PRESSURE DEW POINT TRANSDUCER
TPT-20 / TPT-60

Functional description and operating instructions

List of Contents

1 Scope of supply

The Pressure dew point transducer is supplied in ready-to-use condition. The scope of supply includes a test certificate, a connection plug DIN EN 175 301-803-C as well as a detailed manual.

Additionally, you may require these items, if necessary:

- Measuring chamber and diversion capillary(accessories)
- Power supply unit 24 V DC / 250 mA (accessories)
- 1/2“ T-piece as measuring chamber, Bypass, reduction or interconnection joints, if direct mounting is to be done on a pipeline
- Compressed air hose (ATTENTION! Use only PTFE hose!)
- Display and regulation device for evaluation of signals
- Electrical accessories like isolation amplifiers for connection to super level regulation system

The operating instructions of this device should be read before commissioning. Besides operating instructions, you will also find important information on mounting, commissioning and trouble shooting in the relevant chapters.

2 General dangers and precautions

Please carefully read the following precautions before putting into operation! The symbols used in the operating manual are to make you careful, before hand, regarding safety considerations and dangers. But all these symbols used cannot substitute the text of the associated safety instructions in any way. Therefore, the instructions should also be always read completely!

This symbol indicates likely danger for persons, material or environment. The information provided in the associated text should be duly followed to avoid any kind of risk.

This symbol refers to important application notes and tips, which are necessary for successful working and should be absolutely followed to ensure good results.

2.1 Safety instructions for electrical connection

The device should be operated only with safe low voltage. All other electrical connections of the device should be made with only electronic components which work on safe low voltage.

Therefore, fitment and maintenance of the regulator shall be carried out by only trained personnel. Mounting and servicing operations should be carried out only after switching off the voltage.

Touching the plug or other electronic components should also be avoided in switched off condition. Electronic components can get damaged due to electrostatic discharge process.

The product is not meant for systems, which perform safety related functions. In normal operation also, there is always a danger of malfunctioning, for example because of over voltage or failure of components. The user has to ensure that there are no consequential damages due to malfunctioning or undefined device status. This can be achieved, for example, through redundant components or protection circuits.

Due to wrong tightening torque applied on screws of the connection terminals or by use of inappropriate tool, the terminals can get damaged because of which the insulation or the contact can get disturbed. Badly connected leads can come out during operation and cause a serious risk to safety. Wrongly wired connections can destroy electric components and cause other damages.

2.2 Safety instructions for compressed air systems

These safety regulations are to protect you from dangerous situations or damages.
For ensuring compatibility or suitability of selected components, the technical designer is responsible, who prepares the plan for the system or decides the specification of components. Since our components can be used under diverse operating conditions, the decision for a certain application may be decided only after exact analysis and/or test, so that the fulfilment of specific requirements are verified.

The commissioning of the component is forbidden till one establishes that the machine as well as the system where the component is being used complies with the regulations of EG-guidelines for machines 91/368 EWG.

Pneumatically operated machines or systems should be driven by only trained personnel. Compressed air can be dangerous, if a user is not familiar with its handling. Mounting, commissioning and maintenance of compressed air systems should be done by only trained and experienced personnel.

Maintenance work in the machines or in the plant or extension of individual components should be done only when the plant is in a safe condition and guarded against inadvertent starting.

Before commencing any mounting or maintenance work, the plant must be made pressure free and air to be released.

The energy stored in the compressed gas can lead to unforeseen events causing damage to objects or injury to persons. The risk increases with the operating pressure in the plant. Therefore, all activities are to be executed by only suitably trained personnel. For all activities in the compressed air system, a commensurate alertness is necessary in order to avoid damages!

The loud air release noise, in case of uncontrolled opening of lines under pressure, can damage the hearing or create panic to other persons in the vicinity.

At high flow velocities, the swept along foreign bodies can act like projectiles and cause injury to skin or eyes.

2.3 Product specific safety instructions

The pressure dew point transducer is suitable up to 17 bar at 60 °C. This maximum allowable operating pressure and the maximum operating temperature should not be exceeded. Components connected in series should also be rated as per the operating pressure and application temperature of the plant.

The materials NBR, Viton, Epoxy resin and aluminium have been used inside the device. The media compatibility of these materials should be checked by the user.

3 Important application notes

3.1 Avoiding damage to the measuring probe

Instruments are sensitive and must be treated carefully: Avoid impact, shocks and vibration. The sinter filter protects the sensor against mechanical effects and contamination. Do not remove the filter. Use the measuring probe only with sinter filter in intact condition!

Before installation, ensure that the measuring point has no condensed water, oil or dirt secretion ! If this is the case, then first put the system in order and dry up!

The measuring system is not suitable for strong oil laden compressed air, since an oil film on the sensor directly restricts the response behaviour, chokes the pores of the filter and damage the diverting throttle.

General principle: If you have doubts, you should contact the manufacturer, before you risk errors and damage by experimenting on the object!

3.2 Calibration and measuring accuracy

Before delivery, the pressure dew point transducers are adjusted and checked at multiple temperature and humidity points through a sophisticated calibration process. An adjustment by the end user is not possible.
The calibration is done as per procedures which can have repeatability of PTB national standards. Before delivery, the sensors are checked at one reference point and the test certificate is also supplied together.

Please observe the permissible application temperature range. The measuring accuracy becomes worse at high temperatures. Exceeding the temperature limit damages the measuring probe.

The specified data, specially the achievable measuring accuracy, is applicable at 20 °C. General principle: lower is the temperature at the probe, more exact is the result of measurement. If possible, the measurement should be taken at a cold point or the gas can be cooled down to ambient temperature.

The reference cells available as accessories are ideally suitable to check the measuring accuracy up to approx. -10 °C tpd. The application guidelines must be duly followed and before application, the cells are to be checked as per the application manual! To be always used with unscrewed sinter cap ! Further information can be obtained on request.

With proper application, the measuring probe can be used over many years. Nevertheless, in order to rule out any error, we recommend 12 months calibration periodicity, particularly during application of the measuring probe in critical applications in the lower dew point measuring range.

3.3 Intended application

The pressure dew point transducer is intended for measurement of pressure dew point in clean, dry and oil free compressed air. The range of application is right from -40 ... +60 °C, with which the calibrated application range is reduced to -10 ... +45 °C. The accuracy specified in the technical data sheet is at 20 °C. The permissible operating pressure of the standard version is 0 ... 17 bar (0 ... 1.7 MPa).

4 Application and functional description

In the industry, there are always high quality requirements for the compressed air. Humidity and condensate are not allowed in the compressed air because these often lead to damages on the machines and loss of quality in production. Therefore, normally compressed air dryers are used to reduce the humidity content in air for correct application and to provide high quality compressed air.
However, problems in the dryer are often detected very late, normally only when the damage has already occurred. By that time, a large amount of humidity would have already deposited in the compressed air network, which has to be again dried up with large expenses. Hence, the high quality standards in the industry require a continuous humidity monitoring, that is reliable and has long term stability. Only then the problems can be recognized early, before the damages occur.

The pressure dew point in compressed air systems is hence a relevant parameter for the air quality and should be measured in each system.

The pressure dew point transducer TPT is the ideal device to monitor compressed air quality and give the alarm on time, before the damage occurs.

The pressure dew point transducer TPT 20, with its measuring range of -20 ... +40 °C tpd, is the ideal measuring system for monitoring of cold and membrane dryers.

The pressure dew point transducer TPT 60, with its measuring range of -60 ... +40 °C tpd, is additionally available for the monitoring of adsorption dryers.

The measured pressure dew point value is made available from the transducer as current signal of 4 ... 20 mA and can be further processed by a control system, for example, an SPS or an external regulator. The power supply is externally provided over 24 V DC. The devices are intended for stationary applications like mounting in plants.

The transducer is provided with a display for remote indication of measured dew point values. The measured value is displayed as per °C standard, however can be also be adjusted at works for °F (ordering option). The selected unit is indicated in the display.

A measuring chamber with diverting capillary is available as accessories, which substantially simplifies the mounting. Hence, the devices can be plugged in, for example, to a compressed air socket. Alternatively, the measuring system can also be installed in the compressed air line, in order to avoid flushing air losses.

4.1 Features

- Pressure dew point monitoring for perfect guarantee of compressed air quality
- Standard version up to 17 bar for industrial compressed air systems
- Optionally special models available up to 350 bar for compressed air bottles and medical breathing air
- Large, clear display, dew point display set at works in °C or °F
- Analog output 4 ... 20 mA for –20 ... +40 °C tpd (TPT 20) as well as for –60 ... +40 °C tpd (TPT 60)
- High quality, long term stable Polymer sensor
- Optional measuring chamber with diverting capillary available for fast and simple mounting

4.2 Typical areas of application

- Monitoring of compressed air quality in pneumatic systems and industries
- Function control of compressed air dryers
- Monitoring of breathing air for medical applications
- Food industry, chemical applications
- Granule drying, plastic processing, drying systems

5 Mounting of the device

5.1 Safety instructions

The product should be installed and used only according to the intended application.

Fitment of the transducer and maintenance work should be carried out by only trained personnel. Mounting and servicing operations should be carried out only after switching off the voltage. The current safety regulations must be followed! All activities in the compressed air network should be done in pressure less condition.

The device should be operated only with safe low voltage of 24 V DC.

5.2 Application notes

Before mounting, the compressed air quality is to be checked at the assembly location. In case of water or oil leakage, first the system is to be put in order. With substantial water or oil exposure, the sensor can get damaged.
The compressed air withdrawal from the pipe or the mounting on pipe must be done on the top side. The device must be mounted above the compressed air line, so that in case of any failure, the originated condensate does not flood the probe or the measuring chamber.

The transducer must be assembled only with a stainless steel lug by an Allen key spanner. Maximum tightening torque 50 Nm. During swivelling of the electronics housing, the device can get damaged!

Use only suitable materials. The used materials must be steam diffusion sealed. Hence, please do not use normal PUR-plastic hoses! For flexible connections, only PTFE ("TEFLON “) is recommended as hose material. Up to –30 °C tpd, all metals are suitable, in which stainless steel is to be preferred. Very long probe lines or unnecessary joints are to be avoided.

All the components connected in series with the measuring probe should not show any steam diffusion to the environment! Please only use high quality components, e.g. ball cocks with PTFE gaskets.

Please carefully seal all joints to the probe and the measuring chamber. However, do not use anaerobic liquid sealing materials, because these can damage the sensor element!

With time, heavy particle content deposit on the filter or the diverting throttle /capillary of the measuring chamber, which leads to a delayed response behaviour. In critical cases, an additional micro filter must be fitted before the instrument.

In case of undefined compressed air quality, use condensate separators or particle filters. The additional components must be suitable for the application!

In EMV-critical environment, the measuring chamber should be electrically insulated from the metal tube of the compressed air network. For this purpose, for example, a double nipple of PTFE or polypropylene is suitable, which can be obtained from us on enquiry.

5.3 Procedure for Installation

The installation is done in following steps:

- Mounting of the transducer, as required
- Connection to the compressed air network
- Electrical connection of the power supply and regulator
- Commissioning with Test and functional check-up

5.4 Mounting

Normally, the device is directly installed in a T-piece or plugged to the compressed air socket through a measuring chamber and a plug coupling. Because of the low mass, no additional fastening is required..

If the compressed air line is not sufficiently stable at the mounting location, the transducer can be additionally fastened with a clip at the mounting location.

In case of mounting on a machine, the device can be fixed on a mounting plate with the help of commercial mounting materials.

5.5 Connection at the compressed air network

5.5.1 Direct assembly at the compressed air line

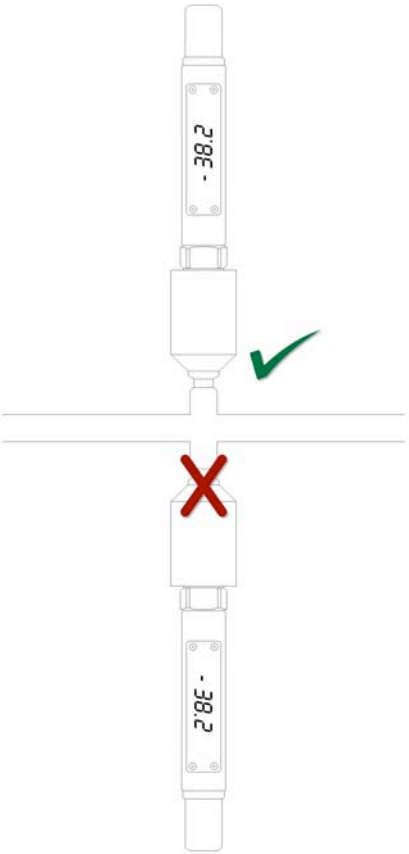
For monitoring of the dryer, normally the device is directly installed after the dryer/filter, in order to safeguard the entire plant. However, the assembly can also take place at any position in the subsequent distribution network, in order to monitor any sub unit or the operating air of a particular machine.

In order to avoid unnecessary consumption of air because of diverted flushing air, the measuring chamber should be preferably installed with the probe into the compressed air line. The probe tip with the filter should not directly rise up into the gas flow, but minimally sit back in the T-joint.

In order to prevent accumulation of condensation in the case of a fault, the transducer or the measuring chamber must be vertically screwed onto the line from above.

Extremely high flow velocities or sudden change in pressure are to be avoided, since the sensor element can be damaged by it!

If a branch line is required for the connection, then it should be only some centimetres long, because the response mode otherwise gets worse, particularly at deep dew point values. With longer branch lines, a measuring chamber with diverting capillary must be used.



Standing up, long branch lines restrict the response mode or lead to false measured values.

For simplifying maintenance and modification, a ball valve can be connected in series directly before the probe. For ball valves, only high-quality designs with Teflon gaskets are suitable!

The electronics housing can be rotated by 300 ° for fitment:

5.5.2 Stationery assembly over hose

By using the measuring chamber with diverting capillary, available as accessories, alternatively the device can be connected over a Teflon connection line to the compressed air supply. For correct functioning and to guarantee the measuring accuracy, a regular flow of approximately 60 l / h must be available, which is set by the capillary.
Occasionally check whether air is getting diverted from the measuring chamber. With choked capillary, the instrument displays high values or releases alarm. In such a case, send the measuring chamber for repair.

5.5.3 Application of a pre-filter/water separator

According to the condition of the compressed air plant and the distribution network, it is possible that unexpectedly dirt, condensate or oil also gets discharged at the measuring point. In order to avoid damage to the transducer in such critical application areas, a water separator with fine filter can also be connected before the device. The components connected in series should not change the humidity content of air or unnecessarily worsen the response behaviour. Suitable components can be obtained from us on enquiry.

5.5.4 Application in granule dryers

For precise measurements in the lower dew point range (-30 ... -40 °C tpd), the temperature of the gas to be measured, should preferably be at room temperature (20 ... 25 °C).

For special applications in the plastic industry, for example, in granule dryers, the temperature of the measured gas is substantially higher. In such a case, a cooling segment must be installed before the measuring chamber. Ideally a copper line of approx. 2 to 5 m is suitable for this, with which the gas can be cooled to ambient temperature. The dew point temperature does not change with the cooling down, since it is an absolute humidity parameter, which is independent of temperature.

In case of measurement of pressure dew point, it is to be noted that there is no pressure drop at the cooling segment, since this would cause a measuring error. Therefore the copper line must be of sufficient cross section.

In case of measurement of deep atmospheric dew point values, the exhaust air should be bled out through a suitably sized capillary tube, in order to prevent return diffusion of environment humidity into the measuring chamber.

For applications in the plastic industry, measuring chambers with cooling water connection are available, with which measurements can also be done with high precision at deep dew point values. Further information can be obtained on request.

5.6 Mounting examples

The device is suitable for a large number of application areas. With the flexible design of measuring chamber, the device can be easily adapted for the intended application:

Connection to a quick coupling:
This connection is fast and simple, without expensive installation in minutes.
For this, use the measuring chamber with plug nipple, screw in the transducer on the 1/2" threads.
The plug nipple can be directly plugged in a compressed air coupling. No intervention into the compressed air network is required.
The volume flow is adjusted to 60 l / h with the diverting throttle.

Fixed connection over a compressed air line:
This connection is ideal with short distance to the main line, since no flushed out air is used.
The measuring probe is screwed in a 1/2“ T-joint. With higher flow rate in the main pipe or in case of danger from pressure hits, the sinter filter must be shifted to the backside with an extension nipple.

Connection over compressed air hose:
For this also, the measuring chamber is used, with permanently adjusted volume flow of 60 l/h. A hose connector is mounted at the measuring chamber.
Note: Only PTFE-Hose to be used for connection!

5.7 Electrical connection

Voltage supply: The device is driven with safe low voltage. The operating voltage is 24 V DC and must be externally provided. A suitable 24 V plug-in power supply unit is available as accessories.

The connection of positive operating voltage is at pin 1, the negative polarity (reference potential) is at pin 2.

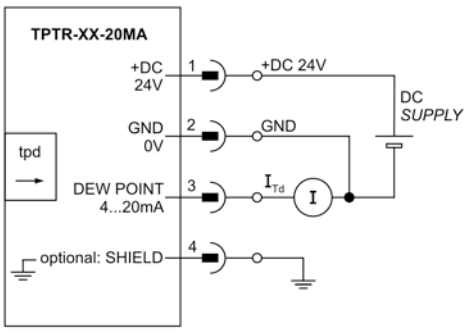
Analog output: The device has an analog output for the industrial standard signal of 4 ... 20 mA. The measured dew point values are passed out at this output, which can then be evaluated, for example, with an SPS or a data acquisition system.

TPT 20: The scaling of signal is 4 mA = -20 °C tpd, 20 mA = 20 °C tpd.

TPT 60: The scaling of signal is 4 mA = -60 °C tpd, 20 mA = 20 °C tpd.

The output of the current signal is provided at pin 3 of the plug. The output is not potentially isolated from the supply. The output is given out as superimposed current, and the device works as current source against reference potential. The maximum load resistance is 400 ohms. An isolation amplifier is required for connection to super level control system, in order to avoid earth inter-coupling. In addition, please also ask the manufacturer of super level regulation system about the final requirements.

Pin	Current output
1	+DC 22 … 30 V
2	GND 0V
3	I td 4 ... 20 mA
4	SHIELD



Voltage output and current output 4 ... 20 mA

5.8 First time operation

Immediately after switching on the operating voltage, the first measured values are shown in the display and passed out over the current interface. If the connection to the compressed air network has been just done, the measured values may still fall further. After some time the values become stable. Depending upon the system, the following values shall be adjusted:

- In cold dryers, the value to be approx. 0 ... 7 °C tpd
- After an additional membrane dryer, value to be approx. -20 ... -10 °C
- After an adsorption dryer approx. -60 ... -30 °C

For functional check, the displayed value can be verified with a portable comparison instrument. In addition, it is recommended to simulate a fault, for example, switching off the dryer for a short while. In such case, the rise in values should be evident.

Caution! This simulation is only carried out, if it can be ensured that there is no risk in the application and damage to the plant or production and any safety violation is also ruled out!

5.9 For the rarest of the cases...

If the device does not come into operation, then please check the following points:

- Is the power supply unit delivering 24 V DC voltage?
- Is the polarity ensured?
- Is the plug correctly connected?

If you have checked all possible causes and still the malfunctioning is not resolved, immediately contact our customer service. Do not open the device otherwise the warranty claim becomes void!

6 Display

General hints for description of operating procedure

The numerals and figures of the display are examples, which have been used for the explanation and clarification of the transmitted contents. The actual display in your device can vary according to the selected settings or ambient conditions.

6.1 View of device front

View of displays	Function
	The measured dew point value is shown in the display. The upper LED on the left of the display shows that the measured value is passed out in °C, the lower LED indicates that the display is in °F.
	In order to achieve maximum accuracy, the sensor element is cyclically heated up. In addition, a heating element is integrated in the sensor. After around 5 minutes of switching on of the operating voltage, the first heating up takes place.
	The heating cycle continues for about 5 minutes and then the sensor cools down again for approx. 5 minutes. During heating, the message "HEAT" appears on the display and during passive cooling down to ambient conditions, the message "COOL" appears. The device does not do measurements during heating, but holds the last measured value at the current output. This process repeats itself for approx. every 13 hours. After the heating cycle, the device is in the normal operating condition and again displays the dew point values.

7 Technical data

Pressure dew point transducer TPT		
Measuring range	-20 ... +40 °C tpd	-60 ... +40 °C tpd
Measuring medium	Compressed air, filtered and dried, ISO 8573 Class 2-4-2	
Sensor element	Capacitive Polymer sensor	
Application temperature	-20 ... +60 °C	
Accuracy (at 20 °C)	≤ ±0,5 K ±1 Digit (tpd -0.0 ... +40.0 °C) ≤ ±1 K ±1 Digit (tpd -10.0 ... 0.0 °C) ≤ ±2 K ±1 Digit (tpd -20.0 ... -10.0 °C)	≤ ±0.5 K ±1 Digit (tpd -0.0 ... +40.0 °C) ≤ ±1 K ±1 Digit (tpd -20.0 ... 0.0 °C) ≤ ±2 K ±1 Digit (tpd -40.0 ... -20.0 °C) ≤ ±5 K ±1 Digit (tpd -60.0 ... -40.0 °C)
Operating pressure	0 Pa ... 1.7 MPa (17 bar)	
Display	red LED-Display, 10 mm	
Measured value	4-digit , Resolution 0.1 °C/°F tpd	
Functions adjustable at works	Display in °C or °F, Output scaling Analog output	
Analog output	4 ... 20 mA / -40 ... +40 °C tpd	4 ... 20 mA / -60 ... +40 °C tpd
Electrical connection	4-pin industrial plug DIN EN 175 301-803-C	
Process connection	Thread G1/2“, SW27, Insert depth approx. 37 mm with Filter	
Sealing	Sealing surface with inserted sealing O-ring NBR (optional: VITON)	
Dimensions	190 x 30 x 30 mm (with plug)	
Weight	350 g	
Power supply	24 V DC, max. 100 mA, reverse polarity protected	
EMV	As per EG-Guidelines 89/336/EWG	
Materials	Electronics : Blue anodised Aluminium, Meas. head: Stainless steel 1.4305	
Enclosure	IP 65 (with connection plug)	
Guarantee	12 Months	
Scope of supply	Instrument with connection plug, Test certificate and documentation	
Rights reserved for change in technical data due to technological advancements!		

7.1 Drawing

8 Maintenance work

With proper usage, the instrument is operational for many years. The used sensor elements are very long term stable, hence normally no re-calibration is required. However, we recommend to send the device in every 12 months for calibration at our works.

The measuring probe is supplied with a stainless steel sinter filter, which should not be removed. The condition of filters should be periodically checked. Polluted or oil choked filter leads to a deterioration of the response behaviour. Send the device to our works for change of filter.

During use of a measuring chamber, if there are unreasonable very high measured values, it should be checked whether the expanded gas is being diverted from the chamber or not. Otherwise, the diverting capillary can be plugged by a external piece. With too low current, too high (Humid) measured values are displayed.

Regularly check the tightness of O-rings, connectors, measuring chamber and other upstream components. Remove leakages and replace defective components in time, such as ball valves.

9 Trouble shooting guide

9.1 The measured value is flow dependent and too high (i.e. too humid)

Cause	Solution
The humidity measuring system is still not stabilised, transient process.	Wait for the stabilization time. If the transducer was kept unused for a longer time in ambient humidity, specially in deep dew point values, the stabilisation time to be considered up to even one hour for the measuring chamber and the sinter filter to dry up. During this time, compressed air must keep flowing through the measuring chamber.
The probe line is leaking to environment.	Seal up faulty points.
Unsuitable measuring line of plastic.	Use Teflon line.
There is condensed water in the measuring chamber or in a fitment thread.	Dry up Components, let the air divert off, wait for stabilization time.
There is condensed water in the system, the lines have not yet dried up after a fault.	After a dryer malfunction, the drying process can take several days. First carry out test measurements as near as possible after the dryer!

9.2 The measured value is too high (i.e. too humid)

Cause	Solution
Filter choked, transient time is too high.	Return the measuring probe to manufacturer for filter replacement .
Sensor oil covered.	Return the measuring probe to manufacturer for repair.
There is condensed water in a branch line of the distribution network. In such a case, the humidity will continuously rise, specially with low air consumption (for example during the night).	This behaviour is being considered as "Normal" in many plants. After a malfunction with visible condensed water, it lasts for a very long time, until all branch lines(without flow) are drained again. This particularly applies to branch lines at cold places. Enforce air removal on rarely used branch lines (i.e. let the air get diverted) to drain the line segment.
Capillary tube of measuring chamber choked.	Replace measuring chamber.

9.3 The measured value is too low (i.e. too dry)

Cause	Solution
The pressure at the measuring point is lower than as in the system, hence the pressure dew point at the sensor becomes drier.	Remove the pressure loss, check the position of valve cock.
The expanded air is measured.	In case of assembly of the transducer in pressure range, the pressure dew point (Dew point under pressure) is measured. During assembly under atmospheric conditions (ambient pressure) or in diversion range (expanded air) of compressed air plant, the atmospheric dew point is measured. The dew point value after the expansion is substantially lower i.e. the air is drier.
The sensor must be re-calibrated.	Send the transducer to the manufacturer for re-calibration.
The sensor is damaged.	Send the transducer to manufacturer for repair.

9.4 The measured values varies significantly

Cause	Solution
The pressure at the measuring point is not constant.	Eliminate pressure loss and create constant pressure/flow conditions.
Significantly different flow conditions, standstill air.	Dry up the plant, release exhaust air at the most distant point of usage.
Water in the plant, back diffusion with standstill air.	Dry up the plant, release exhaust air at the most distant point of usage.
The measured value at the measuring point always comes lower (drier).	In newly connected measuring system or portable measurement: The measured value is not yet stabilised. Mainly with low dew point values, it can last 60 minutes or longer till the measuring line, checking chamber and sinter protection cap are in equilibrium. After a moisture entry: The behaviour is normal, since the plant must be again dried up after a moisture entry. The drying time can depend on many parameters and among other things, it is dependent on intake air quantity and flow and can last for several days (specially at deep dew point values).
The measured value after the plug of measuring chamber on the compressed air line varies significantly.	This behaviour corresponds to physics: Because of the sudden pressure increase there is heat generation due to compression, which is registered by the temperature sensor, but again quickly adjusts itself. Please wait for the stabilization time.

10 Appendix

10.1 Condensate formation in compressed air plants

If air is compressed, then a part of the environment moisture contained in the intake air precipitates as condensate, since compressed air cannot hold so much water as the air at atmospheric pressure. Higher the pressure rises, lower the water which the compressed air can hold and hence the relative humidity further increases. As soon as the relative humidity value reaches 100% rH, it exceeds the dew point and the surplus amount of water vapour precipitates as condensate.
The compressed gas after the compressor is first hot due to the compression heat. However, hot air can hold more water than cold air. If hot air further cools down in the air chamber, then again condensate precipitates. Since normally water surplus in the compressed air is always after the compressor, the dew point and also the temperature at which water condenses corresponds to the temperature of the air chamber.

This is also the reason for condensation of water in the pipeline network: A part of the water always remains in gaseous state in compressed air and it is transported together in the compressed air network towards the point of consumption. Now if the temperature in a part of the pipeline falls further, again humidity precipitates and accumulates in the pipes and then swept away away by the flow. The liquid water causes damages to the machines and pneumatic equipment.

Remedy comes from installation of a cold dryer: With the help of a cooling system, the compressed air can be cooled down to approx. 1 °C. The water precipitates at the cooler, and it is removed from the plant with a water separator and condensate trap. The dew point temperature of compressed air corresponds to the surface temperature of coolers, even after the air is warmed up again. As long as it is ensured that at no position in the distribution network, the temperature is colder than that of the evaporator of the cold dryer, no more water can condense out.

Besides cold dryers, there are other type of compressed air dryers, which work over adsorption drying media or by means of membranes and in such drying, the dew point temperature after the dryer is also a criterion for compressed air quality.

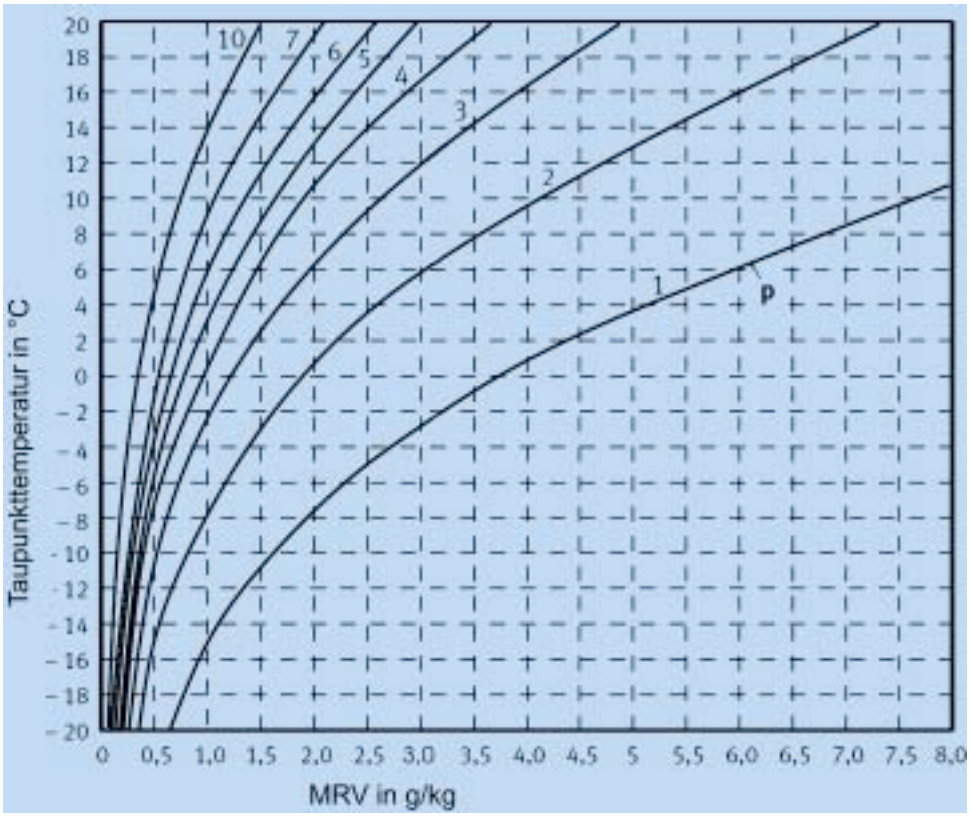
Apart from the problem of condensate formation, there are many other reasons for drying the compressed air. For example, in semiconductor production or in pharmaceutical industry, many technical processes can be carried out only with dry air of defined dew point.

As shown with the above example, the dew point is the temperature, at which gaseous water begins to condense out as liquid. Hence, in a compressed air system, it is the critical temperature, falling below which results into condensate formation and is likely to cause damage to the system.

10.2 Pressure dependence of Dew point

In a compressed air distribution network, the pressure is flow dependent and is lower at the point of usage. Hence, the dew point value to be measured also changes: The value falls and air becomes "Drier".

This also applies, if compressed air is expanded to atmospheric pressure. After expansion, the air is drier and can assume very deep dew point values with higher differential pressures.



In order to evaluate the absolute humidity content (e.g. MRW) of air, it is therefore often advantageous to measure the dew point in the compressed gas (at higher pressure). Because of the measuring principle of the capacitive polymer sensors used here, exact measured values can be achieved same as measurement in expanded air.
Physical conditions in compressed air are certainly more complex due to the large number of effects and opposite acting factors. Therefore, the pressure dew point transducer is an important medium in order to understand the processes and optimise the systems. Only in such a way, one can ensure an everlasting constant quality of compressed air.

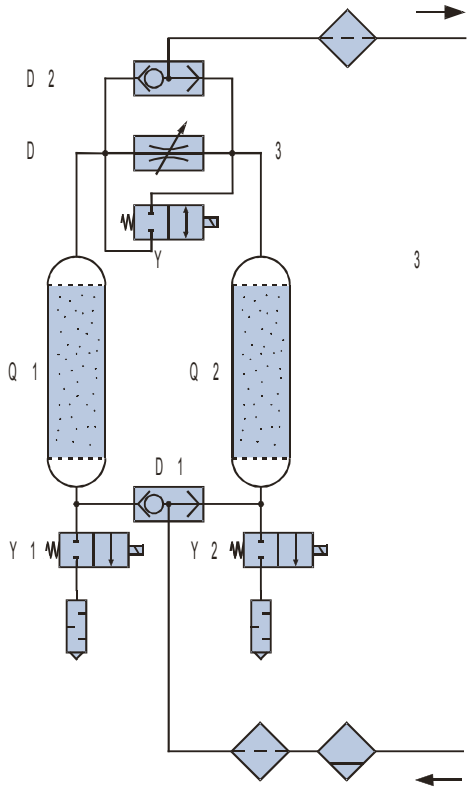
10.3 Thermodynamic concepts

Term	Description
% rH	The relative humidity is the relationship of water vapour partial pressure in the test gas to maximum possible water vapour partial pressure (water vapour-saturation pressure) at the same temperature and total pressure
Test temperature	The test temperature, T_t, is the gas temperature at the measuring location.
Test pressure	The test pressure, Pt, is the total pressure in the gas at the measuring location. The specification defines it as the absolute pressure against vacuum.
Dew point	The dew point is the temperature up to which the gas is to be cooled down so that straight water vapour condenses out as liquid. Normally dew point is valid only for temperatures above the freezing point. In certain cases, water can also condense below the freezing point of liquid. However, in such a case, the dew point temperature is not identical with the frost point temperature.
Frost point	The frost point is the temperature up to which the gas is to be cooled down so that straight water vapour gets condensed to ice. The frost point is valid only for temperatures below the freezing point.
Absolute Humidity	The absolute humidity is the mass of water vapour per unit volume of humid gas.
Specific humidity	The specific humidity is the ratio of the mass of water vapour to the total mass of the humid gas.
Wet bulb temperature	The wet bulb temperature Tw, is the temperature of the moistened thermometer during measurement of relative air humidity with the Aspirations-Psychometer. A thermometer covered with a moistened wool wick is exposed to a constant airflow. After some time, temperature equilibrium is reached. Together with ambient temperature and total pressure, the relative humidity can also be calculated from the wet bulb temperature
Enthalpy	The enthalpy is a measure of the energy which is necessary to bring the gas at a certain temperature, pressure and humidity condition into another condition. The zero point of the enthalpy has been fixed at 0 °C and 0% rH. In practice, it is often not the absolute value but the difference of Enthalpy between two climate-conditions of interest
ppm volume	ppm volume is the ratio of the number of water molecules to the number of molecules of remaining gas components. This humidity parameter is independent of the total pressure and temperature
ppm weight	ppm weight is the ratio of the mass of water molecules to the mass of the molecules of all remaining gas components. This humidity parameter is independent of the total pressure and temperature.

10.4 Working of an adsorption compressed air dryer

The additional measurement of achieved dew point value in compressed air enables reduction of operating cost by optimisation of the regeneration and drying intervals, so that the amount of compressed air required for the drying process (regeneration) with respect to the air consumption is minimized. Through a regulation mechanism, the system automatically adapts itself to the changing operating conditions.

At inlet of dryer, the compressed air with a dew point of about +30 °C tpd is supplied from the air chamber. At outlet of the dryer, the dried compressed air with a dew point value of about.-40 ... -80 °C tpd is supplied for use.



The dryer consists of two drying columns (Q1 and Q2), which alternatively goes into operation or regeneration mode. The cartridge, through which the compressed air passes, dries it and absorbs the water contained in the air. Meanwhile, the second cartridge is flown through in reverse direction by expanded dry air and hence dried out. After some time the two columns are interchanged and the drying process is continued with the column regenerated earlier.

The three solenoid valves (Y1, Y2, Y3) and two OR gates (D1, D2) are used to control the compressed air path through the drying columns. The flushing air for regeneration of drying capsule is created with the flow control valve (D3).

The so called "Molecular mesh" is used as the drying agent in the columns. It is extremely porous material, called as Zeolithe, which contains capillary like pores. The water contained in the compressed air gets stored in these pores.

During flushing through with dry air, which is created by expansion of dried compressed air, the pores again deliver the contained water. Thus the drying agent is regenerated and can be again used in the next cycle for the drying process of compressed air.

Therefore, the energy for drying is exclusively prepared by the energy of the compressed air. Basically, the triggering of valves can take place with a simple timer, however, which must be certainly designed for the most unfavourable operating condition (i.e. max. drying capacity at maximum ambient temperature and maximum air flow). However, the energy consumption will be unreasonably high at partial or no load conditions but it will survive the danger of over-saturated dryers during full load condition.

With the application of pressure dew point transducer, it is possible to apply the measured value for regulation of dryers. Hence, the air is dried only so much, which is necessary for the process and the operating costs are substantially reduced. The period of regeneration interval, when flushing air is used, is adapted as per the desired dew point value at the air outlet of dryer. Therefore, with partial load the energy consumption is much lower without which the humidity content of compressed air gets worse. With no load, the self-air consumption of the dryer is almost zero, with which the operating costs is substantially reduced. The service life of the column also increases, which results in another savings in maintenance costs.
The second alarm contact can be additionally used for alarm signal. Hence, a shut-down of the dryer on overload can be detected and safety measures can be timely introduced .

10.5 Checking measuring accuracy

The measuring accuracy of the humidity probes can be checked up to a range of -10° C tpd with the help of salt reference cells available as accessories. Lithium Chloride cell is suitable for cross checking in this measuring range. Further information can be obtained on request.
The cross checking of the lower measuring range of up to -30 °C is only possible at manufacturer's works in a calibration facility. We recommend re-calibration in a cycle of 12 months.

10.6 Working principle

For technically interested users, there is some further information about the procedures and measuring accuracy of the products:
The capacitive polymer sensor used in the measuring probe measures the relative humidity and a precision NTC measures the temperature. From these two parameters, the (pressure) dew point is calculated with high accuracy with the help of water vapour saturation characteristics stored in the micro-controller.

The vapour pressure saturation characteristics are natural characteristics, which runs non-linear. At higher temperature differences between dew point and ambient temperature, the precision requirements are very high for measurement of relative humidity and it is necessary to calculate a sufficiently accurate dew point value for the process. The measuring accuracy requirements become more stringent with increase in application temperature band towards higher temperatures.

Since the process temperature is normally quite higher than the dew point temperature which can be measured, it results into a measuring band within the lower range of relative humidity. The following table is used for explanation:

Table: Relative humidity [%] as a function of pressure dew point at different ambient temperatures

T_a / t_d	-20 °C	0 °C	23 °C	40 °C	60 °C
-50	3.871	0.6583	0.144	54.93 E-03	20.36 E-03
-40	12.55	2.134	0.4669	0.1781	66.02 E-03
-30	36.96	6.287	1.375	0.5246	0.1955
-20	100.0	17.01	3.720	1.419	0.5260
-10	-	42.66	9.330	3.560	1.319
0	-	100.0	21.86	8.340	3.091
+10	-	-	43.81	16.71	6.195
+20	-	-	83.26	31.80	11.77
+30	-	-	-	57.58	21.34
+40	-	-	-	100.0	37.07
+50	-	-	-	-	61.95
+60	-	-	-	-	100.0

T_d = Dew point in Gas flow, T_a = Ambient temperature

Absolute pressure 10 bar (1 MPa), for Dew/Frost point value <= 0 °C Equilibrium over ice, Dew point value >0 °C Equilibrium over water, Temperature scale ITS-90, Carrier gas dry air without impurities

Due to rise in temperature at the measuring point, the measuring range of the humidity probe shifts in the direction of lower relative humidity. The high accuracy of Polymer humidity probes, that the used polymer sensor element show in lower humidity range, guarantees to reach a range of approx. -40 °C tpd at ambient temperatures of around 23 °C. At 45 °C ambient temperature, the technologically usable range extends to approx. -30 °C tpd.
General principle: The measurement of pressure dew point is more exact if lower is the temperature at the measuring point.

10.7 EG-Conformance details

As per EMV-Guidelines 89/336/EWG

hereby declares that the product

“Pressure dew point monitoring device TPT“

conforms to the essential safety requirements, that are specified in the guidelines of the council of legal rules of the member states regarding electromagnetic compatibility (89/336/EWG). This declaration applies to all units, which are manufactured as per the corresponding manufacturing documents.

Following standards were referred for evaluation of the product with respect to electromagnetic compatibility:

EN 61000-6-3 Electromagnetic compatibility; specialized basic standard for noise emission in residential areas, companies, commercial areas as well as small enterprises

EN 61000-6-1 Electromagnetic compatibility; standard for noise immunity for residential areas, companies, commercial areas as well as small enterprises

The above mentioned manufacturer has ready records for inspection for verifying the conformance.

Löffingen, the 26th of August 2008

Martin Friedrich

10.8 Guarantee

The quality of our products is constantly monitored within the framework of our Quality Management systems as per ISO 9001 standards. The devices are carefully tested and adjusted before despatch. Nevertheless, if still there are any reasons for complaint, we are ready to rectify the shortcomings free of charge within the guarantee period of 24 months, if it is evident that the defect is due to some mistake on our part .
Prerequisite for the fulfilment of guarantee service is that the details of defect should be informed to us immediately and within the stipulated guarantee period.

The guarantee turns void if the device is not duly used in accordance with the installation instruction or damaged by improper handling or tampering with the device. Moreover, defective sensors or sensing units and also calibration service are not covered in the guarantee.

In addition, the guarantee also turns invalid if the device is opened or dismantled. The serial number on the product should not be changed, damaged or removed.

Apart from the guarantee service, if any essential repairs are required to be carried out, the service is free. However, further services and also postage and packing expenses are chargeable.

Compensation demands on the basis of claim for liability or damages during the guarantee period are excluded and these are, in general, not legally covered.

The technical information in this document has been checked with adequate care at our end and is intended to inform about the product and its applications. The descriptions are not to be understood as assurance of the defined characteristics of the product and should be checked by the user for the intended application. Any possible industrial third party patent rights are to be considered.

Issued December 2008 - This documentation supersedes all previous editions.