

# APLISENS

MANUFACTURE OF PRESSURE TRANSMITTERS  
AND CONTROL INSTRUMENTS

## USER'S MANUAL

SMART TEMPERATURE TRANSMITTER  
type: **APT-2000ALW**

Edition A

WARSAW MAY 2011

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 Ex 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,
- condensation of water vapour, large 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.

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## I. APPENDIX Exd



### APT-2000ALW TEMPERATURE TRANSMITTER Exd VERSION

#### 1. Introduction

1.1. This “Appendix Exd.01” applies to transmitters of type APT-2000ALW in Exd versions only, marked on the rating plate as shown in 3 and denoted Exd in the Product Certificate.

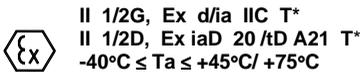
1.2. The appendix contains supplementary information relating to the Exd (flame-proof) versions of mentioned transmitters.

During installation and use of Exd transmitters, reference should be made to **DTR.APT.ALW.02(ENG)** in conjunction with “Appendix Exd.01”.

#### 2. Use of APT-2000ALW transmitters in danger zones

2.1. The transmitters are produced in accordance with the requirements of the following standards:  
EN 60079-0:2006, EN 60079-1: 2007, EN 60079-11:2007, EN 60079-26:2004, EN 61241-0:2006,  
EN 61241-1:2004, EN 61241-11:2006

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:



**KDB 10 ATEX 122X**

T\* - temperature class for transmitter (for gases) or a maximum surface temperature (for dust) derived in clause 5.3 and 5.4.

2.3 Transmitter category and hazard areas.

The category 1/2G, contained within the rating, means that the transmitter may be installed within a type 1 or 2 hazard zone. The process connections may connect to a 0 zone type (see the diagram below for an example).

#### 3. Identifying marks.

Flame-proof transmitters must have a rating plate containing the information specified in paragraph 4.1 of **DTR.APT.ALW.02(ENG)** and also at least the following:

- CE mark and number of notified unit; mark,
- Designation of explosion protection design, certificate number,
- Power supply,
- Process connection,
- Year of manufacture,
- Temperature use range,

#### 4. User information.

Together with the ordered transmitters, the user will receive:

- a) Product Certificate
- b) Declaration of conformity
- c) Copy of certificate – on request
- d) User’s Manual numbered: DTR.APT.ALW.02(ENG) with Appendix Exd0.1.

User can find them b), c), d) at [www.aplisens.pl](http://www.aplisens.pl)

#### 5. Power supply and exploitation of transmitters

5.1. The transmitter connecting should be made after introduction with present instruction content.

Electrically transmitter should be connected according to scheme at p.6 Appendix Exd.01. Transmitter electrical installation should be realised with engineering standard requirements. Electrical connections of transmitters in danger zone should be made by people who have indispensable knowledge and experience in this branch.

5.2. Transmitters should be supplied from DC electrical source with voltage max.45V from transformer feeders or other devices which have at least a strengthened isolation among primary and secondary windings in which don't appear voltage higher than 250V. The duty of power supply installation with above mentioned requirements rests on user.

### 5.3. Measurements of operating temperature of transmitter

5.3.1. After installing the APT-2000ALW transmitter for the medium maximum expected temperature and expected the maximum ambient temperature measure out  $T_p$  temperature of the most hot place on the surface of transmitter and determine the temperature transmitter class or a maximum surface temperature according to p. 5.4.



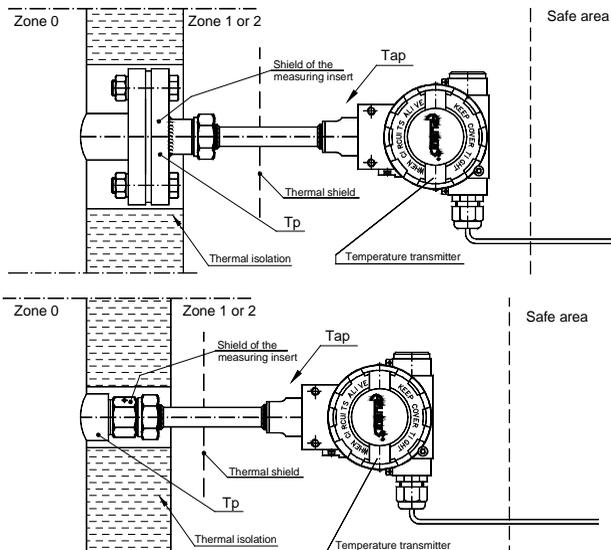
When measuring the warmed media, above ambient, is recommended to determine the temperature of the stub while is screwed into the transmitter or at the wall of the pipe or tank as shown below.

5.3.2. When medium is heated above ambient temperature it is allowed to determine the temperature class of the transmitter or the maximum surface temperature  $T_p$  through the adoption of a maximum temperature of the medium which provides the technological process. Measurement of  $T_p$  isn't then necessary.



If during the measurement of  $T_p$  for maximum temperature expected for the medium is not possible to ensure the maximum expected ambient temperature after the measurement of  $T_p$  one can estimate the potential growth in temperature  $T_p$  due to the increase of ambient temperature.

5.3.3. If the other elements of the plant have or may have a temperature higher than the highest temperature  $T_p$  on the transmitter, security conditions must be ensured in accordance with accepted principles in such cases



### 5.4. Determination of the transmitter temperature class $T^*$ for gas and the maximum surface temperature

1. Determine the temperature class of the transmitter for the gas or the maximum temperature for combustible dust depending on the temperature  $T_p$  from the formula:

$$T^* \geq T_p + 0,1T_p + 5K \text{ for class T3, T6}$$

$$T^* \geq T_p + 0,1T_p + 10K \text{ for class T1, T2}$$

2. Determine the maximum surface temperature transmitter for combustible dust from the formula:

$$T^* \geq T_p + 0,1T_p$$

3. The following table contains the values of permissible ambient temperature depending on the temperature  $T_p$  and temperature class of the transmitter.

| $T_p$ [°C]                  | Temperature class and ambient temperature $T_a$ [°C]               |  |
|-----------------------------|--|--|
| $T_p \leq 75^\circ\text{C}$ | T6 and $T_a = 45^\circ\text{C}$<br>T5 and $T_a = 75^\circ\text{C}$ |  |
| $T_p > 75^\circ\text{C}$    | T4 and T5<br>T3 and T2<br>T1                                       | $T_a = 70^\circ\text{C}$<br>$T_a = 65^\circ\text{C}$<br>$T_a = 60^\circ\text{C}$ |

$T_p$  - transmitter temperature measured in clause 5.3

In the case of significant increase in medium temperature measurement of  $T_p$  must be executed again and again must be specified the temperature class for the gas or the maximum surface temperature combustible dust.

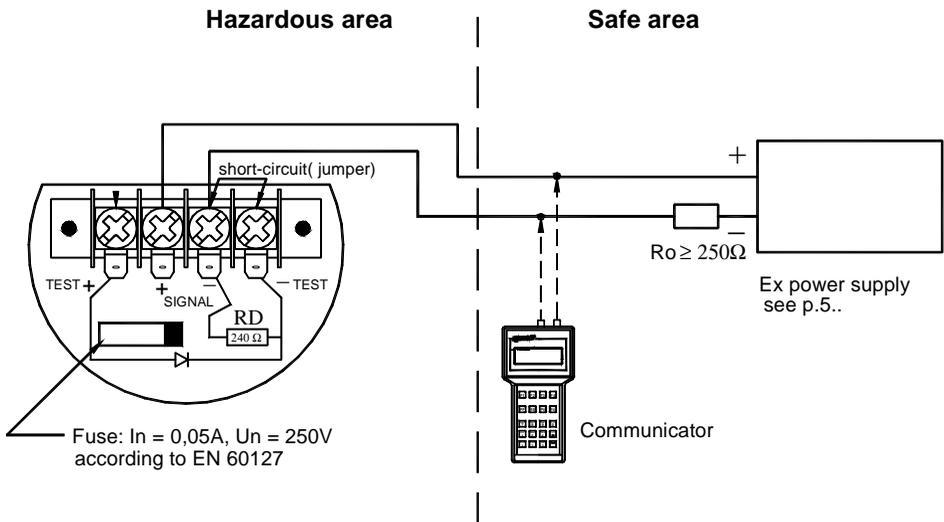


- 5.5. With regard on kind of casing material ( light alloy with large aluminium content), the user is obliged to assure, that possibility of hitting casing does not step out in place of transmitter installation.
- 5.6. In transmitter casing are two holes to assembly of cable intakes from thread M20x1,5 or 1/2 NPT.
- 5.7. Normally transmitters are delivered without installed glands but with blank plugs (corks) in the second hole. They are at table 1 and table 2 at list of packing glands and plugs agreeable with production documentation and accepted by certificate station. Customer should install packing glands according to tables 1 and plugs according to tables 2 (if plugs aren't installed) or other accordance with flame-proof standards.
- 5.8. It is necessary apply a shield cable or without shield cable with round cross-section in protection from elastomer, not moisture absorbing, for example: YKSLY 2 \* 1, YnTKSYekw 1 \* 2 \* 1, LIYCY 2 \* In case of need of use cable about different building customer should co-ordinate this with transmitters manufacturer to choose intakes with cable diameter.
- 5.9. The general principles of connecting and the exploitation of transmitter in Exd realization should be compatible with principles and relating standards for Exd casing devices how in p.2.1, in this including also : EN600079-14, EN60079-17.
- 5.10. During service must be made a check of the tight fastening of covers and the packing glands and the fastening of the cable in the glands. The casing and supply line must be inspected for mechanical damage, and the transmitter rating plate for legibility. Periodic checks should also be made of the diaphragm, which should not carry signs of damage. During maintenance it is recommended that the threads of the covers be lubricated with non-acid vaseline.



**Because of the transmitter damage possibility, the ambient temperature should not be allowed to become higher than 80°C, even when there is no explosion risk.**

## 6. How to connect Exd transmitter APT-2000ALW





**In danger zone don't unscrew transmitter covers and don't change the display position or its back lighting.**



In case of transmitter calibration outside danger zone is possible communicator connecting to <SIGNAL+> and <TEST+> terminals. Transmitter is furnished in communication resistor ( $R_D = 240\Omega$ ), closed with jumper at <SIGNAL-> and <TEST-> terminals installed by manufacturer.  $R_D$  resistor can be use then, when it is necessary to communicate with transmitter from its terminals and the load resistance ( $R_o$ ) in current loop is lower then  $250\Omega$ . Than <SIGNAL-> and <TEST-> terminals have to be open.



Permissible gap of joint is smaller than this was defined in norm EN 60079-1:2008 and can not be greater than passed value on fig. 7.



**Blocking cover method before unscrewing and plumbing possibility is showed at fig 8.**



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

**Table 1** Permitted packing glands.

| Type of packing glands         | Producer     | Screw   | Feature | Other marking      | No of certificate     | Note |
|--------------------------------|--------------|---------|---------|--------------------|-----------------------|------|
| 501/423                        | HAWKE        | M20x1,5 | Exd IIC | dimension OS, O, A | Baseefa 06 ATEX 0056X |      |
| 501/421                        | HAWKE        | M20x1,5 | Exd IIC | dimension OS, O, A | Baseefa 06 ATEX 0056X |      |
| ICG 623                        | HAWKE        | M20x1,5 | Exd IIC | dimension OS, O, A | Baseefa 06 ATEX 0058X |      |
| 501/453                        | HAWKE        | M20x1,5 | Exd IIC | dimension OS, O, A | Baseefa 06 ATEX 0056X | *    |
| 501/453/RAC                    | HAWKE        | M20x1,5 | Exd IIC | dimension OS, O, A | Baseefa 06 ATEX 0056X | *    |
| 501/453/Universal              | HAWKE        | M20x1,5 | Exd IIC | dimension OS, O, A | Baseefa 06 ATEX 0057X | *    |
| ICG 653                        | HAWKE        | M20x1,5 | Exd IIC | dimension OS, O, A | Baseefa 06 ATEX 0058X | *    |
| 8163/2-A2F                     | STAHL        | M20x1,5 | Exd IIC |                    | SIRA06ATEX1188X       |      |
| A2F, A2FRC, SS2K               | CMP-Products | M20x1,5 | Exd IIC |                    | SIRA06ATEX1097X       |      |
| E1FW, E1FX/Z,<br>E2FW, E2FX/Z  | CMP-Products | M20x1,5 | Exd IIC |                    | SIRA06ATEX1097X       | *    |
| T3CDS, T3CDSPB                 | CMP-Products | M20x1,5 | Exd IIC |                    | SIRA06ATEX1283X       | *    |
| PX2K, PXSS2K,<br>PX2KX, PXB2KX | CMP-Products | M20x1,5 | Exd IIC |                    | SIRA06ATEX1097X       | *    |

**Table 2.** permitted plugs

| Type of plug | Producer | Screw   | Feature | Other marking | No of certificate | Note |
|--------------|----------|---------|---------|---------------|-------------------|------|
|              | AGRO AG  | M20x1,5 | Exd IIC | Nr kat.       |                   |      |
| 475          | HAWKE    | M20x1,5 | Exd IIC |               |                   |      |
| 477          | HAWKE    | M20x1,5 | Exd IIC |               |                   |      |

\*) for special cable only.

## II. APPENDIX Exi.



### APT-2000ALW TEMPERATURE TRANSMITTER

Exi VERSION

## 1. Introduction

1.1. This “Appendix Exi” applies to transmitters of type APT-2000ALW in Ex versions only, marked on the rating plate as shown in 2 and 3 and denoted Ex in the Product Certificate.

1.2. The appendix contains supplementary information relating to the Ex versions of these transmitters. During installation and use of Ex transmitters, reference should be made to **DTR.APT.ALW.02(ENG)** in conjunction with “Appendix Exi”.

## 2. Use of APT-2000ALW transmitters in danger zones.

2.1. The transmitters are produced in accordance with the requirements of the following standards:

EN 60079-0:2006, EN 60079-11:2007, EN 60079-26:2006, EN 61241-0:2006, EN 61241-11:2006, EN 50303:2000.

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 Ex ia IIC T4-T6 Ga/Gb

I M1 Ex ia I (version with enclosure ss316L)

II 1D Ex iaD 20 T105°C

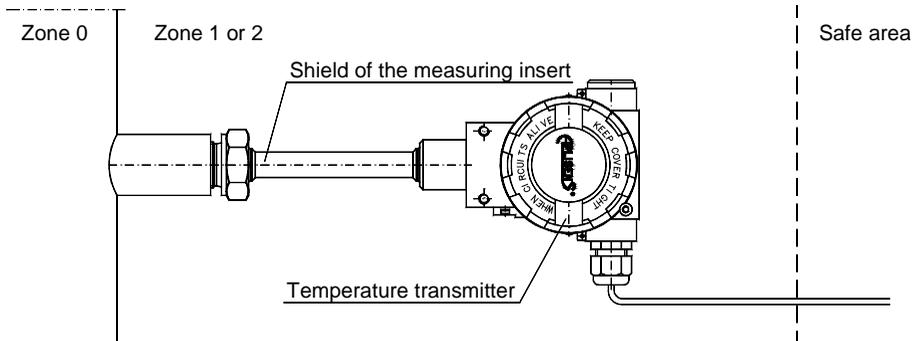
FTZÚ 09 ATEX 0155X



(the temperature class of transmitter depends from medium temperature)

2.3. Transmitter category and hazard areas

The category 1/2G, contained within the rating, means that the transmitter may be installed within a type 1 or 2 hazard zone. Shield of the measuring insert APT-2000ALW, may connect to a 0 zone type (see the diagram below for an example).



## 3. Identifying marks..

Intrinsically safe transmitters must have a rating plate containing the information specified in paragraph 4.1 of DTR.APT.ALW.02(ENG) and also at least the following:



- CE mark and number of notified unit
- designation of explosion protection design, certificate number
- values of parameters such as. Ui, li, Ci, Li,
- year of manufacture

#### 4. User information.

Together with the ordered transmitters, the user will receive:

- Product Certificate,
- Declaration of conformity
- Copy of certificate – on request
- „User’s Manual numbered: „DTR.APT.ALW.02(ENG)” with Appendix Exi..

User can find them at [www.aplisens.pl](http://www.aplisens.pl)

#### 5. Permitted input parameters (based on data from the FTZÚ 09 ATEX 0155X certificate, and certification documentation).



The transmitters should be powered via the associated power feeding and measurement devices provided with the relevant intrinsic-safe certificates. The parameters of their outputs to the danger zone should not exceed the limit power supply parameters for the below specified transmitters.

Temperature classes T4, T5, or T6 depend on the input power and maximum ambient temperature – see p. 5.1, 5.2, 5.3. The ambient temperature range is reduced to  $T_a = -20^{\circ}\text{C}$  to  $+60^{\circ}\text{C}$  if the devices is installed as group I M1 equipment.

External connections are made via integral terminals and cable glands which must be of certified type if they are mounted on the version f or combustible dust hazard application.

##### 5.1. - for power supply with a “linear” characteristic

$U_i = 30\text{V}$   $I_i = 0,1\text{A}$   $P_i = 0,75\text{W}$   $T_a \leq 80^{\circ}\text{C}$  and T4,  $T_a \leq 70^{\circ}\text{C}$  and T5,  $P_i = 0,5\text{W}$   $T_a \leq 45^{\circ}\text{C}$  and T6

Power supply with a “linear” characteristic may be e.g. a typical barrier with parameters

$U_o = 28\text{V}$   $I_o = 0.093\text{A}$   $R_w = 300\Omega$ .

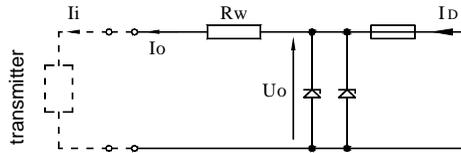


Fig.1. Power supply from a source with “linear” characteristic

##### 5.2. – for power supply with a “trapezoidal” characteristic

$U_i = 24\text{V}$   $I_i = 50\text{mA}$   $P_i = 0,6\text{W}$   $T_a \leq 80^{\circ}\text{C}$  and T5 and  $P_i = 0,5\text{W}$   $T_a \leq 45^{\circ}\text{C}$  and T6

Example of power supply from a source with “trapezoidal” characteristic (see Fig. 2).

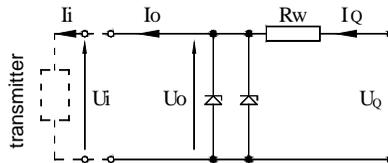


Fig. 2. Power supply from a source with “trapezoidal” characteristic

If  $U_o < \frac{U_q}{2}$  then parameters  $U_q$ ,  $I_o$ ,  $P_o$  are interrelated as follows:

$$U_q = \frac{4P_0}{I_o}, \quad R_w = \frac{U_q}{I_o}, \quad P_0 = \frac{U_o(U_q - U_o)}{R_w} \quad \text{for } U_o \leq 1/2U_q$$

##### 5.3. - for power supply with “rectangular” characteristic

$U_i = 24\text{V}$   $I_i = 25\text{mA}$   $P_i = 0,6\text{W}$   $T_a \leq 80^{\circ}\text{C}$  and T5

The supply of power from a source with a “rectangular” characteristic means that the voltage of the Ex power supply remains constant until current limitation activates.

The protection level of power supplies with a “rectangular” characteristic is normally “ib”. The transmitter powered from such a supply is also a Ex device with protection level “ib”. Example of practical provision of power supply.

- use a stabilized power supply with  $U_o=24\text{V}$  with protection level „ib” and current limited to  $I_o=25\text{mA}$ .



## 1. INTRODUCTION

1.1. This Manual is intended for users of **APT-2000ALW** smart temperature transmitters in normal and intrinsic-safety versions, 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.

Parameters and information given in the remaining part of the manual regard simultaneously all the transmitters, their intrinsically safe versions and version with various types of casings.



1.2. Additional data on **APT-2000ALW** transmitters in Ex versions is contained in the appendix designed to **DTR.APT.ALW.02(ENG) Appendix Exi**. During installation and use of the transmitters in Exi version reference should be made to **DTR.APT.ALW.02(ENG)** in conjunction with **Appendix Exi**.

1.3. Additional data on **APT-2000ALW** transmitters in Exd versions is contained in the appendix designed to **DTR.APT.ALW.02(ENG) Appendix Exd.01**. During installation and use of the transmitters in Exd version reference should be made to **DTR.APT.ALW.02(ENG)** in conjunction with **Appendix Exd.01**

## 2. USER MATERIALS

Transmitters are delivered in single and/or multiple packs.

Together with the transmitter are delivered:

- a. Product certificate, which is also as the warranty card
- b. Declaration of conformity - on request,
- c. Copy of ATEX certificate – on request
- d. User's Manual numbered „DTR.APT.ALW.02(ENG)“.

Items b), c), d) are available at: [www.aplisens.pl](http://www.aplisens.pl)

## 3. APPLICATIONS AND MAIN FEATURES

3.1. The **APT-2000ALW** smart temperature transmitters are designed to measure temperature in various branches of industry in normal conditions as well as in conditions of danger the explosion of gas and dust.



3.2. The **APT-2000ALW** transmitters may be equipped with various types of measuring insert casings which allows for their application in various conditions.

3.3. The **APT-2000ALW** transmitters characterized by:

- a. Two-wire power supply (4...20mA current loop),
- b. Digital signal processing (filtration, linearization, compensation),
- c. Possibility of local configuration from display panel or remotely (HART protocol).
- d. Autodiagnostic system
- e. Ambient temperature effect compensation
- f. Input/output galvanic separation.

## 4. IDENTIFYING MARKS. ORDERING PROCEDURE

### 4.1. Identifying marks

Every transmitter carries a rating plate containing at least the following information:

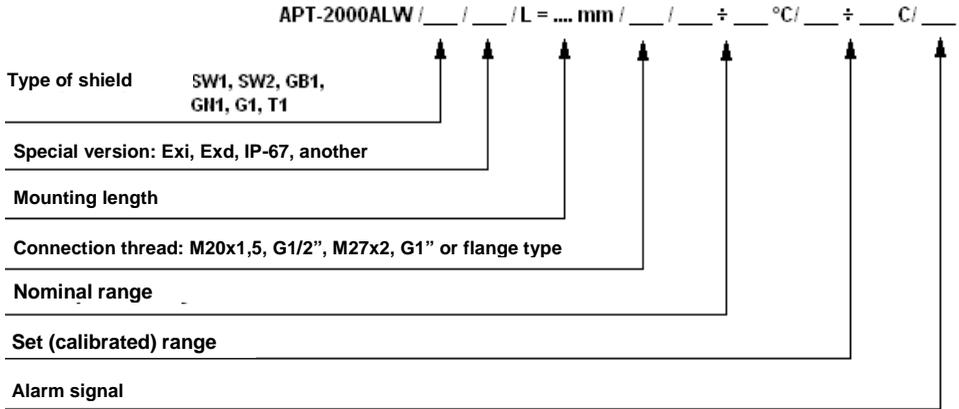
- a. manufacturer name
- b. CE mark
- c. transmitter type: APT-2000ALW
- d. basic range
- e. set range
- f. power supply voltage
- g. output signal
- h. year of manufacture and serial number

4.1.1. The **APT-2000ALW** transmitters in intrinsically safe version have additional designations, which are specified in **DTR.APT.ALW.02 Appendix Exi**.

4.1.2. The **APT-2000ALW** transmitters in Exd version have additional designations, which are specified in **DTR.APT.ALW.02 Appendix Exd.01**.

## 4.2. Ordering procedure

Procedure of ordering



**Example:** Temperature transmitter APT-2000ALW, shield T1, version Exi, mounting length 250 mm, connection flange DN50 PN40, nominal range: -40 do 550 °C, calibrated range: 0 do 300 °C, alarm signal for example 23 mA.

**APT-2000ALW / T1 / Exi / L=250 mm / DN50 Pn40 / - 40 ÷ 550 °C / 0 ÷ 300 °C / 23 mA.**

## 5. TECHNICAL DATA

### 5.1. Electrical parameters

Power supply for normal version

12 \* ÷ 55V DC



**Power supply for intrinsic-safe versions - in accordance with „Appendix Exi”**

**Power supply for Exd versions - in accordance with „Appendix Exd.01”**

Output signal

4÷20mA + Hart Rev.5.1

Communication

realised via a 4÷20mA signal and Hart transmission using KAP-03 communicator or SH05 Aplisens modem or PC computer with APT2000 software

Resistance for communication (Hart)

250÷1100Ω, min 240Ω

Load resistance

$$R_o[\Omega] = \frac{U_{sup}[V] - 12V *}{0,023A}$$

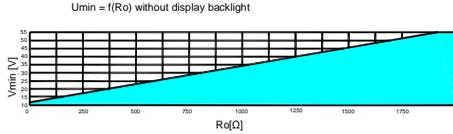
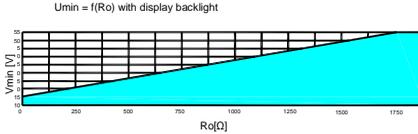
Load resistance for intrinsic-safe versions – in accordance with „Appendix Exi”

\*) 15 V for transmitters with display backlight.



- The value of transmitter minimal supply voltage can be calculated from the following formula:
- $U_{min} = 12 + 0,023 \times R_o$  [V] for transmitter operating without LCD display backlight (or read from the drawing below)
  - $U_{min} = 15 + 0,023 \times R_o$  [V] for converter operating with LCD display backlight. (or read from the drawing below)

Transmitters made in Ex version are delivered with display backlight switched off. The user can switch the backlight on by himself.



**Supply voltage dependence on current loop resistance**

Safe working area (grid) upper colour area.

Voltage for insulation testing

500 VAC or 750 VDC, see p.8.3.

Excess voltage protection

see p.8.3.

**List of current alarms**

| Alarm Type  | Value of Alarm Current |
|-------------|------------------------|
| NORMAL LOW  | 3,75 mA                |
| NORMAL HIGH | 21,6 mA                |
| NAMUR LOW   | 3,6 mA                 |
| NAMUR HIGH  | 21,0 mA                |

| Alarm Type   | Value of Alarm Current   |
|--|--|
| CUSTOM (value of alarm current is defined by user)   | Value of alarm current in interval<br>3,6 mA ÷ 23 mA   |
| LAST VALUE (transmitter does not update analog exit) | Alarm current value is equal to the current value in the time preceding the event which giving an alarm. |

**5.2. Metrological parameters.**

Additional voltage damping

0...30s

Total error of transmitter (digital value)

± (0,05 + 0,05%·z + 0,001·|t|) °C for sensor Pt100  
 ± (0,5 + 0,05%·z) °C for sensor K and t ≤ 375°C  
 ± (0,5 + 0,05%·z + 0,002·(t-375)) °C for sensor K and t >375°C

Additional analogue output error

± 0,04%·z

where:

|t| - modulus of measured temperature in °C

t - the value of measured temperature in °C

z - the range width of transmitter in °C

**5.3. Measurement ranges.**

| Sensor type    | Min. measuring range | Nominal range    | Calibrated range |
|----------------|----------------------|------------------|------------------|
| Pt 100         | 10 °C                | - 200 ... 550 °C | 0 ... 100 °C     |
| Ni-Cr-Ni /K/ * | 10 °C                | - 40 ... 550 °C  | 0 ... 300 °C     |

\* Recommended for measurements with strong vibrations.

## 5.4. Operating conditions.

Ambient temperature range -40°C ÷85°C



Operating temperature for intrinsic-safe versions (Exi) in accordance with „Appendix Exi”.

Operating temperature for Exd versions in accordance with „Appendix Exd.01”.

Relative humidity up to 98%  
 Medium temperature range Pt100 - 200 ... 550 °C  
 N-Cr-NiAl - 40 ... 550 °C

Thermal compensation range -25 ... 75 °C

### 5.4.1. Electromagnetic Compatibility (EMC), immunity

Rating according to EN 61326-1,2for industrial applications

*Electrostatic Discharge Immunity (ESD):*

EN 61000-4-2; S3 level: contact ±6kV, air ±8kV; criterion A

*Conducted Radio Frequency:*

EN 61000-4-6; 0,15... 80MHz, 10V; criterion A

*Radiated electromagnetic Field:*

EN 61000-4-3; 80... 2 000MHz – 10V/m, 2 000 ... 2 700MHz – 1V/m; criterion A

*Electrical Fast Transient (Burst Immunity)*

EN 61000-4-4; ± 2kV power supply port/earth, ± 1kV signal port/earth; criterion A

*Electrical Slow Transient (Surge Immunity):*

EN 61000-4-5; ±0.5kV (±1kV) 0,5kV differentia mode, 1kV common mode; criterion B

### 5.4.2. Electromagnetic Compatibility, emission:

According to CISPR16-1, CISPR 16-2, class B, distance to the antenna 3m, quasi-peak measuring:

*Radiated emission:* 0,15 ... 30MHz, 80-52dBµV/m;  
 30 ... 2000MHz, <54dBµV/m

*Conducted emission:* 0,01 ... 0,150MHz, 96-50dBµV/m;  
 0,150 ... 0,350MHz, 60-50dBµV/m;  
 0,35 ... 30MHz, <50dBµV/m

### 5.4.3. Climatic immunity: dry heat, cold, humidity, salt mist:

*Dry heat:*

EN 60068-2-2, test B; T = 70°C, RH = max 55%

*Cold :*

EN 60068-2-1, test A; T = -25°C,

*Damp heat cycle:*

EN 60068-2-30, test D ; (T = 55°C, RH = min95%, 24h)x2

### 5.4.4. Mechanical immunity

*Shocks:*

EN 60068-2-27, 50g/11ms

*Vibrations:*

EN 60068-2-6, test Fc; up to 1,6mm for 2 ... 25Hz, up to 4g for 25 ... 100Hz

### 5.4.5. Insulation Resistance

>100 MΩ @110V transmitters with gas arresters

>100 MΩ @750V DC transmitters without gas arresters (Exi)

### 5.4.6. High Voltage Test

500V AC, or 750V DC, 1min, transmitters without gas arresters (Ex applications)

75V AC, or 110V DC, 1min, transmitters with gas arresters

### 5.4.7. Enclosure ingress protection

EN 60529, IP 66,67

## 5.5. Construction materials

Electronics casing

High pressure cast of aluminium alloy, lacquered with chemical-resistant oxide enamel, colour yellow (RAL 1003), or stainless steel ss316L – not varnished.

### Shields - materials, diameters and lengths.

| Type of shield | Shield |                       |          | Material of shield        | Connection type      |
|----------------|--------|-----------------------|----------|---------------------------|----------------------|
|                | F [mm] | L [mm]                | I [mm]   |                           |                      |
| SW1            | 18h7   | 100<br>140, 200       | 35<br>65 | 15HM,<br>10H2M,<br>316Lss | -                    |
| SW2            | 24h7   | 140, 200              | 65       | 15HM,<br>10H2M,<br>316Lss | -                    |
| GB1, GN1       | 9 x 1  | 100, 160,<br>250, 400 | -        | 316Lss                    | M20x1,5,<br>G1/2     |
| G1             | 11 x 2 | 100, 160,<br>250, 400 | -        | 316Lss                    | M27x2,<br>G1         |
| T1             | 11 x 2 | 100, 160,<br>250, 400 | -        | 316Lss                    | Flange PN, DIN, ANSI |

## 6. CONSTRUCTION.

### 6.1. Measurement Principles.

A signal from measuring sensor, i.e. from thermometer resistor Pt100 or thermocouple, corresponding to measured medium temperature, is delivered to the input of analogue-digital converter and converted to digital form. In digital form it is sent, through an optoelectronic galvanic barrier, to the microcontroller. The microcontroller reads measured values and, using built-in algorithms, calculates an exact value of temperature on the basis of these algorithms. Calculated value is shown on integrated LCD display, which can be configured depending on the needs (see p. 9.2.5). Digital value of measured temperature is converted to analogue signal 4...20[mA]. Built-in modem BELL202 and implemented communication stack HART Rev.5.1 allow for the communication with the converter, using PC computer and appropriate software or communicator.

The transmitter's output is fitted with a radio-noise filter and other elements protecting against ESD.

A block diagram of the transmitter is presented in Figure 1.

**APT ...** converters monitors the operation of their measuring systems and the correctness of calculations and in case when discrepancies occur they inform about an error displaying a message on LCD display and generating an alarm current in the current loop (depending on configuration).

The measuring signal of sensor has a galvanic separation from measuring line. Thanks of that construction the measurement susceptibility at interferences is reduced as well as the enlarged safety of work in the Ex and flameproof applications.

### 6.2. Construction

The basic units of transmitter are: casing, shield with process connection, measuring sensor and electronic units, transforming signal from measuring sensor into unified output signal.

### 6.2.1. Transmitter casing

A casing of APT... transmitter is made of high-pressure casting of aluminium alloy or 316L steel. It consists of a body, two bolted side covers (full and with pane), cable inlets and plug with M20x1,5 or ½ NPT thread. Inside the casings is divided into two chambers, separated by a header. An additional header, with a ribbon cable is intended for transmitting a signal from temperature sensor to the inside of a transmitter. The casing is equipped with internal and external earth terminals.

### 6.2.2. Electronic board with display

The electronic board, along with a display, is installed in a housing made of polycarbonate, in the bigger of two casing's chambers, where it is possible to rotate it by  $\pm 180^\circ$ , every  $90^\circ$ . A connecting board with terminal strip (fig. 2a) and the elements of interference filter and protecting elements are installed in the second chamber.

### 6.2.3. Shields of the measuring insert

Within the framework of basic version there is a possibility to select one of five types of casings shown on fig.6. The SW1 and SW2 shields are high-tension shields designed to welding. The GB1, GN1 and G1 shields have threaded process connection and designed to screw in assembly sockets. The T1 shield have flange process connection.

## 7. INSTALLATION OF TRANSMITTERS

The APT–2000ALW transmitters can operate in any position.

During the installation of temperature transmitters the casing of electronic system should be protected against exceeding of allowed temperatures. Suitable thermal covers should be used or the transmitters should be mounted in such a position so the heat from medium does not heat up the casing.



**When the transmitters are mounted, particularly in areas endangered by explosion, also the heat conduction of sensor metal casing and ambient temperature for ensuring proper work conditions and temperature classes should be taken into consideration. Data specified in "Annex Exi" are applicable for intrinsically safe versions. Data specified in "Annex Exd01" are applicable flameproof versions.**

## 8. ELECTRICAL CONNECTION

### 8.1. General recommendations

**8.1.1.** 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 shield 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.

### 8.1.2. Wet or rising damp inside transmitter can cause its damage.



**When 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 IP66 protection. It is useful to form the segment of the signal wire leading to the packing gland into a protective loop to prevent condensation from running down in the direction of the gland..**

### 8.2. Electrical connections

The APT-... transmitters are to be connected as shown in fig. 2a – 2d.



In APT-... transmitters, a 240Ω resistor is permanently fitted in series in the transmitter's current circuit and blocked up with jumper between <SIGNAL -> and <TEST -> as shown in fig.2a and 2b. When the resistance in the current loop is lower than 240Ω it is necessary to jumper disassemble to Hart communication.

### 8.3. Protection from excess voltage

**8.3.1.** 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 TVS diodes installed in all types of transmitter (see the table, column 2).

**8.3.2.** 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 (see the table, column 3).

Also external protective devices may be used, e.g. the UZ-2 Aplisens system, 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.

Internal protection of transmitters:

| 1                          | 2   | 3  |
|----------------------------|---|--|
| Type of transmitter        | Protection between wires (TVS diodes) – permitted voltage | Protection between wires and earth and/or casing – type of protection, permitted voltage |
| APT...<br>(normal version) | 68V DC  | Plasma surge arresters - 100V DC   |
| APT...<br>(Exd version)    | 68V DC  | Not applicable   |
| APT...<br>(Exi version)    | 39VDC   | Not applicable   |

**8.3.3.** The voltage in the protective elements must not exceed the maximum permitted values given in columns 2 and 3 of the table.

**i** The insulation test voltages (500V AC or 750V DC) given in 5.1.1 refer to transmitters plasma surge arresters - such protection is not used in Exi versions of transmitters.

### 8.4. Earthing

The transmitters are fitted with internal and external earth terminals.

## 9. SETTING AND REGULATION

### 9.1. Measurement ranges, Definitions

#### 9.1.1. Nominal range

The maximum range of temperature, which the transmitter can measure is called the “**nominal range**” (for specifications of nominal ranges see section 5.3).

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

The internal characteristic conversion curve for the nominal 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.

#### 9.1.2. Set range

When the transmitter is in use the term “**set (calibrated) 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 nominal range or only a part of it.

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

he transmitter may be set to any range within the nominal range of temperature values, subject to the restrictions set out in the table in section 5.3.

#### 9.1.3. Factory range.

in case when lacks information about measuring range, transmitters are setting on “**factory range**”.

/0 ... 100/ °C – factory range for transmitter with Pt100 sensor.

/0 ... 300/ °C – factory range for transmitter with “K” thermoelement.

## 9.2. Configuration and Calibration

**9.2.1.** 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. lower end-point of the set range
- b. upper end-point of the set range
- c. unit
- d. time constant
- e. type of characteristic curve: linear or radical
- f. decimal index

**9.2.2.** 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, serial number, label tag, description tag, date tag, message, record number, sensing module number.

The process of setting the parameters listed in 9.2.1 and 9.2.2 is called "**Configuration**".

### 9.2.3. Remote configuration of transmitters

Configuration and Calibration of the transmitter are carried out using an Aplisens KAP communicator, APT2000 configuration software or using library EDDL software (software PC with Hart/RS232 converter).

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.

For purposes of remote calibration a system shown on the scheme on fig. 2a + 2d should be prepared.

### 9.2.4. Local configuration of transmitters

If the option of local configuration is active, operator can change transmitter set using buttons being below display. The access to buttons will get after unscrewing the side cover. Then we can also change the display position turning it with 90° angle position. (see fig. 4).

If the option of local configuration is active, operator can change transmitter set using buttons being below display. To enter at the local set change of the work mode, you should press one button and hold its about 4s. If using buttons can't change the transmitter configuration, the local transmitter configuration is switched off and to its switching on is necessary to use the KAP 3 Calibrator.

The buttons are signed with symbols: [↑] [↓] [■]

After pressing by 4 seconds any of buttons there will appear on display "**EXIT**".

If we will confirm this announcement across pressing and holding button [■] by 1 sec, we will go out from the local change of the MENU set. If we will not confirm, we can move in MENU and change interesting us parameters. The time of pressing [↑] [↓] [■] has to be longer than 1s.

Longer pressing and holding of [↑] [↓] buttons will cause an automatic scrolling through MENU structure, with step of 0.33 s

Pressing button [↑] moves up in tree's structure MENU

Pressing button [↓] moves down in tree's structure MENU

Pressing [■] confirms choice and leads change.

If no actions are taken in the area of MENU for a period longer than 2 min., then MENU mode will be quitted and a process variable will be displayed.



**DAMPING**

←BACK

0 [S]  
 2 [S]  
 5 [S]  
 10 [S]  
 30 [S]

(Setting of the solid temporary suppression of the process variable)

(Return to Local Menu. If you will confirm this option, you will come back to main tree of Local Menu)

(Confirm one of the following values time constant across longer press button . After parameter confirmation transmitter will confirm the party of command by the "DONE")**TRANSFER**

←BACK

LINEAR  
 SQRT  
 SQRTX^3  
 SQRTX^5  
 SPECIAL  
 SQUARE

(Setting of the current output form)

(Return to Local Menu. If you will confirm this option, you will come back to main tree of Local Menu)

(Confirm one of the following characteristics across longer press button . After parameter confirmation transmitter will confirm the party of command by the "DONE")

(Linear)  
 (Square root)  
 (Square root with  $X^3$ )  
 (Square root with  $X^5$ )  
 (User's)  
 (Square)

**LCD1VARIABLE**

←BACK

CURRENT  
 PERCENT

(Type of the process variable displayed on LCD1)

(Return to Local Menu. If you will confirm this option, you will come back to main tree of Local Menu)

(Confirm one of the following option across longer press button . After parameter confirmation transmitter will confirm the party of command by the "DONE")

(On LCD1 will displayed current value in current loop)

(The percent value output signal will displayed on LCD1)

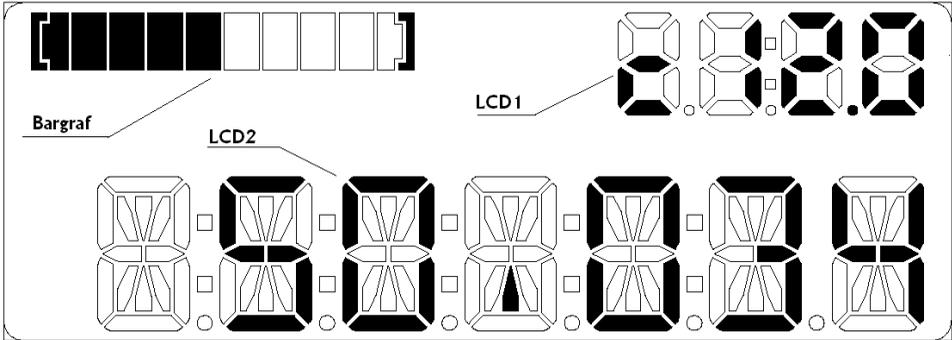




### 9.2.5. LCD display configuration- installed till 2010.

The LCD display configuration can do in dependence from needs. Changes of the display options in local MENU are possible using buttons or remote way using communicator, or the PC software. If it is necessary the display switching off is also possible. The display switching of function is possible with using communicator or PC software only.

The APT... transmitter display exterior is as bellow.



There 3 main displays are visible:

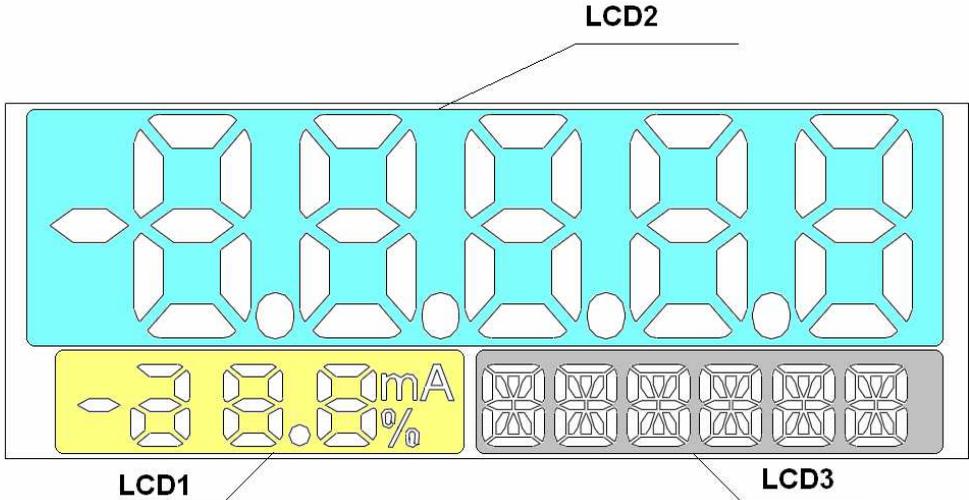
- **Bargraf (display line)** – the current output grade line guidance display. At 0% output guidance, the line units are not blacked. As the guidance is rise the next units will blacked. One unit correspond to 10% guidance. At 100% guidance all line units will blacked.
- **LCD1** - the current or guidance percent preset range display. In accordance with display configuration the current value in 4 -20 mA current loop, or percent guidance preset range is possible to display. When current is displayed , symbol „c” before value is visible.
- **LCD2** – the measured pressure digital value display; the calibrated pressure value according to user's units display; the process variable units or user's units display; the MENU announcement and other information or warning announcement display. The decimal point position is possible to set in local MENU or remotely. When the temperature value limits will exceeded the „ **UNDER** „ or „ **OVER** „ are displayed depending on exceeding direction. The temperature unit or user's unit can be displayed alternatingly with digital value displaying in 10s indicate digital value cycle, or 1s indicate digital value cycle. If it is necessary the display unit switching off in local MENU is possible, or with communicator, or PC software using. The transmitter makes possible rescale on the user's individual the temperature value. To make this is necessary with using communicator or PC software write the corresponding to beginning and to end values of setting range as well as write the own unit name. After activating user's mode the rescale value will be visible on display.
- Local display is equipped in backlight, switching on and switching off with jumper on electronic board.

Fig.4. presents how to change the display position by turn.

Fig.5. presents the procedure of service of backlight

### 9.2.5.1. Setting up a local LCD display - the display in accordance with EN 12405-1 (MID) installed since 2011.

The LCD display configuration can do in dependence from needs. Changes of the display options in local MENU are possible using buttons or remote way using communicator, or the PC software. If it is necessary the display switching off is also possible. The display switching of function is possible with using communicator or PC software only.



There 3 main displays are visible:

- **LCD1** – the current or guidance percent preset range display. In accordance with display configuration the current value in 4 -20 mA current loop, or percent guidance preset range is possible to display.
- **LCD2** – the measured temperature digital value display; the calibrated temperature value according to user's units display; the process variable units or user's units display; the MENU announcement and other information or warning announcement display. In the case the digital temperature value or the calibrated temperature value display, the sign „-“, can be visible before displayed value. The decimal point position is possible to set in local MENU or remotely. The temperature unit or user's unit can be displayed. The transmitter makes possible rescale on the user's individual the temperature value. To make this is necessary with using communicator or PC software write the corresponding to beginning and to end values of setting range as well as write the own unit name. After activating user's mode the rescale value will be visible on display.
- **LCD3** – information display. During normal operation is designed for continuous display of the base unit or the user units. In case of errors in the transmitter's work , it displays an error number. In manual mode, the local change settings menu displays options of selecting the setting. It also displays errors related to the implementation of commands in the local menu of the settings change.
- **Display backlighting** - Local display is equipped in backlight, switching on and switching off with jumper on electronic board. How to handle display backlight is shown in Figure 4a. Figure 4 shows how to change the display position by rotation.



**After configuration it is important to protect the transducers using command HART [247]. During work transmitter should be safe prior to entries. This prevents accidental or intentional changes configurational data. The protection function is accessible in KAP03 communicator, “APT2000 Configurator” software, as well as, in applying DD or DMT programs libraries.**

### 9.3. Calibration.

The transmitter can be calibrated with reference values of the standard operating temperature sensor transmitter to its scale (calibration input) or to current output 4 ... 20 (20 ... 4) mA - (current calibration).

The values set calibration points need not be equal to the upper and lower limit of the basic range. But they can not exceed out up and down. The width of the calibration range shall not be less than the minimum width of the setting range. In order to achieve the best accuracy it is recommended that the calibration points were close to the beginning and end of the setting range. Calibration can be made using the KAP-03 or KAP-03Ex communicator according to the procedure described in the "User's Guide" IO.KAP-03 p 11.3. or other tools provided in clause 9.2.3.

## 10. INSPECTIONS AND SPARE PARTS

### 10.1. Periodic inspections

Periodic inspections should be made in accordance with the regulations to which the user is subject.

During inspection, the shield of the measuring insert 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.

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

### 10.2. Unscheduled inspections

If the transmitters are installed in a location where they may be exposed to mechanical damage, hydraulic impulses or excess voltage, or transmitter operate abnormal – inspections should be carried out as required, check the characteristic of processing.



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.

### 10.3. Spare parts.

Parts of the transmitter which may be subject to wear or damage and require replacement: cover and packing gland gaskets .



**Other listed parts, due to the specific features and requirements of explosion-protected devices, may be replaced only by the manufacturer or by a firm authorized by the manufacturer.**

## 11. 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% .

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.

## 12. 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.

## 13. ADDITIONAL INFORMATION

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

## 14. FIGURES.

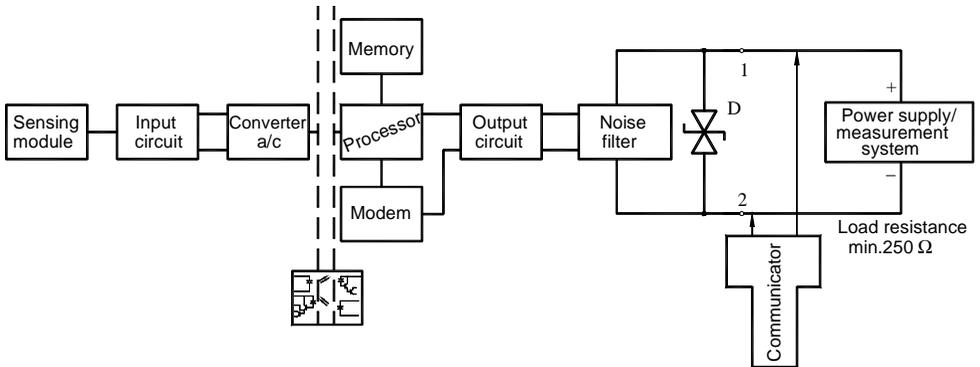


Fig.1. APT... transmitters – block diagram.

For successful communication with transmitter the resistance in measuring loop, behind connected device to communication, should be higher than  $250\Omega$ . If necessary install the additional resistor in the line. The communicator or modem connecting ways to the measuring loop are presented at diagrams. During increasing of resistance in the measure loop at making the good transmission, is necessary to make sure that the tension falls at sum resistances in the loop don't lower minimum tension at transmitter terminals. (see p.5.1).



### Electrical connections for APT... transmitters

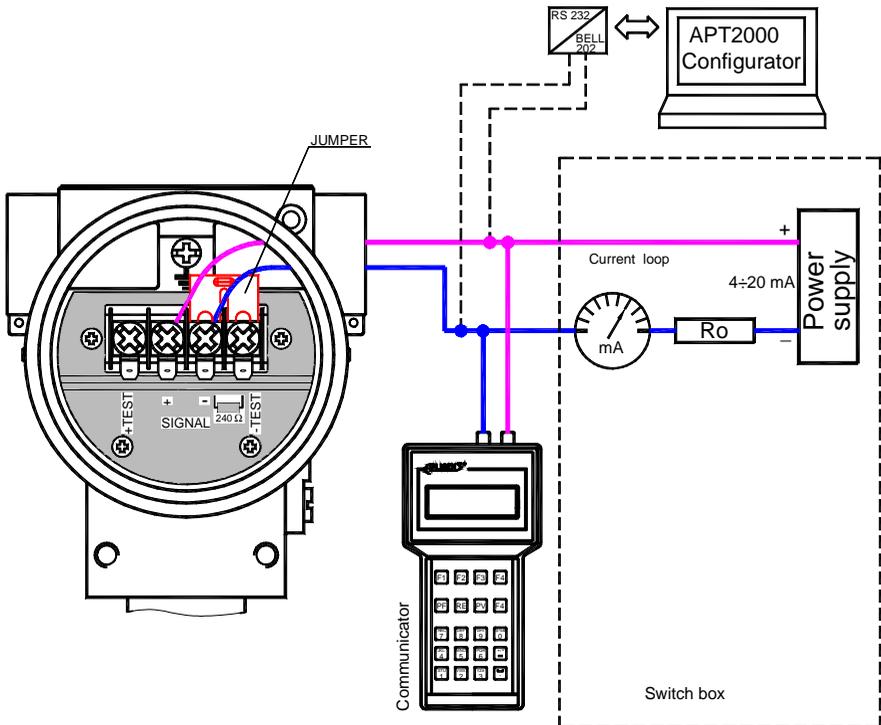
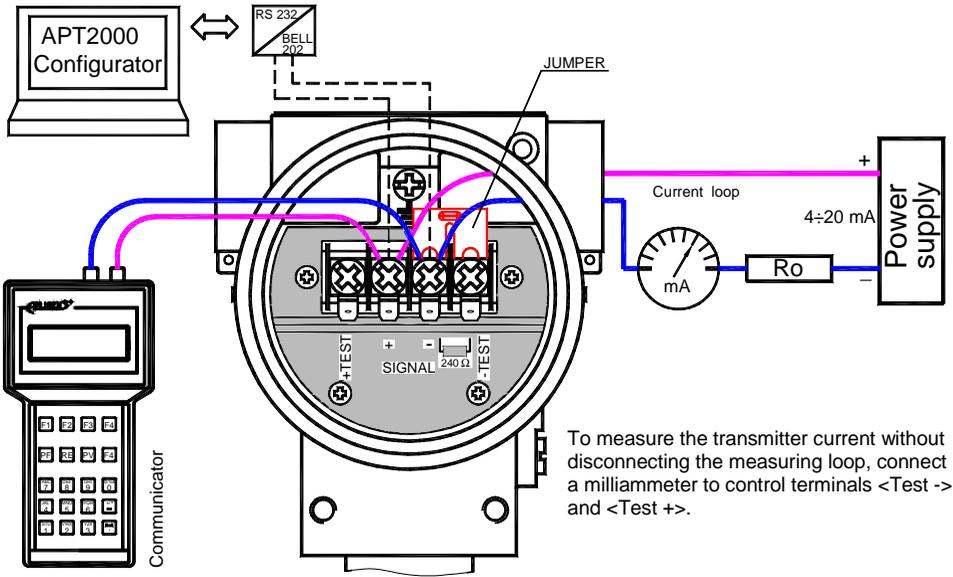
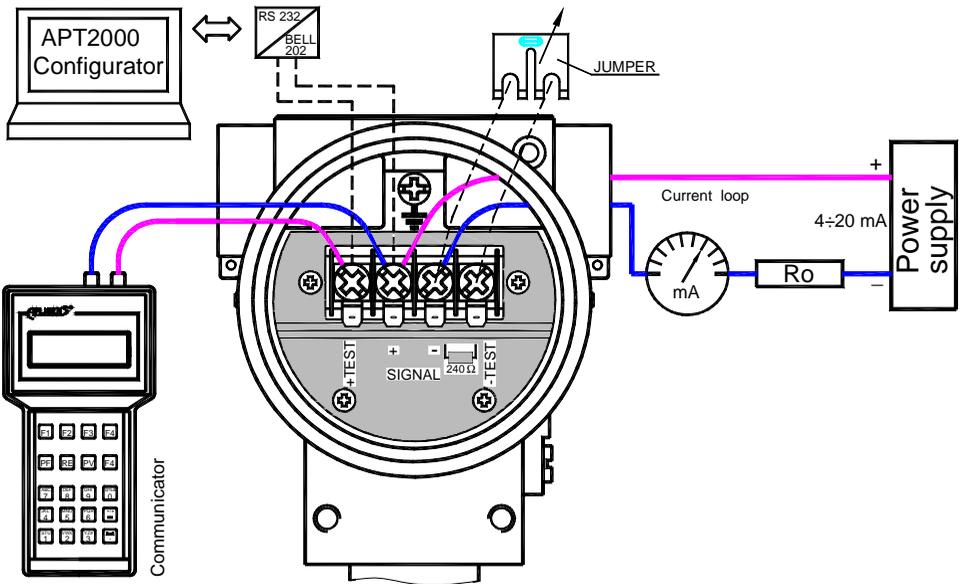


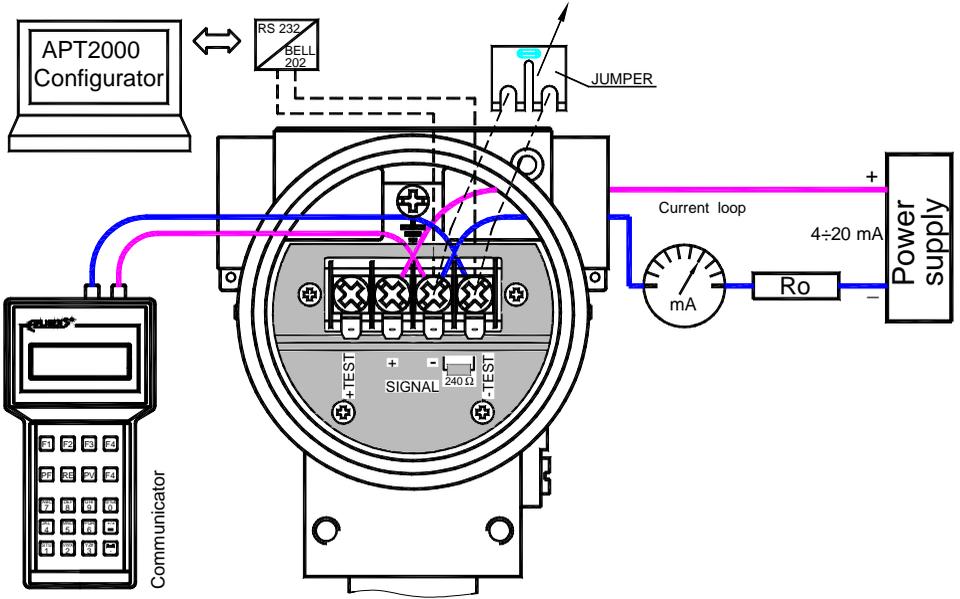
Fig.2a. The link of transmitter and communicator or modem to current line by the switch box ( in case of the resistance in current loop is higher than  $250\Omega$ ).



**Fig.2b.** The link of transmitter and communicator or modem to <SIGNAL+> <SIGNAL-> transmitter terminals in case of the resistance in current loop is **higher than 250Ω**.



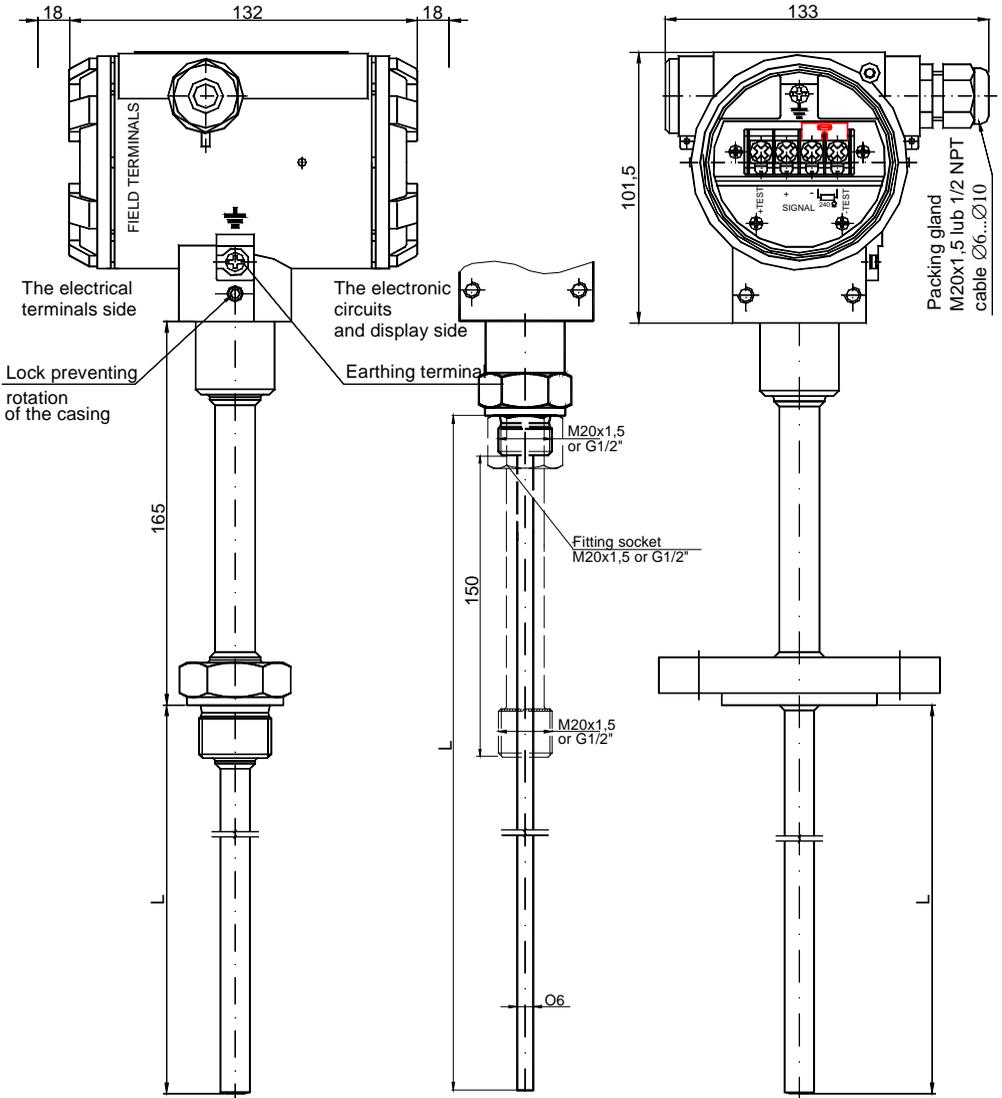
**Fig.2c.** The link of transmitter and communicator or modem to <SIGNAL+> <TEST+> transmitter terminals in case of the resistance in current loop is **smaller than 250Ω**.



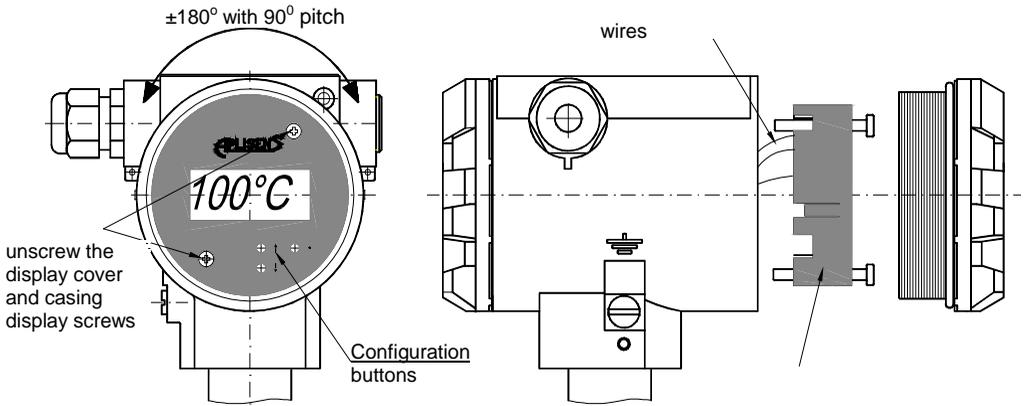
**Fig.2d.** The link of transmitter and communicator or modem to <SIGNAL+> <SIGNAL-> transmitter terminals in case of the resistance in current loop is smaller than 250Ω.



If  $R_o$  in current loop is lower than 250Ω is necessary to connect 240Ω resistor to current loop by remove jumper from <SIGNAL-> and <TEST-> terminals. After communication jumper should cam back at its place.



**Fig.3.** APT-2000ALW smart temperature transmitter



Move the electronic unit from transmitter casing, take up the upper part of the casing with display from the catch and revolve its to left or to right to the display setting at needed position.  
 Rotation possibility  $\pm 180^\circ$  with  $90^\circ$  pitch.  
 Screw on the display unit screws and display cover

**Fig.4.** APT... display rotation possibility, configuration buttons.



Jumper in radial position (as at photo) –back lighting off; jumper in circular position –back lighting on.

**Fig.5.** Back lighting jumper view at transmitter electric board (unit display back side)

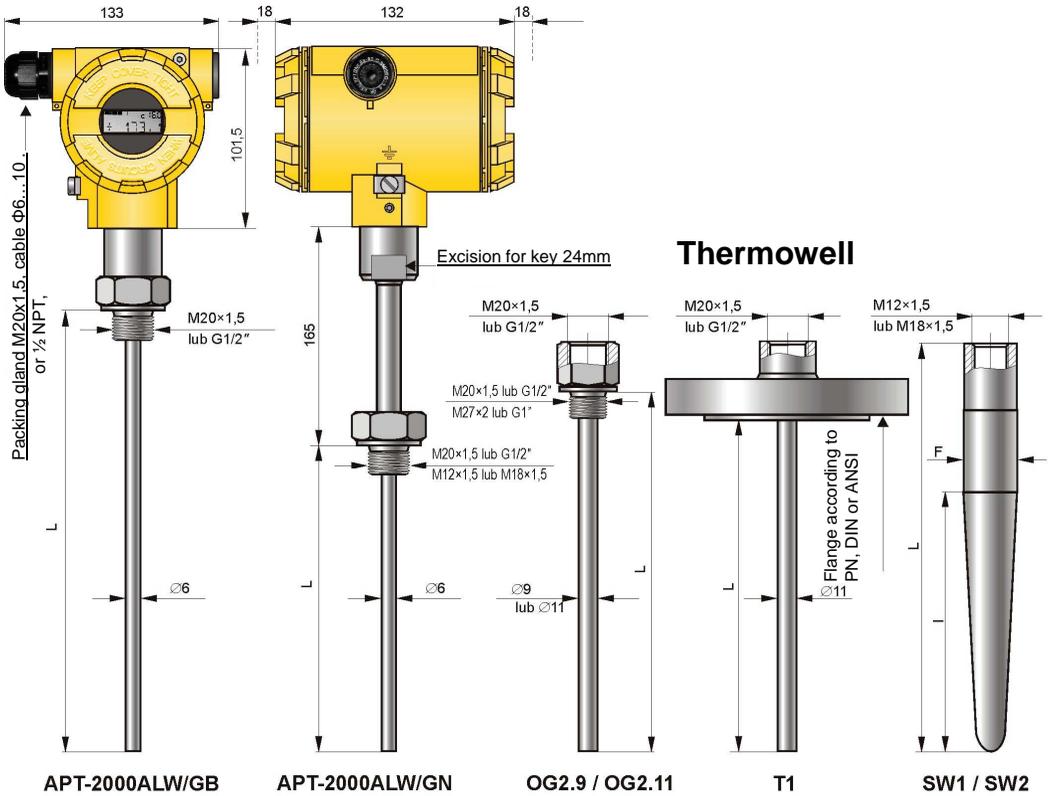
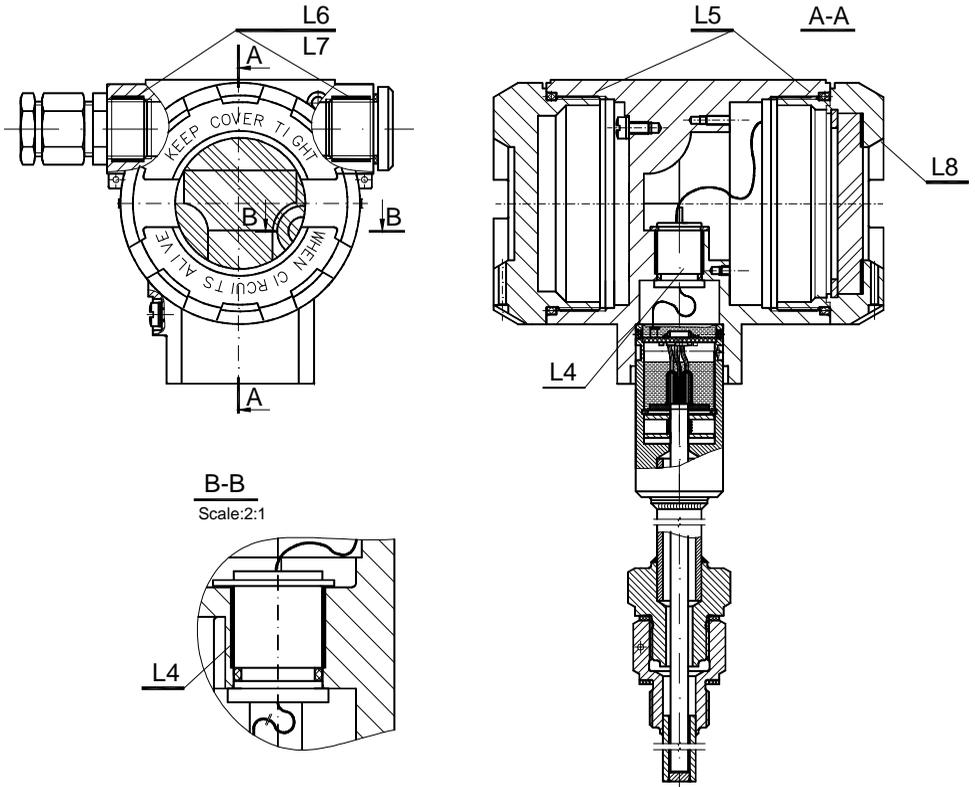
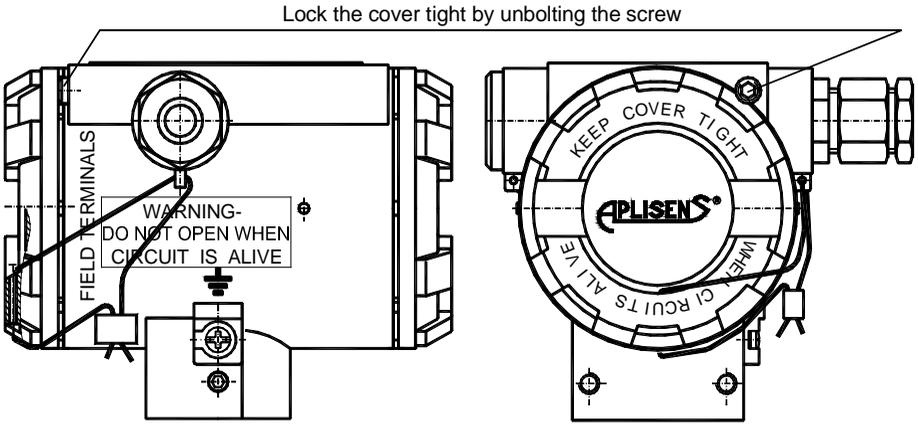


Fig.6. The types of shields of measuring insert.



| MINIMUM WIDTH OF JOINT AND MAXIMUM GAP FOR GROUP IIC ENCLOSURES |   |                       |                                  |          |                      |   |
|---|---|-----------------------|----------------------------------|----------|----------------------|---|
| Nr  | width of joint<br>(min. real)<br>L [mm] | diameter              |                                  | D-d [mm] | quantity<br>of joint | minimum<br>according to<br>PN-EN 60079-1:2008 |
|   |   | D [mm]                | d [mm]                           |          |                      |   |
| L4  | 13,3                                    | O15 <sup>+0,027</sup> | O15 <sup>-0,040<br/>-0,070</sup> | 0,097    | 2                    | width of joint min.12,5                       |
| L5  | 12                                      | M72x1,5               | M72x1,5                          |          | 2                    | min.5 threads<br>engaged(8)                   |
| L6  | 9                                       | M20x1,5               | M20x1,5                          |          | 2                    | min.5 threads<br>engaged(6)                   |
| L7  | 12,7                                    | 1/2NPT                | 1/2NPT                           |          | 2                    | min.6 threads<br>engaged                      |
| L8  | 10                                      |                       |                                  |          | 1                    | cemented joints<br>width of joint min.10      |

Fig.7. The explosion - proof joints of APT-2000ALW transmitter.



**Fig.8.** How to lead the casing of APT-2000ALW transmitter.







