[17]

User’s Manual ver. 2.0.3

Revision no	Date	Description
1.0	27 November 2009	First edition
2.0.1	30 November 2014	Actualization to standard PN-EN-IEC 61508:2010
2.0.2	20 February 2015	Editorial corrections
2.0.3	28 March 2018	P. 2.7 was added Changes have been introduced in p.2.5; 4.2.3; 4.3.3; 12; 13

DTR.APC.APR.ALW.20*(ENG)*

APLISENS

MANUFACTURE OF PRESSURE TRANSMITTERS
AND CONTROL INSTRUMENTS

USER'S MANUAL

SMART PRESSURE TRANSMITTER
type: **APC-2000ALW Safety**
APC-2000ALW Ex Safety

SMART DIFFERENTIAL PRESSURE TRANSMITTER
type: **APR-2000ALW Safety**
APR-2000ALW Ex Safety

ver. 2.0.3

WARSAW MARCH 2018

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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, exposure to direct sunlight;

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

Changes in the production of transmitters may precede a paper updating for the user. The current user manuals are available at www.aplisens.pl.

Important!

Pressure transmitter series **APC-2000ALW Safety and APR-2000ALW Safety** for operation in functional safety loop are to be configured for output signal: **4 ÷ 20mA** or **20 ÷ 4mA** (operation in inversion system). Signal **HART** or **local buttons** changing transmitter settings can be used for both diagnostics and configuration of products at the workplace, but only with functional safety loop deactivated. Following configuration of workplace **Safety** transmitters and activation of **functional safety system with Safety transmitters**, only their **output current signals** are to be used. For safety reasons any tampering with settings of **Safety** transmitters is to be prevented - transmitters offer the possibility of **blocking the change of local settings** by software means and by sealing of housing covers.

CONTENTS

I. APPENDIX Exi

CE 1453 **APC–2000ALW Ex Safety** PRESSURE TRANSMITTER,
APR–2000ALW Ex Safety
DIFFERENTIAL PRESSURE TRANSMITTERS

(Ex VERSION)

1. Introduction

1.1. This "Appendix Exi" applies to transmitters of types APC-2000ALW Ex Safety and APR-2000ALW Ex Safety, marked on the rating plate as shown in 3.

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.APC.APR.ALW.20*(ENG)* in conjunction with "Appendix Exi".**

2. Use of APC… APR… transmitters in danger zones

2.1. The transmitters are produced in accordance with the requirements of the following standards EN 60079-0:2012, EN 60079-26:2007, EN 60079-11:2012, EN 50303:2000.

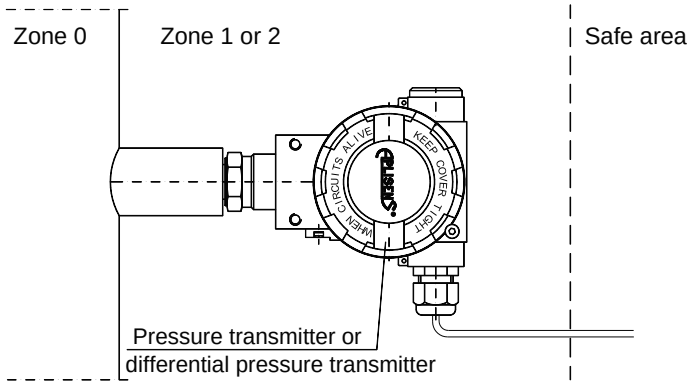
2.2. The transmitters may operate in areas where there is a risk of explosion, in accordance with the rating of the explosion protection design:

II 1/2G Ex ia IIC T5/T6, Ga/Gb
I M1 Ex ia I Ma (version with enclosure ss316)
II 1D Ex ia IIIC T105°C Da

FTZÚ 11 ATEX 0116X

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 APC-2000ALW Ex Safety, APR-2000ALW Ex Safety process connections 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 4.3. DTR.APC.APR.ALW.20*(ENG)* and also at least the following:

- sign transmitters as below: APC-2000ALW/XX Ex Safety where XX marks process connector type,
- CE mark and number of notified unit:, Ex mark
- designation of explosion protection design, certificate number
- values of parameters such as. Ui, Ii, Ci, Li, Pi
- year of manufacture
- inscription: " Version SA - separated supply "- for transmitters with the protection against overvoltage (surge arrester) where should be used galvanically separated powering to ground,

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.APC.APR.ALW.20*(ENG)* with Appendix Exi.

User can find them at www.aplisens.pl

5. Permitted input parameters (based on data from the FTZÚ 11 ATEX 0116X certificate, and certification documentation).

Transmitters equipped in installed surge arresters should be supplied from a source galvanically isolated from ground. Transmitters not equipped in surge arresters meets requirement for insulation 500V rms to ground and doesn't require separated powering.
The designation on the rating plate of the above powering options are given at point. 3

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 below specified.

5.1. - for power supply with a "linear" characteristic

Ui = 28V Ii = 0,1A Pi = 0,7W Ta = 70°C and T5
Ui = 28V Ii = 0,1A Pi = 0,4W Ta = 40°C and T6

Power supply with a "linear" characteristic may be e.g. a typical barrier with parameters
Uo = 28V Io = 0.093A Rw = 300Ω.

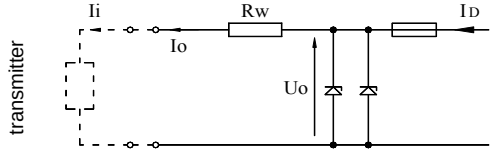


Fig.1. Power supply from a source with "linear" characteristic

5.2. – for power supply with a "trapezial" characteristic
Ui = 24V Ii = 0,05A Pi = 0,6W Ta = 80°C and T5

Example of power supply from a source with "trapezial" characteristic (see Fig. 2).

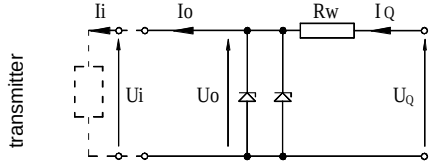


Fig. 2. Power supply from a source with "trapezial" characteristic

If $U_o < \frac{U_Q}{2}$ then parameters U_Q, I_0, P_0 are interrelated as follows:

$$U_Q = \frac{4P_0}{I_0} \quad , \quad Rw = \frac{U_Q}{I_0}, \quad P_0 = \frac{U_0(U_Q - U_0)}{Rw} \quad \text{for } U_0 \le 1/2U_Q$$

5.3. - for power supply with "rectangular" characteristic

Ui = 24V Ii = 0,025A Pi = 0,6W Ta = 80°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 Uo=24V with protection level „ib" and current limited to Io=25mA.

5.4. Input inductance and capacity: Ci = 30nF, Li = 1,35mH
Range of permissible ambient temperature: Ta = -40°C to + 80°C – category M1 and 1D

5.5. Temperature of measured medium can't cause increase temperature housing of transmitter above the ambient temperature Ta specified for a given category.

5.6. Supply voltage min. 16VDC

5.7. Load resistance:

from 28V linear supply

$$\text{Ro max } [\Omega] = \frac{\text{Usup}^{**} - 16\text{V} - (300\Omega^{*} \cdot 0{,}02\text{A})}{0{,}0225\text{A}}$$ for transmitter without display back lighting

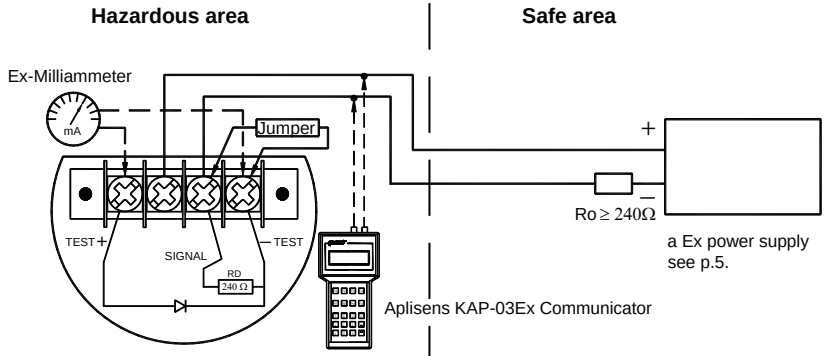
from a source with "trapezial" or "rectangular" characteristic supply

$$\text{Ro max } [\Omega] = \frac{\text{Usup.} - 16\text{V}}{0{,}0225\text{A}}$$

*) barrier resistance **) the real value of voltage from barrier

6. How to connect Ex transmitters APC-2000ALW Ex Safety, APR-2000ALW Ex Safety.

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.



To measure the current in the transmitter without disconnecting the signalling circuit, connect a milliammeter to control sockets <TEST+>, <TEST->.

In hazardous areas, connections to the control terminals must be made using only instruments which are permitted to be used in such areas.

Connecting transmitter to comunicator should be done accorded to Fig. 10a and Fig. 10b at page 17. The communicator must hold an eligibility to use in hazardous area.
Exemple KAP-03 Ex Aplisens production.
In absence of such approval for communicator, the transmitter must be configured and calibrated in safe zone becouse communicator cannot be connected to the line entering to the danger zone.

Transmitter electrical installation should be realised with engineering standard requirements.

It is not allowed 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.

Special conditions for safe use:

Version of transmitter with surge arrester, marked on the plate "Version SA" does not meet the requirements of Section 10.3 of the EN 60079-11:2012 (500Vrms). This must be taken into account when installing the equipment (see p.5).

1. USER INFORMATION.

Transmitters are delivered in single and/or multiple packs.
Together with the ordered transmitters, the user will receive:

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.APC.APR.ALW.20*(ENG)"*.

Items b), c), d) are available at: www.aplisens.pl

2. APPLICATIONS APC-2000ALW (Ex)Safety and APR-2000ALW (Ex) Safety. MAIN FEATURES

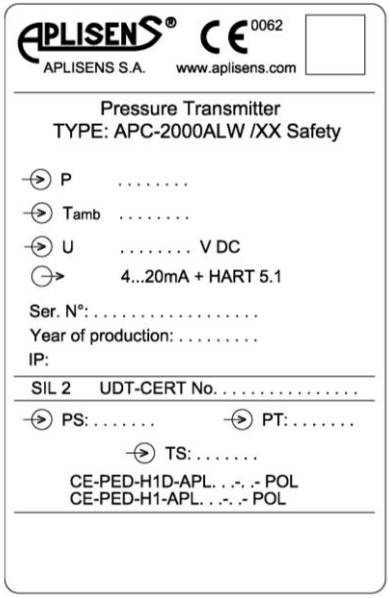
2.1. The **APC-2000ALW (Ex) Safety** smart pressure transmitters are designed to measure gauge pressure, vacuum pressure and absolute pressure of gases, vapours and liquids (including corrosive substances).
Differential pressure transmitters type **APR-2000ALW (Ex) Safety** are used to measure liquid levels in closed tanks, with static pressure up to 25MPa, or 32MPa for special versions and to measure differential pressure across constrictions such as filters and orifices.

2.2. Transmitters **APC(R)-2000ALW (Ex) Safety** can be fitted with a series of diverse process connectors, and also, when application so requires, they can be installed with direct or spaced demisters, which allows using them with various measured media, such as dense media or aggressive media, at high and low temperatures.

2.3. Transmitter series **APC(R)-2000ALW (Ex) Safety** generates output signal 4...20mA (20…4mA in inversion system), in double-duct arrangement.

2.4. Transmitters can be configured following their installation at the workplace. Due to application of "smart" electronics the following settings are available: beginning and end of measurement range, attenuation, elemental processing characteristics, low (LO) and high (HI) level of basic alert. Transmitters can be configured using communicator KAP03 (APLISENS), some other HART communicators or PC computer with HART/RS232 converter and "RAPORT 2" software.

2.5. The rating plates of **APC(R)-2000ALW (Ex) Safety**, transmitters in versions compliant with the PED pressure directive contain the notified body number 0062 next to the CE mark, as well as the designations of certificates number: (H1), maximum allowable pressure PS, test pressure PT, minimum/maximum allowable temperature TS – see fig. below. Copy of SIL Certificate can be found at www.aplisens.pl.



2.6. Pressure transmitters series **APC-2000ALW (Ex) Safety** and differential pressure transmitters series **APR-2000ALW (Ex) Safety** are attached with **SIL 2** certificate for application in **LDM/HDM** work safety systems, to **PN-EN 61508-1 :2010; PN-EN 61508-2:2010; PN_EN 61508-3:2010; PN-EN 61511-1:2007; PN-EN 62061:2008+A1,** issued by notified entity UDT-CERT; 02-353 Warszawa, ul. Szczęśliwicka 34. Copy of SIL Certificate can be found at www.aplisens.pl.

2.7. The transmitters in all versions comply the requirements of the RoHS Directive in accordance with EN 50581.

3. IDENTIFYING MARKS

Each **APC(R)-2000ALW Safety** transmitter has a nameplate with at least the following information: CE symbol, name of manufacturer, type of transmitter, basic range, admissible static pressure, output signal, supply voltage, marking (marks) of admissions and certificates. Marking for order purposes and versions as per up-to-date Information Sheets and the Catalogue.

4. TECHNICAL DATA.

4.1. APC(R)-2000ALW (Ex) Safety - COMMON PARAMETERS

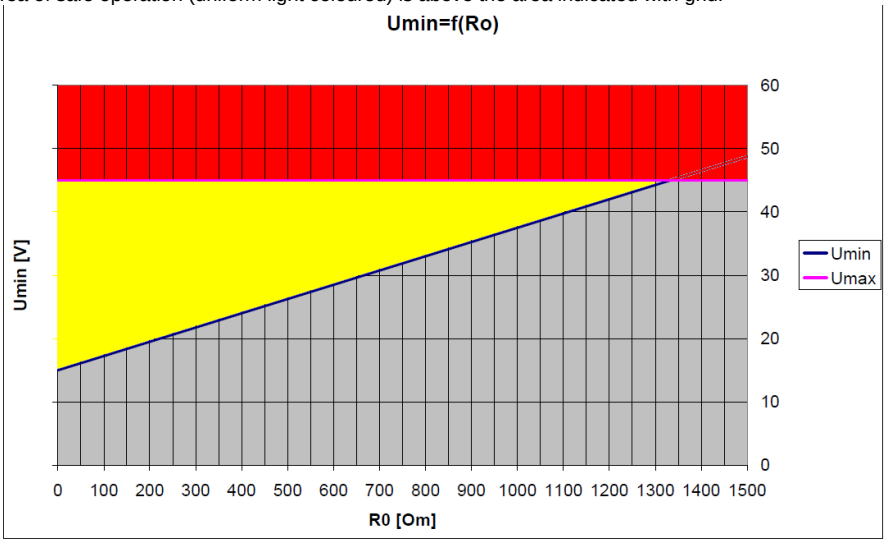
4.1.1. Electrical parameters

Power supply 15 ÷ 45V DC,

Load resistance $Ro[\Omega] = \frac{Usup[V] - 15V}{0{,}0225A}$

Minimum value of transmitter supply voltage can be calculated using below formula:
Umin = 15 + 0,0225 x Ro [V] (or see drawing below)

The area of safe operation (uniform light coloured) is above the area indicated with grid.



Power supply of **intrinsically safe** versions as per **Appendix Exi**

Output signal 4÷20mA , 20…4mA, Hart * rev5

*) only for workplace configuration purposes

Resistance for communication (Hart)	250÷1100Ω, min 240Ω
The time of readiness to work after switching on the power supply	3s
Output updating time	500ms
Additional electronic damping	0...60s

4.1.2. Permitted environmental conditions

Operating temperature range	-40°C***** ÷85°C (for PED version in accordance with p. 4.2.3, 4.3.3)
Medium temperature range	-40°C***** ÷ 120°C – for direct measurement, over 120°C measurement with a transmission tube or diaphragm seal using
for intrinsic-safe versions	in accordance with Appendix Exi.
Thermal compensation range	-25º ÷ 80ºC, -5º ÷ 65ºC for range nº14 for **APC**... -40º ÷ 80ºC special version for **APC**...
Relative humidity	0 ÷ 100%
In operation vibrations and impacts	amplitude 1.6mm, max. acceleration 4g, frequency up to 100Hz
EMC	to PN-EN 61326 industrial environments
Safety Integrity Level; type of operation:	
LDM/HDM	SIL 2 to PN-EN 61508
Basic alert levels	low (LO) <3.7mA or high (HI) >21.5mA** selected by HART command
Critical alert level	always low (LO) < 3,7mA

*) -25º for **APR-2000ALW (Ex) Safety**
**) - preset by manufacturer

4.1.3. Construction materials

Diaphragm seal	Stainless steel 1.4404/1.4435 (316L) or Hastelloy C276
Sensing module	Stainless steel 1.4404 (316L)
Liquid filling the interior the sensing module	Silicone oil, chemically inactive liquid for measurement of oxygen uses.
Connectors for **APC... APR…**	Stainless steel 1.4404 (316L) and Hastelloy C276 for P, GP
C-type vented covers and connectors **APR...**	Stainless steel 1.4404 (316L)
Electronics casing	High pressure cast of aluminium alloy, lacquered with chemical-resistant oxide enamel, colour yellow (RAL 1003). or stainless steel ss316.

4.1.4. Enclosure ingress protection.

IP66/67according to. PN-EN 60529:2003

4.1.5. Response time on pressure stroke

Maximum response time on pressure stroke - 1,2 s.

4.2. APC-2000ALW (Ex) Safety - MEASUREMENT RANGES AND METROLOGICAL PARAMETERS.

4.2.1. Measurement ranges

N°	Nominal measuring range (FSO)	Minimum set range	Rangeability	Overpressure limit (without hysteresis)
1.	0...1000bar (0...100MPa)	10bar (1MPa)	100:1	1200bar (120MPa)
2.	0...300bar (0...30MPa)	3bar (300kPa)	100:1	450bar (45MPa)
3.	0...70bar (0...7MPa)	0,7bar (70kPa)	100:1	140bar (14MPa)
4.	0...25bar (0...2,5MPa)	0,25bar (25kPa)	100:1	50bar (5MPa)
5.	0...7bar (0...0,7MPa)	0,07bar (7kPa)	100:1	14bar (1,4MPa)
6.	-1...1,5bar (-100...150kPa)	120mbar (12kPa)	20:1	4bar (400kPa)
7.	0...2bar (0...200kPa)	100mbar (10kPa)	20:1	4bar (400kPa)
8.	0...1bar (0...100kPa)	50mbar (5kPa)	20:1	2bar (200kPa)
9.	-0,5...0,5bar (-50...50kPa)	50mbar (5kPa)	20:1	2bar (200kPa)
10.	0...0,25bar (0...25kPa)	25mbar (2,5kPa)	10:1	1bar (100kPa)
11.	-100...100mbar (-10...10kPa)	20mbar (2kPa)	10:1	1bar (100kPa)
12.	0...1,3bar abs (0...130kPa abs)	100mbar abs (10kPa abs)	13:1	2bar (200kPa)
13.	0...7bar abs (0...0,7MPa abs)	100mbar abs (10kPa abs)	70:1	14bar (1,4MPa)

14.	0...25bar abs (0...2,5MPa abs)	0,25bar abs (25kPa abs)	100:1	50bar (5MPa)
15.	0...70bar abs (0...7MPa abs)	0,7bar abs (70kPa abs)	100:1	140bar (14MPa)
(Other nominal ranges to be agreed)				

4.2.2. Metrological parameters

Accuracy	max ± 0,075% of the calibrated range (max ± 0,16% for range nº12).
Long term stability	≤ accuracy for 3 years (for the nominal measuring range)
Error due to supply voltage changes	max ± 0,002%(FSO)/1V
Thermal error	max ± 0,08%(FSO)/10ºC max ± 0,1% FSO/10°C for ranges n°10, 11, 12.
Thermal error for the whole thermal compensation range	max ± 0,25%(FSO) (max ± 0,4% FSO/10°C for ranges n°10, 11, 12.

4.2.3. PED - versions. Measurement ranges.

APC-2000ALW (Ex) Safety transmitters, in the PED Pressure Directive versions, are produced with a measurement range in the interval from –1bar to 400bar gage, or from 0 to 400bar absolute, with the overpressure up to PS=440bar.

Temperature limits: for options according to H1 Modules: TS min/max:-40 ÷ 100ºC

4.2.4. Pressure Connectors

M-type connector with M20x1.5 thread – see figure 5a, available for PED version
P-type connector with M20x1.5 thread – see figure 6a, available for PED version
G1/2 -type connector with G1/2" thread – see figure 8a, available for PED version
GP -type connector with G1/2" thread, available for PED version
RM-type connector with M20x1.5 thread and radiator
RP-type connector with M20x1.5 thread and radiator
G1/4-type connector with G1/4 thread, available for PED version
1/2"NPT -type connector with 1/2"NPT tread, available for PED version
R1/2-type connector with R1/2 tread, available for PED version

4.3. APR-2000ALW (Ex) Safety - MEASUREMENT RANGES AND METROLOGICAL PARAMETERS

4.3.1. Measurement ranges

N°	Nominal measuring range (FSO)	Minimum set range	Rangeability	Overpressure limit	Static pressure limit
1	0...16bar (0...1,6MPa)	1,6bar (160kPa)	10:1	250, 320bar (40bar for P-type connector) (PS=275bar for PED version)	
2	0...2,5bar (0...250kPa)	0,2bar (20kPa)	10:1		
3	0...1bar (0...100kPa)	70mbar (7kPa)	14:1		
4	0...0,25bar (0...25kPa)	10mbar (1kPa)	25:1		
5	-5...70mbar (-0,5...7kPa)	4mbar (0,4kPa)	18:1		
6	-25...25mbar (-2,5...2,5kPa)	1,8mbar (0,18kPa)	20:1		
7	-0,5...0,5bar (-50...50kPa)	0,1bar (10kPa)	10:1		
(Other nominal ranges to be agreed)					

4.3.2. Metrological parameters

Accuracy	± 0,075% of the calibrated range
Long term stability	≤ accuracy for 3 years (for the nominal measuring range)
Error due to supply voltage changes	± 0,002%(FSO)/1V
Thermal error	± 0,08%(FSO)/10ºC
Thermal error for the whole thermal compensation range	± 0,3%(FSO)
Zero shift error for static pressure*	± 0,08 % (FSO)/10bar ± 0,01 % (FSO)/10bar (for range n°4) ± 0,03 % (FSO)/10bar (for range n°5)
Cut-off on radical characteristic curve	up to10% of flow.

*) zeroing in static pressure conditions with zero differential pressure eliminate this error.

4.3.3. PED - versions. Measurement ranges

APR-2000ALW (Ex) Safety transmitters which conform to PED are characterised by a measurement range of between -1bar and 250bar, static pressure of 250bar and the overpressure of PS=275bar.

The permissible operating temperature for option according to:

- H1 Module is between TS min/max: -25ºC and 100ºC;

4.3.4. Pressure Connectors.

- C-type connector to mount together with a valve manifold
- P-type connector

5. CONSTRUCTION.

5.1. ELECTRONIC SYSTEM. MEASUREMENT PRINCIPLE

Electrical signal from Sensor module(s), proportional to the value of measured pressure and temperature, is fed to the input of analogue-digital transmitter and transformed into digital signal. Digital signal is then transferred, via optoelectronic galvanic isolation, to the main circuit board. Microchip controller of the main circuit board reads the values measured and based on such values calculates the accurate pressure value. Digital value of measured pressure is then transformed into analogue signal 4...20[mA]. Furthermore the calculated value is displayed on integrated LCD screen. The transmitter can be configured using local MENU buttons. Implemented communication stack HART rev5 enables communication and configuration of transmitter using modem connected to PC computer and suitable software, or using communicator. Electrical connection of the transmitter is fitted with interference eliminator with overvoltage protections.

Transmitters **APC(R)-2000ALW (Ex) Safety** continuously monitor the operation of their hardware resources and correctness of calculations, and in the event of any failures they report errors by setting of alarm current in current loop. Furthermore error message is displayed on local LCD screen stating the error number. Head electronics are galvanically isolated from measuring line. Galvanic isolation reduces susceptibility of measurement to interferences.

5.2. MECHANICAL CONSTRUCTION.

5.2.1. Transmitter housing

Housing of **APC(R)-2000ALW (Ex) Safety** transmitter is executed in high-pressure aluminium cast or in stainless steel, and comprise a body and two threaded lateral covers, one of which is fitted with sight-glass. There are two openings for cable glands with thread M20x1.5 or ½" NPT in the housing (redundant opening is to be stopped with a plug). The housing is fitted with both internal and external earthing terminal. Dimensions of transmitters are shown in Fig.2.

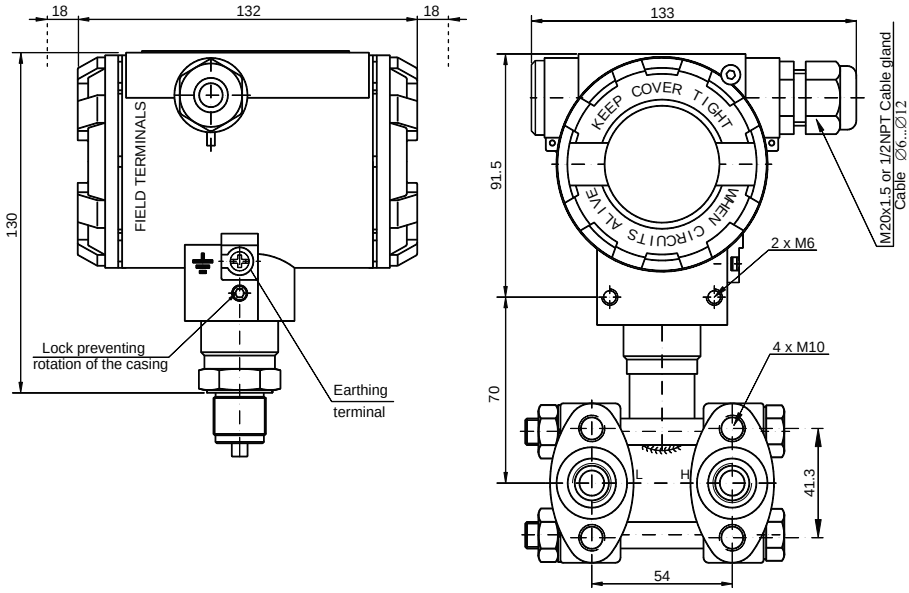


Fig.2. APC(R)-2000ALW (Ex) Safety pressure transmitter. Dimensions.

5.2.2. Electronics assembly with display

The main electronics circuit board with display is placed in the polycarbonate housing. The assembly is installed inside the bigger of two housing chambers. Display can be adjusted for best viewing with 90° step. Displayed is positioned by manufacturer as per the information included with order. Default display position is vertical transmitter reading position, pressure connection down, without display backlight.

5.2.3. Sensor modules. Pressure connectors of transmitters. Examples

Sensor module is a transmitter assembly fitted with silicon measuring membrane. The membrane is located in the space filled with silicon oil, closed with a gland with glass isolated electrical leads on one side and with membrane isolating the medium on the other side. Heads are fitted with stub pipes allowing connection of transmitter to pressure system. Standard pressure connections and system outlets are shown in drawings. The head of **APR-2000ALW (Ex) Safety** transmitter is fitted with two type P connectors or type C process connector for mounting the valve manifold.

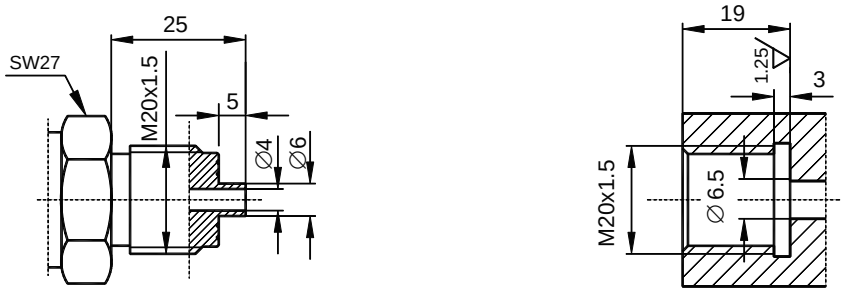


Fig.3. M-type pressure connector with M20x1.5 thread

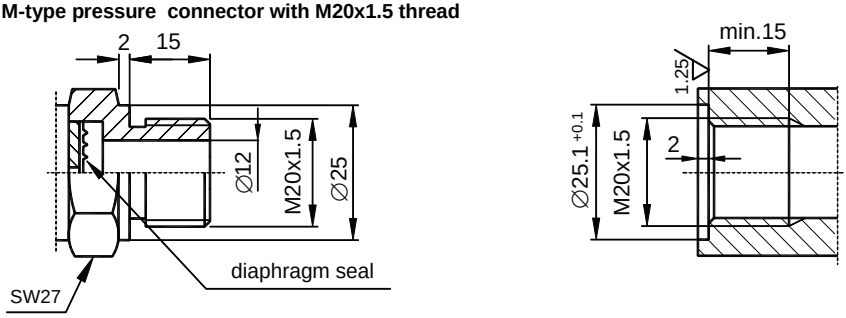


Fig.4. P-type connector with M20x1.5 thread with increased opening Ø12

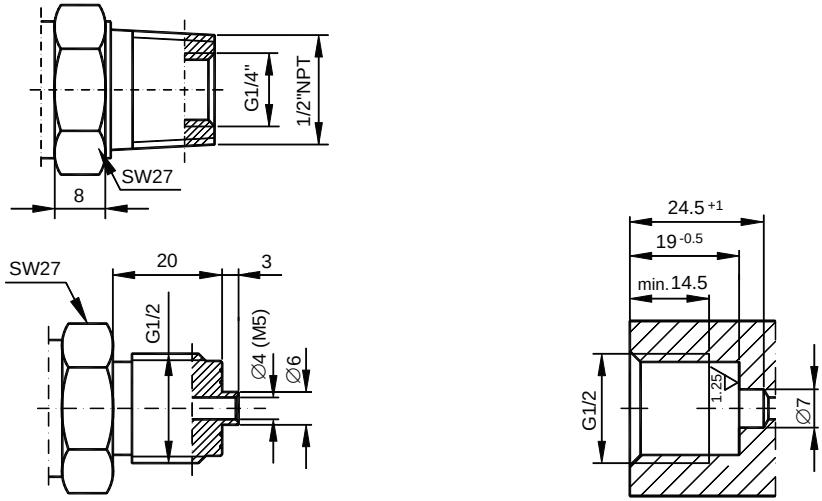


Fig.5. 1/2”NPT type and G1/2-type pressure connector with G1/2” thread

6. PLACE OF INSTALLATION

6.1. GENERAL RECOMMENDATIONS

6.1.1. Pressure and differential pressure transmitters can be installed both indoors and outdoors. When outdoors it is to be installed in the booth or under the roof.

6.1.2. Location of transmitter in the facility is to ensure access for maintenance and protection against mechanical damages. Method of mounting the transmitter and configuration of pressure feeding ducts, so-called “impulse tubes”, are to meet following requirements:

- impulse tubes are to be possibly short and with sufficient cross-section, routed without sharp kinks, in order to prevent their blocking;
- in the case of gaseous medium transmitters are to be installed above measuring point, so that the condensate could flow to the intake of measured pressure, whereas in the case of liquid medium, steam or when using protecting liquid, downstream the the pressure intake;
- it is recommended that impulse tubes are declined, i.e. they are not to be installed horizontally or vertically, unless the impulse tube is looped - so-called "pig tail";
- when we install differential pressure transmitter equal level or equal differential level of filler liquid is to be maintained in both impulse tubes, as well as the same temperature of both impulse tubes, position effect error corrected be zeroing and impulse tubes filled.
- avoid fitting of metering orifice at high points of process system for liquids, and at low points for gases.
- configuration of impulse tubes and connection system of three- and five-way valves are to be selected considering measurement results and such needs as “pressure zeroing” of facility transmitters, operation of impulse tubes during degasification, drainage and washing.

6.1.3. Potential system sources of measurement errors, such as leaks, blocking of too narrow tubes by sediments, gas bubbles in tubes with liquids or liquid in gas tube, differential density and/or differential level in measuring tubes, etc., are to be eliminated.

6.2. LOW AMBIENT TEMPERATURES

When measuring the pressure of liquid with freezing point higher than ambient temperature adequate anti-freezing protection of measuring system is to be provided. This applies in particular to transmitters installed outdoors.

Such protection can be in the form of filing impulse tubes with e.g. the mixture of ethyleneglycol and water, or with other liquid with freezing point lower than ambient temperature. Also available methods of thermal insulation can be applied. It is to be remembered, however, than thermal insulation protection of transmitter and impulse tubes works only short-term. During long periods of low temperature both transmitter and impulse tubes are to be heated.

6.3. HIGH MEDIUM TEMPERATURE.

In the case of pressure transmitter **APC(R)-2000ALW (Ex) Safety** the maximum temperature of medium is 120°C. Sensor module of transmitter is protected against temperatures higher than 120°C by way of sufficiently long impulse tubes, which disperse heat and reduce the temperature of transmitter Sensor module.

6.4. MECHANICAL VIBRATION. IMPACTS. CORROSIVE MEDIA

6.4.1. Pressure transmitters **APC(R)-2000ALW (Ex) Safety** are resistant to vibrations at the place of installation, up to 4g and within frequency range up to 100Hz. Stronger vibrations are to be isolated by means of flexible impulse tubes or choosing other location for installation and using remote diaphragm seals.

6.4.2. Parts which contact the medium are to be executed in materials corresponding with chemical (corrosive) properties of the medium. In particular the membrane material is to be thoroughly selected, and when the medium is likely to cause the corrosion of membrane executed in stainless steel 1.4404/1.4435 (316L), a transmitter utilizing coated membrane or membrane executed in other material, more resistant to given medium, is to be used.

6.4.3. In locations exposed to hazard of hitting with heavy object, which in extreme situations is likely to cause breaking of the part of the system with transmitter and leakage of the medium, suitable guards or other protections are to be used, both for safety reasons and to prevent sparking, or of transmitter in such location avoided.

7. INSTALLATION AND MECHANICAL CONNECTIONS

7.1. APC-2000ALW (Ex) Safety. INSTALLATION AND CONNECTIONS TO PRESSURE SYSTEM.

7.1.1. Transmitters **APC-2000ALW (Ex) Safety** can be mounted directly on rigid impulse tubes. Pressure transmitters are mounted on one-way vented valves. Such connection of transmitter allows its easy cutting off of the system for washing of measuring membrane, local calibration, diagnostics, etc. Transmitters can work in any position, however cable inlets are best positioned horizontally or facing downwards. In the event of fitting at the facility with medium at elevated temperature it is beneficial to install transmitters in some distance from the stream of hot air. It is recommended that pressure connectors of transmitters are used with corresponding outlets, see Fig. 3 ÷ 4.

7.1.2. Transmitter is to be tightened in the socket with torque corresponding with type of seal used and measured pressure.

7.1.3. Transmitter **APC-2000ALW (Ex) Safety** can be installed using universal “AL holder” allowing installation, in any position, on supporting structure or vertical or horizontal tube ∅35 ... ∅65 (Fig.6).

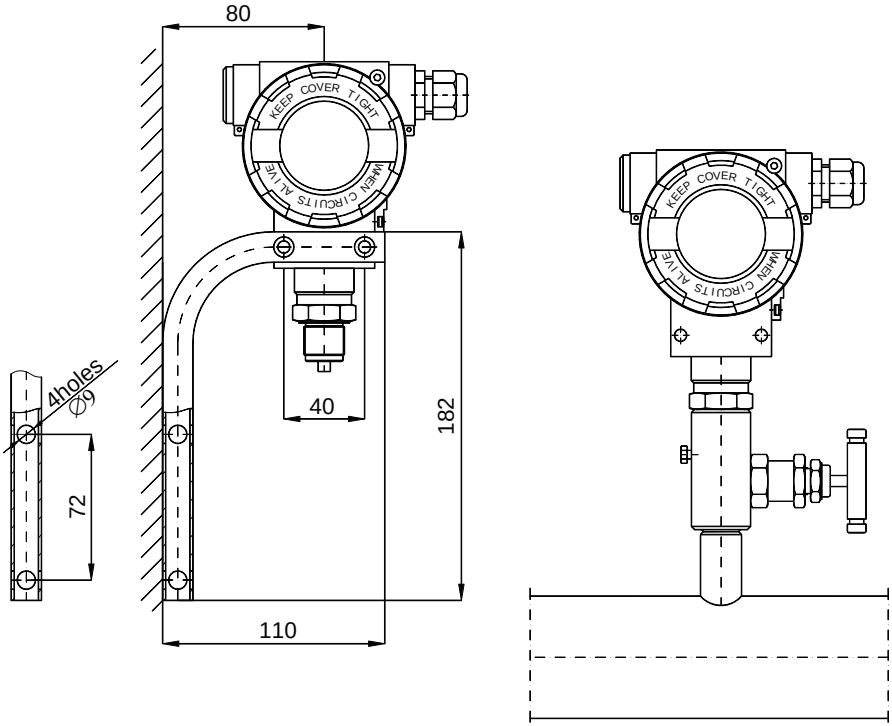


Fig.6. Mounting methods of APC-2000ALW (Ex) Safety transmitter

7.2. APR-2000ALW (Ex) Safety. . INSTALLATION AND CONNECTIONS TO PRESSURE SYSTEM.

7.2.1. Transmitters **APR-2000ALW (Ex) Safety** can be mounted directly on rigid impulse tubes. Differential pressure transmitters are mounted on three- or five-way valves. Such connection of transmitter allows its easy cutting off of the system for washing of measuring membrane, local calibration, diagnostics, etc. Connections of transmitters with two stub-pipes M20 x 1.5 (type P connector) are to be executed using straight couplers with type C nuts to PN-82/M-42306. When flexible tubes are used in connection transmitters are to be additionally mounted on tube, panel, supporting structure. Transmitters with **type P stub pipes,** or other type, can be mounted using mounting set "∅25 holder" (Fig.8) for tube ∅25 or to flat surface, using angle section.

7.2.2. Transmitters **APR-2000ALW (Ex) Safety** with connector covers (type C connector) can be mounted on three- or five-way valve units to tube 2" or to flat surface, using C-2 holder (Fig.7).

7.2.3. When completing the fittings for mounting of transmitters information on connecting and reducing components, sockets, valves, reducing clamps, signal tubes offered by APLISENS can be useful.
Such information can be found in our catalogue.

Pressure can be fed to transmitters after making sure that transmitter with correctly selected measuring range to value of measured pressure is installed, that seals are correctly selected and installed, and that all threaded joints are adequately tightened.

Any attempt to undo bolts or stub pipes at pressurized transmitter is likely to cause leakage of the medium and resulting hazard to personnel.

When disassembling transmitter it is to be cut-off from process pressure, or process pressure is to be reduced to atmospheric pressure. Exercise extreme care and use all precautions in case of working with aggressive, caustic, explosive or other media, which constitute a hazard to personnel. If necessary wash disassembled part of the system.

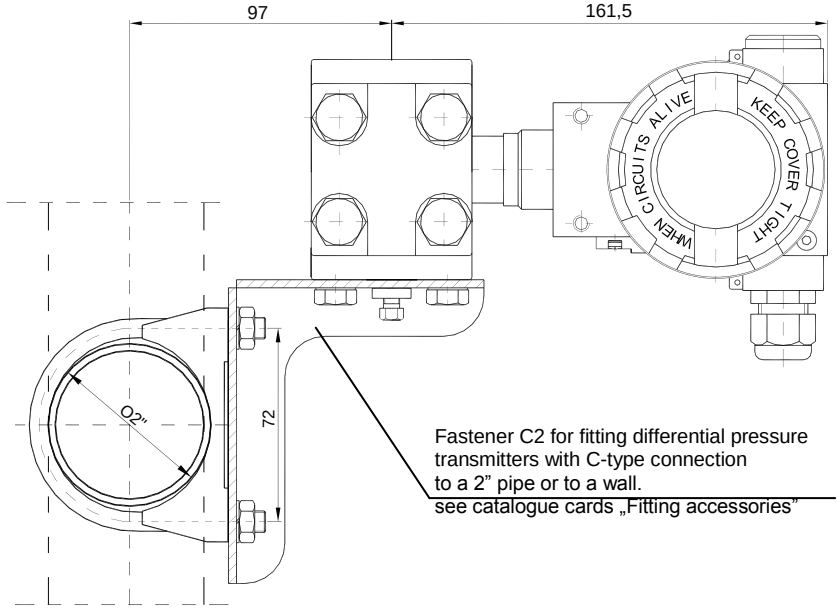


Fig.7. Example of mounting of APR-2000ALW (Ex) Safety transmitter with type C connector.

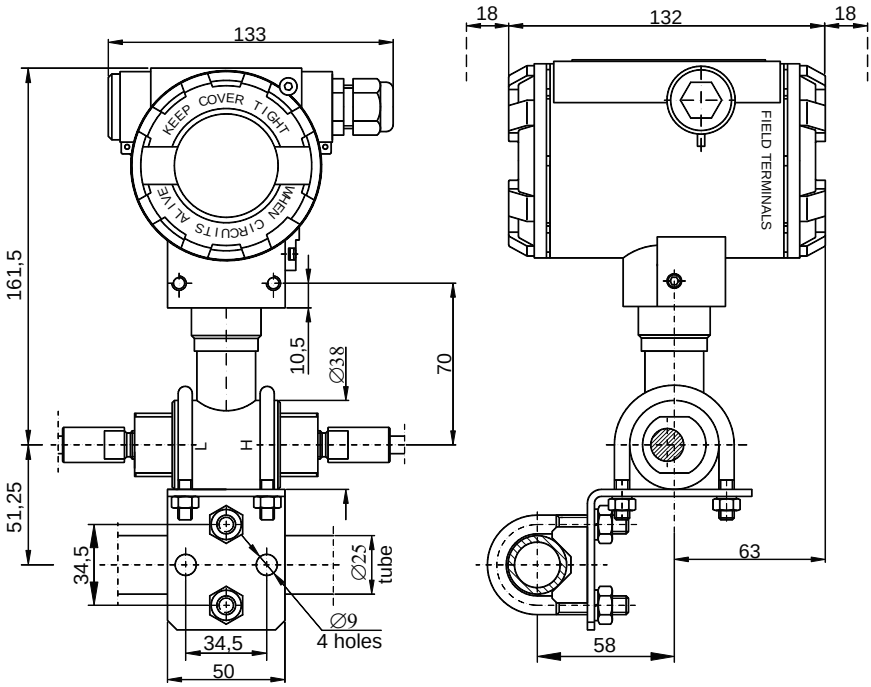


Fig 8 Example of mounting of APR-2000ALW (Ex) Safety transmitter with C type connector on tube.

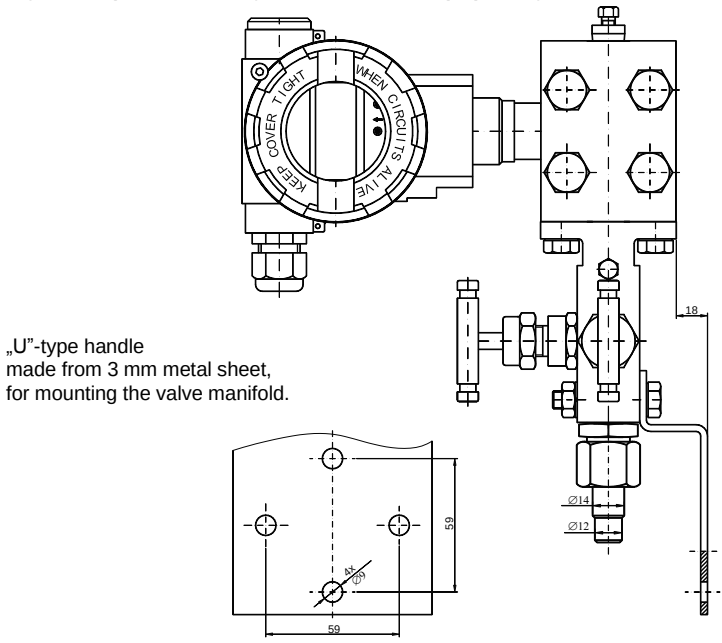


Fig.9. Example of mounting of APR-2000ALW (Ex) Safety transmitter with a valve manifold

8. ELECTRICAL CONNECTIONS

8.1. GENERAL RECOMMENDATIONS

8.1.1. It is recommended that signal lines are executed in twisted wire, and in the case of high electromagnetic interferences in shielded twisted wire. Avoid routing signal cables along the interfering cables, e.g. near large consumers of electric energy. Appliances working with transmitters are to be resistant to electromagnetic interferences from power supply or signal transmission lines, as per the requirements concerning electromagnetic compatibility. It is also advisable to use interference eliminators on the primary side of transformers, power supply units supplying power to transmitters and appliances working with transmitters.

8.1.2. Cable diameter is to match the cable gland used in the transmitter. The cable is to be so routed and placed that mechanical stresses are avoided. Cable gland and transmitter housing cover are to be carefully tightened. Transmitter earthing is to be analysed. Transmitter can be earthed via process connector or via earthing terminals, external or internal.

The section of signal cable leading to transmitter gland is to be formed as drip loop, the lowest point of which is to be situated below cable inlet to the gland, to prevent condensate ingress to the gland.

8.2. ELECTRICAL CONNECTIONS OF TRANSMITTERS

For execution of electrical connections of transmitters **APC(R)-2000ALW (Ex) Safety** see Fig. 10. Resistor 240 Ω is serially integrated, permanently, in the current circuit of transmitter and shorted with jumper on connection terminals between <SIGNAL–> and <TEST–>, see Fig. 10b. To use the that resistor in Hart communication, e.g. in the event of too low resistance in measurement loop, the jumper is to be removed.

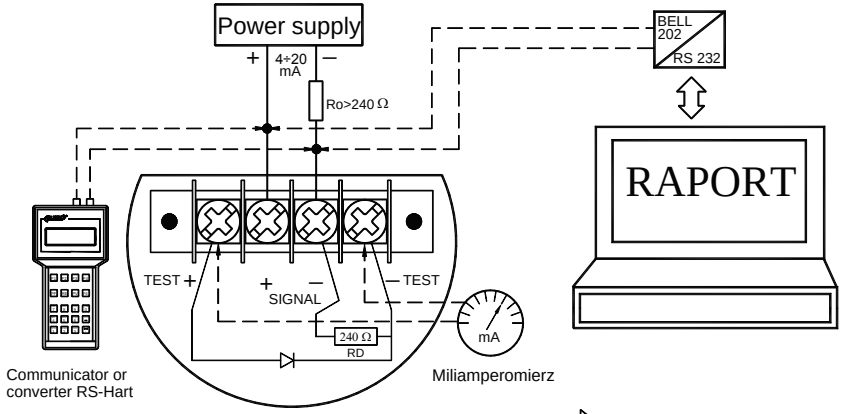


Fig. 10a

To measure the current in the transmitter without disconnecting the signalling circuit, connect a milliammeter to control terminals <Test -> and <Test +>. Permitted fall in voltage on the milliammeter: 200mV.

Connecting the communicator

1. When resistance seen from transmitter to the line is Ro > 240Ω, then we can communicate with the transmitter via connection to line <Signal +> and <Signal ->, see Fig 10a. (Ro = line resistance + load)
2. When < 240Ω communication shall not be established, and Ro is to be increased to min. 240Ω as in Fig.10a. Transmitter is fitted with additional communication resistor RD = 240Ω (Fig. 10b). (During normal operation terminals <Signal -> and <Test -> are to be together, not to introduce additional resistance from line circuits). RD resistor is used when we want to establish local communication with transmitter (from its terminals), when Ro < 240Ω. (Then terminals <Signal -> and <Test -> are to be apart).

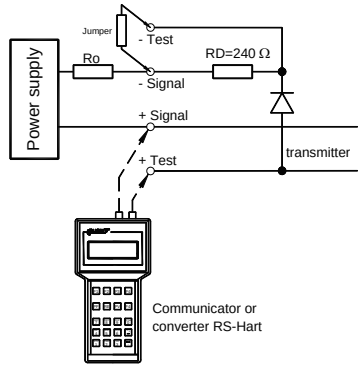


Fig. 10b

Fig. 10. Electrical system of transmitter connections with available variants for reception of analogue signal 4 – 20mA and Hart for purposes of configuration at the facility.

8.3. LOCAL LCD DISPLAY CONFIGURATION.

Indicator options can be modified in local MENU of transmitter, using buttons or communicator, or modem Hart/RS232 and PC software. The indicator can be deactivated, as necessary. Deactivation function is available via communicator or PC computer..

i Transmitter APC(R)-2000ALW (Ex) Safety can be configured only outside of functional safety loop. Transmitter operating in functional safety system is to feature output signal 4 – 20mA (20 – 4mA in inversion system) and preset modification blocked by software and by sealing. For method of sealing transmitter covers see Fig.12.

For local display of transmitter **APC(R)-2000ALW Safety** see Fig. 11.

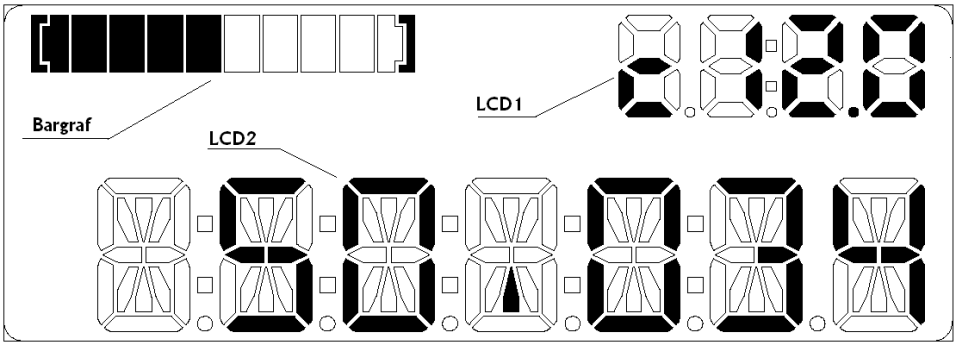


Fig. 11. LCD display screen of transmitter APC(R)-2000ALW (Ex) Safety.

3 basic fields are represented in the display screen:

- **Bargraph** - the field of current output control degree. With 0% output control the segments of bargraph rule are not blackened. The segments shall blacken with increase in control level. One segment is 10% control. With 100% control all bargraph rule segments are blackened..
- **LCD1** - the field, where current or percentage of preset range control is displayed. Depending on indicator configuration either the value of current in current line 4-20 mA, being actual process variable, or preset range control percentage can be displayed. When the current value is displayed, the value is preceded with symbol "**c**".
- **LCD2** – the field, where digital value of pressure measured by transmitter, pressure value rescaled to user units, variable process unit or user unit, MENU messages and other alerts and informations are displayed. In the case of displaying digital value of pressure and rescaled pressure, such value can be preceded by symbol "-". Position of decimal comma can be set either in local MENU or remotely. In case of display overfilling (displayed value exceeding **"99999"**, in the filed LCD2 **"COMMA"** message is displayed. In case of pressure value exceeding permissible limits **"UNDER"** or **"OVER"** message shall be displayed, depending on the direction of excess. Pressure unit or user unit can be displayed alternately to digital value indicated in the cycle (10s digital value, 1 s unit). As necessary displaying of unit can be deactivated in local MENU, using communicator or PC software. Transmitter allows rescaling of pressure values to user units. To rescale enter the value corresponding to beginning and end of preset range and select the name of unit, using communicator or PC software.
  After activation of user mode rescaled value shall be visible on indicator.

8.4. OVERVOLTAGE AND INTERFERENCE PROTECTIONS

Overvoltage and interference protections in transmitters is ensured by interference eliminators. Overvoltage protection between the conductors of measuring line (loop) is effected by means of TVS diodes installed in all interference eliminators of transmitters. Overvoltage protections between measurement line and earthing or housing, which are not protected by TVS diodes connected between loop conductors, is effected by means of surge arresters.
Intrinsically safe versions of transmitters are not fitted with surge arresters. To enhance the level of protection against interference and overvoltage also external protections can be used, such as **UZ-2** system by APLISENS, as well as shielded system wiring. With long measurement lines it is advantageous to use one protection near the transmitter (or inside the transmitter), and the other at inputs to appliances working with transmitter.
Transmitters without magnetos withstand insulation test voltage 500V AC or 750V DC in the case of transmitters with magnetos insulation test voltage is limited to the value of magneto ignition voltage and it exceeds 100V.

8.5. EARTHING

Transmitters are fitted with internal and external earthing terminals.

9. SETTING AND REGULATION

Transmitters **APC(R)-2000ALW (Ex) Safety** are factory calibrated for the range as specified in the order or for basic range. After of transmitter at the facility, transmitter "zero" can be displaced and require adjustment. It applies in particular to small measurement ranges of pressure and position of the transmitter at the facility different than during calibration, and also cases of filling impulse tubes with separating liquid and transmitters with remote diaphragm seals.

i Setting (adjustment) of transmitter zero signal can be effected using buttons, after unscrewing the cover of transmitter electronic assembly housing, see Fig.3, using communicator KAP03, or using PC computer, Raport 2 software and modem Hart/RS - Clauses 9.2.3, 9.2.4, 9.2.5.

9.1. BASIC RANGE AND PRESET RANGE. DEFINITIONS

9.1.1. The maximum pressure or differential pressure range which can be processed by the transmitter is called **basic range** (specification of basic ranges see Clause 4.2.1, 4.3.1). The width of basic scope is the difference between the upper and the lower limit of basic range. Transmitter memory holds the internal processing characteristics, including basic range. That is a reference characteristics for all settings that affect the output signal of the transmitter.

9.1.2. Transmitter user uses the expression **preset range** of pressure. Preset range is the range with current value 4mA assigned to the beginning and the value 20mA assigned to the end (with inversion characteristics respectively 20mA and 4mA). Preset range can coincide with basic range or only cover its fragment. The width of preset range is the difference between the end and the beginning of preset range. Transmitter can be preset to any range within pressure values corresponding to basic range, allowing for limitations as in Tables in Clause 4.2.1 and 4.3.1.

9.2. CONFIGURATION AND CALIBRATION

9.2.1. Transmitter properties permit adjustment and modification of presets, metrological parameters and identification parameters. Adjustable metrological parameters of transmitter include:

a) pressure units displayed with value of measured pressure
b) the end of preset range
c) the beginning of preset range
d) time constant
e) characteristics: linear or elemental

Information parameters which cannot be modified or parameters preset by manufacturer include

f) basic alert level: LO (low) or HI (high)
g the upper limit of basic range
h) the lower limit of basic range
i) minimum width of preset range

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. Transmitters can also be **calibrated**, by referring their indications to output pressure controlled by reference instrument.

9.2.4. Configuration and calibration of transmitter are effected using type KAP03 communicator by APLISENS, some HART communicators or PC computer with HART/RS232 converter and RAPORT 2 software by APLISENS. Configuration software RAPORT 2 is delivered with INTERVAL LINEARISATION software, which allows entering of 21 point non-linear utility characteristics to the transmitter. Functions of type KAP communicator are described in its Operating Manual, and data related to HART/RS232 converter are included in information sheet HART/RS232 CONVERTER.

9.2.5. Local configuration of transmitters (using buttons)

When the option of local configuration is active operator shall be able to modify settings using buttons below the display. Buttons can be accessed after undoing the side cover.
To enter modification of local presets mode press and hold any of the three buttons for ca. 4s. Absence of transmitter response to holding of button means that local configuration option is blocked. In such case setting override using communicator or computer is possible, preceded with making available, using the same tools, the option of local configuration (see → command HART 132,133)

Buttons are marked with symbols [↑] [↓] [◙]

Pressing and holding any of the three buttons for 4 seconds shall cause displaying of **EXIT** message**.**
Accepting of the message by pressing and holding for 1 s of [◙] button, shall cause existing the MENU of local modification of settings.
Otherwise we can move up and down the MENU tree, selecting and accepting desired parameters. In any case pressing and holding time of [↑] [↓] [◙] buttons is to be [no] longer than 1s.
Longer holding of [↑] [↓] button shall cause automatic moving up and down MENU tree with 1 s step.

Pressing of [↑] causes moving up the MENU tree
Pressing of [↓] causes moving down the MENU tree
Pressing of [◙] causes accepting and execution of selection

EXIT		(First announcement which will see after inclusion of Menu Local.
|		If you will confirm this option, you will go out from Local Menu
|		and you will come back to continue of measuring)
|		
PV ZERO_____		
|	****	
|	**←BACK**	(Return to Local Menu. If you will confirm this option,
|	**|**	you will come back to main tree of Local Menu)
|	**|**	
|	**PV ZERO**	(Pressure zeroing. If you will confirm this option,
|		transmitter will confirm the party of command
|		by the "DONE" announcement or the proper number of error will notify.)

SET LRV_____ (The Setting of the range of the set LRV beginning) -(no change of span))

\

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

BY PRESsure (Setting LRV across setting pressure. If you will confirm this option, transmitter will confirm the party of command by the "DONE" announcement or the proper number of error will notify)

BY VALUe (Setting the LRV across inscribing of value.)

\

(*After confirmation will display current LRV value before the passage in mode of edition)*

↓

↓

+/- (Choose and confirm sign introduced parameter)

↓

00000 (Introduce in sequence , digit after digit, 5 digital number with point or without point. After confirmation the last 5 digit of the parameter transmitter will confirm the party of command by the "DONE" announcement or the proper number of error will notify. The parameter will be written down in units "UNIT")

SET URV___ (The setting of the end of the set URV range)

\

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

BY PRESsure (Setting URV across setting pressure. If you will confirm this option, transmitter will confirm the party of command by the "DONE" announcement or the proper number of error will notify

BY VALUe (Setting the URV across inscribing of value)

\

(After confirmation will display current URV value before the passage in mode of edition)

↓

↓

+/- (Choose and confirm sign introduced parameter)

↓

00000 (Introduce in sequence, digit after digit, 5 digital number with point or without point. After confirmation the last 5 digit of the parameter transmitter will confirm the party of command by the "DONE" announcement or the proper number of error will notify. The parameter will be written down in units "UNIT")

UNIT_____

|	****	
|	**←BACK**	(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")
|	**IN_H2O**	
|	**IN_HG**	
|	**FT_H2O**	
|	**MM_H2O**	
|	**MM_HG**	
|	**PSI**	
|	**BAR**	
|	**MBAR**	
|	**G/SQCM**	
|	**KG/SQCM**	
|	**PA**	
|	**KPA**	
|	**TORR**	
|	**ATM**	
|	**M_H2O**	
|	**MPA**	
|	**INH20@4**	
|	**MMH2O@4**	

||DAMPING_		(Setting of the solid temporary suppression of the process variable)
|	****	
|	**←BACK**	(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")
|	**0 [S]**	
|	**2 [S]**	
|	**5 [S]**	
|	**10 [S]**	
|	**30 [S]**	
|	**60 [S]**	

TRANSFEr_ (Setting of the current output form)
| ****
| **←BACK** (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** ((Linear)
| **SQRT** (square root)
| **SPECIAL** (user's)
| **SQUARE** (square)
|

% SQRT___ (Square root characteristic cut-of point setting)
| ****
| **←BACK** (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 percent value across
| **|** longer press button ◙. After parameter confirmation
| **|** transmitter will confirm the party of command by the "DONE")
| **0,0 %**
| **0,2 %**
| **0,4 %**
| **0,6 %**
| **0,9 %**
| **1,0 %**

|
|

LCD1VARiable (Type of the process variable displayed on LCD1)
| ****
| **←BACK** (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")

| **CURRENT** (On LCD1 will displayed current value in current loop)
| **|**

| **PERCENT** (The percent value output signal will displayed on LCD1)
|

LCD2VARiable (Type of the process variable displayed on LCD2)
- ****
- **←BACK** (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")
- **PRESSURe** (The pressure value will displayed on LCD2)
- **USER** (The user's units will displayed on LCD2)
- **UNIT** (The current unit or user's unit alternately with process variable will displayed on LCD2)
- **NO UNIT** (The current unit or user's unit alternately with process variable will not displayed on LCD2)

LCD2 DP (The process variable point position on LCD2)
- ****
- **←BACK** (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")
- **XXXXX•**
- **XXXX•X**
- **XXX•XX**
- **XX•XXX**
- **•XXXXX**

FACTORY (Come back to factory setting)
- ****
- **←BACK** (Return to Local Menu. If you will confirm this option, you will come back to main tree of Local Menu)
- (Confirm the command as bellow across longer press button ◙. After parameter confirmation transmitter will confirm the party of command by the "DONE")
- **RECALL**

RESET____ (The program enforcement of the transmitter restart)

\
←**BACK** (Return to Local Menu. If you will confirm this option, you will come back to main tree of Local Menu)
|
|
| (Confirm the command as bellow across longer press
| button ◙. After parameter confirmation transmitter will
| confirm the party of command by the "DONE")
|
RESET

Local Menu, error reports.

During executing in Local Menu some functions, LCD2 announcement can be displayed on the screen. The error displaying evidences about no realization of command of Local Menu.
The shortened description of errors announcements is showed below.

ERR_L07 [in_write_protected_mode]. Error will ensue out when we try to change setting in Local Menu, but transmitter is protected before recording. To to make the change of setting with Local Menu using, transmitter has to have the included service of Local Menu as well as switched off protection before record. These parameters modification is possible by using KAP -03 communicator, "RAPORT" program or software using library EDDL.

- default setting:
  Local Menu service switched on
  protection before record switched off

ERR_L09 [applied_process_too_high]. Error will ensue out when given parameter (pressure) exceed admissible value. Zeroing or the range setting verifying is necessary.

ERR_L10 [applied_process_too_low]. Error will ensue out when given parameter (pressure) will too low. Zeroing or the range setting verifying is necessary.

ERR_L14 [span_too_small]. Error will ensue out when in result of setting range executing change the width of the range will be smaller than admissible.

ERR_L16 [acces_restricted]. Error will ensue out when the service of Local Menu is switched off, and the user tries to call out the Menu Local service. You should switch on the service of Local Menu with the KAP-03 communicator, "RAPORT" program, or software using library EDDL.
Warning!, ERR_L16 announcement can be displayed as well by zeroing attempt of the absolute transmitter .!

WNG_L14 [WARNING!, new Lower Range Value Pushed !] Error will ensue out when the end of range set (the URV) change will cause the change of the range set beginning (LRV).

9.2.6. Remote configuration

Remote configuration is possible with KAP-XX communicator or PC software. Measuring circuit should be in accordance with the fig. 10.

10. INSPECTIONS, MAINTENANCE, SPARE PARTS

10.1. PERIODIC INSPECTIONS

Periodic inspections are to be performed in accordance with standards mandatory to user.
During inspection the condition of pressure connectors (absence of clearances and leaks) and electrical connectors (integrity of connections and the condition of seal at the gland), and the condition of isolating membranes (bloom, corrosion) is to be checked. Processing characteristics is to be verified by performing operations typical for **CALIBRATION** procedure and, possibly, **CONFIGURATION** procedure.

10.2. UNSCHEDULED INSPECTIONS

When at the place of installation transmitter is exposed to risk of mechanical damage, pressure overload, hydraulic pulses, overvoltage, sediments and crystallization of medium, undercutting of membrane, or incorrect operation of transmitter is observed – inspections are to be performed, as necessary. Check the condition of the membrane, clean it, check protection diodes (absence of shorting), check processing characteristics.
In case of observing the absence or incorrect value of signal in transmission line, check the line, the condition of connections at terminal strips, connectors, etc. Check if values of power supply voltage and load resistance are correct. In case of connecting communicator to power supply line of transmitter, the symptom of line damage could be the message "No response" or "Check connections". When the line is working check the transmitter.

10.3. CLEANING THE DIAPHRAGM SEAL, OVERLOADING DAMAGE

10.3.1. 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.

10.3.2. Other causes of incorrect operation of transmitters are also damages to sensor membranes due to overloads, caused by, e.g.

- feeding excessive pressure,,
- freezing or solidification of medium,
- pushing or scraping of membrane with hard object, e.g. screwdriver.

Damage symptoms are usually absence of or incorrect response of transmitter to changes in pressure; stable value of output current, usually below 4mA, or above 20mA, rarely in the range 4 – 20mA.

10.4. SPARE PARTS

Parts of transmitter exposed to wear and tear or damage, subject to replacement: cover seal.

In case of versions ATEX, PED, SIL other parts can be replaced only by manufacturer or entity authorized by manufacturer.

11. PACKAGING, STORAGE, TRANSPORT

Transmitters are to be protected against damage during transport and packed in collective and/or unitary packages. The transmitters should be stored in multiple packs under cover, in a place free of vapours and reactive substances, with temperature and humidity not exceed the limits specified in p. 4.1.2
When storing transmitters with uncovered membrane or diaphragm seal connectors, without package, membranes are to be secured with guards protecting them against incidental damage.
Transmitters are to be transported in packages secured against displacement of transmitters in packages and displacement of packages in the means of transport. Transmitters can be transported on land, sea or in the air, provided that means of transport eliminate direct effect of weather conditions. Requirements concerning transport to PN-EN 13876:2005.

12. GUARANTEE

Manufacturer warrants under the conditions specified in the Product Certificate which is also a guarantee card.

13. SCRAPPING. UTILIZATION

Waste or damaged transmitters should be dismantled and disposed of in accordance with Directive (2012/19/EC) on waste electrical and electronic equipment (WEEE) or returned to the manufacturer.

14. ADDITIONAL INFORMATION

Some applications of pressure transmitters require blocking and sealing of covers to prevent tampering with settings and adjustments. For method of sealing transmitter series **APC(R)-2000ALW (Ex) Safety** see Fig. 12.

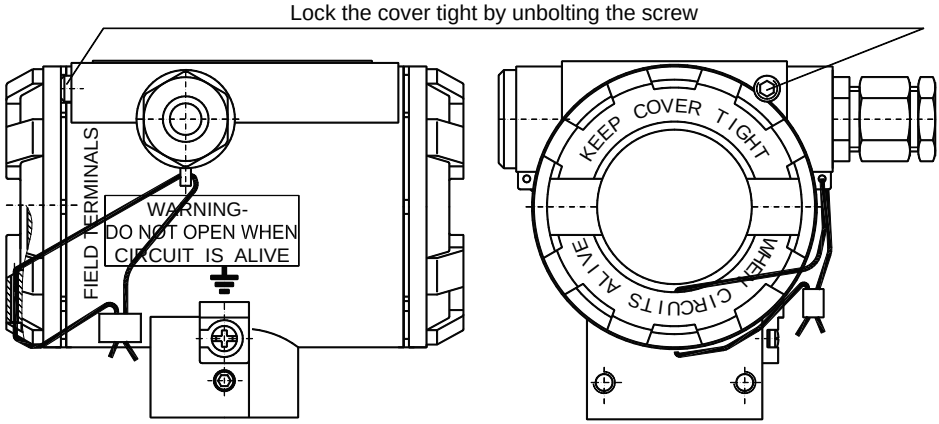


Fig.12. Method of sealing the housings of transmitter series APC(R)-2000ALW (Ex) Safety

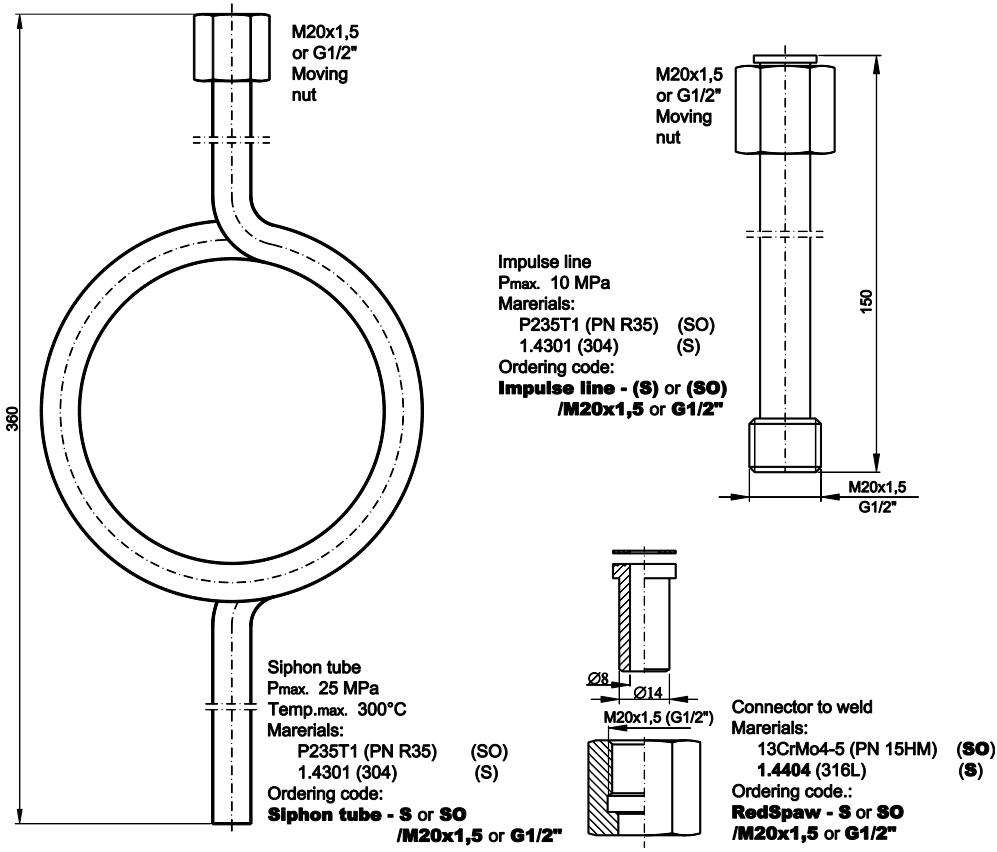


Fig.13. Additional equipment for fitting of pressure transmitters

Prepared; J.Wąsowski

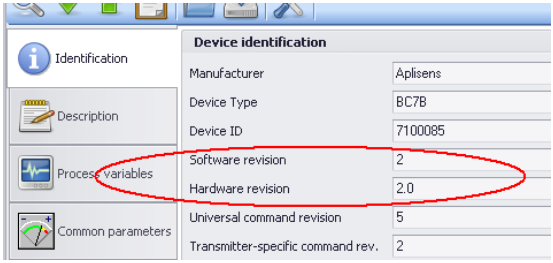
15. INFORMATION RELATED TO FUNCTIONAL SAFETY

Note!
Estimating the functional safety applies only to:

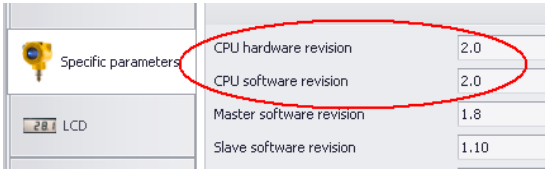
- base device with main electronic components
- pressure sensor with the membrane and electronic equipment;
- process connection mounted directly.

Additional process equipment such as the separator adapters, separators, valves etc. are not included in the calculations.

Note!
The following estimation of functional safety applies only to hardware version 2.0 (MPC5-SIS-rev2 main board) and software version 2.0 (MPC5-SIS-rev2.hex).
The hardware and software version may be found using the RAPORT 2 software in the "Identification" tab.



Or in the "Transmitter parameters > Version Information" tab.



15.1 Description of safety requirements and boundary conditions, signals related to safety and safety functions

For APC(R)-2000ALW (Ex) Safety transmitters the signal related to safety is the analogue 4-20mA output signal. All safety functions are related to just this output. The APC(R)-2000ALW (Ex) Safety transmitters have the capability to communicate using the HART protocol to provide configuration and diagnostic readouts, however the **HART communication may not be used** in case of operation in a safety loop.

The APC(R)-2000ALW (Ex) Safety transmitters generate an process variable analogue signal in the range ≥ 3.8-3.9 mA – ≤ 20.5 mA). Depending on the settings this signal may be proportional or inversely proportional to the measured pressure or pressure difference. This current is detected by the logic controller connected to the current loop, which monitors whether the supplied signal is:

- within the pressure or differential pressure measurement range between the lower range value (LRV) and the upper range value (URV)
  Range (≥ 4.0 mA – ≤ 20.0 mA) with simple characteristics (4-20 mA)
  Range (≤ 20.0 mA – ≥ 4.0 mA) with inverse characteristics (20-4 mA)

- within the pressure or differential pressure measurement range below the lower range value (LRV)
  Range (≥3.9 mA – ≤ 4.0 mA) for Normal mode with simple characteristics (4-20 mA)
  Range (≥3.8 mA – ≤ 4.0 mA) for Namur mode with simple characteristics (4-20 mA)
  or
  Range (≥ 20.0 mA - ≤ 20.5 mA) for Normal mode with inverse characteristics (20-4 mA)
  Range (≥ 20.0 mA - ≤ 20.5 mA) for Namur mode with inverse characteristics (20-4 mA)

- within the pressure or differential pressure measurement range above the upper range value (URV).
  Range (≥ 20.0 mA - ≤ 20.5 mA) for Normal mode with simple characteristics (4-20 mA)
  Range (≥ 20.0 mA - ≤ 20.5 mA) for Namur mode with simple characteristics (4-20 mA)
  or
  Range (≥3.9 mA – ≤ 4.0 mA) for Normal mode with inverse characteristics (20-4 mA)
  Range (≥3.8 mA – ≤ 4.0 mA) for Namur mode with inverse characteristics (20-4 mA)
  or
  Range (≤ 3.7 mA) for type "L" alarm signal
  Range (≥ 21.5 mA) for type "H" alarm signal

During the operation of the transmitter in the functional safety loop errors may occur which are caused by external factors or internal factors related to the measurement device. The group of external factors include pressure overload, electric surge, voltage dips or losses, strong, overnormative radioelectric interference etc.
The internal factors include all types failures to the transmitter caused by wear of components or defects of installation.

These faults may be divided into the following categories:

Safe diagnosable failures	SD
Safe undiagnosable failures	SU
Dangerous diagnosable failures	DD
Dangerous undiagnosable failures	DU

The design of the transmitter allows for the detection of numerous DD type failures.

- SU type failure do not have a direct impact on the measurement process and do not affect the safety functions.

- SD type failure do not have a direct impact on the measurement process and do not affect the safety functions, however they may be detected by the device and signalled.

- DD type failure may have a direct impact on the measurement process, however they are detected by the internal control systems, which signal the fault status using the alarm signal.

- DU type failure are not detected by the internal control systems, therefore they have a direct impact on the measurement process and affect the safety functions.

The probability of the above mentioned faults is described using the FMEDA method (in accordance with the IEC61508:2010 standard) applied during the design analysis process. The results describing the probable frequency of the failures will be presented further in the table.

DD type failures and their respective alarm signals:
Alarm signals signalised by ≤ 3.7 mA current are designated as "LO".
Alarm signals signalised by ≥ 21.5 mA current are designated as "HI".

The APC(R)-2000ALW Safety transmitters are equipped with a dual alarm system. The first of those is called the "primary" signal and it operates with HI or LO alarms (type HI or LO depends on the configuration selected by the user). The configuration of alarms may be set using the Raport 2 software developed by APLISENS or other software using the DDL/DTM libraries provided by APLISENS.

The second of the alarm systems, called the "reserve" operates only with "LO" type signals. If the operation of the primary alarm system is diagnosed as faulty, if the program loop is interrupted by the processor or if a erroneous mathematical operation is performed, the "reserve" alarm system takes over the signalling of critical faults. In that case the electrical system is completely disconnected from the power supply, therefore the ≤ 3.7 mA alarm signal is used.

Alarms of the "primary" alarm system may be deactivated after their cause subsides (e.g. return to the conditions before the pressure overload, subsiding the overnormative radioelectric interference).

Alarms of the reserve alarm system and the disconnection of the transmitter from the power line are a static condition. In order to restore the operation of the transmitter after a critical alarm the power must be disconnected and connected again.

Apart from the alarm signal denoting DD failures diagnosed by the electronic system and processor software there are also dangerous diagnosable failures:
- which may occur in the connection in series of components which participate in conducting electric current in the 4-20 mA current loop. In such cases this is related to damage of a component or connection of "open" components, which results in the transmitter not receiving power from the current line and the current flow is ≤ 3.7 mA.
- which may occur in output circuits of the transmitter (filters, overvoltage protection units) as parallel damage of the "short-circuit" type and as a result the transmitter will receive shunted power supply without operating and at the same time will receive ≥ 21.5 mA.

The table below presents the exact causes of diagnosable dangerous alarms and their membership in the "HI" or "LO" group.

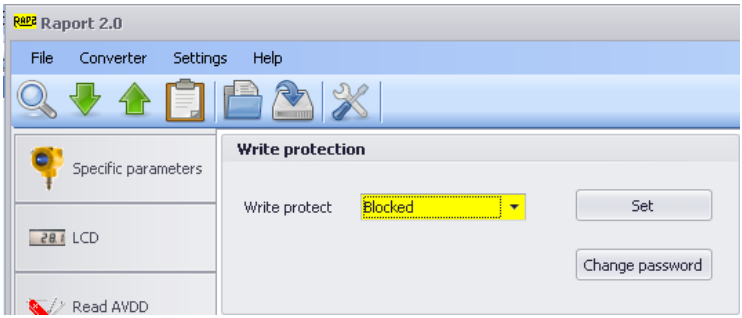
Type of detected fault	Probable cause	Signal type	Comments
RAM error	Processor damage	LO or HI	Alarm signal selection option
FLASH memory program checksum error	Uncontrolled overwriting of the of the program memory, FLASH memory damage, processor damage	LO or HI	Alarm signal selection option
Checksum error in EEPROM memory blocks	Uncontrolled overwriting of the of the memory coefficients, FLASH memory damage, processor damage	LO or HI	Alarm signal selection option
Error of the local quartz resonator	Resonator damage, processor oscillator damage, damage of component connection	LO or HI	Alarm signal selection option
Error of local communication loop with the Master processor of the optical barrier	Damage of components or component connections, overnormative radioelectric interference	LO or HI	Alarm signal selection option
Error of remote communication loop with the Slave processor of the optical barrier	Damage of components or component connections, overnormative radioelectric interference	LO or HI	Alarm signal selection option
Communication error of packages through the optical barrier	Damage of components or component connections, overnormative radioelectric interference	LO or HI	Alarm signal selection option
Error of the ADC transmitter in the pressure measurement channel	Damage of components or component connections, overnormative radioelectric interference Pressure overload Pressure sensor structure damage	LO or HI	Alarm signal selection option
Error of the ADC transmitter in the sensor structure temperature measurement channel	Damage of components or component connections, overnormative radioelectric interference Pressure sensor structure damage	LO or HI	Alarm signal selection option
Allowed temperature limit exceeding error	Exceeding the threshold values of ambient temperature of transmitter, damage of the element or element connections	LO or HI	Alarm signal selection option
Error of mathematical calculations in the pressure measurement channel	Error of the processor's arithmometer, threshold condition during mathematical calculations, division by 0	**LO**	Critical alarm, Always LO
Error of mathematical calculations in the sensor structure temperature measurement channel	Error of the processor's arithmometer, threshold condition during mathematical calculations, division by 0	**LO**	Critical alarm, Always LO
Current loop error – difference between the assigned value and the readout exceeds 1% of the current range (160μA)	Damage of components or component connections, overnormative radioelectric interference, incorrect power supply parameters	**LO**	Critical alarm, Always LO

15.2 Restrictions on using the APC(APR)-2000ALW Safety transmitters in functional safety systems:

- The transmitter is configured for operation in a functional safety loop after the required settings related to its identification, metrology and alarm modes are made must have the following locks set:

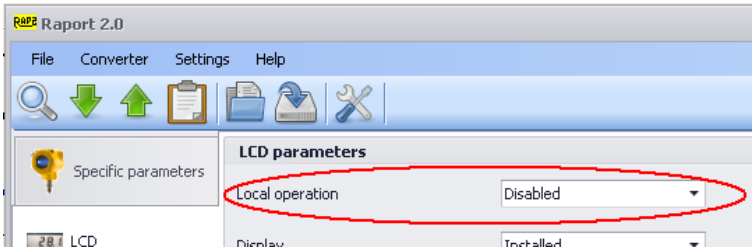
  - protection against writing data to the transmitter via the HART protocol, using a communicator or an appropriate program e.g. Raport 2

  (example screenshot from the Raport 2 software)



  - protection against making local changes in the settings using the Local Menu in the transmitter (control buttons) made using the communicator or an appropriate program e.g. Raport 2

  (example screenshot from the Raport 2 software)



- Before start-up it is required to perform full tests of functions related to safety as specified in the manual:
  „SIL SAFETY MANUAL - "Safety function tests for APC(APR)-2000 Safety transmitters - rev. 2.0.2";
- The maximum period between consecutive safety function tests – "Proof test interval" – is 1 year;
- Any faulty equipment must be replaced immediately after the fault is detected;
- The probability of failure specified in this manual is based on the Mean Time To Repair (MTTR) equal to 72 hours.

15.3 Hardware safety integrity: architectural constraints on type B safety-related subsystems (IEC 61508-2, 7.4.4.2.2).

Safe failure fraction	**Type B hardware fault tolerance** (Toleration of equipment failures N in type B subsystems)		
SFF	**HFT=0**	**HFT=1**	**HFT=2**
< 60 %	Not allowed	SIL1	SIL2
60 % ... < 90 %	SIL1	SIL2	SIL3
90 % … <99 %	SIL2	SIL3	SIL4
≥ 99 %	SIL3	SIL4	SIL4
A hardware fault tolerance of N means that N+1 faults could causa a loss of the safety function.			

15.4 Hardware safety integrity: architectural constraints on type B safety-related subsystems (IEC 61508-2, 7.4.4.2.2).

Safety integrity level (SIL)	Average probability of a dangerous failure on demand PFDavg of the safety function **(LDM)**	Average probability of a dangerous failure for a safety functionoperating in high demand mode of operation or continuous mode of operation **(HDM)**
4	$[10^{-5}, 10^{-4})$	$[10^{-9}, 10^{-8})$
3	$[10^{-4}, 10^{-3})$	$[10^{-8}, 10^{-7})$
2	$[10^{-3}, 10^{-2})$	$[10^{-7}, 10^{-6})$
1	$[10^{-2}, 10^{-1})$	$[10^{-6}, 10^{-5})$

15.5 "Proven in use" method for pressure and differential pressure transmitters.

Pressure and differential pressure transmitters manufactured in the period from 06.2009 to 31.08.2013 were selected. Operating time of transmitters was counted since 01.2010 (date of SIL certification for products APC(R)-2000ALW Safety) up to 31.08.2014. All transmitters were custom-made. Operating time of transmitters to suspend (S) or failure (F) was counted since next month after manufacture. It should be assumed with great probability that the majority of defective products was sent by the customer to the service centre since all tested transmitters are covered by 5-year warranty of their manufacturer. In accordance with the IEC 61508 standard, the reliability parameters have been specified at 70% of one-sided lower confidence limit.

The purpose of this analysis was to determine the following parameters:

- MTTF,
- B10 Life,
- Reliability,
- Expected Failure,
- B2 Life,
- Probability of Failure,
- Failure Rate

The reliability parameters were calculated using ReliaSoft software: Weibull++9.

Results of the "Proven in use" analysis for APC-2000ALW Safety.

Number of transmitters working until freezing: 94 pcs
Number of working hours until freezing: 2 007 500
Number of working hours to failure: 24 090
Number of failing transmitters: 1 pc

Analysis Summary		
	Calculated	Rounded
MTTF Lower Bound (0,3)	2,031590E+06 Hr; 231,916667 Yr 832868,023521 Hr; 95,076258 Yr	2,03E+06 Hr; 231,92 Yr 832868,02 Hr; 95,08 Yr
B10 Life Lower Bound (0,3)	214049,370005 Hr; 24,434860 Yr 87751,404433 Hr; 10,017284 Yr	214049,37 Hr; 24,43 Yr 87751,40 Hr; 10,02 Yr
Reliability R (43800 Hr) Lower Bound (0,3)	97,8671 % 94,8770%	97,9% 94,9 %
Expected Failure T=43800 Hr	2,026255	2
B2 Life Reliable Life Lower Bound (0,3)	41043,618159 Hr; 4,685345 Yr 16826,188913 Hr; 1,920798 Yr	41043,62 Hr; 4,69 Yr 16826,19 Hr; 1,92 Yr
Probability of Failure t=43800 Hr	2,1329 %	2,1 %
Failure Rate Lower Bound (0,3)	4,9223E-07/Hr 7,973E-07/Hr	4,92E-07/Hr 7,97E-07/Hr

Results of the "Proven in use" analysis for APR-2000ALW Safety.
Number of transmitters working until suspension: 145 pcs
Number of working hours until freezing: 3 008 330
Number of working hours to failure: 61 320
Number of failing transmitters: 6 pcs

Analysis Summary		
	Calculated	Rounded
MTTF Lower Bound (0,3)	635578,003308 Hr; 72,554567 Yr 347352,328966 Hr; 39,652092 Yr	635578 Hr; 72,55Yr 347352,33Hr; 39,65 Yr
B10 Life Lower Bound (0,3)	56827,046790 Hr; 6,487106 Yr 43933,577252 Hr; 5,015249 Yr	56827,05 Hr; 6,49 Yr 43933,58 Hr; 5,02 Yr
Reliability R(43800 Hr) Lower Bound (0,3)	92,0874 % 90,0302 %	92,1 % 90,0 %
Expected Failure T=43800	11,948026	12
B2 Life Reliable Life Lower Bound (0,3)	9852,752310 Hr; 1,124743 Yr 7253,985624 Hr; 0,828081 Yr	9852,75 Hr; 1,12 Yr 7253,99 Hr; 0,83 Yr
Probability of Failure t=43800	7,9126 %	7,9 %

Results of the "Proven in use" analysis for APR-2000ALW Ex Safety.
Number of transmitters working until suspension: 31 pcs
Number of working hours until freezing: 446 760
Number of working hours to failure: 1 460
Number of failing transmitters: 1 pc

Analysis Summary		
	Calculated	Rounded
MTTF Lower Bound (0,3)	439460 Hr; 50,166667 Yr 271304,803419 Hr; 30,970868 Yr	439460 Hr; 50,17 Yr 271304,80 Hr; 30,97 Yr
B10 Life Lower Bound (0,3)	46301,732211 Hr; 5,285586 Yr 28584,813989 Hr; 3,263107 Yr	46301,73 Hr; 5,29 Yr 28584,81 Hr; 3,26 Yr
Reliability R(43800 Hr) Lower Bound (0,3)	90,5138 % 85,0916 %	90,5 % 85,1 %
Expected Failure T=43800	3,035584	3
B2 Life Reliable Life Lower Bound (0,3)	8878,281758 Hr; 1,013502 Yr 5481,091537 Hr; 0625695 Yr	8878,28 Hr; 1,01 Yr 5481,09 Hr; 0,63 Yr
Probability of Failure t=43800	9,4862 %	9,5 %
Failure Rate Lower Bound (0,3)	2,276E-06/Hr 3,686E-06/Hr	2,28E-06/Hr 3,69E-06/Hr

Results of the "Proven in use" analysis for APC-2000ALW Ex Safety.
Number of transmitters working until suspension: 29 pcs
Number of working hours until freezing: 386 170
Number of working hours to failure: 0
Number of failing transmitters: 0 pc

In selected time period, no failures of APC-2000ALW Ex SAFETY transmitters were detected. The mechanical design and the electronics of analysed transmitters are identical with differential pressure transmitters type APC-2000ALW SAFETY. After performing the analysis, it was found that with high probability the results for APC-2000ALW Ex SAFETY transmitters are comparable with the results for differential pressure transmitters type APC-2000ALW SAFETY.

15.6 The FMEDA method (Failure Modes effects and Diagnostic Analysis).

The calculations of reliability parameters were made on the basis of electronic components used in the tested transmitters. The reliability of elements was determined using the MIL-HDBK-217F standard taking into consideration the operating conditions of each component. For all electronic components the mean ambient temperature of 55°C was assumed.
"Failure rate" for semiconductor components was given for the 60% confidence level.

The purpose of this analysis was to determine the following parameters:
- λ – total Failure rate (per hour) of a channel in a subsystem,
- λSD - detected safe failure rate (per hour) of a channel in a subsystem,
- λSU – undetected safe failure rate (per hour) of a channel in a subsystem,
- λDD - detected dangerous failure rate (per hour) of a channel in a subsystem,
- λDU - undetected dangerous failure rate (per hour) of a channel in a subsystem,
- DC - diagnostic coverage,
- SFF - safe failure factor,
- MTBF - mean time between failures.

Until the full calculations of the reliability parameters the "Proven in use" method has been selected to estimate the measurement sensors failures intensity coefficient.

Pressure and differential pressure transmitters manufactured in the period from 03.2012 to 31.08.2013 were selected for the analysis. The operating times of the transmitters were counted between 03.2012 and 30.09.2014. All transmitters were custom-made. Operating time of transmitters until suspension or failure was counted starting in the month following the manufacture. It should be assumed with great probability that the majority of defective products was sent by the customer to the service centre since all tested transmitters are covered by 5-year warranty of their manufacturer. In accordance with the IEC 61508 standard, the reliability parameters have been specified at 70% of one-sided lower confidence limit.
The purpose of the "Proven in use" analysis was establishing the λDU undetected dangerous failure rate coefficients.

Reliability parameter values calculated using the FMEDA method for the APC(R)-2000ALW Safety transmitter, “N” version:

λSD	0
λSU	$1{,}487248032\times10^{-6}$ 1/h
λDD	$1{,}698482536\times10^{-6}$ 1/h
λDU	$0{,}093924697\times10^{-6}$ 1/h
λtotal	$3{,}279655265\times10^{-6}$ 1/h
DC	94,75985731 %
SFF	97,13614118 %
MTTF	304910 h
MTTR	72 h
MTBF	304982 h

Reliability parameter values calculated using the FMEDA method for the APC(R)-2000ALW Safety transmitter, “Ex” version:

λSD	0
λSU	$1{,}553211672\times10^{-6}$ 1/h
λDD	$1{,}734435474\times10^{-6}$ 1/h
λDU	$0{,}0960715\times10^{-6}$ 1/h
λtotal	$3{,}383718647\times10^{-6}$ 1/h
DC	94,75164521 %
SFF	97,16077161 %
MTTF	295533 h
MTTR	72 h
MTBF	295605 h

Summary analysis.

Type of Transmitter ↓	λ	λSD	λSU	λDD	λDU	SFF	DC	MTBF
APC-2000ALW	$3{,}279\times10^{-6}$ 1/h 3279 FIT	0 FIT	$1{,}487\times10^{-6}$ 1/h 1487 FIT	$1{,}698\times10^{-6}$ 1/h 1698 FIT	$0{,}939\times10^{-7}$ 1/h 94 FIT	97,14 %	94,76 %	$3{,}050\times10^{5}$ h
APR-2000ALW	$3{,}279\times10^{-6}$ 1/h 3279 FIT	0 FIT	$1{,}487\times10^{-6}$ 1/h 1487 FIT	$1{,}698\times10^{-6}$ 1/h 1698 FIT	$0{,}941\times10^{-7}$ 1/h 94 FIT	97,13 %	94,75 %	$3{,}050\times10^{5}$ h
APC-2000ALW Ex	$3{,}383\times10^{-6}$ 1/h 3383 FIT	0 FIT	$1{,}553\times10^{-6}$ 1/h 1553 FIT	$1{,}734\times10^{-6}$ 1/h 1734 FIT	$0{,}961\times10^{-7}$ 1/h 96 FIT	97,16 %	94,75 %	$2{,}956\times10^{5}$ h
APR-2000ALW Ex	$3{,}383\times10^{-6}$ 1/h 3383 FIT	0 FIT	$1{,}553\times10^{-6}$ 1/h 1553 FIT	$1{,}734\times10^{-6}$ 1/h 1734 FIT	$0{,}962\times10^{-7}$ 1/h 96 FIT	97,16 %	94,74 %	$2{,}956\times10^{5}$ h

Periods between periodical tests for different products (according to IEC 61508-6, p. B.3.):

APC-2000ALW	T[Proof] = 1 year	T[Proof] = 2 years	T[Proof] = 5 years	T[Proof] = 10 years
	$PFD_G = 5{,}35\times10^{-4}$	$PFD_G = 9{,}46\times10^{-4}$	$PFD_G = 2{,}18\times10^{-3}$	$PFD_G = 4{,}24\times10^{-3}$
APR-2000ALW	T[Proof] = 1 year	T[Proof] = 2 years	T[Proof] = 5 years	T[Proof] = 10 years
	$PFD_G = 5{,}35\times10^{-4}$	$PFD_G = 9{,}46\times10^{-4}$	$PFD_G = 2{,}18\times10^{-3}$	$PFD_G = 4{,}24\times10^{-3}$
APC-2000ALW Ex	T[Proof] = 1 year	T[Proof] = 2 years	T[Proof] = 5 years	T[Proof] = 10 years
	$PFD_G = 5{,}46\times10^{-4}$	$PFD_G = 9{,}67\times10^{-4}$	$PFD_G = 2{,}23\times10^{-3}$	$PFD_G = 4{,}33\times10^{-3}$
APR-2000ALW Ex	T[Proof] = 1 year	T[Proof] = 2 years	T[Proof] = 5 years	T[Proof] = 10 years
	$PFD_G = 5{,}46\times10^{-4}$	$PFD_G = 9{,}67\times10^{-4}$	$PFD_G = 2{,}23\times10^{-3}$	$PFD_G = 4{,}33\times10^{-3}$

SIL	**SIL2**
HFT	**0**
Instrument type	**B**
Architecture	**1oo1 D**

The APC(R)-2000ALW Safety and APC(R)-2000ALW Ex Safety pressure transmitters meet the requirements of safety integrity level SIL2 with the hardware failure tolerance HFT=0, by implementing the 1oo1 architecture with diverse software diagnostics in one channel in continuous operation mode in the type B subsystem.
For the above mentioned products manufacturer recommends periodic testing interval = 1 Year.
The document [19] SIL SAFETY MANUAL describes “Perfect Proof Test” for the APC(APR)-2000ALW Safety transmitters. This test has ability to detect 100% of the possible Dangerous Undetected failures.

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