Pressure Dew point monitoring device
TPW – HP 330

Functional description and operating instructions

List of Contents

1 Scope of supply

The Pressure dew point monitoring device is supplied in ready-to-use condition. The scope of supply includes a plug-in power supply unit, a test certificate as well as a detailed manual.

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

There if fatal danger in touching the live parts. 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. Excessive heat generated due to contact resistance at the terminal connections can lead to fire. Wrongly wired connections can destroy electric components and cause other damages.

2.2 Safety instructions for compressed air systems

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

The attached measuring chamber with probe is suitable up to 17 bar. This maximum allowable operating pressure should not be exceeded. Components connected in series should also be rated as per the operating pressure and application temperature of the plant.

By opening the probe housing, removing the sinter cap and improper handling or forceful application shall make the product devoid of guarantee claims.

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.

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 damages the diverting throttle.

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

3.2 Calibration and measuring accuracy

Before delivery, the pressure dew point probes are adjusted and checked at multiple temperature and humidity points through a sophisticated calibration process. An adjustment by the end user is not possible.

Please observe the permissible application temperature range. The measuring accuracy becomes worse at higher 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 probe is intended for measurement of pressure dew point in clean, dry and oil free compressed air. The range of application is right from -60 ... +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 ... 330 bar (0... 33 MPa).

4 Humidity measurement in compressed air systems

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 TPW HP 330 with its measuring range of -60 ... +60 °C tpd is the ideal measuring system for monitoring of cold, adsorption and membrane dryers. The device is primarily meant for stationery applications, however, because of its simple connection, it is also suitable as a portable instrument.

5 Features

- Pressure dew point monitoring for perfect guarantee of compressed air quality
- Standard version up to 330 bar for industrial compressed air plants
- Large, clear display, dew point display swappable between °C or °F
- Display of 10 different measuring datas
- integrated Hx - calculator
- Adjustable limits with Hysteresis for early and main alarm
- Simple operation over keyboard, clear operating procedure
- Optical and acoustic alarm generator integrated in the device, switchable
- External, potential free relay switch output for early and main alarm
- Serial interface RS 232 and RS 485
- Analog output 4 ... 20 mA for –40 ... +40 °tpd
- High grade, long term stable polymer sensor

5.1 Typical areas of application

- Monitoring of compressed air for pneumatics and in the industry
- Regulation of adsorption dryers
- Monitoring of breathing gas for medical applications
- Food industry, chemical applications
- Plastic processing, drying systems

6 Function

If compressed air is not dried before feeding into the compressed air network, considerable amount of condensate gets accumulated in the air line network and causes malfunctioning of valves, pneumatic components and finally leads to loss of production. Hence, the pressure dew point in compressed air system is a decisive parameter for air quality and should be measured in every plant. In addition, there are applications, where the humid air can lead to damages, for example, in compressed air lifted shafts or slides.

The pressure dew point instrument TPW HP 330 is an ideal device for monitoring compressed air quality and give out an alarm at the right time before any damage occurs. The compact device is meant for monitoring of cold and membrane dryers down to -60° tpd.

The device is provided with an integrated measuring chamber with protection filter and diverting throttle. The power supply is through an enclosed plug-in type power supply unit. For installation of measuring system, no intervention in the electrical fitment work is required.

7 Functional scope

The stationary dewpoint device AIRSECURE model TPW are controller as well warning device.

The TPW HP 330 has three potential free relay contacts (Normally open).The first potential free relay contact can be used for regulation of the dryer. In this case, the first output will activate a new drying cycle, if the adjusted value will be passed over.

Two dew point based switching points and switching hysteresis can be adjusted over the soft touch keyboard. The second switching point can be used, for example, as an early warning alarm and the third switching point for main alarm. Alternatively, the first switching point can also be used for regulation of the dryer. The overshooting of the alarm values is additionally signalled over a flash light on the top of the device (option) and also indicated on a acoustic signal generator (option).

For connection to a super level regulation or monitoring system, the device has an analog output 4 ... 20 mA which is scaled on the measuring range of -40 ... +40 °C tpd.

Additionally, a serial interface is also integrated, which enables connection to a PC. Direct connection to the PC is possible with the RS232/USB connection cable available as accessories and with this, recording of measurement data is possible. The software PCLOG available as accessories enables graphic representation of measured values and simplifies commissioning of larger plants.

The TPW HP 330 also has an output to connect an external alarm generator (optical and acoustic). An external alarm light is available as accessories.

8 Mounting of the device

8.1 Safety instructions

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

Fitment of the regulator 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. This also applies to all external connections, for example, the relay outputs.

8.2 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 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 measuring chamber.

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 valves 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, 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.

8.3 Procedure for Installation

The installation is done in following steps:

- Fastening of the device, if required
- Connection at the compressed air network
- Connection at the power supply
- First time operation
- Adjustment of switching point
- Test and functional check

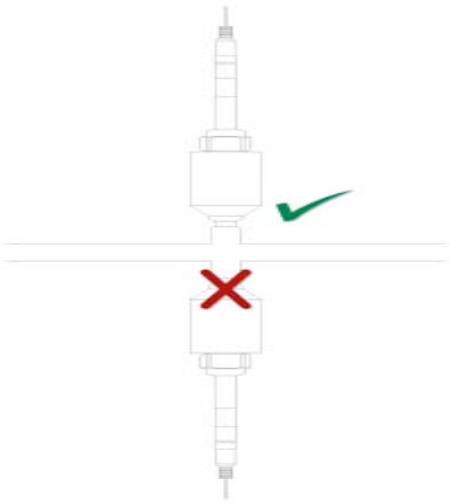
8.4 Mounting

In case of mounting on a machine, the device can be mounted on an even surface with the help of enclosed mounting bracket. A drilling template is provided in the Appendix section of these instructions.

9 Connection at the compressed air network

9.1 Direct stationery assembly at the compressed air line

In stationery applications, normally the device is directly installed after the dryer/filter, in order to monitor 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 prevent accumulation of condensation in the case of a fault, the device 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.

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

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

9.2 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 measuring probe 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.

9.3 Connection of power supply

The device is to be operated with safe low voltage. A suitable plug-in power supply unit is already installed.

An expensive electrical installation is avoided and the device is immediately ready for use.

The enclosed plug-in power pack with Euro plug is a high quality model with wide input range and is suitable for voltage supply of 90-240 V. This power pack is suitable for complete Europe wide application.

9.4 First time operation

After plugging the power pack, the device immediately comes into operation. There are no further switches. Soon after switching on, the first measured values are readily displayed. If the connection to the compressed air network has been just done for the first time, the measurements shall 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
- With an additional membrane dryer, value to be approx. -20 ... -10 °C
- With an adsorption dryer, the value to be approx. -60 ... -30 °C

9.5 For the rarest of the cases...

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

- Is there voltage in mains socket?
- Is the mains plug correctly inserted
- Is the socket of voltage supply sufficiently inserted inside?

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!

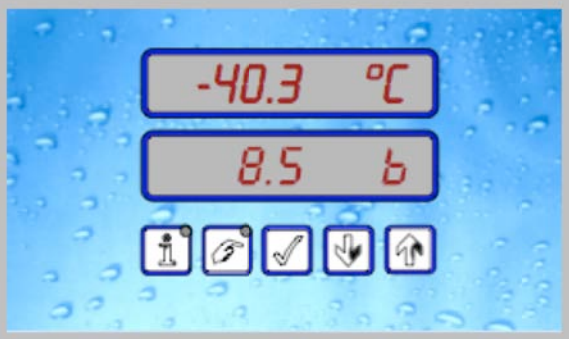
10 Operation

General hints for description of operating procedure

All figures in the display, numerals and configuration shown 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.

10.1 View of device front and the control elements

10.2 Description of Displays

View of Displays	Function
	The upper display line is for showing pressure dew point The lower display line is for showing pressure

10.3 Device specific application notes

The pressure is measured and displayed as relative pressure to the ambient pressure similar to to a pitot tube manometer. Below 1 bar, the pressure is displayed in mbar without decimal places and above 1 bar it is displayed in bar with decimal places. In the pressure less condition, the display can show a low offset value (up to 200 mbar), this is not a device error which separately lies in the range of specified measuring accuracy. The pressure measurement can not be used for measurement of vacuum, in this case the device displays the message "A5".

10.4 Operation of keys

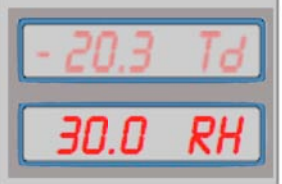
The keys of control unit have the following basic functions:

Key	Description	Function
	Info-Key	Choice of different values on display
	Settings-Key	Setting the regulation and alarm value
	Enter-Key	Accepting the new adjusted value
	Backwards	Decreasing the adjusted value
	Forward	Increasing the adjusted value

10.5 Display of the selected physical value

Each of the 2 displays shows a physical value. The shown value is either a measured value or a calculated value. There is a choice of 10 different values.

Notice: factory-provided the upper display shows the dewpoint and the lower display shows the gastemperature.

	Function	display
	By pressing the info-key the configuration of the display can be started. The outshining activated display can be changed now by pressing the arrow keys	
	By pressing the info-key again you can choose between upper and lower display	
	By pressing the backward- or forward-key the physical values can be selected for the outshining display.	
	The selected value has to be confirmed by pressing the enter-key the selected value will be show now in the relevant display the two places at the right end of the display will switch to the selected unit shortly.	

The enclosed chart shows the functional attribution between shown symbols in display and physical values

Shown symbol	Related value
TA	temperature
RH	relative moisture
PA	pressure
Td	dewpoint
AH	absolute moisture
ET	enthalpie
VA	steampressure
Vd	partialpressure
MV	Mixture ratio volume
MW	Mixture ratio weight

10.6 Switching on the device

In order to guarantee high long term stability of the dew point probes, the sensor element is cyclically heated up. The heating takes place for all the 13 h for a period of approx. 5 min. each after which the sensor passively cools down again to ambient conditions.

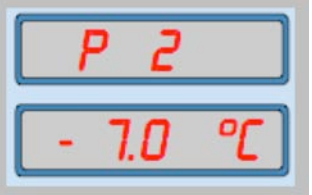
During heating, the message "HEAT “ appears on the display and during passive cooling down up to ambient temperature the message "COOL “ appears:

Status of the device	View of display
The device is heating up the sensor element.	
The device waits, until the sensor element is cooled down again.	

The heating up is re-started at each connection of the power supply thereafter again for all 13 hours. During the entire cycle, the last measurements are held up and no further measurement are done, and therefore, during this time span, no alarm signal comes up in the case of limit overshooting. Only after the heating/cooling cycle is completed, the device further continues with the measurement and alarm evaluation.

10.7 Changing the Alarm and Regulation value

The device is used for monitoring and regulation of dew points. In settings, the user can set a dew point limit value for both early warning alarm and main alarm. In addition, the desired regulation value of dew point can be entered, as per which the triggering of dryers are to be determined through a relay.

Operation of keys	View of display
 By operating the settings key, you can go to the configuration of alarm and regulation value. The upper display line shows the Regulation/Alarm value parameter being adjusted (in this case “P1”) and the lower display line shows the dew point alarm value being set.	
 By repeated pressing of the settings key, you can switch between the individual setting parameters ("P1 to P3") .	
 With the help of the Backward/Forward keys, you can change the desired regulation value(step-by-step in whole number without decimal places).	
 With the "Enter" key, the new Alarm/Regulation values are taken up by the system and the measurements are shown again (pressure dew point in the upper line and pressure in the lower line)	

The following table shows the assignment of symbols shown in the display for the corresponding regulation/alarm values:

Displayed Symbol	Associated Regulation/Alarm value
P1	Regulation value for dryer
P2	Main alarm dew point value
P3	Early warning alarm dew point value

10.8 Alarm and Error display

If an alarm or error appears, it is shown on the display. The possible reasons of error are denoted by different displays:

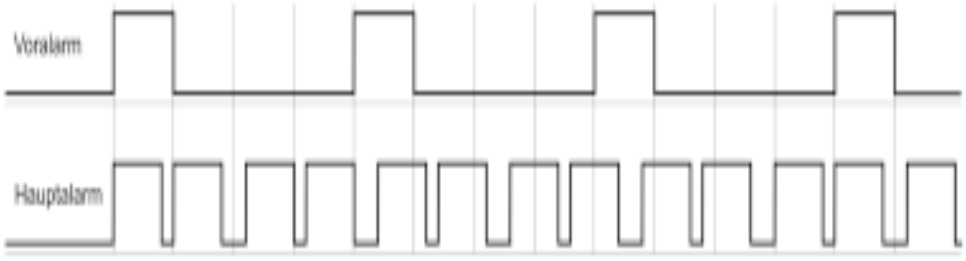
Error description	View of display
Applicable for all errors A1 to A6: It seems some hardware problem has occurred. Probably the electronics of the device is damaged. Please send the device to us for check-up.	
Adjusted value P2 (Dew point alarm value) is reached.	
Adjusted value P3 (Dew point pre-alarm) is reached.	

10.9 Alarm management

The monitoring device has an internal Alarm-LED and a built-in alarm generator. Moreover, an external alarm signal (acoustic and optical) can be connected at the extension socket which is to be synchronised with the internal trigger.

The device has a two stage alarm system. The light blinks briefly at early warning alarm condition with long gaps between the blinking signals. For the acoustic alarm generator also, the triggering is only short.

For main-alarm, the blinking signal is longer, simultaneously also the acoustic signal.



With the Enter key on the keyboard, the acoustic signal can be acknowledged and switched off. However, the optical signal remains still active until the disturbance is removed and the pressure dew point again lies within the alarm limit.

After 12 hours, the acoustic signal is also switched on again, provided the alarm signal is still persisting.

11 Technical data

PRESSURE DEW POINT MONITORING DEVICE TPW 60	
Measuring range	-60 ... +40 °C tpd
Sensor element	Capacitive Polymer sensor
Application temperature	-10 ... +50 °C
Accuracy (at 23 °C)	≤ ±1 K (tpd -10.0 ... +40.0 °C) ≤ ±2 K (tpd -20.0 ... -10.0 °C) ≤ ±3 K (tpd -30.0 ... -20.0 °C) ≤ ±4 K (tpd -40.0 ... -30.0 °C)
Operating (relativ) pressure	0 Pa ... 33 MPa (330 bar)
Media compatibility	Clean, oil free compressed air (filtered and dried, ISO 8573-Class 2-4-2)
Display	Red LED-Display, 14 mm
Measured value	4-digits with units °C / °F, Resolution 0.1 °C tpd
Operation	4 Keys (Soft touch keyboard)
Functions	2 adjustable alarm-limits with Hysteresis, display switchable between °C or °F
Relay output	2 potential isolated Normally open 36 V DC, 24 V AC, max. 2 A surge suppression with Varistor 39 V
Analog output	4 ... 20 mA / -40 ... +40 °C tpd
Serial interface	RS232 / RS485, 4800 Bd, 8N1
Ext. Signal generator	15 V / 50 mA
Electrical connection	15-pin SUB-D socket
Sensor protection filter	Stainless steel sinter filter 40 µm
Measuring chamber	Attached, with diverting throttle, pre-adjusted at 60 Nl / h
Compressed air connection	3/8“ internal threads
Power supply	24 V DC, max. 300 mA, reverse polarity protected, DC-plug 2.1 mm
Plug-in power supply unit	90 - 240 V / 7 VA max., output voltage 24 V DC
EMV Noise emission	EN 61000-6-3:2001
EMV Noise immunity	EN 61000-6-2:2001
Housing	Electronics:Plastic housing, IP 20 Measuring chamber: Aluminium
Guarantee	24 Months
Scope of supply	Instrument with attached measuring chamber/Diverting throttle, plug connection NW 7.2 mm, plug-in power supply unit, Operating manual, Test certificate
Rights reserved for change in technical data due to technological advancements!	

11.1 Drawing

12 Connection of external components

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

Fitment of the regulator 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!

The device should be operated only with safe low voltage. This also applies to all external connections, for example, the relay outputs.

The device is provided with extensive outputs for extension of functionalities:

- An external alarm light for remote mounting, if the device is not in a noticeable position e.g. mounted in compressor room.
- Two potential free alarm outputs (Normally closed i.e. residual loop current) for early warning and main alarm. The contact of the early warning alarm can also be alternatively used for regulation of a dryer.
- External power supply, for example, if the device is connected to other components and these are also to be fed by the device.
- An analog output 4... 20 mA for connection to an SPS or a super level measuring system.
- A digital RS 232 or 485 interface for connection to a PC over COM-port or USB interface. For this purpose, the software PCLOG is available, as accessories for recording the measuring curves.

12.1 Overview of the clamps at the connection room

12.1.1 Connection with the grid

The delivery of the TPW 60 is including a power cable and plug. This can be removed, if the device will be fix connected to electrical installation.

The connection of the power supply takes place at three clamps in the connection room.

The power pack of the device is primary electrically interlocked with fuse No. 1

Power supply 230 V		
clamp	**description**	**function**
1	neutral conductor, shield	connection grid neutral conductor
2	grounding equipment conductor	grounding equipment conductor, 0 V
3	phase 230 V	

The rest of the connectors and jacks (for example LON) in the connection room are not in use and are not allowed to be connected.

12.1.2 Relay Main Alarm

The relay contact is a potential free change-over-contact with a capacity of 250V/10A AC.

The switch polarity of the relays adjustable with the jumper on the top of the relay.
This way it is possible with the combination of the chosen contact (opener / closer) to reach, that the loop of quiescent current will open at alarm or at shut down of the power supply and give signal.

The LED at the top of alarm relay shows the actual switching status and will flash at activated anchor.

Relay, Main Alarm, Clamp Alarm Contact		
clamp	**description**	**function**
1	opener	Contact will open at activated relay
2	closer	Contact will close at activated relay
3	center contact	Collective pole of change over contact

The external connections of the superior control system, which are connected with the alarm clamps, could also have dangerous voltage potentials at switched off power supply.

Please regard the safety instructions.

12.1.3 Relay Pre Alarm

The Pre-Alarm will be wired at the 8-pole clamps block at clamp 5 and 6 in the row below.

The relay contact is a potential free closer with a capacity of 30V/30A DC or 250V/3A AC.

If there is no pre-alarm, the relay is activated and the contact is closed (loop of quiescent current). If there is a pre-alarm, no grid-voltage or a brake of a cable the loop of quiescent current is interrupted.

The LED at the top of alarm relay shows the actual switching status and will flash at activated anchor (that means, if there is no alarm)

Relay, Pre Alarm		
clamp	**description**	**function**
5	REL3 closer	Contact will open at pre alarm
6	REL3 closer	

The external connections of the superior control system, which are connected with the alarm clamps, could also have dangerous voltage potentials at switched off power supply.

Please regard the safety instructions.

12.1.4 Relay Control adsorption dryer

The relay output to activate the drying cycle will be wired at the 8-pole clamps block at the clamp 3 and 4 in the upper row.

The relay contact is a potential free closer with a capacity of 30V/30A DC or 250V/3A AC.

If the dewpoint regulation value (= must value of the dryer) will be overshooted, that means, the compressed air is to wet, the relay will be activated and the contact will close.

The LED at the top of alarm relay shows the actual switching status and will flash at activated anchor (that means, the compressed air is to wet)

Relay, control dryer		
clamp	**description**	**function**
3	REL2 closer	Contact will closer at wet compressed air
4	REL2 closer	

The external connections of the superior control system, which are connected with the alarm clamps, could also have dangerous voltage potentials at switched off power supply.

Please regard the safety instructions.

12.1.5 Analog output

The device has an analog output for an industrial standard signal 4... 20 mA. The measured dew point is given out at this output, which can be further evaluated, for example, with an SPS or a data acquisition system.

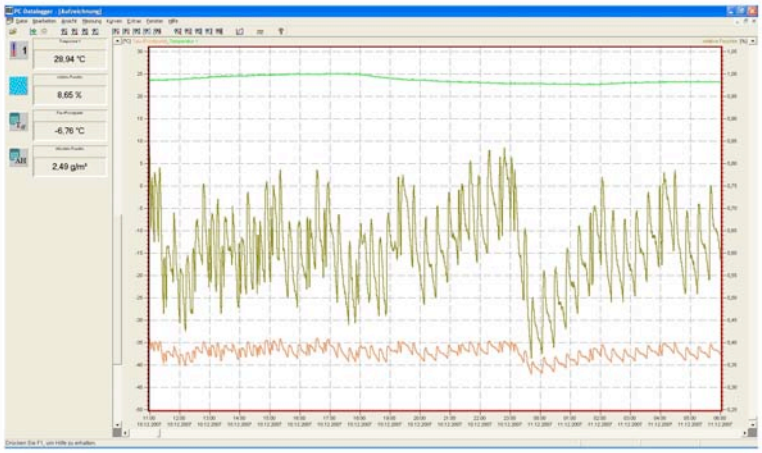
The scaling of the signal is 4 mA = -60° tpd, 20 mA = 20 °C tpd.

Analog output 4...20 mA	
description	**function**
A GND	
AANNAA OUT OU	Current source 4...20 mA

12.1.6 RS 232 -Interface

The RS 232 interface is compatible to commercial PCs. A matching interface cable as well as an USB adapter are available as accessories. The data format is compatible with the software PCLOG.

12.1.7 Software PCLOG



The software is used for visualisation of measured dew point values in the plant and is an efficient tool for installation of large compressors and compressed air systems.

Besides storing data of measured humidity values on hard disk, the software offers a very important feature of graphical representation of all measured and recorded channels in the form of temperature Vs time chart (online scriber function). By means of Drag & Click, the window section can be enlarged and the time or temperature axis can be scaled as desired. Besides the graphic view, representation is also possible in the form of a table. The in-between space is used for capturing measured data series into a spreadsheet program (for example EXCELTM) or for word processing. All tables and graphic representations can be printed out in colour. In addition, simple monitoring and regulation functions are also integrated in the software. Limits can be set for each channel. An acoustic signal is given out when the values are exceeded. Control of external alarm units is possible by a relay card, which is to be attached at the USB port.

13 Special type of applications

13.1 Stationery mounting location with cooling segment

For precise measurements in the lower dew point range (-10... -20 °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.

Performing a measurement: The connection takes place over a plug nipple with valve cock. First the air quality should be checked at the measuring point, for which the ball valve to be kept at "Divert" position. With condensate discharge, the measurement should be discontinued and first the plant should be put in order..

Then, the ball valve is to be kept in "Measure" position, and closed 3 times and opened again with a gap of approx. 20 seconds. Hence, draining the sinter filter is accelerated. Then (by opening ball valve and diverting air) the stabilization time must be waited for, until the measured values do not continue to fall further. Hence, the valid pressure dew point value is obtained.

The ball valve should be again closed before change to the next measuring point. In case of shorter gaps between measurements, shorter stabilization times are observed at the next measuring point.

13.2 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.

In case of unreasonable measured values, it should be checked whether the expanded gas is being diverted. If it is not so, then the diverting capillary can be plugged by a external piece. With very low flow, 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.

14 Trouble shooting guide

14.1 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 measuring system 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!

14.2 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.

14.3 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 measuring probe 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 measuring probe to the manufacturer for re-calibration.
The sensor is damaged.	Send the measuring probe to manufacturer for repair.

14.4 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 is too high, and after that, the temperature quickly falls to the actual value.	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.

15 Appendix

15.1 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.

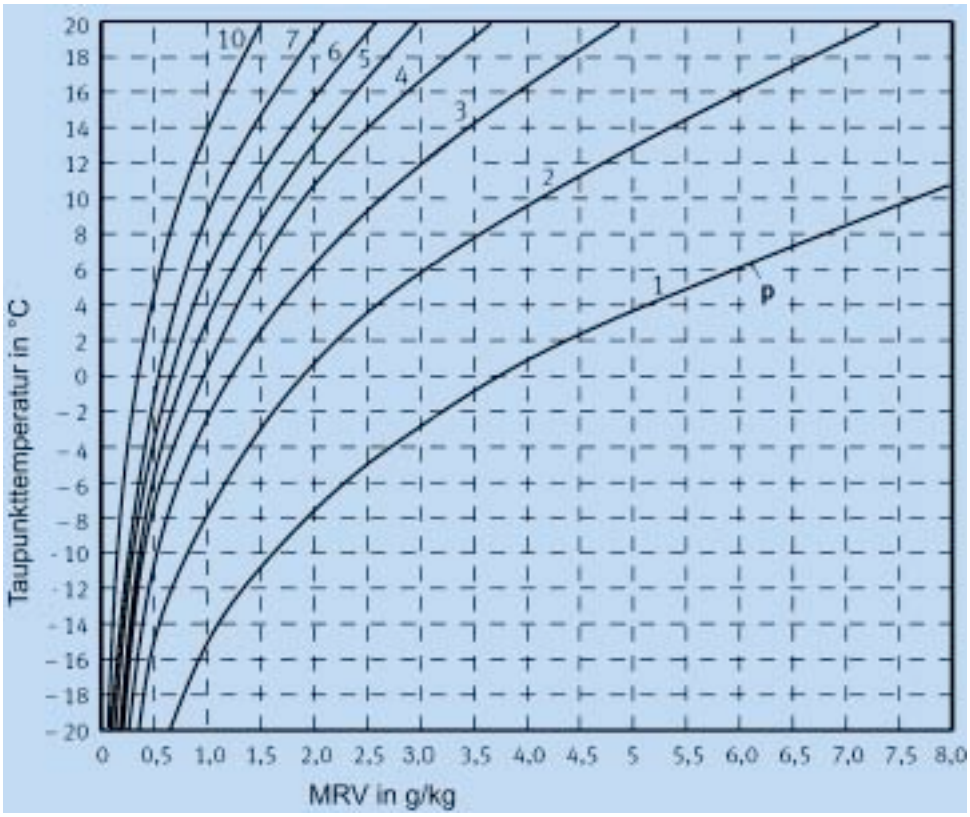
Apart from the problem of condensate formation, there are many other reasons for drying the compressed air. For example, in semiconductor production or in pharmaceutical industry, many technical processes can be carried out only with dry air of defined dew point.

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.

15.2 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 instrument 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.

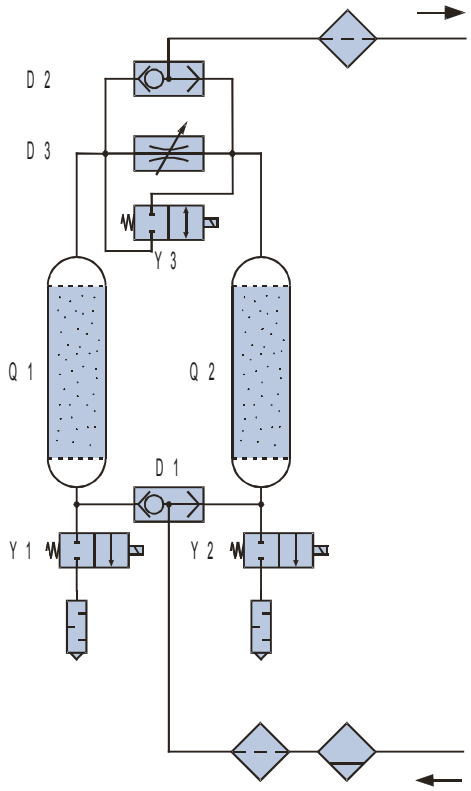
15.3 Thermodynamic concepts

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.

16 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 ° 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 regulator IDPC 40, it is possible to use the first alarm contact 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.

17 Checking the measuring accuracy

The measuring accuracy of the humidity probes can be checked up to a range of -5° 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.

18 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.

18.1 Format of data transfer at the serial interface

The interface works with a data rate of 4800 bauds, 8 data-bits, no parity and a Stopbit.

The transfer of useful data takes place in lines. All characters are ASCII coded. All information is sent continuously without separation characters. In one line, information of only one channel is transferred. Each line closes with the character 'Carriage return' '<CR>´. Several lines form a data-block. A data-block can have the following contents, for example :

```
@<CR>
I01010100B00725030178<CR>
V010892A1<CR>
I02020100B00725030148<CR>
V0216B0EA<CR>
$<CR>
```

The data block has a following structure:

- The starting sequence ´@ <CR>´
- The Identifier of a channel. The line begins with the character 'I', followed by the logical channel number, configuration data and the sensor serial number. The line is closed with the check sum and the character '<CR>'. The identifier does not contain any measured values.
- The measured values of a channel. The data line begins with the character ´V´, followed by the logical channel number and then by useful data (measured values). Only numerical measurement values and two characters check sum (CRC) are transferred at the end of the line.
- The identifier and measured values follow the same scheme for all other channels.
- The continuation character ´$´ <CR>´ is sent at the end of a data-block.

In TPW 20, the temperature values are transferred with channel 01 and humidity values(relative humidity) are transferred with channel 02.

- All information is represented in binary format and transferred in ASCII-encoded form without separation characters.
- Identification letter ´V´ at the beginning of the line, two ASCII -characters logical channel number (01 for temperature, 02 for humidity), 4 ASCII -characters measurement data, 2 ASCII -characters checksum
- The temperature has a resolution of 0.01 °C. The hexadecimal value is to be interpreted as signed integer and to convert it into decimal number, it is to be divided by 100. With this, one gets the temperature value in °C with two right comma places.
- The humidity has a resolution of 0.005%. The hexadecimal value is to be changed into a decimal number by dividing by 200. With this, one gets the humidity value rH in% with two right comma places.
- In the above shown example, the measured temperature is 21.94 °C and the air humidity is 29.04% rH.

19 EG-Conformance details

As per EMV-Guidelines 89/336/EWG

hereby declares that the product

“Pressure Dew point Monitoring Device TPW 60“

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.

München, den 04.Juni 2009

Ralf Kotzock

20 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.