# VAISALA

## USER'S GUIDE

# Vaisala Multiparameter Transmitter DPT145 for SF$_6$ Gas

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# CHAPTER 1
# GENERAL INFORMATION

This chapter provides general notes for the manual and the DPT145.

## About This Manual

This manual provides information for installing, operating, and maintaining Vaisala Multiparameter Transmitter DPT145 for $SF_6$ Gas.

### Contents of This Manual

This manual consists of the following chapters:

- Chapter 1, General Information, provides general notes for the manual and the DPT145.
- Chapter 2, Product Overview, introduces the features, advantages, and the product nomenclature.
- Chapter 3, Functional Description, describes the primary application and the sensor technology of DPT145.
- Chapter 4, Installation, provides you with information that is intended to help you install the DPT145.
- Chapter 5, Operation, contains information that is needed to operate the DPT145.
- Chapter 6, Maintenance, provides information that is needed in basic maintenance of the DPT145.
- Chapter 7, Troubleshooting, describes common problems, their probable causes and remedies, and provides contact information for technical support.
- Chapter 8, Technical Data, provides the technical data of the DPT145.

# Version Information

**Table 1        Manual Revisions**

| Manual Code | Description |
|---|---|
| M211371EN-B | October 2011. This manual. Updated technical specification. Minor editorial corrections. |
| M211371EN-A | Previous version. |

# Related Manuals

**Table 2        Related Manuals**

| Manual Code | Manual Name |
|---|---|
| M211369EN | DPT145 Quick Guide |

# Documentation Conventions

Throughout the manual, important safety considerations are highlighted as follows:

| | |
|---|---|
| **WARNING** | Warning alerts you to a serious hazard. If you do not read and follow instructions very carefully at this point, there is a risk of injury or even death. |

| | |
|---|---|
| **CAUTION** | Caution warns you of a potential hazard. If you do not read and follow instructions carefully at this point, the product could be damaged or important data could be lost. |

| | |
|---|---|
| **NOTE** | Note highlights important information on using the product. |

# Safety

The DPT145 transmitter delivered to you has been tested for safety and approved as shipped from the factory. Note the following precautions:

| WARNING | Ground the product and verify outdoor installation grounding periodically to minimize shock hazard. |
|---|---|

| CAUTION | Do not modify the unit. Improper modification can damage the product or lead to malfunction. |
|---|---|

| CAUTION | Do not drop or hit the transmitter. The sensor is fragile and may break from a sudden shock. |
|---|---|
| | When transporting the transmitter, use the original shipping box from Vaisala. |

| CAUTION | Do not open the connection between the adapter and the transmitter. They are connected at the factory, and the connection should remain unopened to guarantee tightness. |
|---|---|
| | Use tools only on the nut of the adapter, where the transport protection cap is connected. |

| NOTE | Keep the transmitter dry and clean. |
|---|---|
| | Do not remove the yellow transport protection cap before you are ready to install the transmitter. Uncapped transmitters will absorb moisture which will affect the dewpoint measurement. |

| NOTE | Connect the transmitter directly to the main $SF_6$ gas volume, not behind a sampling line. |
|---|---|
| | After installation, the transmitter will have a small amount of moisture inside it. In still, dry gas it takes a long time until vapor pressure inside the measurement cell reaches equilibrium with the main gas tank. It is not unusual for the stabilization of the dewpoint reading to take several days after installation. |

## ESD Protection

Electrostatic Discharge (ESD) can cause immediate or latent damage to electronic circuits. Vaisala products are adequately protected against ESD for their intended use. It is possible to damage the product, however, by delivering electrostatic discharges when touching, removing, or inserting any objects inside the equipment housing.

To make sure you are not delivering high static voltages yourself:

- Handle ESD sensitive components on a properly grounded and protected ESD workbench.
- When an ESD workbench is not available, ground yourself to the equipment chassis with a wrist strap and a resistive connection cord.
- If you are unable to take either of the above precautions, touch a conductive part of the equipment chassis with your other hand before touching ESD sensitive components.
- Always hold component boards by the edges and avoid touching the component contacts.

# Recycling

| | |
|---|---|
|  | Recycle all applicable material. |

| | |
|---|---|
|  | Dispose of the unit according to statutory regulations. Do not dispose of with regular household refuse. |

# Regulatory Compliances

The Vaisala Multiparameter Transmitter DPT145 for $SF_6$ Gas is in conformity with the provisions of the following EU directive(s):

- EMC-Directive

Conformity is shown by compliance with the following standards:

- EN 61326-1: Electrical equipment for measurement, control, and laboratory use – EMC requirements – for use in industrial locations.
- EN 550022: Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement.

$$C\ \epsilon \qquad \underset{N17728}{\mathcal{C}}$$

# Patent Notice

The Vaisala Multiparameter Transmitter DPT145 for $SF_6$ Gas is protected by, for example, the following patents and their corresponding national rights:

Finnish patent 98861, French patent 6650303, German patent 69418174, Japanese patent 3585973, UK patent 0665303, and U.S. patent 5607564.

# Trademarks

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Windows® is a registered trademark of Microsoft Corporation in the United States and/or other countries.

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# Warranty

Visit our Internet pages for more information and our standard warranty terms and conditions: [www.vaisala.com/warranty](www.vaisala.com/warranty).

Please observe that any such warranty may not be valid in case of damage due to normal wear and tear, exceptional operating conditions, negligent handling or installation, or unauthorized modifications. Please see the applicable supply contract or Conditions of Sale for details of the warranty for each product.

# CHAPTER 2
# PRODUCT OVERVIEW

This chapter introduces the features, advantages, and the product nomenclature.

## Introduction to DPT145

Vaisala Multiparameter Transmitter DPT145 for $SF_6$ Gas is a digital transmitter with a non-isolated RS-485 output. Its compact size makes it well suited for integration into OEM systems.

DPT145 is always delivered with an integrated mechanical adapter: DILO DN20, ABB Malmkvist, or Alstom G1/2". The connection between the adapter and the transmitter is helium leak tested at the factory.

DPT145 combines online measurement of dewpoint, pressure, and temperature. DPT145 also calculates four other quantities, including $SF_6$ density.

**Table 3        Output Parameters of DPT145**

| Parameter | Abbreviation | Metric Unit | Non-Metric Unit |
|---|---|---|---|
| Dewpoint/frost point temperature* | Tdf | °C | °F |
| Dewpoint/frost point temperature*, converted to atmospheric pressure | Tdfatm | °C | °F |
| ppm moisture, by volume | H20 | ppm | ppm |
| Pressure, absolute | P | bara | psia |
| Pressure, normalized to 20 °C (68 °F) | Pnorm | bara | psia |
| Density | Rhoo | $kg/m^3$ | $kg/m^3$ |
| Temperature | T | °C | °F |

* When the dewpoint is below 0 °C, the transmitter outputs frostpoint for $T_d$

# Basic Features and Options

- Utilizes the Vaisala MPS1 multiparameter sensor with Vaisala's BAROCAP® and DRYCAP® technologies.
- Measurement ranges of measured parameters:
    - Dewpoint  -50 ... +30 °C (-58 ... +86 °F) $T_d$
    - Pressure, absolute 1 ... 10 bar (14.5 ... 145 psi)
    - Temperature -40 ... +80 °C (-40 ... +176 °F)
- Measurement is configurable for pure $SF_6$ or mixed gas.
- Non-isolated RS-485 digital output.
- Easy verification of dewpoint measurement with the Vaisala DRYCAP® Hand-Held Dewpoint Meter DM70.
- Delivered with an integrated mechanical adapter that must be specified during ordering. The adapter options are:
    - DILO DN20
    - ABB Malmkvist
    - Alstom G1/2"
- Optional accessories:
    - Weather shield: necessary for outdoor installations.
    - USB service cable for configuration and calibration.



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**Figure 1        DPT145 with DILO DN20 Adapter**

# Transmitter Parts
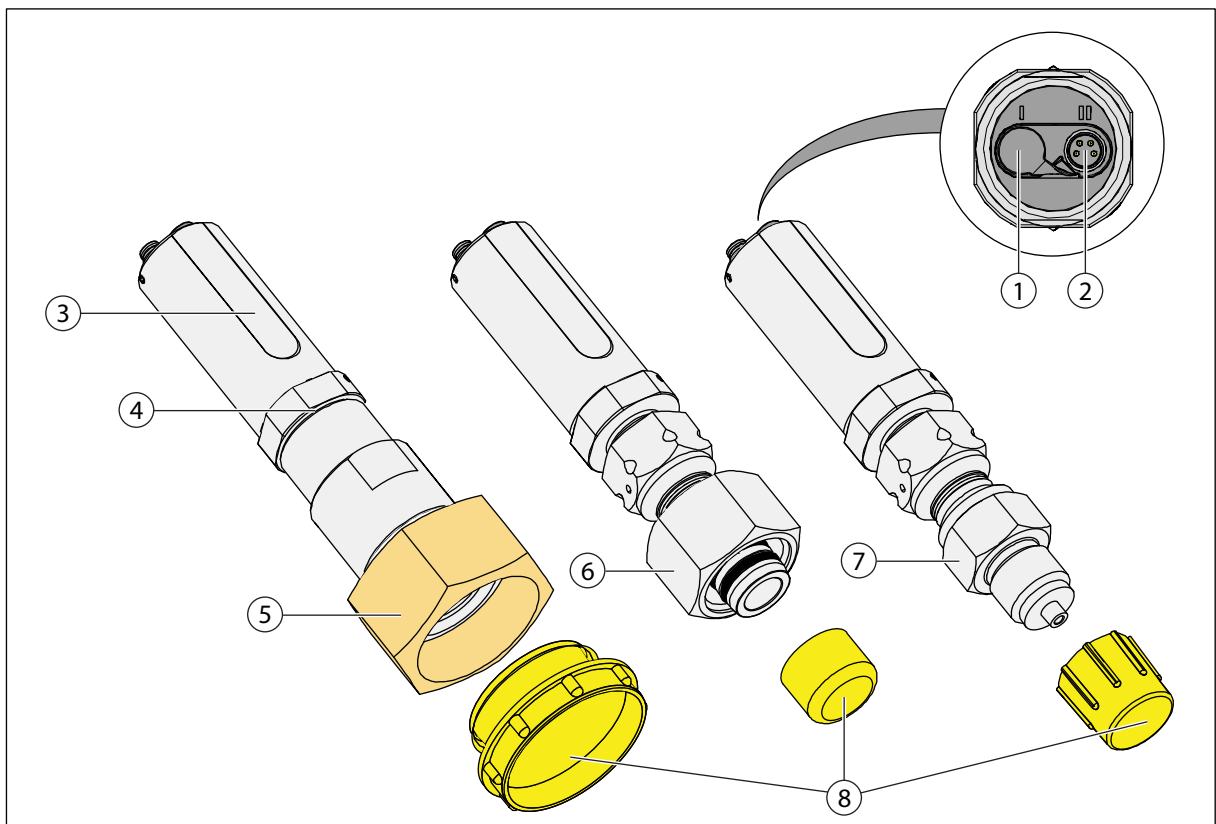


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**DPT145 Transmitter Parts and Adapters**

1 = Port I: Supply voltage only (optional, does not have to be used)
2 = Port II: RS-485 line and supply voltage
3 = Type label
4 = Connection between transmitter body and adapter – do not open
5 = DILO DN20 adapter: 50 mm nut with M45X2 inner thread
6 = ABB Malmkvist adapter
7 = Alstom G1/2" adapter
8 = Transport protection cap – remove only when ready to install

# Weather Shield

The transmitter and its connectors are rated IP65. However, installing the transmitter outside without protection is not recommended. The installation should be such that the transmitter is not exposed to direct rain, icing, or solar radiation.

A suitable weather shield is available from Vaisala. The weather shield is designed to clamp over the adapter, and to accommodate the available cable options.



1108-022

**Figure 2      Weather Shield**

DPT145 is assembled to the weather shield at the factory if the weather shield is ordered with the transmitter. Weather shields are also available separately.

# CHAPTER 3
# FUNCTIONAL DESCRIPTION

This chapter describes the primary application and the sensor technology of DPT145.

## Measurement Needs of SF$_6$ Insulation

Sulphur hexafluoride (SF$_6$) is used as an insulating gas in transmission and distribution equipment such as switchgears and circuit breakers. It effectively prevents arcing during switch-offs and protects equipment from failures.

In order to maintain SF$_6$ insulation properties and to reduce the formation of unwanted secondary decomposition products, the amount of water vapor in the gas insulated system (GIS) should be kept to a minimum. Also, the SF$_6$ system needs to be pressure tight for best insulation performance and safe operation of the equipment.

There is always some diffusion of water molecules from high ambient water vapor pressure to low vapor pressure inside the system. The more connection points the higher the diffusion rate. DPT145 is ideally suited to the online monitoring of dewpoint, pressure, and temperature in such a system. Sudden and minor leakages are immediately detected by the direct normalized pressure measurement, while online dewpoint measurement alerts the user to moisture issues.

With online monitoring, on-site visits can be kept to a minimum. The long calibration interval of DPT145 means practically service-free operation.

# Sensor Technology

## MPS1 Multiparameter Sensor

DPT145 combines Vaisala's proven DRYCAP® sensor technology
for industrial dewpoint measurement with BAROCAP® pressure
sensor technology. Both technologies are integrated on the same
MPS1 multiparameter sensor element, allowing for a highly compact
and versatile transmitter.
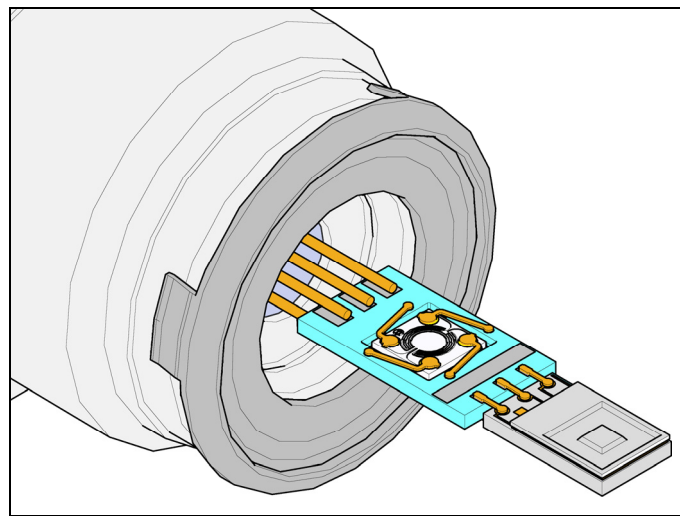


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**Figure 3        MPS1 Sensor**

There are several important advantages in using a transmitter with an
integrated sensor:

- Reduces installation work and cost.
- Improves the leak tightness of the system as connection points are
  minimized.
- Enables online monitoring of all supported parameters.

## DRYCAP® Technology

Vaisala DRYCAP® dewpoint measurement technology ensures
accurate measurement with excellent long term stability. This results
in very low maintenance requirements for the transmitter. The lasting
performance is achieved with microprocessor technology and
software that automatically performs self-diagnostic functions in
addition to the normal dewpoint measurement. The self-diagnostic
procedures that are conducted are called auto-calibration and sensor
purge.

## Auto-Calibration

The auto-calibration feature of the MPS1 multiparameter sensor is an automatic procedure which greatly reduces the possible drift in the dry end of the dewpoint measurement. It is performed at one hour intervals, and when the power is switched on. During auto-calibration the sensor is warmed for a short period (< 1 min) and the sensor capacitance values are evaluated at the elevated temperature. The possible dry end drift is then corrected to correspond to the calibrated values. During the auto-calibration the transmitter outputs the dewpoint value prior to the procedure.

Auto-calibration is carried out only if several criteria for the measurement environment are fulfilled. This ensures the reliability of the adjustments, and maintains the excellent long term stability. These criteria include, for example, a stable enough moisture level in the measured atmosphere. If the conditions are not fulfilled, the auto-calibration function is postponed until satisfactory conditions are reached.

## Sensor Purge

Sensor purge is also an automatic procedure that minimizes the drift at the wet end readings of the dewpoint measurement. Sensor purge is performed twice a day, and five minutes after the power is switched on. The sensor is heated for several minutes which will then evaporate all excess molecules out of the sensor polymer. This, together with the auto-calibration results in a very small drift of the sensor due to the very linear behaviour of the polymer technology.

# BAROCAP® Technology

The BAROCAP® silicon capacitive absolute pressure sensor was developed by Vaisala for barometric pressure measurement applications. The BAROCAP® sensor has excellent hysteresis and repeatability characteristics, low temperature dependence, and a very good long-term stability. The ruggedness of the BAROCAP® sensor is outstanding and the sensor is resistant to mechanical and thermal shocks. The pressure measurement of the MPS1 multiparameter sensor is based on an advanced RC oscillator and reference capacitors against which the capacitive pressure sensor is continuously measured. The microprocessor of the transmitter performs compensation for pressure linearity and temperature dependence.

# DPT145 Startup Sequence

When the transmitter is powered up, it will perform the sequence shown in Figure 4 below. After a five-second startup, the transmitter will measure normally for five minutes, after which it will perform the sensor purge and auto-calibration functions. This can take up to six minutes, during which time the output is frozen: it will display the last measured values before the sensor purge began.

Normal operation and output is typically achieved no later than 11 minutes after startup. The sensor purge will repeat every 12 hours, and auto-calibration every hour. The output will again be frozen for their duration.
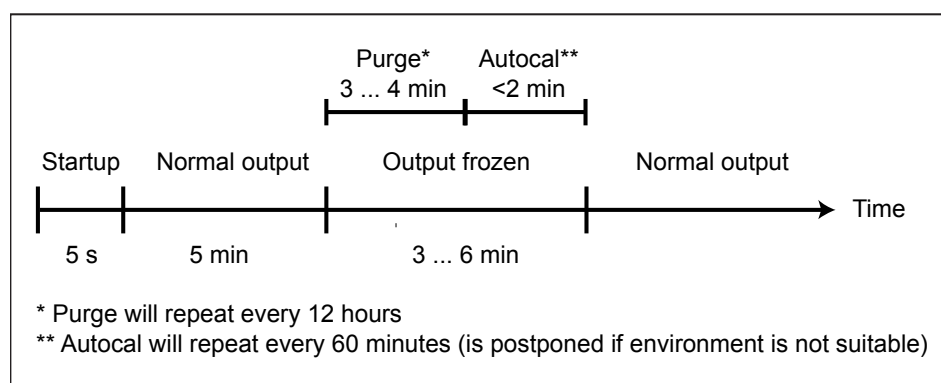


1108-033

**Figure 4        DPT145 Startup Sequence**

| NOTE | The transmitter always performs this sequence when starting up. Keep the transmitter continuously powered to optimize its measurement performance and availability. |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|

# CHAPTER 4
# INSTALLATION

This chapter provides you with information that is intended to help you install the DPT145.

## Transmitter Configuration Before Installation

Depending on your application, you may need to configure some transmitter features before physically installing it.

1.  By default, DPT145 transmitters are configured for single transmitter operation. Serial operation mode is **STOP** and address is **0**.

    To configure transmitters for operation on a common line, you must give each transmitter a unique address (range 0 ... 255) and set their serial operation mode to POLL.

2.  The default serial line settings may not be right for your RS-485 line.

3.  You may need to change the transmitter's settings for the measured gas. You can configure the mixing ratio of $SF_6$, and the molar weight of the other gas.

An easy way to configure the measured gas is to connect the DPT145 to the MI70 indicator using the MI70 connection cable (Vaisala order code 219980). You can change the settings in the **Measurement Settings** menu. See Figure 5 below.



1108-039
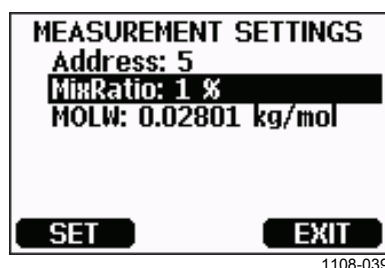
**Figure 5        DPT145 Configuration with the MI70 Indicator**

For full configuration options, use the USB service cable and a terminal program on a PC. Instructions for using the serial line and the serial commands are provided in Chapter 5, Operation, on page 31.

# Selecting the Location

Online dewpoint measurement in still gas is much more demanding than pressure or temperature measurement. A very tight installation is crucial: not only pressure tight, but also vapor tight.
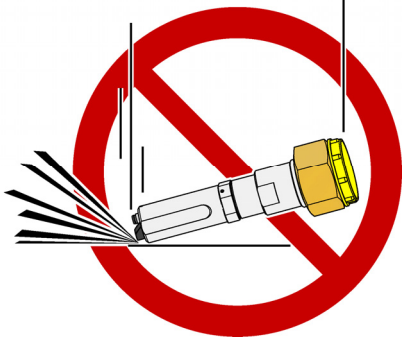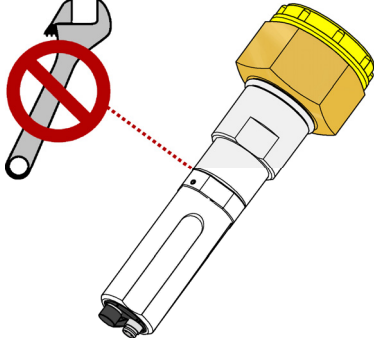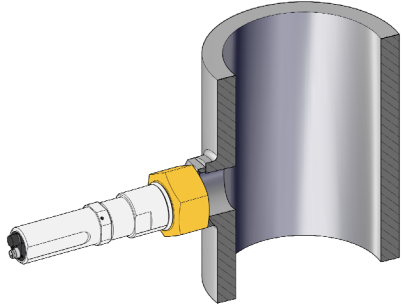
It is always best to connect the transmitter directly to the main $SF_6$ gas volume, **not behind a sampling line**. Avoid extension pipes, T-pieces, and multi-connection points.



1108-034

**Figure 6        Indoor Installation in a Circuit Breaker**

# Warning – Read Before Installation



## CAUTION

Do not drop or hit the transmitter. The sensor is fragile and may break from a sudden shock.

When transporting the transmitter, use the original shipping box from Vaisala.



## CAUTION

Do not open the connection between the adapter and the transmitter. They are connected at the factory, and the connection should remain unopened to guarantee tightness.

Use tools only on the nut of the adapter, where the transport protection cap is connected.



## NOTE

Keep the transmitter dry and clean.

Do not remove the yellow transport protection cap before you are ready to install the transmitter. Uncapped transmitters will absorb moisture which will affect the dewpoint measurement.



## NOTE

Connect the transmitter directly to the main $SF_6$ gas volume, not behind a sampling line.

After installation, the transmitter will have a small amount of moisture inside it. In still, dry gas it takes a long time until vapor pressure inside the measurement cell reaches equilibrium with the main gas tank. It is not unusual for the stabilization of the dewpoint reading to take several days after installation.

# Installation Without Weather Shield
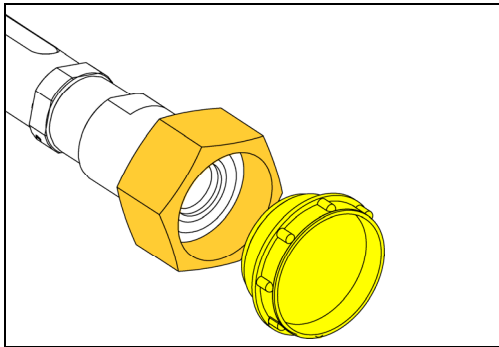


1. Remove the yellow transport protection plug when you are ready to install the transmitter.
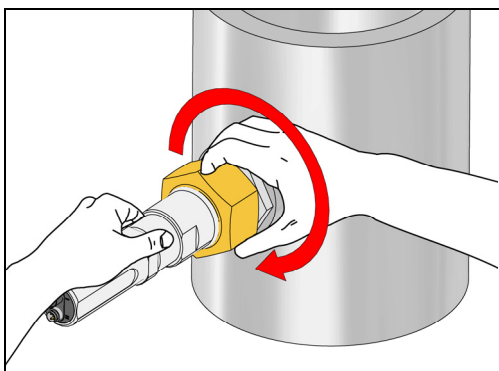


2. Install the transmitter to the mechanical coupling and tighten by hand.
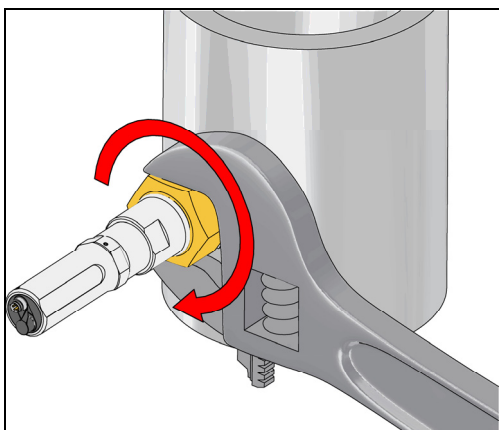


3. Use a wrench to tighten the connection. Turn from the adapter, not from the transmitter body!

   Use sufficient force to achieve a tight installation. The system must be leak-free for accurate measurement.
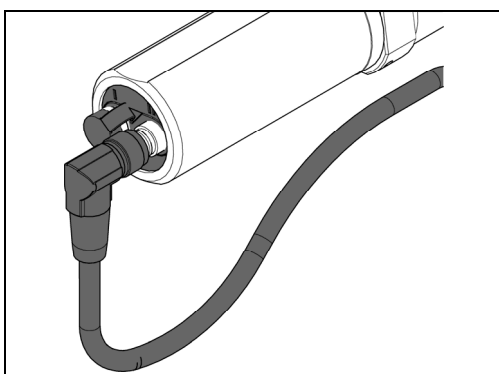


4. Connect the cable to port II on the transmitter.

   Use a cable with a suitable connector for your installation (straight or angled).

   Let some of the cable hang from the back of the transmitter, so that condensation cannot run along the cable to the transmitter.

# Installation With Weather Shield
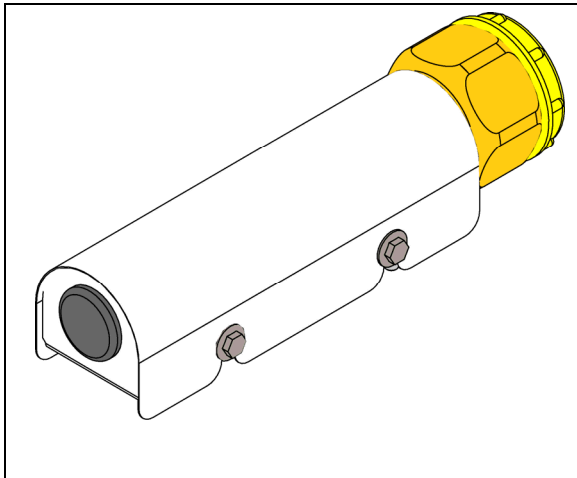


1. When DPT145 is ordered with the weather shield, the transmitter is delivered already attached to the shield.

   If you have ordered the weather shield separately, attach the transmitter to the weather shield before continuing this procedure. Fit the clamp of the weather shield over the adapter, not the transmitter body. For ABB Malmkvist and Alstom G1/2" type adapters, place the clamp over the notches in the adapter.
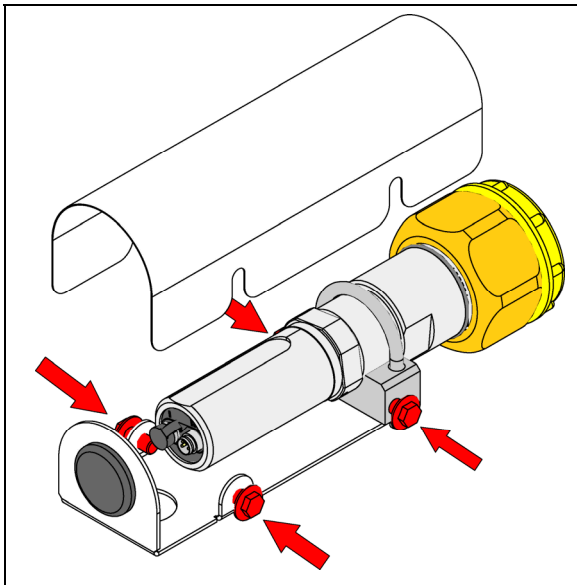


2. Use an 8 mm box-end wrench to loosen the four bolts that hold the weather shield cover. Remove the cover.

   It is not necessary to remove the bolts, they can remain in place during installation.
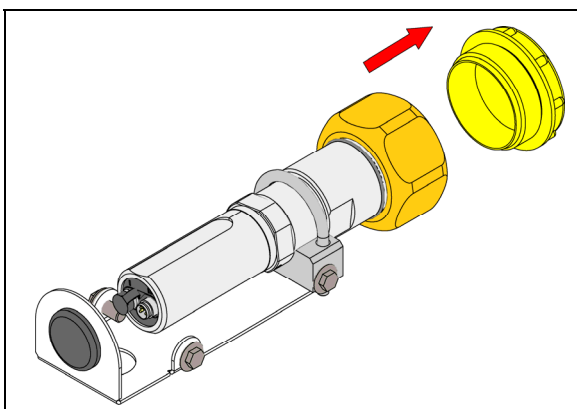


3. Remove the yellow transport protection plug. Make sure the surfaces are clean and dry.
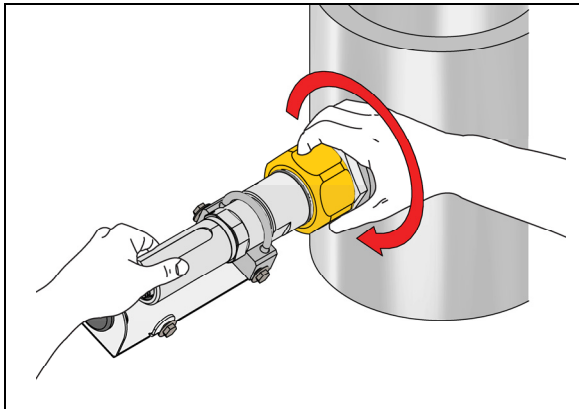
4. Install the transmitter to the mechanical coupling and tighten by hand. Try to keep the weather shield level.
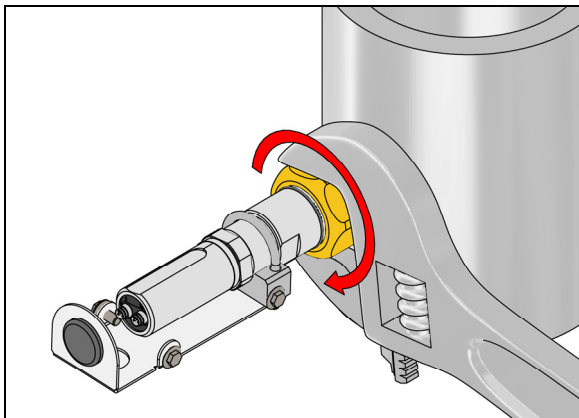


5. Use a wrench to tighten the connection. Turn from the adapter, not from the transmitter body!

Use sufficient force to achieve a tight installation. The system must be leak-free for accurate measurement.
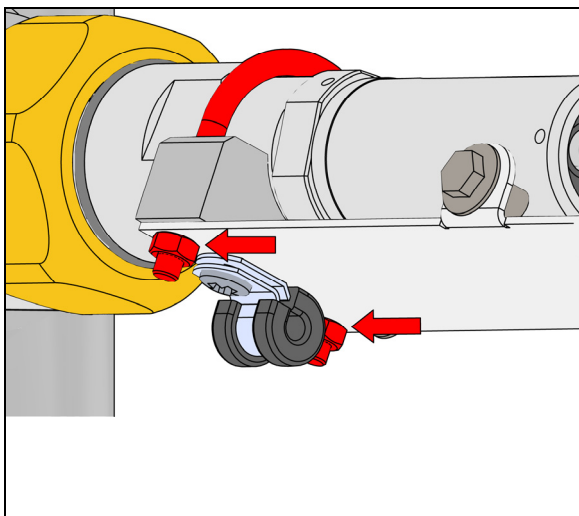


If the weather shield is tilted after the installation, you can straighten it by loosening the two nuts that keep the clamp tight. Tighten the nuts after weather shield is straight.

**Note**: The cable with the angled connector has a fixed direction, and is designed to be routed straight down from port II. If you rotate the transmitter inside the weather shield, or if you have the Alstom G1/2" type adapter, you may have to use a cable with a straight connector.
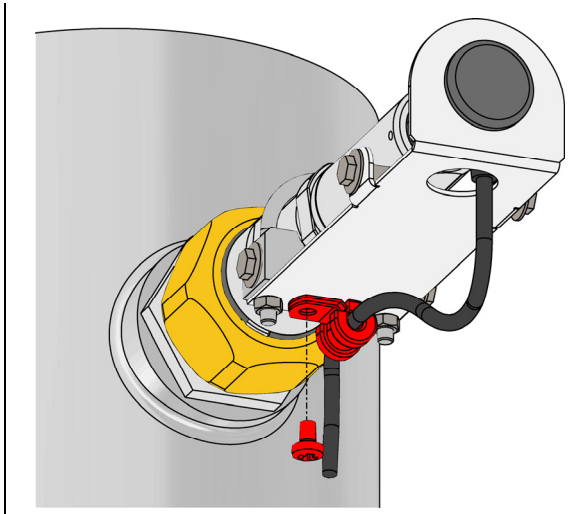
6. Connect the cable to port II on the transmitter, and route the cable to the cable clamp on the underside of the weather shield. Attach the cable using a crosshead screwdriver.

Note: Let some of the cable hang from the back of the transmitter, so that condensation cannot run along the cable to the transmitter.
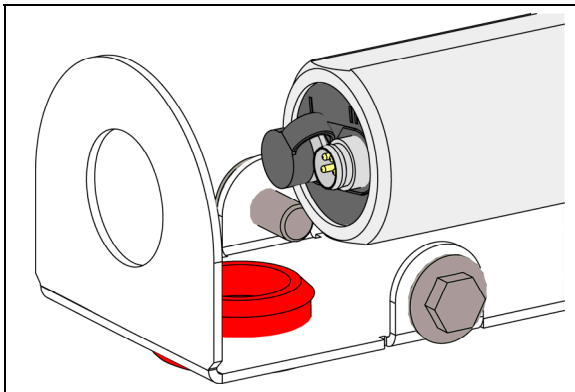
**For cables with a straight connector:** move the rubber plug to the bottom hole and route the cable from the back of the weather shield.
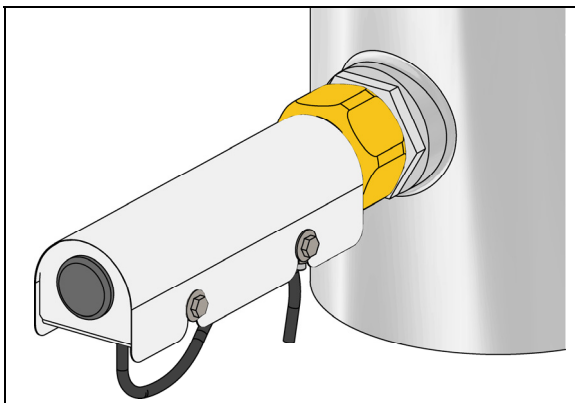
7. Replace the weather shield cover using an 8 mm box-end wrench.

# Wiring

## Standard Wiring

Connect supply voltage and RS-485 to port II. Port I does not need to be used at all, and can remain covered.
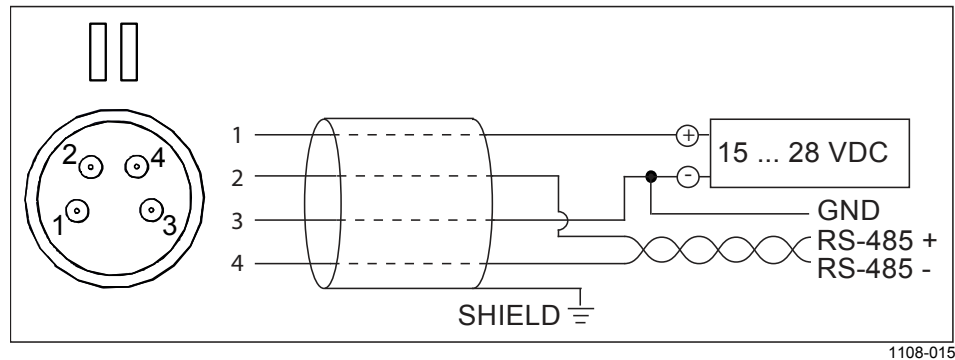


1108-015

**Figure 7        Wiring Non-Isolated RS-485**

**Wire Colors for Vaisala Cables**

| Pin | Connection on Port I | Connection on Port II | Wire Color |
|-----|---------------------|----------------------|-----------|
| 1 | VDC supply+ | VDC supply+ | Brown |
| 2 | | RS-485 D0- | White |
| 3 | GND | GND | Blue |
| 4 | | RS-485 D1+ | Black |

Note the following:

- The ground pin (pin 3) on both ports is internally connected to each other and to transmitter chassis. The chassis connection is through a 1 MΩ resistor and a 40 nF capacitor that are connected in parallel.
- The frames of the M8 connectors are not connected to the chassis.

## Alternate Wiring for Power Supply

If necessary, you can provide supply voltage using Port I, and only wire RS-485 for Port II. **Do not supply power from both ports**.



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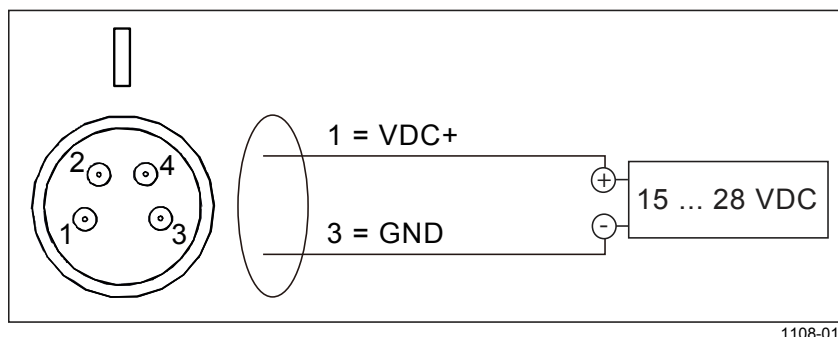
**Figure 8        Wiring Power Supply Using Port I**

# Stabilization of Dewpoint Reading After Installation

After installation, the transmitter will have a small amount of moisture inside it. In still, dry gas it takes a long time until vapor pressure inside the measurement cell reaches equilibrium with the main gas tank. It is not unusual for the stabilization of the dewpoint reading to take several days after installation.

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# CHAPTER 5
# OPERATION

This chapter contains information that is needed to operate the DPT145.

## Transmitter Start-Up

When the transmitter is connected to power supply, there is a delay of five seconds as the transmitter starts up. After the start-up is complete, the transmitter will behave according to the configured serial mode:

- In STOP mode, the transmitter outputs the transmitter model and software version.
- In RUN mode a measurement output starts immediately.
- In POLL mode the transmitter does not output anything after power-up.

For a description of the modes, see section Set Serial Line Operating Mode on page 44.

For a description of how the diagnostic functions of the sensor affect the availability of live measurement at start-up, see section DPT145 Startup Sequence on page 20.

# Serial Communication

## Connecting to the Serial Interface

DPT145 can be connected to a PC using the RS-485 line on
Port II. It is recommended that you use the USB service cable
(Vaisala order code 219690) for the connection, since the cable also
provides the  operating power from the USB port.

If you have not used the USB service cable before, install the driver
that came with the cable. Refer to section Installing the Driver for the
USB Service Cable below for detailed instructions.

### Installing the Driver for the USB Service Cable

Before taking the USB service cable into use, you must install the
provided USB driver on your PC. When installing the driver, you
must acknowledge any security prompts that may appear. The driver
is compatible with Windows 2000, Windows XP, Windows Server
2003, and Windows Vista.

1.     Check that the USB service cable is not connected. Disconnect
       the cable if you have already connected it.
2.     Insert the media that came with the cable, or download the
       driver from www.vaisala.com.
3.     Execute the USB driver installation program (setup.exe), and
       accept the installation defaults. The installation of the driver
       may take several minutes.
4.     After the driver has been installed, connect the USB service
       cable to a USB port on your PC. Windows will detect the new
       device, and use the driver automatically.
5.     The installation has reserved a COM port for the cable. Verify
       the port number, and the status of the cable, using the **Vaisala
       USB Instrument Finder** program that has been installed in the
       Windows Start menu.

Windows will recognize each individual cable as a different device,
and reserve a new COM port. Remember to use the correct port in the
settings of your terminal program.

There is no reason to uninstall the driver for normal use. However, if
you wish to remove the driver files and all Vaisala USB cable
devices, you can do so by uninstalling the entry for **Vaisala USB
Instrument Driver** from the **Add or Remove Programs (Programs
and Features** in Windows Vista) in the Windows Control Panel.

# Terminal Application Settings

The serial interface settings of the DPT145 RS-485 line are presented in Table 4 below.

**Table 4        Default Serial Interface Settings**

| Property | Description / Value |
|----------|---------------------|
| Baud rate | 19200 |
| Parity | None |
| Data bits | 8 |
| Stop bits | 1 |
| Flow control | None |

The steps below describe how to connect to the DPT145 using the PuTTY terminal application for Windows (available for download at www.vaisala.com) and a USB serial interface cable:

1. Connect the USB serial interface cable between your PC and the RS-485 port of DPT145 (port II).

2. Start the PuTTY application.

3. Select the **Serial** settings category, and check that the correct COM port is selected in the **Serial line to connect to** field.

   Note: You can check which port the USB cable is using with the **Vaisala USB Instrument Finder program** that has been installed in the Windows Start menu.

4. Check that the other serial settings are correct for your connection, and change if necessary. **Flow control** should be set to **None** unless you have a reason to change it.

5. Click the **Open** button to open the connection window and start using the serial line.

   Note: If PuTTY is unable to open the serial port you selected, it will show you an error message instead. If this happens, restart PuTTY and check the settings.

6. You may need to adjust the **Local echo** setting in the **Terminal** category to see what you are typing on the serial line. To access the configuration screen while a session is running, click the right mouse button over the session window, and select **Change Settings...** from the pop-up menu.
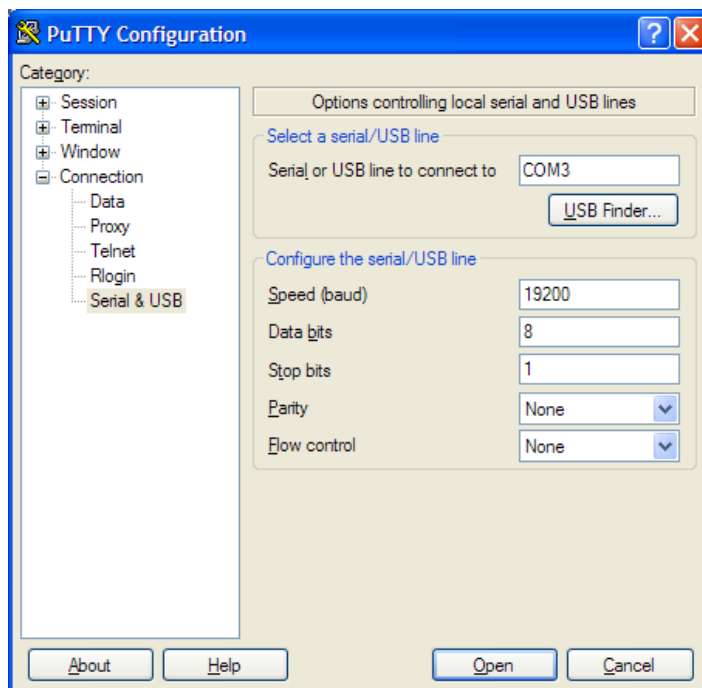
0807-004

**Figure 9        PuTTY Terminal Application**

# List of Serial Commands

All commands can be issued either in uppercase or lowercase. In the command examples, the keyboard input by the user is in **bold** type.

The notation <cr> refers to pressing the carriage return (**Enter**) key on your computer keyboard. Enter a <cr> to clear the command buffer before starting to enter commands.

**Table 5        List of Serial Commands**

| Command | Description |
|---|---|
| ? | Show device information |
| ?? | Show device information (overrides poll mode) |
| ADDR [0 … 255] | Show or set transmitter address |
| CLOSE | Close the temporary connection  and return the device to POLL mode |
| ERRS | Display the currently active errors |
| FORM [modifier string] | Set output format |
| FRESTORE | Restore factory settings |
| HELP | Show list of currently available serial commands |
| INTV [0 ... 255 S/MIN/H] | Set the continuous output interval (for RUN mode and R command) |
| OPEN [0 … 255] | Open a line to transmitter at defined address |
| R | Start the continuous outputting |
| RESET | Reset the transmitter |
| S | Stop the continuous outputting |
| SDELAY [0 … 255] | Set response sending delay |
| SEND [0 … 255] | Output readings once (specify address for transmitters in POLL mode) |
| SERI [baud p d s] | Show or set the serial interface settings |
| SMODE [mode] | Show or set startup serial mode: RUN, STOP, or POLL |
| SNUM | Display transmitter serial number |
| TIME | Show transmitter uptime |
| UNIT [m/n] | Select metric or non-metric units |
| VERS | Show transmitter firmware version |
| PNORMT [-100 ... 100] | Show or set the temperature for pressure normalization |
| MIXRATIO [0 ... 100] | Show or set ratio (%) of $SF_6$ in the measured environment |
| N2MOLW [weight] | Show or set molecular weight of other gas |

# Device Information

## Show Device Information

The **?** command outputs a listing of device information.

**?**<cr>

Command **??** is a similar command that is designed to be used if the transmitter is in POLL mode but its address is unknown. The transmitter will respond to the **??** command even while in POLL mode. Do not use the **??** command if you have more than one transmitter on an RS-485 line.

Example:

```
?
DPT145 1.0.23
Serial number  : F4040007
Batch number   : F3420050
Module number  : F3410001
Sensor number  : F1610000
Cal. date      : 20110907
Cal. info      : Vaisala/HEL
Time           : 02:41:01
Serial mode    :    STOP
Baud P D S     :    19200 N 8 1
Output interval:       5 S
Serial delay   :       10
Address        :        0
Mixing ratio   : 100.00% SF6 and   0.00% ideal gas
Ideal gas MolW : 2.8013401e-02 kg/mol
```

# Show Currently Active Errors

Use the **ERRS** command to display the currently active transmitter error messages. Possible errors and their causes are listed in Table 10 on page 54.

**ERRS**<cr>

Example:

```
errs
No errors
```

Example (one active error, caused by physical damage to the sensor):

```
errs
T MEAS error
```

# Show Command List

Use the **HELP** command to show a list serial commands:

**HELP**<cr>

Example:

```
help
ADDR
CLOSE
ERRS
FORM
FRESTORE
INTV
OPEN
R
RESET
SDELAY
SEND
SERI
SMODE
SNUM
TIME
UNIT
VERS
PNORMT
MIXRATIO
N2MOLW
```

### Show Firmware Version

**VERS**<cr>

Example:

```
vers
DPT145 1.0.23
```

### Show Serial Number

**SNUM**<cr>

Example:

```
snum
Serial number  : F4040007
```

# Serial Line Output Commands

## Start Measurement Output

Use the **R** command to start the continuous outputting of measurement values as an ASCII text string to the serial line. The format of the measurement message is set with the **FORM** command.

**R**<cr>

Example (measurement message in default format):

```
r
Tdf= 12.5 'C Tdfatm= 13.6 'C H2O= 15561 ppm  P=  0.947
bara Pnorm=  0.943 bara Rhoo=  1.1 kg/m3 T= 24.5 'C
Tdf= 12.5 'C Tdfatm= 13.6 'C H2O= 15563 ppm  P=  0.947
bara Pnorm=  0.942 bara Rhoo=  1.1 kg/m3 T= 24.5 'C
Tdf= 12.5 'C Tdfatm= 13.5 'C H2O= 15555 ppm  P=  0.948
bara Pnorm=  0.943 bara Rhoo=  1.1 kg/m3 T= 24.5 'C
...
```

Outputting the results continues in intervals issued with the command **INTV**. You can stop the output by pressing the **Esc** key, or with the command **S**. Since the interface is half-duplex, you must enter the commands when the transmitter is not outputting.

## Stop Measurement Output

You can stop the measurement output by pressing **ESC**, or with the **S** command:

**S**<cr>

## Set Output Interval

Use the **INTV** command to change the output interval of the automatically repeating measurement messages. The measurement messages are repeated in the RUN mode, or after the **R** command has been given.

**INTV** [*n xxx*]<cr>

where

n          =   time interval, range 0 ... 255
xxx        =   time unit = "S", "MIN", or "H"

The shortest output interval (with n = 0) outputs the measurement messages as quickly as the transmitter's internal measurement cycle produces them, without additional delay.

Example:

```
intv 1 min
Output interval:        1 MIN
```

## Output a Reading Once

Use the **SEND** command to output a single measurement message. The output message is sent in the format that has been set using the **FORM** command.

**SEND** [*address*]<cr>

where

address = Address of the transmitter, range 0 ... 255.

Specifying the address is only necessary if the target transmitter is in POLL mode, and has not been accessed with the OPEN command.

Example:

```
send
Tdf= 15.4 'C Tdfatm= 16.2 'C H2O= 18539 ppm  P=  0.959
bara Pnorm=  0.951 bara Rhoo=  1.1 kg/m3 T= 25.4 'C
```

# Configuring Measurement Parameters

## Set Mixing Ratio

Use the **MIXRATIO** command to set the mixing ratio of $SF_6$ and the other gas.

**MIXRATIO** [*ratio*]<cr>

where

ratio = Amount of $SF_6$ in the measurement environment, range 0 ... 100%.

Example:

```
mixratio 50
MIX RATIO       :  50.00 %
```

# Set Molar Weight of Other Gas

Use the **N2MOLW** command to set the molar weight of the other gas (not $SF_6$) in the measurement environment.

**N2MOLW** [*weight*]<cr>

where

weight = Molar weight of the other gas in kg/mol. The default is 2.8013401e-02, which is the molar mass of $N_2$.

Example:

```
n2molw
OTHER GAS MOLAR: 2.8013401e-02 kg/mol ?
```

# Set Pressure Normalization Temperature

Use the **PNORMT** command to set the temperature that is used to calculate the normalized pressure parameter.

**PNORMT** [*t*]<cr>

where

t = Temperature in Celsius, range -100 ... 100. The default is 20.

Example:

```
pnormt 20
P_NORM_T        :  20.00 'C
```

# Set Measurement Output Format

Use the serial line command **FORM** to change the measurement message sent by the transmitter. You can freely define the output message to include the desired parameters, formatting options, text strings, and additional fields.

**FORM** [*modifier string*]<cr>

where

modifier string  =  String of parameters and modifiers that defines the output format, length 1 ... 153 characters. Maximum length may be shorter when text strings are used. See Table 6 and Table 7 on page 43, and examples below.

You can return to the default format using the "**FORM /**" command.

Example of default output (continuous output from RUN mode):

```
Tdf=  8.1 'C Tdfatm=  8.2 'C H2O= 10870 ppm P=  1.002
bara Pnorm=  0.992 bara Rhoo=  6.0 kg/m3 T= 22.8 'C
Tdf=  8.1 'C Tdfatm=  8.2 'C H2O= 10878 ppm P=  1.002
bara Pnorm=  0.992 bara Rhoo=  6.0 kg/m3 T= 22.8 'C
...
```

Command to set output format as Tdf and P with Modulus-256 checksum:

```
form 3.1 "Tdf=" Tdf U3 3.3 "P=" P " " U4 " " CS2 \r \n
```

Output example:

```
Tdf= 12.5'C P=  0.949 bara 72
Tdf= 12.5'C P=  0.950 bara 6A
...
```

Command to set output format as Tdf and P, with **start of text** (ASCII character 002) and **end of text** (003) ASCII codes, and without line feed and carriage return at the end:

```
form #002 3.1 "Tdf=" Tdf U3 3.3 "P=" P " " U4 #003
```

Output example (ASCII codes not visible here):

```
Tdf= 11.6'C P=  0.952 baraTdf= 11.6'C P=  0.951 baraTdf=
11.6'C P=  0.951 baraTdf= 11.6'C P=  0.950 baraTdf=
12.5'C P=  0.951 baraTdf= 12.3'C P=  0.952 bara
...
```

**Table 6        FORM Command Parameters**

| Measured Parameter | Abbreviation in FORM Command |
|---|---|
| Dewpoint/frost point temperature | Tdf |
| Dewpoint/frost point temperature, converted to atmospheric pressure | Tdfa |
| ppm moisture, by volume | H20 |
| Pressure, absolute | P |
| Pressure, normalized | Pnorm |
| Density | Rhoo |
| Temperature | Ta |

**Table 7        FORM Command Modifiers**

| Modifier | Description |
|---|---|
| x.y | Length modifier (number of digits and decimal places) |
| #t | Tabulator |
| #r | Carriage-return |
| #n | Line feed |
| "" | String constant, length 1 ... 15 characters |
| #xxx | ASCII code value (decimal) of a special character; for example, **#027** for ESC |
| ADDR | Transmitter address (0 ... 255) |
| ERR | Currently active transmitter errors in a four bit field: bit0bit1bit2bit3bit4<br><br>bit0 T MEAS error<br>bit1 P out of range error<br>bit2 Fmeas error<br>bit3 Flash csum error |
| SN | Transmitter serial number |
| TIME | Time since transmitter was started or reset |
| Ux | Shows the name of the measurement unit using "x" number of characters. For example, **U3** shows the name of the measurement unit with three characters |
| CS2 | Modulus-256 checksum of message sent so far, ASCII encoded hexadecimal notation |
| CS4 | Modulus-65536 checksum of message sent so far, ASCII encoded hexadecimal notation |
| CSX | NMEA xor-checksum of message sent so far, ASCII encoded hexadecimal notation |

## Select Unit

Use the **UNIT** command to select metric or non-metric output units.

**UNIT** [*x*]<cr>

where

x = Selects the unit type to output:
    m = metric units, for example, Celsius
    n = nonmetric units, for example, Fahrenheit

Example:

```
unit m
Units            : Metric
```

# Configuring Serial Line Operation

## Set Serial Line Operating Mode

Use the **SMODE** command to set the start-up operating mode of the serial line.

**SMODE** [*mode*]<cr>

where

mode = STOP, RUN, or POLL.

**Table 8        Selection of Output Modes**

| Mode | Measurement Output | Available Commands |
|------|--------------------|--------------------|
| STOP | Only with the **SEND** command. | All (default mode). |
| RUN | Automatic output. | Only command **S.** |
| POLL | Only with the **SEND** [*addr*] command. | **SEND** [*addr*] and **OPEN** [*addr*]. Other commands available after opening a line to the transmitter using the **OPEN** command.<br><br>Use with RS-485 buses where multiple transmitters can share the same line. |

Selected output mode will be activated at next reset or power up.

Example:

```
smode poll
Serial mode   :      POLL
```

# Set Serial Line Settings

Use the **SERI** command to set the serial line settings. The new settings will be taken into use when the transmitter is reset or powered up.

Note that changing the serial line settings will slightly alter how the transmitter works with the MI70 indicator. If you are not using the default settings of 19200 N 8 1, you will have to power off the MI70 before it can find the transmitter (you will not be able to connect it on-the-fly).

**SERI** [*b p d s*]<cr>

where

| | | |
|---|---|---|
| *b* | = | baud rate (300, 600, 1200, 2400, 4800, 9600, or 19200) |
| *p* | = | parity (n = none, e = even, o = odd) |
| *d* | = | data bits (7 or 8) |
| *s* | = | stop bits (1 or 2) |

Example:

```
seri 9600 e 7 1
Baud P D S    :    9600 E 7 1
```

# Set Transmitter Address

To operate in the POLL mode, the transmitter must have an address. If multiple transmitters share the same serial line, each transmitter must have a different address.

For a description of the serial interface modes, see section Set Serial Line Operating Mode on page 44.

**ADDR** [*address*]<cr>

where

address      =     Transmitter address, range 0 ... 255.

Example:

```
addr
Address      :      0     ?
```

## Set Serial Line Response Time

With the **SDELAY** command you can set delay (response time) of the serial line, or view the currently set delay value. Increasing the value by one increases the delay by 4 milliseconds. For example, the default value is 10 which equals a ~40 ms answer delay.

**SDELAY** [*delay*]<cr>

where

delay   =   Serial line delay, range 0 … 255.


Example:

```
sdelay 20
Serial delay  :        20
```

# Other Commands

## Opening the Transmitter in POLL Mode

Use the **OPEN** command to connect to a transmitter that is in POLL mode.

**OPEN** [*address*]<cr>

where

address   =   Transmitter address, range 0 ... 255.


Example (target transmitter in POLL mode, with address 5):

```
open 5
DPT145  5 line opened for operator commands
```

# Closing the Connection to a Transmitter in POLL Mode

The **CLOSE** command closes the connection to a transmitter.

**CLOSE**<cr>

Example:

```
close
line closed
```

# Show Transmitter Uptime

Use the **TIME** command to show how long the transmitter has been operating since it was last reset or powered up.

**TIME**<cr>

Example:

```
time
Time             : 00:51:41
```

# Reset Transmitter

Use the **RESET** command to reset the transmitter.

**RESET**<cr>

When the **RESET** command is given, the transmitter will restart as if it had just been powered on. All transmitter settings are retained. The serial line mode of the transmitter will be set to the mode that was set using the **SMODE** command.

# Restore Factory Settings

Use the **FRESTORE** command to restore the factory settings to the transmitter. All user settings will be lost.

**FRESTORE**<cr>

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# CHAPTER 6
# MAINTENANCE

This chapter provides information that is needed in basic maintenance of the DPT145.

## Periodic Maintenance

### Cleaning

The body of the transmitter can be cleaned by wiping with a moistened lint-free cloth. Do not immerse the transmitter in liquid, and do not use cleaning agents or solvents.

### Calibration and Adjustment

DPT145 is fully calibrated as shipped from factory. If there is a reason to believe that device is not within the accuracy specifications, you can perform a field check using the DM70 hand-held dewpoint meter, or an MI70 indicator with another DPT145.

If the field check indicates that the DPT145 is not within its accuracy specifications, contact a Vaisala Service Center or your local Vaisala representative to have the DPT145 adjusted.

# Field Check Using an MI70 Indicator

Vaisala recommends the following equipment for field checking:

- A fully charged MI70 indicator (the measurement display that is included in the DM70 package)
- A calibrated reference probe that is suitable for the intended measurement environment and dewpoint range. The DMP74C probe is recommended for checking the dewpoint and temperature measurement accuracy. For checking all parameters, you can use another DPT145 transmitter as a reference.
- You also need a connection cable (Vaisala order code: 219980) to connect the DPT145 to the MI70 indicator. If you have two DPT145 transmitters, you need two cables.

| NOTE | In the procedure below, the readings of the transmitter and the reference probe are checked simultaneously. You can also check the reference probe and the DPT145 separately if they cannot be connected at the same time. |
|---|---|

Perform the check as follows:

1.  Place the reference probe and the DPT145 in the reference environment.
2.  Connect the reference probe and the DPT145 to the MI70 indicator:
    - Reference probe to Port I
    - DPT145 to Port II

3.  Turn on the MI70 indicator.
4.  Check and adjust the environment settings if prompted. Refer to the DM70 User's Guide for the settings of the DMP74C probe.
5.  Disable the **Auto power off** function of the MI70 indicator to prevent the indicator from powering off in the middle of the check. Check the setting in the **Settings** - **User Interface** menu, and change if necessary.
6.  The MI70 can display three parameters at one time. To compare the readings of the DPT145 and the reference probe, select the desired parameter from the **Display – Quantities and Units** menu of the MI70. Select the same parameter from port I and II, and the delta parameter that shows the difference between the two. For example, $\Delta T_{d/f}$ shows the difference in dewpoint between the two probes.
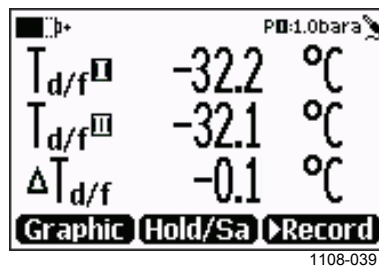
1108-039

**Figure 10        Comparing Dewpoint Readings on MI70**

7.    After the measurement has stabilized, check the difference
between the readings. It will give you an indication of the
approximate drift of the DPT145 and its need for calibration.
The difference between the readings should be no greater than
the combined measurement uncertainty of the DPT145 and the
reference probe.

8.    Write down the results and repeat the comparison for each
parameter you want to check.

9.    If adjustment is required, contact a Vaisala Service Center or
your local Vaisala representative to have the DPT145 adjusted.

| NOTE | Some notes on using the MI70 indicator with the DPT145: |
|---|---|
| | - If you disconnect the DPT145 while the MI70 indicator is on, the quantities measured will remain on the screen, but no measurement will be shown. |
| | - Temperature measured by the DPT145 is shown as parameter **Ta** (not T) in the MI70. |
| | - The messages from the transmitter will appear in English even if the MI70 has been set to another language. |

# Repair Maintenance

There are no user serviceable parts inside the transmitter. If there is a problem with your transmitter that you are unable to solve yourself or with the help of the Vaisala Helpdesk, contact a Vaisala Service Center to have the transmitter repaired.

For troubleshooting instructions and Vaisala contact information, see Chapter 7, Troubleshooting, on page 53.

# CHAPTER 7
# TROUBLESHOOTING

This chapter describes common problems, their probable causes and remedies, and provides contact information for technical support.

## Solving Typical Problems

Some problems can be solved by simply resetting the transmitter. You can reset the transmitter by disconnecting the power or issuing the **RESET** command using the service port.

If resetting does not help, and if the problem is related to transmitter software or settings, you can restore the factory configuration of the transmitter by issuing the **FRESTORE** command. If you are unable to solve your problem with the transmitter, contact Vaisala technical support. See section Technical Support on page 55.

**Table 9          Troubleshooting Table**

| Problem | Possible Causes and Solutions |
|---|---|
| Dewpoint reading is not stable after installation: reading indicates slow drying. | This is normal behavior after installation. See section Stabilization of Dewpoint Reading After Installation on page 29. |
| Pressure reading is not stable: reading indicates falling pressure. Dewpoint temperature may be rising. | Leak in the measurement environment. Locate and repair the leak. |
| Transmitter outputs stars "****" instead of measurement data | Possible causes: damaged sensor, incorrect supply voltage, and unsuitable measurement environment.<br><br>Power cycle or reset the transmitter, and see if the problem continues. Check the active errors using the **ERRS** command. Check the power supply. |
| Unable to access transmitter on the RS-485 line. | Possible causes: Incorrect wiring, unknown serial settings, transmitter in POLL mode with unknown address.<br><br>Check wiring. Try connecting as instructed in section Unknown Serial Settings on page 54. Issue the **??** command to make the transmitter respond in POLL mode. |

# Error Messages

The transmitter has error codes that can be displayed on the serial line using the **ERRS** command. See section Show Currently Active Errors on page 37.

Table 10          Error Messages

| Error Message | Possible Cause and Solution |
|---|---|
| T MEAS error | MPS1 sensor damaged or missing. |
| F meas error | Contact a Vaisala service center. |
| Voltage error | Supply voltage out of range. |
| Voltage too low error | Check and correct. |
| Program flash check sum error | Internal transmitter error. If the error remains after a reset and restoring the factory settings, contact a Vaisala service center. |
| Parameter flash check sum error | |
| INFOA check sum error | |
| SCOEFS check sum error | |
| CURRENT check sum error | |

# Unknown Serial Settings

If you are not sure what the current serial settings of your transmitter are, follow the steps below to connect to the transmitter. This procedure assumes you have the USB service cable available.

For more information on the USB service cable and the PuTTY terminal application, see section Serial Communication on page 32.

1.   Connect the USB service cable to your PC, but do not connect it to the transmitter yet.

2.   Start a terminal application and open a terminal session using the default serial settings of 19200 8 N 1.

3.   Plug the USB service cable into the transmitter, and immediately send the hash character # to the serial line:

     #

4.   The normal startup of the transmitter is now interrupted, and the transmitter is available for commands with the default serial settings.

5.   You can now check the transmitter's information by issuing the **?** command:

     ?

     The transmitter's currently stored serial settings are visible on the line marked **Baud P D S**.

# Technical Support

For technical questions, contact the Vaisala technical support by e-mail at helpdesk@vaisala.com. Provide at least the following supporting information:

- Name and model of the product in question
- Serial number of the product
- Name and location of the installation site
- Name and contact information of a technically competent person who can provide further information on the problem.

# Product Returns

If the product must be returned for service, see www.vaisala.com/returns.

For contact information of Vaisala Service Centers, see www.vaisala.com/servicecenters.

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# CHAPTER 8
# TECHNICAL DATA

This chapter provides the technical data of the DPT145.

## Specifications

**Table 11        Measured Parameters**

| Parameter | Measured Range |
|---|---|
| Dewpoint | -50 ... +30 °C (-58 ... +86 °F) |
| Pressure, absolute | 1 ... 10 bar (14.5 ... 145 psi) |
| Temperature | -40 ... +80 °C (-40 ... +176 °F) |

**Table 12        Calculated Parameters**

| Parameter | Measured Range |
|---|---|
| Pressure, normalized to 20 °C (68 °F) | 1 ... 12 bara (14.5…174 psia) |
| $SF_6$ or $SF_6/N_2$ mixture density | 0 ... 100 kg/m$^3$ |
| ppm moisture, by volume | 40 ... 40 000 ppm |
| Dewpoint, converted to atmospheric pressure | -65 … +30 °C (-85 ... +86 °F) |

**Table 13        Performance**

| Property | Description / Value |
|---|---|
| Dewpoint accuracy | ±3 °C (±5.4 °F), see Figure 11 on page 58 |
| Dewpoint stability | typical drift < 2 °C (3.6 °F)/5a |
| Pressure accuracy at 23 °C (73.4 °F) | ±0.4 %FS |
| Pressure temperature dependence | ±0.1 % FS/10 °C (18 °F) |
| Temperature accuracy<br>    0 ... +40 °C (+32 ... +104 °F)<br>    -40 ... +80 °C (-40 ... +176 °F) | <br>±0.5 °C (± 0.9 °F)<br>±1 °C (± 1.8 °F) |
| Density accuracy (pure $SF_6$, 1 ... 10 bara)<br>    0 ... 40 °C (+32 ... +104 °F)<br>    -40 ... +60 °C (-40 ... +140 °F) | <br>±1 %FS<br>±2.2 % |
| ppm accuracy, typical<br>(5 ... 1000 ppm, 7 bar) | <br>±(7 ppm + 15 % of reading) |
| Sensor response time<br>    Pressure response time<br>    Dewpoint response time*<br>    63% [90%] at 20°C and 1 bar<br>        -50 -> -10 °C Tdf<br>        -10 -> -50 °C Tdf | <br>< 1 s<br><br><br>5 s [10 s]<br>10 s [2.5 min] |

* system equilibrium related response time is typically longer
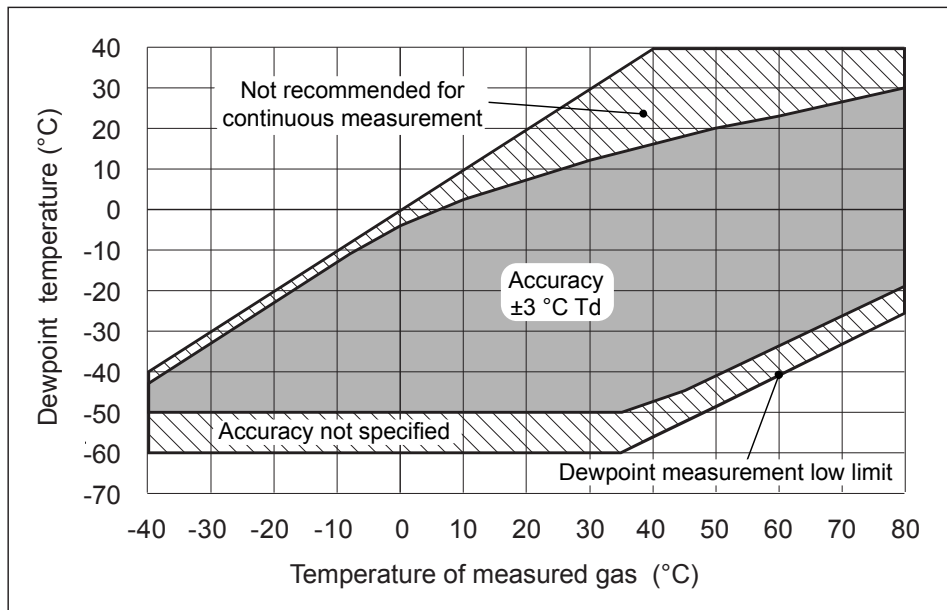
1107-032

**Figure 11     DPT145 Dewpoint Measurement Accuracy**

**Table 14     Operating Environment**

| Property | Description / Value |
|---|---|
| Operating temperature of electronics | -40 … +60 °C (-40 ... +140 °F) |
| Pressure | 0 … 50 bar (0…725 psi) |
| Relative humidity | 0 ... 100 % |
| Measured gases | $SF_6$ <br> $SF_6/N_2$ mixture |

**Table 15     Outputs**

| Property | Description / Value |
|---|---|
| Digital output | RS-485, non-isolated, Vaisala protocol |
| Connector | 4-pin M8 |

**Table 16      General**

| Property | Description / Value |
|---|---|
| Sensor | Vaisala MPS1 multiparameter sensor |
| Operating voltage | 15 ... 28 VDC<br>20 ... 28 VDC in cold temperatures<br>(-40 ... -20 °C (-40 ... -4 °F)) |
| Supply current<br>    during normal measurement<br>    during self-diagnostics | <br>20 mA<br>max 300 mA pulsed |
| Housing material | AISI316L |
| Housing classification | IP65 (NEMA4)<br>Weather shield to be used for<br>continuous outdoor installations |
| Storage temperature range<br>    transmitter only<br>    shipment package | <br>-40 … +80 °C (-40 ... +176 °F)<br>-20 … +80 °C (-4 ... +176 °F) |
| Mechanical connection | DILO DN20, ABB Malmkvist, or<br>Alstom G1/2" compatible connector |
| Weight (with DILO adapter) | 765 g (27.0 oz) |
| Electromagnetic compatibility | Complies with EMC standard<br>EN61326-1, Electrical equipment for<br>measurement, control and laboratory<br>use - EMC requirements; Industrial<br>environment |
| Tested levels<br>    EN/IEC 61000-4-2,<br>    Electrostatic Discharge<br>    EN/IEC 61000-4-3,<br>    RF field immunity<br>    EN/IEC 61000-4-4,<br>    Electric Fast Transient<br>    EN/IEC 61000-4-5, Surge<br><br><br>    EN/IEC 61000-4-6,<br>    Conducted RF Immunity | <br><br>8kV con / 15kV air<br><br>10V/m (80MHz-4.2GHz)<br><br>±2kV power and signal<br>±2kV power line to ground<br>/ ±1kV signal line to ground<br>and power line to line<br><br>10Vemf  power line and digital output |
| Mechanical vibration<br>    EN/IEC 60068-2-6,<br>    Fc Sinusoidial vibration | <br><br>±6 g,<br>5-500 Hz sweep 60 min/axis, 3-axis |

# Spare Parts and Accessories

Table 17        DPT145 Spare Parts and Accessories

| Description | Order Code |
| --- | --- |
| Connection cable for MI70 Indicator / DM70 Dewpoint Meter | 219980 |
| USB connection cable | 219690 |
| Protection plug for connector | 218675SP |
| 1.5 m Shielded PUR cable with 90° connector | 231519SP |
| 3m Shielded PUR cable with 90° connector | 231520SP |
| 5 m Shielded PUR cable with 90° connector | 231521SP |
| 10 m Shielded PUR cable with 90° connector | 231522SP |
| 3.0m Shielded FEP cable with straight connector | 226902SP |
| Weather shield | ASM210326SP |

# Dimensions in mm
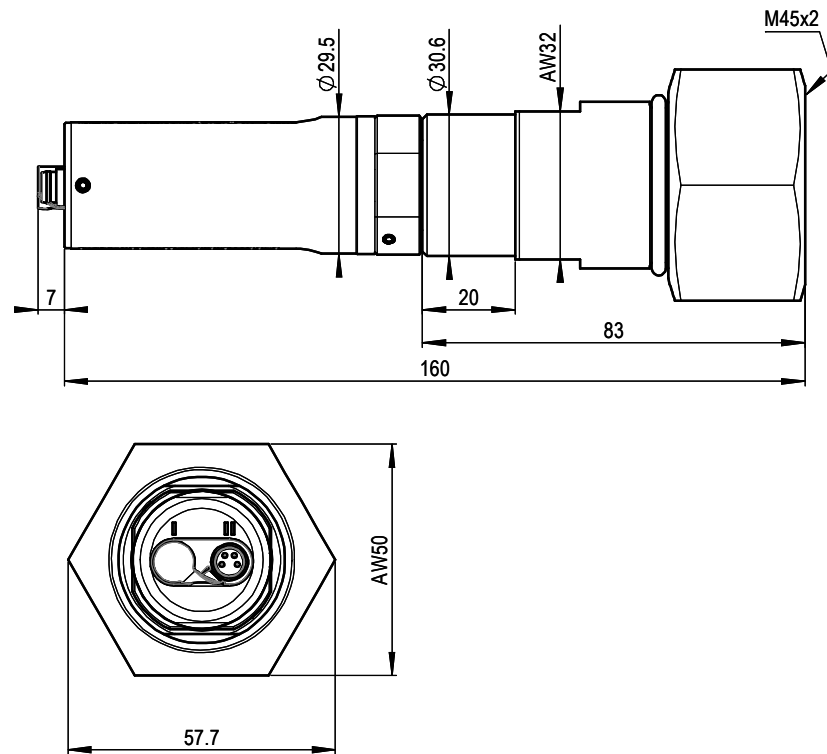


1108-017

**Figure 12        DPT145 with DILO DN20 Adapter**
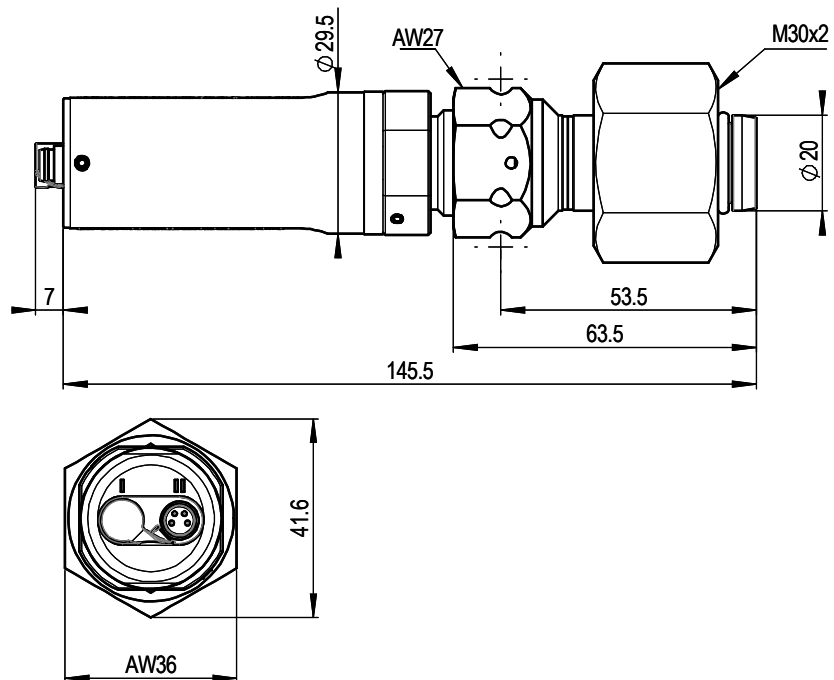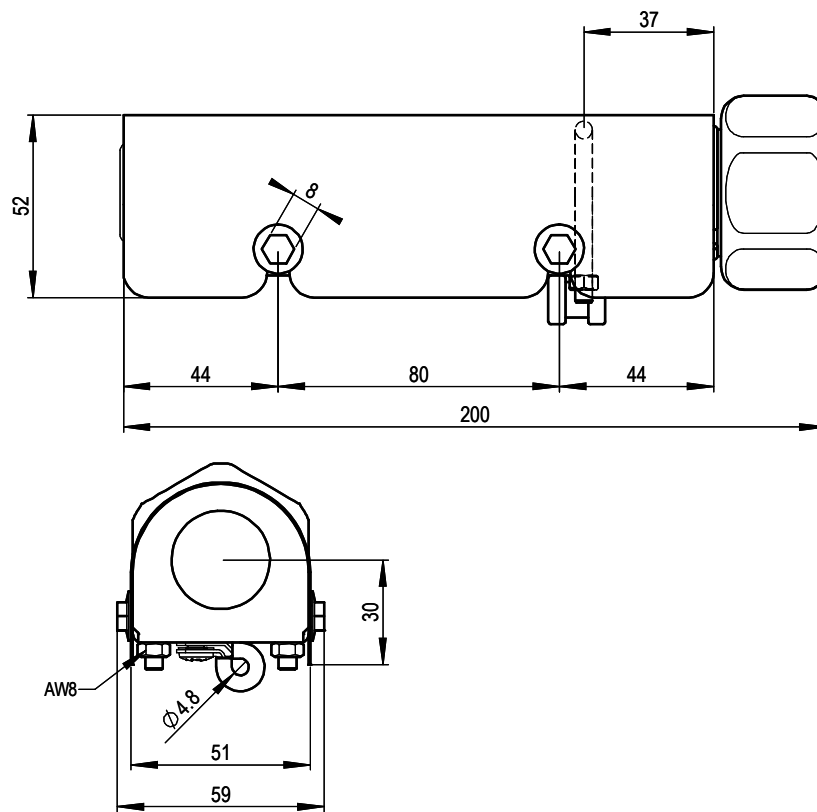


1108-018

**Figure 13        DPT145 with ABB Malmkvist Adapter**
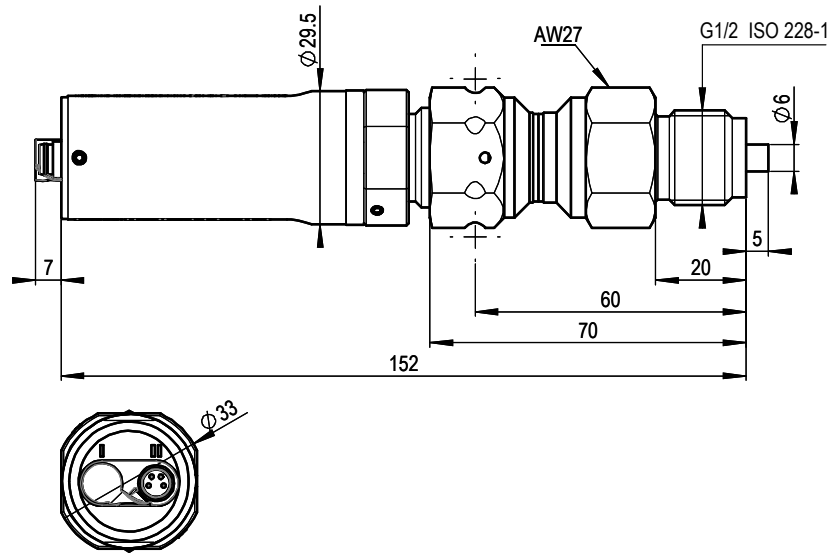
1108-019

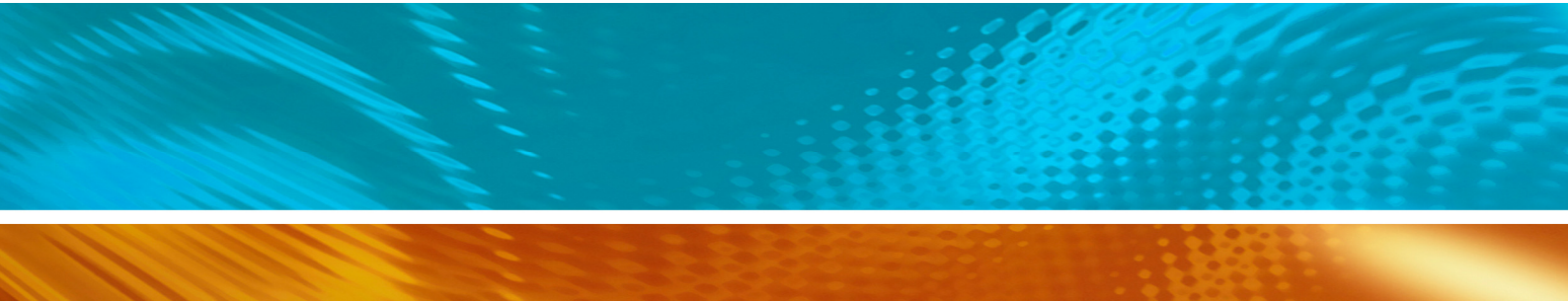**Figure 14     DPT145 with Alstom G1/2" Adapter**



1108-020

**Figure 15     DPT145 with DILO DN20 Adapter and Weather
Shield**

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