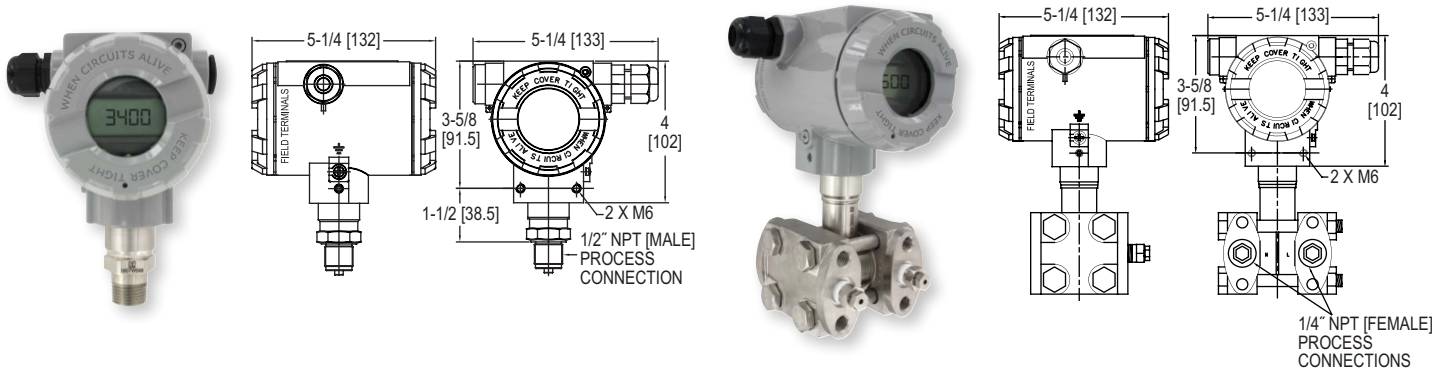




Series 3400 and 3500 Smart Pressure Transmitters

Specifications - Installation and Operating Instructions



The **Series 3400 and 3500 Smart Pressure Transmitters** are microprocessor-based high performance transmitters, which have flexible pressure calibration, push button configuration, and are programmable using HART® Communication. The Series 3400 and 3500 are capable of being configured with three push buttons located inside the front cover of the units (a field calibrator is not required for configuration.) The transmitter software compensates for thermal effects, improving performance. EEPROM stores configuration settings and stores sensor correction coefficients in the event of shutdowns or power loss. The 3400 and 3500 can be configured to be ATEX/IECEx approved for use in hazardous (Classified) locations. The rangeability allows the smart transmitter to be configured to fit most applications.

FEATURES/BENEFITS

- High accuracy ($\pm 0.075\%$ FS)
- 3400 Rangeability (up to 100:1)
- 3500 Rangeability (up to 25:1)
- Completely configurable using push buttons (no calibrator required)
- Fail-mode process function
- Automatic ambient temperature compensation

APPLICATIONS

- Water and wastewater
- Chemical and petrochemical
- Pulp and paper
- Oil and gas
- Food and beverage
- Filter or pump differential pressure
- Critical process monitoring

SPECIFICATIONS





3400 SPECIFICATIONS

Service: Compatible gases, steam, liquids, or vapors.
Wetted Materials: 316L SS.
Accuracy: $\pm 0.075\%$ FS (@20°C).
Rangeability: Up to 100:1 turn down.
Stability: $\leq 0.075\%$ FSO/3 years.
Temperature Limits: Ambient: -40 to 185°F (-40 to 85°C); Process w/ -DS: -40 to 400°F (-40 to 204.4°C).
Thermal Effect: $< \pm 0.05\%$ span/10°C.
Power Requirements: 10-55 VDC.
Output Signal: 4-20 mA.
Response Time: 16 to 480 ms (programmable).
Dampening Time: 0 to 60 s.
Electrical Connections: Packing gland M20x1.5, two 1/2" female NPT conduit, screw terminal.
Process Connection: 1/2" female or male NPT.
Enclosure Rating: NEMA 4X IP66/IP67.
Agency Approvals: CE; -IS, -FP suffix: ATEX Compliant **CE** 2813 **II** 2G Ex ia/db IIC T6/T5 Gb Ta<80°C, T5 / II 2D Ex ia/tb IIIC T85°C/T100°C Db. Type Certificate No. KDB 17ATEX0056X. ATEX Standards: EN 60079-0:2012+A11:2013, EN 60079-1:2014, EN 60079-11:2012, EN 60079-26:2015, EN 60079-31:2014 IECEx Compliant: Ex ia/db IIC T6/T5 Gb / Ex ia/tb IIIC T85°C/T100°C Db. Certificate of Conformity IECEx KDB 17.0008X. IECEx Standards: IEC 60079-0:2011, IEC 60079-1:2014-06, IEC 60079-11:2011, IEC 60079-26:2006, IEC 60079-31:2013.

3500 SPECIFICATIONS

Service: Compatible gases, steam, liquids, or vapors.
Wetted Materials: 316L SS and FPM; with Diaphragm Seal: 316L SS.
Accuracy: $\pm 0.075\%$ FS (@20°C).
Rangeability: Up to 25:1 turn down.
Stability: $\leq 0.075\%$ FSO/3 years.
Temperature Limits: Ambient: -40 to 185°F (-40 to 85°C); Process w/ -DS: -40 to 400°F (-40 to 204.4°C).
Thermal Effect: $< \pm 0.05\%$ span/10°C.
Power Requirements: 10-55 VDC.
Output Signal: 4-20 mA.
Response Time: 16 to 480 ms (programmable).
Dampening Time: 0 to 60 s.
Electrical Connections: Packing gland M20x1.5, two 1/2" female NPT conduit, screw terminal.
Process Connection: 1/4" female NPT.
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Explanation of Symbols:

Symbol	Description
	Warning to proceed strictly in accordance with the information contained in the documentation in order to ensure the safety and full functionality of the device.
	Information particularly useful during installation and operation of the device.
	Information particularly useful during installation and operation of an Ex 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 suitably functional condition, or use of the device other than for its intended purpose.
- Installation should be carried out by qualified personnel having the necessary authorization 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 risk to personnel 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 personnel, the device is not to be installed or used in particularly hostile conditions, where the following risks occur:



- possibility of mechanical impacts, excessive shocks and vibration;
- excessive temperature fluctuation;
- condensation of water vapor, dust, icing.




Installation of intrinsically safe 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 <http://www.dwyer-inst.com/>

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FEATURES, INSTALLATION AND MAINTENANCE OF TRANSMITTERS

1. INTRODUCTION

- 1.1. This manual is intended for users of Series 3400 smart pressure transmitters, and Series 3500 smart differential pressure transmitters. It contains the data and guidelines necessary to understand the operation of the transmitters. It includes essential recommendations regarding installation and use, as well as emergency procedures. The parameters and information specified for transmitters identified here as Series 3400 and 3500 also apply to their explosion-proof versions, as well as all variations differing by the type of the process terminals. Information on the transmitter sizes and the method of installation apply to all versions of transmitters.
- 1.2. Technical data for the diaphragm seals and for the 3400 and 3500 transmitters are contained in Appendix III.
- 1.3. The transmitters comply with the requirements of EU directives as shown on the plate and with the relevant Declaration of Conformity.
- 1.4. Additional data for Series 3400 and 3500 transmitters in intrinsic-safety Exi versions in accordance with ATEX directive is contained in Appendix II and in flame-proof Exd versions in Appendix I.
 During installation and use of the transmitters in Exi or Exd version in accordance with ATEX directive, reference should be made to Appendix II or Appendix I respectively.
- 1.5. Additional data for Series 3400 and 3500 transmitters in intrinsic-safety Exi versions in accordance with IECEx certificate is contained in Appendix II and in flame-proof Exd versions in Appendix I.
During installation and use of the transmitters in Exi or Exd version in accordance with IECEx certificate, reference should be made to Appendix I or Appendix II.
- 2.0. The transmitters in all versions comply the requirements of the RoHS Directive in accordance with EN 50581: 2012.

2. USER MATERIALS

Transmitters are delivered in single and/or multiple packs. Together with the transmitter are delivered:

- a) Product certificate
- b) User's Manual numbered: P-3400-3500

Items are available on <http://www.dwyer-inst.com/>

3. APPLICATIONS AND MAIN FEATURES

- 3.1. The Series 3400 smart pressure transmitters are designed to measure gauge pressure, vacuum pressure and absolute pressure of gases, vapors and liquids (including corrosive substances).
The Series 3500 differential pressure transmitters are used to measure liquid levels in closed tanks with static pressure up to 25MPa, and differential pressure across constrictions such as filters and orifices.
- 3.2. The transmitters may be fitted with a variety of process connectors, which enables them to be used in a variety of conditions such as thick or highly reactive media, high and low temperatures, etc.
- 3.3. 3400 and 3500 transmitters generate a 4-20 mA output signal and a digital HART signal in a two-wire system (current loop). The use of smart electronics enables regulation of the zero point, the measurement range, damping, radical conversion characteristic and other functions using an KAP communicator or from a PC using a HART/RS232 or HART/USB/ Converter and "Raport 2" configuration software.

4. IDENTIFYING MARKS. ORDERING PROCEDURE

- 4.1. Every transmitter carries a rating plate containing at least the following information: CE mark, manufacturer name, transmitter type, serial number, pressure range, static pressure limit, output signal, power supply voltage. Version types and the method of specifying the desired product are described on the catalog page.

- 4.2. 3400 and 3500 transmitters in Exi version or Exd version have additional markings as described in Appendix II or Appendix I.
- 4.3. The transmitters in all versions comply the requirements of the RoHS Directive in accordance with EN 50581.

5. TECHNICAL DATA

- 5.1. 3400 and 3500 common parameters
 - 5.1.1. 3400 and 3500 electrical parameters

Versions of the transmitter	Minimum supply voltage at transmitter terminals U _{min} [V] DC	Maximum supply voltage at transmitter terminals U _{max} [V] DC	Notes
Normal	10**	55V DC	
Intrinsically safe (Exi)	10.5**	30V DC	see Appendix I
Explosion proof (Exd)	13.5*	45V DC	See Appendix II

*Setting the indicator backlight increases the minimum supply voltage by 3V.
**Minimum supply voltage with backlight on (backlight cannot be turned off).

Output signal 4-20 mA + HART rev.5.1
Communication with the transmitter to check its configuration parameters is carried out via HART transmission protocol and signal of 4-20 mA. For this purpose: KAP-03, KAP-03Ex communicator, HART/RS232 converter or HART/USB Converter or another converter, PC computer and Raport 2 program can be used.

Resistance of power supply cables or resistors for communication, and output resistance of the power supply can lead to voltage drops on the way from the power supply to transmitter terminals. Therefore, the maximum resistance permitted to be included in a series circuit with the power supply should be calculated (R_{max} load resistance). The total resistance in the Ro current loop must be lower than this value to ensure the minimum voltage on the terminals of the converter throughout the current loop operating range (up to 22.5 mA with regard to HART alarms and communication).

The resistance necessary for communication (HART) min 240 Ω
The maximum values of R_{max} permissible load resistance for the supply voltage of the power supply (U_{sup}[V] DC) should be calculated based on the following formula:

$$R_{max}[\Omega] = \frac{U_{sup}[V] - U_{min}[V]}{0.0225[A]}$$

When the Ro total load resistance in the current loop is given, the minimum supply voltage (U_{sup} [V] DC) required for the use of the power supply can be calculated likewise.

$$U_{sup}[V] = U_{min}[V] + 0.0225 [A] \times R_o[\Omega]$$

where:
R_{max} – maximum permissible load resistance for a specific voltage of the power supply. Ro – total resistance in the current loop
U_{sup} – supply voltage

The maximum length of the connection cable	1500 m (4921ft)
Output updating time	16...480 ms (programmable)
Additional electronic damping	150 ms – version Exd 0...60 s

- 5.1.2. 3400 and 3500 Construction materials

Diaphragm seal for 3400	SS 1.4404/1.4435(316L)
Diaphragm seal for 3500	SS 1.4404/1.4435(316L)
Sensing module	SS 1.4404 (316L)
Liquid filling the interior the sensing module chemically	Silicone oil, inactive liquid for measurement of oxygen uses.
Connectors for 3400	SS 1.4404 (316L)
Electronics casing	High pressure cast of aluminium alloy, lacquered with chemical-resistant oxide enamel, or 1.4401 (316)

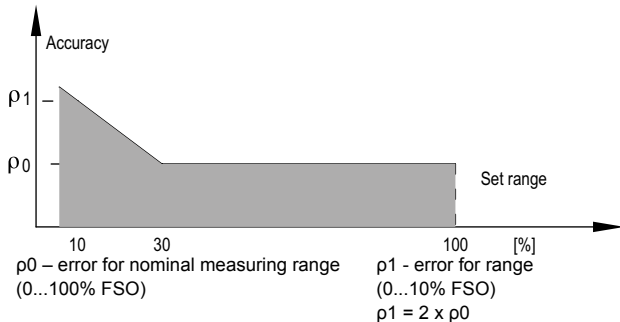
Materials for 3400 and 3500 transmitters with diaphragm seals are described in Appendix III

5.1.3. Enclosure ingress protection
IP 66,67 according to EN 60529

5.1.4. Response time on pressure stroke

In response to the pressure stroke measured by the transmitter - full change (100%) of the transmitter output current is carried out over a period of one to a maximum of two values of processing time. The value of transmitter response time can be set in the Raport 2 program using the slider on the tab Specific parameters
-> Configuration.

5.1.5. Accuracy depending on the set range



5.2. Series 3400 Measurement ranges and metrological parameters

5.2.1. Measurement ranges

	Nominal Measuring Range	Minimum Set Range	Rangeability	Overpressure Limit
01	0 to 18 psia	1.5 psia	13:1	29 psi
03	0 to 100 psia	1.5 psia	70:1	203 psi
05	0 to 350 psia	3.6 psia	100:1	725 psi
07	0 to 1000 psia	10.2 psia	100:1	2030 psi
10	0 to 15 psi	0.7 psi	20:1	29 psi
11	0 to 30 psi	1.5 psi	20:1	58 psi
13	0 to 100 psi	1 psi	100:1	203 psi
15	0 to 350 psi	3.6 psi	100:1	725 psi
17	0 to 1000 psi	10.2 psi	100:1	2030 psi
20	0 to 2300 psi	23.2 psi	100:1	6526 psi
23	0 to 4350 psi	43.5 psi	100:1	6526 psi
26	0 to 8700 psi	87 psi	100:1	17404 psi
29	0 to 14500 psi	145 psi	100:1	17404 psi
60	0 to 1.3 bar abs	100 mbar abs	13:1	2 bar
61	0 to 7 bar abs	100 mbar abs	70:1	14 bar
63	0 to 25 bar abs	0.25 bar abs	100:1	50 bar
65	0 to 70 bar abs	0.7 bar abs	100:1	140 bar
71	0 to 1 bar	50 mbar	20:1	2 bar
72	0 to 2 bar	100 mbar	20:1	4 bar
73	0 to 7 bar	0.07 bar	100:1	14 bar
75	0 to 25 bar	0.25 bar	100:1	50 bar
77	0 to 70 bar	0.7 bar	100:1	140 bar
80	0 to 160 bar	1.6 bar	100:1	450 bar
83	0 to 300 bar	3 bar	100:1	450 bar
85	0 to 600 bar	6 bar	100:1	1200 bar
89	0 to 1000 bar	10 bar	100:1	1200 bar

5.2.2. Permitted environmental conditions

Operating temperature range -40° - 85°C
 Operating temperature range for flame-proof versions in accordance with Appendix I.
 Operating temperature range for intrinsic-safe versions in accordance with Appendix II.



Medium temperature range -40° - 120°C – for direct measurement, over 120°C measurement with a transmission tube or diaphragm seal
 Thermal compensation range -25° - 80°C
 Relative humidity max 98% with condensation

For transmitters with diaphragm seals permissible temperature and corrosive properties of the medium depend on the type of separators, see Appendix III.

5.2.3. Metrological parameters

Accuracy $\leq \pm 0.075\%$ for the calibrated range
 Long term stability \leq accuracy / 3 years (for the nominal measuring range) or $\leq 2 \times$ accuracy 5 years (for the nominal measuring range)
 Error due to supply voltage changes max $\pm 0.002\%$ (FSO)/1V
 Thermal error $< \pm 0.05\%$ (FSO)/10°C
 Thermal error for the whole thermal Compensation range max $\pm 0.25\%$ (FSO)

5.2.5. Series 3400, Pressure Connectors

- 1/2" NPT M -type connector with 1/2" NPT male and internal thread G1/4"



Limitation of the maximum measuring range to 70MPa for transmitters with 1/2" NPT-M connectors for male thread 1/2" NPT.

5.3 Series 3500 Measurement ranges and metrological parameters

5.3.1. Series 3500. Measurement ranges

	Nominal Measuring Range	Minimum Set Range	Rangeability	Overpressure/Static Pressure Limit
02	± 10 in w.c.	0.8 in w.c.	25:1	2900 psi
04	0 to 30 in w.c.	1.6 in w.c.	18:1	3625/6091 psi
08	0 to 100 in w.c.	4 in w.c.	25:1	3625/6091 psi
10	± 200 in w.c.	40 in w.c.	10:1	3625/6091 psi
15	0 to 1000 in w.c.	2813 in w.c.	10:1	3625/6091 psi
20	0 to 15 psi	0.7 psi	20:1	3625/6091 psi
25	0 to 100 psi	23 psi	10:1	3625/6091 psi
38	0 to 230 psi	23 psi	10:1	3625/6091 psi
40	0 to 1000 psi	101.5 psi	10:1	3625/6091 psi
50	± 2.5 in w.c.	0.4 in w.c.	14:1	290 psi
60	± 1.5 psi	0.15 psi	20:1	3625/6091 psi
70	0 to 0.25 bar	10 mbar	25:1	250/420 bar
71	0 to 1 bar	50 mbar	20:1	250/420 bar
72	0 to 2.5 bar	0.2 bar	12.5:1	250/420 bar
75	0 to 16 bar	1.6 bar	10:1	250/420 bar
78	0 to 70 bar	7 bar	10:1	250/420 bar
80	± 7 mbar	1 mbar	14:1	20 bar

5.3.2. Series 3500. Permitted environmental conditions

Operating temperature range -25° - 85°C
 Operating temperature range for flame-proof versions in accordance with Appendix I.
 Operating temperature range for intrinsic-safe versions in accordance with Appendix II.
 Medium temperature range -25° - 120°C – for direct measurement,
 Thermal compensation range -25° - 80°C
 Relative humidity max 98% with condensation

For transmitters with diaphragm seals permissible temperature and corrosive properties of the medium depend on the type of separators, see Appendix III.

5.3.3. Series 3500, Metrological parameters

Accuracy

$\leq \pm 0.075\%$ (FSO) of the calibrated range
 $\leq \pm 0.1\%$ (FSO) for range -80, -50

Long term stability

\leq accuracy / 3 years
 or $\leq 2 \times$ accuracy / 5 years

Error due to supply voltage changes

$\pm 0.002\%$ (FSO)/1V

Thermal error

$\leq \pm 0.05\%$ (FSO)/10°C for range -02, -04, -08, -10, -15, -20, -25, -38, -40, -60, -70, -71, -72, -75, -78
 $\leq \pm 0.08\%$ (FSO)/10°C for range -80, -50

$\leq \pm 0.25\%$ (FSO) for the whole compensation range
 $\leq \pm 0.1\%$ (FSO) for the whole compensation range for range n° -02, -04, -08, -10, -15, -20, -25, -38, -40, -60, -70, -71, -72, -75, -78

Zero shift error for static pressure*

$\pm 0.06\%$ (FSO)/10bar (for range -38, -40, -75, -78)
 $\pm 0.01\%$ (FSO)/10bar (for range -02, -04, -08, -10, -15, -20, -25, -60, -70, -71, -72)
 $\pm 0.02\%$ (FSO)/10bar (for range -80, -50)
 $\pm 0.01\%$ (FSO)/10bar (for range -38, -75)
 up to 10% of flow.

Cut-off on radical characteristic curve

*Zeroing in static pressure conditions with zero differential pressure eliminates this error.

5.3.4. Series 3500 with Diaphragm Seal. Metrological parameters

Accuracy

$\leq \pm 0.1\%$ (FSO)

The other parameters are as given in 5.3.3.

5.3.5. Series 3500 Pressure Connectors

3500 – Cover flanges with 1/4" female NPT process connections to mount together with a valve manifold (see Figure 1).

3500 with single direct diaphragm seal – as in the example (Figure 2) or with other diaphragm seals in accordance with Appendix III.

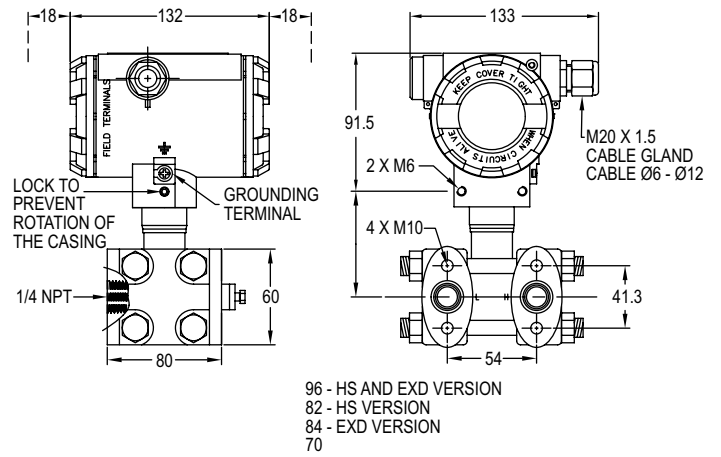


Figure 1 - Series 3500 differential pressure transmitter

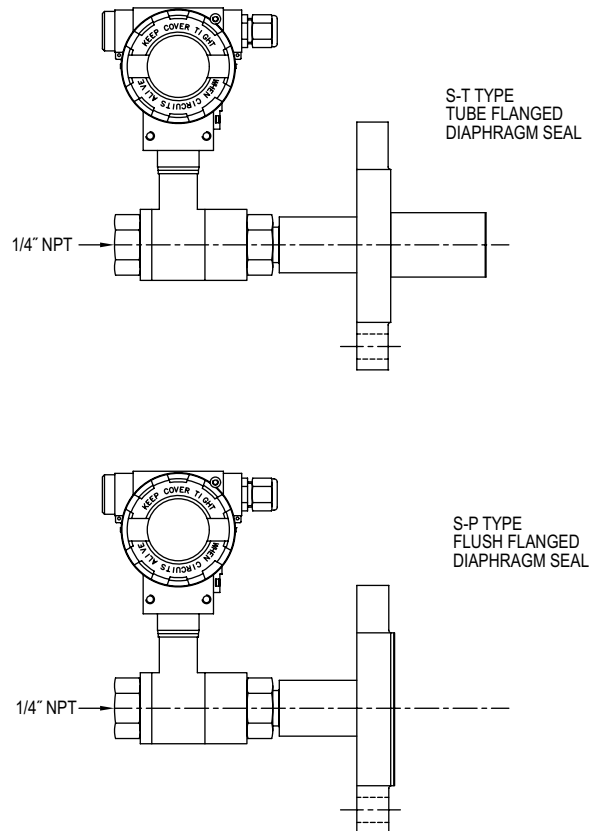


Figure 2: Series 3500 differential pressure transmitter with a single direct diaphragm seal (example)

6. CONSTRUCTION

6.1. Principle of measurement. Electronic system construction

The electrical signal from the sensor, which is proportional to the pressure, is sent to an analog input and converted to a digital signal. The digital signal is then transmitted via optoelectronic galvanic isolation to the conditioning module. The main plate microcontroller reads measured values and, using internal algorithms, calculates the exact value of pressure and temperature. The calculated value of the process variable is displayed on the integrated LCD screen, which can be configured as needed. The digital value of the measured pressure signal is converted to an analog 4-20 mA signal. A built-in modem BELL 202 and HART rev5.1 communication stack enables communication with the transmitter via a converter HART/RS232 attached to a PC and software, or via communicator. The electrical output of the transmitter is equipped with a suppression filter and surge protective elements. The block circuit of the transmitter is presented at Figure 3. The Series 3400 and 3500 transmitters monitor the work of their hardware resources to determine the correctness of calculations. In the event of an error the 3400 and 3500 transmitters will display an error message on the LCD and expose an alarm current to the output loop. Sensor electronics are galvanically isolated from the measuring line. This galvanic isolation reduces susceptibility of measurement interference and offers increased safety in intrinsically safe and flameproof applications.



Communicator or converter electrical connections to transmitter measuring lines. For successful communication with the transmitter the resistance in measuring loop should be higher than 240 Ω. If necessary install an additional resistor in the line. The connections to a communicator or converter are presented in the diagrams. When increasing resistance in the measuring loop it is important to note that the resistance should be added in series with the loop not at the transmitter terminals. (see 5.1.1)

Connection of the 3400 and 3500 transmitter

Connect as shown in Figure 10a. If it is necessary to enable communication with the transmitter, a communicator or converter can also be connected. Optional connection configurations to communication devices are shown below.

Communicator or converter connection near to a switch box

In order to enable communication with a transmitter at a distant location via connection to a switch box, make sure that the resistance R_o from the point of connection of the communicator to the power supply source lies within the range of 240 to 1100 Ω. If necessary, an additional resistance can be integrated into the line. Connect the communicator or converter as shown in Figure 10a.

6.2. Enclosure of transmitters

Enclosures of 3400 and 3500 transmitters are made of die-cast aluminum alloy or stainless steel and consist of a body and two screwed covers (display and electrical connection), one of which is equipped with a glass window. The enclosure provides two holes on the cable entries with 1/2" NPT thread (the unused hole is sealed with stopper). The housing consists of two chambers separated by an electrical culvert. Housing is equipped with both internal and external grounding terminals. The basic units of transmitter are: the sensor module which converts the pressure signal into an electrical signal, and the main electronic circuit board which transforms this signal into a unified output signal.

6.3. Main electronics plate with display

Main plate electronics with display is placed in a casing of polycarbonate. It is placed in the larger chamber where it is possible to change the display position by 345° with 15° increments to required position (see Figure 4). In the second chamber is a connecting board with protective devices and the EMC filter.

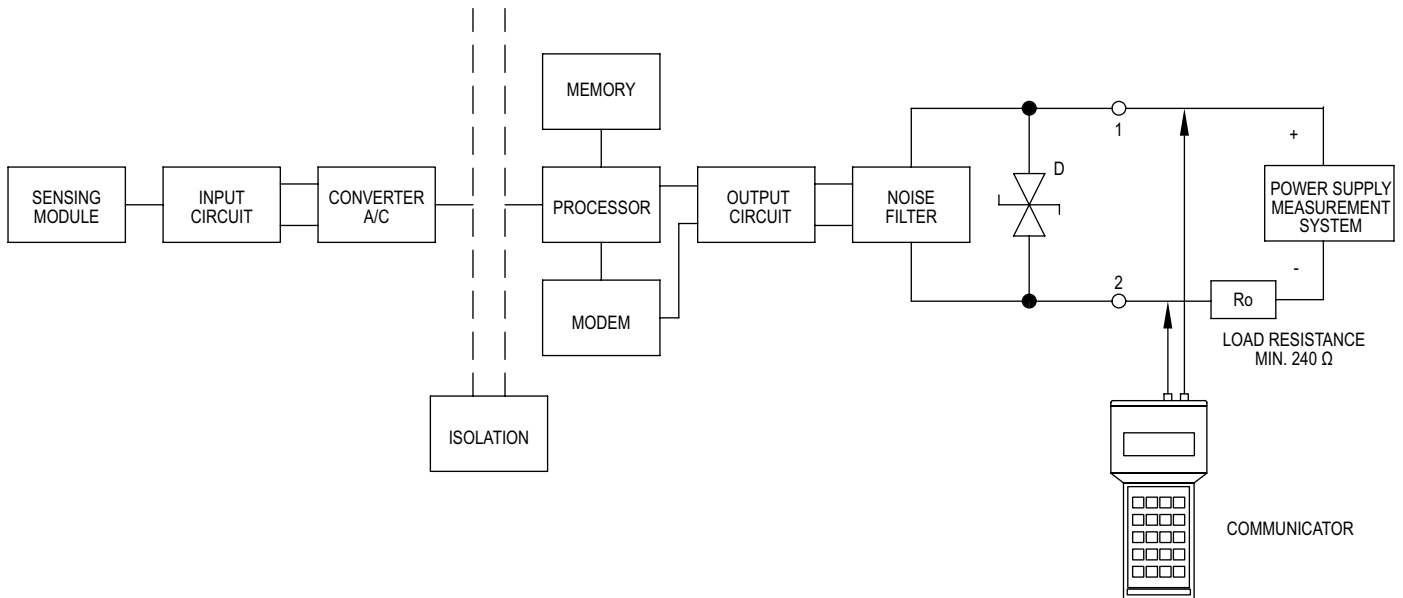


Figure 3: 3400 and 3500 transmitters – block diagram

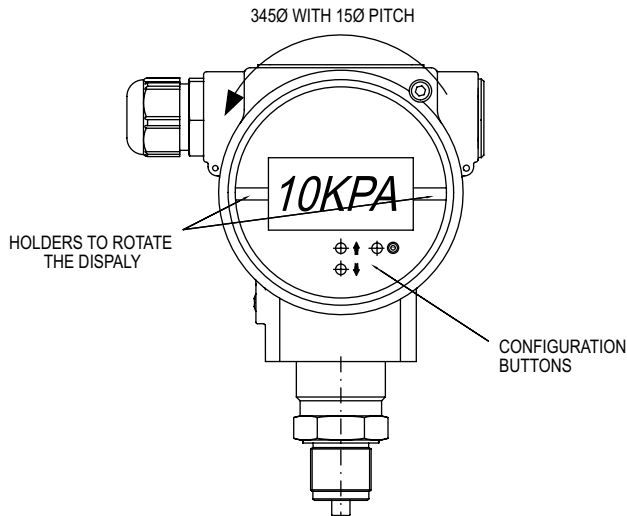


Figure 4: Series 3400 and 3500 display rotation and configuration buttons

6.4. Measuring head

The measuring head is a measuring unit equipped with a silicon diaphragm sensor. The sensor is placed in an enclosed silicone oil-filled space. On one side of the culvert are the leads insulated in glass on the other side of the separating diaphragm which separates the sensor from the medium (3500 transmitters have two separated diaphragms).

6.5. Separators

For pressure measurement of viscous, chemically reactive or hot process mediums, the transmitter may be additionally fitted with various types of diaphragm seal.

The diaphragm seal transmits the process pressure via an inert fluid fill between the diaphragm of the seal and the diaphragm of the transmitter. When remote diaphragm seals are fitted, the pressure between the diaphragm seal and the transmitter is via a filled capillary. The seal's construction is dependent on the process medium properties and the application operating conditions.

7. PLACE OF INSTALLATION

7.1. General recommendations

7.1.1. The 3400 and 3500 transmitters can be installed both indoors and outdoors. It is recommended that transmitters intended for outdoor use be placed in a box or under cover.

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

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



7.1.3. Where there is a risk of damage to the transmitter through impact (which can result in extreme cases with the transmitter being separated from the connecting pipework thus permitting leakage of medium), appropriate means of protection should be applied for obvious safety reasons and to avoid the possibility of sparking caused by being struck. If the transmitter cannot be suitably protected then an alternative mounting location should be utilized.



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

7.2. Low Ambient Temperature



When the solidification point of the liquid whose pressure is being measured is higher than the ambient temperature, steps should be taken to protect the measurement apparatus from freezing effects such as medium expansion. This is particularly important in the case of open-air installations. Protection is obtained by filling the impulse lines with a mixture of ethylene glycol and water, or another liquid whose solidification point does not exceed the ambient temperature. Thermal insulation can protect the transmitter casing and lines only from brief exposure to low temperatures. Where the temperature is very low, the transmitter and impulse lines should be heated.

7.3. High Medium Temperature

The 3400 and 3500 transmitters may be used to measure media with temperatures of up to 120°C. To protect the sensing module from temperatures higher than 120°C, long impulse lines are used to disperse the heat and to lower the temperature of the sensing module. Where it is not possible to use impulse lines of the required length, 3400 and 3500 transmitters with remote diaphragm seals should be used (see Appendix III).



Data as per Appendix I apply for the Exd version and Appendix II apply for the Exi version.

7.4. Electrostatic Risks

Lacquer on the enclosure, plastic rating plate, and teflon on the diaphragm seals are a non-conductive layer applied to a conductive surface. Transmitters in this version should be located in a place where there is no possibility of electrostatic charging. In particular by contact with the electrified dust particles that may leak or be blown out of the process if there is risk of dust explosion.

7.5. Mechanical Vibration shocks. Corrosive Media

7.5.1. Transmitters should correctly work with vibrations with amplitudes to 1.6 mm and accelerations to 4g. If strong vibrations are carried via the pressure line and disturb the measurement, elastic pulse lines or transmitters with a remote diaphragm seal should be used.

7.5.2. Transmitters should not be installed in places where the diaphragm, made of 1.4404/1.4435 (316L) steel, would be subject to corrosion by the medium being measured.

8. INSTALLATION AND MECHANICAL CONNECTIONS

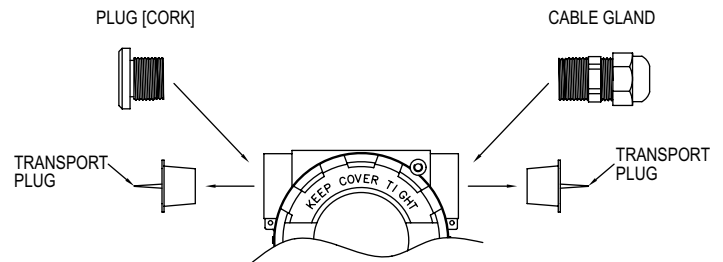


Figure 5: 3400 and 3500 conduit entries

The 3400 and 3500 transmitters can operate in any position. When installed on an object with a high-temperature medium, it is advantageous to mount the transmitter in a horizontal position or downwards. This should be done in such a way that the transmitter is kept away from the rising hot air. For small measurement ranges the reading can be affected by the transmitter position, by the impulse lines configuration, or the way in which they are filled with liquid. This error can be corrected using the zero-setting function.

8.1. Series 3400 Installation and connections

8.1.1. The Series 3400 transmitters can be mounted directly on the rigid impulse lines.

8.1.2. If the pressure is applied via a flexible plastic tube, the transmitter should be mounted on a support with Red Ø6-M reduction. The types of the impulse tubes are to be selected depending on the pressure measured value and the medium temperature.

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

8.1.4. The 3400 transmitter can be installed using a universal "AL" holder allowing to mount the transmitter in any position on the support or a horizontal or vertical pipe Ø35... Ø65 (Figure 6).

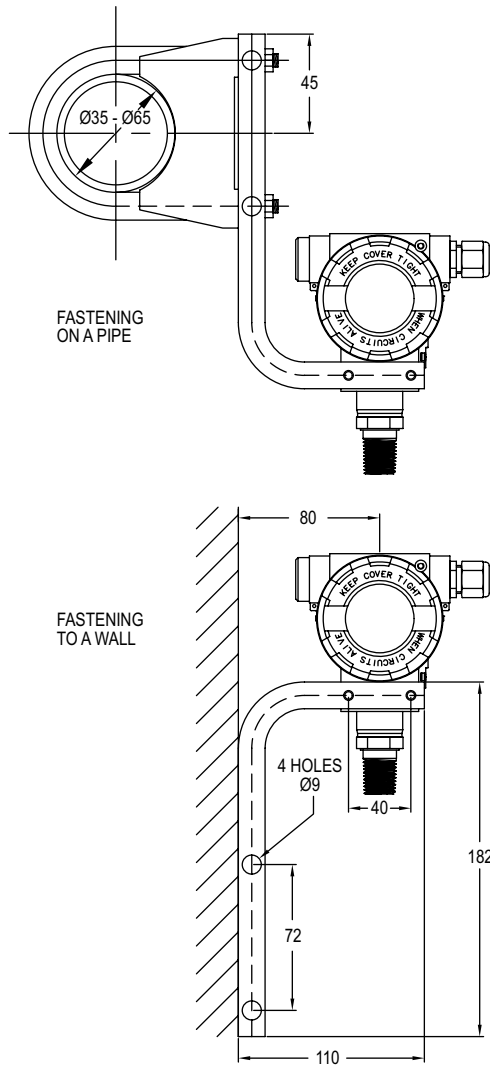


Figure 6: Example: how to install the Series 3400 transmitter

8.2. Series 3500 Installation and connections

8.2.1. The Series 3500 transmitters can be installed using the Ø25 Fastener (Figure 7) on an Ø25 pipe or on a flat surface using an angle bracket

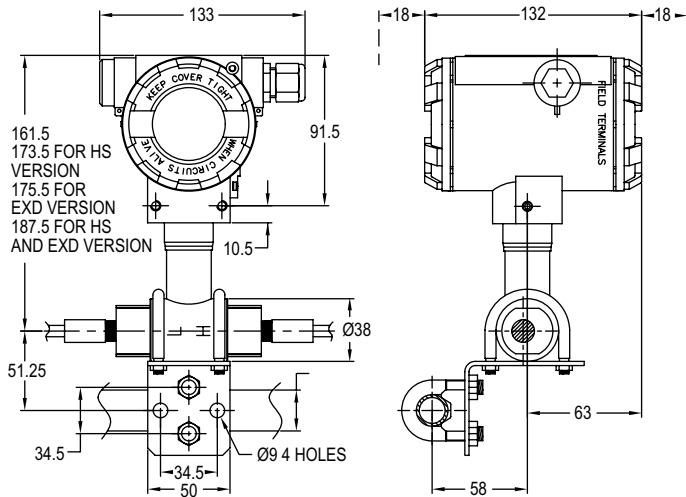


Figure 7: Example - How to install the Series 3500 transmitters with remote diaphragm seals

8.2.2. The Series 3500 transmitters with connecting cover (Figure 1) are designed for installation on 3-valve or 5-valve manifolds to a 2" pipe or to a flat surface using the mounting bracket shown in Figure 8, and Figure 9.

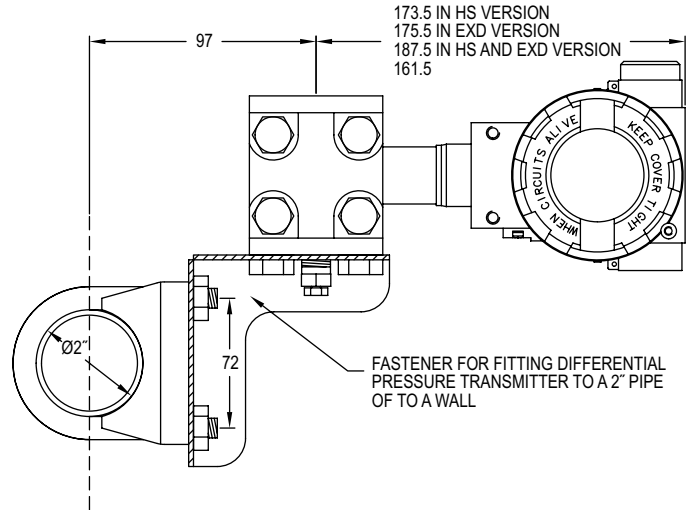
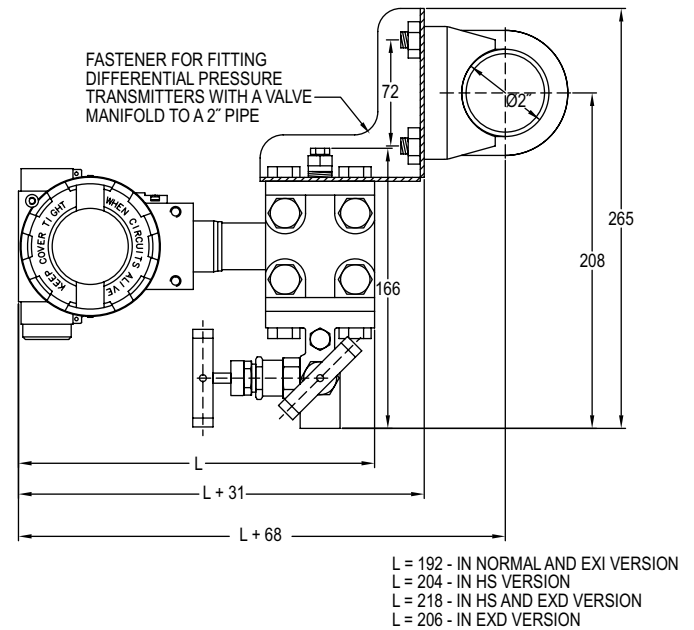


Figure 8: Example - How to install the Series 3500 transmitter on a vertical or horizontal pipe



L = 192 - IN NORMAL AND EXI VERSION
 L = 204 - IN HS VERSION
 L = 218 - IN HS AND EXD VERSION
 L = 206 - IN EXD VERSION

Figure 9: Example - How to install the Series 3500 transmitter with a valve manifold to a 2" pipe



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

Attempts to undo the screws or fixing connector pipes on a transmitter under pressure may cause the medium to leak and create hazards for the personnel. When disassembling the transmitter, it is necessary to disconnect it from the process pressure or bring the pressure to atmospheric level, and to take particular care and precautions in case of media which are highly reactive, caustic, explosive or otherwise hazardous to personnel. If necessary, flush this part of the system.



Transmitters with flange diaphragm seals are to be installed on the corresponding counter flanges on the facility. It is recommended that the user matches the screw joint material to the pressure, temperature, flange material and seal to ensure tightness of the flange joint in the expected operating conditions. Screws complying with ISO 261 are to be used for flanges used in the 3400 and 3500 transmitters. Additional data concerning the diaphragm seals are specified in Appendix III.

9. ELECTRICAL CONNECTION

9.1. General recommendations

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

The devices used together with the transmitters should be resistant to electromagnetic interference from the transmission line in accordance with compatibility requirements. It is also beneficial to use anti-interference filters on the primary side of the transformers, the power supplies used for the transmitters and apparatus used in conjunction with them.

9.1.2. Moisture buildup inside the transmitter casing can cause damage.

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

9.2. Electrical connections for Series 3400 and 3500

The 3400 and 3500 transmitters are to be connected as shown in Figure 10a – 10d. In 3400 and 3500 transmitters, a $240\ \Omega$ resistor is permanently fitted in series in the transmitter's current circuit and blocked up with jumper between <SIGNAL+> and <TEST-> as shown in Figure 10a and 10b. When the resistance in the current loop is lower than $240\ \Omega$ it is necessary to remove the jumper.

Figure 10: Electrical connections for 3400 and 3500 transmitters

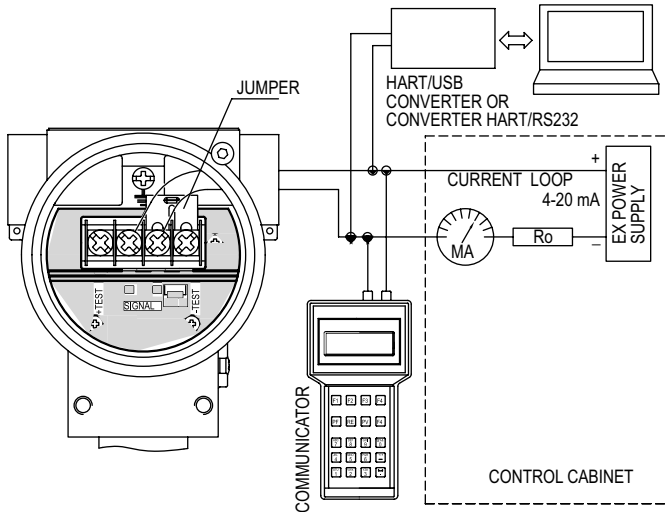


Figure 10a: The link of transmitter and communicator or converter to current line by the switch box (in case of the resistance in current loop is higher than $240\ \Omega$)

Communicator or converter connection to the transmitter's terminals
In order to enable local communication by connecting a communicator or converter to the transmitter's terminals, make sure that the resistance R_o from the transmitter's terminals to the power supply source lies within the range of $240\text{-}1100\ \Omega$. If so, connect the communicator or converter to the terminals <+> <-> as shown in Figure 10b.

Communicator or converter connection to the transmitter's terminals
In order to enable local communication by connecting a communicator or converter to the transmitter's terminals, make sure that the resistance R_o from the transmitter's terminals to the power supply source lies within the range of $240\text{-}1100\ \Omega$. If so, connect the communicator or converter to the terminals <+> <-> as shown in Figure 10b.

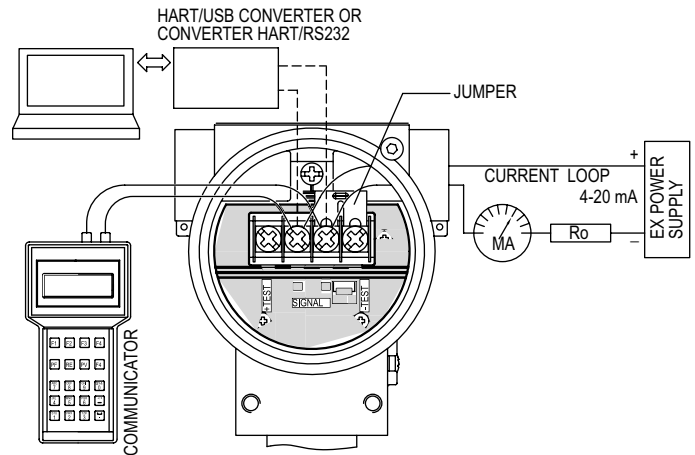


Figure 10b: The link of transmitter and communicator or converter to <SIGNAL+> <SIGNAL-> transmitter terminals in case of the resistance in current loop is higher than $240\ \Omega$

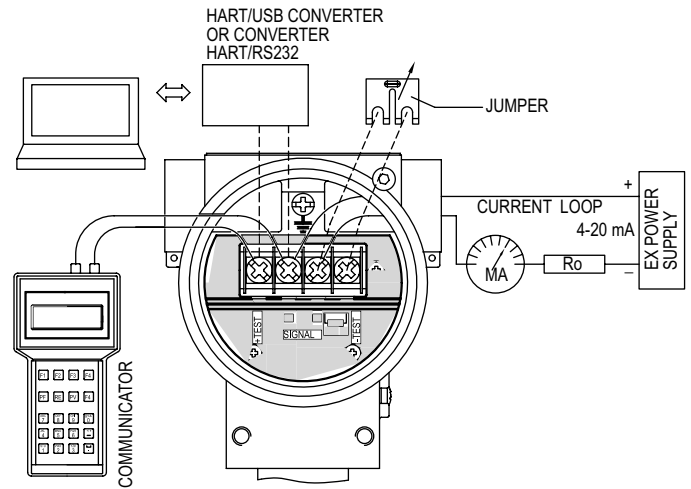


Figure 10c: The link of transmitter and communicator or converter to <SIGNAL+> <TEST+> transmitter terminals in case of the resistance in current loop is smaller than $240\ \Omega$

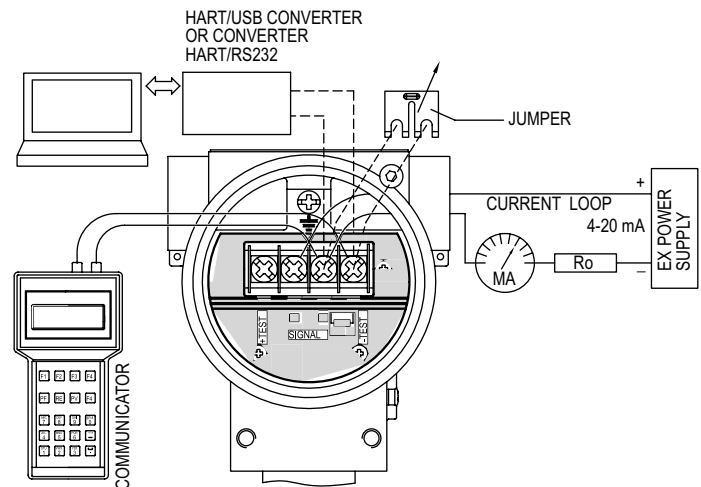


Figure 10d: The link of transmitter and communicator or converter to <SIGNAL+> <SIGNAL-> transmitter terminals in case of the resistance in current loop is smaller than $240\ \Omega$



If Ro in current loop is lower than 240Ω is necessary to connect 240Ω resistor to current loop by remove jumper from <SIGNAL-> and <TEST-> terminals.

After communication jumper should come back at its place.

9.3. Protection from excess voltage

- 9.3.1. 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).
- 9.3.2. External protective devices may also be used. 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	
Type of transmitter	Protection between wires (TVS diodes) – nominal voltage
3400 and 3500	68V DC (for normal and Exd version 39V DC (for Exi version)

- 9.3.3. The voltage in the protective elements must not exceed the maximum permitted values given in column 2 of the table.

9.4. Earthing

The transmitters are fitted with internal and external earth terminals.

10. SETTING AND REGULATION

3400 and 3500 transmitters are factory calibrated to the range stated in the order or to the basic range. After installation, the transmitter's zero-point may drift and require adjustment. This applies particularly in cases where the measurement range is small, where the impulse lines are filled with a separating liquid or where 3400 and 3500 transmitters are used with remote diaphragm seals.

10.1. Transmitter Range, Basic Range. Definitions

- 10.1.1. The maximum range of pressure, or differential pressure, which the transmitter can measure is called the "basic range" (for specifications of basic ranges see section 5.2.1 and 5.3.1). The width of the basic range is the difference between the upper and lower limits of the basic range. The internal characteristic conversion curve for the basic range is coded in the transmitter's memory. This is the reference curve used when making any adjustments which affect the transmitter's output signal.
- 10.1.2. When the transmitter is in use the term "set range" is used. The set range is the range whose lower end-point corresponds to an output current of 4 mA and whose upper end-point corresponds to a current of 20 mA (or 20 mA and 4 mA respectively when the conversion curve is inverted). The set range may cover the whole of the basic range or only a part of it. The width of the set range is the difference between its upper and lower end-points. The transmitter may be set to any range within the basic range of pressure values, subject to the restrictions set out in the table in section 5.2.1 and 5.3.1.

10.2. Configuration and Calibration

- 10.2.1. The transmitter has features which enable metrological and identification parameters to be set and altered. The configurable metrological parameters affecting the transmitter's output current include the following:
 - a) unit in which the measured pressure is expressed on the display
 - b) upper end-point of the set range
 - c) lower end-point of the set range
 - d) time constant
 - e) type of characteristic curve: linear or radical
 Parameters of an informational nature which cannot be altered include the following:
 - f) upper limit of the basic range
 - g) lower limit of the basic range
 - h) minimum range
- 10.2.2. Other identification parameters, not affecting the output signal, include: device address, device type code, factory identification code, factory device code, number of preambles (3-20), UCS, TSD, program version, electronics version, flags, serial number, label tag, description tag, date tag, message, record number, and sensing module number. The process of setting the parameters listed in 10.2.1 is called "Configuration".

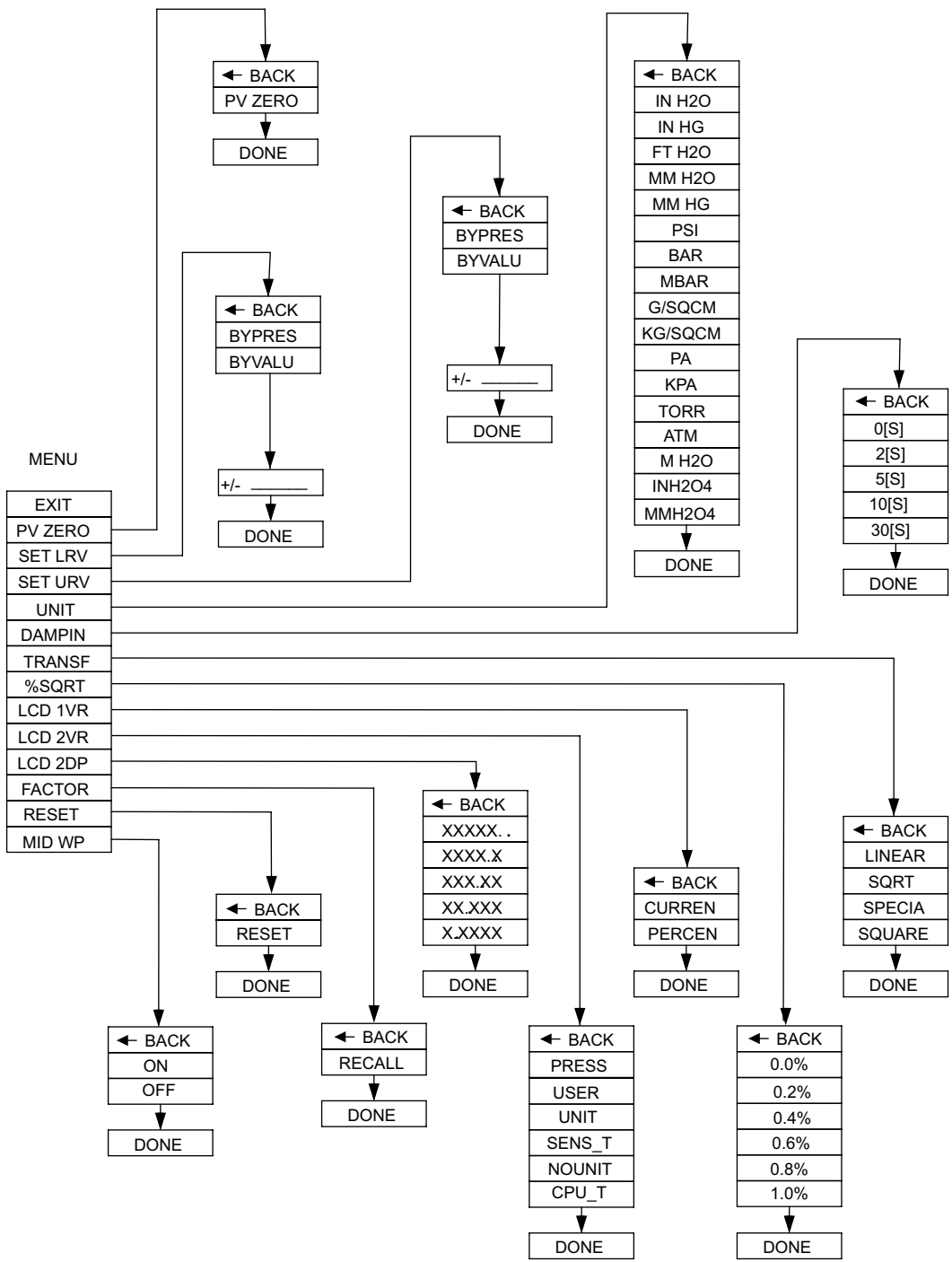
- 10.2.3. It is possible to carry out a "pressure zeroing" procedure, for example to compensate for measurement deviation caused by a change in position during the transmitter installation.

The transmitter may also be calibrated, by taking readings with the input pressure controlled using a standard device. These process and zero-point adjustments are referred to as "Calibration".

- 10.2.4. Configuration and Calibration of the transmitter are carried out using a KAP communicator, certain HART communicators or a PC with HART/RS232 converter and "Raport 2" software. Together with the "Raport 2" configuration software there is "INTERVAL LINEARIZATION" software supplied to enable the input of 21-point nonlinear functional characteristics to the transmitter. A description of the functions of the KAP communicator is contained in the KAP Communicator Operating Manual, and information on the HART/RS232 converter or HART/USB converter can be found on the converter user manual.

10.2.5. TRANSMITTER CONFIGURATION WITH USING ITS BUTTONS AND LOCAL MENU

- 10.2.5.1. Local menu - structure. Local configuration of transmitters. If the option of local configuration is active, the operator can change the transmitter set using the buttons below the display. To gain access to these buttons the operator must unscrew the cover. The display position can also be adjusted with the cover removed (see Figure 4). To enter changes at the local set mode, press one of the buttons and hold it for 4 seconds. If after pressing the button the display reads the message ERR_L16, local configuration of the transmitter is switched off. In order to switch on local configuration it is necessary to use the KAP-03 calibrator or a PC with HART communication protocol. The buttons are signed with symbols: [↑] [↓] [■]. After pressing any of the buttons for 4 s the display will read "EXIT". If you will confirm this message by pressing and holding button [■] by 1 s, you will leave the local configuration menu. If you do not confirm, you can navigate the menu and change settings using the method listed below. Pressing button [↑] moves up in tree's structure. Pressing button [↓] moves down in tree's structure. Pressing [■] for 1 second will advance into selected parameter. No action in the menu for more than 2 minutes will cause automatic exit from the menu and display the process variable. The menu tree structure for local configuration of the 3400 and 3500 transmitters is shown below.



The selected unit should be confirmed by pressing [OK] for 1 second. After confirmation the transmitter will display "DONE" or report the error number. The "← BACK" option allows navigation up one level in the tree structure.

10.2.5.2. Local Menu, error reports.
During command entry, an error code may be displayed indicating an invalid command. A shortened list of error codes is shown below.

ERR_L07 [in_write_protected_mode] This error will display when attempting to change settings in local menu with write protection enabled. In order to make changes to the settings the transmitter must be equipped with local menu option as well as having write protection disabled. It is possible to modify write protection using the KAP-03communicator or a PC with HART communication software using library EDDL.
• default setting:
Local Menu service: Switched on write
Protection: Switched off

ERR_L09 [applied_process_too_high] This error will display when process pressure exceeds the upper range end.

ERR_L10 [applied_process_too_low] This error will display when process pressure is below the lower range end.

ERR_L14 [span_too_small] This error will display when attempting to set the upper and lower range ends too close together.

ERR_L16 [access_restricted] This error will display when the user attempts to access the local configuration menu when it is switched off. To switch on local configuration menu it is necessary to use KAP-03 communicator or a PC with HART communication software using library EDDL.
Warning! ERR_L16 error code may also be displayed due to a zeroing attempt of an absolute transmitter.

WNG_L14 [WARNING! New Lower Range Value Pushed !] This error will display when upper range end will cause the lower range end to be changed.

10.2.6. View local LCD display

Changing the display options is possible using local configuration buttons, or remotely using a communicator. The 3400 and 3500 transmitter display is shown below.

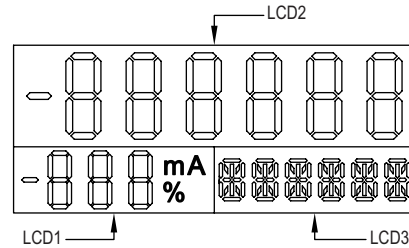


Figure 11: LCD display sections

The 3 main displays:

- LCD1 – The current or percentage output display. Depending on configuration the current value in the 4-20mA loop or the current percentage output will be displayed.
- LCD2 – This section of the LCD can display any of the following depending on display configuration. This section can display the measured pressure value, the calibrated pressure value based on user selected units, the process variable units, user units, pressure sensor/CPU temperature, the MENU announcement and information, or the warning announcement display. When the measured pressure value or calibrated pressure value are displayed, a "-" sign can be displayed indicating a negative value. The decimal position can be set through the local MENU or remotely using a communicator. The 3400 and 3500 make it possible to set up custom units. In order to do this it is necessary to use a communicator or PC software. Simply write the corresponding low value and high value of the range and enter a unit name. When using a custom unit the rescale value will be visible on the display.
- LCD3 – This section acts as an information display. During normal operation base units or user units will be displayed here. In the event of an error in operation this section will display an error code. In manual mode the local menu displays configuration options. It also displays errors related to the implementation of commands in the local menu.

DESCRIPTIONS		
Local Menu	Submenu	Notice
EXIT		Return from the local Menu to the normal operation of the transmitter
PVZERO		Pressure zeroing
SETLRV	BYPRES BYVALU +/-	Setting the lower range of values set by the done pressure (no change of span) Set across set pressure Set across inscribing of value (after approval at display the current value will appear before the passage in edit mode) Select and confirm sign introduced parameter. Introduce in sequence, digit after digit, 5 digital numbers with or without a decimal point. After confirmation the 5th digit of the parameter transmitter will confirm the command by displaying "DONE" or the corresponding error code. The parameter will be written down in units "UNIT"
SETURV		Set the upper range value by the done pressure
UNIT	IN_H2O IN_HG FT_H2O MM_H2O MM_HG MBAR G/SQCM KG/SQCM KPA TORR ATM M_H2O MPA INH2O4 MMH2O4	Menu process variable units Inches of water at a temperature of 68°F Inches of mercury at a temperature of 68°F Foot of water a temperature of 68°F Millimeters of water at a temperature of 68°F Millimeters of mercury at 0°C Millibar Grams per square centimeters Kilogram per square centimeters, technical atmosphere Kilopascal Tor (mm Hg) Physical atmosphere Meter of water at 4°C Megapascal Inches of water at a temperature of 4°C Millimeters of water at 4°C
DAMPIN		Set of the solid temporary suppression of the process variable
TRANSF	LINEAR SQRT SPECIA SQUARE	Set of the current output form Linear Square root User's special Square
%SQRT		Square root characteristic cut-of point setting
LCD1VR	CURREN PERCEN	Assigning a process variable to LCD1 LCD1 will display current value in current loop in [mA] The percent value of the output signal will display on LCD1- in [%]
LCD2VR	PRESS USER SENS_T CPU_T	Assigning a process variable to LCD2 The pressure value will display on LCD2 The user's units will be displayed on LCD2. Scaling of the user range and record of the user units can be made using a computer or communicator, see → HART command No. 244.245 The current temperature of pressure sensor will display on LCD2 The current temperature of the transmitter CPU will display on LCD2 - in [°C]
LCD2DP		Set the decimal point position on LCD2. In a situation where the value provided to display on the display LCD2 cannot be displayed properly due to the position of the decimal point, this is indicated by displaying the four flashing dots ••••. In this case, you must enter to the local menu setting and move the decimal point respectively to the right.
FACTOR		Back to factory settings (removing of current and pressure calibrations)
RESET		Reboot your transmitter
MID_WP	ON OFF	Blocking records / change the parameters associated with transmitter metrology Switch on blocking Switch off blocking

Display backlighting - Local display is equipped with a backlight. Figure 4 shows how to change the display position by rotation.

WARNING Exceeding the high limit or the low limit of the specified operating range by 50% will result in LCD2 displaying “ o V E r ” or “ u n d E r ” respectively. Such situation is encountered most often when using a differential pressure transmitter, created when supplying a large static pressure with a blockage or a leak in one of the capillaries.

After configuration it is important to protect the transmitters using command HART [247]. During operation, the transmitter should be protected prior to entries. This prevents accidental or intentional changes to configuration data. The protection function is accessible in KAP03 communicator, “Raport 2” software, as well as, in applying DD or DMT programs libraries.

10.2.7. Remote configuration

Remote configuration is possible with KAP-03 communicator or PC software. Measuring circuit should be in accordance with Figure 10.

10.2.8. Configuration of Series 3500 transmitters for flow measurements with an orifice plate.

It is important to properly place the transmitter based on the type of measured medium, otherwise it may negatively impact the measurement.

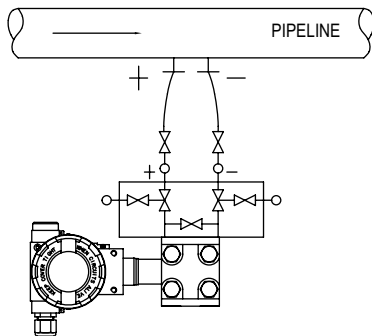


Figure 12: Mounting diagram for liquid and steam flow

The transmitter should be located below the pipeline in order to prevent the accumulation of air bubbles in the connecting line.

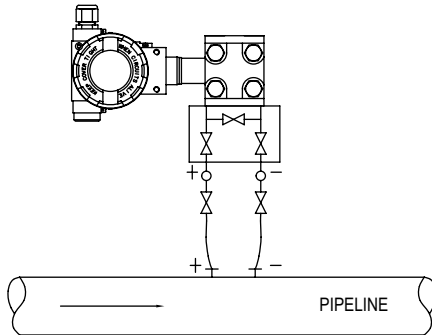


Figure 13: Mounting diagram for gas flow

The transmitter should be located above the pipeline in order to enable the condensate to drain from the pipeline. Function describing the relationship between mass flow and differential pressure is:

$$Q_m = \sqrt{2\rho\Delta p}$$

Function describing the relationship between volume flow and differential pressure is:

$$Q_v = \sqrt{\frac{2\Delta p}{\rho}}$$

ρ – medium density

Δp – differential pressure

Orifice flow meters are based on the square root output signal from the differential pressure transmitters. To achieve this function you should:

- Install the 3500 transmitter to the flow measurement workstation with orifice;
- Make the transmitter zeroing at the workstation; remotely using computer and Raport 2 software or locally with transmitter buttons according to 10.2.5 of the Manual;
- Set the square root output transmitter signal and the cutoff point [in % FS];

remotely using computer and Raport 2 software according to 10.2.4 or locally with transmitter buttons (up to 1% only) according to 10.2.5 of the Manual.

For transmitters with software from 1.9 version, the cutoff point setting means that when the pressure is increasing from 0 to set cutoff point (n%FS), the output signal is zero (4 mA), but in the setting cutoff point and above its, the transmitter output signal passes to the square root output for the current transmitter output, and to the linear output for the HART transmitter output. If the pressure on orifice falls below the n%FS setting minus 0.2% (hysteresis), the output transmitter signal will switch to zero (4 mA). The cutoff operation algorithm on the analog output signal example is shown at the below figure.

Description:

I [mA]	Analog output signal; loop current [4-20 mA] or A [%]
n%	Cutoff point at square root output transmitter signal
PV or Z [%]	Axis of the process variable in user unit or in percent of the set range
LRV	Lower range value; the lower value of the pressure set range (corresponding to the 4 mA current output signal)
URV	Upper range value; the upper value of the pressure set range (corresponding to the 20 mA current output signal)

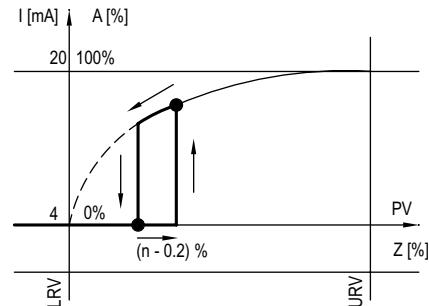


Figure 14: Series 3500 transmitter analog output signal with setting cutoff point in n%

The device configuration example:

Transmitter configuration parameters

- Basic range 0 to 100 kPa
- Set range 0 to 50 kPa
- Cutoff 5% of the set range

Assemble the measuring system in accordance with Figure 10 and run Raport2 according to IO.RAPORT2:

- Set the zero of the transmitter – tab page: Basic Commands → Zeroing;
- Set the width of the set range the transmitter to a value of 0-50 kPa - tab page: Common Parameters → Lower Range Value and Upper Range Value
- Set the square root output signal of transmitter – tab page: Common Parameters → Transfer Function
- Enter 5 in the parameter area inflection point – tab page: Common Parameters → Start point rad
- Save the data to the transmitter (button: Write Parameters).

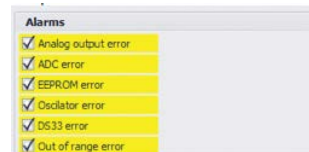
The cutoff function will be implemented to 5% of set range with pressure increase and to 4.8% of set range with a pressure decrease

10.3. Alarms

The alarms indicate the operating parameters of the transmitter (maximum temperature, pressure) are being exceeded, and failures of the electronic components. You can see the diagnostic checklist of alarm statuses by using RAPORT 2 software after reading transmitter parameters. In this way, the values of the alarm current in the line can also be set to <3.7 (low) or >21.5 mA (high), as well as a suitable configuration of alarms in the transmitter can be ordered from the manufacturer.

Due to extensive diagnostic mechanisms, the alarms were grouped by type in order to simplify the user interface. The user can decide what type of alarm will trigger the alarm current in the current loop. It is recommended for the transmitter to operate with the alarm current function turned on.

Example:



The user can also specify the type of alarm current: >21.5 mA (high alarm) or <3.7 mA (low alarm).

Example:



Exceeding the basic range of the pressure by more than 50% is signaled on the display using the OVER 'ouEr' or UNDER 'undEr' message.

The 3400 and 3500 (Ex) 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 to 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 to 4 mA) Range (> 20.0 mA ... ≤ 20.5 mA) for Namur mode with inverse characteristics (20 to 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 to 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

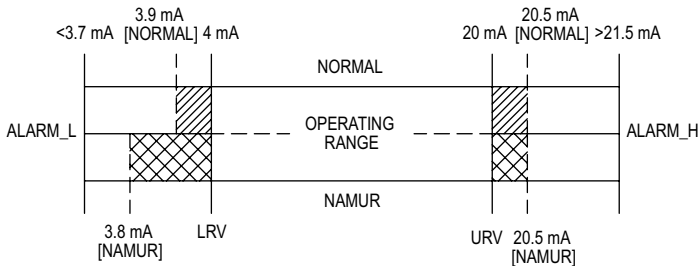


Figure 15: Alarm output operation

11. INSPECTIONS AND SPARE PARTS

11.1. Periodic service

Periodic inspections should be made in accordance with the regulations to which the user is subject. During inspection, the pressure connectors should be checked for loose connections and leaks, the electrical connectors should be checked with regard to tightness and the state of the gaskets, and cable glands, and the diaphragm seals should be checked for tarnishing and corrosion. Check the characteristic conversion curve by following the procedures for "Calibration" and, where appropriate, "Configuration".

11.2. Other services

If the transmitters are installed in a location where they may be exposed to mechanical damage, excess pressure, hydraulic impulses, excess voltage; or the diaphragm may be in danger from sedimentation, crystallization, or erosion; inspections should be carried out as required. Where it is found that the signal in the transmission line is absent or its value is incorrect, a check should be made on the line and its terminal connections. Check whether the values of the supply voltage and load resistance are correct.

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

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

11.3. Cleaning the Diaphragm Seal, Overloading Damage

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

The only permitted method is the dissolving of sediment.

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

- Application of excessive pressure
- Freezing or solidification of the medium
- Action of a hard object, such as a screwdriver, on the diaphragm

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

11.4. Spare parts

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

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

12. PACKING, STORAGE AND TRANSPORT

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

The transmitters should be stored in multiple packs under cover, in a place free of vapors and reactive substances, with temperature and humidity not exceeding the limits specified in 5.2.2 for Series 3400 or 5.3.2 for Series 3500 Transmitters with uncovered diaphragm or seal connectors, stored without packaging, should have covers to prevent damage to the diaphragm. During transportation, the transmitters should be packed and secured so as to prevent them from shifting. Any means of transport may be used provided direct atmospheric effects are eliminated.

13. GUARANTEE

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

14. SCRAPPING, DISPOSAL

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.

15. ADDITIONAL INFORMATION

15.1. Related documents

- IO.KAP-03.02 – Communicator User's Manual
- IO.RAPORT 2 – "Raport 2" software and HART/RS232 converter User's Manual
- DTR.HB.01 – HART/USB converter User's Manual
- "INTERVAL LINEARIZATION" software

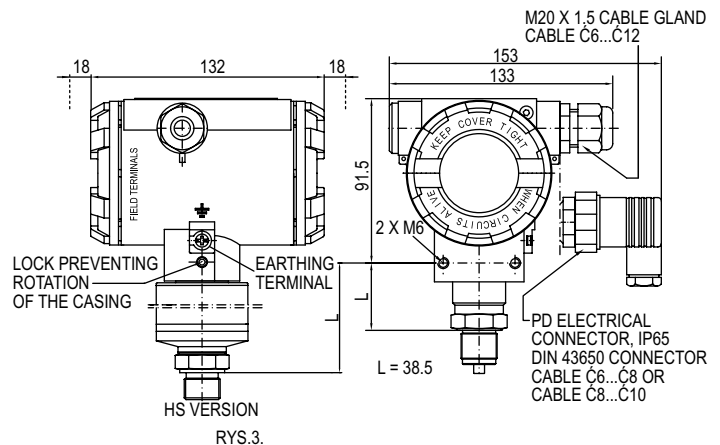


Figure 16: Series 3400 smart pressure transmitter

APPENDIX I Flameproof –FP Option

Introduction

This Appendix applies to Series 3400 Smart Pressure Transmitters and Series 3500 Smart Differential Pressure Transmitters with –FP suffix (ATEX/IECEX flameproof construction).

NOTICE

Units without suffix –FP or –IS are not Directive 2014/34/EU (ATEX) compliant. These units are not intended for use in potentially hazardous atmospheres in the EU. These units may be CE marked for other Directives of the EU.

CAUTION GENERAL



- Protection provided by the equipment may be impaired if the equipment is used in a manner not specified by the manufacturer.
- Risk of electric shock – disconnect supply circuit before opening. Keep unit tightly closed while circuits are live.
- Suitable insulation between signal wiring and hazardous voltage wiring must be provided.

This Appendix contains supplementary information relating to the FP flameproof versions compatible with ATEX Directive 2014/34/EU. During installation and use of flameproof transmitters, reference should be made to the Installation and Operating Manual in conjunction with this Appendix.

1. Use of 3400 and 3500 transmitters in hazardous locations

- 1.1 The transmitters are produced in accordance with the requirements of the following standards:

EN 60079-0:2012+A11:2013, EN 60079-1:2014, EN 60079-11:2012, EN 60079-26:2015, EN 60079-31:2014;

IEC 60079-0:2012, IEC 60079-1:2014, IEC 60079-11:2011, IEC 60079-31:2013, IEC 60079-26:2006.

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

Depending on type and device version the following markings are used:

CE II 2G Ex ia/db IIC T6/T5 Gb
II 2D Ex ia/tb IIIC T85°C/T100°C Db
KDB 17 ATEX 0056X

Ex Ex ia/db IIC T6/T5 Gb
Ex ia/tb IIIC T85°C/T100°C Db
IECEX KDB 17.0008X

Marking T6 and T85°C applies to range $-40^{\circ}\text{C} < T_a \leq 45^{\circ}\text{C}$
Marking T5 and T100°C applies to range $-40^{\circ}\text{C} < T_a \leq 75^{\circ}\text{C}$

1.3 Transmitter category and hazard areas.

The ATEX category 1/2G (1/2D) and IECEx Equipment Protection Level (EPL) Ga/Gb (Da/Db) means that the transmitter may be installed within Type 1 (21) or Type 2 (22) hazardous zones. The transmitter process connections may connect to a Type 0 (20) zone type (see the Figure 1a below for an example). The category 2G (2D) and EPL Gb (Db) means that the transmitter together with process connections may be installed within a Type 1 (21) or Type 2 (22) hazardous zone

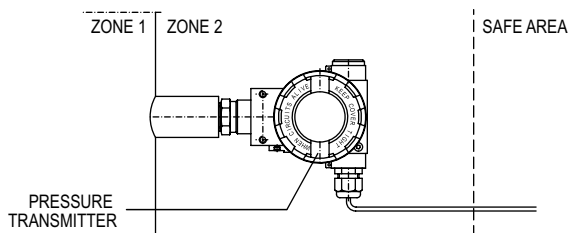


Figure 1A

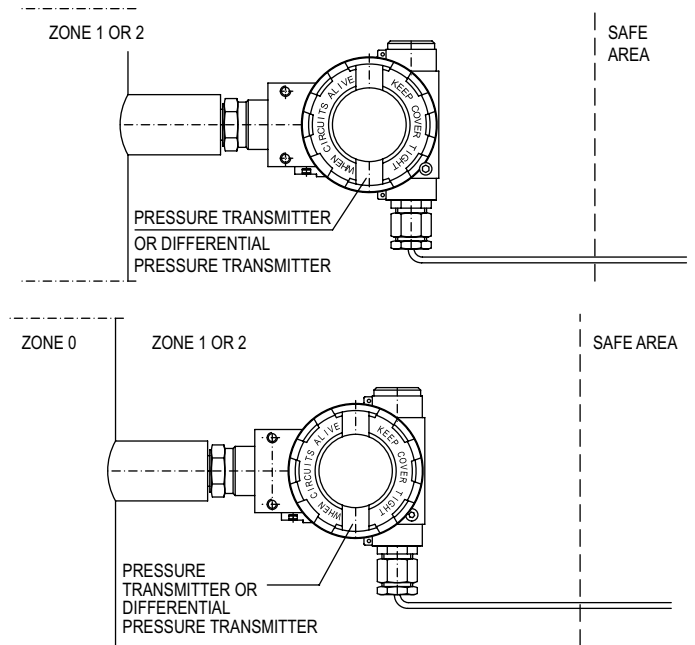


Figure 1B

2. Identifying marks

Flameproof transmitters must have a nameplate containing the following information:

- a.) **CE** Mark and number of notified body
- b.) **Ex** Mark, and designation of explosion protection type and certificate number
- c.) Supply voltage
- d.) Electrical connection type
- e.) Year of manufacture
- f.) Temperature use range

3. User information

Together with the ordered transmitters, the user will receive:

- a.) Product certificate
 - b.) Declaration of conformity
 - c.) Installation and operating manual
- Items b.) and c.) are also available on www.dwyer-inst.com.

4 Installation and power supply

WARNING HAZARDOUS LOCATIONS, FLAMEPROOF (-FP SUFFIX)

- Keep cover tightly closed when in operation.
- De-energize supply circuit before opening.
- After de-energizing, delay 3 minutes before opening.
- To prevent ignition in hazardous locations, replace cover before energizing the electrical circuits.
- Do not remove covers to change display or backlighting while in hazardous location.
- Device is not field-repairable and should be returned to Dwyer Instruments, Inc. if repair is needed.

WARNING In areas where there is a risk of dust explosion, transmitters in aluminum alloy casing covered with lacquer and transmitters with plastic rating plates or with diaphragm seals covered by Teflon should be installed in way to prevent electrostatic charging according to p. 7.4.

- 4.1 Read and understand all information provided in this Appendix before attempting installation of the 3400 Smart Pressure Transmitter or 3500 Smart Differential Pressure Transmitter.
- 4.2. Electrical connection of the transmitter must be made according to this Appendix. Transmitter electrical installation should be in accordance with engineering standard requirements. Electrical connections of transmitters in hazardous locations should be made by personnel who have indispensable knowledge and experience in this area. Earth clamps must be used to earth transmitters. In the event that transmitters come in contact with structural metal parts or pipes which are connected to the equipotential bonding system, transmitters are not required to be earthed.
- 4.3 Transmitters must be supplied from DC source with maximum voltage 55 V, from a transformer or other device with strengthened isolation between the primary and secondary windings, with maximum a voltage of 250 V. It is the responsibility of the user to provide power matching these requirements.

- 4.4 Transmitters may be used in ambient temperatures (Ta) between -40°C < Ta ≤45°C for class T6 or between -40°C < Ta ≤ 45°C for class T6 or between -40°C < Ta 75°C for T5.
- 4.5 Transmitter sensor diaphragm should not be subject to damage during installation and use. The diaphragm is made from 1.4404/1.4435 (316L) or Hastelloy thin foil and cannot be subject to incompatible materials.
- 4.6 With regard on kind of casing material (light alloy with large aluminum content), the user is obliged to assure, that possibility of hitting casing does not step out in place of transmitter installation.
- 4.7 In transmitter casing are two holes to assembly of cable glands from thread M20x1.5 or 1/2 NPT.
- 4.8 Normally transmitters are delivered without installed glands but with blank plugs (corks) in the second hole. The list of cable glands and plugs acceptable with production documentation and accepted by certificate station is specified in Table 1 and Table 2. The user should install cable glands according to Tables 1 and plugs according to Table 2 (if plugs aren't installed) or other accordance with flameproof standards.
- 4.9 Signal cable must be shielded; if the cable is not shielded, it must have a round cross-section with moisture-proof insulation. The general principles of connection and use of flameproof transmitters should be compatible with principles and relating standards for casing devices in this Appendix and EN 60079-14, EN 60079-17 and IEC 600079-14, IEC 60079-17.
- 4.10 Routine maintenance must include a check of the security of covers and the cable glands and the fastening of the cable in the glands. The casing, supply line, nameplate, and diaphragm must be inspected for mechanical damage. During maintenance it is recommended that the threads of the covers be lubricated with non-acidic grease.

W.E. Anderson
Attn. Repair Department
250 High Grove Rd
Grandview, MO 64030

TABLE 1: PERMITTED CABLE GLANDS					
Type	Producer	Screw	Feature	Other Making	No. of Certificate
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		SIRA06A-TEX1188X
A2F, A2FRC, SS2K	CMP-Products	M20x1.5	Exd IIC		SIRA06A-TEX1097X
E1FW, E1FX/Z, E2FW, E2FX/Z	CMP-Products	M20x1.5	Exd IIC		SIRA06A-TEX1097X
T3CDS, T3CDSPB	CMP-Products	M20x1.5	Exd IIC		SIRA06A-TEX1283X
PX2K, PXSS2K, PX2KX, PXB2KX	CMP-Products	M20x1.5	Exd IIC		SIRA06A-TEX1097X

(*) for special cable only.

5. Electrical connections

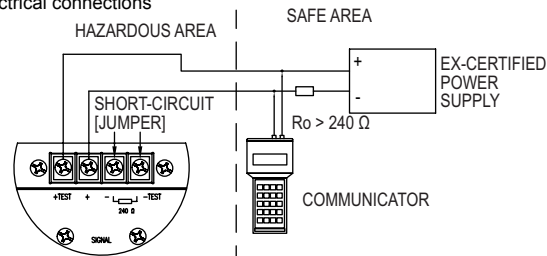


Figure 2

In case of transmitter calibration outside the hazardous zone, connect as follows:

<SIGNAL+> and <TEST+> terminals. Transmitter is provided with a communication resistor (RD = 240 Ω), closed with a jumper at <SIGNAL-> and <TEST-> terminals installed by manufacturer. RD resistor can be used when it is necessary to communicate with transmitter from its terminals and the load resistance (Ro) in current loop is lower than 240 Ω. If so, <SIGNAL-> and <TEST-> terminals have to be open.

CAUTION Do not remove covers to change display or backlight while explosive atmosphere is present. A method to block the cover is shown in Appendix I Figure 3.

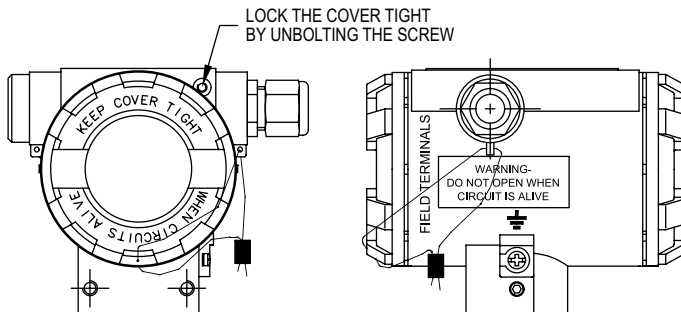


Figure 3: How to lock the casing of Series 3400 and 3500 transmitters

NOTICE Units in need of repair should be returned to the following address, freight prepaid. Include a brief explanation of the problem and any relevant application information.

TABLE 2: PERMITTED PLUGS					
Type	Producer	Screw	Feature	Other Making	No. of Certificate
475	HAWKE	M20x1.5	Exd IIC		Baseefa 10ATEX 0262X
477	HAWKE	M20x1.5	Exd IIC		Baseefa 10ATEX 0262X

NOTICE Special conditions for safe use: (Refer to EU-Type Certificate KDB 17 ATEX 0056X)

- Permissible gap of flameproof joint "L4" of Appendix I Figure 4 is smaller than defined in EN 60079-1:2007 and cannot be greater than the value passed. See Table 1 for flameproof joint specifications.

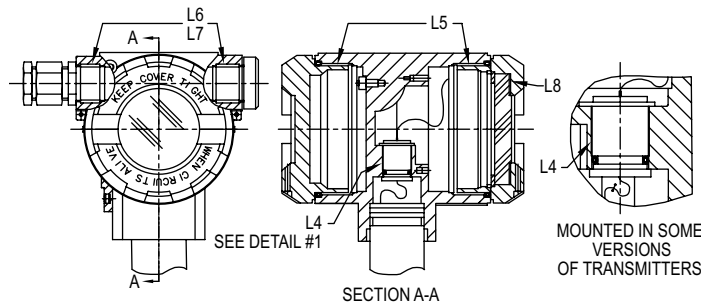


Figure 4: The explosion - proof joints of Series 3400 and 3500 transmitters

EXPLOSION-PROOF ROADS FOR GROUP IIC.						
N°	Minimum Length of Slot L mm	Diameter		D-d mm	Quantity of Joint	Minimum According to EN 60079-1
		D mm	d mm			
L4	13.2	Ø15 ^{+0.027}	Ø15 ^{+0.040} Ø15 ^{+0.070}	0.097	1 or 2	Length of slot min. 12.5
L5	12	M72 x 1.5	M72 x 1.5		2	Min. 5 threads engaged (8)
L6	9	M20 x 1.5	M20 x 1.5		2	Min. 5 threads engaged (6)
L7	12.7	1/2 NPT	1/2 NPT		2	Min. 6 threads engaged
L8	10				1	Cemented joints length of joint min.10

APPENDIX II Intrinsically Safe –IS Option

Introduction

This Appendix applies to Series 3400 Smart Pressure Transmitters and Series 3500 Smart Differential Pressure Transmitters with –IS suffix (ATEX/IECEx intrinsically safe construction).

NOTICE Units without suffix –FP or –IS are not Directive 2014/34/EU (ATEX) compliant. These units are not intended for use in potentially hazardous atmospheres in the EU. These units may be CE marked for other Directives of the EU.

CAUTION GENERAL



- Protection provided by the equipment may be impaired if the equipment is used in a manner not specified by the manufacturer.
- Risk of electric shock – disconnect supply circuit before opening. Keep unit tightly closed while circuits are live.
- Suitable insulation between signal wiring and hazardous voltage wiring must be provided.

This Appendix contains supplementary information relating to the IS intrinsically safe versions compatible with ATEX Directive 2014/34/EU. During installation and use of flameproof transmitters, reference should be made to the Installation and Operating Manual in conjunction with this Appendix.

- Use of 3400 and 3500 transmitters in hazardous locations
 - The transmitters are produced in accordance with the requirements of the following standards:

EN 60079-0:2012+A11:2013, EN 60079-11:2012, EN 50303:2000; IEC 60079-0:2011, IEC 60079-11:2011

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

Depending on type and device version the following markings are used:

CE II 1/2G Ex ia IIC T4/T5 Ga/Gb
II 1/2D Ex ia IIIC T105°C Da
FTZÚ 17 ATEX 0112X

Ex Ex ia IIC T4/T5 Ga/Gb
Ex ia IIIC T105°C Da
IECEx FTZÚ 17.0024X

- Transmitter category and hazard areas.
The ATEX category 1/2G (1/2D) and IECEx Equipment Protection Level (EPL) Ga/Gb means that the transmitter may be installed within Type 1 (21) or Type 2 (22) hazardous zones. The transmitter process connections may connect to a Type 0 (20) zone type (see the Appendix II Figure 1 below for an example).

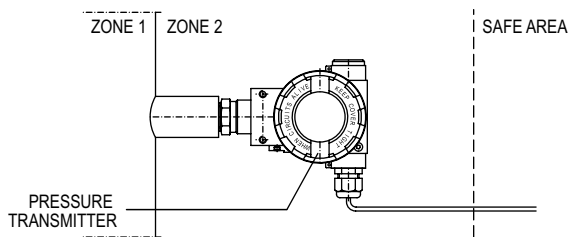


Figure 1

4. Identifying marks

Intrinsically safe transmitters must have a nameplate containing the following information:

- CE** Mark and number of notified body
- Ex** Mark, and designation of explosion protection type and certificate number
- Supply voltage
- Parameters U_i , I_i , P_i , C_i , L_i
- Year of manufacture
- Temperature use range

5. User information

Together with the ordered transmitters, the user will receive:

- Product certificate
 - Declaration of conformity
 - Installation and operating manual
- Items b.) and c.) are also available on www.dwyer-inst.com.

6. Input parameters (based on certificate FTZÚ 17 ATEX 0112X)

WARNING HAZARDOUS LOCATIONS, FLAMEPROOF (-FP SUFFIX)

- Keep cover tightly closed when in operation.
- De-energize supply circuit before opening.
- After de-energizing, delay 3 minutes before opening.
- To prevent ignition in hazardous locations, replace cover before energizing the electrical circuits.
- Do not remove covers to change display or backlighting while in hazardous location.
- Device is not field-repairable and should be returned to Dwyer Instruments, Inc. if repair is needed.

WARNING In areas where there is a risk of dust explosion, transmitters in aluminum alloy casing covered with lacquer and transmitters with plastic rating plates or with diaphragm seals covered by Teflon should be installed in way to prevent electrostatic charging according to p. 7.4.

- Read and understand all information provided in this Appendix before attempting installation of the 3400 Smart Pressure Transmitter or 3500 Smart Differential Pressure Transmitter.
- Electrical connection of the transmitter must be made according to this Appendix. Transmitter electrical installation should be in accordance with engineering standard requirements. Electrical connections of transmitters in hazardous locations should be made by personnel who have indispensable knowledge and experience in this area. Earth clamps must be used to earth transmitters. In the event that transmitters come in contact with structural metal parts or pipes which are connected to the equipotential bonding system, transmitters are not required to be earthed.

CAUTION ELECTRICAL RATINGS

- Minimum supply voltage is 16 VDC.
- Equipment must be powered via power supply and measurement devices certified as intrinsically safe. Output parameters to the hazard zone must not exceed the power supply limits below.
- Transmitters must be supplied from a DC source with a maximum voltage of 55 V, from a transformer or other device with strengthened isolation between the primary and secondary windings, with maximum a voltage of 250 V. It is the responsibility of the user to provide power matching these requirements

- For power supplies with a linear characteristic:
 $U_i = 28 \text{ V}$ $I_i = 0.1 \text{ A}$ $P_i = 0.7 \text{ W}$ $T_a = 70^\circ\text{C}$ and T5
 $U_i = 28 \text{ V}$ $I_i = 0.1 \text{ A}$ $P_i = 0.4 \text{ W}$ $T_a = 40^\circ\text{C}$ and T6

Example of a power supply with a linear characteristic may be a typical barrier with parameters

$U_o = 28 \text{ V}$ $I_o = 0.93 \text{ A}$ $R_w = 300 \Omega$

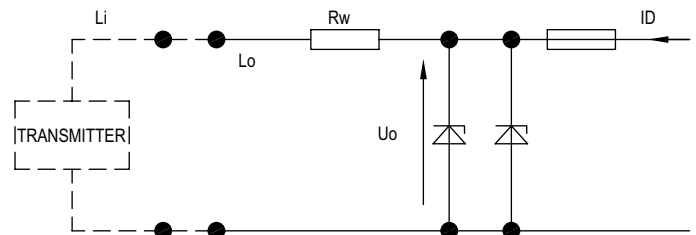


Figure 2: Power supply from a source with linear characteristic

- For power supplies with trapezoidal characteristics:
 $U_i = 24 \text{ V}$ $I_i = 0.05 \text{ A}$ $P_i = 0.6 \text{ W}$ $T_a = 80^\circ\text{C}$ and T5

Example of a power supply with trapezoidal characteristics:

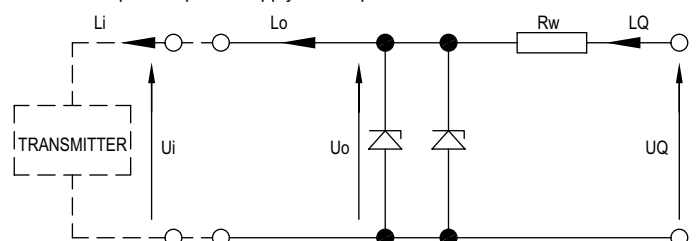


Figure 3: Power supply from a source with a trapezoidal characteristic

If $U_o < U_Q$ The parameters U_Q , I_o , and P_o are interrelated as follows:			
2			
$U_Q = 4P_o$	$R_w = U_Q$	$P_o = U_o (U_Q - U_o)$	for $U_o \leq 1/2 U_Q$
I_o	R_w		

6.5. For power supplies with a rectangular characteristic:
 $U_i = 24 \text{ V}$ $I_i = 0.025 \text{ A}$ $P_i = 0.6 \text{ W}$ $T_a = 80^\circ\text{C}$ and T5

Supplying power from a source with a rectangular characteristic means 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". When the transmitter is powered from such a supply it is also an Ex device with protection level "ib".

Example of practical power supply: stabilized power supply with $U_o = 24 \text{ V}$ with protection level "ib" and current limited to $I_o 25 \text{ mA}$.

6.6. Input inductance and capacity: $C_i = 30 \text{ nF}$ $L_i = 1.35 \text{ mH}$

CAUTION

- Range of permissible ambient temperature: $T_a = -40^\circ\text{C}$ to 80°C Category 1D.
- Process medium must not increase enclosure temperature above ambient T_a .

6.7. Load resistance
 From 28 VDC linear supply
 $R_o \text{ max } (\Omega) = \frac{U_{\text{sup}} - 16 \text{ V} - (300 \cdot I_o)}{0.0225 \text{ A}}$

Without display backlighting

From a trapezoidal or rectangular power supply
 $R_o \text{ max } (\Omega) = \frac{U_{\text{sup}} - 16 \text{ V}}{0.0225 \text{ A}}$

*Real voltage from barrier
 **Barrier resistance

6.8. Transmitters may be used in ambient temperatures (T_a) between $-40^\circ\text{C} < T_a \leq 45^\circ\text{C}$ for class T6 or between $-40^\circ\text{C} < T_a \leq 45^\circ\text{C}$ for class T6 or between $-40^\circ\text{C} < T_a 75^\circ\text{C}$ for T5.

6.9. Transmitter sensor diaphragm should not be subject to damage during installation and use. The diaphragm is made from 1.4404/1.4435 (316L) or Hastelloy thin foil and cannot be subject to incompatible materials.

6.10. With regard on kind of casing material (light alloy with large aluminum content), the user is obliged to assure, that possibility of hitting casing does not step out in place of transmitter installation.

6.11. In transmitter casing are two holes to assembly of cable glands from thread M20x1.5 or 1/2 NPT.

6.12. Normally transmitters are delivered without installed glands but with blank plugs (corks) in the second hole. The list of cable glands and plugs \ acceptable with production documentation and accepted by certificate station is specified in Table 1 and Table 2. The user should install cable glands according to Tables 1 and plugs according to Table 2 (if plugs aren't installed) or other accordance with flameproof standards.

6.13. Signal cable must be shielded; if the cable is not shielded, it must have a round cross-section with moisture-proof insulation.
 The general principles of connection and use of intrinsically safe transmitters should be compatible with principles and relating standards for casing devices in this Appendix and EN 60079-14, EN 60079-17 and IEC 60079-14, IEC 60079-17.

6.14. Routine maintenance must include a check of the security of covers and the cable glands and the fastening of the cable in the glands. The casing, supply line, nameplate, and diaphragm must be inspected for mechanical damage. During maintenance it is recommended that the threads of the covers be lubricated with non-acidic grease.

7. Electrical connections

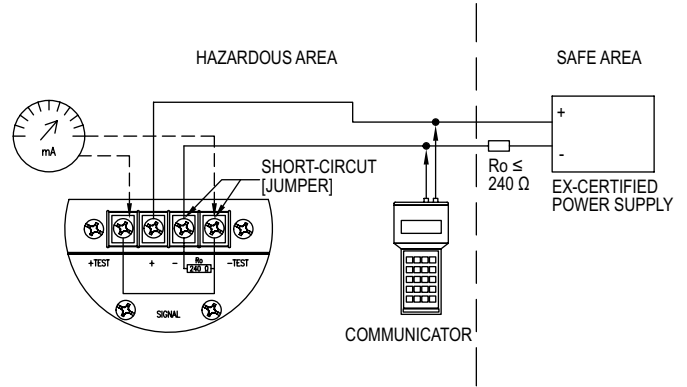


Figure 4

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

If the equipment is calibrated outside the hazard zone, connect as follows: <SIGNAL+> and <TEST+> terminals. Transmitter is provided with a communication resistor ($R_D = 240 \Omega$), closed with a jumper at <SIGNAL-> and <TEST-> terminals installed by manufacturer. R_D resistor can be use when it is necessary to communicate with transmitter from its terminals and the load resistance (R_o) in current loop is greater than 240Ω . If so, <SIGNAL-> and <TEST-> terminals have to be open.

CAUTION Do not remove covers to change display or backlight while explosive atmosphere is present. A method to block the cover is shown in Appendix II Figure 5.

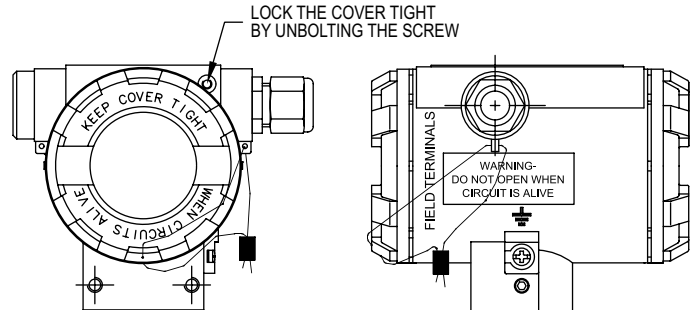


Figure 5: How to lock the casing of Series 3400 and 3500 transmitters

WARNING Substitution of components may impair intrinsic safety of models with -IS suffix. Use a damp cloth with soap and water for cleaning and decontamination. Solvents may damage O-ring seals. Units in need of repair should be returned to the following address, freight prepaid. Include a brief explanation of the problem and any relevant application information.

W.E. Anderson
 Attn. Repair Department
 250 High Grove Rd
 Grandview, MO 64030

NOTICE Special conditions for safe use:

1. Versions of transmitter with surge arrester marked on plate "SA", do not meet the requirements of Section 10.3 of the standard EN 60079-11:2012 (500Vrms). This must be taken into account when installing the equipment.
2. Under certain extreme circumstances in dust explosive atmospheres, the device with painting of aluminum enclosure and with plastic tables and with elements of diaphragm seals covered by PTFE may store an ignition-capable level of electrostatic charge. The device shall not be installed in a location where the external conditions are conducive to the build-up of electrostatic charge.
3. If the diaphragm seal contains titan parts, it must be protected against mechanical drops.

APPENDIX III Diaphragm Seals

Recommendations

The version of the transmitter with two remote diaphragm seals is recommended for the measurement of pressure differences when the hydrostatic pressure of the manometric fluid in the capillaries (which depends on the vertical spacing of the seals) is significantly less than the measuring range of the transmitter. The best metrological results are obtained when the applied capillaries are identical, as short as possible, and terminated with identical seals. When using this configuration any temperature errors related to the remote sealing affect both of the measurement chambers in the same way and thus cancel each other out.

A transmitter with a direct diaphragm seal (connected to the positive measurement chamber) and a remote diaphragm seal (connected to the negative chamber) is recommended for hydrostatic measurements of: levels, densities, phase boundaries, and pressure differences (with differentiated height of pulse source points*). In this configuration, during ambient temperature fluctuations, two opposite phenomena occur simultaneously. Thermal expansion causes a change in volume (and hence also a change in density) of the manometric fluid in the capillary, which results in a change of the hydrostatic pressure related to the vertical spacing of the seals.

This phenomenon is counteracted by the elastic reaction of the diaphragm of the remote diaphragm seal which is displaced by the change in volume of manometric fluid. Based on tests and experiments the transmitters are provided with carefully selected seal diaphragms which guarantee compensation of the errors resulted from the ambient temperature changes.

Application and construction

The differential pressure transmitter is applicable to the measurement of pressure differences of: gases, vapors, and liquids in cases where it is necessary to use seals and the pressure pulse source points may be several meters apart. Typical applications include the hydrostatic measurement of: levels in closed tanks, densities, phase boundaries, measurement of filter loss, pressure differences between media in pasteurizers etc. The available range of the diaphragm seals allows measurement of a wide variety of media. The active element is a piezoresistant silicon sensor separated from the medium by a distance sealing system. The special design of the measuring unit means that it can withstand pressure surges and overloads of up to 40bar. The electronic circuits are enclosed in a casing with a degree of protection IP65 or IP66.

Metrological Parameters

Accuracy $\leq \pm 0.1\%$ (FSO)

Other parameters correspond to the overall Series 3500

Configuration of the Series 3500 transmitters to measure the level, density of liquid and phase boundary

To simplify the mathematical operations we introduce the density coefficient of the medium $X\rho$

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

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

Configuration of the Series 3500 transmitters to measure the level of liquid in a tank.

The measurement task:

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

1. Install the transmitter in its working position on an empty tank.
2. Make the electrical connection of the transmitter, providing the ability to use HART® communication
3. Connect the KAP-03 communicator, identify the transmitter and select the "configuration" function.
4. On the configuration menu select the "rearranging" procedure.
5. On the "rearranging" menu:
 - a) change the units of measurement to mm H₂O at 4°C;
 - b) enter the values for the start ($X\rho \times h_{\text{min}}$ [mm])
 - c) to compensate for the hydrostatic pressure of the manometric fluid, the start of the measurement range should be set using regulated pressure' when subject to the action of only the manometric fluid (empty tank) the transmitter will shift the start and end-points of the range, compensating for the value of that pressure.

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

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

Start [mm H₂O] = $-H$ [mm] $\times X\rho_{\text{oil}}$

End [mm H₂O] =

$=h_{\text{max}}$ [mm] $\times X\rho_{\text{measured liquid}} - H$ [mm] $\times X\rho_{\text{oil}}$

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

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

Configuration of the Series 3500 transmitters to measure density of liquids.

The measurement task:

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

1. Calculate the value of the start of the range as follows:
 $H_{[\text{mm}]} \times (X\rho_{\min} - X\rho_{\text{oil}}) =$
 $= 3000 \times (0.6 - 1.068) = -1404 \text{ [mm H}_2\text{O]}$
2. Calculate the value of the end of the range as follows:
 $H_{[\text{mm}]} \times (X\rho_{\max} - X\rho_{\text{oil}}) =$
 $= 3000 \times (1.2 - 1.068) = 396 \text{ [mm H}_2\text{O]}$
3. Set the zero point of the transmitter with the diaphragm seals positioned at the same level.
4. Install the transmitter in its working position.
5. Make the electrical connections to the transmitter, providing for the possibility of using HART communication.
6. Connect the KAP-0'.I communicator, identify the transmitter and select the "configuration" function.
7. On the configuration menu select "reranging" procedure.
8. On the "reranging" menu:
 - a) change the measurement units to mm H₂O at 4°C;
 - b) enter the calculated values for the start (-1404) and end (396) of the range.

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

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



This symbol indicates waste electrical products should not be disposed of with household waste. Please recycle where facilities exist. Check with your Local Authority or retailer for recycling advice.

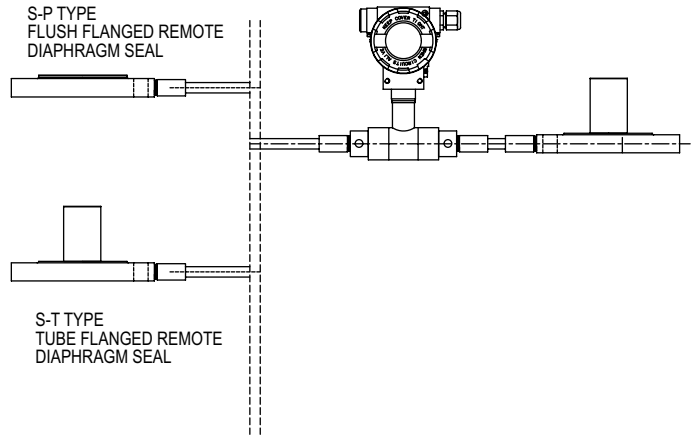


Figure 1: Series 3500 differential pressure transmitter with two remote diaphragm seals (examples)

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