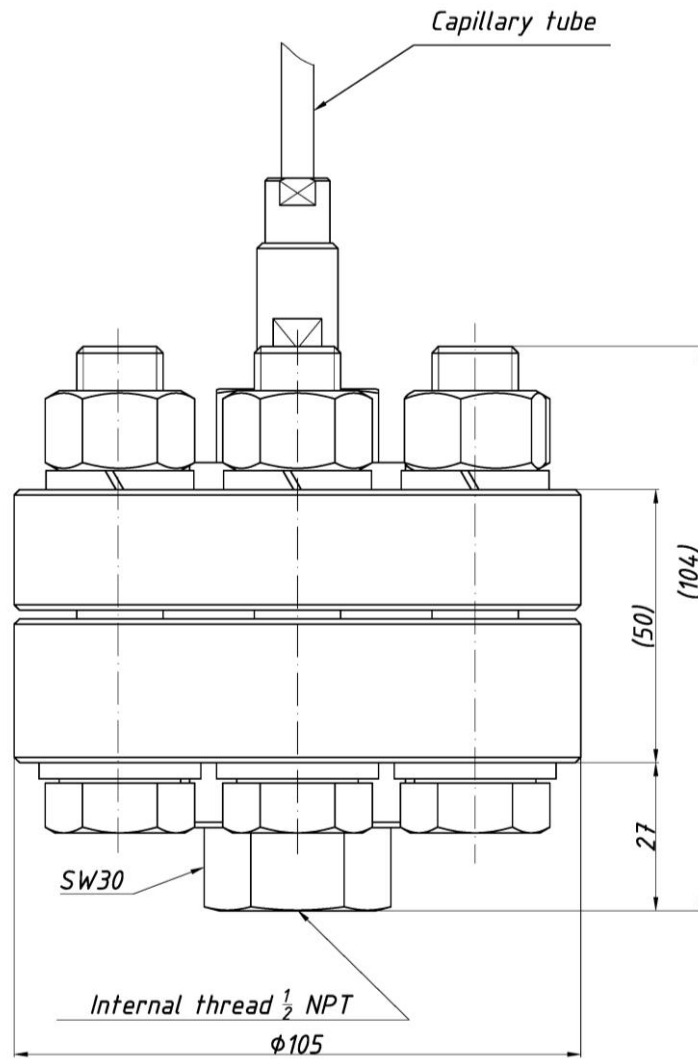


Figure 99. S-Comp60MPa separator - overall dimensions.

Using in each type of separation				
	Direct	Distance (S-Comp10/25/60)	With distance separators (S-Comp10/25/60)	With direct and distance separators (S-Comp10/25/60)
Transmitter				
APC-2000ALW Safety	✗	✓	✗	✗
APR-2000ALW Safety	✗	✓	✓	✓*
*S-Comp10/25/60MPa is intended for distance mounting only.				

Pressure gauge	Type of separation	Minimum measurement range width
APC-2000ALW Safety	Distance	1 MPa
APR-2000ALW Safety	Distance	16 kPa

Table 47. Recommended minimum range width of separator S-Comp10/25/60MPa.

Maximum measuring range:

- S-Comp10MPa: 10 MPa;
- S-Comp25MPa: 25 MPa;
- S-Comp60MPa: 60 MPa.

Permissible overload:

- S-Comp10MPa: 16 MPa;
- S-Comp25MPa: 28 MPa;
- S-Comp60MPa: 70 MPa.

Medium temperature range: -30 ... 180°C.

Special version:

- separators S-Comp25MPa, S-Comp60MPa with opening ¼ NPT which enables to flush the diaphragm.

Separator body and diaphragm material: steel 316L.

Gasket material:

- S-Comp10MPa, S-Comp25MPa – Teflon;
- S-Comp60MPa – Monel.

14.1.7. Threaded chemical seals with large diaphragm S-CompCh

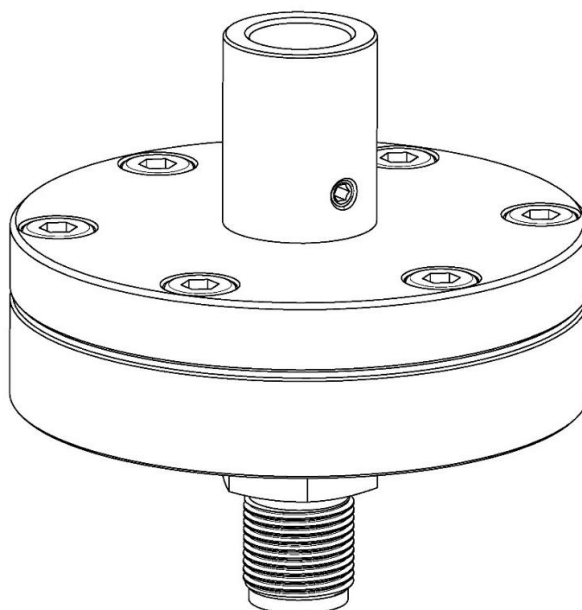


Figure 100. S-CompCh separator - view in isometry.

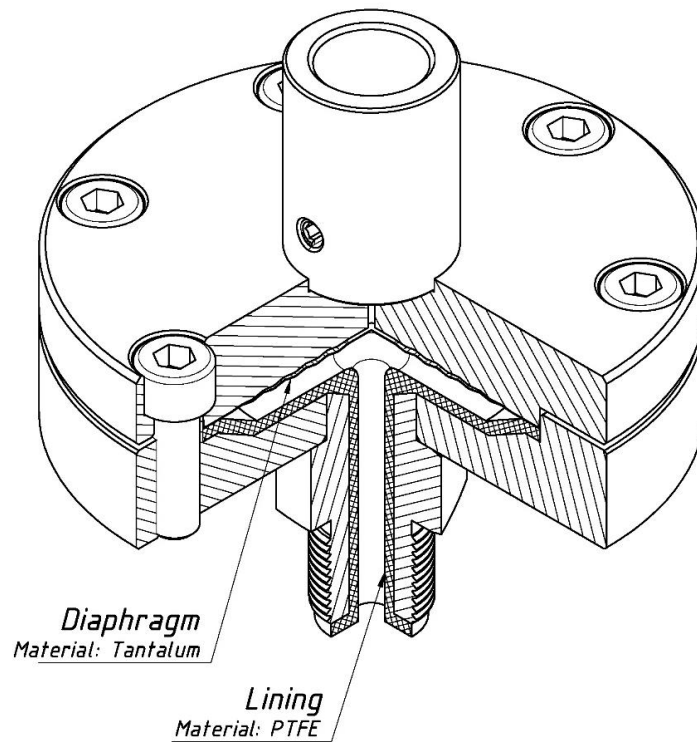


Figure 101. S-CompCh - view of half section.

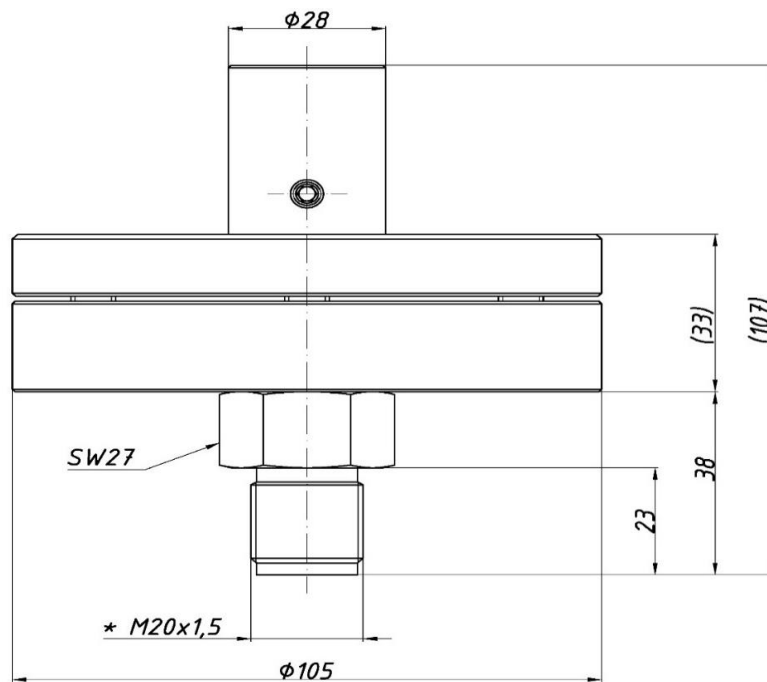


Figure 102. S-CompCh - overall dimensions.

***Optionally G ½ .**

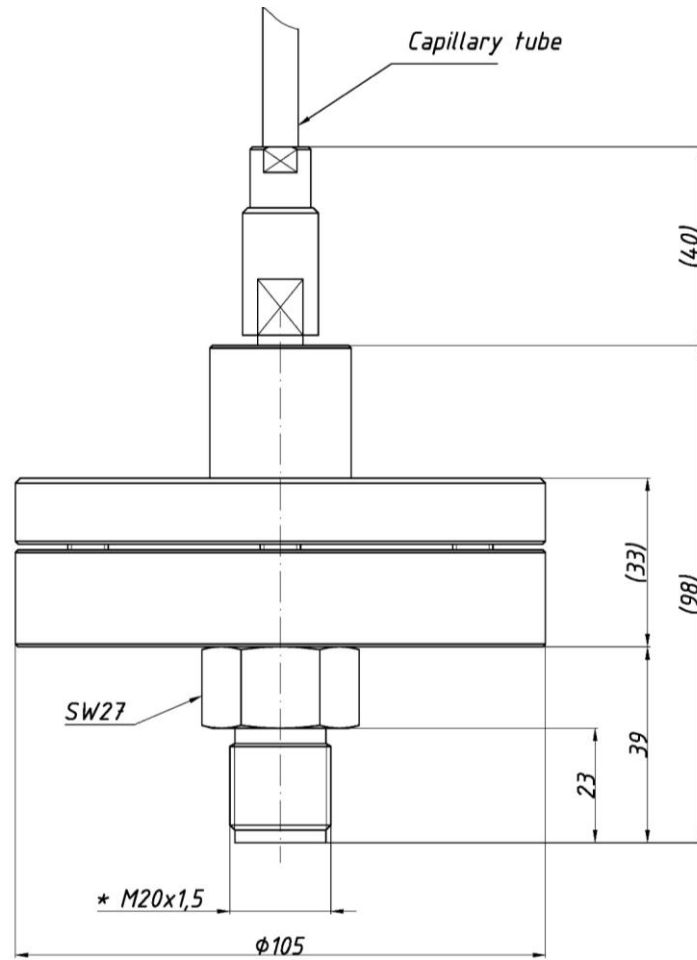


Figure 103. S-CompChK - overall dimensions.

***Optionally G ½ .**

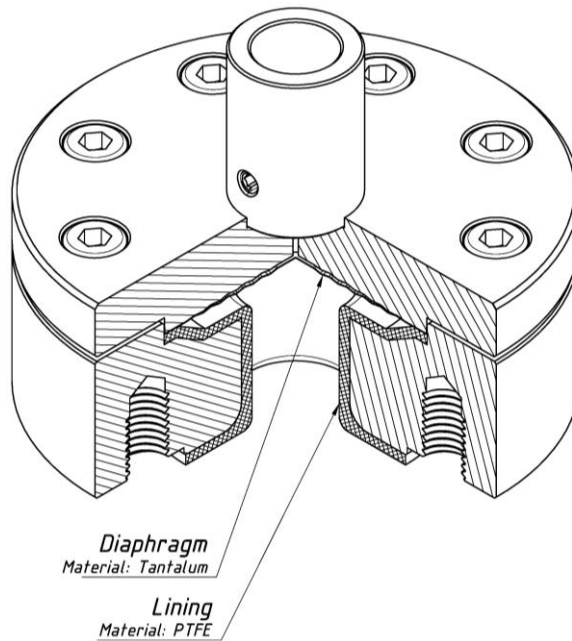


Figure 104. S-CompCh DN25 separator.

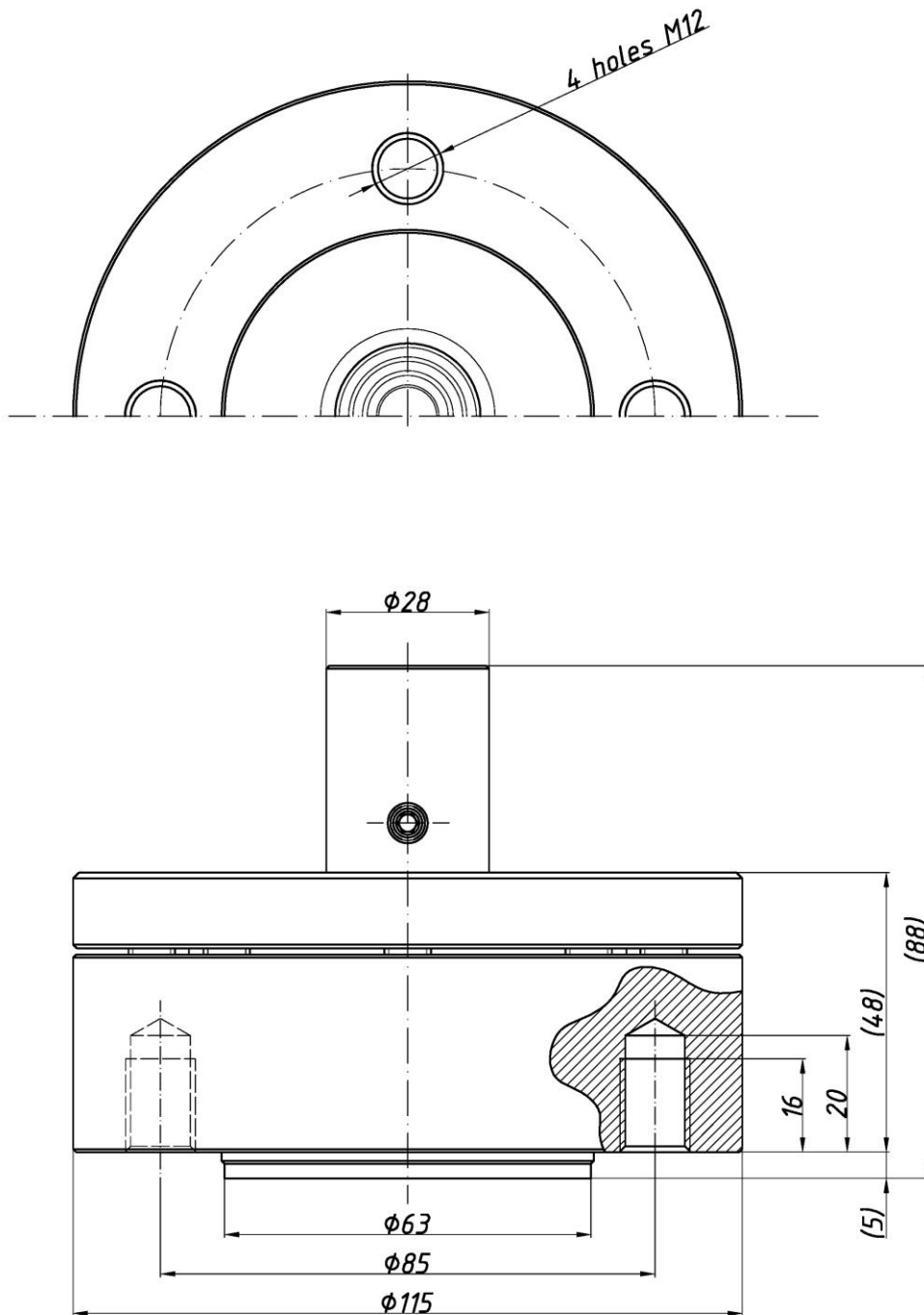


Figure 105. Separator S-CompCh DN25, half section view.

Separators S-CompCh are used for pressure measurements of chemically aggressive media. Separator parts that are in direct contact with measured medium are made of Teflon and Tantalum. These materials allow for the pressure measurements of many aggressive chemical compounds such as hydrochloric, sulphuric and nitric acid of any concentrations. Separators S-CompCh shall not be used for the measurement of hydrofluoric acid, gaseous fluorine and soda lye.

	Using in each type of separation			
	Direct (S-CompCh)	Distance (S-CompChK)	With distance separators (S-CompChK)	With direct and distance separators (S-Comp/S-CompChK)
Transmitter				
APC-2000ALW Safety	✓	✓	✗	✗
APR-2000ALW Safety	✓	✓	✓	✓

Transmitter	Type of separation	Minimum measurement range width
APC(R)-2000ALW Safety	Direct	40
	Distance	100

Table 48. Recommended minimum measurement range width of separator S-CompCh/K (kPa).

Maximum measurement range width: 0...1.6 MPa.

Type of separation	Absolute “zero” error
Direct	0.1 kPa/10°C
Distance (capillary tube 2 m)	0.6 kPa/10°C

Table 49. Additional absolute “zero” error due to the ambient temperature changes.



Please note!

The additional “zero” error due to changes of the medium temperature depends on the temperature gradient in the oil separation system and in every case is significantly smaller than the errors given in the table above.

Medium temperature range: -30 ... 100°C.

Permissible overload: 2.5 MPa.

14.1.8. Sanitary diaphragm seals

Separators S-DIN and S-Clamp are equipped with standard hygienic connections enabling the execution of measurements under aseptic conditions. Typical application of the above-mentioned separators is the measurement of pressure and level in the food and pharmaceutical industry. Aseptic separator S-Poziom is most frequently installed in the bottom of tanks. Thanks to a special design with protruded diaphragm, it does not form a pit in the area of the tank head, which eliminates the problem of products or cleaning media deposited in the pressure connection.

	Using in each type of separation			
	Direct	Distance	With distance separators	With direct and distance separators
Transmitter	S-Poziom 50mm/ S-DIN 50mm/ S-Clamp 2"/ S-DIN/ S-SMS/ S-Clamp/ S-POZIOM 50/ S-POZIOM 25/ S-DRD 65/ S-Varivent®.			
APC-2000ALW Safety	✓	✓	✗	✗
APR-2000ALW Safety	✓	✓	✓	✓

Transmitter	Type of separation	Minimum width measuring range
APC(R)-2000ALW Safety*	Direct	10
	Distance	50
*The ranges listed in the table for the variable range transmitter APC(R)-2000ALW Safety shall be understood as set ranges.		

Table 50 Recommended minimum measurement range width (kPa).

Maximum measurement range: 0...2.5 MPa.



Please note!

For the purpose of measurements within the ranges lower than the recommended ones, it is suggested to use the following types of separators special Clamp 3" and DIN 80 mm.

Type of separation	Absolute "zero" error per 10°C for the separator	
	S-Clamp and S-DIN	S-Poziom
Direct	0.08 kPa/10°C	0.03 kPa/10°C
Distance (capillary tube 2 m)	0.5 kPa/10°C	0.3 kPa/10°C

Table 51. Additional absolute "zero" error due to the ambient temperature changes.



For a set of pressure transmitter and special separator (with larger diameter) temperature errors diminish proportionally to the third power of the active diaphragm diameter.



Please note!

Additional "zero" error due to the changes of the medium temperature depends on the temperature gradient in the oil separation system and in each case it is considerably smaller than the errors given in the table above.

Basic dimensions of separators with standard connections intended for food industry.

S-DIN

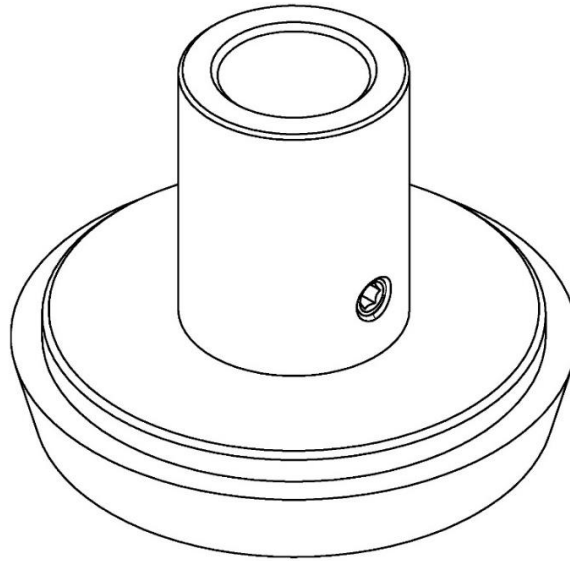


Figure 106. S-DIN separator. View in isometry.

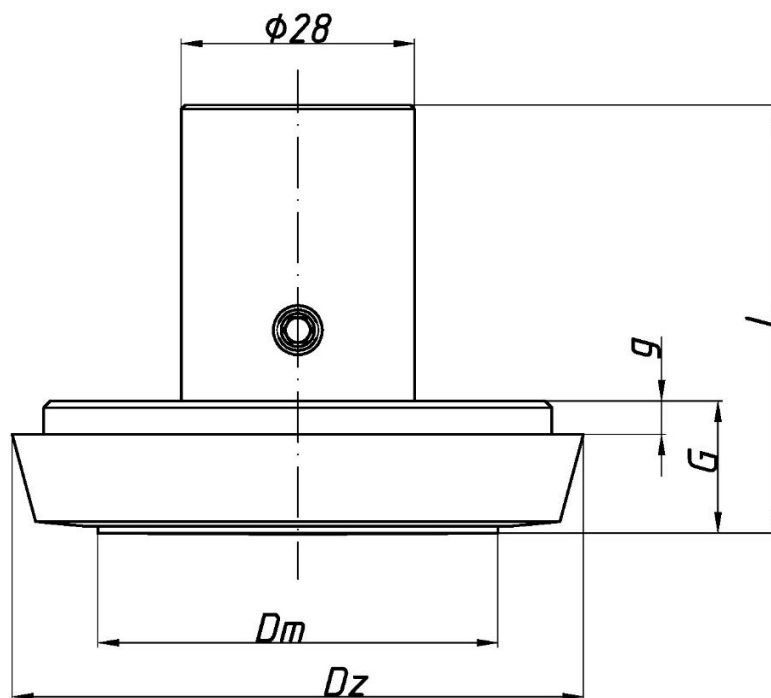


Figure 107. S-DIN - overall dimensions.

Separator	Dz [mm]	Dm [mm]	G [mm]	g [mm]	L [mm]
S-DIN 25	44	25	15,8	5	52,3
S-DIN 32	50	30	15,8	5	52,3
S-DIN 40	56	35	14,8	4	51,3
S-DIN 50	68,5	48	15,8	4	51,3
S-DIN 65	86	59	16,8	4	52,3
S-DIN 80	100	75	16,8	4	52,3

Table 52. Size of S-DIN separators acc. to DIN 11851, for pipes acc. to DIN 11850 series 2.

S-DIN (distance separator with capillary in axis)

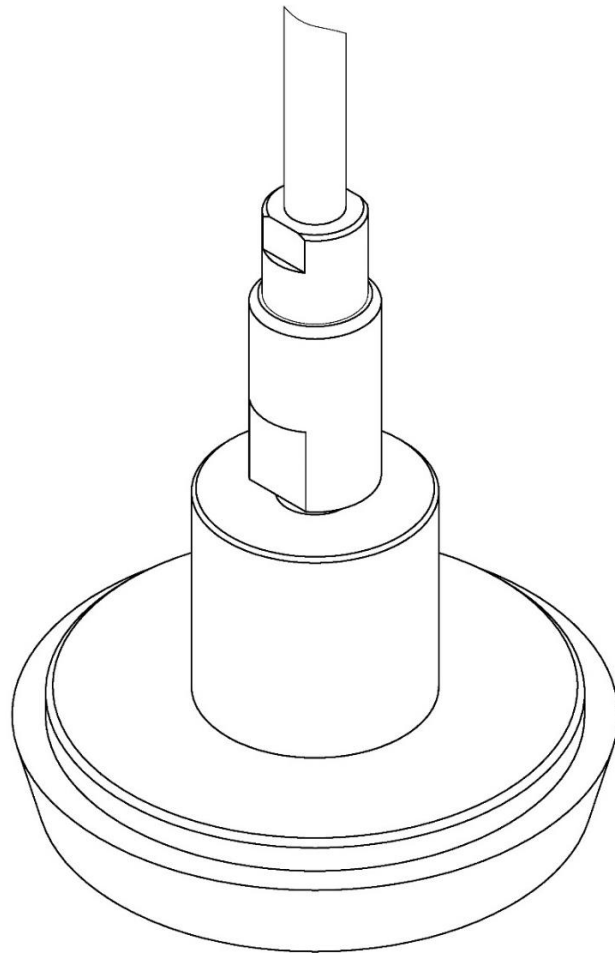


Figure 108. S-K DIN with capillary in axis.

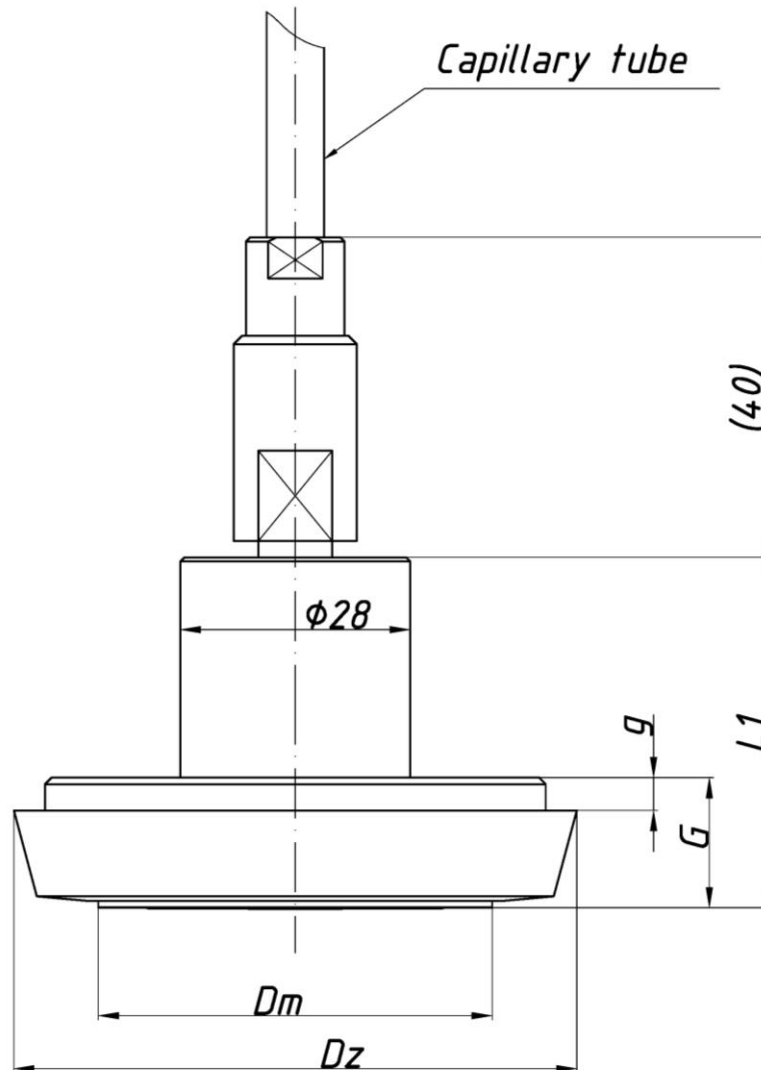


Figure 109. S-K DIN separator with capillary in axis - overall dimensions.

Separator	Dz [mm]	Dm [mm]	G [mm]	g [mm]	L1 [mm]
S-DIN 25	44	25	15.8	5	43,3
S-DIN 32	50	30	15.8	5	43,3
S-DIN 40	56	35	14.8	4	42,3
S-DIN 50	68.5	48	15.8	4	42,3
S-DIN 65	86	59	16.8	4	43,3
S-DIN 80	100	75	16.8	4	43,3

Table 53. Dimensions of separators S-K DIN according to DIN 11851 for pipes consistent with DIN 11850 Series 2.

S-SMS

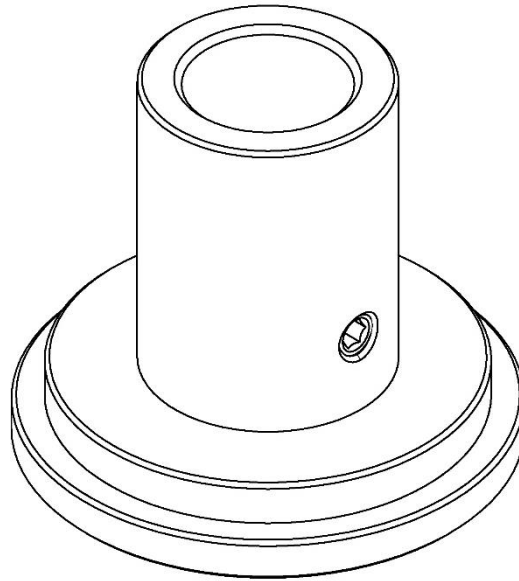


Figure 110. S-SMS separator. View in isometry.

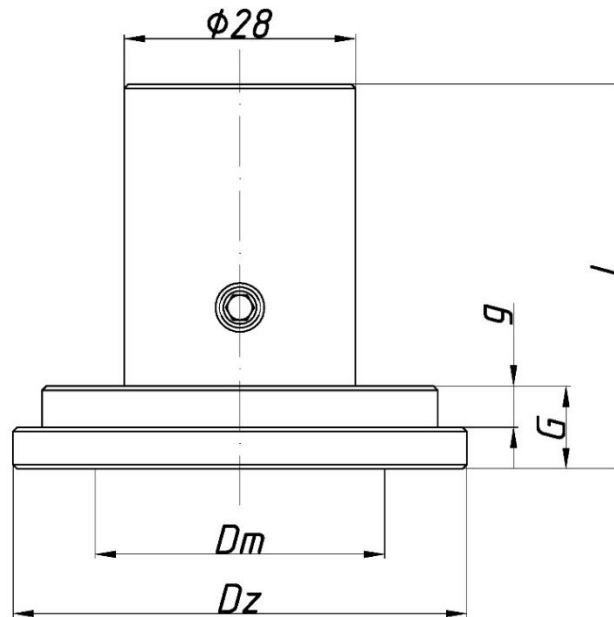


Figure 111. Overall dimensions of separator S-SMS.

Separator	Dz [mm]	Dm [mm]	G [mm]	g [mm]	L [mm]
S-SMS 1"	35.5	25	6.2	2	42.7
S-SMS 1.5"	54.9	35	10	4	46.5
S-SMS 2"	64.9	48	10	5	46.5

Table 54. Dimensions of separator S-SMS according to SMS (SS 3352) for pipes consistent with ISO 1127 Series 2 or ISO 2037/1992.

Separator S-SMS distance with capillary in axis of separator

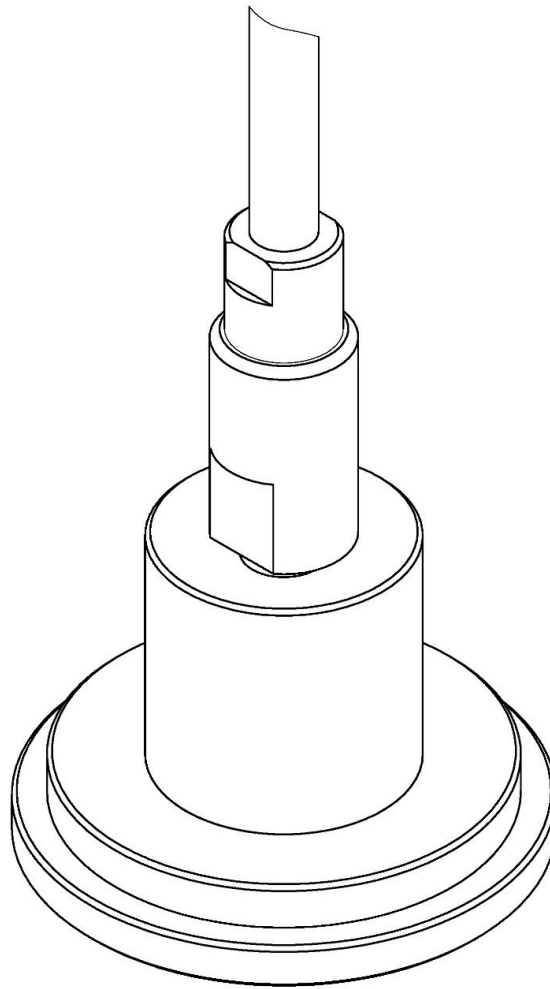


Figure 112. S-K SMS separator with capillary in axis. View in isometry.

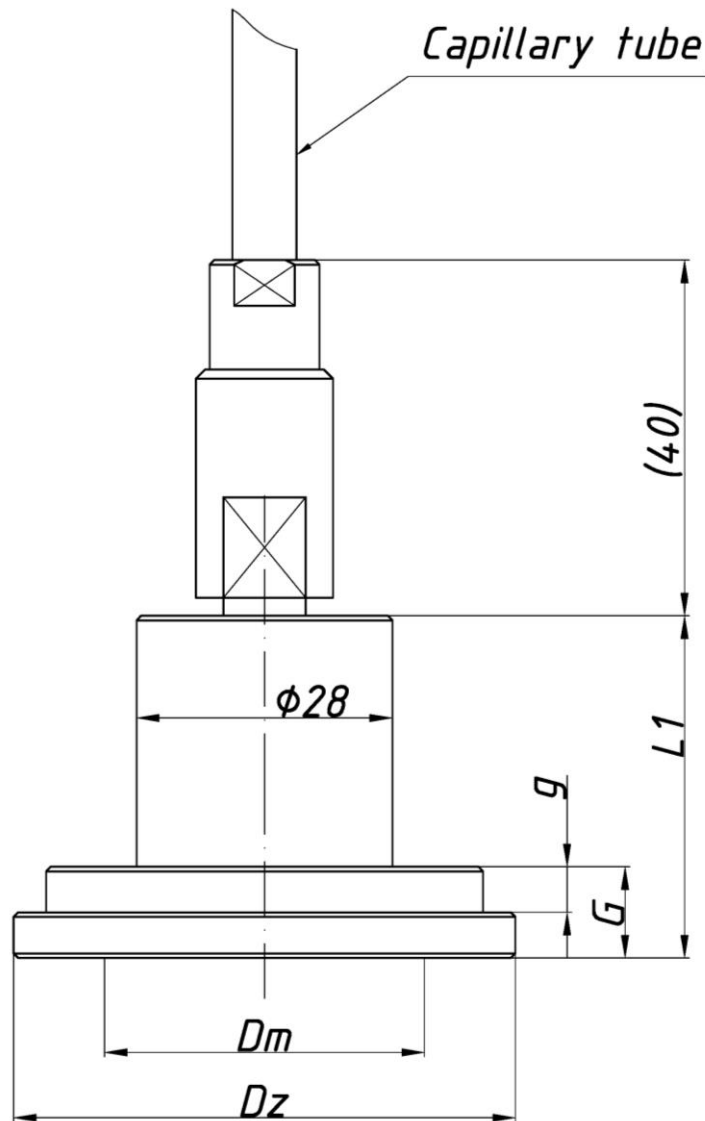


Figure 113. S-K SMS separator with capillary in axis - overall dimensions.

Separator	Dz [mm]	Dm [mm]	G [mm]	g [mm]	L ₁ [mm]
S-SMS 1"	35,5	25	6,2	2	33,7
S-SMS 1,5"	54,9	35	10	4	37,5
S-SMS 2"	64,9	48	10	5	37,5

Table 55. Dimensions of separator S-K SMS according to SMS (SS 3352) for pipes consistent with ISO 1127 Series 2 or ISO 2037/1992.

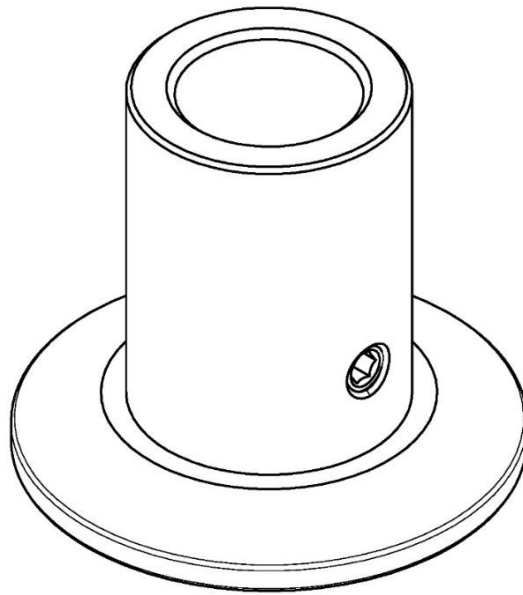
S-Clamp

Figure 114. S-Clamp separator. View in isometry.

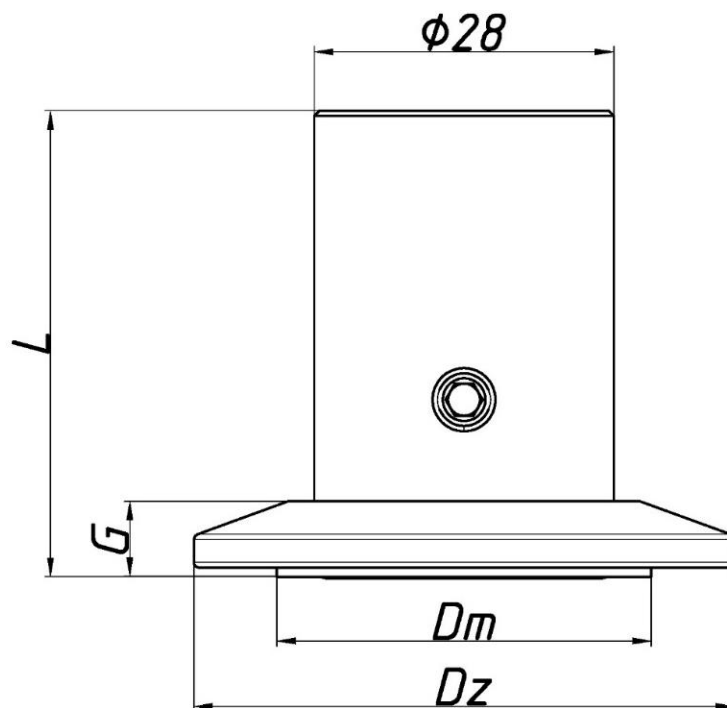


Figure 115. S-Clamp separator- overall dimensions.

Separator	Dz [mm]	Dm [mm]	G [mm]	L [mm]
S-Clamp 1"	50.5	22	7	43.5
S-Clamp 1.5"	50.5	35	7	43.5
S-Clamp 2"	64	48	7	43.5
S-Clamp 2.5"	77.5	54	7	43.5
S-Clamp 3"	91	70	7.8	44.3
S-Clamp 4"	119	89	9.8	45.8

Table 56. Dimensions of separator S-Clamp according to DIN 32676 for pipes consistent with DIN 11866 Series C or ASME BPE.

Separator	Dz [mm]	Dm [mm]	G [mm]	L [mm]
S-Clamp DN 25	50.5	25	7	43.5
S-Clamp DN 40	50.5	35	7	43.5
S-Clamp DN 50	64	48	7	43.5
S-Clamp DN 65	91	70	7.8	44.3
S-Clamp DN 100	119	89	9.8	45.8

Table 57. Dimensions of separator S-Clamp according to DIN 32676 for pipes consistent with DIN 11866 Series A or DIN 11850 series 2.

S-K Clamp (distance separator with capillary in axis)

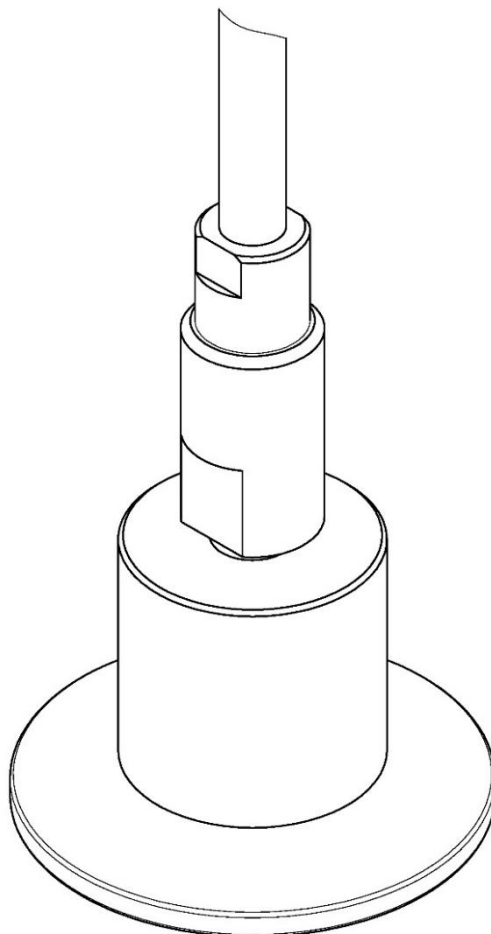


Figure 116. S-K Clamp separator (distance separator with capillary in axis).

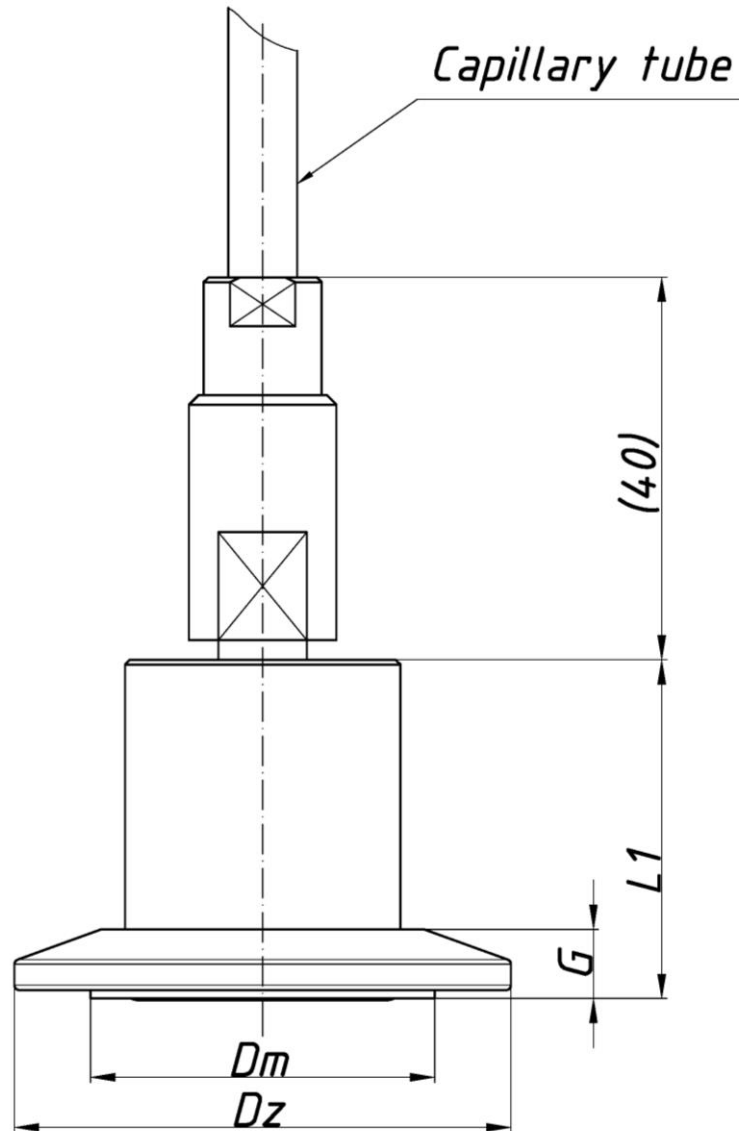


Figure 117. S-K Clamp separator - overall dimensions.

Separator	Dz [mm]	Dm [mm]	G [mm]	L1 [mm]
S-Clamp 1"	50.5	22	7	34.5
S-Clamp 1.5"	50.5	35	7	34.5
S-Clamp 2"	64	48	7	34.5
S-Clamp 2.5"	77.5	54	7	34.5
S-Clamp 3"	91	70	7.8	35.3
S-Clamp 4"	119	89	9.8	36.8

Table 58. Dimensions of separator S-K Clamp according to DIN 32676 for pipes consistent with DIN 11866 series C or ASME BPE.

Separator	Dz [mm]	Dm [mm]	G [mm]	L ₁ [mm]
S-Clamp DN 25	50.5	25	7	34.5
S-Clamp DN 40	50.5	35	7	34.5
S-Clamp DN 50	64	48	7	34.5
S-Clamp DN 65	91	70	7.8	35.3
S-Clamp DN 100	119	89	9.8	36.8

Table 59. Dimensions of separator S-K Clamp according to DIN 32676 for pipes consistent with DIN 11866 series A or DIN 11850 series 2.

S-POZIOM 25

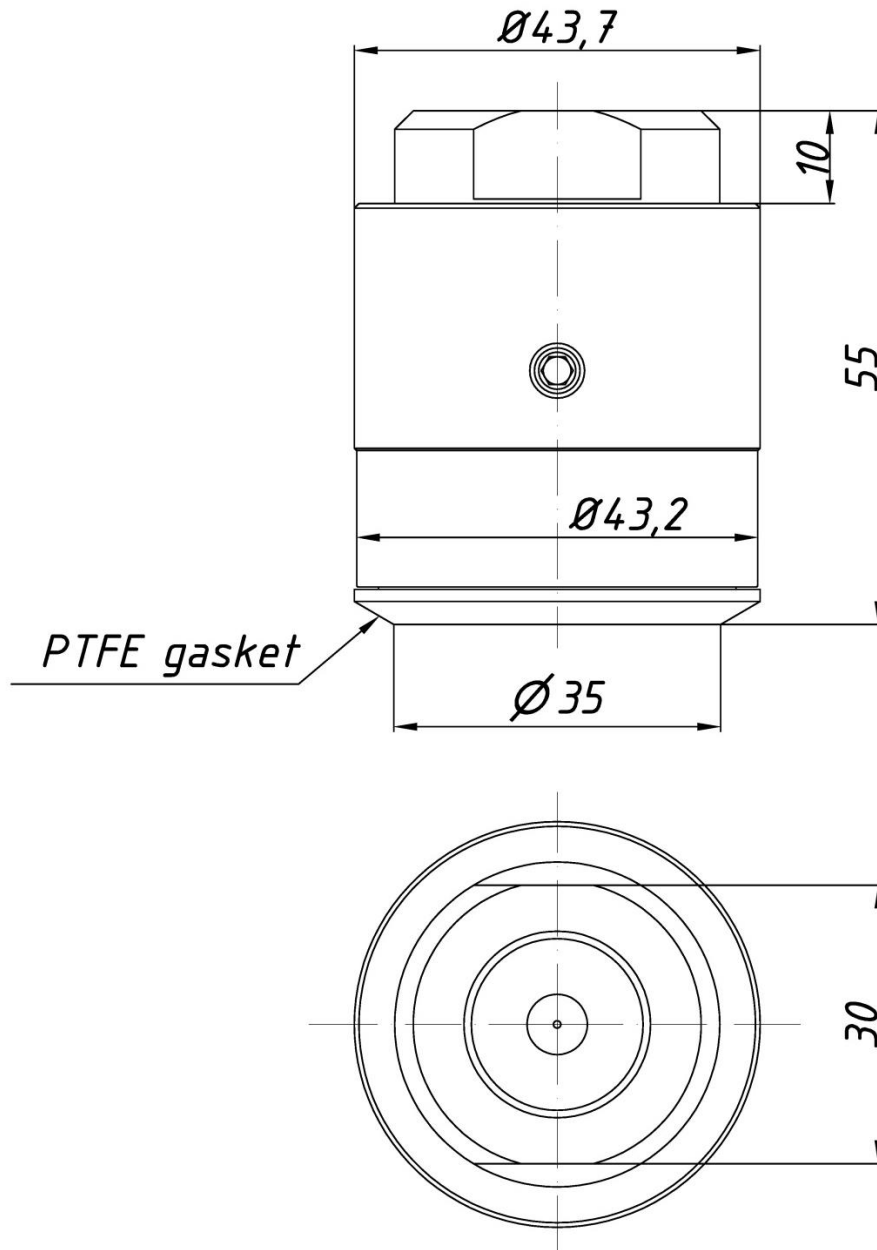


Figure 118. S-POZIOM 25 separator - overall dimensions.

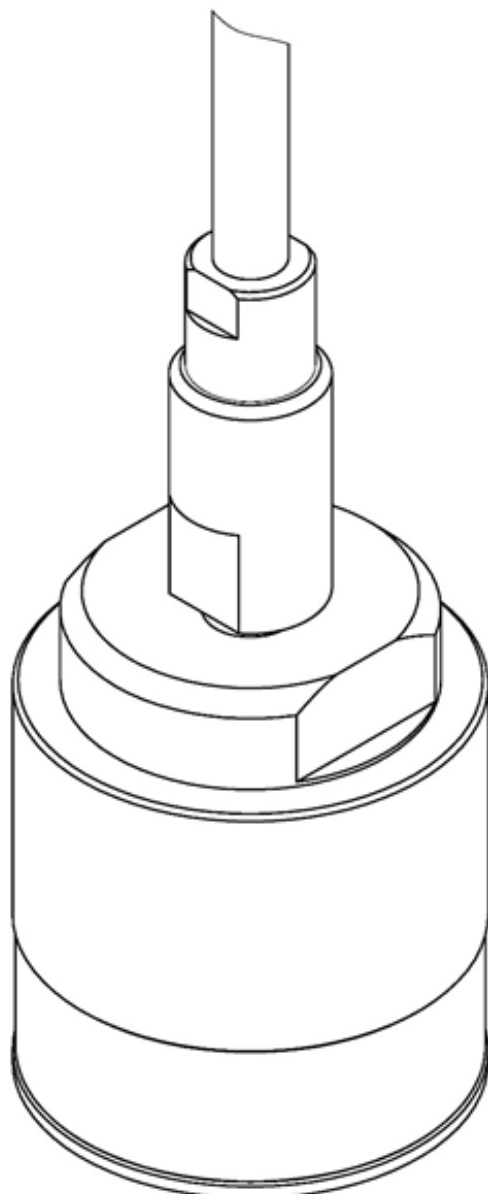


Figure 119. S-K Poziom 25 distance separator with capillary in axis.

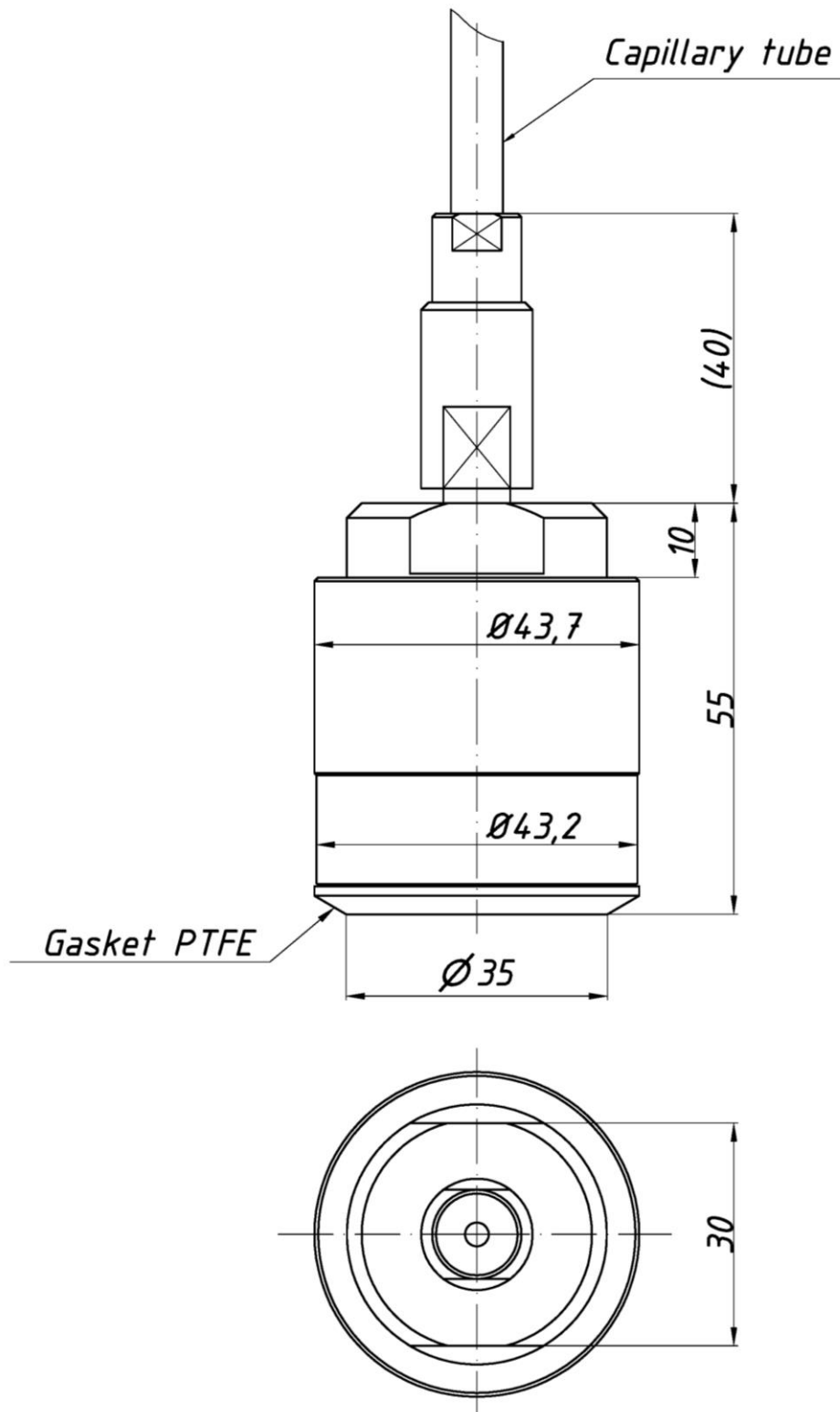


Figure 120. S-K Poziom 25 distance separator with capillary in axis - overall dimensions.

S-Poziom 50

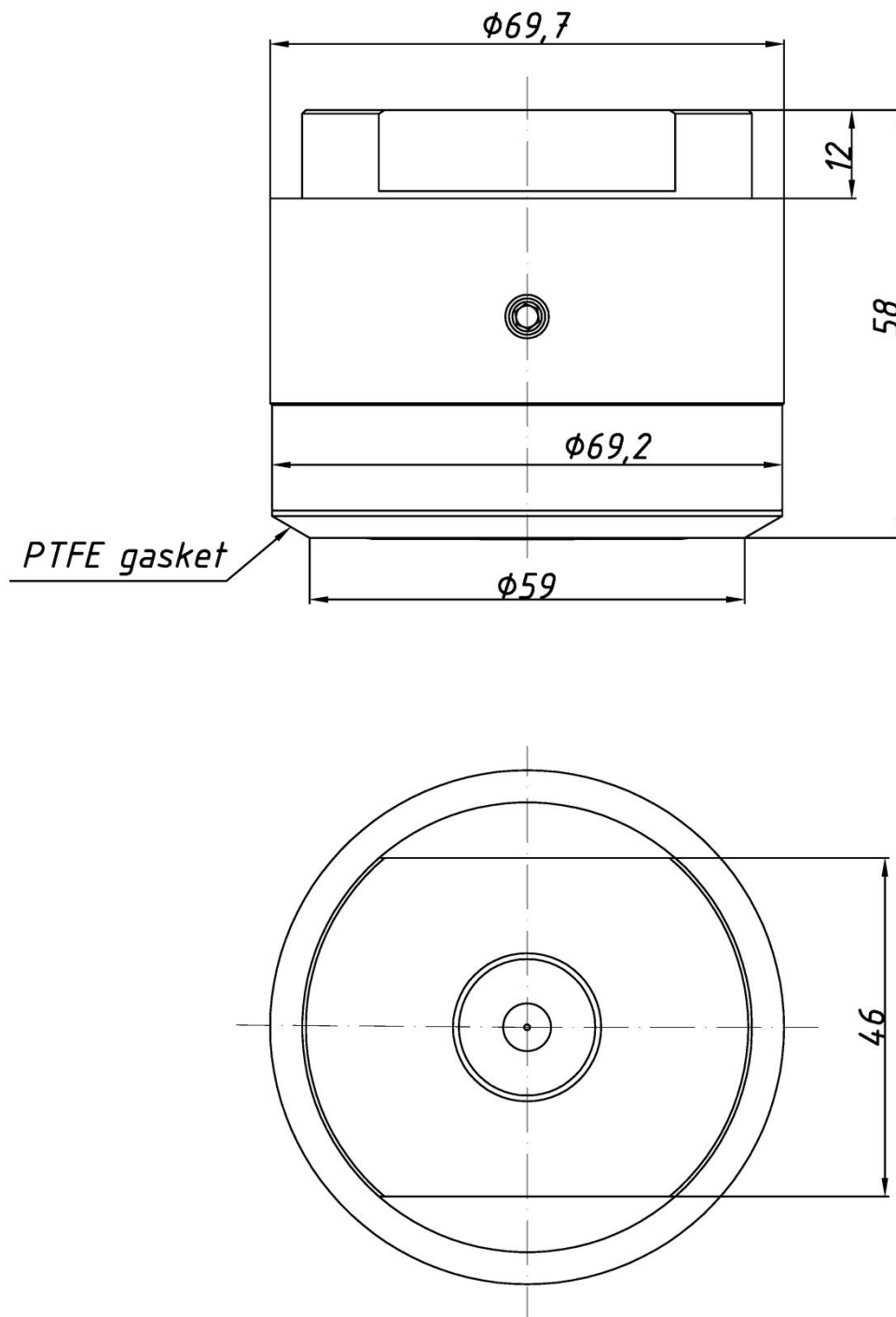


Figure 121. S-Poziom 50 separator - overall dimensions..

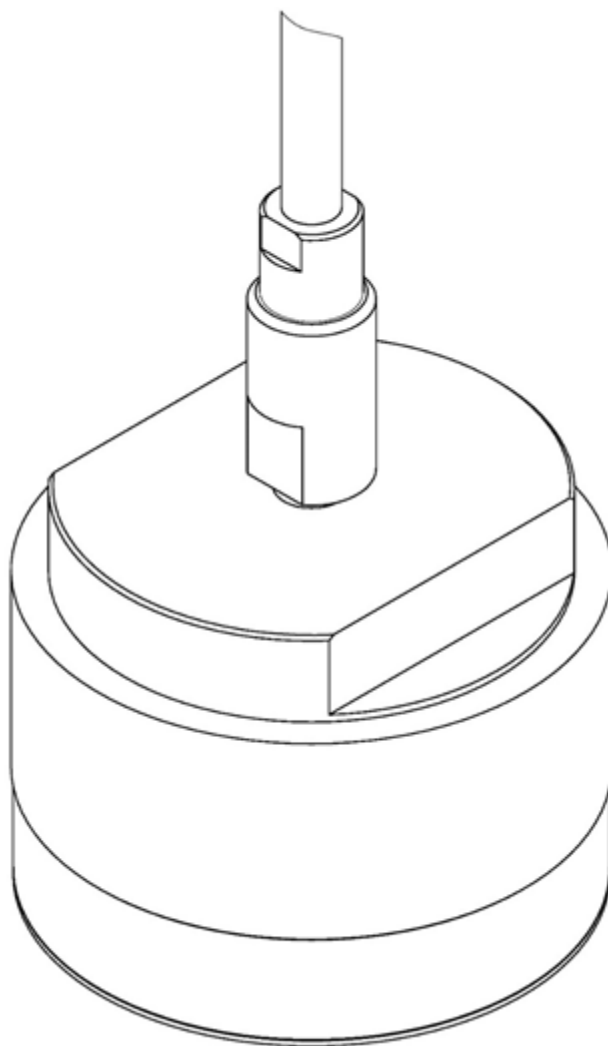


Figure 122. S-K Poziom 50 distance separator with capillary n axis, view in isometry.

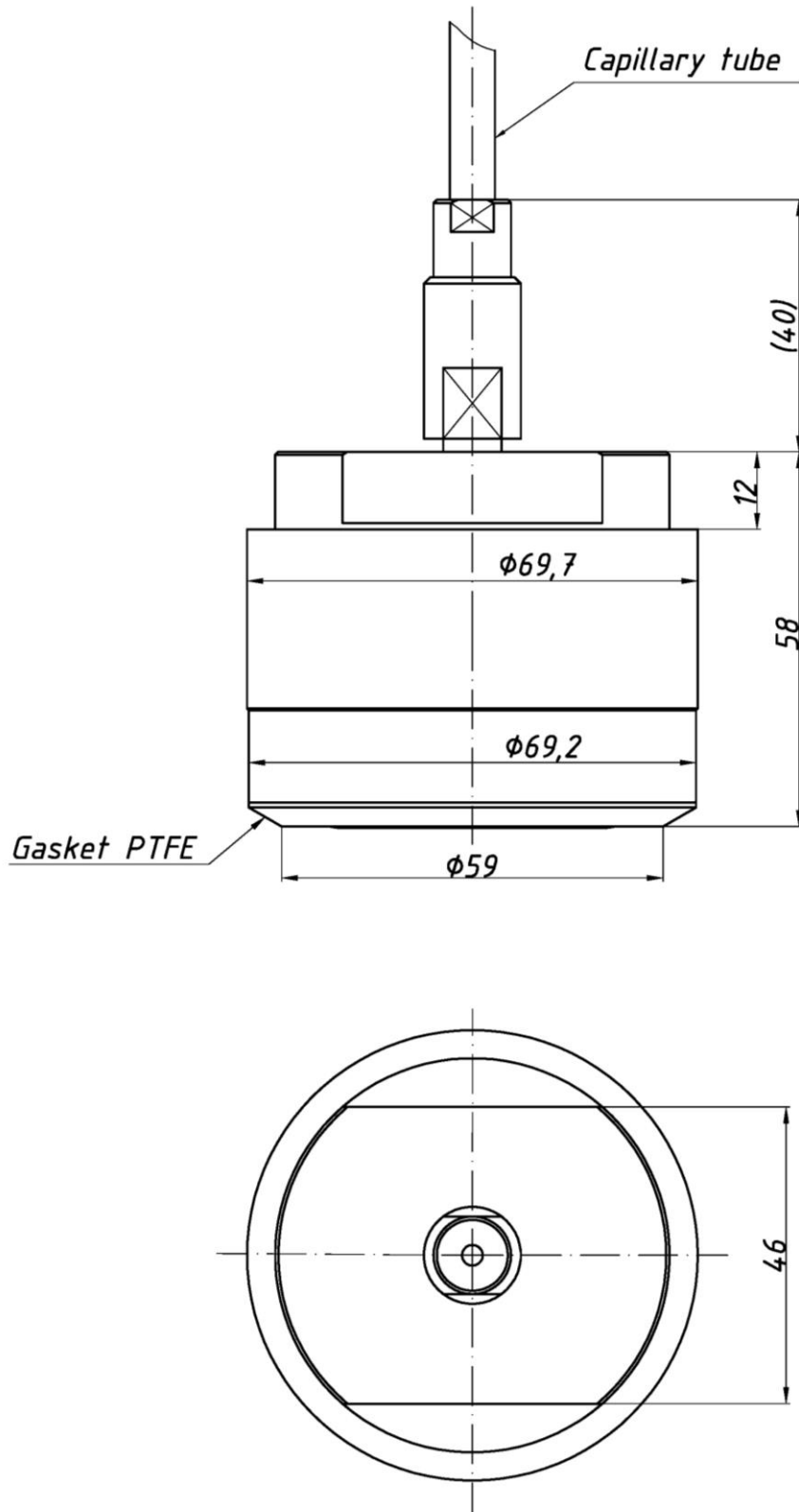


Figure 123. S-K Poziom 50 distance separator with capillary in axis - overall dimensions.

S-DRD 65

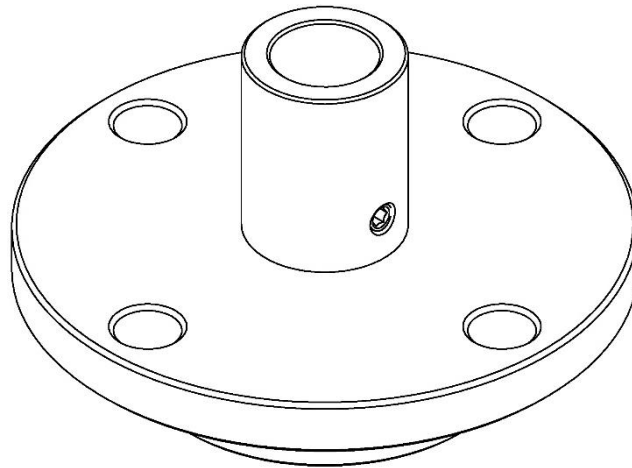


Figure 124. S-DRD 65 separator. View in isometry.

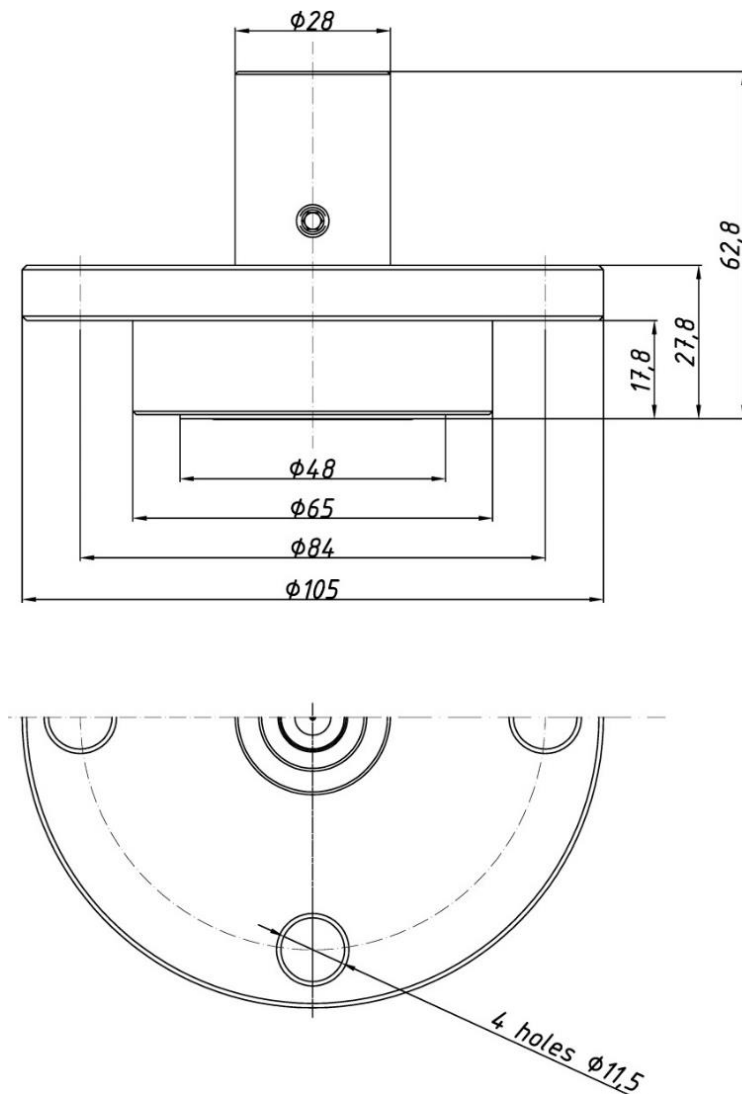


Figure 125. S-DRD 65 separator - overall dimensions.

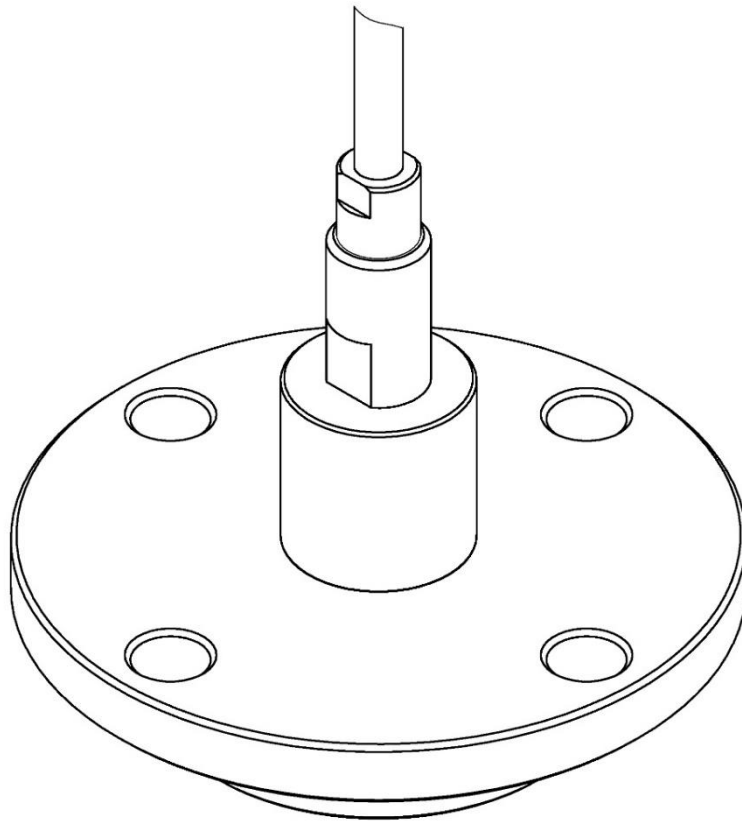


Figure 126. S-DRD 65 separator(distance separator with capillary in axis) - view in isometry.

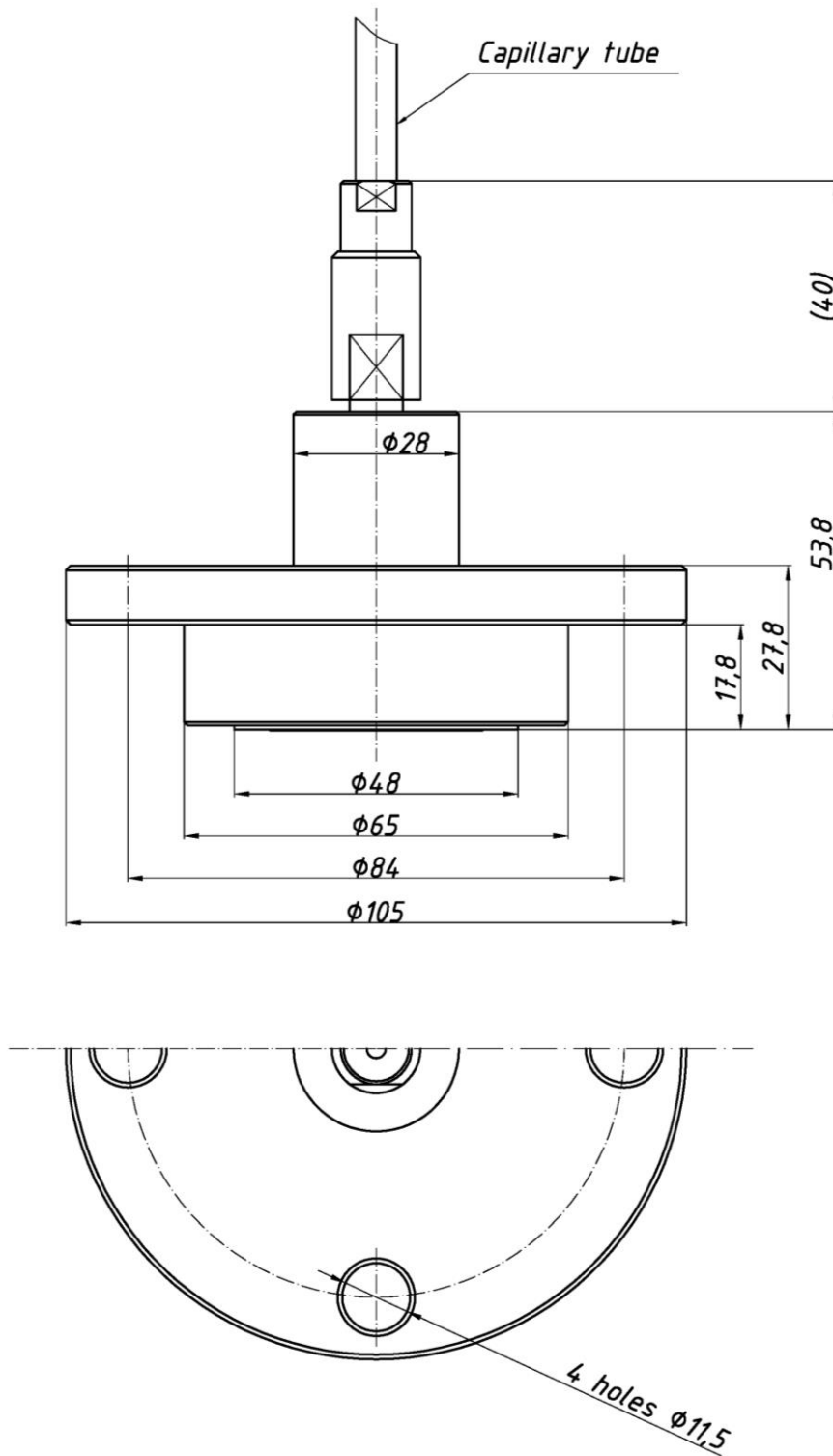


Figure 127. S-K DRD 65 separator (distance separator with capillary in axis) - overall dimensions.

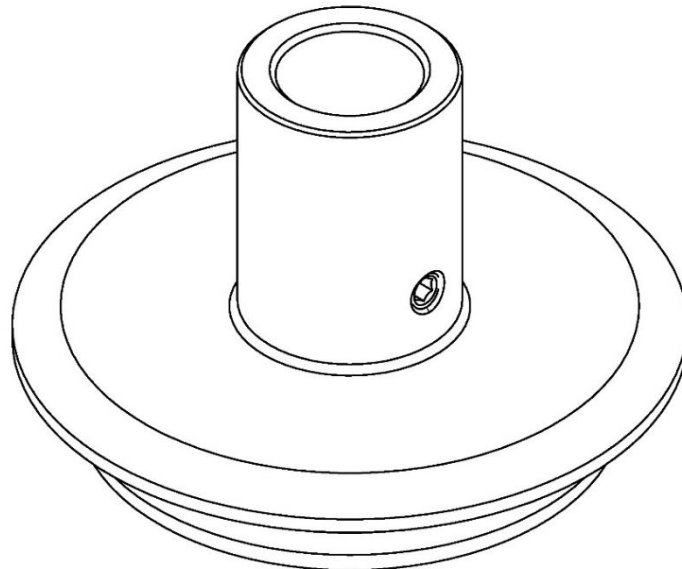
S-Varivent

Figure 128. S-Varivent DN50 separator - view in isometry.

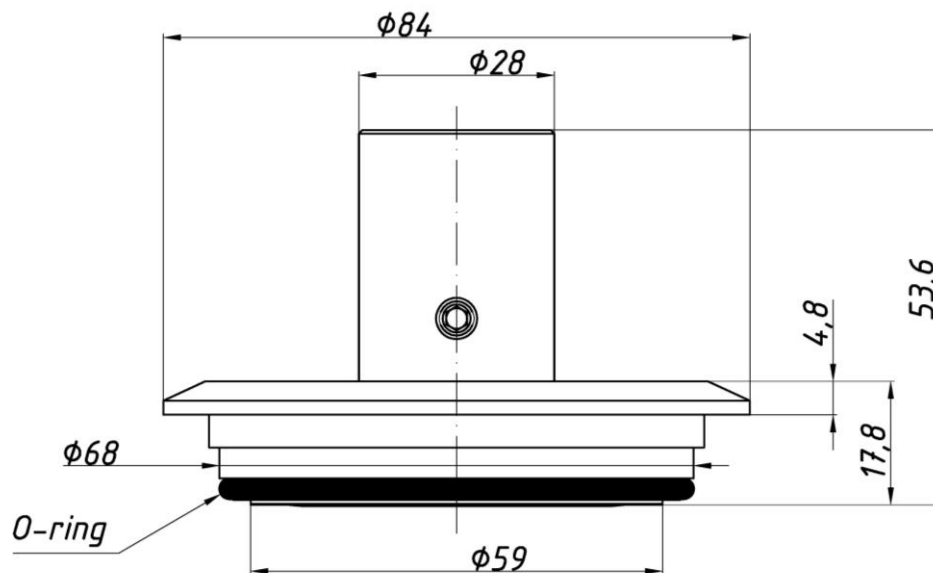


Figure 129. S-Varivent DN50 separator - overall dimensions.

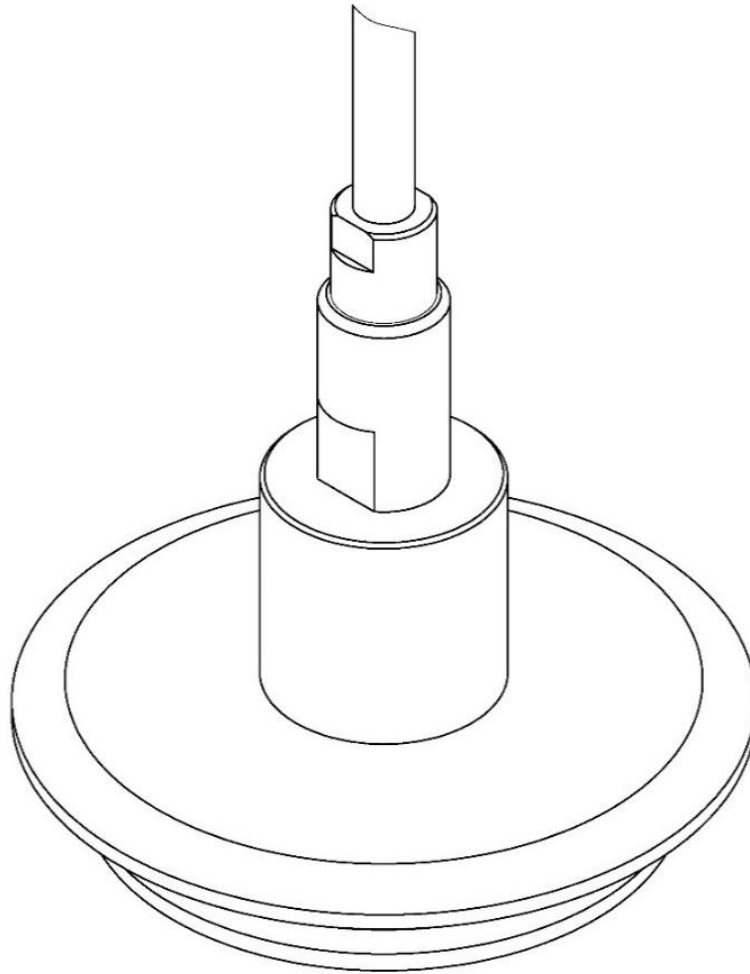
S-K Varivent

Figure 130. S-K Varivent DN50 separator (distance separator with capillary in axis) - view in isometry.

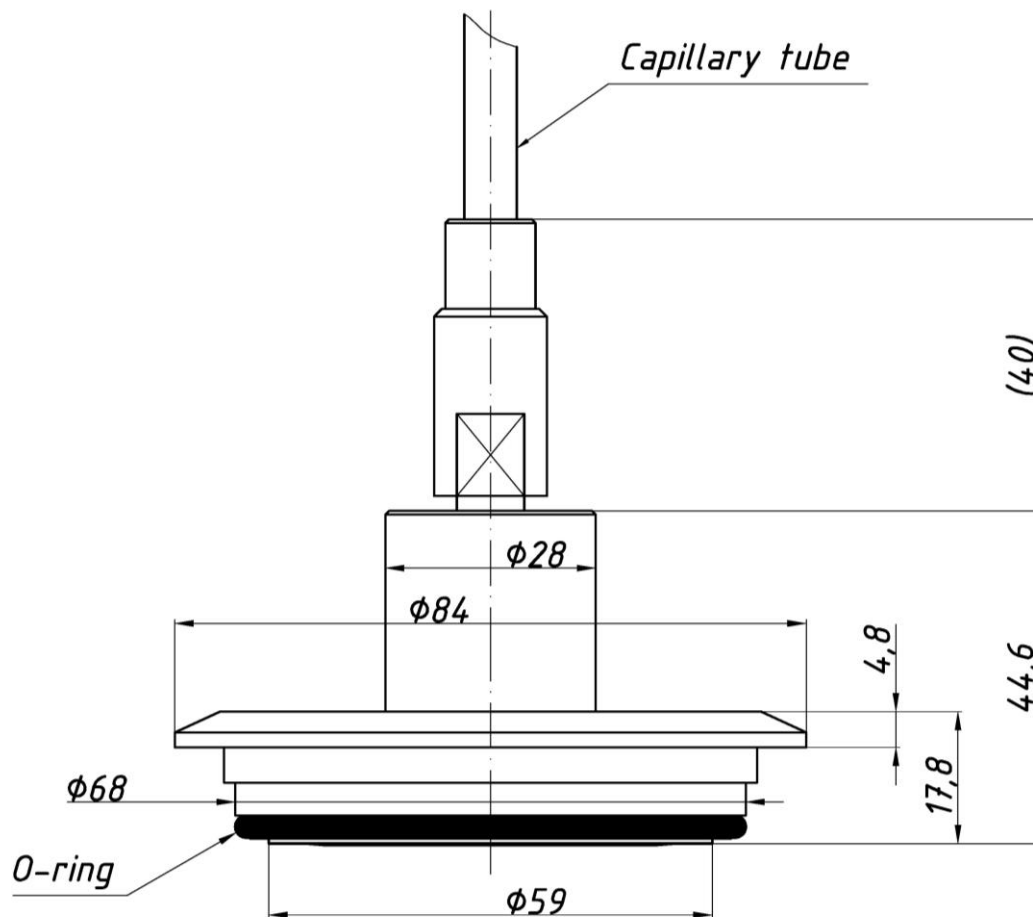


Figure 131. S-K Varivent DN50 (distance separator with capillary in axis) - overall dimensions.

Medium temperature range:

- -30 ... 200°C for distance separation;
- -20 ... 150°C for direct separation;
- -30 ... 85°C for operation in the range up to -100 kPa.

Special versions:

- filling with NEOBEE M-20 liquid permitted to come into contact with food (medium temperature: -10 ... 150°C);
- separators sanitary seals, e.g. DIN 25 mm, DIN 40 mm or Tri-Clamp® 1", Tri-Clamp1.5", SMS 50 mm, DRD, Homogenizator, Varivent;
- seal with customised connection;
- direct diaphragm seal for medium temp. over 150°C;
- other to be agreed with Aplisens consultants.

14.1.9.S-Mazut separators

Separator S-Mazut is used to measure the media characterized by increased viscosity and temperature up to 150°C (315°C for distance separation). A typical application is the measurement of mazout pressure in burners and mazout nodes of power boilers.

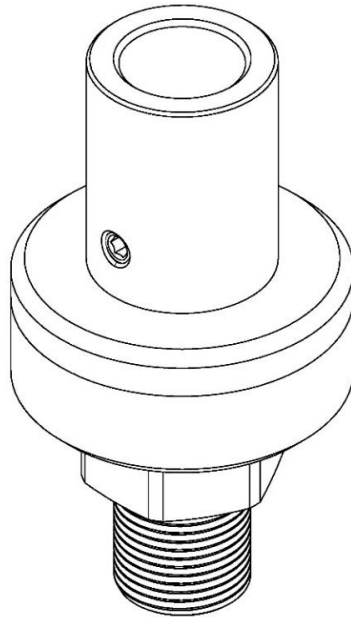


Figure 132. S-Mazut separator. View in isometry.

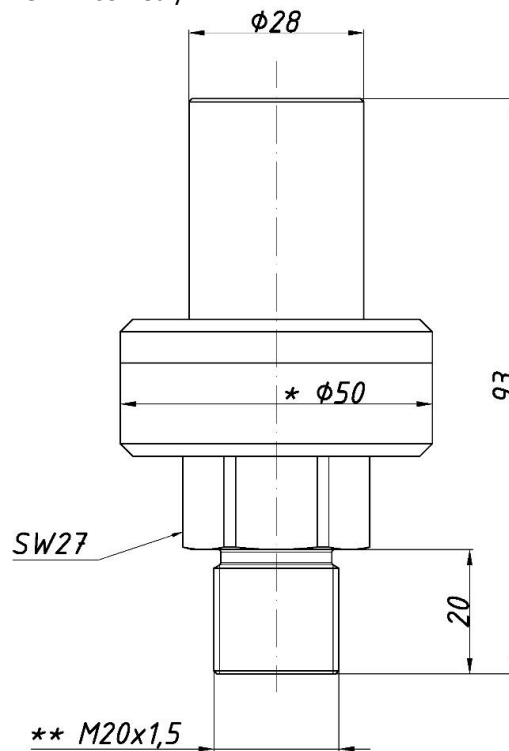


Figure 133. S-Mazut separator - overall dimensions.

Please note!

*special execution ϕ 75, ϕ 100;

**optionally G $\frac{1}{2}$.

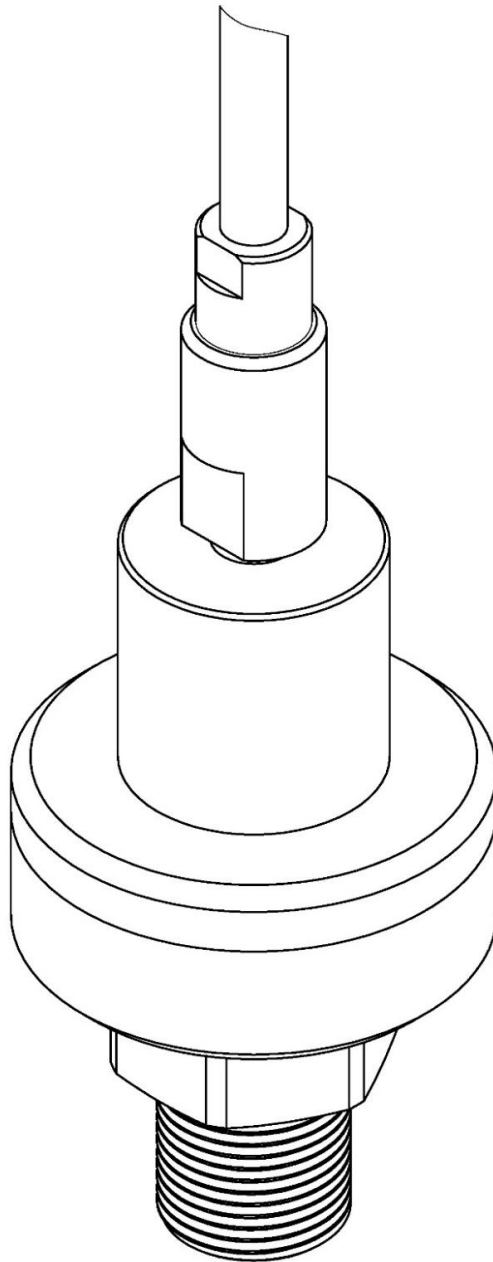
S-MazutK (distance separator with capillary in axis)

Figure 134. S-MazutK distance separator with capillary in axis. View in isometry.

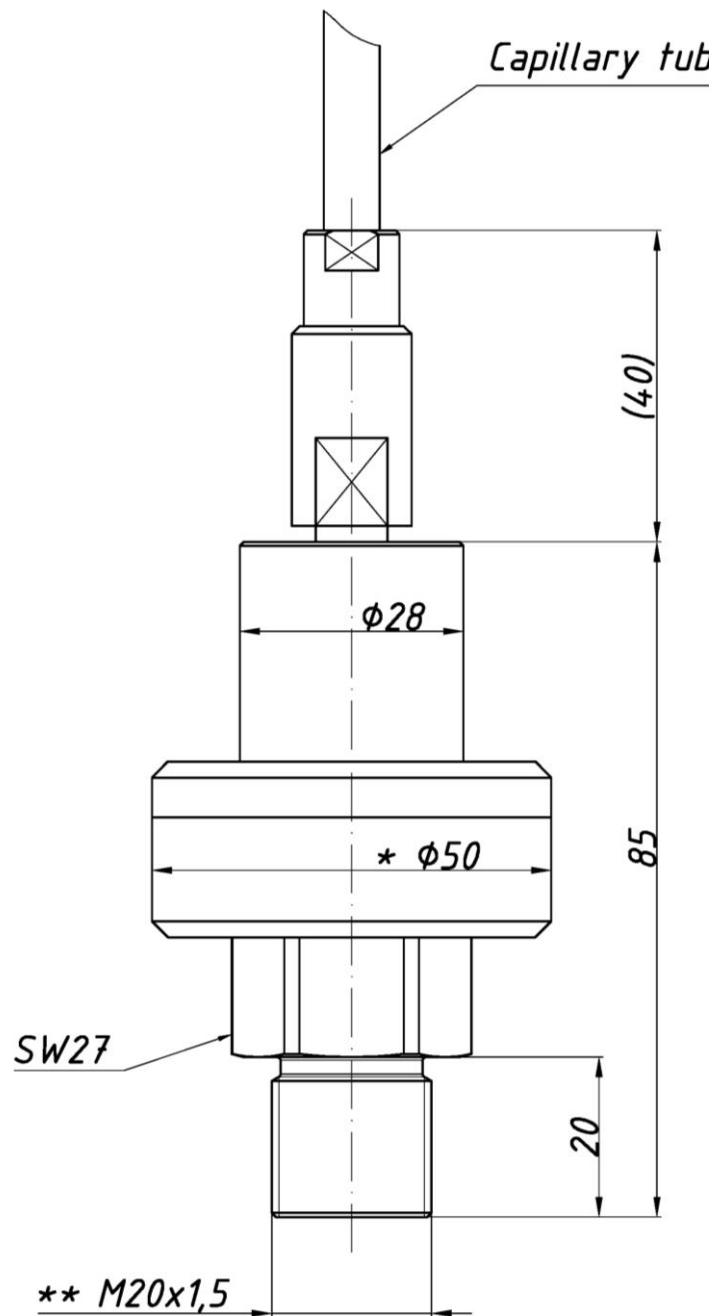
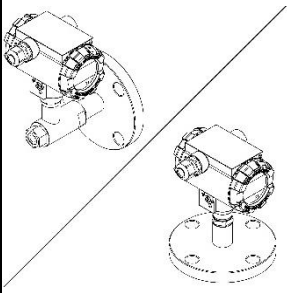
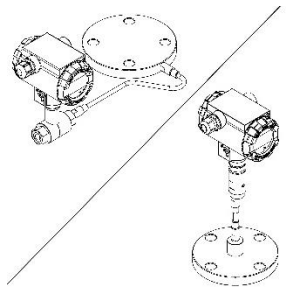
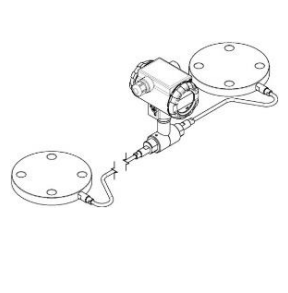
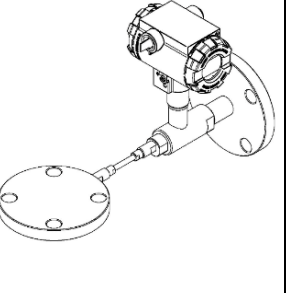


Figure 135. S-MazutK distance separator with capillary in axis - overall dimensions.

Please note!

*special execution $\phi 75$, $\phi 100$;

**optionally G $\frac{1}{2}$.

	Using in each type of separation			
	Direct (S-Mazut)	Distance (S-MazutK)	With distance separators (S-MazutK)	With direct and distance separators (S-Mazut/S-MazutK)
Transmitter				
APC-2000ALW Safety	✓	✓	✗	✗
APR-2000ALW Safety	✓	✓	✓	✓

Type of separation	Min. width range		
	S-Mazut	S-Mazut75	S-Mazut100
Direct	250	10	5
Distance	600	40	25

Table 60. Recommended minimum measurement range width (kPa) for separator S-Mazut/K.

Maximum measurement range: 0 ... 7 MPa.

Type of separation	Absolute "zero" error		
	S-Mazut	S-Mazut75	S-Mazut100
Direct	0,4kPa/10°C	0,2kPa/10°C	0,08kPa/10°C
Distance (capillary 2m)	0,5kPa/10°C	0,3kPa/10°C	0,1kPa/10°C

Table 61. Additional absolute "zero" error due to the ambient temperature changes of separator S-Mazut, S-Mazut75 and S-Mazut100.



Please note!

For a set of pressure transmitter and special separator (with larger diameter) temperature errors diminish proportionally to the third power of the active diaphragm diameter. Additional "zero" error due to the changes of the medium temperature depends on the temperature gradient in the oil separation system and in each case it is considerably smaller than the errors given in the table above.

Medium temperature range:

- -10 ... 315°C for distance separation;
- -10 ... 150°C for direct separation.

Special versions:

- versions $\varnothing 75$, $\varnothing 100$ for low ranges;
- other to be agreed with Aplisens consultants.

Permissible overload:

- S-Mazut: 11 MPa;
- S-Mazut75: 5MPa;
- S-Mazut100: 4MPa.

Diaphragm and connection material: 1.4404 (steel 316L).

14.1.10. S-RC separators

Separators S-RC are used for measurements of hot media characterized by increased viscosity, solidification or contamination wherever it is impossible to use an impulse tube.

For installation of transmitters with S-RC separators on site, it is recommended to welding mounting rings manufactured by Aplisens S.A..

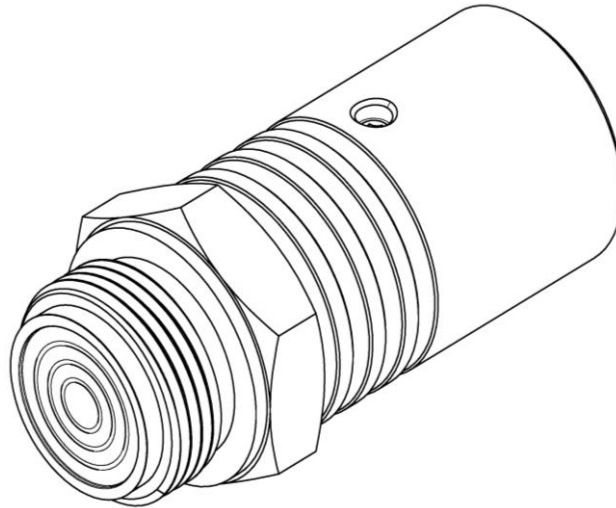


Figure 136. S-RCM30x2 separator - view in isometry.

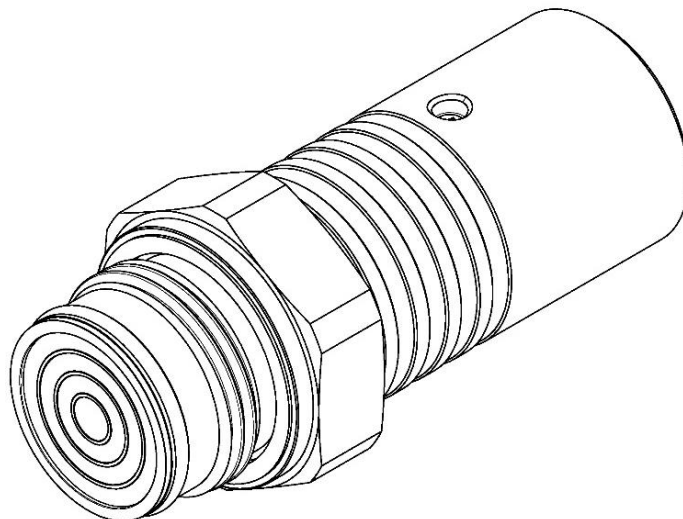


Figure 137. S-RCG1 separator - view in isometry.

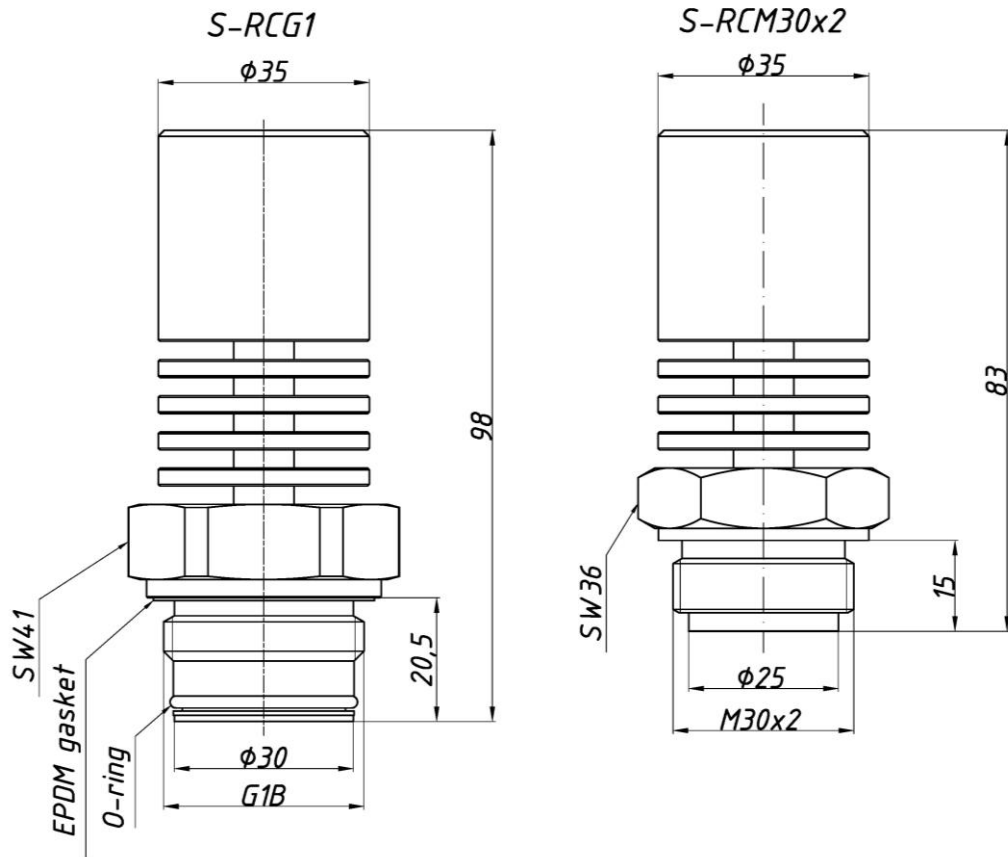


Figure 138. S-RCG1 and S-RCM30x2 separators - overall dimensions.

Using in each type of separation				
	Direct (S-RC)	Distance	With distance separators	With direct and distance separators (S-RC)
Transmitter				
APC-2000ALW Safety	✓	✗	✗	✗
APR-2000ALW Safety	✓	✗	✗	✓*
*S-RC separators is intended for direct mounting only.				

Recommended minimum measurement range width: 40 kPa.

Maximum measuring range:

- for S-RCM30x2: 0 ... 4 MPa;
- for S-RCG1: 0 ... 4 MPa.

Permissible overload:

- for S-RCM30x2: 10MPa;
- for S-RCG1: 10 MPa.

Additional absolute “zero” error due to the ambient temperature:

- 6 kPa/10°C for range \geq 250 kPa;
- 1 kPa/10°C for range $<$ 250 kPa.

Diaphragm and separator material: 1.4404 (steel 316L).

Special versions:

- separator for the temperature up to 260°C;
- Hastelloy-wetted parts of separator made of Hastelloy C 276 (permissible pressure 4 MPa);
- aseptic version S-RCG1, S-RCM30x2 – sealing upstream the thread, filling with edible oil (max. temp. 150°C);
- other to be agreed with Aplisens consultants.

14.2. Diaphragms and gauge fluids

Two components of separator have the greatest impact on temperature errors occurring after its application. These are the flexibility of the separator diaphragm and the thermal expansion coefficient of the liquid filling the measuring set.

Flexibility of the diaphragm is mostly affected by the diaphragm diameter proportionally to the third power of the active diameter. Diaphragms with smaller diameter are stiffer than those with large diameters. Diaphragms and rabbits are made of the following materials:

- 316L or 321;
- Hastelloy C 276;
- Tantalum;
- titanium;
- nickel;
- Monel.

When selecting liquids to fill the separators, the following should be taken into account:

- their different thermal expansion. Greater expansion- more serious measurement errors;
- their different density. Higher density- longer response time to pressure signal;
- their range of operating temperatures. At low temperatures the liquids become too dense and at high temperatures begin to evaporate;
- their usability in the food industry or oxygen installations.

Separator liquids						
Liquid symbol	Density at 25°C [kg/dm ³]	Viscosity at 25°F [cSt]	Expansion coefficient [x10 ⁻³ °C]	Permissible temperature range for absolute pressures from 1 kPa to 100 kPa [°C]	Permissible temperature range for pressures above 100 kPa _{ABS} [°C]	Comments
DC550	1,068	115	0.78	-40; +200	-40; +315	-
DH	1,097	175	0.77	+20; +260	+20; +370	-
AK20	0,945	20	0.97	-70; +150	-70; +270	-
M20	0.92	9.5	1,008	-20; +150	-20; +150	For food
Fluorolube	1.87 at 38°C	5.0 at 38°C	10 °C- 1.53	-30; +80	-30; +150	For versions designed for oxygen applications
			38 °C- 0.85			

Table 62. List of fluid parameters for separators.

14.3. Temperature operating ranges

Distance separators may operate at permissible temperatures for gauge fluids with which the separators are filled.

Direct separators may operate at ambient temperatures up to 85°C and may measure the media with the temperature below the maximum allowable temperature for liquid filling the separator. The temperature of the medium must not cause the increase of the temperature of the transmitter above 85°C. Therefore, direct separators, depending on their separating diaphragm, can measure the media in a very limited range of temperatures. The use of a direct separator with a radiator increases the permissible temperature of the medium, even by 40°C. Variations of the medium temperature and ambient temperature cause an indication error of transmitter resulting from different thermal expansion of the liquid and separator material. This error is higher the more rigid the separator diaphragm is.

14.4. Response times

Response time T98 of separator S-P DN80 filled with DC550 oil with capillary tube 1.5 m at 25°C is 3 seconds.

14.5. Maintenance

If sediment is formed on the diaphragm, it is not allowed to remove it by mechanical method by scraping or rubbing. The deposit should be dissolved and rinsed using only a soft brush to facilitate these operations.

When washing, do not direct a strong stream of the cleaning agent to the diaphragm.

Flanged separators may also be equipped with separator diaphragm flushing rings or have an integrated flushing ring. Flushing of the diaphragm is done without the necessity to dismantle the separator from the customer's system.

14.6. Installation instructions

General mounting recommendations:

- protect the separating diaphragms (especially at low measuring ranges) from dynamic impacts of the medium, e.g. when filling the tank with liquid;
- never allow for freezing of the medium, crystallization or precipitation of hardening deposits in the place where the separator is installed.

The figure below shows an exemplary mounting diagram of transmitter APR-2000ALW Safety with direct separator:

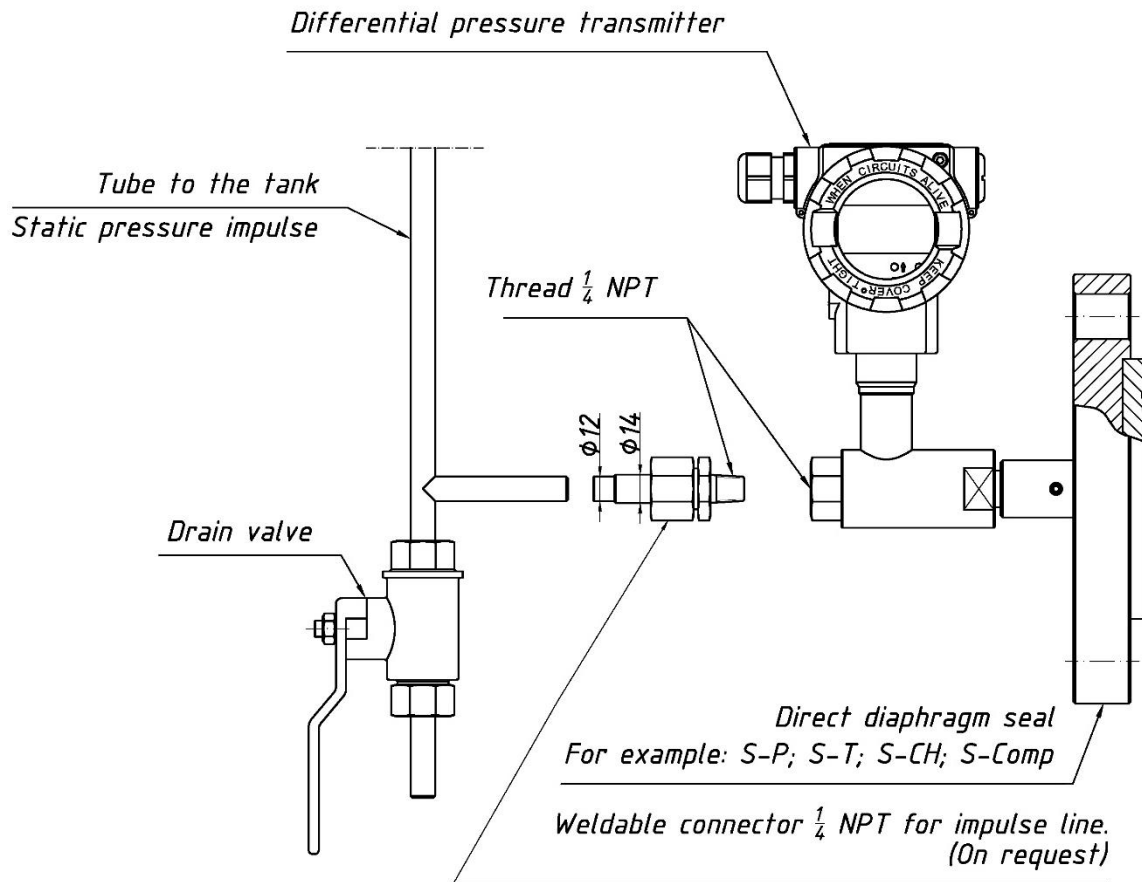


Figure 139. Exemplary installation of transmitter APR-2000ALW Safety with direct separator.

It is recommended to use the transmitter with two distance separators for measuring the differential pressure wherever the hydrostatic pressure of the gauge fluid in capillary tubes, related to the vertical spacing of separators, is significantly lower than the measurement range of the transmitter. The best metrological results are obtained using the possibly shortest identical capillary tubes ended with identical separators. In such configuration, additional temperature errors associated with distance separation equally affect both measuring chambers of the differential pressure transmitter and thus compensate each other.

The figure below shows an exemplary diagram of the filter loss measurement when two distance separators are used:

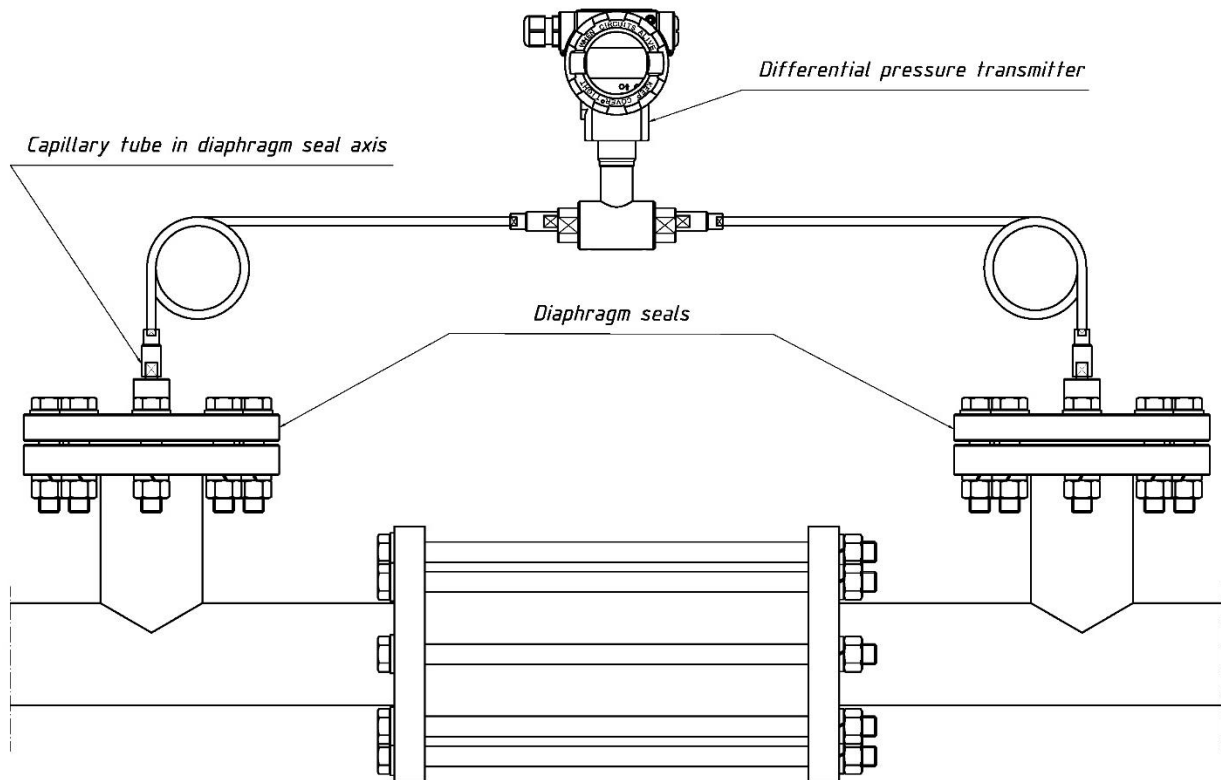


Figure 140. Exemplary installation of transmitter APR-2000ALW Safety with two distance separators.

14.7. Vacuum/negative pressure applications

In case of liquid level measurement in the tank using two distance separators, it is recommended to install the transmitter below the lower separator. This applies to the situation when negative pressure may occur in the tank. This will prevent the vacuum load of the separator diaphragm caused by the presence of oil in the capillary tubes. If for any reasons the transmitter must be installed above the lower separator, it should not be higher than one meter.

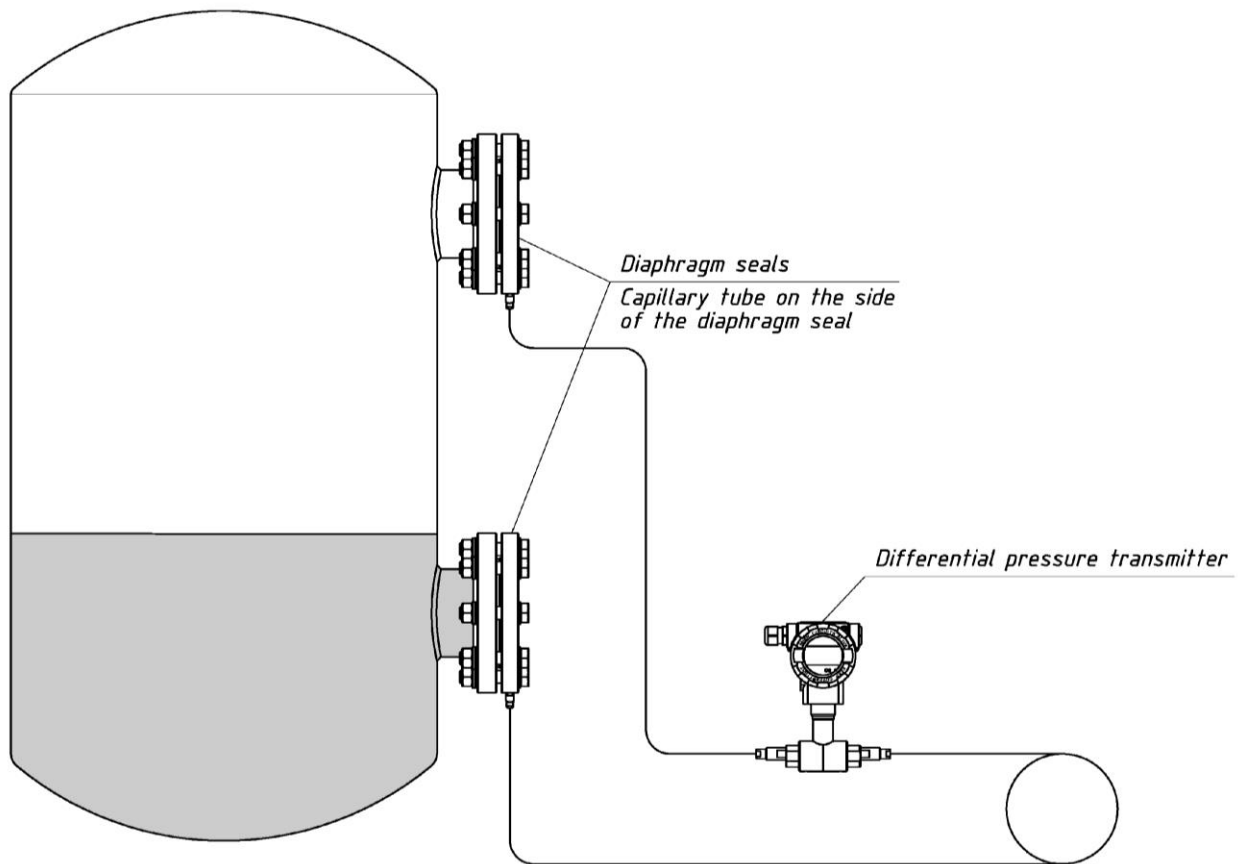


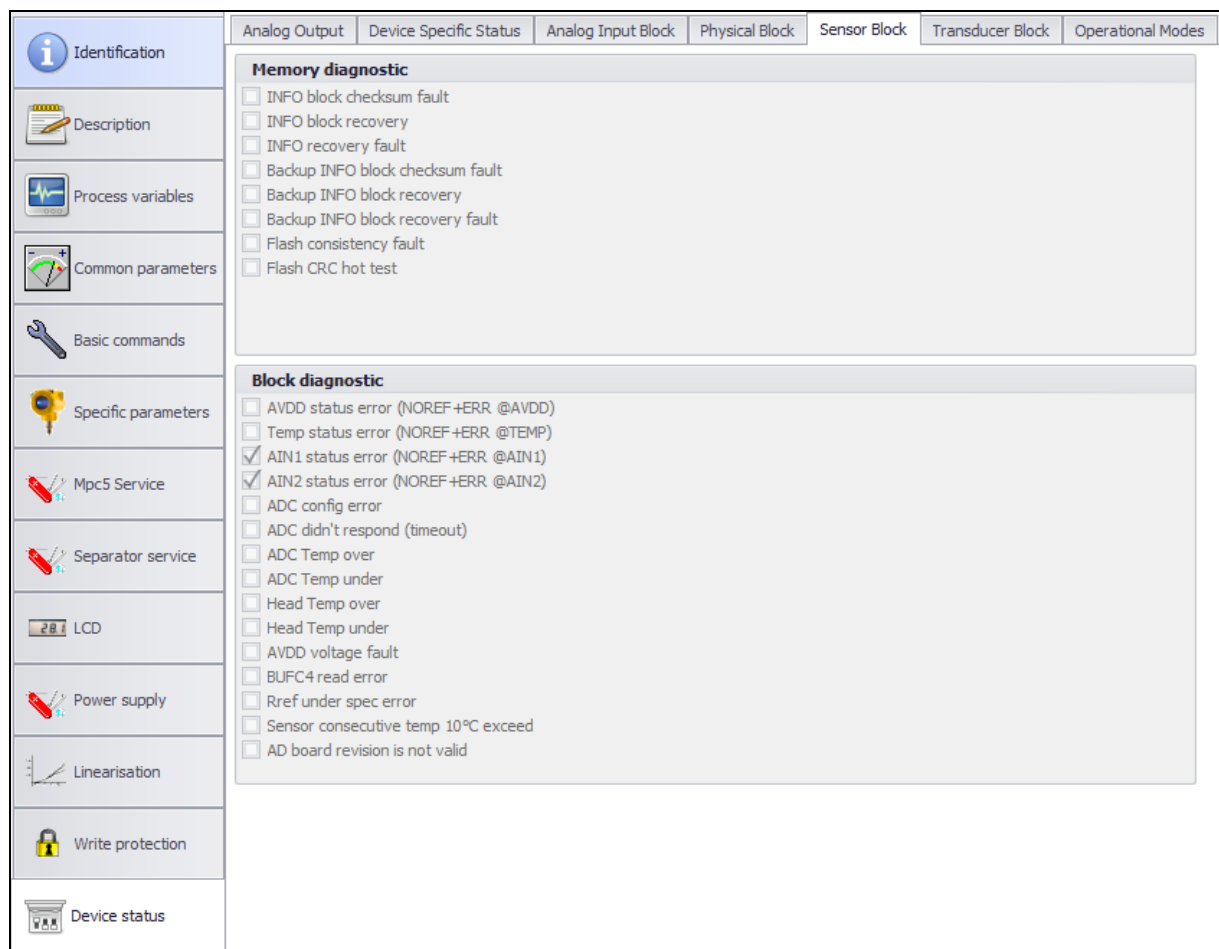
Figure 141. Example of installation in the case of vacuum/negative pressure application.

15. Troubleshooting

15.1. Malfunction messages on LCD display

In the case of diagnosed failures, transmitter APC(R)-2000ALW Safety will inform the user about the failure by setting alarm current $I_{AL} < 3.600 \text{ mA}$ and displaying a blinking collective error number on LCD2. The error number is displayed in the E character format and 4-digit decimal numbers. To identify the cause of malfunction, it is necessary to:

- read out statuses of Analog Input, Physical Block, Sensor Block and Transmitter Block through HART communication. The statuses marked in these blocks will indicate a relatively accurate cause of a failure. This is a recommended method of obtaining information about a kind of malfunction.



The screenshot shows a diagnostic interface with a sidebar on the left and a main content area on the right. The sidebar contains the following menu items: Identification, Description, Process variables, Common parameters, Basic commands, Specific parameters, Mpc5 Service, Separator service, LCD, Power supply, Linearisation, Write protection, and Device status. The main content area has tabs for Analog Output, Device Specific Status, Analog Input Block, Physical Block, Sensor Block, Transducer Block, and Operational Modes. The 'Sensor Block' tab is selected, displaying two diagnostic sections: 'Memory diagnostic' and 'Block diagnostic'. The 'Memory diagnostic' section lists several error types, all of which are currently unchecked. The 'Block diagnostic' section lists various error types, with 'AIN1 status error (NOREF+ERR @AIN1)' and 'AIN2 status error (NOREF+ERR @AIN2)' checked, indicating active faults.

Figure 142. Example of the Sensor Block statuses read out from the transmitter via Raport 2.

- If the readout via HART communication is difficult or impossible for some reasons, it is possible to use the error status number displayed on the transmitter's LCD2 screen. This is a summary status which is a synthesis of failures and errors of all the blocks. For this reason, it is less precise. To decode it, proceed as follows:
 - replace a 4-digit decimal number displayed after E to a binary value, e.g. by means of a Windows calculator with a programmer's view option;
 - read out statuses from the table below, one in the binary value item means that the status is active, zero means the status is not active.

Binary value bit	Status name	Description
BIT0 (1 dec)	SECURITY_VIOLATION	The permissible number of 20 attempts of unauthorised access to change the access password or unauthorized change of write protection was exceeded. The attempt counter takes into account the repetitions of HART command performed automatically by Master, thus when configuring Master, for example, to 2 repetitions, a user can make max. 10 attempts. The next unauthorized attempt will result in displaying the message and setting alarm current $I_{AL} < 3.600 \text{ mA}$. This condition will continue until the transmitter is reset or disconnected and then re-energized. If the access password is lost, the transmitter must be sent back to the manufacturer to restore the default password.
BIT1 (2 dec)	CLOCK_FAULT	The local quartz generator failure has been diagnosed. The transmitter will switch to the operation mode with the DCO standby generator and will set alarm current $I_{AL} < 3.600 \text{ mA}$. This condition will continue until the transmitter is reset or disconnected and then re-energized. If the failure is repeated once again, the transmitter must be sent back to the service center.
BIT2 (4 dec)	MEMORY_FAULT	RAM or FLASH memory fault was detected. This is a major failure of the equipment. The message on the display may appear only momentarily because due to the critical failure, the control will be taken over by the internal redundant alarm module WDT_SIL which disconnects the transmitter's internal power supply. The display will be off. Current will flow in the current loop $I_{AL} \ll 3.600 \text{ mA}$. This condition will continue until the transmitter is disconnected and then re-energized. If the failure is repeated once again, the transmitter must be sent back to the service center.
BIT3 (8 dec)	SENSOR_FAULT	Saturation of A/D transducer (USAL, LSAL), equipment problem related to damage of pressure measuring structure in the head or component damage in the pressure sensor block or sensor power supply were diagnosed. The transmitter will set alarm current $I_{AL} < 3.600 \text{ mA}$. This condition will continue until the cause of the damage ceases to exist. To determine whether the cause may be pressure overload, the pressure transmitter should be vented or pressure should be compensated between L and H levels (for differential pressure transmitter). If after this operation, the transmitter returns to the measurement indication without error, this means that the cause of the error was exceeded pressure (USAL or LSAL). Otherwise, if the error is still displayed, it is likely that a failure occurred and the transmitter must be sent back to service center.
BIT4 (16 dec)	BARRIER_COMM_FAULT	The digital communication failure through an optical galvanic barrier has been detected. The transmitter will set alarm current $I_{AL} < 3.600 \text{ mA}$. This condition will continue until the cause of the damage ceases to exist. The transmitter must be sent back to the service center.
BIT5 (32 dec)	VOLTAGE_FAULT	Incorrect supply voltage of one of the transmitter modules has been detected. The transmitter will set alarm current $I_{AL} < 3.600 \text{ mA}$. This condition will continue until the cause of the damage ceases to exist. The transmitter must be sent back to the service center.
BIT6 (64 dec)	CURRENT_LOOP_FAULT	Difference greater than 1% (160 μA) between the current measured by the transmitter in the current loop 4 ... 20 mA and set

		current calculated by the transmitter was detected. The transmitter will set alarm current $I_{AL} < 3.600 \text{ mA}$. If in an alarm condition the difference between the measured current and the set current calculated by the transmitter is less than 1%, the transmitter will remain in such an alarm condition. This condition will continue until the cause of the damage ceases to exist. However, if the alarm current will also deviate by more than 1% from the value of set current calculated by the transmitter, the control will be taken over by redundant alarm module WDT_SIL which disconnects the transmitter's internal power supply. The display will be off. Current in the current loop will be $I_{AL} \ll 3.600 \text{ mA}$. This condition will continue until the transmitter is disconnected and then re-energized. As the error may appear as a result of very strong over-normative radio interference, the quality of the voltages supplying the transmitter with regard to EMC must be checked. If the power supply is correct and the failure is repeated once again, the transmitter must be sent back to the service center.
BIT7 (128 dec)	PV_OUTOFLIM	The LPL or UPL point was exceeded on pressure/differential pressure scale. The digital measurement of the transmitter outside these points is not possible. The transmitter will set alarm current $I_{AL} < 3.600 \text{ mA}$. This condition will continue until the cause of the overload ceases to exist. If the transmitter is within the correct pressure range according to the information on the nameplate and the error message is still displayed, this may indicate a failure of the transmitter component. In this situation, the transmitter must be sent back to the service center.
BIT8 (256 dec)	SEC_NEXT_VAR_OUTOFLIM	The limits of the permissible temperature range of the transmitter operation were exceeded. The temperature measurement is done at 3 points: pressure sensor, A/D transducer and main CPU controller. The transmitter will set alarm current $I_{AL} < 3.600 \text{ mA}$. This condition will continue until the operating temperature returns to its correct range. If the transmitter is within the correct temperature range according to the information on the nameplate and the error message is still displayed, this may indicate a failure of the transmitter component. In this situation, the transmitter must be sent back to the service center.

Table 63. Numbers of error statuses displayed on the display.

15.2. Failure statuses read using HART

The transmitter allows to reading out statuses using HART communication. The range of information available in this way is broader than the information that is diagnosed based on the error number shown on the transmitter display. Diagnostics allows to read out the operation parameters of the transmitter blocks. Exemplary screen shots from "Raport 2" show the range of available diagnostic information. If the transmitter reports an error and the cause is not known, the manufacturer recommends using HART diagnostics to determine the type of failure during contact with the service centre. The statuses indicated in the figures below are of indicative nature and show the way of displaying the failures.

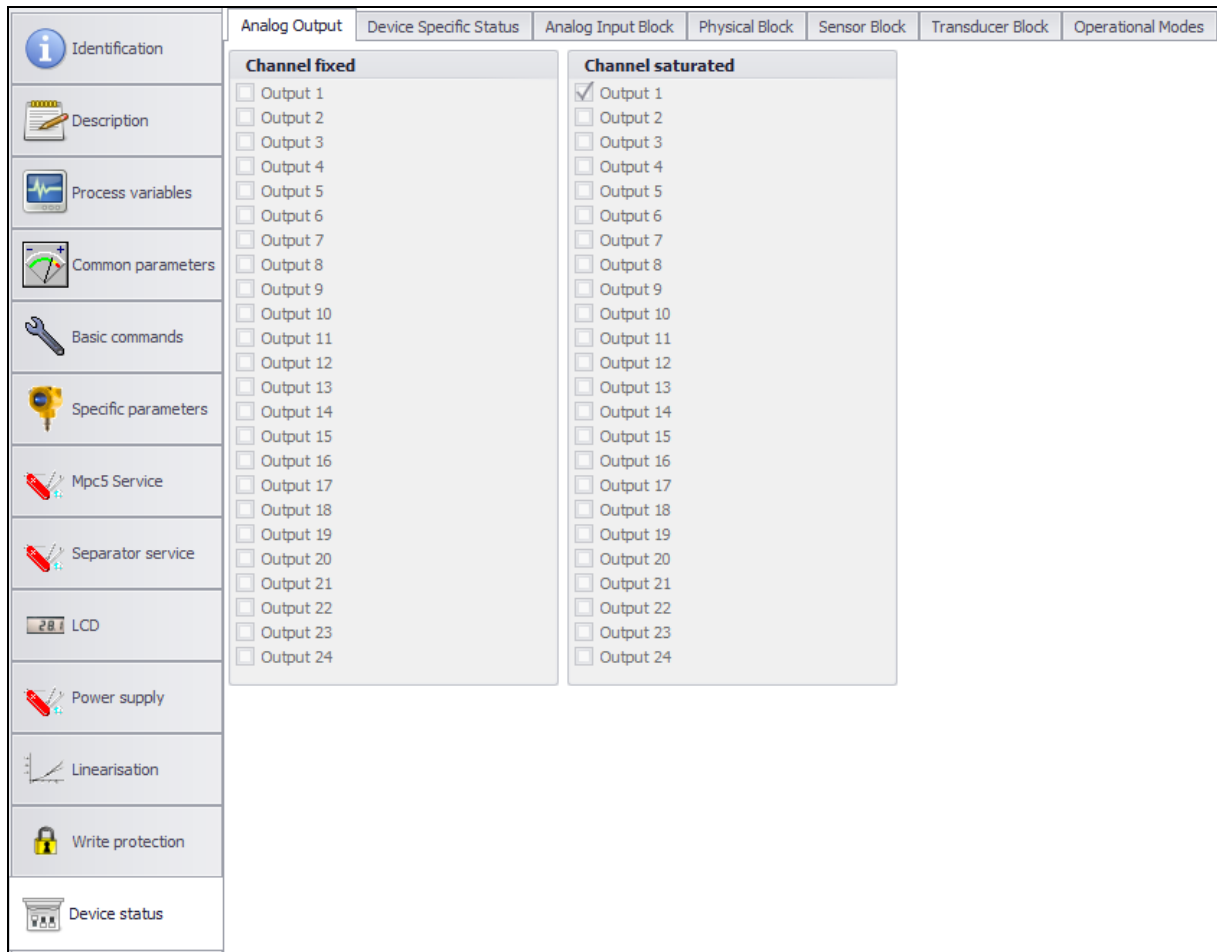


Figure 143. Statuses of the analog output block.

	Analog Output	Device Specific Status	Analog Input Block	Physical Block	Sensor Block	Transducer Block	Operational Modes
<ul style="list-style-type: none"> Identification Description Process variables Common parameters Basic commands Specific parameters Mpc5 Service Separator service LCD Power supply Linearisation Write protection Device status 	Device specific status <ul style="list-style-type: none"> <input type="checkbox"/> Security violation <input type="checkbox"/> Clock fault <input type="checkbox"/> Memory fault <input checked="" type="checkbox"/> Sensor fault <input type="checkbox"/> Barrier communication fault <input type="checkbox"/> Internal voltage fault <input type="checkbox"/> Current loop regulation fault <input type="checkbox"/> PV out of limits <input type="checkbox"/> Second or next variable out of limits <input type="checkbox"/> Analog output saturated <input type="checkbox"/> Output current fixed <input type="checkbox"/> Hot start occurred 		Configuration changes counter Counter <input type="text" value="36"/>				

Figure 144. Summary statuses.

	Analog Output	Device Specific Status	Analog Input Block	Physical Block	Sensor Block	Transducer Block	Operational Modes
<ul style="list-style-type: none"> Identification Description Process variables Common parameters Basic commands Specific parameters Mpc5 Service Separator service LCD Power supply Linearisation Write protection Device status 	<p>Memory diagnostic</p> <ul style="list-style-type: none"> <input type="checkbox"/> INFO block checksum fault <input type="checkbox"/> INFO block recovery <input type="checkbox"/> INFO recovery fault <input type="checkbox"/> Backup INFO block checksum fault <input type="checkbox"/> Backup INFO block recovery <input type="checkbox"/> Backup INFO block recovery fault <input type="checkbox"/> Flash consistency fault <input type="checkbox"/> Flash CRC hot test 						
	<p>Block diagnostic</p> <ul style="list-style-type: none"> <input type="checkbox"/> AI Current Loop Fault 						

Figure 145. Analog input block statuses.

	Analog Output	Device Specific Status	Analog Input Block	Physical Block	Sensor Block	Transducer Block	Operational Modes
<ul style="list-style-type: none"> Identification Description Process variables Common parameters Basic commands Specific parameters Mpc5 Service Separator service LCD Power supply Linearisation Write protection Device status 	<p>Memory diagnostic</p> <ul style="list-style-type: none"> <input type="checkbox"/> INFO block checksum fault <input type="checkbox"/> INFO block recovery <input type="checkbox"/> INFO recovery fault <input type="checkbox"/> Backup INFO block checksum fault <input type="checkbox"/> Backup INFO block recovery <input type="checkbox"/> Backup INFO block recovery fault <input type="checkbox"/> Flash consistency fault <input type="checkbox"/> Flash CRC hot test <p>Block diagnostic</p> <ul style="list-style-type: none"> <input type="checkbox"/> LFXT1 fault <input type="checkbox"/> Local loopback (Master) fault <input type="checkbox"/> Remote loopback (Slave) fault <input type="checkbox"/> Barrier data error <input type="checkbox"/> ADC not ready <input type="checkbox"/> MSP temp over <input type="checkbox"/> MSP temp under 						

Figure 146. Physical block statuses.

	Analog Output	Device Specific Status	Analog Input Block	Physical Block	Sensor Block	Transducer Block	Operational Modes
<ul style="list-style-type: none"> Identification Description Process variables Common parameters Basic commands Specific parameters Mpc5 Service Separator service LCD Power supply Linearisation Write protection Device status 	<div style="border: 1px solid gray; padding: 5px;"> <p>Memory diagnostic</p> <ul style="list-style-type: none"> <input type="checkbox"/> INFO block checksum fault <input type="checkbox"/> INFO block recovery <input type="checkbox"/> INFO recovery fault <input type="checkbox"/> Backup INFO block checksum fault <input type="checkbox"/> Backup INFO block recovery <input type="checkbox"/> Backup INFO block recovery fault <input type="checkbox"/> Flash consistency fault <input type="checkbox"/> Flash CRC hot test </div> <div style="border: 1px solid gray; padding: 5px; margin-top: 5px;"> <p>Block diagnostic</p> <ul style="list-style-type: none"> <input type="checkbox"/> AVDD status error (NOREF+ERR @AVDD) <input type="checkbox"/> Temp status error (NOREF+ERR @TEMP) <input checked="" type="checkbox"/> AIN1 status error (NOREF+ERR @AIN1) <input checked="" type="checkbox"/> AIN2 status error (NOREF+ERR @AIN2) <input type="checkbox"/> ADC config error <input type="checkbox"/> ADC didn't respond (timeout) <input type="checkbox"/> ADC Temp over <input type="checkbox"/> ADC Temp under <input type="checkbox"/> Head Temp over <input type="checkbox"/> Head Temp under <input type="checkbox"/> AVDD voltage fault <input type="checkbox"/> BUFC4 read error <input type="checkbox"/> Rref under spec error <input type="checkbox"/> Sensor consecutive temp 10°C exceed <input type="checkbox"/> AD board revision is not valid </div>						

Figure 147. Sensor block statuses.

	Analog Output	Device Specific Status	Analog Input Block	Physical Block	Sensor Block	Transducer Block	Operational Modes
<ul style="list-style-type: none"> Identification Description Process variables Common parameters Basic commands Specific parameters Mpc5 Service Separator service LCD Power supply Linearisation Write protection Device status 	<p>Memory diagnostic</p> <ul style="list-style-type: none"> <input type="checkbox"/> INFO block checksum fault <input type="checkbox"/> INFO block recovery <input type="checkbox"/> INFO recovery fault <input type="checkbox"/> Backup INFO block checksum fault <input type="checkbox"/> Backup INFO block recovery <input type="checkbox"/> Backup INFO block recovery fault <input type="checkbox"/> Flash consistency fault <input type="checkbox"/> Flash CRC hot test 						
	<p>Block diagnostic</p> <ul style="list-style-type: none"> <input type="checkbox"/> PV over range <input type="checkbox"/> PV under range <input type="checkbox"/> PV high limited <input type="checkbox"/> PV low limited <input type="checkbox"/> Access violation 						

Figure 148. Transmitter block statuses.

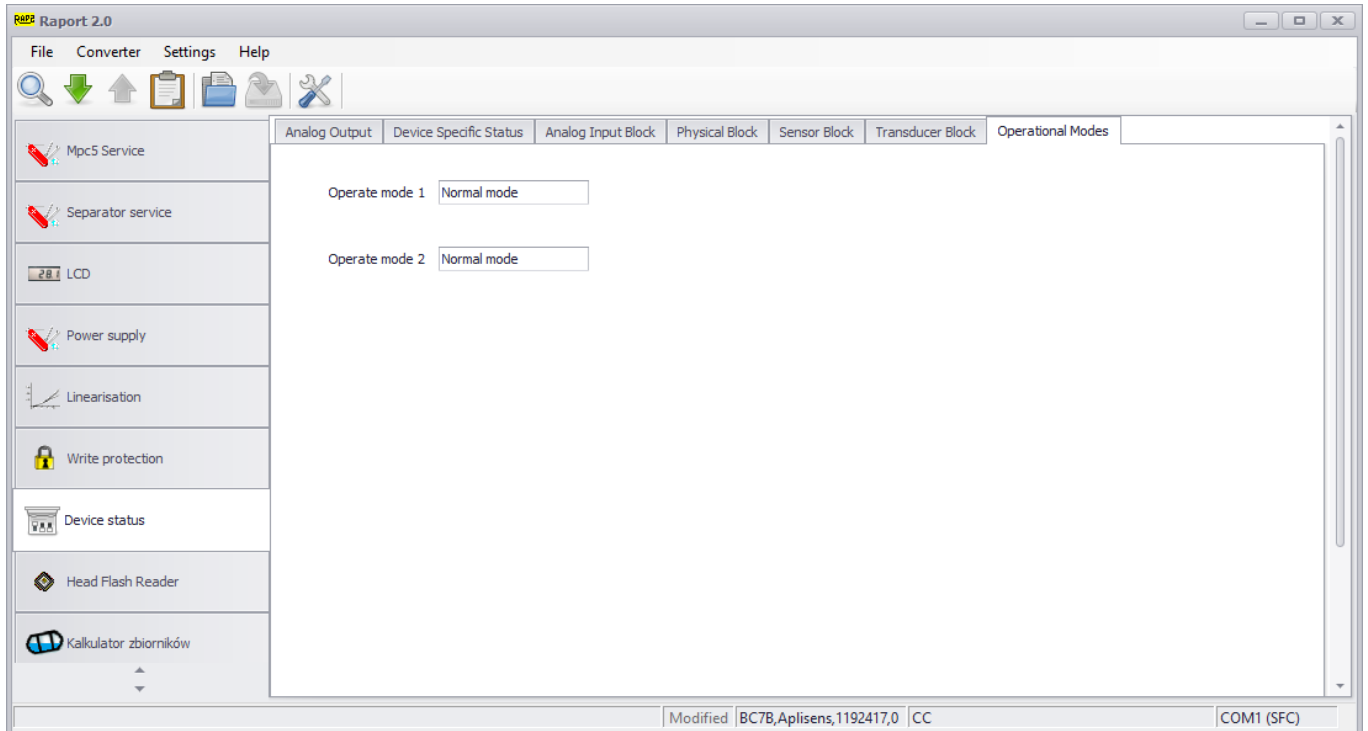


Figure 149. Operational modes statuses.

15.3. Influence of malfunction and failure on transmitter operation and output current

Any diagnosed malfunctioning and failures trigger alarm current $I_{AL} < 3.600 \text{ mA}$ (approx. 3.440 mA) or $I_{AL} < < 3.600 \text{ mA}$ (approx. 0.300 mA). These two types of alarms differ from one another in the method of their handling.

When the cause of failure ceases to exist, alarm current $I_{AL} < 3.600 \text{ mA}$ (approx. 3.440 mA) usually automatically returns to the process current of the measurement (except for an alarm caused by unauthorized attempt to change the access password or unauthorized change of write protection).

Alarm current $I_{AL} < < 3.600 \text{ mA}$ (approx. 0.300 mA) is activated by a separate alarm module triggered in critical situations from the point of view of the transmitter diagnostics. This condition is latched, the transmitter will remain in it until the power supply is disconnected and then reclosed.

16. Certificates, approvals, attestation, declarations

16.1. CE mark



Transmitters APC(R)-2000ALW Safety have been designed to meet the latest safety requirements, and they have been tested and have left the factory in a safe condition. The transmitters comply with the applicable standards and regulations listed in the EU declaration of conformity and therefore meet the statutory requirements of the EU directives. Aplisens S.A. confirms the conformance of the transmitter by placing the CE mark on it.

16.2. Ex certificates

Certificates allowing to use the transmitter in explosion-risk areas.

16.2.1. ATEX Certificates (Europe)



On the nameplate indicates that the product complies with the requirements of the European ATEX directive on explosion protection.

Intrinsically safe Exi version

Certificate No KDB 19 ATEX 0011X

Applied standards: EN 60079-0:2012, EN 60079-11:2012, EN 50303:2000

Designation: I M1 Ex ia I Ma (only in the housing made of steel 316)

II 1/2G Ex ia IIC T5/T4 Ga/Gb

II 1D Ex ia IIIC T105°C Da



Linear power supply	Orthogonal power supply		Trapezoidal power supply
U _i = 30V	U _i =24V	U _i = 24V	U _i = 24V. U _Q =48V
I _i = 0.1A	I _i =0,025A	I _i = 0.05A	I _i = 0.05A
P _i = 0.75W	P _i =0,6W	P _i = 1.2W	P _i = 0.7W
C _i = 2.5nF	C _i =2,5nF	C _i = 2.5nF	C _i = 2.5nF
L _i = 18μH	L _i =18μH	L _i = 18μH	L _i = 18μH
- 40°C ≤ T _a ≤ + 80°C (T5)	- 40°C ≤ T _a ≤ + 80°C (T5)	- 40°C ≤ T _a ≤ + 80°C (T4)	- 40°C ≤ T _a ≤ + 80°C (T5)

Table 64. Intrinsically safe Exi version (ATEX). Permissible input parameters.

Special safe use conditions:

- The maximum temperature of the external heating source cannot heat the transmitter above the maximum declared ambient temperature.
- In hazardous zones of dust explosion, transmitters with painted aluminium housing as well as transmitters equipped with plastic nameplate and PTFE-coated diaphragm separator components should be installed in a way that prevents electrostatic charging specified in accordance with Explosion-Proof Device User Manual EN.IX.APC.APR.ALW p. 6.
- A diaphragm separator with titanium components must be protected from mechanical impacts.
- If a transmitter with a nameplate containing various explosion-proof designs is used, the type of protection applied must be permanently marked on the nameplate before installation (see Explosion-Proof Device User Manual EN.IX.APC.APR.ALW Figure 1).
- An intrinsically safe transmitter version with surge arrester, marked on the nameplate as "SA" does not meet the requirements of clause 10.3 of EN 60079-11 (500Vrms). The device should be installed in accordance with Explosion-Proof Device User Manual EN.IX.APC.APR.ALW p.11.

Flameproof Exd version

Certificate No KDB 19 ATEX 0011X

Applied standards: EN 60079-0:2012, EN 60079-1:2014, EN 60079-11:2011, EN 60079-26:2015, EN 60079-31:2014



Designation: I M2 Ex db ia I Ma (only in the housing made of steel 316)

II 1/2G Ex ia/db IIC T6/T5 Ga/Gb

II 2G Ex ia/db IIC T6/T5 Gb

II 1/2D Ex ia/tb IIIC T105°C Da/Db

II 2D Ex ia/tb IIIC T105°C Db

Permissible range of operating temperatures		Temperature class and max. temp. of surface
Ambient temperature	Process temperature	
$-40^{\circ}\text{C} \leq T_a \leq 40^{\circ}\text{C}$	$-40^{\circ}\text{C} \div 40^{\circ}\text{C}$	T6/T105°C
$-40^{\circ}\text{C} \leq T_a \leq 75^{\circ}\text{C}$	$-40^{\circ}\text{C} \div 75^{\circ}\text{C}$	T5/T105°C

Table 65. Flameproof Exd version (ATEX). Permissible ranges of operating temperatures. Temperature classes.

Special safe use conditions:

- The maximum temperature of the external heating source cannot heat the transmitter above the maximum declared ambient temperature.
- In hazardous zones of dust explosion, transmitters with painted aluminium housing as well as transmitters equipped with plastic nameplate and PTFE-coated diaphragm separator components should be installed in a way that prevents electrostatic charging specified in accordance with Explosion-Proof Device User Manual EN.IX.APC.APR.ALW point 6.
- A diaphragm separator with titanium components must be protected from mechanical impacts.
- If a transmitter with a nameplate containing various explosion-proof designs is used, the type of protection applied must be permanently marked on the nameplate before installation (see Explosion-Proof Device User Manual EN.IX.APC.APR.ALW Figure 1).
- Some gaps of flameproof joint are smaller and longer than those required in table 1 of EN 60079-1 (see Explosion-Proof Device User Manual EN.IX.APC.APR.ALW Table 7).
- For a transmitter with a flameproof enclosure, the diaphragm should not be exposed to damage during transmitter installation and operation. The transmitter diaphragm is made of stainless steel, Hastelloy or Tantalum and must not be exposed to contact with a medium that may damage it.

16.2.2. IECEx certificates

**Intrinsically safe Exi version**

Certificate No IECEx KDB 19.0003X

Applied standards: IEC 60079-0:2017, IEC 60079-11:2011

Designations: Ex ia I Ma (only in the housing made of steel 316)

Ex ia IIC T5/T4 Ga/Gb

Ex ia IIIC T105°C Da

Linear power supply	Orthogonal power supply		Trapezoidal power supply
U _i = 30V	U _i =24V	U _i = 24V	U _i = 24V, U _Q = 48V
i _i = 0.1A	i _i =0,025A	i _i = 0.05A	i _i = 0.05A
P _i = 0.75W	P _i =0,6W	P _i = 1.2W	P _i = 0.7W
C _i = 2.5nF	C _i =2,5nF	C _i = 2.5nF	C _i = 2.5nF
L _i = 18μH	L _i =18μH	L _i = 18μH	L _i = 18μH
- 40°C ≤ T _a ≤ + 80°C (T5)	- 40°C ≤ T _a ≤ + 80°C (T5)	- 40°C ≤ T _a ≤ + 80°C (T4)	- 40°C ≤ T _a ≤ + 80°C (T5)

Table 66. Intrinsically safe Exi version (IECEx). Permissible input parameters.

Special safe use conditions:

- The maximum temperature of the external heating source cannot heat the transmitter above the maximum declared ambient temperature.
- In hazardous zones of dust explosion, transmitters with painted aluminium housing as well as transmitters equipped with plastic nameplate and PTFE-coated diaphragm separator components should be installed in a way that prevents electrostatic charging specified in accordance with Explosion-Proof Device User Manual EN.IX.APC.APR.ALW p. 6.
- A diaphragm separator with titanium components must be protected from mechanical impacts.
- If a transmitter with a nameplate containing various explosion-proof designs is used, the type of protection applied must be permanently marked on the nameplate before installation (see Explosion-Proof Device User Manual EN.IX.APC.APR.ALW Figure 1).
- An intrinsically safe transmitter version with surge arrester, marked on the nameplate as "SA" does not meet the requirements of clause 10.3 of EN 60079-11 (500Vrms). The device should be installed in accordance with Explosion-Proof Device User Manual EN.IX.APC.APR.ALW p.11.

Flameproof Exd version

Certificate No IECEx KDB 19.0003X

Applied standards: IEC 60079-0:2017, IEC 60079-1:2014, IEC 60079-11:2011, IEC 60079-26:201, IEC 60079-31:2013

Designations: Ex db ia I Ma (only in the housing made of steel 316)

Ex ia/db IIC T6/T5 Ga/Gb

Ex ia/db IIC T6/T5 Gb

Ex ia/tb IIIC T105°C Da/Db

Ex ia/tb IIIC T105°C Db



Permissible range of operating temperatures		Temperature class and max. temp. of surface
Ambient temperature	Process temperature	
-40°C ≤ T _a ≤ 40°C	-40°C ÷ 40°C	T6/T105°C
-40°C ≤ T _a ≤ 75°C	-40°C ÷ 75°C	T5/T105°C

Table 67. Flameproof Exd version (IECEx). Permissible ranges of operating temperatures. Temperature classes.

Special safe use conditions:

- The maximum temperature of the external heating source cannot heat the transmitter above the maximum declared ambient temperature.
- In hazardous zones of dust explosion, transmitters with painted aluminium housing as well as transmitters equipped with plastic nameplate and PTFE-coated diaphragm separator components should be installed in a way that prevents electrostatic charging specified in accordance with Explosion-Proof Device User Manual EN.IX.APC.APR.ALW point 6.
- A diaphragm separator with titanium components must be protected from mechanical impacts.
- If a transmitter with a nameplate containing various explosion-proof designs is used, the type of protection applied must be permanently marked on the nameplate before installation (see Explosion-Proof Device User Manual EN.IX.APC.APR.ALW Figure 1).
- Some gaps of flameproof joint are smaller and longer than those required in table 1 of EN 60079-1 (see Explosion-Proof Device User Manual EN.IX.APC.APR.ALW Table 7).
- For a transmitter with a flameproof enclosure, the diaphragm should not be exposed to damage during transmitter installation and operation. The transmitter diaphragm is made of stainless steel, Hastelloy or Tantalum and must not be exposed to contact with a medium that may damage it.

16.3. Hygienic applications

Transmitters with separators equipped with hygienic connectors allow for measurements in aseptic/hygiene conditions. They are usually used in the food, pharmaceutical and biotechnology industries. The measuring instrument can be connected to a separator directly or using a capillary tube. Hygienic transmitters have a hygiene certificate issued by NIZP-PZH (National Institute of Public Health – State Institute of Hygiene). A certificate issued by NIZP-PZH (National Institute of Public Health – State Institute of Hygiene) for a given product certifies that it is safe for human health and/or the environment, provided that it is used in accordance with the intended purpose.

16.4. Marine certificates

Pressure and differential pressure transmitters: APC-2000ALW Safety, APR-2000ALW Safety designed for marine applications meet Det Norske Veritas (DNV) rules for classification vessels, ships, offshore units, high speed and light crafts and have DNV GL Certificate No TAA000019J for applications in the following system standards:

- temperature: class D;
- humidity: class B;
- vibrations: class B;
- EMC class: B;
- housing: class C.

16.5. SIL certificate



Urząd Dozoru Technicznego
UDT-CERT

CERTIFICATE

No. 939/CW/001

Office of Technical Inspection
Product Certification Body UDT-CERT

certifies that

pressure transmitters
APC-2000ALW Safety ID 0001 0004 0002 XXXX XXXX XXXX XXXX XX¹⁾
differential pressure transmitters
APR-2000ALW Safety ID: 0002 0004 0002 XXXX XXXX XXXX XXXX XX¹⁾

¹⁾ X manufacturer's designation in the ID code, not related to the certificate

manufactured by

APLISENS S.A.
ul. Morelowa 7
03-192 Warszawa

satisfy the requirements of the standards

PN-EN 61508:2010 parts 1 ÷ 7
PN-EN 61511-1:2017 + PN-EN 61511-1:2017/A1:2018-03
PN-EN 62061:2008 + PN-EN 62061:2008/A1:2013-06 + PN-EN 62061:2008/A2:2016-01

for safety integrity level

up to and including SIL 3, with a tolerance of hardware faults HFT = 1 according to Route 1_H
up to and including SIL 2, with a tolerance of hardware faults HFT = 0 according to Route 1_H

and satisfy the requirements of systematic integrity

up to and including SC3 according to Route 1_s

Products	λ_{total} FIT	λ_{NE} FIT	λ_{SD} FIT	λ_{SU} FIT	λ_{DD} FIT	λ_{DU} FIT	SFF %
APC-2000ALW Safety	905,321	265,723	0	138,208	451,857	49,533	92,256
APR-2000ALW Safety	919,621	265,723	0	138,208	453,387	62,303	90,472

The products can be used in safety-related systems that meet the requirements up to and including SIL3. SIL verification of a security-related system is the responsibility of the system integrator.

The conditions for issue and validity of the Certificate are specified in the Annex.

Date of issue: **06.06.2019**

Director of Certification and Conformity
Assessment Department



Jacek Niemczyk




UDT-CERT, 02-353 WARSZAWA, ul. SZCZEŚLIWICKA 34

16.6. Declaration of conformity SIL/PN-EN IEC 61508



SIL DECLARATION OF CONFORMITY

Document number DZ.APC.APR.ALW.SIL.ID.REV4

Manufacturer: **APLISENS S.A.,
Morelowa 7 St., 03-192 Warsaw**

Declare with full responsibility that:

pressure transmitters

APC-2000ALW Safety ID: 0001 0004 0002 XXXX XXXX XXXX XXXX XX¹⁾

differential pressure transmitters

APR-2000ALW Safety ID: 0002 0004 0002 XXXX XXXX XXXX XXXX XX¹⁾

¹⁾X in the ID code is manufacturer's indication not related to the certificate

meet the requirements of standards:

PN-EN 61508:2010 Part 1÷7

PN-EN 61511-1:2017 + PN-EN 61511-1:2017/A1:2018-03

PN-EN 62061:2008 + PN-EN 62061:2008/A1:2013-06 + PN-EN 62061:2008/A2:2016-01

Products	λ_{total} FIT	λ_{NE} FIT	λ_{SD} FIT	λ_{SU} FIT	λ_{DD} FIT	λ_{DU} FIT	SFF %	DC %	MTBF
APC-2000ALW Safety	905,321	265,723	0	138,208	451,857	49,533	92,256	90,121	1,105x10 ⁶ h 126 Yrs
APR-2000ALW Safety	919,621	265,723	0	138,208	453,387	62,303	90,472	87,919	1,087x10 ⁶ h 124 Yrs

HFT=0, Route 1 _H	SIL 2
HFT=1, Route 1 _H	SIL 3
Systematic Capability, Route 1 _S	SC 3 (SIL 3 Capable)
Subsystem	Type B

The products can be used in safety-related systems that meet the requirements up to and including SIL 3. SIL verification of a security-related system is the responsibility of the system integrator.

Certificate No. 939/CW/001 was issued by UDT-CERT, Office of Technical Inspection, Szczęśliwicka 34 St., 02-353 Warsaw 06.06.2019.

Warsaw, 27.08.2019


Daniel Samczak
 Functional Safety Coordinator

Morelowa 7 St., Warsaw 03-192
 phone +48 22 814-07-77 fax +48 22 814-07-78
 e-mail: export@aplisens.com
 www.aplisens.com

16.7. Standards and guidelines

Directives/Standards	Standards
ATEX 2014/34/EU	EN 60079-0, EN 60079-1, EN 60079-11, EN 60079-26, EN 60079-31, EN 50303
EMC 2014/30/EU	EN 61326-1, EN 61326-2-3, EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6, EN 55011
RoHS 2011/65/EU	EN 50581
IECEX	IEC 60079-0, IEC 60079-1, IEC 60079-11, IEC 60079-26, IEC 60079-31
Other	EN 61508, EN 60068-2-6, EN 60068-2-27, EN 60529, EN 61511, EN 60654, EN 61298, EN 60770

Table 68. Applied standards and guidelines.

16.8. Inspection certificates


The following certificates are available on request:

Type of certificate	Standard, description
Final calibration certificate (16.8.1);	
Transmitter temperature compensation control certificate (16.8.2);	
Calibration certificate issued by Accredited Laboratory (16.8.3);	
Material certificate (wetted parts) (16.8.4);	PN-EN10204;2006
Material certificate (wetted parts) (16.8.4);	NACE MR0175/ISO 15156
Certificate of the National Institute of Hygiene (16.8.5);	PN-EN 1672-2
Hydrostatic test (16.8.6)	
Washing certificate (16.8.7)	
Roughness certificate (16.8.8)	

Table 69. Inspection certificates.

16.8.1. Final calibration certificate.

In the course of the manufacturing process, in addition to automated computerised temperature compensation, linearization and calibration, the transmitter is subject to final pressure calibration and calibration of the output current controller. Below there is an exemplary printout from the process program for semi-automatic final calibration.



**APLISENS S.A. - MANUFACTURE OF INDUSTRIAL
MEASURING INSTRUMENTS AND AUTOMATION EQUIPMENT**
7, MORELOWA STR. 03-192 WARSAW, POLAND
tel. +48 22 814-07-77, fax +48 22 814-07-78

Test certificate

Type: **APC-2000ALW**
 Serial No: **10150394**
 Sensor No: **1507K143**
TECHNICAL PARAMETERS:
 Base range: **0 ... 25 kPa** Accuracy: **± 0.075 %**
 Set range: **0 ... 0.25 bar**
 Output signal: **4 ... 20 mA** Transm. func.: **Linear**
TEST EQUIPMENT:
 Pressure controller: **MENSOR, 600, [610445]**
 Multimeter: **KEITHLEY, MODEL 2000, [188...]**
 Standard resistor: **100 Ohm, RN-1[123/200...]**
 Ambient temperature: **22.7 °C**

Operational characteristics for base range

Standard input pressure as % of range	Pressure applied	Standard output signal	Measured output signal	Deviation
%	kPa	mA	mA	%
0	0.000	4.000	4.000	0.000
25	6.250	8.000	7.997	-0.019
50	12.500	12.000	11.998	-0.013
75	18.750	16.000	15.999	-0.006
100	25.000	20.000	20.000	0.000

This product complies with operational requirements.

Test date: **Monday, 12 October 2015** **QUALITY INSPECTION**
 Printed on: **Monday, 22 July 2019**
 Remarks:

Aplicens S.A. informs about calibration possibilities of pressure and differential pressure transmitters in our accredited calibration laboratory

Figure 150. Final calibration certificate.



A final calibration certificate is available on the request.

16.8.2. Transmitter temperature compensation control certificate

Automated temperature compensation, linearization and calibration of the transmitter are performed at the stage of manufacture. Below there is an exemplary record from the process of the transmitter temperature compensation control. This is a certificate of fulfilment of the required metrological parameters of the transmitter in the assumed range of operating temperatures.

Rozpoczęcie procesu: 2019-07-18 09:29:25
 Zakończenie procesu: 2019-07-19 06:03:14
 Stanowisko: KOMORA16
 Zbiór: MPC5 -10÷10kPa *
 Numer seryjny: 5912050; nr głowicy: 1905K050 , Software: 3.5, Hardware: 3.0, Zakres nastawiony: -10,0 ... 10,0 [kPa]
 Pozycja: 1
 Użyte przyrządy pomiarowe:
 - Zadajnik: Zadajnik #1 MENSOR, PCS 400,600383,4,38,0
 - Voltomierz: Keithley KEITHLEY INSTRUMENTS INC.,MODEL 2000,1160167,A20 /A02
 Błędy procesu: Brak

Odczytana wartość ciśnienia obliczona przez przetwornik [kPa]:

Zakładana dokładność obliczonego ciśnienia: 0,1%

[kPa]/[°C]	-25	0	75	50	25
-10,000	-9,999	<u>-9,963</u>	<u>-9,970</u>	<u>-9,917</u>	-9,994
-5,000	-5,001	-4,983	-4,983	<u>-4,958</u>	-5,002
0,000	-0,018	-0,008	0,006	<u>0,096</u>	-0,003
5,000	4,981	4,994	<u>4,994</u>	<u>4,967</u>	4,997
10,000	10,003	<u>10,030</u>	<u>9,904</u>	<u>9,963</u>	<u>10,021</u>
Max błąd [%]	0,094	0,186	0,482	0,478	0,107
Max błąd temp./10°C [%]	0,018	0,062	0,118	0,197	-

Odczytana wartość prądu odczytana komendą HART w funkcji ciśnienia [mA]:

Zakładana dokładność prądu w linii: 0,1%

Prąd [mA]/[°C]	-25	0	75	50	25
4,000	4,001	<u>4,030</u>	<u>4,057</u>	<u>4,070</u>	4,005
8,000	7,999	8,014	8,009	<u>8,033</u>	7,998
12,000	11,986	11,994	<u>12,053</u>	<u>12,076</u>	11,998
16,000	15,985	15,996	<u>15,956</u>	<u>15,974</u>	15,998
20,000	20,000	<u>20,024</u>	<u>19,923</u>	<u>19,971</u>	<u>20,017</u>
Max błąd [%]	0,094	0,186	0,482	0,478	0,107
Max błąd temp./10°C [%]	0,018	0,062	0,118	0,197	-

Zmierzona wartość prądu w funkcji prądu zadanego [mA]:

Zakładana dokładność prądu w linii: 0,1%

Prąd [mA]/[°C]	-25	0	75	50	25
4,000	3,994	3,997	4,008	4,003	4,000
8,000	7,995	7,998	8,006	8,003	8,000
12,000	11,996	11,999	12,004	12,001	12,000
16,000	15,998	16,000	16,003	16,001	16,000
20,000	20,001	20,001	20,002	20,000	20,000
Max błąd [%]	0,041	0,017	0,050	0,022	0,003
Max błąd temp./10°C [%]	0,008	0,007	0,010	0,009	-

Odczytana wartość prądu zwrotnego PVIret (na rezystorze R2B) w funkcji prądu zadanego [mA]:

Zakładana dokładność prądu zwrotnego : 0,1%

Prąd [mA]/[°C]	-25	0	75	50	25
4,000	3,989	3,994	4,011	4,006	3,997
8,000	7,992	7,994	8,002	8,000	7,997
12,000	11,991	11,994	12,003	11,999	11,997
16,000	15,993	16,000	16,000	15,995	15,993
20,000	19,998	20,000	19,995	19,998	20,003
Max błąd [%]	0,067	0,040	0,067	0,039	0,042
Max błąd temp./10°C [%]	0,018	0,062	0,118	0,197	-

Wersja programu: 1.43.0.0

Figure 151. Transmitter compensation control certificate- example.



A transmitter temperature compensation control certificate is available on the request.

16.8.3. Calibration certificate issued by Calibration Laboratory Aplisens

CALIBRATION LABORATORY APLISENS
APLISENS JSC – Manufacture of industrial measuring devices and automation equipment
 Morelowa 7, 03-192 WARSAW POLAND
 tel.: 22 814 07 77, fax: 22 814 07 78
 http://www.aplisens.pl, e-mail: laboratorium@aplisens.pl

Calibration laboratory accredited by
 Polish Centre for Accreditation, a signatory to EA MLA and ILAC MRA
 that include recognition of calibration certificates.
 Accreditation No AP 122.

CALIBRATION CERTIFICATE

Date of issue: 30 July 2019 Certificate No: 0000 Page: 1/2

OBJECT OF CALIBRATION Name: Pressure transmitter
 Manufacturer: Aplisens
 Type: APC-2000ALW
 Serial number: 01234567
 Range of indication: (0-2.5) MPa
 Output signal: (4-20) mA, linear characteristic
 Accuracy: ± 0.075% of the indication range
 Scale interval: 0.001 mA corresponds to the pressure 0.00015625 MPa

APPLICANT Aplisens
 Morelowa 7
 03-192 Warsaw, Poland

CALIBRATION METHOD Calibration has been done according to working procedure ... edition ... from

ENVIRONMENTAL CONDITIONS Environment temperature: (19.9±20.4) °C
 Relative humidity: (20.2±21.7) %
 Atmospheric pressure: (1005.8±1006.8) hPa

DATE OF CALIBRATION 30 July 2019

TRACEABILITY This certificate is issued under the agreement EA MLA in the field of calibration and provides traceability of measurement results to the International System of Units (SI)

CALIBRATION RESULTS The results have been presented on page 2 of this certificate including uncertainty of measurement.

UNCERTAINTY OF MEASUREMENT Uncertainty of measurement has been evaluated in compliance with EA-4/02 M:2013. The expanded uncertainty assigned corresponds to a coverage probability of 95 % and the coverage factor $k = 2$.

This certificate may be presented or copied as a whole document only.

CALIBRATION CERTIFICATE issued by ACCREDITED LABORATORY No AP 122

Date of issue: 30 July 2019 Certificate No: 0000 Page: 2/2

CALIBRATION RESULTS Calibration results are the following:

Reference pressure value	Current strength value related to reference pressure value	Measured of current strength value	Pressure value related to measured of current strength value	Measurement error		Uncertainty of measurement	
				mA	MPa	mA	MPa
0.0000	4.000	3.999	-0.0002	-0.001	-0.0002	0.002	0.0003
0.6250	8.000	8.002	0.6253	0.002	0.0003	0.002	0.0003
1.2500	12.000	12.003	1.2505	0.003	0.0005	0.002	0.0003
1.8750	16.000	16.003	1.8755	0.003	0.0005	0.003	0.0005
2.5000	20.000	20.000	2.5000	0.000	0.0000	0.003	0.0005

Authorized by:

Figure 152. Calibration certificate.



The CALIBRATION CERTIFICATE issued by the Calibration Laboratory is available on the request.

16.8.4. Material certificate of wetted parts according to PN-EN 10204

Below you will find an exemplary certificate compliant with PN-EN 10204-3.1.


		APLISENS S.A. MANUFACTURING OF INDUSTRIAL MEASUREMENT INSTRUMENTS AND AUTOMATION COMPONENTS		Warsaw 2019-07-19	
DECLARATION OF CONFORMITY WITH CERTIFICATE OF 3.1 TYPE EN 10204 RELATING TO MATERIALS OF THE WETTED PARTS CERTYFIKAT ZGODNOŚCI Z ATESTAMI RODZAJU 3.1 EN 10204 DLA MATERIAŁÓW UŻYTYCH NA CZĘŚCI ZWILŻANE Certificate No.: 20190719/112725					
Customer:			Customer Order No.:		
PRODUCT			TYPE		
Smart differential pressure transmitter			APR-2000.ALW		
Material numbers & TAGs					
Part	Lot No.	Heat No.	Material		
(DIAPHRAGM RING)			316L		
(DIAPHRAGM)			316L		
(PROCESS FLANGE)			316L		
(UPPER BODY OF DIAPHRAGM)			316L		
(UPPER BODY OF DIAPHRAGM L)			316L		
(VENT BODY)			316L		
(VENT SPINDLE TIP)			316L		
Additional information (informacje dodatkowe): 1. Parts for assemblies were made acc. to documentation. /Części do montażu wyrobów zostały wykonane zgodnie z dokumentacją/ 2. The assemblies was made acc. to construction documentation and order. /Montaż został przeprowadzony zgodnie z dokumentacją i zamówieniem/ 3. Good working of products is confirmed. /Pobyt urządzeń się prawidłowo! /działania wyrobów/ 4. Attachments: inspection certificates 3.1 /Załączniki: świadectwa odbioru 3.1/					
Signature					
Aplisens S.A. (PL) 03-192 Warszawa ul. Morelowa 7 KRS 0000302835 NIP 113-08-88-504 REGON 12265485 Certyfikat ISO Nr 274131-2018-AQ-POL-RvA			tel. +48 (22) 814 07 77 fax +48 (22) 814 07 78 aplisens@aplisens.pl www.aplisens.pl		
Safety clause/Klauzula bezpieczeństwa: http://aplisens.pl/pdf/info/informacje_podstawowe_dotyczace_przetwarzania_danych_osobowych.pdf					

Figure 153. Material certificate of wetted parts according to PN-EN 10204.



A declaration of conformity with certificates for the materials used in the transmitter wetted parts is available on the request.

16.8.5. Certificate of the National Institute of Hygiene




NARODOWY INSTYTUT ZDROWIA PUBLICZNEGO
- Państwowy Zakład Higieny

NATIONAL INSTITUTE OF PUBLIC HEALTH
- National Institute of Hygiene

Zakład Bezpieczeństwa Żywności
Food Safety Department

ŚWIADECTWO JAKOŚCI ZDROWOTNEJ
CERTIFICATE OF HEALTH QUALITY

H-HŻ-6071-221/17/D



Niniejszym zaświadcza się, że niżej wymieniony wyrób
o zadeklarowanym przez producenta składzie, wykorzystywany zgodnie z przeznaczeniem,
nie stanowi zagrożenia dla zdrowia człowieka

**This is to certify that the below named product, having composition as declared by the manufacturer
does not pose hazard to human health when used according to its purpose**

Wyrób/Product:

1. Przetworniki ciśnienia typ: PC-28, PC-28.Modbus, PC-28.Smart, PC-29A, PC-29B, PC-50, APC-2000,
2. Przetworniki różnicy ciśnień typ: PR-28, PR-50, PR-54, APR-2000
3. Przetwornik różnicy ciśnień typ: APR-2200
4. Separatory membranowe typ: S-P, S-T, S-TK-P, S-Comp, S-Pozic, S-DIN, S-Clamp, S-SMS, S-DRD, S-Varivent, S-RC, S-CG1", S-CG1½", S-CGSI

Zawierający/Containing:

1. Stal nierdzewna gat. 1.4404 wg DIN (316L wg AISI) (przylącze procesowe typ: M, P, G1/2, GP, ½"NPT, RM, RG, 1/2", CM3, 2, CG1, CG1/2) lub Hastelloy C276 (membrana przylącza procesowego typ: GP, 30x2); PTFE, EPDM (uszczelki)
2. Stal nierdzewna gat. 1.4404 wg DIN (316L wg AISI) (przylącze procesowe typu: P, C); PTFE, EPDM (uszczelki)
3. Stal nierdzewna gat. 1.4404 wg DIN (316L wg AISI) (separatory membranowe); PTFE, EPDM (uszczelki)
4. Stal nierdzewna gat. 1.4404 wg DIN (316L wg AISI) (membrany); PTFE, EPDM (uszczelki)

Przeznaczony do/Destined for: pomiaru ciśnienia lub poziomu wody przeznaczonej do spożycia oraz mediów w przemyśle spożywczym

Urządzenia stosowane w przemyśle spożywczym powinny spełniać wymagania normy PN-EN 1672-2 Maszyny dla przemysłu spożywczego. Wymagania z zakresu higieny.


Wytwórca /Manufacturer: APLISENS S.A. Produkcja Przemysłowej Aparatury Pomiarowej i Elementów Automatyki
03-192 Warszawa, ul. Morełowa 7

Niniejszy dokument wydano dla/This certificate was issued to:
APLISENS S.A. Produkcja Przemysłowej Aparatury Pomiarowej i Elementów Automatyki
03-192 Warszawa, ul. Morełowa 7

Niniejsze świadectwo może być zmienione lub unieważnione po przedstawieniu odpowiednich dowodów przez którąkolwiek stronę. Świadectwo traci ważność w przypadku wprowadzenia zmian w składzie wyrobu lub technologii jego produkcji. Świadectwo nie dotyczy cech użytkowych wyrobu ani spełniania przez niego wymogów bhp.

This certificate may be corrected or cancelled after appropriate evidence is presented by any party. Any change in composition of the above mentioned product or in its manufacturing technology cancels this certificate. This certificate does not concern functional and work safety characteristics of the product.

Data wystawienia świadectwa: 2017-10-10
/Date of issue/
Świadectwo ważne do: 2020-10-10
/This certificate is valid until/



dr Jacek Postupolski
Zakład Bezpieczeństwa Żywności

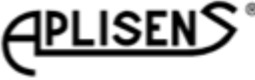
00-791 Warszawa, ul. Chocimska 24, tel.: +48 22 542 13 14, faks +48 22 542 13 92,
www.pzh.gov.pl, e-mail: sekr.zbz@pzh.gov.pl
Regon: 000288461, NIP: 525-000-87-32, PL 98 1020 1042 0000 8302 0200 8027 (SWIFT CODE): BPKO PL PW

Figure 154. Certificate of the National Institute of Hygiene.



A certificate of the National Institute of Hygiene is available on the request.

16.8.6. Certificate of hydrostatic test

	APLISENS S.A. - MANUFACTURE OF INDUSTRIAL MEASURING INSTRUMENTS AND AUTOMATION EQUIPMENT 7, MORELOWA STR. 03-192 WARSAW, POLAND tel. +48 22 814-07-77, fax +48 22 814-07-78
Inspection certificate of the pressure test	
Analog pressure transmitter	
Type: APC-2000ALW Serial No: 10150394 Sensor No: 1507K143	
TECHNICAL PARAMETERS: Base range: 0 ... 25 kPa Accuracy: ± 0.075 % Output signal: 4 ... 20 mA	
ENVIRONMENT CONDITIONS Ambient temperature: 0 °C	
TEST EQUIPMENT: Pressure controller:	
<small>Test equipment is maintained in accordance with the company's quality system. Serial numbers of test equipment are shown in bracket</small>	
TEST PARAMETERS Test pressure: [bar] Duration of test [min]: 10 Test result: positive	
Test date: Monday, 22 July 2019 Printed on: Monday, 22 July 2019	QUALITY INSPECTION
Remarks:	


Aplisens S.A. informs about calibration possibilities of pressure and differential pressure transmitters in our accredited calibration laboratory

Figure 155. Certificate of hydrostatic test.



A pressure hydrostatic test is available on the request.

16.8.7. Cleaning certificate

	APLISENS S.A. - MANUFACTURE OF INDUSTRIAL MEASURING INSTRUMENTS AND AUTOMATION EQUIPMENT 7, MOREŁOWA STR. 03-192 WARSAW, POLAND tel. +48 22 814-07-77, fax +48 22 814-07-78
---	--

CLEANING REPORT / ŚWIADECTWO MYCIA

We hereby acknowledge that equipment with the following serial numbers:
 Niniejszym potwierdzamy, że urządzenia o następujących numerach fabrycznych:

10050394

have been cleaned and can be used in oxygen systems.
 zostały odfuszczone i mogą być używane w instalacjach tlenowych.

Printed on: Monday, 22 July 2019	QUALITY INSPECTION / KONTROLA JAKOŚCI
---	--

Apisens S.A. informs about calibration possibilities of pressure and differential pressure transmitters in our accredited calibration laboratory

Figure 156. Cleaning certificate.



A cleaning report is available on the request.

16.8.8. Roughness certificate

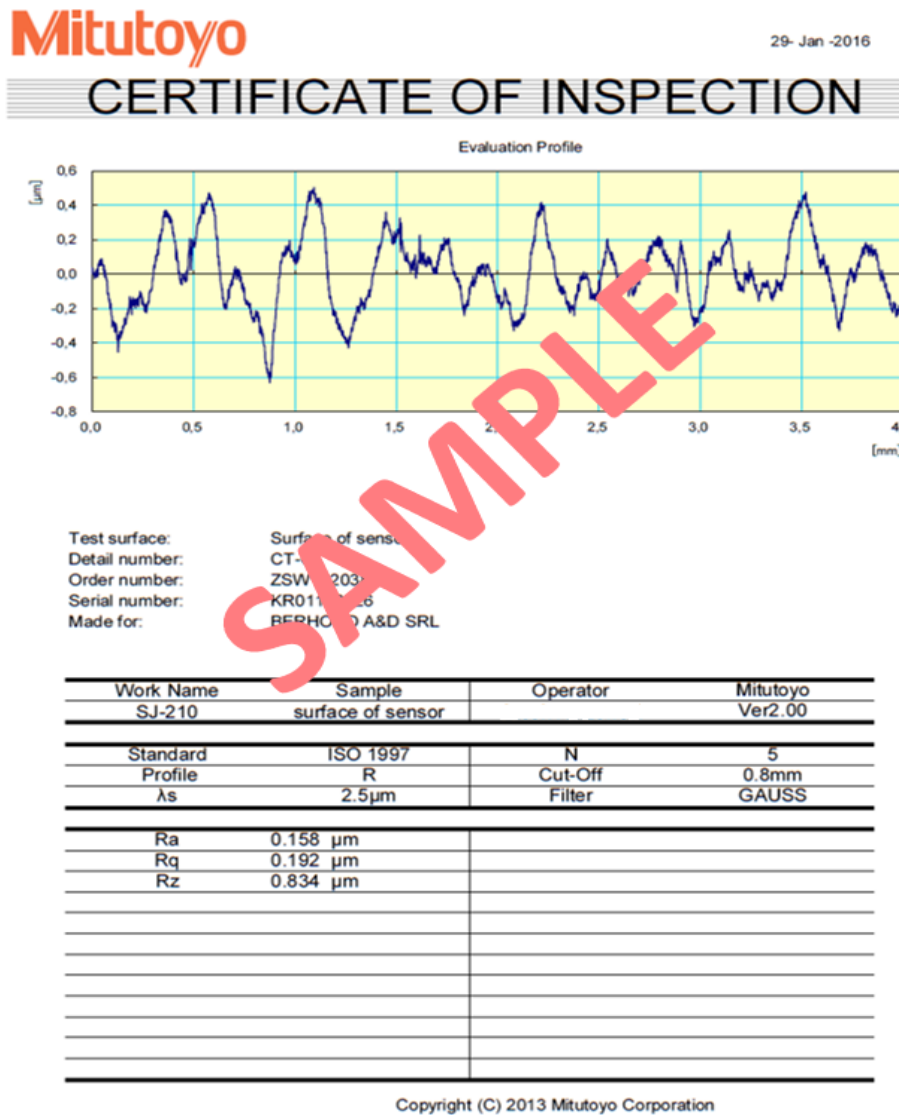


Figure 157. Roughness certificate.



A roughness certificate is available on the request.

16.9. Declaration of conformity



N° DZ.APC.APR.ALW.SIL.ID.U1.ENG

EU Declaration of Conformity

issued under the sole responsibility of the manufacturer

The object of this declaration, pressure device:

Pressure transmitters **APC-2000ALW Safety ID:** 0001 0004 0002 XXXX XXXX XXXX XXXX XX,
 Differential pressure transmitters **APR-2000ALW Safety ID:** 0002 0004 0002 XXXX XXXX XXXX XXXX XX.

Manufacturer: **APLISENS S.A., ul. Morelowa 7, 03-192 Warszawa**

We hereby declare under the sole responsibility, that the object of the declaration defined above comply with relevant Union harmonization legislation.

Pressure transmitters **APC-2000ALW Safety ID:** 0001 0004 0002 XXXX XXXX XXXX XXXX XX, differential pressure transmitters **APR-2000ALW Safety ID:** 0002 0004 0002 XXXX XXXX XXXX XXXX XX in all versions comply with directive:

- **EMC – 2014/30/EU** dated 26 February 2014

Conformity assessment procedure: module A. The following standard was applied EN 61326-1:2013.

- **RoHS – 2011/65/EU** dated 08 June 2011

Conformity assessment procedure: module A, according to Decision No 768/2008/EC of the European Parliament and of the Council. The following standard was applied: EN 50581:2012.

Pressure transmitters **APC-2000ALW Safety ID:** 0001 0004 0002 XXXX XXXX XXXX XXXX XX, differential pressure transmitters **APR-2000ALW Safety ID:** 0002 0004 0002 XXXX XXXX XXXX XXXX XX in intrinsically safe versions comply with directive:

- **ATEX – 2014/34/EU** dated 26 February 2014

Intrinsically safe versions of transmitters are marked with the following certificate marking:

II 1/2G Ex ia IIC T5/T4 Ga/Gb
 II 1D Ex ia IIIC T105°C Da
 I M1 Ex ia I Ma (version with ss316 housing)
 KDB 19 ATEX 0011X

Conformity assessment procedure: module B. NB no.1026, Physical Technical Testing Institute, Pikarska 7, 716 07 Ostrava Radvanice.

The following standards were applied: EN 60079-0:2012+A11:2013, EN 60079-11:2012, EN 50303:2000.

Pressure transmitters **APC-2000ALW Safety ID:** 0001 0004 0002 XXXX XXXX XXXX XXXX XX, differential pressure transmitters **APR-2000ALW Safety ID:** 0002 0004 0002 XXXX XXXX XXXX XXXX XX, in explosion-proof versions are marked with the following certificate marking:

I M2 Ex db ia I Mb (version with ss316 housing) I M2 Ex db ia I Mb (version with ss316 housing)
 II 1/2G Ex ia / db IIC T6/T5 Ga/Gb or II 2G Ex ia / db IIC T6/T5 Gb
 II 1/2D Ex ia / tb IIIC T105°C Da/Db II 2D Ex ia / tb IIIC T105°C Db

KDB 19 ATEX 0011X

Conformity assessment procedure: module B. NB no.1453, Central Mining Institute, Plac Gwarków 1, 40-166 Katowice.

The following standards were applied: EN 60079-0:2012+A11:2013, EN 60079-1:2014, EN 60079-11:2012, EN 60079-26:2015, EN 60079-31:2014.

Notification of quality assurance: module D. NB no.1453, Central Mining Institute, Plac Gwarków 1, 40-166 Katowice.

Warsaw, 05.06.2019

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17. Additional documentation

User's manual:

- EN.IO.APC.APR.ALW.2.SFT
User's manual. Pressure and differential pressure transmitters APC-2000ALW Safety, APR-2000ALW Safety.

Functional safety instructions (SIL):

- EN.IB.APC.APR.ALW.2.SFT
SIL safety instructions. Pressure and differential pressure transmitters APC-2000ALW Safety APR-2000ALW Safety.

Ex safety instructions:

- EN.IX.APC.APR.ALW
Explosion-proof device user manual.

18. History of revisions

Revision No.	Document revision	Description of changes
-	01.A.001/2019.04	First version of the document, developed by KBF, DKD, DR.
1	01.A.002/2019.09	Changed QR code, separator application tables was changed, operation and storage temperature was updated, developed by KBF, DKD, DR.
2	01.A.003/2019.11	Figure 129 and 131 was changed – changed overall dimensions of S-Varivent.