D-Series
SMART Differential Pressure Transmitter with Two Diaphragm Seals
Models: DPR-2200

Key Features
- High accuracy ±0.1%
- 4-20mA analogue with digital communications
- Fully HART ® compatible
- Static pressure limit up to 420 bar
- ATEX certified (Intrinsic Safety, Flameproof)
- Fully welded sensor guarantees tightness of oil systems for long term usage
- Ability to locally configure measuring range

Series Overview
The D-Series pressure, differential pressure and temperature transmitters offer customers cost-effective and accurate solutions to their individual process requirements. Available with a wide range of process connections and easily configurable via the D-Soft software, the D-Series can be used for a variety of applications where pressure, differential pressure, temperature, level or flow measurements are needed. Other models in this series include:
- DPR-2000G SMART Differential Pressure Transmitter for low ranges
- DPC-2000 SMART Pressure Transmitter
- DPT-2000 SMART Temperature Transmitter
- DPR-2000 SMART Differential Pressure transmitter

Product Applications
The DPR-2200 is suitable for a wide range of applications for measuring:
- Differential Pressure
- Level
- Flow

The choice of models available ensures that the DPR-2200 is:
- Suitable for use in corrosive atmospheres
- Resistant to chemical attack

How can we help you?
Delta Controls offers fast, efficient and knowledgeable support when and where you need it. Please visit our website at www.delta-controls.com to find your local support centre or call us on:
+44 (0) 1252 729 140
The 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: level, density, phase boundaries and pressure differences (with differentiated height of pulse source points*).

In such a configuration, at ambient temperature changes, two opposite phenomena appear concurrently. Thermal expansion causes the change in the volume (and hence also the 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 upper diaphragm seal, which is displaced by the change in manometric fluid volume. Based on tests and experiments, the Delta transmitters are provided with carefully selected seal diaphragms which guarantee compensation of errors caused by changes in ambient temperatures.

The best metrological results are obtained using the assembly which include DN 80, DN 100, A 109 and S-Comp diaphragm seals or S-Mazut, S-DIN and S-Clamp diaphragm seals with a diameter of at least 65 mm, where the length of the capillary is (1-1.3) x (vertical spacing of seals). It is recommended to use identical diaphragm seals at the both upper and lower connection points.

* The difference in height of pulse source points, at which the hydrostatic pressure of the manometric fluid is comparable to or greater than the range of the transmitter.
Note: The appropriate configuration of the complete set of pressure transmitter, diaphragm seals and capillaries, as well as the proper selection of manometric fluid depends on several factors such as: the physical and chemical properties; the temperature range of the medium; the vertical spacing of the diaphragm seals; the measuring range; the static pressure range; the range of ambient temperatures; the technical specification for the mechanical connection of the diaphragm seals to the pressure devices.
Application & Construction

The differential pressure transmitter is applicable to the measurement of pressure differences of: gas, vapour and liquid, in cases where it is necessary to use seals and the pressure pulse source points may be several metres apart. Typical applications include the hydrostatic measurement of: level in closed tanks; density and phase boundaries; filter loss pressure differences between media in pasteurisers etc. The available range of the diaphragm seals allow measurement at great majority of media. The active element is a piezoresistant silicon sensor separated from the medium by a distance sealing systems. The special design of the measuring uni 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 66.

Configuration & Comms

The settings of the following metrological parameters can be changed:
♦ the units of pressure in which the range is configured
♦ stat and end points of the range, time constant
♦ inverted characteristic (output signal 20 ÷ 4mA)

The transmitter is configured and calibrated using a KAP-03 communicator, other communicators (HART) or a PC using an RS-HART converter and Delta D-Soft configuration software.

The data interchange with the transmitter enables users transmitter identification, as well as readings of the currently measured differential pressure value, output current and range width percentage.

Measuring Ranges

<table>
<thead>
<tr>
<th>Nominal measuring range (FSO)</th>
<th>Minimum set range</th>
<th>Vertical spacing of diaphragm seals</th>
<th>Maximum set range width, considering the actual vertical spacing of the diaphragm seals (m)</th>
<th>Static pressure limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>-160…160 mbar</td>
<td>0.1 m H₂O</td>
<td>1.7 m</td>
<td>40 bar</td>
<td>40 bar</td>
</tr>
<tr>
<td>-0.5…0.5 bar</td>
<td>0.5 m H₂O</td>
<td>6 m</td>
<td>40 bar</td>
<td>40 bar</td>
</tr>
<tr>
<td>-1.5…2 bar</td>
<td>1.5 m H₂O</td>
<td>15 m</td>
<td>16 bar</td>
<td>40 bar</td>
</tr>
<tr>
<td>-1.6…16 bar</td>
<td>1 bar</td>
<td>15 m</td>
<td>16 bar</td>
<td>40 bar</td>
</tr>
</tbody>
</table>

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

Metrological parameters

Accuracy ≤±0.1% (FSO)
**See DPR-2000ALW Differential Pressure Transmitter datasheet for other parameters
DPR-2000ALW

Sealing Effect Errors - see Diaphragm Seal datasheet

NOTE: The additional absolute zero error due to ambient temperature can be compensated by configuring the transmitter, seals and capillaries in accordance with the recommendations on the front page of this datasheet

Electrical parameters - see DPR-2000ALW Differential Pressure Transmitter datasheet

Operating conditions

Operating temperature range (ambient temperature) - 25-85°C
DPR-2200ALW/EEx - -25-80°C

Medium temperature range - see Diaphragm Seal datasheet

Special versions, certificates:
EExia - ATEX Intrinsic safety
EEexd - ATEX Explosion proof
100 bar, 160 bar - static pressure limit: 100bar or 160bar
Non-standard basic range
Others
Transmitters with HART protocol

**DPR-2200ALW**

[Diagram of DPR-2200ALW]

**Version: DPR-2200ALE**

With 0...5 or 0...20mA output signal

[Diagram of DPR-2200ALE]

### How to Order

<table>
<thead>
<tr>
<th>Model</th>
<th>Codes</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DPR-2200</td>
<td>ALW</td>
<td>Smart differential pressure transmitter.</td>
</tr>
<tr>
<td>Casing,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output signal</td>
<td>ALE</td>
<td></td>
</tr>
<tr>
<td>ALW/SS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Version, Certificates +</td>
<td>/Ex ia</td>
<td></td>
</tr>
<tr>
<td>+ more than one option is available</td>
<td>/Ex ib</td>
<td></td>
</tr>
<tr>
<td>/100bar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>/160bar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nominal measuring range</td>
<td>(-)</td>
<td></td>
</tr>
<tr>
<td>(+ not standard ranges available on request)</td>
<td>(-)</td>
<td></td>
</tr>
<tr>
<td>Measuring set range</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process connections</td>
<td>(+)</td>
<td></td>
</tr>
<tr>
<td>/US</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical connection</td>
<td>(-)</td>
<td></td>
</tr>
<tr>
<td>Accessories</td>
<td>/FI25</td>
<td></td>
</tr>
<tr>
<td>Other specification</td>
<td>(-)</td>
<td></td>
</tr>
</tbody>
</table>

**Description**

- DPR-2200: Smart differential pressure transmitter.
- ALW: Stainless steel housing, IP66/IP67, with display, output 4-20mA + Hart.
- ALE: Stainless steel housing, IP66/IP67, with display, output 4-20mA + Hart.
- ALW/SS: Aluminum housing, IP66/IP67, with display, output 4-20mA + Hart.
- /Ex ia: Ex ia IIC T4 Ga, static pressure limit - 100bar.
- /Ex ib: Ex ib IIC T5 Ga, static pressure limit - 160bar.
- /Ex ic: Ex ic IIC T6 Ga, static pressure limit - 250bar.
- /US: Packing gland M20x1,5.
- /FI25: Mounting bracket type F125 for 2" pipe, material 304ss.
- (-): Capillary length on (-) side of transmitter.
- (+): Capillary length on (+) side of transmitter.
- /US: Packing gland M20x1,5.
- Thread 1/2NPT Female.
- Description of required parameters.

**Range**

- 4-20mA
- 4-24mA
- 4-9mA
- 4mA

**Static pressure limit**

- 100bar
- 160bar

**Start and end of calibrated range in relation to 4mA and 20mA output**

- 160÷160mbar
- 0.5÷0.5bar
- 1.6÷2bar
- 1.6÷16bar

**Direct diaphragm seal or remote diaphragm seal mounted on the (+) side of the transmitter - code as given in the relevant diaphragm seal sheet**

**Remote diaphragm seal mounted on the (-) side of the transmitter - code as given in the relevant diaphragm seal sheet (chapter III - seals)**

**Capillary length on (+) side of transmitter**

**Capillary length on (-) side of transmitter**

**Packing gland available on request.**

**For pressures >250mbar**

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**Electrical Diagrams**

- Stainless steel housing, IP66/IP67, with display, output 4-20mA + Hart.
- Ex I M1 Ex ia I Ma (steel enclosure only).
- Ex II 1/2G Ex ia IIC T4/T5 Ga/Gb.
- Ex I M2 Ex d ia I Mb (steel enclosure only).
- Ex II 1/2G Ex ia/d IIC T6/T5 Ga/Gb.
- Ex II 1/2G Ex ia IIB T4/T5 Ga/Gb (version with Teflon shielded cable).
- For pressures >250mbar (not available for ALE).
- Ex II 1/2D Ex ia IIIC T85°C/100°C Da/Db.
- Ex II 1/2G Ex ia IIC T4/T5 Ga/Gb.
Directions for Use

To simplify the mathematical operations, we introduce the density coefficient of the medium, \( X_p \).

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

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

Configuration of the transmitter to measure the level of liquid in a tank

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

1. Install the transmitter in its working position on an empty tank.
2. Make the electrical connections of the transmitter, providing for the ability to use HART communication.
3. Connect the KAP-02 communicator, identify the transmitter and select the “configuration” function.
4. On the configuration menu select the “Reranging” procedure.
5. On the “Reranging” menu:
   a) change the units of measurement to mm H₂O at 4°C;
   b) enter the values for the start \( (X_p \times h_{\text{min}} [\text{mm}]) \) and end \( (X_p \times h_{\text{max}} [\text{mm}]) \) of the measurement range, namely 0 and \( (0.87 h_{\text{max}} [\text{mm}]) \) respectively;
   c) to compensate for the hydrostatic pressure of the manometric fluid, the start of the measurement range should be set using regulated pressure; when subject to the action of only the manometric fluid (empty tank) the transmitter will shift the stop and end-points of the range, compensating for the value of that pressure.

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

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

\[
\text{Start [mm H}_2\text{O]} = -H [\text{mm}] \times X_{\text{pol}}
\]

\[
\text{End [mm H}_2\text{O]} = \frac{h_{\text{max}} [\text{mm}]}{X_{\text{pol}}} - H [\text{mm}] \times X_{\text{pol}}
\]

- \( \rho_{\text{pol}} \) for DC-550 oil is equal to 1.068 g/cm³
- \( \rho_{\text{pol}} \) for AK-20 oil is equal to 0.945 g/cm³

Configuration of the transmitter to measure density of liquids

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

1. Calculate the value of the start of the range as follows:
   \[
   H_{\text{mm]}\times (X_{\text{pol}} - X_{\text{pol}}) = 3000 \times (0.6 - 1.068) = -1404 \text{ [mm H}_2\text{O]}
   \]
2. Calculate the value of the end of the range as follows:
   \[
   H_{\text{mm]}\times (X_{\text{pol}} - X_{\text{pol}}) = 3000 \times (1.2 - 1.068) = 396 \text{ [mm H}_2\text{O]}
   \]
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-03 communicator, identify the transmitter and select the “configuration” function.
7. On the configuration menu select “Reranging” procedure.
8. On the “Reranging” menu:
   a) change the measurement units to mm H₂O at 4°C;
   b) enter the calculated values for the start (~1404) and end (396) of the range.

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

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

**Measurement of phase boundary**

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

**Example:**

Calculate the measurement range start and end points for an DPR E-2200 transmitter configured to measure phase boundary height in the range 0–1000 mm between liquids of density \( \rho_1 = 0.7 \text{ g/cm}^3 \) and \( \rho_2 = 1.0 \text{ g/cm}^3 \), where the vertical spacing of the seals \( H = 1600 \text{ mm} \).

The sealing system uses DC -550 oil with a density of 1.068 g/cm³.

Additional remarks

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

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

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

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

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

\[
H[\text{mm}] \leq \frac{X_{P_{\text{min}}} - X_{P_{\text{oil}}}}{X_{P_{\text{max}}} - X_{P_{\text{oil}}}}
\]

\[
H[\text{mm}] \leq \frac{X_{P_{\text{oil}}}}{X_{P_{\text{max}}}}
\]

**Example:**

Determine the maximum vertical spacing of the seals for the DPR-2200 AL transmitter when measuring the density of liquid between 0.6 and 1.2 g/cm³. The sealing system uses AK-20 silicone oil with a density of 0.945 g/cm³.

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

\[
H[\text{mm}] \leq \frac{-1020}{0.6 - 0.945}
\]

\[
H[\text{mm}] \leq 2957
\]

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

\[
H[\text{mm}] \leq \frac{1020}{1.2 - 0.945}
\]

\[
H[\text{mm}] \leq 4000
\]

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