

APLISENS

MANUFACTURE OF PRESSURE TRANSMITTERS
AND CONTROL INSTRUMENTS

USER'S MANUAL

INTRINSICALLY SAFE SMART PRESSURE TRANSMITTER
type: **APCE-2000EE_x**





INTRINSICALLY SAFE SMART DIFFERENTIAL
PRESSURE TRANSMITTER type:
APRE-2000EE_x, APRE-2200EE_x, APRE-2000EE_xG, APRE-2000EE_xY

SMART PRESSURE TRANSMITTER
type: **APCE-2000**

SMART DIFFERENTIAL PRESSURE TRANSMITTER
type:
APRE-2000, APRE-2200, APRE-2000G, APRE-2000/Y

WARSAW MAY 2006

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 a type EEx device.
	Information on disposal of used equipment

BASIC REQUIREMENTS AND SAFE USE

- **The manufacturer will not be liable for damage resulting from incorrect installation, failure to maintain the device in a suitable technical condition, or use of the device other than for its intended purpose.**
- Installation should be carried out by qualified staff having the required authorizations to install electrical and pressure-measuring devices. The installer is responsible for performing the installation in accordance with these instructions and with the electromagnetic compatibility and safety regulations and standards applicable to the type of installation.
- The device should be configured appropriately for the purpose for which it is to be used. Incorrect configuration may cause erroneous functioning, leading to damage to the device or an accident.
- In systems with pressure transmitters there exists, in case of leakage, a danger to staff on the side where the medium is under pressure. All safety and protection requirements must be observed during installation, operation and inspections.
- If a device is not functioning correctly, disconnect it and send it for repair to the manufacturer or to a firm authorized by the manufacturer.



In order to minimize the risk of malfunction and associated risks to staff, the device is not to be installed or used in particularly unfavourable conditions, where the following dangers occur:

- possibility of mechanical impacts, excessive shocks and vibration;
- excessive temperature fluctuation, exposure to direct sunlight;
- condensation of water vapour, dust, icing.



Installation of intrinsic safety versions should be performed with particular care, in accordance with the regulations and standards applicable to that type of installation.

The manufacturer reserves the right to make changes (not having a negative impact on the operational and metrological parameters of the products) without updating the contents of the technical manual.

CONTENTS

I.	APPENDIX Ex	3
1.	INTRODUCTION	6
2.	USER MATERIALS	6
3.	APPLICATIONS AND MAIN FEATURES	6
4.	IDENTIFYING MARKS. ORDERING PROCEDURE	6
5.	TECHNICAL DATA	7
5.1.	APCE... APRE... COMMON PARAMETERS	7
5.2.	APCE... MEASUREMENT RANGES AND METROLOGICAL PARAMETERS	8
5.3.	APRE-2000 - MEASUREMENT RANGES AND METROLOGICAL PARAMETERS	9
5.4.	APRE-2200. MEASUREMENT RANGES AND METROLOGICAL PARAMETERS	9
5.5.	APRE-2000G. MEASUREMENT RANGES AND METROLOGICAL PARAMETERS	10
5.6.	APRE-2000/Y. MEASUREMENT RANGES AND METROLOGICAL PARAMETERS	10
6.	CONSTRUCTION, PRESSURE CONNECTORS, ELECTRICAL CONNECTORS	11
6.1.	MEASUREMENT PRINCIPLES, ELECTRONIC SYSTEM	11
6.2.	CONSTRUCTION	11
6.3.	CASING, ELECTRICAL CONNECTIONS	11
7.	PLACE OF INSTALLATION OF TRANSMITTERS	12
7.1.	GENERAL RECOMMENDATIONS	12
7.2.	LOW AMBIENT TEMPERATURE	12
7.3.	HIGH MEDIUM TEMPERATURE	12
7.4.	MECHANICAL VIBRATION, CORROSIVE MEDIA	13
8.	INSTALLATION AND MECHANICAL CONNECTIONS	13
8.1.	APCE... INSTALLATION AND CONNECTIONS	13
8.2.	APRE... INSTALLATION AND CONNECTIONS	13
8.3.	APRE-2000G. INSTALLATION AND CONNECTIONS	13
8.4.	APRE-2000/Y. INSTALLATION AND CONNECTIONS	14
9.	ELECTRICAL CONNECTION	14
9.1.	GENERAL RECOMMENDATIONS	14
9.2.	CONNECTIONS FOR TRANSMITTERS WITH PD-TYPE CONNECTOR	14
9.3.	CONNECTIONS FOR TRANSMITTERS WITH TERMINAL BOX (PZ-TYPE CONNECTOR)	14
9.4.	PROTECTION FROM EXCESS VOLTAGE	15
9.5.	EARTHING	15
10.	SETTING AND REGULATION	15
10.1.	TRANSMITTER RANGE, DEFINITIONS	15
10.2.	CONFIGURATION AND CALIBRATION	16
11.	INSPECTIONS AND SPARE PARTS	19
11.1.	PERIODIC INSPECTIONS	19
11.2.	UNSCHEDULED INSPECTIONS	19
11.3.	CLEANING THE DIAPHRAGM SEAL, OVERLOADING DAMAGE	20
11.4.	SPARE PARTS	20
12.	PACKING, STORAGE AND TRANSPORT	20
13.	GUARANTEE	20
14.	ADDITIONAL INFORMATION	20
15.	FIGURES	21
FIGURE 1.	APCE... APRE... TRANSMITTERS – BLOCK DIAGRAM	21
FIGURE 2.	ELECTRICAL CONNECTIONS FOR APCE... APRE... TRANSMITTERS	21
FIGURE 3.	APCE-2000 TRANSMITTER WITH PD CONNECTOR	22
FIGURE 4.	APCE-2000 TRANSMITTER WITH PZ CONNECTOR	22
FIGURE 5.	M-TYPE CONNECTOR WITH M20X1.5 THREAD	23
FIGURE 6.	P-TYPE CONNECTOR WITH M20X1.5 THREAD	23
FIGURE 7.	CM30X2-TYPE CONNECTOR WITH FLUSH DIAPHRAGM WITH M30X2 THREAD	23
FIGURE 8.	PROCESS CONNECTIONS G1/2" AND G1"	24
FIGURE 9.	APRE-2000 DIFFERENTIAL PRESSURE TRANSMITTER WITH P-TYPE CONNECTOR	25
FIGURE 10.	APRE-2000 DIFFERENTIAL PRESSURE TRANSMITTER WITH C TYPE VENTED COVERS	26
FIGURE 11.	APRE-2000 DIFFERENTIAL PRESSURE TRANSMITTER WITH A SINGLE DIRECT DIAPHRAGM SEAL (EXAMPLES)	26
FIGURE 12.	APRE-2200 DIFFERENTIAL PRESSURE TRANSMITTER WITH TWO REMOTE DIAPHRAGM SEALS (EXAMPLES)	27
FIGURE 13.	APRE-2200 DIFFERENTIAL PRESSURE TRANSMITTER WITH DIRECT DIAPHRAGM SEAL AND REMOTE DIAPHRAGM SEAL (EXAMPLES)	27
FIGURE 14.	APRE-2000G SMART DIFFERENTIAL PRESSURE TRANSMITTER FOR NON-AGGRESSIVE GASES	28
FIGURE 15.	APRE-2000/Y SMART LEVEL PROBE FOR PRESSURE TANKS	29
FIGURE 16.	ADDITIONAL EQUIPMENT FOR FITTING OF PRESSURE TRANSMITTERS	30
FIGURE 17.	EXAMPLE: HOW TO INSTALL THE APRE-2200 TRANSMITTERS WITH REMOTE DIAPHRAGM	31
FIGURE 18.	EXAMPLE: HOW TO INSTALL THE APRE-2000 TRANSMITTER ON A VERTICAL OR HORIZONTAL PIPE	31
FIGURE 19.	EXAMPLE: HOW TO INSTALL THE APRE-2000 TRANSMITTER WITH A VALVE MANIFOLD TO A WALL	32

I. APPENDIX Ex

DTR.APCE.APRE.01(ENG)

Appendix Ex.01



SMART PRESSURE TRANSMITTER type APCE-2000EEx,
 SMART DIFFERENTIAL PRESSURE TRANSMITTERS
 type APRE-2000EEx, APRE-2200EEx including:
 APRE-2000EExG for non-aggressive gases
 APRE-2000EExY for measurement of level and density
 EEx VERSIONS

1. Introduction

1.1. This "Appendix Ex.01" applies only to transmitters of types APCE-2000EEx, APRE-2000EEx, APRE-2200EEx in EEx versions, marked on the rating plate as shown in 2.2 and denoted EEx in the Product Certificate.

1.2. The appendix contains supplementary information relating to the EEx versions of these transmitters. During installation and use of EEx transmitters, reference should be made to DTR.APCE.APRE.01(ENG) in conjunction with "Appendix Ex.01".

2. Use of APCE-2000EEx, APRE-2000EEx, APRE-2200EEx and APRE-2000EExG, APRE-2000EExY transmitters in danger zones.

2.1. The transmitters are produced in accordance with the requirements of the following standards PN-EN 50014:2002, PN-EN 50020:2003, PN-EN 50284:2003 and PN-EN 50303:2002 (U).

2.2. The transmitters may operate in areas where there is a risk of explosion, in accordance with the rating of the explosion protection design:



II 1/2G EEx ia IIC T4/T5/T6 (rating for industrial uses),
 I M1 EEx ia I (rating for mining uses)
 KDB 04ATEX059 (certificate number).
 KDB 04ATEX059/1 (supplementary certificate number).
 KDB 04ATEX059/2 (supplementary certificate number).

3. Identifying marks

Intrinsically safe transmitters must have a rating plate containing the information specified in paragraph 4 of DTR.APCE.APRE.01(ENG) and also at least the following:

- CE mark and number of notified unit: 1453 in the case of GIG KDB, mark
- designation of explosion protection design, certificate number
- values of parameters such as. Ui, Ii, Pi, Ci, Li
- marking of electrical and process connections
- year of manufacture

4. User information.

Together with the transmitters ordered, the user will receive: User's Manual numbered: DTR.APCE.APRE.01(ENG) with Appendix Ex, and also the Product Certificate.

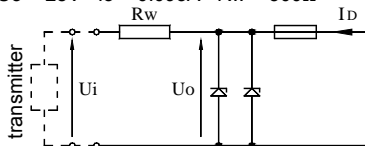
5. Permitted input parameters (based on data from the KDB 04ATEX059 and KDB 04ATEX059/1, KDB 04ATEX059/2 certificates, and certification documentation).

5.1. - for power supply with a linear characteristic

a) $U_i = 28V$ $I_i = 0,1A$ $P_i = 0,67W$ for $T_a \leq 60^\circ C$ and T6 and for $T_a \leq 80^\circ C$ and T5

b) $U_i = 28V$ $I_i = 0,1A$ $P_i = 0,53W$ for $T_a \leq 70^\circ C$ and T6

Power supply with a "linear" characteristic may be e.g. a typical barrier with parameters
 $U_o = 28V$ $I_o = 0.093A$ $R_w = 300\Omega$



Example of practical provision of power supply for case a):
 use the barrier with the parameters given above

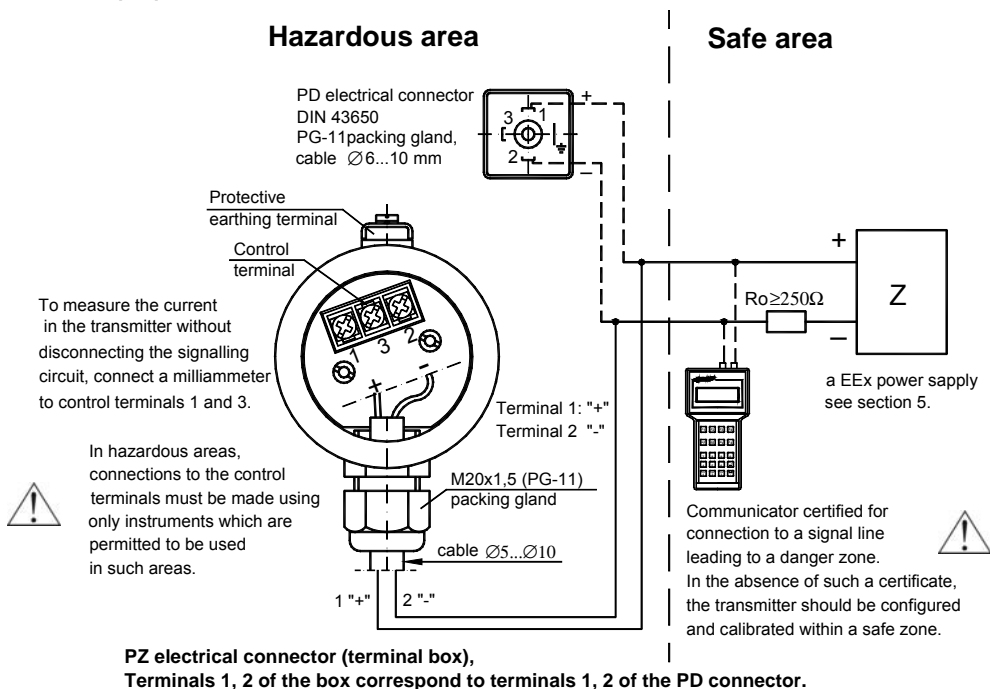
Fig.1. Power supply from a source with "linear" characteristic

6. How to connect EEx transmitters: APCE-2000EEx, APRE-2000EEx, APRE-2200EEx



The transmitter and other devices in the measuring loop should be connected in accordance with the intrinsic-safety and explosion-safety regulations and the conditions for use in dangerous areas.

Failure to observe the intrinsic-safety regulations can cause explosion and the resulting hazard to people.



7. Basic requirements according to EN 50039 for type A and B leads used to connect the transmitter to the power supply and measurement circuit.

7.1. Thickness of insulation according to type of material, but not less than 0.2mm.

7.2. Insulation strength:

- $2U_N$ but not less than 500VAC for the wire
- 500VAC between the cable screen and the connected wires;
- 1000VAC between two groups of wires, each of which contains half the connected wires of the cable.

7.3. Multiwire cable must not carry any circuit which is not an intrinsically safe circuit.

7.4. The cable must not carry circuits with a maximum voltage exceeding 60V.

7.5. The cables should be protected from damage, for example using channels, shielding pipes, cable racks, durable fastenings etc.



It is not permitted to repair or otherwise interfere with the transmitter's electrical circuits in any way. Damage and possible repair may be assessed only by the manufacturer or another authorized party.

1. INTRODUCTION

1.1. This manual is intended for users of **APCE-2000** smart pressure transmitters, **APRE-2000**, **APRE-2200**, **APRE-2000G** smart differential pressure transmitters and **APRE-2000/Y** smart level probes containing the data and guidelines necessary to understand the functioning of the transmitters and how to operate them. It includes essential recommendations concerning installation and use, as well as emergency procedures.

1.2. Technical data for the diaphragm seals and for the **APCE-2000**, **APRE-2000**, **APRE-2200** transmitters are contained in the catalogue cards "DIAPHRAGM SEALS".

1.3. The transmitters comply with the requirements of EU directives as shown on the plate and with the relevant Declaration of Conformity.

1.4. Additional data on **APCE-2000EEEx**, **APRE-2000EEEx**, **APRE-2000EEExG**, **APRE-2000EEExY** and **APRE-2200EEEx** transmitters in EEx versions covered by the EU-type test certificate number **KDB 04ATEX059** and **KDB 04ATEX059/1** is contained in the appendix designated **DTR.APCE.APRE.01(ENG) Appendix Ex.01**.



During installation and use of the transmitters in EEx version, reference should be made to **DTR.APCE.APRE.01(ENG)** in conjunction with **Appendix Ex.01**.

1.5. The **APCE-2000**, **APRE-2000**, **APCE-2000EEEx**, **APRE-2000EEEx** transmitters are also made in a version which complies with the PED pressure directive, meet the requirements for category IV, and then carry additional markings as in 4.3 and 4.4.

1.6. Parameters and information given for **APCE...**, **APRE...** transmitters apply to the **APCE-2000**, **APRE-2000**, **APRE-2200**, **APRE-2200G**, **APRE-2000G**, **APRE-2000/Y** transmitters and to the corresponding anti-explosion versions **APCE-2000EEEx**, **APRE-2000EEEx**, **APRE-2200EEEx**, **APRE-2000EEExG**, **APRE-2000EEExY** as well as all variants with different types of electrical and process connections.



2. USER MATERIALS

Transmitters are delivered in single and/or multiple packs.

A transmitter is delivered together with a "Product Certificate" which also serves as a guarantee card.

A batch of transmitters is supplied together with the Technical Manual (DTR).

At the customer's request, a "Declaration of Compliance" and/or Certificate will be supplied.

(These documents can also be found on the Internet.)

3. APPLICATIONS AND MAIN FEATURES

3.1. The **APCE...** smart pressure transmitter are designed to measure positive gauge pressure, vacuum pressure and absolute pressure of gases, vapours and liquids (including corrosive substances).

3.2. Differential pressure transmitters type **APRE-2000** are used to measure liquid levels in closed tanks, with static pressure of up to 25MPa or 32MPa for special versions and to measure differential pressure across constrictions such as filters and orifices.



3.3. The transmitters may be fitted with a range of types of process connectors, which enables them to be used in a variety of conditions such as thick or highly reactive media, high and low temperatures, etc.

3.4. **APRE-2000G** transmitters are designed to measure absolute pressure, overpressure and differential pressure of non-reactive gases. Typical applications include the measurement of air blasts, chimney draughts, or pressure and overpressure in combustion chambers.

The transmitter is constructed to withstand excess pressure of up to 35kPa or 100kPa.

3.5. **APRE-2000/Y** level probes are used to measure the level in closed tanks where the medium is accessed from the top of the tank.

3.6. **APCE...**, **APRE...** transmitters generate a 4...20mA output signal and a digital communication signal in a two-wire system. The use of smart electronics enables regulation of the zero point, the measurement range, damping, radical conversion characteristic and other functions using an Aplisens **KAP** communicator or from a PC using a Hart/RS232 converter and Aplisens "Raport-01" configuration software.

4. IDENTIFYING MARKS. ORDERING PROCEDURE

4.1. Every transmitter carries a rating plate containing at least the following information: CE mark, numbers of notified institutions and designations of certificates obtained, name of manufacturer, type, factory number, basic range, min. set range, static pressure limit, output signal, power supply voltage

Version types and the method of specifying the desired product when ordering are described in the current "Information Cards" and the Catalogue.

4.2. APCE...APRE...-transmitters in version: EEx approval have additional markings as described in DTR.APCE.APRE.01(ENG) Appendix Ex.01.



4.3. The rating plates of transmitters of type APCE-2000 in versions compliant with the PED pressure directive contain the notified unit number 0062 next to the CE mark, as well as the designations of certificates number: CE-PED- H1D-APL003-04-PL.

4.4. The rating plates of transmitters of type APRE-2000 in versions compliant with the PED pressure directive contain the notified unit number 0062 next to the CE mark, as well as the designations of certificates number: CE-PED- H1D-APL 002-05-PL.

5. TECHNICAL DATA.

5.1. APCE..., APRE...-Common parameters

5.1.1. APCE..., APRE... Electrical parameters

Power supply for non-intrinsic-safe versions	10,5 ÷ 36V DC, rated 24V DC
Power supply for intrinsic-safe versions	in accordance with Appendix Ex.01.
Output signal	4÷20mA or inverse 20÷4mA set from communicator
Communication	Communication takes place via a 4÷20mA signal using specialized Aplisens equipment, (see. 10.2.4).
Resistance required for communication	250÷1100 Ω
Load resistance	$R_{Lmax}[\Omega] = \frac{U_{sup}[V] - 10,5V}{0,02A} \times 0,85$
Minimum supply voltage	$U_{min}[V] = \frac{R_L[\Omega] \times 0,02A}{0,85} + 10,5V$
for specified load resistance $R_L[\Omega]$	
Time for stabilization of output signal	0,3s (for APCE..., APRE-2000G)
Time for stabilization of output signal	0,5s (for APRE-2000, APRE-2200)
Additional electronic damping	0...30s
Voltage for insulation testing	500 VAC or 750 VDC, see 9.4.
Excess voltage protection	see 9.4.

5.1.2. APCE..., APRE.... Permitted environmental conditions

Operating temperature range	- 40°C ÷ 85°C (ambient temperature) – for APCE...
	- 25°C ÷ 85°C (ambient temperature) – for APRE...

(Operating temperature range for intrinsic-safe versions in accordance with Appendix Ex.01

Medium temperature range	-40°C ÷ 120°C – direct measurement – for APCE...
	-25°C ÷ 120°C – direct measurement – for APRE...,
	over 120°C measurement with the use of a transmission tube or diaphragm seal.
Medium temperature range APRE-2000	to 100°C for version compliant with the PED pressure directive
Thermal compensation range	- -25° ÷ 80°C,
	(-5° ÷ 65°C for range – n°12 APCE...)
	(-40° ÷ 80°C for special version APCE)
	-10 ÷ 70 °C for APRE-2000G
Relative humidity	0% ÷ 90%
Vibration during operation	not recommended
Exposure to direct sunlight	not recommended

5.1.3. APCE..., APRE... Construction materials

Diaphragm seal for APCE...	Stainless steel 316L (00H17N14M2) or Hastelloy C276
Diaphragm seal for APRE...	Hastelloy C276
Sensing module	Stainless steel 316L (00H17N14M2)
Casing for electronic parts	Stainless steel 304 (0H18N9)
Connectors for APCE...	Stainless steel 316L (00H17N14M2) or Hastelloy C276 only for P, GP, CM30x2
C-type vented covers and connectors for APRE...	Stainless steel 316L (00H17N14M2)
Liquid filling the interior the sensing module	Silicone oil, chemically inactive liquid for measurement of oxygen.

5.1.4. APCE..., APRE... Ingress Protection Rating of Case IP65 wg. PN-EN 60529:2003.

5.2. APCE...- Measurement ranges and metrological parameters.

5.2.1. APCE..., Measurement ranges

N	Basic range (FSO)	Minimum set range	Ability to shift the start of the range	Overpressure limit (without hysteresis)
1.	0...30 MPa	300 kPa	0...29,7 MPa	45 MPa
2.	0...7 MPa	70 kPa	0...6,93 MPa	14 MPa
3.	0...2,5 MPa	25 kPa	0...2,475 MPa	5 MPa
4.	0...0,7 MPa	7 kPa	0...0,693 MPa	1,4 MPa
5.	-100...150 kPa	12 kPa	-100...138 kPa	400 kPa
6.	0...200 kPa	10 kPa	0...190 kPa	400 kPa
7.	0...100 kPa	5 kPa	0...95 kPa	200 kPa
8.	-50...50 kPa	5 kPa	-50...45 kPa	200 kPa
9.	0...25 kPa	2,5 kPa	0...22,5 kPa	100 kPa
10.	-10...10 kPa	2 kPa	-10...8 kPa	100 kPa
11.	-1,5...7 kPa*	0,5 kPa	-1,5...6,5 kPa	50 kPa
12.	-0,7...0,7 kPa*	0,1 kPa	-0,7...0,6 kPa	50 kPa
13.	0...110 kPa (abs.press.)	5 kPa	0...105 kPa(abs.press.)	200 kPa
14.	0...700 kPa (abs.press.)	7 kPa	0...693 kPa (abs.press.)	1,4 MPa
15.	0...2,5 MPa (abs.press.)	25 kPa	0...2,475MPa (abs.press.)	5 MPa
16.	0...7 MPa (abs.press.)	70 kPa	0...6,93 MPa (abs.press.)	14 MPa
* - only for transmitters without diaphragm seal,			(Other ranges available upon agreement)	

5.2.2. APCE..., Metrological parameters

Accuracy	max $\pm 0,1\%$ for the basic range (0,25% for range n°12)
Long term stability (for the basic range)	accuracy for 2 years
Error due to supply voltage changes	max $\pm 0,002\%$ (FSO)/1V
Thermal error	max $\pm 0,08\%$ (FSO)/10°C (max $\pm 0,1\%$ FSO/10°C for range n°10, 11, 12).
Thermal error for the whole thermal compensation range	max $\pm 0,25\%$ (FSO) (max $\pm 0,4\%$ FSO/10°C for range n°10, 11, 12).

5.2.3. APCE..., Pressure Connectors

M-type connector with M20x1.5 thread – see figure 5a,
P-type connector with M20x1.5 thread – see figure 6a,
CM30x2-type connector with flush diaphragm – see figure 7a,
G1/2 -type connector with G1/2" thread – see figure 8a,
GP -type connector with G1/2" thread,
CG1-type connector with G1" thread and flush diaphragm – see figure 8e,
other connection types by arrangement.

5.3. APRE-2000 - Measurement ranges and metrological parameters.

5.3.1. APRE-2000, Measurement ranges.

N	Basic range (FSO)	Minimum set range	Ability to shift the start of the range	Overpressure limit	Static pressure limit
1	0...1,6 MPa	160 kPa	0...1440 kPa	25, 32MPa (4MPa for P-type connector) (25MPa for version compliant with the PED pressure directive) 4MPa	
2	0...200 kPa	20 kPa	0...180 kPa		
3	0...100 kPa	7 kPa	0...93 kPa		
4	0...25 kPa	1 kPa	0...24 kPa		
5	-0,5...7 kPa	0,4 kPa	-0,5...6,6 kPa		
6	-50...+50 kPa	10 kPa	-50...+40 kPa		
Other ranges available upon agreement.			Range n° 6 recommended for measurement of levels with a direct mount diaphragm seals and a filled (or empty) impulse line.		

5.3.2. APRE-2000, Metrological parameters

Accuracy	max $\pm 0,1\%$ for the basic range
Long term stability (for the basic range)	\leq accuracy for 3 years
Error due to supply voltage changes	max $\pm 0,002\%$ (FSO)/1V
Thermal error	max $\pm 0,08\%$ (FSO)/10°C
Thermal error for the whole thermal compensation range	max $\pm 0,3\%$ (FSO)
Zero shift error for static pressure*	max $\pm 0,08\%$ (FSO)/1MPa max $\pm 0,02\%$ (FSO)/1MPa (for range n°4) max $\pm 0,05\%$ (FSO)/1MPa (for range n°5)
Cut-off on radical characteristic curve	cut-off of up to 10% of flow.

* This error can be eliminated by zeroing the transmitter in static pressure conditions with zero differential pressure.

5.3.3. APRE-2000, Pressure Connectors

APRE-2000 without diaphragm seals - P-type connector with M20x1.5 thread – see fig.9 or C-type connector to mount together with a valve manifold see fig.10.

APRE-2000 with single direct diaphragm seal – as in the example (figure 11) or with other diaphragm seals in accordance with catalogue cards "DIAPHRAGM SEALS".

5.4. APRE-2200, Measurement ranges and metrological parameters.

5.4.1. APRE-2200, Measurement ranges

Basic range (FSO)	Minimum set range	Vertical spacing of diaphragm seals.	Maximum configurable range dependent on the actual vertical spacing of diaphragm seals. (m)	Static pressure limit
-16...16 kPa	0,1 mH ₂ O	1,7m	[1,6+(vertical spacing of sealsx94)]mH ₂ O	4MPa
-50...50 kPa	0.5 mH ₂ O	6m	[5+(vertical spacing of sealsx1,04)]mH ₂ O	4MPa
-130...200 kPa	1,5 mH ₂ O	12m	[20+(vertical spacing of sealsx1,04)]mH ₂ O	4MPa
-130...1600kPa	100 kPa	12m	1600kPa	4MPa

5.4.2. APRE-2200, Metrological parameters

Accuracy	$\pm 0,1\%$ (FSO)
Thermal error	$\pm 0,08\%$ (FSO) / 10 °C
Thermal error for the whole thermal compensation range	$\pm 0,3\%$ (FSO)
Zero shift error for static pressure	$\pm 0,08\%$ (FSO) / 1MPa
Error related to changes of Usup.	$\pm 0,002\%$ (FSO) / V
Additional errors due to effects of sealing	see catalogue cards "DIAPHRAGM SEALS".



The maximum vertical diaphragm seal spacing shown in the table applies to level measurement, ensuring that it is possible to set the zero point of the transmitter when the tank is empty. For measurements of density or phase boundaries (in the sugar and chemical industries and in refineries) the vertical spacing of the diaphragm seals can be larger.

N	1	2
Accuracy for full range	± 0,16 %	± 0,2 %
Accuracy for minimum range	± 0,5 %	± 0,6 %
Error due to ambient temperature changes	0,4 % for temperatures –25...+80°C	
Zero shift error for static pressure *	0.08 % / 1MPa	0.1 % / 1MPa

* This error can be eliminated by zeroing the transmitter in static pressure conditions with zero differential pressure.

Range of medium densities – up to $1,1 \text{ g/cm}^3$ – (standard version)
 – over $1,1 \text{ g/cm}^3$ – (special version by arrangement with APLISENS)

6. CONSTRUCTION, PRESSURE CONNECTORS, ELECTRICAL CONNECTORS

6.1. Measurement Principles, Electronic System.

APCE... electronic pressure transmitters and **APRE...** electronic differential pressure transmitters work by converting changes in the resistance of a piezoresistive bridge, which are proportional to the pressure difference being measured, into a standard current signal.

The active sensing element is a silicon diaphragm with in-diffused piezoresistors, separated from the medium by a sealing diaphragm and manometric fluid.

The electronic system digitally processes the measurement signal and generates output signals: an analogue $4\div20 \text{ mA}$ signal and a digital communication signal.

A block diagram of the transmitter is presented in Figure 1. In the input circuit two analogue signals are formed, reflecting the measured pressure and the temperature of the sensing module. These signals are digitalized and input to a microprocessor which controls the transmitter's operation. Using data input during the production process adjusts for thermal errors and carries out linearization.

After processing, the digital signal is again converted into an analogue $4\div20\text{mA}$ current signal, with a superimposed digital communication signal.

For communication with the transmitter via the signal line a special Aplisens KAP communicator, or a computer meeting the requirements given in 10.2.4, is used.

The transmitter's input point is fitted with a noise filter and elements protecting against excess voltage.

6.2. Construction.

The main components of the smart pressure transmitter are the sensing module, in which the pressure signal is converted into a non-uniformized signal, and the electronic system, which converts the signal from the sensing module into a $4\div20\text{mA}$ output signal and produces a digital communication signal.

6.2.1. In the **APCE...** transmitters the pressure connectors may be attached to the sensing module as in figures 5a, 6a, 7a, 8 and other. They are equipped with a diaphragm separating the internal part of the head from the medium.

6.2.2. In the **APRE-2000** transmitters, the sensing module has two P-type connectors (figure 9), or C-type connecting covers for installation on a valve manifold (figure 10).

6.2.3. The **APRE-2000** transmitters may be fitted with an single direct diaphragm seal, mounted on the "+" pressure input of the sensing module, while the "-" input is a $\frac{1}{4}\text{NPT}$ socket (figure 11).

The **APRE-2200** transmitter is fitted with two diaphragm seals and can be produced in two versions:

- with one direct diaphragm seal and one remote diaphragm seal (figure 13);
- with two remote diaphragm seals (figure 12).

The diaphragm seal transmits the pressure obtained from the medium. The pressure is transmitted via a manometric fluid which fills the space between the diaphragm of the seal and the diaphragm of the sensing module. In the case of remote diaphragm seals, pressure is transmitted via a capillary linking the transmitter's sensing module to the diaphragm seal.

The construction of the seals depends on the medium properties and operating conditions for which they are intended.

Technical data relating to the diaphragm seals' dimensions and operating conditions can be found in catalogue cards "DIAPHRAGM SEALS".

6.2.4. In the case of the **APRE-2000G** transmitter, the sensing module is located inside the casing. It is designed for the measurement of low pressures of non-aggressive gases, with a permitted overpressure of 100kPa (or 35kPa). The basic (economy) version of this transmitter has terminals fitting $\varnothing 6 \times 1$ elastic tubes, while the industrial version has adapters as shown in figure 14.

6.2.5. Smart level probe is equipped in diaphragm seal and flange to fixing on tank.

6.3. Casing, Electrical Connections

APCE..., **APRE...** transmitters are cased in a $\varnothing 51$ pipe with a PD (DIN 43650) or PZ type connector.

6.3.1. The **PD** type connector (figure 3) is located on the floor of the casing ($\varnothing 51$ pipe) and sealed with a rubber washer. The base of the connector and the casing are connected detachably to the active sensing module and are fastened with two slotted nuts.

6.3.2. Transmitters with a **PZ** type connector (figure 4) have a terminal box connected permanently to the casing.

The box is closed with a serrated lid (in EEx-version with a smooth rounded lid) and has an external earthing terminal. Mounted on the inside is a terminal block equipped with additional control terminals, galvanically connected to terminals 1, 2 and 3. By connecting a milliammeter to sockets 1 and 3, a local measurement can be made of the current in the transmitter without the need to disconnect the measuring circuit.

7. PLACE OF INSTALLATION OF TRANSMITTERS

7.1. General recommendations

7.1.1. The smart pressure transmitter and differential pressure transmitter can be installed both indoors and outdoors. It is recommended that transmitters intended for outdoor use be placed in a box or under cover. There is no need for a cover in the case of transmitters with **PZ** type connector.

7.1.2. The place of installation should be chosen in such a way as to allow access to the device and to protect it from mechanical damage. In planning the installation of the transmitter and configuration of the impulse lines, attention should be paid to the following requirements:

- The impulse lines should be as short as possible, with a sufficiently large cross-section, and free of sharp bends, in order to prevent blockages;
- Where the medium is a gas, the transmitters should be installed above the measuring point, so that condensation flows down towards the site of the pressure measurement; where the medium is a liquid or where a protective liquid is used, the transmitters should be installed below the place where the pressure measurement is taken;
- The impulse lines should be inclined at a gradient of at least 10cm/m;
- The levels of filling liquid in the impulse lines should be equal or kept constant difference,
- The configuration of the impulse lines and the valve connection system should be chosen with regard to the measurement conditions and to requirements such as the need to reset the transmitters in position and the need for access to the impulse lines during water or gas removal and flushing.



7.1.3. Where there is a risk of heavy objects hitting the instrument (resulting, in extreme cases, in a part of the system with transducers being torn off and medium leakage), appropriate means of protection should be applied for safety reasons and to avoid the possibility of sparking or other, more appropriate location should be selected for the transmitter.

7.1.4. Attention should also be paid to possible installation faults which may lead to measurement errors, such as connections which are not tight, sediment blockage in lines which are too narrow, gas bubbles in a liquid line or liquid column in a gas line etc.

7.2. Low Ambient Temperature.



When the solidification point of the liquid whose pressure is being measured is greater than the ambient temperature, steps should be taken to protect the measurement apparatus from freezing effects.

This is particularly important in the case open-air installations.

Protection is obtained by filling the impulse lines with a mixture of ethylene glycol and water, or another liquid whose solidification point does not exceed the ambient temperature. Thermal insulation can protect the casing of the transmitter and lines only from brief exposure to low temperatures. Where the temperature is very low, the transmitter and impulse lines are should be heated.

7.3. High Medium Temperature.

The **APCE...**, **APRE...** transmitters may be used to measure media with temperatures of up to 120°C.

To protect the sensing module from temperatures in excess of 120°C, suitably long impulse lines are used to disperse the heat and to lower the temperature of the module.

Where it is not possible to use impulse lines of the required length, **APCE...**, **APRE...** transmitters with remote diaphragm seals should be used (see catalogue cards "DIAPHRAGM SEALS").



Data as per Appendix Ex.01 apply for the EEx version.

7.4. Mechanical Vibration, Corrosive Media.

7.4.1. The transmitter should be installed in a place which is free of vibrations. If vibrations are carried to the transmitter via the impulse lines, use should be made of elastic lines or a **APCE...**, **APRE...** transmitters with a remote diaphragm seal.



7.4.2. Transmitters should not be installed in places where the diaphragm, made of 316L steel (00H17N14M2), would be subject to corrosion by the medium being measured

If possible, transmitters with diaphragms made of Hastelloy C276 should be used, or other means of protection applied (e.g. in the form of a separating liquid) or transmitters with diaphragm seals adapted for measuring aggressive mediums according to catalogue cards "DIAPHRAGM SEALS" should be used.

8. INSTALLATION AND MECHANICAL CONNECTIONS

The **APCE...**, **APRE...** transmitters (except APRE-2000G and APRE-2000/Y) can operate in any position. When installed on an object with a high-temperature medium, it is advantageous to mount the transmitter in a horizontal position with the packing gland pointing downwards or to the side, in such a way that the transmitter is kept away from the stream of rising hot air. When the measurement range is small, the reading can be affected by the position of the transmitter and by the configuration of the impulse lines and the way in which they are filled with liquid. This error can be corrected using the zero-setting function.

8.1. APCE... Installation and connections

8.1.1. The **APCE...** transmitters can be mounted directly on rigid impulse lines.

Where connectors are used as in figures 5a, 6a and 7a, it is recommended that connection sockets be used as shown in figure 5b, 6b, 7b or 7c.

It is recommended that sockets labeled "Socket CG1" and „Socket CG1/2" Fig. 8 are used for CG1 and CG1/2 connections, respectively.

Besides, there are adapters for standard DIN50, (DIN40, DIN25, Clamp2", Clamp1,5", Clamp1") type connections provided for readouts carried out in aseptic conditions using transmitters with CM30x2 connection.

There are seals provided for every transmitter with P, CM30x2, CG1, CG1/2 and GP type connections.

The material of the seal is selected based on the pressure value and the type and temperature of the medium.

8.1.2. If the pressure is applied via a flexible plastic tube, the transmitter should be mounted on a support with Red Ø6-M reduction.

In case of metal pipes, the used connections should comply with PN-82/M-42306.

The types of the impulse tubes (Fig.16) are to be selected depending on the measured value of the pressure and the medium temperature.

8.1.3. Tighten the transmitter in the socket with a torque appropriate for the type of the used seal and the measured pressure.

8.2. APRE... Installation and connections

8.2.1. The **APRE 2000** transmitters can be mounted directly on rigid impulse lines.

To connect the basic versions of transmitters, with two M20 x 1.5 stubs (P-type connector), one can use (for example) straight connecting elements with nuts (type C). If elastic impulse lines are used for connection purposes, the transmitter should be additionally fastened to a pipe, panel or supporting construction.

8.2.2. The **APRE-2000** and **APRE-2200** can be installed using the Fastener Ø25 (figure 17.) on a Ø25 pipe or on a flat surface using an angle bracket.

8.2.3. The **APRE-2000** with connecting cover (C-type connector) (figure 10) are designed for installation on 3-valve or 5-valve manifolds to a 2" pipe or to a flat surface using an fastener "C-2" (figure18) or "U" (figure 19).

8.3. APRE-2000G. Installation and connections

8.3.1. The "economy" version of the **APRE-2000G** transmitter can be mounted on a wall, panel or other stable construction, using a clamp with Ø9 holes (Figure 14).

The transmitter is fitted with stubs with a terminal which fits a Ø 6x1 elastic impulse tube.

When the impulse is transmitted via a metal terminal with M20 x 1.5 opening, an adapter is used between the M20 x 1.5 thread and the Ø6x1 terminal.

Install the transmitter in a vertical position.

Where there is a significant difference between the height at which the transmitter is mounted and the height of the impulse source, particularly if the measurement range is small, the reading may fluctuate depending on the temperature difference between the impulse lines.

This effect can be reduced by ensuring that the lines run side by side.

8.3.2. The **APRE-2000G** transmitter can also be fitted with an adapter (Figure 14) creating a C-type connector, designed for installation on a 3-valve or 5-valve manifold. Aplisens can also supply transmitters ready mounted on valves.

8.4. APRE-2000/Y. Installation and connections

The **APRE-2000/Y** level probes installed in places where liquid levels are measured in closed tanks, with access to medium from top of tank see figure 15 and 10.2.6.

Install the probe in a vertical position.

Pressure may be transmitted to the installed device only after checking that it has a measurement range which properly corresponds to the value of the measured pressure, that gaskets have been properly selected and fitted, and the connector has been properly screwed tight.



Attempts to undo the screws or fixing connector pipes on a transmitter under pressure may cause the medium to leak and create hazards for the personnel.

When disassembling the transmitter, it is necessary to disconnect it from the process pressure or bring the pressure to atmospheric level, and to take particular care and precautions in case of media which are highly reactive, caustic, explosive or otherwise hazardous to personnel.

If necessary, rinse out this part of the system.

Transmitters with flange diaphragm seals are to be installed on the corresponding counterflanges on the facility.

It is recommended that the user matches the screw joints material to the pressure, temperature, flange material and seal to ensure tightness of the flange joint in the expected operating conditions..



Coarse-threaded screws complying with ISO 261 are to be used for flanges used in the APCE..., APRE... transmitters.

Additional data concerning the diaphragm seals are specified in the catalogue cards "DIAPHRAGM SEALS".

9. ELECTRICAL CONNECTION

9.1. General recommendations

It is recommended that twisted pair cabling be used for the signal lines. If the transmitter and signal line are subject to a large amount of electromagnetic interference, then screened twisted pair cable should be used.

The signal wires should not run alongside network power supply cables or near to large electrically-powered devices.

The devices used together with the transmitters should be resistant to electromagnetic interference from the transmission line in accordance with compatibility requirements.

It is also beneficial to use anti-interference filters on the primary side of the transformers, the power supplies used for the transmitters and apparatus used in conjunction with them.

9.2. Connections for transmitters with PD-type connector.

The transmitters with **PD** type connectors are to be connected as shown in figure 2a.

To make the connections, remove the terminal block from the contact pins together with its cover.

Then remove the block from its cover, levering it off with the end of a screwdriver inserted into the slot provided for this purpose. Connect the wires to the block.



Where the isolation of the wires in the packing gland is ineffective (for example, when single wires are used) the opening of the gland should be carefully sealed with an elastic sealing compound to obtain IP65 ingress protection. It is useful to form the segment of the signal wire leading to the PG-11 packing gland into a protective loop to prevent condensation from running down in the direction of the gland.

9.3. Connections for transmitters with terminal box (PZ-type connector).

The transmitters with **PZ**-type connectors should be connected by linking the signal wires to a terminal block, as shown in figure 2a and 2b. Carefully screw in the cover and cork of the packing gland, making sure that the wire is tightly packed. Where necessary, the packing gland should be further sealed as described in 9.2.

9.4. Protection from excess voltage

9.4.1. The transmitters may be in danger from excess voltage caused by connection faults or atmospheric electrical discharge.

Protection from excess voltage between the wires of the transmission line is provided by transil diodes installed in all types of transmitter (see the table, column 2).

9.4.2. In order to protect against excess voltage between the transmission line and the casing or earth (not prevented by the diodes connected between the transmission wires), additional protection is provided in the form of plasma surge arresters or transil diodes (see the table, column 3).

In the case of unprotected transmitters, external protective devices may be used, e.g. the UZ-2 system produced by Aplisens, or others. When the transmission lines are long, it is advantageous to use one protective device near the transmitter (or inside it), and another near entry points to other devices used in conjunction with it.

Devices used to protect transmitters:

1	2	3
Type of transmitter	Protection between wires (transil diodes) – permitted voltage	Protection between wires and earth and/or casing – type of protection, permitted voltage
APCE..., APRE...	36V DC	Plasma surge arresters - 100V DC (Not applicable to EEx version).

9.4.3. When excess voltage protection is used, the voltage in the protective elements must not exceed the maximum permitted values given in columns 2 and 3 of the table.

Such protection is not used in EEx versions of transmitters.



The insulation test voltages (500V AC or 750V DC) given in 5.1.3 refer to transmitters without the protective devices described in 9.4.2.

Such protection is not used in EEx versions of transmitters.

9.5. Earthing

The transmitters are fitted with internal and external earth terminals.

10. SETTING AND REGULATION

APCE..., APRE... transmitters are factory calibrated to the range stated in the order or to the basic range.

After installation, the transmitter's zero-point may drift and require adjustment.

This applies particularly in cases where the measurement range is small, where the impulse lines are filled with a separating liquid or where **APCE..., APRE...** transmitters are used with remote diaphragm seals.

10.1. Transmitter Range, Definitions

10.1.1. The maximum range of absolute or differential pressure which the transmitter can measure is called the **“basic range”** (for specifications of basic ranges see 5.2.1, 5.3.1, 5.4.1 and 5.5.1 and 5.6.1).

The width of the basic range is the difference between the upper and lower limits of the basic range.

The internal characteristic conversion curve for the basic range is coded in the transmitter's memory.

This is the reference curve used when making any adjustments which affect the transmitter's output signal.

10.1.2. When the transmitter is in use the term **“set range”** is used. The set range is the range whose lower end-point corresponds to an output current of 4mA and whose upper end-point corresponds to a current of 20mA (or 20mA and 4mA respectively when the conversion curve is inverted).

The set range may cover the whole of the basic range or only a part of it.

The width of the set range is the difference between its upper and lower end-points.

The transmitter may be set to any range within the basic range of pressure values, subject to the restrictions set out in the table in 5.2.1, 5.3.1, 5.4.1, 5.5.1 and 5.6.1.

10.2. Configuration and Calibration

10.2.1. The transmitter has features which enable metrological and identification parameters to be set and altered. The configurable metrological parameters affecting the transmitter's output current include the following:

- a) unit in which the measured pressure is expressed on the display
- b) upper end-point of the set range
- c) lower end-point of the set range
- d) time constant
- e) type of characteristic curve: linear or radical

Parameters of an informational nature which cannot be altered include the following:

- f) upper limit of the maximum range
- g) lower limit of the maximum range
- h) minimum range

10.2.2. Other identification parameters, not affecting the output signal, include: device address, device type code, factory identification code, factory device code, number of preambles (3÷20), UCS, TSD, program version, electronics version, flags, factory number, label tag, description tag, date tag, message, record number, sensing module number.

The process of setting the parameters listed in 10.2.1 and 10.2.2 is called **“Configuration”**.

10.2.3. It is possible to carry out a **“pressure zeroing”** procedure, for example in order to compensate for measurement deviation caused by a change in position when the transmitter is installed.

The transmitter may also be **calibrated**, by taking readings with the input pressure controlled using a standard device. This process and zero-point adjustment are called **“Calibration”**.

10.2.4. Configuration and Calibration of the transmitter are carried out using an Aplisens KAP communicator, certain Hart communicators or a PC with Hart/RS232 converter and Aplisens Raport-01 software.

Together with the “RAPORT-01” configuration software there is a „INTERVAL LINEARIZATION” software supplied to enable the input of 21-point nonlinear functional characteristics to the transducer.

A description of the functions of the KAP communicator is contained in the KAP Communicator Operating Manual, and information on the Hart/RS232 converter can be found on the Hart/RS232/01 Converter information sheet.



A list of Hart protocol commands implemented for APCE..., APRE... transmitters is contained in the IO.HART operating instructions available at www.aplisens.pl.

10.2.5. Configuration of the APRE-2200 and APRE-2200Ex transmitters to measure the level, density of liquid and phase boundary

To simplify the mathematical operations we introduce the density coefficient of the medium X_p .

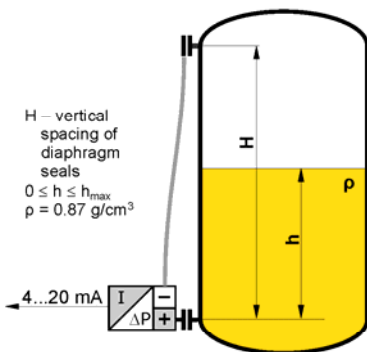
$$X_p = \frac{\rho_{\text{medium}} [\text{g/cm}^3]}{\rho_{\text{water at 4}^\circ\text{C}} [\text{g/cm}^3]}$$

Since the density of water at 4°C is 1 g/cm³, the density coefficient X_p is numerically equal to the density of the medium expressed in g/cm³. To determine the hydrostatic pressure of a column of liquid in mm H₂O, it is sufficient to multiply the height of the column h [mm] by the density coefficient of the liquid X_p . Since it is easy to determine the hydrostatic pressure in mm H₂O and the transmitter can be configured in those units, in the descriptions of measurement methods given below we will make use of pressures expressed in mm H₂O and the density coefficient X_p .

Configuration of the APR-2200 transmitter to measure the level of liquid in a tank

The measurement task:

To convert a variation in the level of a liquid with density $\rho = 0.87 \text{ g/cm}^3$ between 0 and h_{max} to a variation in the output signal from 4 to 20 mA.



1. Install the transmitter in its working position on an empty tank.
2. Make the electrical connections of the transmitter, providing for the ability to use HART communication.
3. Connect the KAP-01 communicator, identify the transmitter and select the "configuration" function.

4. On the configuration menu select the "Reranging" procedure.
5. On the "Reranging" menu:
 - a) change the units of measurement to mm H₂O at 4°C;
 - b) enter the values for the start ($X_p \times h_{\text{min}}$ [mm]) and end ($X_p \times h_{\text{max}}$ [mm]) of the measurement range, namely 0 and ($0.87 h_{\text{max}}$ [mm]) respectively;
 - c) to compensate for the hydrostatic pressure of the manometric fluid, the start of the measurement range should be set using regulated pressure; when subject to the action of only the manometric fluid (empty tank) the transmitter will shift the start and end-points of the range, compensating for the value of that pressure.

When the transmitter has been configured in this way it is ready to be used to carry out the given measurement task.

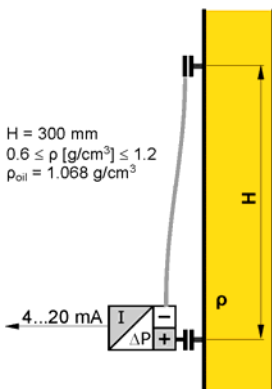
If it is not possible to empty the tank to configure the transmitter, the hydrostatic pressure of the manometric fluid should be calculated by multiplying the vertical spacing of the diaphragm seals by the density coefficient of the oil in the capillaries. This pressure should be taken into account when entering the values for the start and end of the range:

$$\text{Start [mm H}_2\text{O]} = -H [\text{mm}] \times X_{p_{\text{oil}}}$$

$$\text{End [mm H}_2\text{O]} = h_{\text{max}} [\text{mm}] \times X_{p_{\text{measured liquid}}} - H [\text{mm}] \times X_{p_{\text{oil}}}$$

ρ_{oil} for DC-550 oil is equal to 1.068 g/cm³
 ρ_{oil} for AK-20 oil is equal to 0.945 g/cm³

Configuration of the APR-2200 transmitter to measure density of liquids



The measurement task:

To convert a variation in liquid density from $\rho_{\text{min}} = 0.6 \text{ g/cm}^3$ to $\rho_{\text{max}} = 1.2 \text{ g/cm}^3$ to a variation in the output signal from 4 to 20 mA, with the vertical spacing of the diaphragm seals equal to $H = 3000 \text{ mm}$. The sealing system is filled with DC-550 oil with density $\rho_{\text{oil}} = 1.068 \text{ g/cm}^3$.

1. Calculate the value of the start of the range as follows:
 $H_{[\text{mm}]} \times (X_{p_{\text{min}}} - X_{p_{\text{oil}}}) = 3000 \times (0.6 - 1.068) = -1404 [\text{mm H}_2\text{O}]$
2. Calculate the value of the end of the range as follows:
 $H_{[\text{mm}]} \times (X_{p_{\text{max}}} - X_{p_{\text{oil}}}) = 3000 \times (1.2 - 1.068) = 396 [\text{mm H}_2\text{O}]$
3. Set the zero point of the transmitter with the diaphragm seals positioned at the same level.
4. Install the transmitter in its working position.
5. Make the electrical connections to the transmitter, providing for the possibility of using HART communication.

6. Connect the KAP-01 communicator, identify the transmitter and select the "configuration" function.
7. On the configuration menu select "Reranging" procedure.
8. On the "Reranging" menu:
 - a) change the measurement units to mm H₂O at 4°C;
 - b) enter the calculated values for the start (-1404) and end (396) of the range.

When the transmitter has been configured in this way it is ready to be used to carry out the given measurement task.

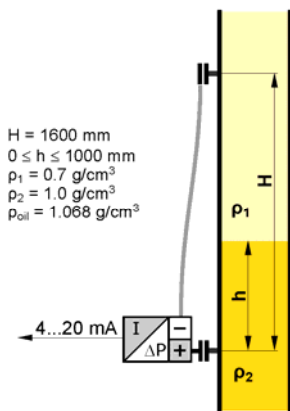
Note: If it is possible to fill the space between the seals with a liquid whose density corresponds to the start of the measurement range, the start of the range of the transmitter can be set using regulated pressure.

Measurement of phase boundary

The height of the phase boundary of liquids of different densities is determined by measuring the average density of the medium between the seals.

Example:

Calculate the measurement range start and end points for an APR-2200 transmitter configured to measure phase boundary height in the range 0–1000 mm between liquids of density $\rho_1 = 0.7 \text{ g/cm}^3$ and $\rho_2 = 1.0 \text{ g/cm}^3$, where the vertical spacing of the seals $H = 1600 \text{ mm}$. The sealing system uses DC-550 oil with a density of 1.068 g/cm^3 .



To determine the start of the measurement range, calculate the pressure difference at the transmitter when the tank is filled with the lighter liquid only:

$$1600 [\text{mm}] \times (0.7 - 1.068) = -588.8 [\text{mm H}_2\text{O}]$$

To determine the end-point of the range, add the increase in pressure resulting from the appearance of a 1 metre column of the heavier liquid:

$$\begin{aligned} -588.8 [\text{mm H}_2\text{O}] + (1.0 - 0.7) \times 1000 [\text{mm}] &= \\ &= -288.8 [\text{mm H}_2\text{O}] \end{aligned}$$

Additional remarks

The settings of the transmitter can be adjusted with reference to laboratory results from density measurements carried out on samples of the liquid being measured. This is most often necessary when the measurement takes place in a pipeline segment where the flow velocity of the measured liquid reaches several m/s.

Increasing the vertical spacing of the diaphragm seals widens the range and often improves measurement accuracy.

In planning the spacing of the diaphragm seals, ensure that the pressure difference at the transmitter lies within the basic range.

The maximum vertical spacing of the diaphragm seals (H) depends on the transmitter's basic range and the boundary values for the density of the measured liquid (ρ_{\min} ; ρ_{\max}).

If $\rho_{\min} < \rho_{\text{oil}} < \rho_{\max}$, the seal spacing H should satisfy the following conditions:

$$H [\text{mm}] \leq \frac{\text{lower boundary of range [mm H}_2\text{O}]}{X\rho_{\min} - X\rho_{\text{oil}}}$$

$$H [\text{mm}] \leq \frac{\text{upper boundary of range [mm H}_2\text{O}]}{X\rho_{\max} - X\rho_{\text{oil}}}$$

Example:

Determine the maximum vertical spacing of the seals for the APR-2200 / -10...10 kPa transmitter when measuring the density of liquid between 0.6 and 1.2 g/cm^3 . The sealing system uses AK-20 silicone oil with a density of 0.945 g/cm^3 .

The lower boundary of the range of the transmitter is $-10 \text{ kPa} = -1020 \text{ mm H}_2\text{O}$

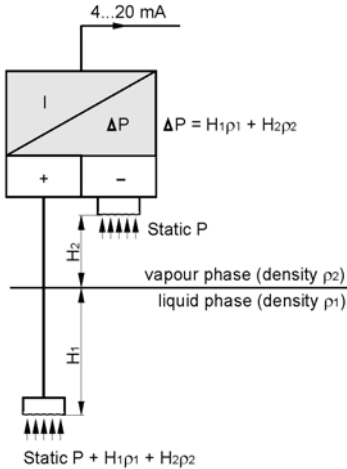
$$\begin{aligned} H [\text{mm}] &\leq \frac{-1020}{0.6 - 0.945} \Rightarrow H [\text{mm}] \leq \frac{-1020}{-0.345} \Rightarrow \\ H [\text{mm}] &\leq 2957 \end{aligned}$$

The upper boundary of the range of the transmitter is $+10 \text{ kPa} = 1020 \text{ mm H}_2\text{O}$

$$\begin{aligned} H [\text{mm}] &\leq \frac{1020}{1.2 - 0.945} \Rightarrow H [\text{mm}] \leq \frac{1020}{0.255} \Rightarrow \\ H [\text{mm}] &\leq 4000 \end{aligned}$$

In the example, both conditions are satisfied when the spacing of the seals is not more than 2957 mm.

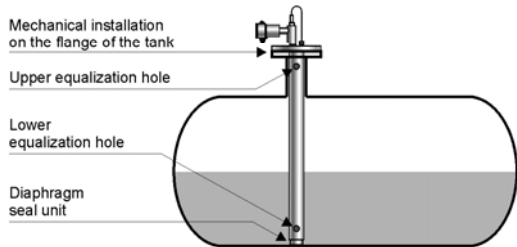
10.2.6. Configuration of the APRE-220/Y smart level probes.



Principles of operation

Measurement is carried out using an APR-2000 differential pressure transmitter, enabling compensation for static pressure in the tank. The value processed is just the hydrostatic pressure of the medium measured at the level of the diaphragm of the lower seal. This pressure is the sum of the hydrostatic pressures of the liquid and vapour phases of the medium. In most practical measurement situations the density of the vapour phase is negligibly small, and therefore the measured hydrostatic pressure relates only to the height of the liquid phase column and can be taken as representing the level of the surface of the liquid phase. For media where the density of the vapour phase is significant (e.g. propane) the level found by the method described can be treated as the theoretical level of the liquid level obtained by adding the actual liquid phase to the condensed vapour phase.

Example of installation on a tank



Configuration example

To convert a rise in the level of liquid with density 0.87 from 0 to 3200 mm to a current change from 4 to 20 mA.

1. Install the transmitter in working position, place the seal at the appropriate height (tank empty).
2. Calculate the width of the measurement range in mm H₂O (4°C): $3200 \text{ mm} \times 0.87 \text{ g/cm}^3 = 2784 \text{ mm H}_2\text{O}$.
3. Using the communicator, set the transmitter to use the units **mm H₂O at 4°C**.
4. To determine the start of the measurement range, read off via the communicator the hydrostatic pressure produced by the manometric fluid in the capillary (e.g. **-4250 mm H₂O**).
5. To determine the end-point of the measurement range, add the value **-4250 mm H₂O** and the width of the measurement range **-4250 mm H₂O + 2784 mm H₂O = -1466 mm H₂O**.
6. Using the communicator enter the calculated start (**-4250 mm H₂O**) and end-point (**-1466 mm H₂O**) of the measurement range and send as a block to the transmitter. After receiving these parameters the transmitter will perform measurements as required.

11. INSPECTIONS AND SPARE PARTS.

11.1. Periodic inspections

Periodic inspections should be made in accordance with the regulations to which the user is subject. During inspection, the pressure connectors should be checked for loose connections and leaks, the electrical connectors should be checked with regard to tightness and the state of the gaskets, packing glands, and the diaphragm seals should be checked for tarnishing and corrosion.

Check the characteristic conversion curve by following the procedures for "Calibration" and, where appropriate, "Configuration".

11.2. Unscheduled inspections

If the transmitters are installed in a location where they may be exposed to mechanical damage, excess pressure, hydraulic impulses or excess voltage, or the diaphragm may be in danger from sedimentation, crystallization or erosion, inspections should be carried out as required.

Where it is found that the signal in the transmission line is absent or its value is incorrect, a check should be made on the line and its terminal connections.

Check whether the values of the supply voltage and load resistance are correct.

If a communicator is connected to the power supply line of the transmitter, a fault in the line may be indicated by the message "No response" or "Check connection".

If the line is in order, check the operation of the transmitter.

11.3. Cleaning the Diaphragm Seal, Overloading Damage

11.3.1. Sediment and dirt which have formed on the diaphragm in the course of operation must not be removed by mechanical means, as this may damage both the diaphragm and the transmitter itself.

The only permitted method is the dissolving of sediment.

11.3.2. Sometimes transmitters malfunction due to damage caused by overloading, e.g. in case of:



- **application of excessive pressure;**
- **freezing or solidification of the medium;**
- **action of a hard object, such as a screwdriver, on the diaphragm.**

Usually in such cases the symptoms are such that the output current falls below 4mA or rises above 20mA, and the transmitter fails to respond to input pressure.

11.4. Spare parts.

The following transmitter parts may need replacing due to damage or normal wear

- transmitters with PD connector: terminal block with angular cover and seal, connector base with seal, rating plate, case
- transmitters with PZ connector: cover seal and packing gland.

In the EEx version, the user may replace only the terminal block with angular shield and the seal in the PD connector, or the seal and packing gland in the PZ connector.



Other parts, due to their special characteristics and anti-explosive requirements, may be replaced only by the manufacturer or an authorized firm.

12. PACKING, STORAGE AND TRANSPORT

The transmitters should be packed singly or in sets, in such a way as to protect them from damage during transportation.

The transmitters should be stored in multiple packs under cover, in a place free of vapours and reactive substances, with an air temperature between +5°C and +40°C, and relative humidity of not more than 85%. Transmitters with uncovered diaphragm or seal connectors, stored without packaging, should have covers to prevent damage to the diaphragm.

During transportation, the transmitters should be packed and secured so as to prevent them from shifting.

Any means of transport may be used, provided direct atmospheric effects are eliminated.

13. GUARANTEE

The manufacturer guarantees the proper operation of the transmitters for a period of 24 months from the date of purchase and servicing provided under the guarantee and following the guarantee period. In the case of special versions, the guarantee period shall be agreed by the manufacturer and the user, but shall not be less than 12 months.

14. ADDITIONAL INFORMATION

The manufacturer reserves the right to make constructional and technological changes which do not lower the quality of the transmitters.

14.1. Related documents

- "KAP– Communicator Operating Manual" supplied with the Aplisens communicator.
- Hart/RS232/01 Converter information sheet.
- Raport-01" software.
- „INTERVAL LINEARIZATION " software.

14.2. Related standards

PN-EN 60529:2003	Degrees of protection provided by enclosures (IP Code)
PN-EN61010-1	Safety requirements for electrical equipment for measurement, control and laboratory use. General requirements.
PN-82/M-42306	Screwed connectors of pressure gauges
PN-81/M-42009	Automatics and industrial measurements. The packing, the storage and transport of devices. General requirements
PN-EN 1092-1:2004 (U)	Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories. – Part 1: Steel flanges

15. FIGURES

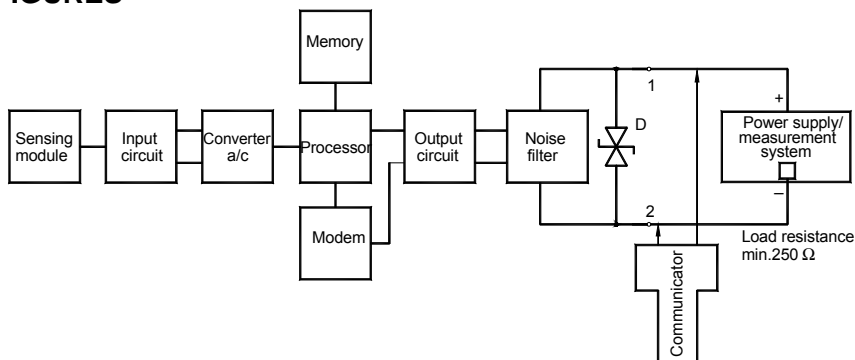


Figure 1. APCE...,APRE... transmitters – block diagram.

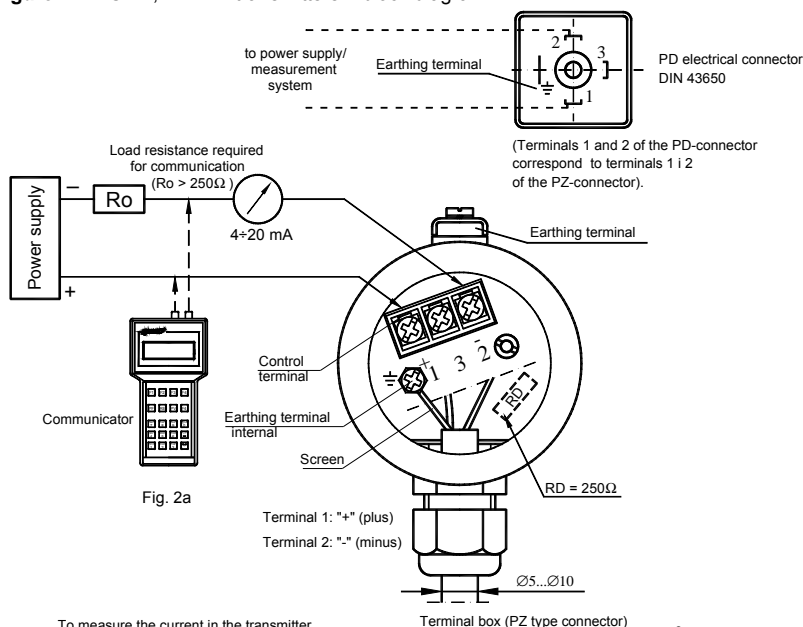


Fig. 2a

i To measure the current in the transmitter without disconnecting the signalling circuit, connect a millimeter to control terminals 1 and 3. Permitted fall in voltage on the millimeter: 200mV.

Connecting the communicator

1. If the resistance seen from the transmitter in the direction of the line is $R_o > 250\Omega$, we can communicate with the transmitter via a connection to line 1 and 2, as shown on Fig 2a. (R_o = line resistance + load)
2. If $R_o < 250\Omega$, there will be no communication and R in the system should be increased to at least 250Ω , as shown on Fig. 2a.
3. On request, the transmitter can be equipped with additional communication resistor $RD = 250\Omega$ (Fig. 2b). (During normal operation terminals 1 and 3 are shorted). The RD resistor is used when you wish to communicate with the transmitter locally (from its terminals) and $R_o < 250\Omega$. (Terminals 1 and 3 must be opened).

Terminals 1 and 2 apply for PD and PZ type connection.
Terminal 3 applies for PZ type connection only.

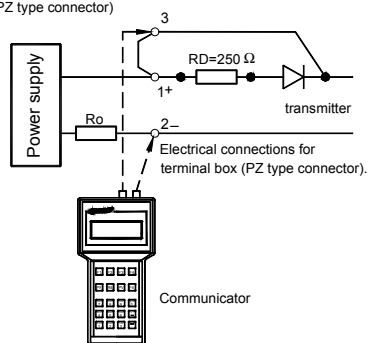


Fig. 2b

Figure 2. Electrical connections for APCE...,APRE... transmitters

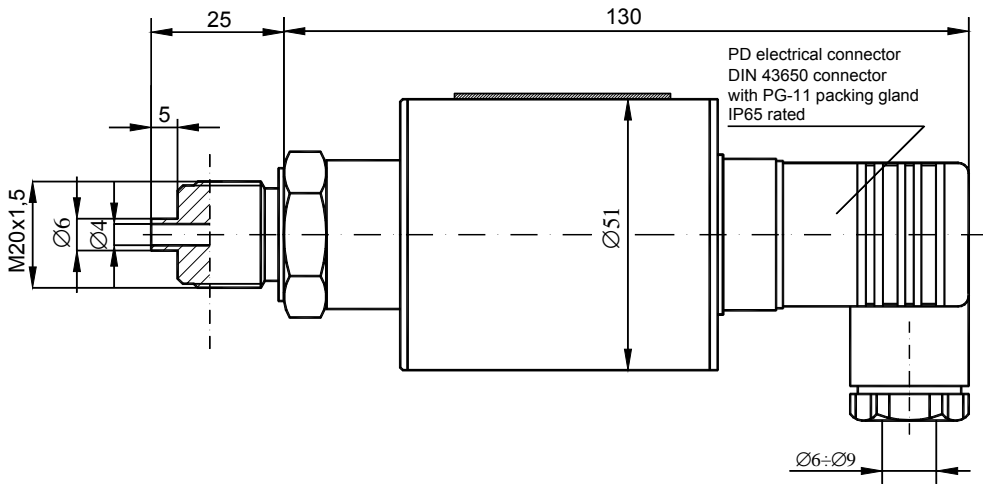


Figure 3. APCE-2000 transmitter with PD connector.

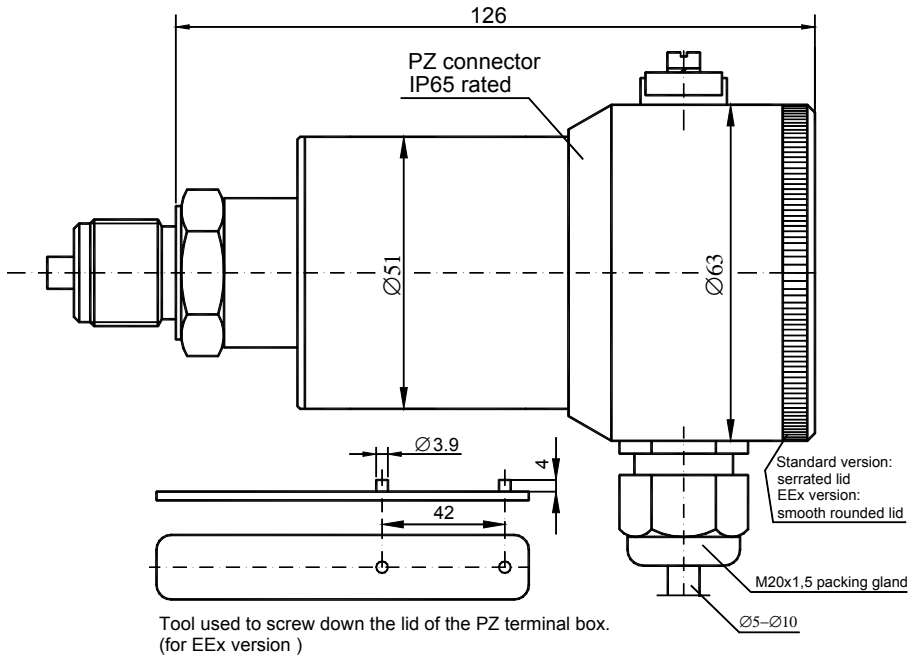


Figure 4. APCE-2000 transmitter with PZ connector

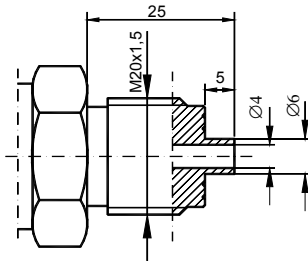


Fig.5a. M-type connector
with M20x1.5 thread

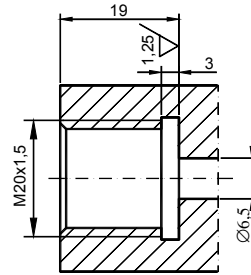


Fig.5b. Socket for use with transmitters
with M-type connector.

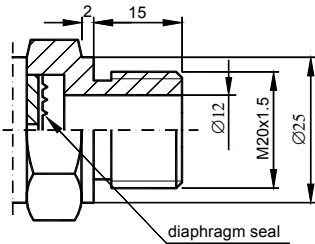


Fig.6a. P-type connector
with M20x1.5 thread

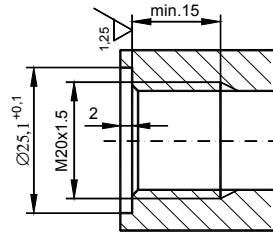


Fig.6b. Socket for use with transmitters
with P-type connector. P.

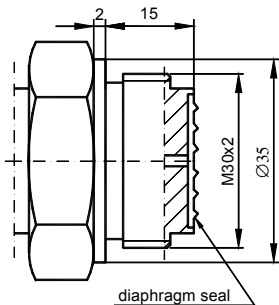


Fig.7a. CM30x2-type connector
with flush diaphragm
with M30x2 thread,

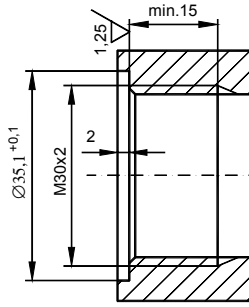


Fig.7b. Socket for use with
transmitters with
CM30x2-type connector
with flush diaphragm.

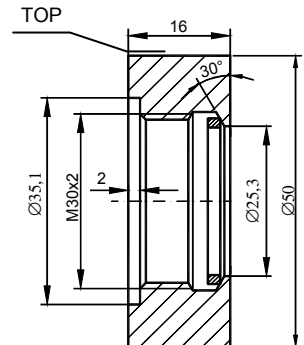


Fig.7c. Weldable fitting ring for use
with transmitters with
CM30x2-type connector
Material: 316Lss
Sealing: teflon



The ring in Fig. 7c must be welded in place with the word TOP upwards

Figure 5. M-type connector with M20x1.5 thread

Figure 6. P-type connector with M20x1.5 thread

Figure 7. CM30x2-type connector with flush diaphragm with M30x2 thread

Order code Socket CM30x2

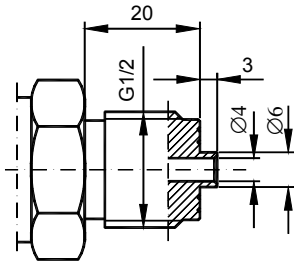


Fig.8a. G1/2-type connector
with G1/2" thread

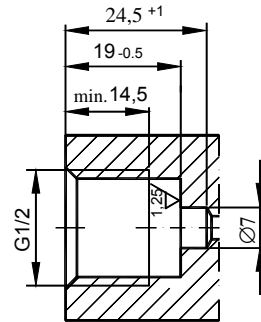


Fig.8b. Socket for use with transmitters
with G1/2-type connector.

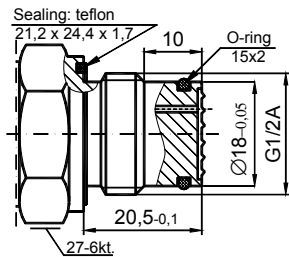


Fig.8c. CG1/2 -type connector
with flush diaphragm
with G1/2" thread,

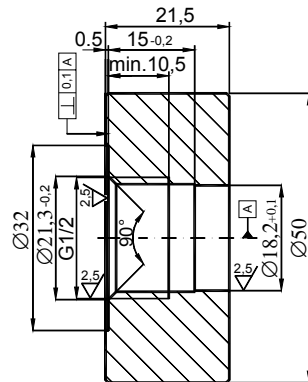


Fig.8d. Weldable fitting ring for use with
transmitters with CG1/2 - type connector
Material – 316Lss
Order code Socket CG1/2

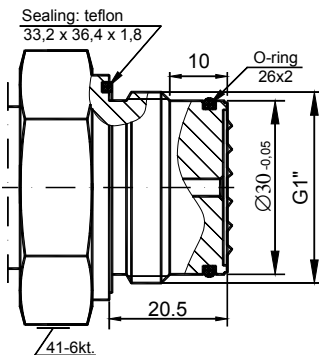


Fig.8e. CG1-type connector
with flush diaphragm
with G1" thread,

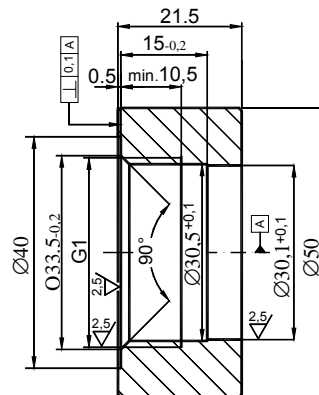


Fig.8f. Weldable fitting ring for use with
transmitters with CG1 - type connector
Material – 316Lss
Order code Socket CG1

Figure 8. Process connections G1/2" and G1".

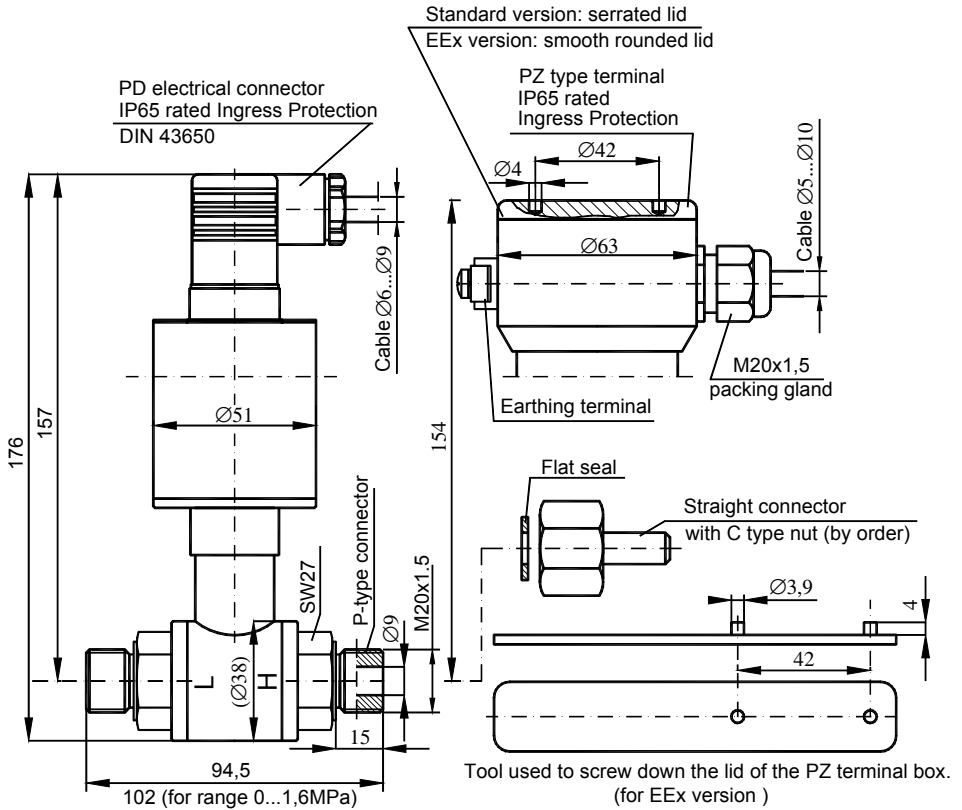


Figure 9. APRE-2000 differential pressure transmitter with P-type connector

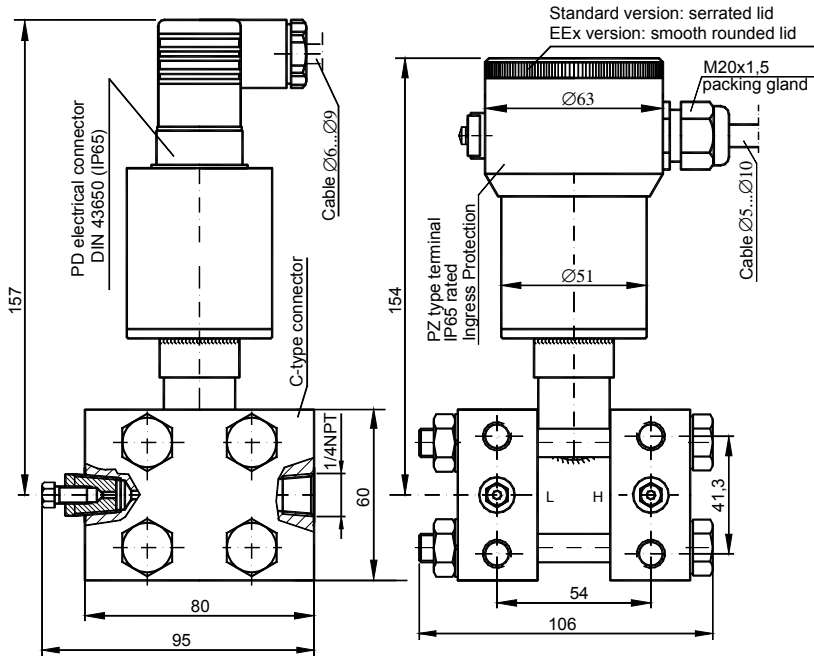


Figure 10. APRE-2000 differential pressure transmitter with C type vented covers.

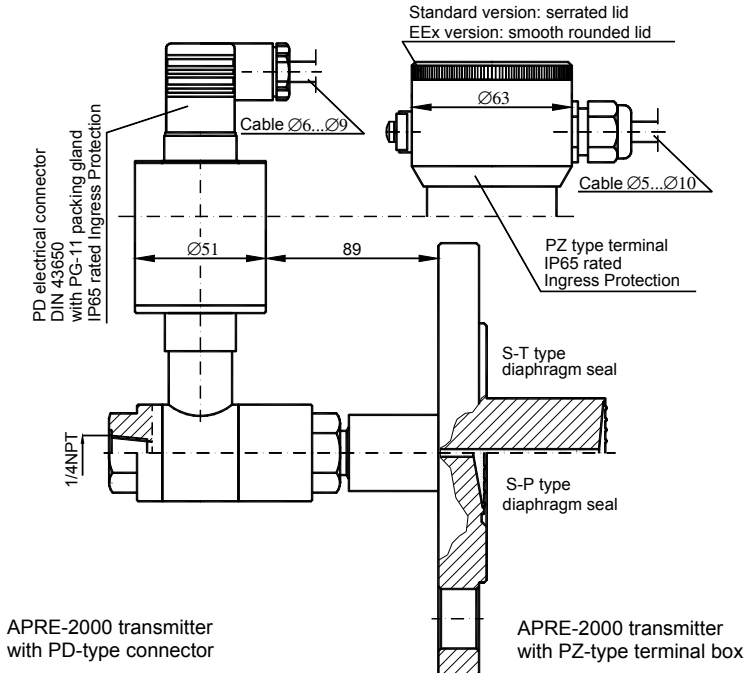


Figure 11. APRE-2000 differential pressure transmitter with a single direct diaphragm seal (examples).

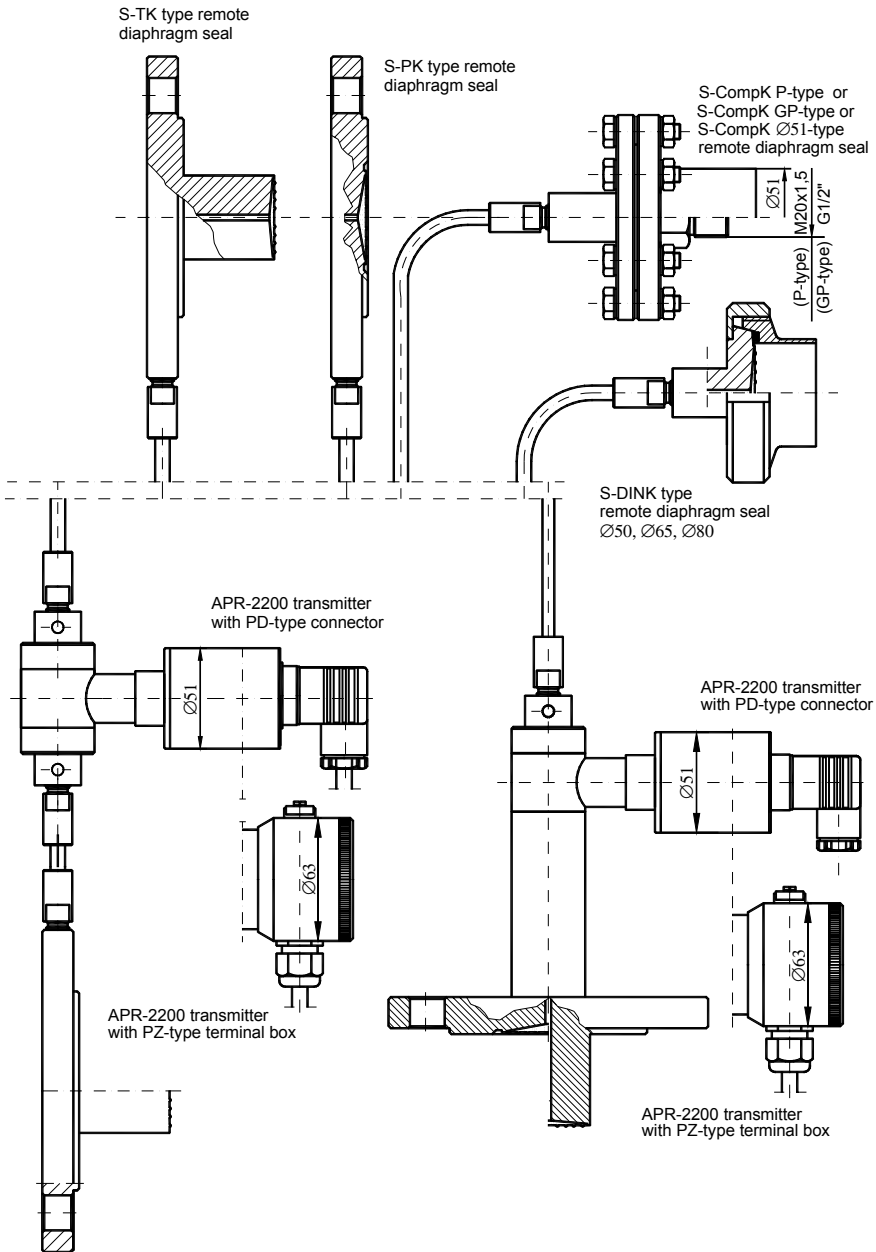


Figure 12. APRE-2200 differential pressure transmitter with two remote diaphragm seals (examples).

Figure 13. APRE-2200 differential pressure transmitter with direct diaphragm seal and remote diaphragm seal (examples).

Figure a.

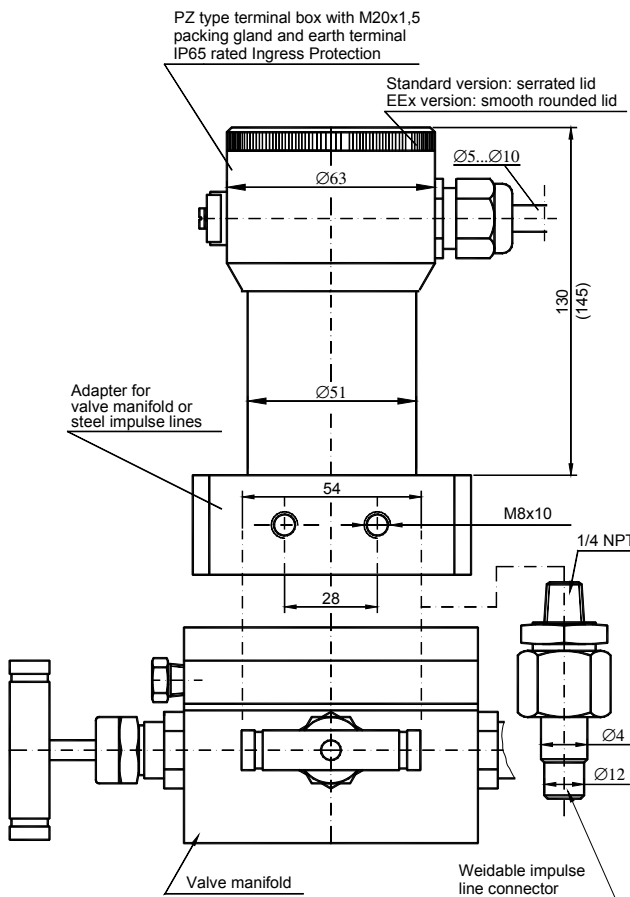


Figure b.

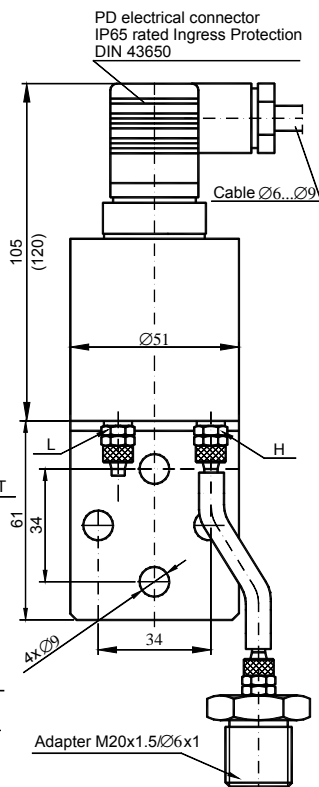


Figure 14. APRE-2000G Smart differential pressure transmitter for non-aggressive gases.

- APRE-2000G transmitter – industrial version with C type process connector to mount together with a valve manifold or weldable impulse line connectors.
An example with PZ type electrical connector.
- APRE-2000G transmitter – economical version with PCV type process connector.
An example with PD type electrical connector.

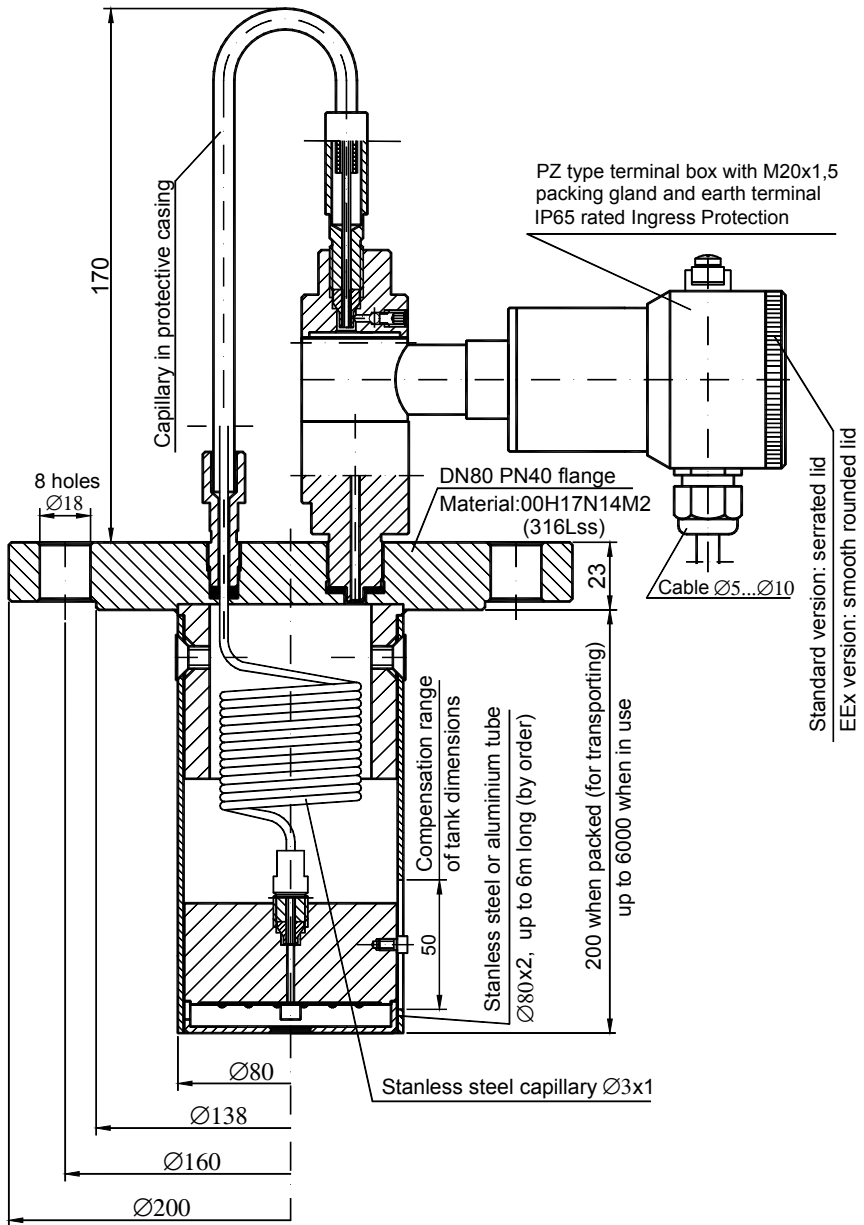


Figure 15. APRE-2000/Y Smart level probe for pressure tanks

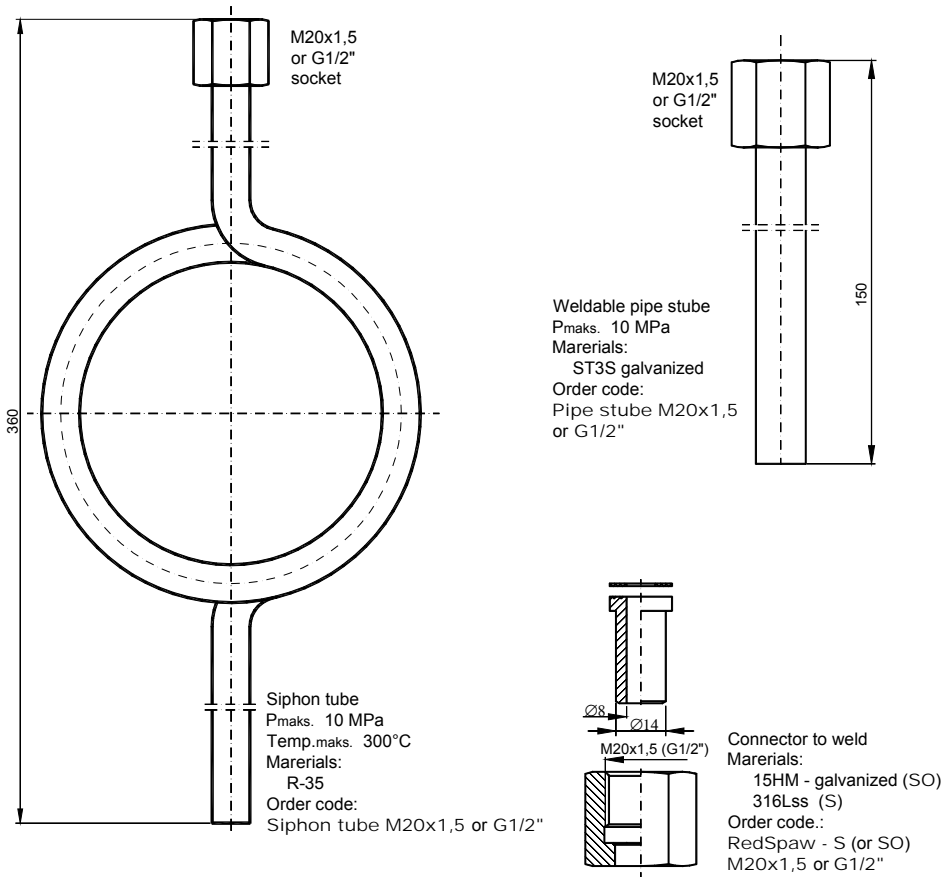
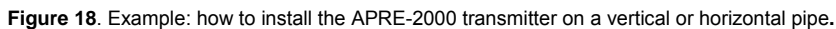


Figure 16. Additional equipment for fitting of pressure transmitters.



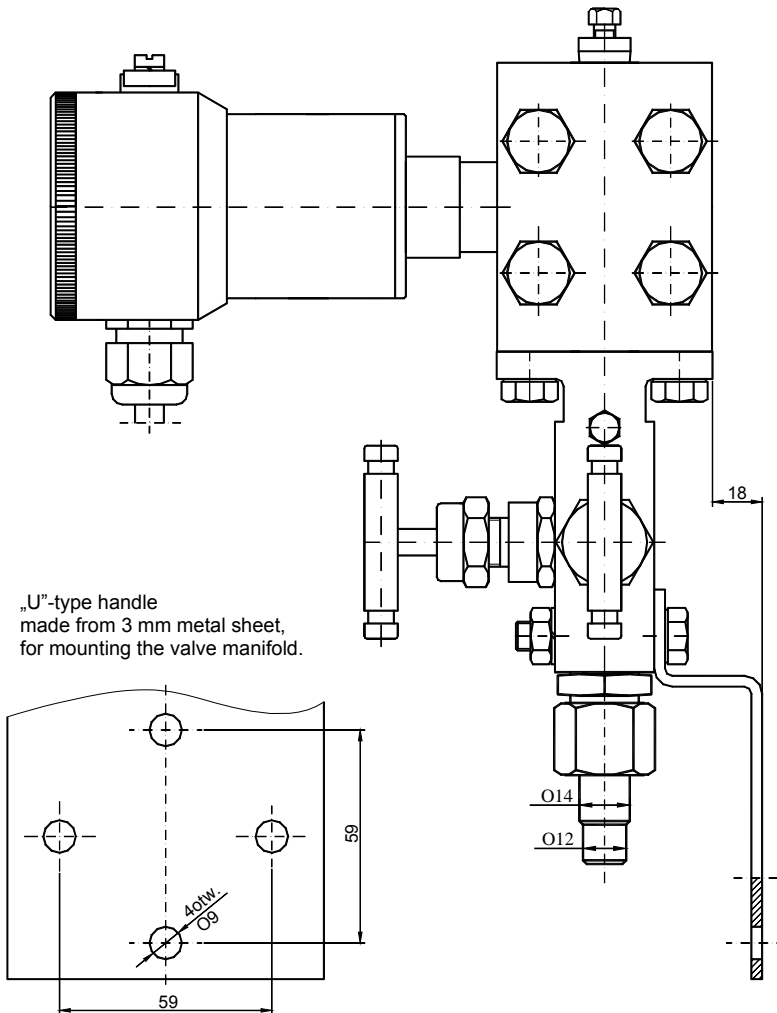


Figure 19. Example: how to install the APRE-2000 transmitter with a valve manifold to a wall.