Precision SAW Hygrometer DM500

USER'S GUIDE

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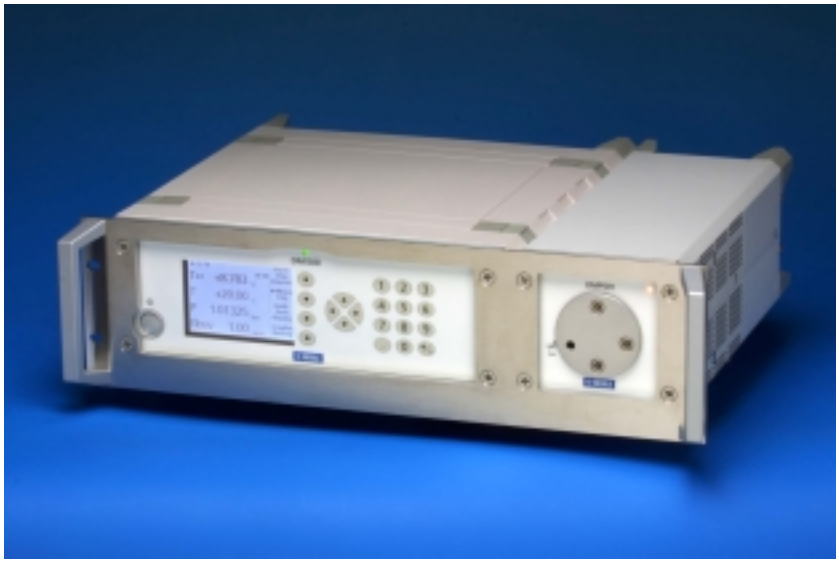

VAISALA

PUBLISHED BY

Vaisala Oyj
P.O. Box 26
FIN-00421 Helsinki
Finland

Phone (int.): (+358 9) 894 91
Fax: (+358 9) 8949 2227

Visit our Internet pages at http://www.vaisala.com/

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CHAPTER 1

GENERAL INFORMATION

About This Manual

This manual contains instructions for performing accurate dewpoint measurements with Precision SAW Hygrometer DM500.

Safety

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

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

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

NOTE	Note highlights important information on using the product.

Getting Help

Contact Vaisala technical support:

E-mail	helpdesk@vaisala.com
Telephone	+358 9 8949 2789
Fax	+358 9 8949 2790

Warranty

Vaisala hereby represents and warrants all Products manufactured by Vaisala and sold hereunder to be free from defects in workmanship or material during a period of twelve (12) months from the date of delivery save for products for which a special warranty is given. If any Product proves however to be defective in workmanship or material within the period herein provided Vaisala undertakes to the exclusion of any other remedy to repair or at its own option replace the defective Product or part thereof free of charge and otherwise on the same conditions as for the original Product or part without extension to original warranty time. Defective parts replaced in accordance with this clause shall be placed at the disposal of Vaisala.

Vaisala also warrants the quality of all repair and service works performed by its employees to products sold by it. In case the repair or service works should appear inadequate or faulty and should this cause malfunction or nonfunction of the product to which the service was performed Vaisala shall at its free option either repair or have repaired or replace the product in question. The working hours used by employees of Vaisala for such repair or replacement shall be free of charge to the client. This service warranty shall be valid for a period of six (6) months from the date the service measures were completed.

This warranty is however subject to following conditions:

a) A substantiated written claim as to any alleged defects shall have been received by Vaisala within thirty (30) days after the defect or fault became known or occurred, and

b) The allegedly defective Product or part shall, should Vaisala so require, be sent to the works of Vaisala or to such other place as Vaisala may indicate in writing, freight and insurance prepaid and properly packed and labelled, unless Vaisala agrees to inspect and repair the Product or replace it on site.

This warranty does not however apply when the defect has been caused through

a) normal wear and tear or accident;

b) misuse or other unsuitable or unauthorized use of the Product or negligence or error in storing, maintaining or in handling the Product or any equipment thereof;

c) wrong installation or assembly or failure to service the Product or otherwise follow Vaisala's service instructions including any repairs or installation or assembly or service made by unauthorized personnel not approved by Vaisala or replacements with parts not manufactured or supplied by Vaisala;

d) modifications or changes of the Product as well as any adding to it without Vaisala's prior authorization;

e) other factors depending on the Customer or a third party.

Notwithstanding the aforesaid Vaisala's liability under this clause shall not apply to any defects arising out of materials, designs or instructions provided by the Customer.

This warranty is expressly in lieu of and excludes all other conditions, warranties and liabilities, express or implied, whether under law, statute or otherwise, including without limitation any implied warranties of merchantability or of fitness for a particular purpose and all other obligations and liabilities of Vaisala or its representatives with respect to any defect or deficiency applicable to or resulting directly or indirectly from the Products supplied hereunder, which obligations and liabilities are hereby expressly cancelled and waived. Vaisala's liability shall under no circumstances exceed the invoice price of any Product for which a warranty claim is made, nor shall Vaisala in any circumstances be liable for lost profits or other consequential loss whether direct or indirect or for special damages.

CHAPTER 2

PRODUCT DESCRIPTION

DM500 is a high accuracy dewpoint temperature measuring instrument capable of measuring dewpoints down to -75 ºC with an accuracy of ± 0.2 ºC. DM500 can be used with 100...240VAC 50/60 Hz, 4.5 A power supply. The suitable power cable for different countries is selected when ordering the device (EUR/UK/US/JAP/AUS).

The DM500 system consists of the user interface unit DMI500 and the dewpoint sensing unit DMP501. Four of the following quantities can be displayed at a time:

-dewpoint/frostpoint **$T_{d/f}$** (ºC or ºF), more about dewpoint/frostpoint on page xx.
-dewpoint **T_d** (ºC or ºF)
-partial water vapour pressure **P_w** (mbar)
-humid air volume/dry air volume **H_2O** (ppm_v)
-relative humidity **RH** (%)
-temperature **T** (ºC or ºF)
-pressure **P** (bar, hPa, psi, torr)
-air flow rate **flow** (slpm, scfh)

The DM500 system includes two packages including the following parts:

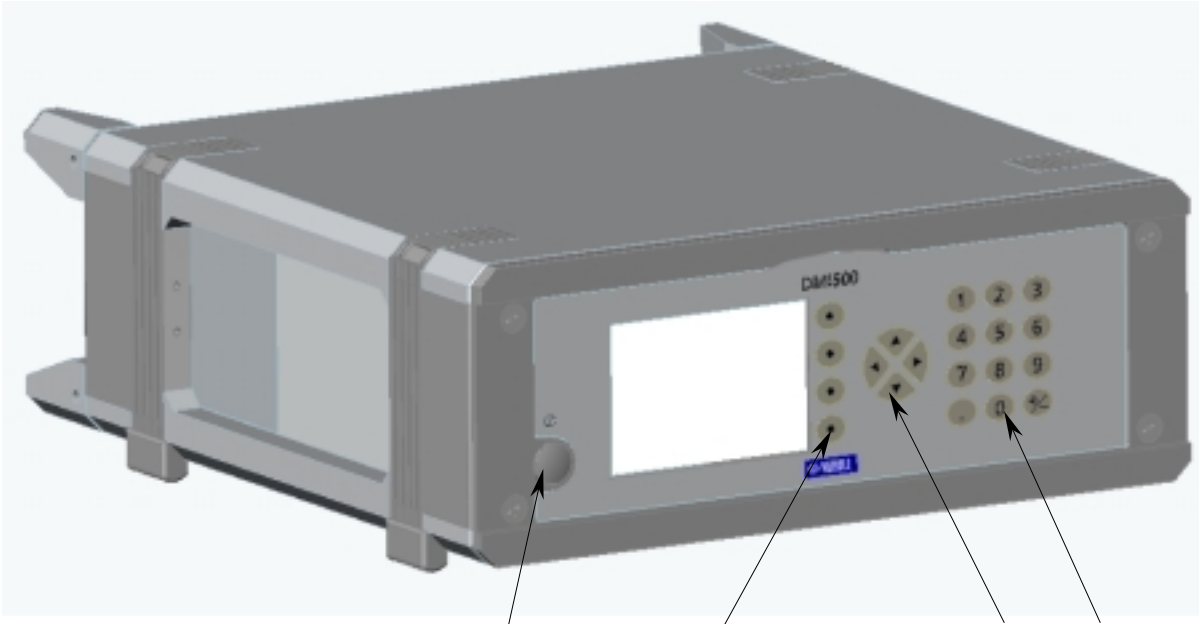
DMI500

- DMI500 user interface unit
- serial cable for EIA-232 (RS-232)
- CD-Rom including MI70 Link software; to transfer logged data to your PC
- power supply cable (according to the customer's requirement)

DMP501

- DMP501 dewpoint sensing unit
- Swagelok spare tube fittings for 1/4" tubes for the sample gas line (to replace default tube fittings (6 mm)
- Allen key; to remove the sensor cup and to adjust the sample flow.
- water tubing for the condense water outlet

Front panels

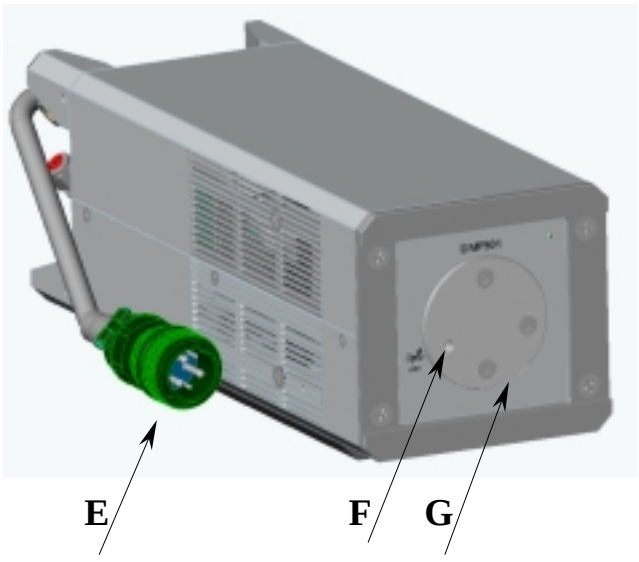


DMI500 User Interface Unit

A Mains switch ⏻. Press to turn the device ON/OFF.
B Configurable softkeys ⊙. Press down to activate the menu function shown beside the button.
C Arrow keypad ▶. Press any of the arrow buttons to open path for the menus. In the menus,you can navigate with arrow buttons. Up and down arrows for moving in the menu, left-pointing arrow for selecting menu item, right-pointing arrow for returning to previous menu.
D Numeric keypad. Numerical input can be given with the number keypad.

DMP501 Dewpoint Sensing Unit

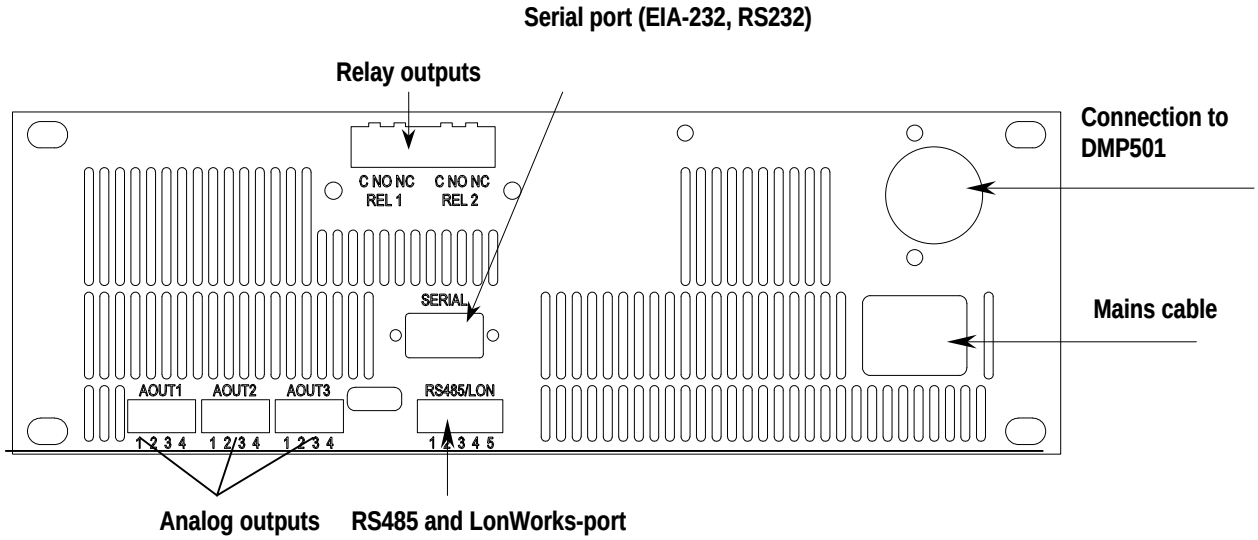
E Power/data cable; connect to the back panel of the DMI500
F Allen screw for adjusting the sample flow.
G Sensor cup; three Allen screws to open the cup for sensor cleaning.



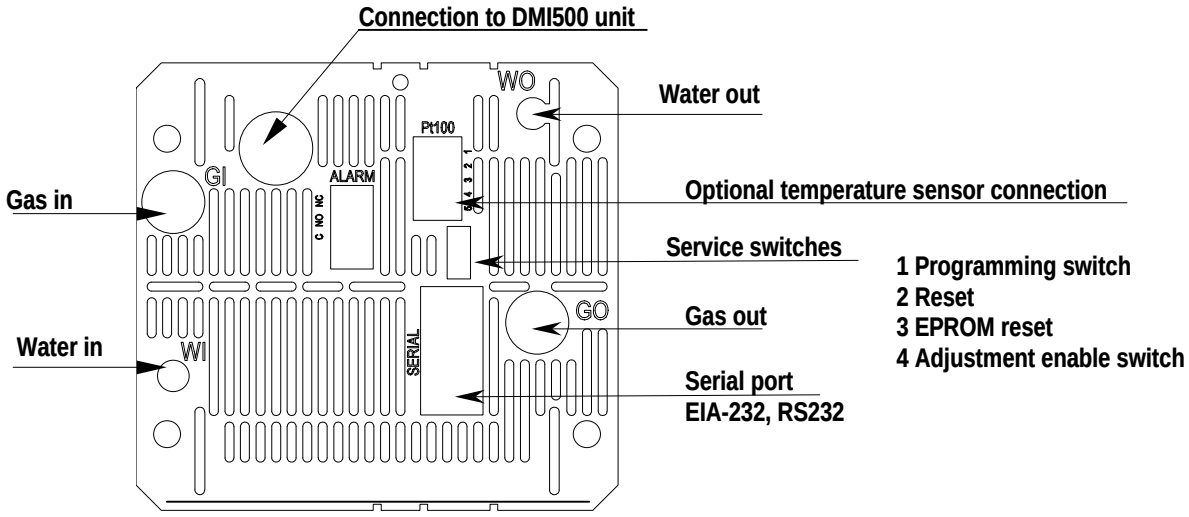
NOTE	Warranty is void if DMP501 case is opened by the user !

Back panels

DMI500 User Interface Unit



DMP501



Optional accessories

Description	Order code
Rack mounting kit	DM500RMP
Portability kit	DM500PAK
Extension cable 2.5 m	DM500ECS
Extension cable 10 m	DM500ECL
mains EURO	6543
mains UK	210548
mains US/Japan	210547
mains AUS	210619

Factory calibration and repair service

WARNING Please note that there are no user-serviceable parts inside the DMP501 or DMI500. To avoid safety risks with hazardous voltage or hazardous energy, the enclosures shall not be opened except by authorized Vaisala service personnel.

Vaisala SSD Service Centres

Vaisala SSD Service, Vanha Nurmijärventie 21 FIN-01670 Vantaa, FINLAND.
Phone: +358 9 8949 2758, Fax +358 9 8949 2295, ssdservice@vaisala.com

Vaisala Inc., 100 Commerce Way, Woburn, MA 01801-1068, USA.
Phone: +1 781 933 4500, Fax +1 781 933 8029, us-customersupport@vaisala.com

Vaisala KK, 42 Kagurazaka 6-Chome, Shinjuku-Ku, Tokyo 162-0825, JAPAN.
Phone: +81 3 3266 9611, Fax +81 3 3266 9610, aftersales.asia@vaisala.com

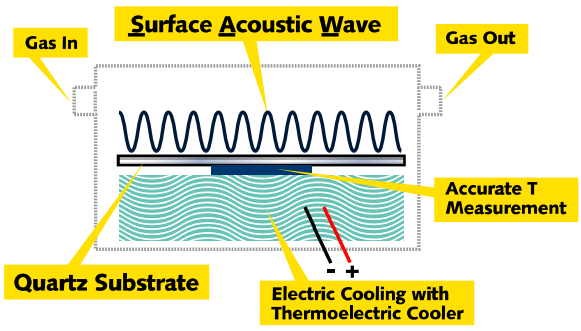
Internet: http://www.vaisala.com
Technical support: helpdesk@vaisala.com

CHAPTER 3

PRINCIPLE OF OPERATION

DM500 Principle of operation

DM500 is an automatic, continuously controlling condensation hygrometer designed to measure dewpoint temperatures from -75 °C to +60 °C, depending on the model. The system consists of the DMP501 dewpoint sensing unit and the DMI500 user interface unit. The measured gas flows through the sensing unit, where it contacts a temperature controlled quartz surface. The quartz surface is monitored for the presence of condensation. The presence or absence of condensation is sensed using surface acoustic wave (SAW) technology. In the measuring mode, the temperature of the quartz surface is varied until condensation exists in equilibrium. Temperature of the sensor element is measured with a temperature sensor (1/3 DIN B, Pt100, 4-wire) bonded on the backside of the quartz substrate. This measured value is used to accurately output the dew/frostpoint temperature.



Sensing element

The DEWCAP® SAW sensor, as used in the condensation hygrometer, integrates the cooled surface (where condensation forms) with the detection mechanism in one element. The element consists of a transmitting and a receiving antenna

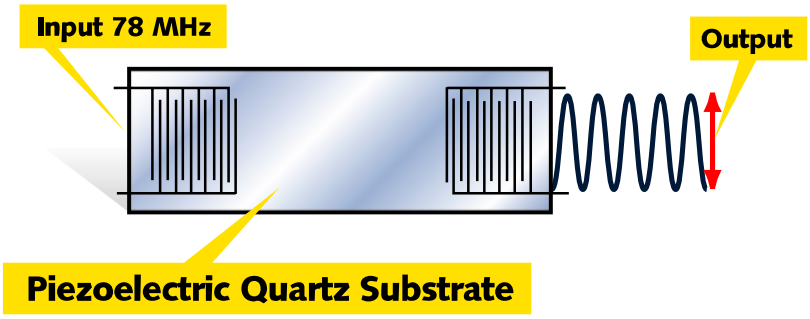
photolithographically patterned on a single mechanically very durable crystal quartz chip.

RF-signal

A radio frequence (RF) signal fed to the transmitting antenna is converted to a micromechanical wave. The mechanical wave propagates along the sensing element surface to the receiving antenna, where the mechanical wave is re-converted to an RF-signal. As the wave propagates at the sensor surface only, it is very sensitive to condensation in contact with the surface.

The difference between dewpoint and frostpoint

The presence of liquid condensation on the element alters the signature in a repeatable way. The freezing of the condensate on the element causes a distinctly different signal change, thus enabling the determination of whether dew or frost are on the element.



Analysis of the received wave in terms of frequency and amplitude provides the information required to control the element's temperature in such a way that a thin layer of dew or frost remains in equilibrium on the element. Additionally, analysis can determine the presence or absence of hygroscopic contaminants on the element.

Hygroscopic dirt like salt is a common source of error in conventional dewpoint measurement techniques.The DEWCAP® sensor can detect the presence of salts on the sensor surface. The salt sensing self-diagnostics can be turned on/off by the user with a special software procedure that can detect if the RF signal is not propagating through the circuit as espected

Contamination and chemical resistance

The DM500 operates reliably even with substantial particulate contamination on the sensing element. Analysis of frequency and impedance makes it possible to

distinguish between frost and dew and to give warning of hygroscopic contaminants on the detector.

Use of a quartz wafer as a sensor substrate results in excellent resistance to aggressive chemicals. Wetted parts inside the DMP501 dewpoint sensing unit are limited to stainless steel, silicone, tantalum, quartz, Vectra® (Liquid Crystal Polyester).

Vectra and silicone parts as well as those optional components that have water-absorbing materials are located downstream from the active area of the sensor thus not disturbing the measurement especially in low dewpoints.

CHAPTER 4

GENERAL ABOUT SAMPLING AND RESULTS

Gas sampling

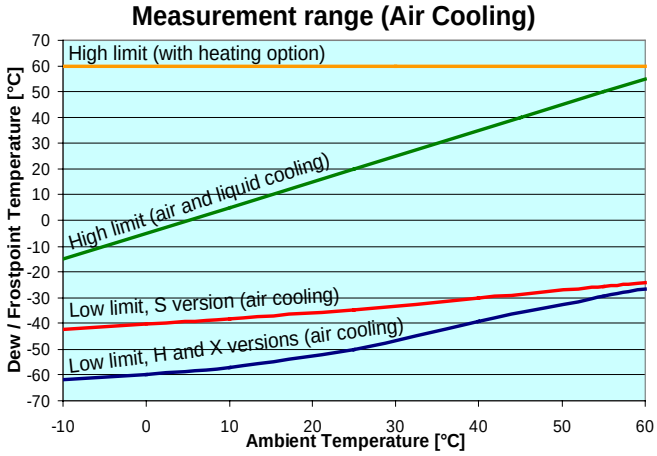
When measuring low dewpoints, all installations must comply with the strict requirements. Clean environment is always beneficial for humidity measurements, but this is especially critical at very low humidities. It is important to use high quality stainless steel tubes (electro polished), particularly clean and dry. Contamination has often a hygroscopic effect. Attention must be paid to correct and tight gas connections. The ambient temperature and the temperature of all parts of the sampling pathway must be kept above the dewpoint to avoid condensation.

The following recommendations shall be taken into account when measuring in very dry environments.

- minimise the number of connections to avoid leaks
- ensure that flow rate is adequate
- avoid dead ends as they cannot be flushed easily
- the temperature of the gas line components must never lie under the dewpoint of the sample gas, as this leads to condensation and false results
- sample tubing shall be as short as possible, the surface area should be minimised by using the tubing with the smallest diameter that the flow conditions shall permit
- surface finishing of wetted surfaces is important, polished or electropolished steel is recommended for the best results
- avoid hygroscopic materials in the sampling lines, use stainless steel membranes instead of rubber membranes
- choose impermeable materials to avoid inward diffusion of moisture through sampling tubes and enclosures, such impermeable materials include high quality stainless steel and metals. Avoid PVC or nylon tubes !
- PTF (Teflon) tubes are suitable dor dewpoints down to -40 °C.

The effect of the ambient air temperature on cooling capacity

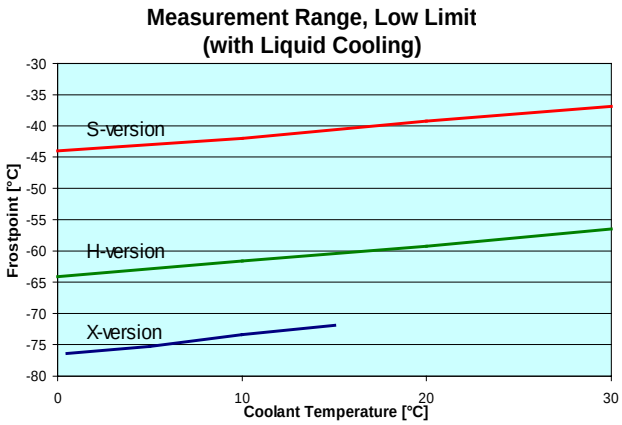
The cooling capacity of the sensor is dependent on the cooling water temperature, as shown in the figure (below). In general, the cooler the ambient air is, the lower dewpoint can be reached. By using air as a cooling medium, the lowest normally achievable dewpoint is about -50 ºC. When measuring lower dewpoint, watercooling must be used. Recommended air temperature: 10...40 ºC (50...104 ºF).



Effect of ambient air temperature on lowest achievable stable sensor temperature.

The effect of the liquid coolant temperature on cooling capacity

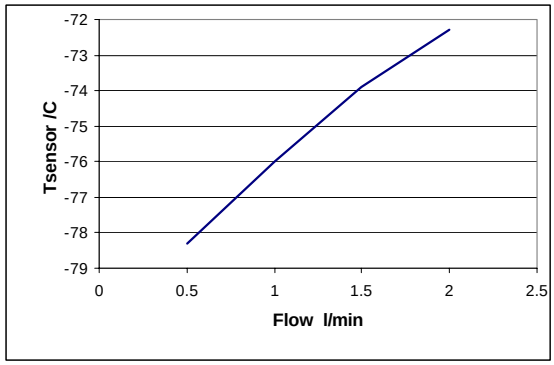
The cooling capacity of the sensor is dependent on the cooling water temperature, as shown in the figure (below). Recommended water temperature: < 15 ºC (50 ºF).



Effect of water temperature on lowest achievable stable sensor temperature. (Sample gas flow 1.0 slpm; T_{amb} 23°C; water flow 5 l/min)

The effect of the sample gas flow rate on cooling capacity and result deviation

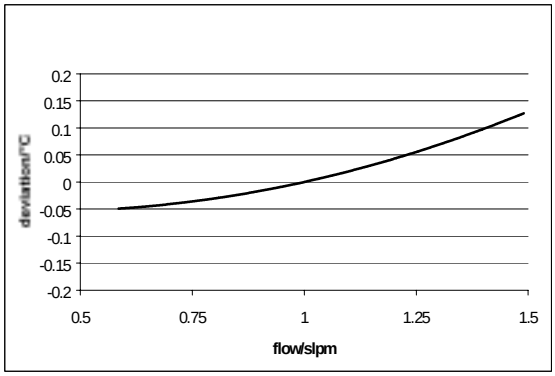
The cooling effect of the gas flow rate is shown in the figure (on the right). Low flow rate increases cooling capacity but also increases response time.



Effect of sample flow rate on lowest achievable stable sensor temperature.

The sample flow rate has an effect on the deviation of the measurement results as shown in the figure (on the right).

Sample flow rate range: 0.5...1.5 l/min.
Recommended sample flow rate: 1.0 l/min.



Effect of sample flow rate on dewpoint measurement at -60 ºC .

Optional heated gas lines

The optional heated gas lines keep the internal gas lines and sensor chamber temperature above 60ºC. (The user must take care of heating the external gas lines). To facilitate external gas line heating control, the relay output on the back plate of the DMP501 activates when heating is ON. In order to keep the gas connections warm enough, the external gas line should be heated 100ºC above ambient.

NOTE	After switching on the heating option, allow the system warm up at least 30 minutes to ensure that no condensation occurs in the gas lines.

WARNING	When heater function is activated, don't touch with bare fingers the hot cap of the sensor chamber. Please use gloves when detaching the cap.

Wetted materials of the optional parts

Pump	Polyarylamide, NBR (nitril butyl rubber), galvanized steel.
Flow sensor	Silicon nitride, polyetherimide, fluorocarbon, aluminium oxide, epoxy, silicon and gold.
Integrated pressure sensors	Stainless steel (AISI 316)
Integrated flow sensor	Silicon nitride, polyethermide, fluorocarbon, aluminium, oxide, epoxy, silicon, gold
External temperature sensor	Glass, stainless steel, silicone

CHAPTER 5

SETTING UP FOR OPERATION

Connection of the DMI500 and DMP501 units

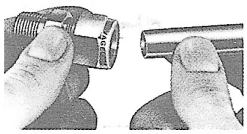
Unpack the instrument carefully and check that all parts are visually undamaged.

1. Connect the DMP501 dewpoint sensing unit to the DMI500 user interface unit as follows:

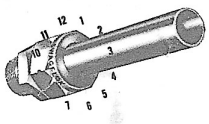
- Insert the male connector at the end of the DMP501 power cable (see page 9, item E) into the female connector on the back panel of the DMI500 unit. Tighten the sleeve nut (and simultaneously press the connector in) until the connectors are perfectly mated. If the probe is not connected properly, the measured values on the display are replaced by lines.

- Connect the serial output cable, analog output data cable (back panel of the DMI500) and relay connections (back panel of the DMI500), when used. See the ports from page 10 Back panels.

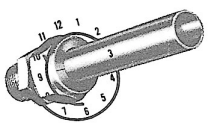
Swagelok tube fittings' installation instructions



Step 1: Insert the tubing into the Swagelok tube fitting. Tubing should rest firmly on the shoulder of the fitting. Nut shall be fingertight.



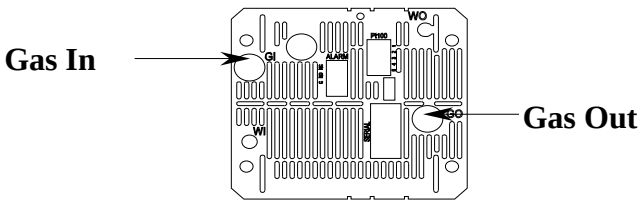
Step 2: Mark the nut at the 6 o'clock position.



Step 3: Hold the fitting body with a backup wrench and tighten the nut 1¼ turns. Watch the marking and make one complete turn and continue to 9 o'clock position.

Connecting the sample gas flow

Back panel of the DMP501



1. Detach the Swagelok fittings from Gas In (GI) and Gas Out (GO) connections. If the sample gas can flow out to measuring room, it is not necessary to connect the GO fitting. Replace the 6 mm fitting with the 1/4" adapter fitting (provided), if needed. If you use the adapter fitting, see that the 6 mm side is connected to the Gas In -connection.
2. Attach the gas tubes (diameter of 6 mm or1/4") to the Swagelok fittings.
3. Replace the Swagelok fitting (with the tubing) into the GI connector. (Connect similarly the Gas Out tubing, if necessary).
4. Let the sample gas flow with a flow rate of 0.5...1.5 l/min (recommended 1.0 l/min)
5. If needed, adjust the sample flow rate by turning the Allen screw (in the sensor cup, see page 9, item F) with a key (provided).

WARNING	Do not connect flammable, highly reactive or toxic gases to the instrument. Ensure adequate ventilation when using other gases than air.

Selecting the cooling method

Use either air or water in sensor cooling.

- water cooling: when measuring dewpoint below -50 ºC (-58 ºF)

- air cooling: when measuring dewpoint above -50 ºC

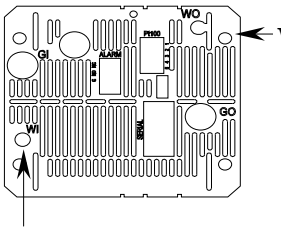
Use of subzero water/glycol or ethanol mixture as the cooler liquid is not recommended, as there is a risk of substantial ice formation inside the probe unit.

However, subzero cooling liquid can be used for short periods. To ensure sufficient cooling capacity, please follow the instructions below. The temperature of the cooling air/water and flow rate of the sample gas have an effect on the cooling capacity.

When using air cooling, the fan inside the device is cooling the system. When using water cooling, connect the water as instructed in the following chapter.

Connecting the cooling liquid

Back panel of the DMP500



Water Out

Water In

1. Remove the Swagelok fittings from Water In (WI) and Water Out (WO) connections.
2. Attach the tubes (diameter of 8 mm) to the Swagelok fittings (diameter of 8 mm or 5/16"). Plastic tubes are recommended.
3. Connect the water inflow tubing to the connector WI. And similarly the water outflow tubing to connector WO. Reverse water flow can be used as well.
4. Replace the Swagelok fittings to the back panel connectors.
5. Let the water flow with the flow rate of 5...20 l/min, temperature of water shall be <+15 ºC (50 ºF). Check for leaks and tighten if necessary.

Once the water tube connections have been tightened, the water tubing should be disconnected from the Swagelock fittings.

Connecting the condensation water drain tube

Significant moisture condensation occurs only if the system is water-cooled. Connect the condensation water drain tube to the outlet situated on the right-side panel of the DMP501.

1. Connect the silicone tube to the metal tube protruding from the right-side of the DMP501 sensing unit .
2. The tube end must be placed at least 300 mm below the probe bottom level, in a drain or in a small vessel where the condensed moisture can be safely drained. The amount of condensed moisture is small, typically tens of milliliters per 24 h of operation.

WARNING	Do not assemble the instrument in a location where condensed water dripping out of the system could cause a hazard, like above high-voltage power supplies.

CHAPTER 6

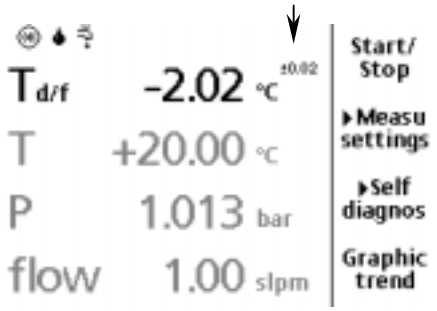
MEASURING THE DEWPOINT

1. After the installation procedures, turn the power on by pressing the power ON/OFF button ⏻.
2. Let the system warm up for at least 1 minute before starting the measurements.
3. When the device is ready for use, the display below appears:

Display before activating the measurement mode

4. Select the water or air cooling method. Press the soft key ⊙ **▸Measu settings,** select by using arrow button **Cooling method.** Select **WATER** or **AIR**. See page 20, *Selecting the cooling method.*
5. Start measurement by pressing ⊙ **START/STOP.**
6. Wait until yellow led turns to green in the DMP500 dewpoint sensing unit front panel. The ⧖ symbol disappears from the display and the error limit value appears on the upper right corner of the display. The measuring cycle is now balanced. You can follow the stabilization from the graphic trend.

Error limit value.



Measurement mode display.

7. Droplet symbol ♦ on the upper left corner of the display indicates the presence of dew on the sensor.

If the condensate on the sensor freezes the droplet changes to a snowflake symbol ❄. If the sensor has both dew and frost on the surface, both ♦ and ❄ symbols are displayed. The moment of instability is indicated both by blinking ♦ and ❄ symbols as well as by increased error limit value. The instability period usually lasts less than 10 minutes until the condensate is frozen. Thus, the user need not keep track of the moisture phase in order to obtain reliable measurement results in the temperature range where either dew or frost or both can exist on the sensor (typically 0 ºC...-30 ºC)

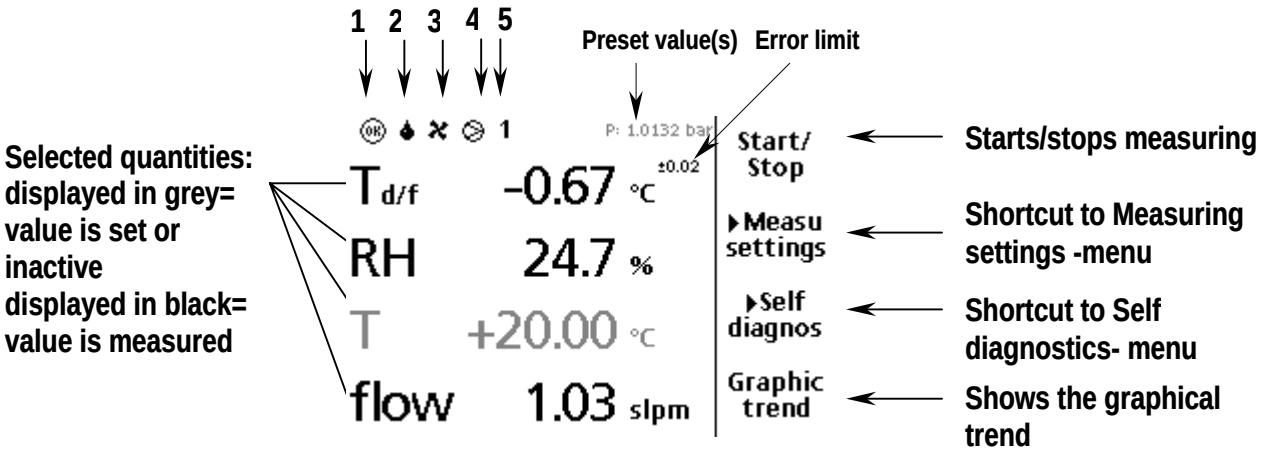
More about the moisture phases ♦❄

The system detects the phase of the moisture on the sensor automatically and uses this phase data when converting measured sensor temperature to the user selected unit. For example, if the user wishes to output dewpoint, not frostpoint, the system uses the measured sensor temperature as dewpoint temperature as long as the moisture phase remains liquid (♦ symbol in the display). If the dewpoint is low, the sensor may freeze. The system detects the moment of freezing and thereafter considers the sensor temperature to be the frostpoint temperature. This frostpoint temperature is automatically converted to a corresponding dewpoint temperature, which is then displayed to the user. The symbol on the display changes to ❄ after the freezing is complete.

CHAPTER 7

DISPLAYS AND MENUS

Basic display (in measuring mode)



1 Symbol which indicates if the measuring is activate (OK) or stopped (STOP).

2 Symbol which indicates the form of the moisture on the sensor ♦ water, ❄ frost

3 Symbol which indicates the cooling method, ✕ air, ⛲ water

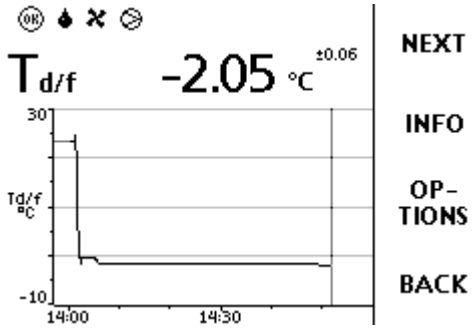
4 Symbol which indicates that optional pump for the sampling line is ON. If this symbol is not shown, the pump is OFF.

5 Shows the that in this case the relay 1 is in working mode.

Error limit: The 2Σ deviation of the measured dewpoint temperatures.
Appears when the system is balanced. During an instable intermediate moisture phase indicated by blinking ♦ and ❄ symbols, error limit value is higher than in stabilized state.
Preset value(s): All the preset values are shown if they are not selected for the display.

Values shown in the display in black colour are active measured values. Temperature, flow or pressure values in grey colour are preset, not measured. T_d /$T_{d/f}$ are grey when showing the sensor temperature when the measurement is in stop mode. Other humidity quantities are not shown in stop mode.

Graphical display



Graphical display shows you the measurements in a form of curve. From the curve you can examine the data trend and history of the last few hours.

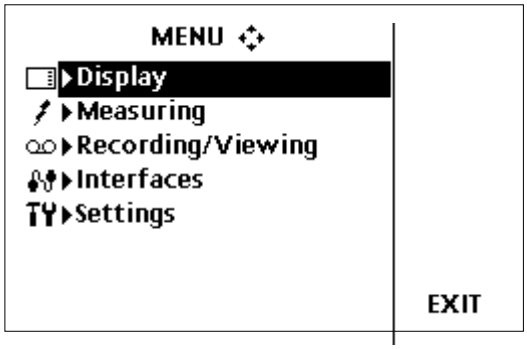
1. In basic display, press ⊙ **Graphic trend** or (alternatively open the **MENU,** select ▶**Display-Graphic trend).**
2. Graphical display opens. More information on page **Graphichal trend.**
3. Press ⊙ **BACK** to return to the basic display.

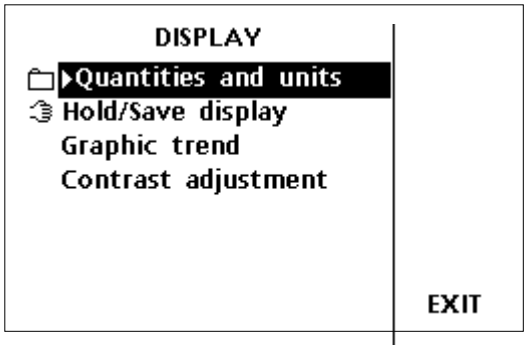
More information on graphic trend on page 34.

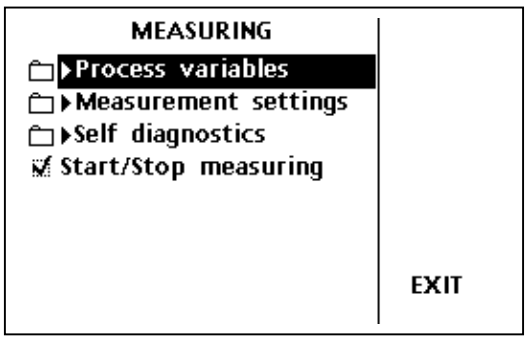
Menus and navigation

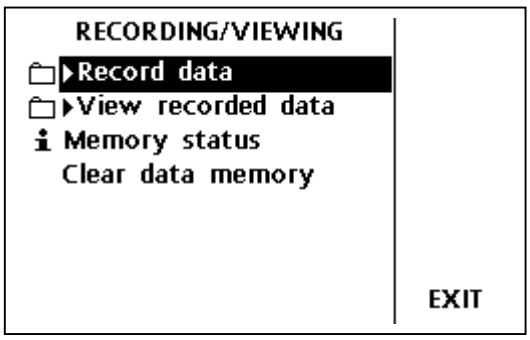
In the menus you can change settings and select the functions.

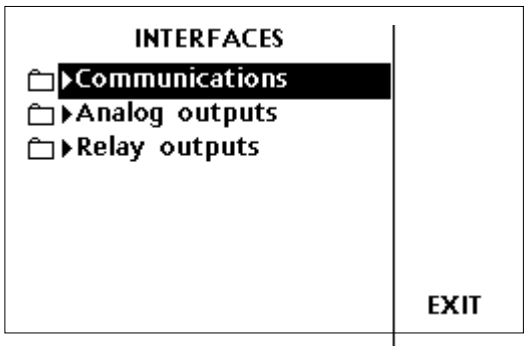
1. Open the main menu by pressing any of the ▲▼▶◀ buttons.
2. Move in the menus by using ▲▼ buttons.
3. Select the item with ▶ buttom.
4. Press ◀ to return to the earlier level.
5. **EXIT** returns you back to the basic display.

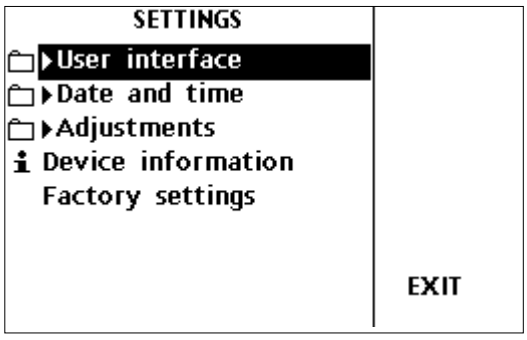












CHAPTER 8

BASIC SETTINGS

User Interface

Setting the language

1. Open the **MENU:** press Ⓑ.
2. Select ▶**Settings**, press Ⓑ.
3. Select ▶**User Interface,** press Ⓑ.
4. Select **Language**, press ⊙ **SET.**
5. Select the language (English/ German/ French/ Finnish/ Spanish) and press ⊙ **SELECT**.
6. Press ⊙ **EXIT** to return to the basic display.

Changing the shortcut keys

As a default, the four shortcut keys refer to the functions **Start/Stop**, **▶Measurement settings, Self diagnostics** and **Graphic trend.** If needed, a shortcut for the functions can be changed to correspond your needs.

1. Open the **MENU:** press ⓓ.
2. Select **▶Settings**, press ⓓ.
3. Select **▶User Interface,** press ⓓ.
4. Select **Program shortcut keys**, press ⊙ **START.**
5. Press the shortcut key you want to change, f.ex. **▶Measurement settings.**
6. Select the new shortcut function by using arrow buttons, press ⊙ **SELECT**. Answer **YES** to confirm your selection, otherwise answer **NO** and continue from item 4.
7. Press ⊙ **EXIT** to return to the basic display.

Key click ON/OFF

You can turn ON/OFF the button pressing sound effect.

1. Open the **MENU**: press ⓓ.
2. Select **▶Settings,** press ⓓ.
3. Select **▶User interface,** press ⓓ.
4. To turn OFF or ON sound effect while pressing the buttons, select **Key Click** and press ⊙ **ON/OFF**.
5. Press ⊙ **EXIT** to return to the basic display.

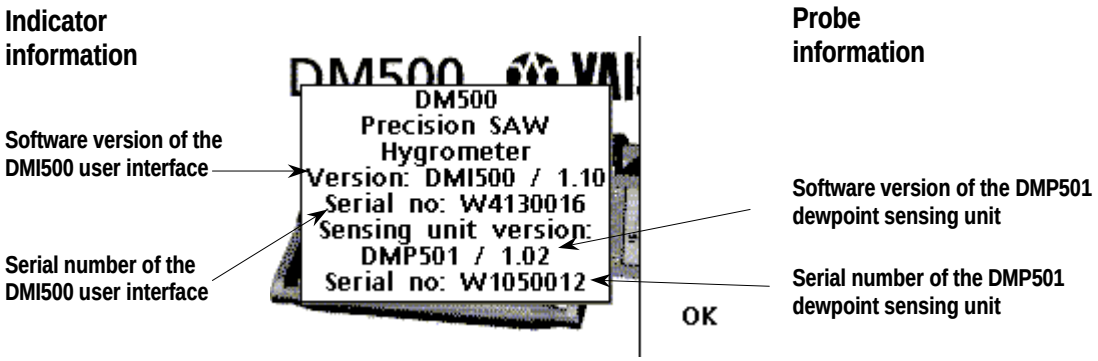
Setting date and time

1. Open the **MENU:** press ⓑ.
2. Select ▶**Setting**, press ⓑ.
3. Select ▶**Date and time**, press ⓑ.
4. The default date presentation format is *year-month-day*, f.ex. 2001-11-01. To change the date, select **Date** and press ⊙ **SET.** Change the date by using arrow buttons or numerical buttons.To confirm the date, press ⊙ **OK**. If you want to change the format, select **Date format,** press ⊙ **SET.** Select the otherdate format *month/day/year* or *date.month.year),* press ⊙ **SELECT.**
5. The default time presentation format is 24-hour clock. To change the time, select **Time** and press ⊙ **SET.** Change the time by using arrow buttons and numerical buttons.To confirm the time, press ⊙ **OK.** If you want to change the format, select **12-hour clock**, press ⊙ **ON/OFF.**
6. Press ⊙ **EXIT.**

Device information

The basic information about the DM500 is found as follows:

1. Open the **MENU:** press ⊳.
2. Select ▸**Settings**, press⊳.
3. Select **Device information,** press ⊙ **SHOW.**
4. The display gives the basic information on the device. Press ⊙ **OK** and ⊙ **EXIT** to return to the basic display.



Reverting factory settings

Factory settings can be reverted to clear all changed settings and data memory. Reverting factory settings does not effect on probe calibration.

1. Open the **MENU:** press ⊳ .
2. Select ▸**Settings**, press ⊳.
3. Select **Factory settings,** press ⊙ **REVERT.** Press ⊙ **YES** to confirm the reverting.
4. The device resets automatically.

CHAPTER 9

DISPLAY SETTINGS

Display backlight

The display backlight is automatically on when the device is turned on. After 10 hours use, the backlight turns off. When pressing any button, the light turns on again.

Selecting the quantities and units

The following quantities and units can be chosen to the display:

Parameter	**Unit**
$T_{d/f}$, T_d, T	°C or °F
P_w	mbar
H_2O	ppm_v
RH	%RH
Pressure	bar, hPa, psi, torr
Flow	slpm, scfh

More about the difference between $T_{d/f}$,T_d on page 88.

1. Open the **MENU**; press ▷.
2. Select ▶**Display**, press ▷
3. Select ▶**Quantities and units**, press ▷
4. Select the quantity you want by using the arrow buttons, press ⊙ **SELECT**.
5. Select and change similarly the other quantities and units. Four quantities can be chosen for the display.
6. Press ⊙ **EXIT** to return to the basic display.

NOTE	When changing the unit via the serial line, the display unit changes simultaneously.

Hold/Save display

Hold/Save function enables you to freeze a certain display reading. This reading can be saved into the memory as a single data point.

1. Open **MENU:** press ▷.
2. Select ▶**Display**, press ▷
3. Select **Hold/Save display,** press ⊙ **HOLD** to freeze the display. The frozen measurement data is displayed.
4. Press ⊙ **SAVE** to save the reading or ⊙ **EXIT** to return to the basic display.
5. You can save several readings with **HOLD-SAVE** function. All the individually saved readings are stored in a same file marked with and with a start date.
6. To view the saved readings, open the menu, select ▶**Recording/Viewing,** press ▷, select ▶**View recorded data,** press ▷.
7. Select the file marked with press ⊙ **SHOW**. Now you can see the firstly saved data reading on the display numerically and pointed out in graphics with a vertical line (the curve shows all the individual data points). Press ▷ to see the next data point numerically etc. The saving times of individual data points are shown in the first row of the display, after the date.
8. Press ⊙ **NEXT** to see the other parameters (temperature, pressure and flow).
9. Press ⊙ **INFO** to see the statistics of the saved data points.
10. Press ⊙ **OPTIONS** to set the following graph options

Show value: Select ⊙ **YES** to have the data points shown numerically. Select ⊙ **NO** to hide the numerical value.

Hide function keys: Select ⊙ **YES** to hide the function keys shown in the right side of the display. Select ⊙ **NO** to have the function keys shown.

Automatic scale: Select ⊙ **YES** to have the y-axis scaled automatically. Select ⊙ **NO** to have the y-axis scaled manually. To set the scaling manually, select with the arrow button the **Min** and **Max** values and change the values by using

the numerical buttons. If you set manually impossible values (for example min>max), the automatic scaling is forced to the on-state.

11. Press ⊙ **BACK** and ⊙ **EXIT** to return to the basic display.

All the individual **Hold/Save** data points are saved in the same file until the power is switched OFF. When switching ON again and saving data, the data points are saved in a different data file.

Graphic trend

Graphic trend shows you the data curve from the time turning on the device.

1. Open **MENU:** press ▷.

2. Select **▶Display**, press ▷

3. Select **Graphic trend,** press ⊙ **SHOW.**

4. Press ⊙ **NEXT** to see the graphic trend of the other parameters.

5. Press ⊙ **INFO** to see the statistics of the saved data.

6. Press ⊙ **OPTIONS** to set the following graph options

Show value: Select ⊙ **YES** to have the data shown numerically. Select ⊙ **NO** to hide the numerical value.
Hide function keys: Select ⊙ **YES** to hide the function keys shown in the right side of the display. Select ⊙ **NO** to have the function keys shown.

Automatic scale: Select ⊙ **YES** to have the y-axis scaled automatically. Select ⊙ **NO** to have the y-axis scaled manually. To set the scaling manually, select with the arrow button the **Min** and **Max** values and chenge the values by using the numerical buttons. If you set manually impossible values (for example min>max), the automatic scaling is forced to the on-state.

8. To zoom in the curve, press the arrow button △. To zoom out, press the button ▽. To select the individual data points from the curve, press either of the buttons ▷◁.

9. Press ⊙ **BACK** and ⊙ **EXIT** to return to the basic display.

Contrast adjustment

You can change the contrast of the LCD display using the **Contrast adjustment**.

1. Open **MENU:** press ⓑ.
2. Select ▶**Display**, press ⓑ
3. Select **Contrast adjustment,** press ⊙ **START.**
4. To increase the contrast, press ⊙ **DARK.**
5. To decrease the contrast, press ⊙ **LIGHT.**
6. Press ⊙ **OK** and ⊙ **EXIT** to return to the basic display.

CHAPTER 10

MEASUREMENT SETTINGS

From the measurement settings menu you can set on/off the dew/frost sensing, choose the cooling method, set the response speed, select the transient recovery time and turn on/off the pump.

Automatic frost detection

The automatic dew/frost sensing procedure senses if the condensate on the sensor is water (dew) or ice (frost). If the sensing is turned OFF, the $T_{d/f}$ value can be either **dewpoint** or **frostpoint**, depending on the sensor state. Then the other water content quantities are disabled. If the sensing is ON (default), the $T_{d/f}$ value below temperature of 0 ºC/32 ºF is always **frostpoint**.

1. Open **MENU:** press ▷.
2. Select ▶**Measuring**, press ▷
3. Select ▶**Measurement settings,** press ▷
4. Select **Autom.frost detection.**
5. To enable the sensing , press ⊙ **ON.**
6. To disable the sensing, press ⊙ **OFF.**
7. Press ⊙ **EXIT** to return to the basic display.

NOTE	Cleanliness of the sensor is essential for the proper operation of frost detection.

Cooling method air/water

Select the cooling method air ( ) or water ( ) by using this function. Water cooling is recommended when measuring dewpoints below -50 ºC (-58 ºF) or above +40 ºC (104 ºF).

This selection optimizes the operation of thermoelectric coolers.

1. Open **MENU:** press ⓓ.
2. Select ▶**Measuring**, press ⓓ
3. Select ▶**Measurement settings,** press ⓓ
4. Select **Cooling method.**
5. To select air cooling, press ⊙ **AIR.**
6. To select water cooling, press ⊙ **WATER.**
7. Press ⊙ **EXIT** to return to the basic display.

More information about selecting the cooling method on page 20.

Statistical filtering

The statistical filtering is on as default. When the filtering is on, the dewpoint reading is changing in steps and the statistical uncertainty value is calculated for each reading and the statistical error limit is shown in the display. If the filtering is turned off, the reading shows the trend of the sensor temperature variation in real time. Thus, changes in humidity can be seen more rapidly and the error limit is not shown in a display.

1. Open **MENU:** press ⓓ.
2. Select ▶**Measuring**, press ⓓ
3. Select ▶**Measurement settings,** press ⓓ
4. Select **Statistical filtering,** press ⊙ **OFF.**
5. Press ⊙ **EXIT** to return to the basic display.

Response speed

You can set the response speed to stable, normal (default) or fast. If fast transients in the dewpoint prevent the system from reaching balance, the signal can be stabilized by selecting the **Stable** response speed. Fastest response time is achieved by setting the speed to **Fast** but this may increase the noise in the dewpoint measurement As a rule of thumb, always use the fastest setting that gives stable readings!

6. Open **MENU:** press ▷.
7. Select ▶**Measuring**, press ▷
8. Select ▶**Measurement settings,** press ▷
9. Select **Response,** press ⊙ **SET.**

Select one of the following options:

Stable: Press ⊙ **SELECT** to have the slowest response speed.
Normal: Press ⊙ **SELECT** to have normal response speed
Fast: Press ⊙ **SELECT** to have fast response speed

10. Press ⊙ **EXIT** to return to the basic display.

Transient recovery time

The transient recovery time is the time the sensor waits before starting the fast recovery cycle after rapid dewpoint change. If there are large, rapid step changes in humidity level the shorter transient recovery times are recommended. If the changes are slow (like typically at low dewpoints), the longer transient recovery times are recommended.

1. Open **MENU:** press ⓓ.
2. Select ▶**Measuring**, press ⓓ
3. Select ▶**Measurement settings,** press ⓓ
4. Select **Transient recov.,** press ⊙ **SET.**
5. Select one of the following options, press ⊙ **SELECT.**

   20 s, 60 s, 2 min (default), 5 min, 15 min, Off
6. Press ⊙ **EXIT** to return to the basic display.

Setting the temperature, pressure and flow values

In case the device does not have the optional temperature, pressure and flow sensors, the fixed manually fed values (e.g. for calculations) are given as follows:

1. Open **MENU:** press ⓓ.
2. Select ▶**Measuring**, press ⓓ
3. Select ▶**Process variables,** press ⓓ
4. Select the parameter you want to change by using the arrow buttons.
5. Press ⊙ **CLEAR** to clear the old value.
6. Set the new value by using numerical buttons.
7. Press ⊙ **OK** to confirm the settings.
8. Press ⊙ **EXIT** to return to the basic display.

The **Process variables** selection menu is only available for those parameters that are set, not measured.

CHAPTER 11

SELF DIAGNOSTICS SETTINGS

The DM500 goes through a self diagnostics procedure when the power is switched on. If an error is found, the error display tells about it. However, there are some self diagnostics operations that the user can set, such as Salt detecting, Sensor circuit check and Cooling capacity test.

Salt detection

During the salt detection function the sensor impedance is detected to see if there is a hygroscopic contamination on the sensor. The clean sensor value (salt detection limit) is checked as reference. Therefore, please clean the sensor always before determining the clean sensor value. The clean sensor value is preset at the factory, but re-determination by the user is recommended for optimum results.

Salt detection works only when there is dew on the sensor. Frostpoint measurement is very little affected by hygroscopic contaminants, due to the limited mobility of the ions. Consequently, a typical effect of hygroscopic contamination on measurements is a large positive offset that appears after the moisture phase on the sensor changes from frost to dew.

The salt detection, as well as the clean sensor value determination require a gas flow with dewpoint above 0º C through the probe. Lower dewpoints can also be used as long as the moisture phase remains liquid.

The **automatic salt detection** is off as a default. The interval and salt detection limit can be set by the user. The **manual salt detection** is recommended to start only after sensor cleaning to check if the sensor is clean.

If the salt detection sees salt on the sensor (message on the display), please clean the sensor carefully, see page 77. The salt warning message is shown when the measured value decreases below 80 % of

the salt detection limit. It is not recommended to use serial commands during the salt detection.

1. Open **MENU:** press ⓓ.
2. Select ▶**Measuring**, press ⓓ
3. Select ▶**Self diagnostics,** press ⓓ
4. Select ▶**Salt detection.**
5. To enable the automatic sensing , select **Autodetect interval**, press ⊙ **SET** and give the salt sensing interval (1... 99 h) by using the numeric buttons.
6. Press ⊙ **OK** .
7. Select **Clean sensor value,** press ⊙ **DETERMINE** . In this stage, the system measures the salt detection limit (clean reference). The sensor should be cleaned before performing this function.
8. To disable the automatic sensing, press ⊙ **OFF.**
9. To start the manual salt sensing test, select **Manual salt sensing** and press ⊙ **START.**
10. Press ⊙ **EXIT** to return to the basic display.

Sensor circuit check

During the sensor circuit check the sensor is heated up and the propagation of the RF-signal through the circuit is checked. If the system is not operating as expected the error message is shown, see page 78, *Error messages*. The sensor circuit check also re-calculates the transmission for a dry sensor, thus performing contamination compensation.

Sensor circuit check is performed automatically each time when the measuring is started. During the measuring, the periodical checking is not done (default) unless the automatic sensor circuit check is turned on by setting the interval. In case there is a need for checking the operation of the sensor periodically , or if automatic dry-out cycle for the sensor is desired, you can set the automatic checking interval (1...99 h) as follows:

1. Open **MENU:** press ⓓ.
2. Select ▶**Measuring**, press ⓓ

3. Select ▶**Self diagnostics,** press ⓑ
4. Select **Sensor circuit chk.**
5. To turn on the sensor checking circuit and set the checking interval, press ⊙ **SET.**
6. Set the interval (1...99 h) by using the numerical buttons.
7. Press ⊙ **OK** to confirm the setting. Now the automatic sensor circuit check will be done in determined intervals.
8. If needed to turn off the checking operation, press ⊙ **OFF.**
9. Press ⊙ **EXIT** to return to the basic display.

Cooling capacity test

In the cooling capacity test the sensor is cooled to the lowest possible temperature.

1. Open **MENU:** press ⓔ.
2. Select ▶**Measuring**, press ⓔ
3. Select ▶**Self diagnostics,** press ⓔ
4. Select **Cooling capacity test**
5. Press ⊙ **START** to start the test. The test may take up to 20 min. During that time the display is not shown, and the measuring is stopped. The serial output command R shows frozen values. You can cancel the testing sequence by pressing the ⊙ **CANCEL**.
6. If the message 'Low cooling system performance' is shown, see page 78.
7. Press ⊙ **EXIT** to return to the basic display.

The following factors affect the cooling capacity: temperature of the environment, temperature of the cooling water and gas flow rate of the sample. Please, check that these settings are correct, see chapter *Setting up for operation*, page 19. With air cooling, a temperature around -50 ºC should be reached; with water cooling, the lowest temperature should be around -75 ºC. The actual value depends on the above mentioned factors!

Error history

The error history shows on the display sixteen last shown error messages.

1. Open **MENU:** press ⓔ.
2. Select ▶**Measuring**, press ⓔ
3. Select ▶**Self diagnostics,** press ⓔ
4. Select **Error history**

5. Press ⊙ **SHOW** to see the last shown error display. Press ⊙ **NEXT** to see the earlier ones.
6. To clear the error history, press ⊙ **CLEAR.**
7. Press ⊙ **EXIT** to return to the basic display.

CHAPTER 12

RECORDING DATA

Data recording

You can record measurement data and view the recorded data on the display.

1. Open **MENU:** press ⓑ.
2. Select ▶**Recording/Viewing**, press ⓑ
3. Select ▶**Record data,** press ⓑ
4. Select **Interval,** press ⊙ **SET.**
5. Set the measurement interval by selecting the interval time by using the arrow buttons, press ⊙ **SELECT.** See the table below. Note, you can not set longer interval than the measurement duration !
6. Set the measurement duration (5 min, 15 min, 30 min, 1 hours, 3 hours, 12 hours, 24 hours, 7 days, 30 days, memory full) by selecting **Duration**, press ⊙ **SET.** Note the maximum recording durations based on the measurement interval !
7. Start recording: select **Start/Stop recording**, press ⊙ **START.** The progress bar  is shown on the display showing the amount of recorded data.

Interval	Max. recording duration (memory full)
5 s	68 min
15 s	3 h
30 s	6 h
1 min	13 h
5 min	68 h
15 min	8 d
30 min	17 d
1 hour	34 d
3 hours	102 d
12 hours	409 d

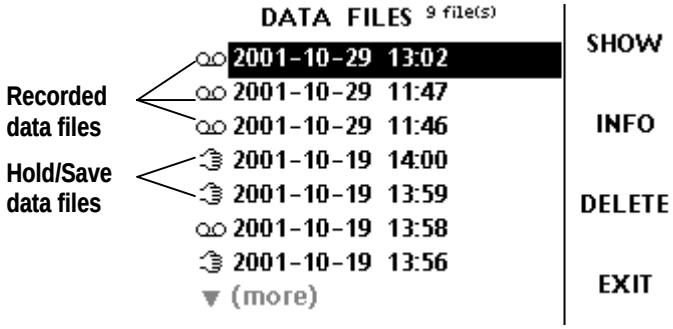
Stopping recording

1. Open **MENU:** press Ⓡ.
2. Select ▶**Recording/Viewing**, press Ⓡ
3. Select ▶**Record data,** press Ⓡ
4. To stop recording select **Start/Stop recording** and press ⊙ **STOP.**
5. Now you can go and see the recorded file by selecting ⊙ **SHOW**.

Viewing recorded data

When viewing the recorded data, firstly choose for the basic display the quantities you want to view. Then follow the instructions below.

1. Open the **MENU:** press Ⓡ
2. Select ▶**Recording/Viewing**, press Ⓡ.
3. Select ▶**View recorded data,** press Ⓡ.
4. Select the file you want to view, press ⊙ **SHOW.** The files are identified according to the date and starting time of recording.



5. Press ⊙ **SHOW** to get the graphical view, press .
6. Use the following shortcut keys if needed (see more details from page 29):

Next: Show the data of the other quantities.
Info: Show the statistic of the selected quantity.

Options:Select the graph options.
Back: Takes you back to the data file list.

7. Press ⊙ **EXIT** to return to the basic display.

Checking the recording memory status

You can check how much there is free space for recording in the memory.

1. Open the **MENU:** press Ⓑ
2. Select ▶**Recording/Viewing**, press Ⓑ.
3. Select **Memory status,** press ⊙ **SHOW** to see the amount of memory in use and the estimated free space.
4. To return to the basic display, press ⊙ **OK** and ⊙ **EXIT.**

Deleting all recorded files

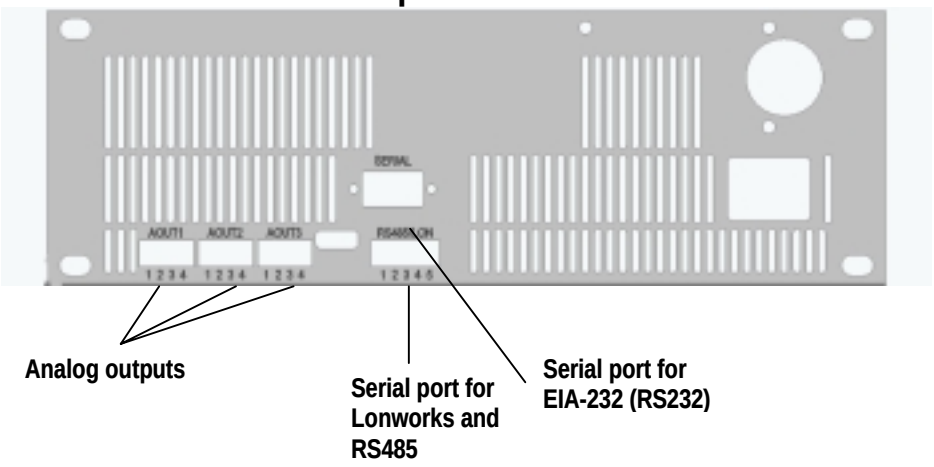
The data memory can be cleared as follows:

1. Open the **MENU:** press Ⓑ.
2. Select ▶**Recording/Viewing**, press Ⓑ.
3. Select **Clear data memory,** press ⊙ **CLEAR.** Press ⊙ **YES** to confirm deletion of all recorded data files.
4. To return to the basic display, press ⊙ **EXIT.**

CHAPTER 13

OUTPUT INTERFACES

DMI500 User Interface unit back panel



Serial communication settings

Connect the DM500 to PC by using a serial cable (provided). When connecting EIA-232 (RS232), use the port called 'SERIAL'. When connecting optional RS485, use the port called 'RS485/LON'. Connect the RS485 as follows:

4-wire connection

Terminal	Data line
1	R+ (input to DM500) ⇐
2	R- (input to DM500) ⇐
3	T+ (output from DM500) ⇒
4	T- (output from DM500) ⇒
5	Shield

2-wire connection

Terminal	Data line
1	R/T+ connect the same line to terminals 1 and 3
2	R/T- connect the same line to terminals 2 and 4
3	R/T+ connect the same line to terminals 1 and 3
4	R/T- connect the same line to terminals 2 and 4
5	Shield

Select the DM500 communication mode and data transfer settings as follows:

1. Open the **MENU:** press ⓑ.
2. Select ▶**Interfaces**, press ⓑ.
3. Select ▶**Communications,** press ⓑ.
4. Select **Comm. mode**, press ⊙ **SET.**
5. Select one of the following mode, press ⊙ **SELECT**:

STOP: Outputs measurements only by command. All commands can be used.
RUN: Outputs measurements automatically in a format set by a serial command **FORM**. Only serial command **S** can be used.
POLL: Outputs measurements only with the serial command **SEND**.
MI70 Link: Sets the MI70 Link program communication parameters. Other communication settings have no effect when using MI70 Link software.

6. Set the polling address if needed, select **Polling address**, press ⊙ **SET**.
7. Give the address for POLL communication mode by using numerical buttons, press ⊙ **OK.**
8. Select **Baud rate,** press ⊙ **SET**.
9. Select one of the following baud rate, press ⊙ **SELECT**:

300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600,115200 bps

10. Select the **Serial format,** press ⊙ **SET.**
11. Select the data bits (7 or 8), parity (N=none, E=even, O=odd) and stop bits (1 or 2), press ⊙ **SELECT.**
12. Select **Echo** or **Half duplex**, press ⊙ **NO/YES** to turn on/off the functions.
13. To return to the basic display, press ⊙ **EXIT.**

Analog outputs (optional)

DMI500 user interface can be equipped with three optional 4...20 mA galvanically isolated current outputs. The port connections are as follows:

pin 1: ch+ pin 2: ch- pin 3: test pin 4: shield

You can scale the output to any output range but it is recommended to have the scaling within the measuring range to get accurate measurements. To select the output quantities and to scale the output:

1. Connect the analog output signal cable connector to the connector.

2. Open the **MENU:** press ▷
3. Select ▶**Interfaces**, press ▷.
4. Select ▶**Analog outputs,** press ▷.
5. Select ▶**Output 1,** press ▷.
6. Select **Quantity**, press ⊙ **SET** , select the quantity for the analog output and press ⊙ **SELECT.**
7. Select **Scale**, press ⊙ **SET.**
8. Press ⊙ **CLEAR** and give the lowest value (value represented by 4 mA current) by using numerical buttons.Press ▷ and ⊙ **CLEAR,** give the highest value (value represented by 20 mA current).
9. Press ⊙ **OK** and ⊙ **EXIT.**
10. Select the quantity and scaling for the other outputs similarly.

Relay outputs (optional)

The DMI500 user interface can be equipped with two configurable single pole double throw relays. The maximum voltage connected to relay terminals is 42 V DC/60 V Peak.

To select the parameters/quantities to control the relays:

1. Open the **MENU,** press ▷
2. Select ▶**Interfaces**, press ▷.
3. Select ▶**Relay outputs,** press ▷.
4. Select ▶**Relay 1,** press ▷.
5. Select **Quantity**, press ⊙ **SET**, select the quantity for the relay output and press ⊙ **SELECT.**
6. Select **Work: above xx**, press ⊙ **SET.** Set the value above which you want the relay to be activated. Use numeric buttons. Press ⊙ **OK.**
7. Select **Release: below xx,** press ⊙ **SET.** Set the value below which you want the relay to be released. Use numeric buttons. Press ⊙ **OK.**

When the value is in between the work and release values, relay's state depends on whether the value is increasing or decreasing. When value is increasing the relay is not activated until the 'Work above' set point

is reached. If the value is decreasing, the state is not released until the 'Release below' set point is reached. This hysteresis is to prevent the relay switching back and forth when measured value is not stable near to the set point values given.

8. If you want to change the work and release states to operate in a opposite directions, select the state **Work: above xx** and press ⊙ **BELOW.** At the same time the **Release: below xx** changes accordingly. Check the set point values after changing the operation direction.

9. Press ⊙ **EXIT** to return to the basic display.

10. Set the other relay similarly.

LonWorks® network connection (optional)

Check that the EIA-232 (RS232) cable is not connected to the 9-pin connector of the DMI500.

NOTE	The EIA-232 and LONWORKS® network cable must never be connected simultaneously.

1. Connect the TP/FT-10 network cable to the pins 3 and 4 of the RS485/LON connector of the DMI500. (see page 48, *Output interfaces).*

2. Open the **MENU,** press ⊳

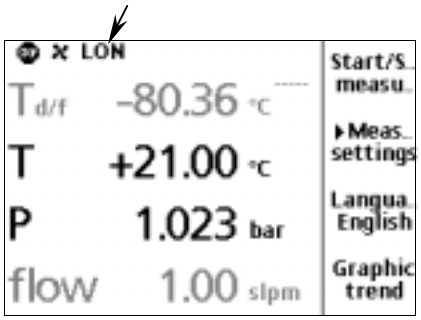
3. Select ▶**Interfaces**, press ⊳.

4. Select ▶**Communications,** press ⊳.

5. Select **Comm. mode**, press ⊙ **SET**

6. Select **LonWorks®,** press ⊙ **SELECT.** There is an option in this menu that allows sending a "service pin" message to the network.

LONWORKS® network interface reports the status in the status row of the DMI500 main display.



The LON status annunciator has three states:

- Not visible - Network interface is configured and working properly. The node may still be offline. Check the device status with your network management tool.
- Blinking - Network interface is not configured. You need to commission the DM500 network interface with your network management tool.
- Staying on - Network interface is not working properly. Service may be required.The LON status annunciator is also shown for a few seconds when a "wink" network management message is received (only if LONWORKS® is the active communication mode).

CHAPTER 14

CALIBRATION AND ADJUSTMENT

General about calibration and adjustments

Calibration interval

The DMP501 dewpoint sensing unit is fully calibrated as shipped from factory. The recommended calibration interval is one year. However, calibration shall be done if there is a reason to believe that device is not within the accuracy specifications.

In adjustment, the reading of DM500 is changed to correspond to the reference value. After adjustment, the original calibration certificate shipped with the product is not valid anymore.

Calibration laboratory

The dewpoint calibration shall be carried out at Vaisala or in other calibration laboratory capable to perform high accuracy dewpoint calibrations traceable to national/international standards.

Making an adjustment

DMP501 needs 4...10 dewpoint reference points within dewpoint temperature range -80 ºC...+60 ºC for the adjustment. These dewpoint reference points shall be traceable to appropriate standards. The dewpoint temperature references shall cover the measurement area in which the instrument is used.

The adjustment can be done also by using the serial commands.

If you have adjusted the device earlier, you shall clear the previous adjustments before giving new adjustment data.

1. Open the **MENU:** press ▷ .

2. Select ▶**Settings**, press ⓑ.
3. Select ▶**Adjustments,** press ⓑ.
4. Select ▶**Dewpoint adjustments,** press ⓑ.
5. Press ⊙ **CLEAR** and ⊙ **YES** , **OK** to clear the old adjustment data

Connect the reference gas flow to the gas inlet and measure the readings in 4...10 points. Write down the readings in the different reference points. Feed the reference points and corresponding readings to the device to make the adjustment.

6. Turn the service switch 4 to ON-position (adjustment enabled), see page 10, DMP501 back panel, service switches.
7. Open the **MENU:** press ⓑ .
8. Select ▶**Settings**, press ⓑ.
9. Select ▶**Adjustments,** press ⓑ.
10. Select ▶**Dewpoint adjustments,** press ⓑ.
11. Press ⊙ **SET.** Give the reference value (**Ref.**) by using the numeric buttons. Then, give the measured value (**Meas.**). Press ⊙ **OK.**
12. Select with the arrow button the next reference point and press ⊙ **SET.**
13. Continue giving the references.
14. Make an adjustment by pressing ⊙ **Adjust.**
15. The adjustment result is shown.
16. Press ⊙ **EXIT.**
17. Turn the service switch 4 to OFF-position (adjustment disabled).

The system calculates a 3rd degree correction polynome fitted to the adjustment data.

CHAPTER 15

SERIAL LINE COMMANDS

Connect the RS-232 cable to the connector on the back panel of the DMI500 user interface unit. The serial cable can also be connected to the back panel of the DMP501 probe. This port, however, has a limited command set and fixed format (9600/8/1/none), and connecting to this port may increase the susceptibility to electromagnetic interference.

Serial commands

Output commands

R*	Continuous output
S*	Stopping the continuous output
ADDR	Setting the device address
SEND*	Outputting one single reading
INTV*	Setting the output interval
FORM	Defining the output format

Operational commands

START*	Starting the measurement
STOP*	Stopping the measurement
PUMP*	Starting/Stopping the optional sample gas pump
HEAT*	Starting/Stopping the optional heater
SALT*	Enables/disables the salt contamination detection
SCAL*	Starts the salt detection limit determination cycle

Setting commands

SERI	Setting the serial communication parameters
UNIT	Setting the units
TIME	Setting the date and time
ALARM	Setting the relays
ASEL	Setting the analog outputs
ASCL	Scaling the analog outputs
COOLER*	Setting the cooling method status
FLOW*	Setting the flow value
XFLOW*	Setting the flow value temporarily
PRES*	Setting the pressure
XPRES*	Setting the pressure value temporarily
TP*	Setting the temperature
XTP*	Setting the temperature value temporarily

Adjustment commands

CDP*	Adjusting the dewpoint temperature (in 4...10 points)
CTP*	Adjusting the temperature (in 2 points)

FCAL*	Adjusting the flow meter (in 1 point)
PCAL*	Adjusting the pressure sensor (in 2 points)

Others

?	Outputting the device settings
??	Outputting the device settings in POLL-state
DEL	Deleting the datafiles
DIR	Outputting list of datafiles
ECHO	Setting the echo ON/OFF
ERRS	Outputting the error messages
HELP	Outputting the commands
INIE*	Returning the factory settings
SMODE	Selecting the operation mode
OPEN	Opening the line
CLOSE	Closing the line
PLAY	Outputting the datafile or history memory
SCC*	Sensor circuit check
SSC*	Sensor status check
SNUM	Outputting the serial numbers of DM500
VERS*	Outputting the program name and version

*when serial cable is connected to the probe unit's service port, only the commands marked with * can be used. Command syntax and output may be different in direct connection to DMP501 probe.

Output commands (DMI500)

R Continuous output

R ↵

Outputting measured values continuously. You can modify the form of the output with the command **FORM** (see page 57). The resulting interval can be set with the command **INTV** (see page 57). The command R does not change the default operation mode set with the command SMODE.

```
>r
 0.000 'C        0.00 'C           0.00 hPa    0.00 slpm
 0.000 'C        0.00 'C           0.00 hPa    0.00 slpm
```

S Stopping the continuous output

S ↵

Type **S** to stop outputting.

ADDR Setting the device address

ADDR xx ↵

where xx = **0..99** (address)

The address is used in POLL mode when more than one device is connected to one serial line.

SEND Outputting one single reading

SEND x↵

where: x= device address (0...99) in POLL-state.

If not in POLL-state, type only SEND without address.

INTV Setting the output interval

INTV xxx yyy ↵

where: xxx= output interval yyy = unit (s, min, h)

```
>INTV 1 MIN <CR>
Output interval:    1 MIN<CR><LF>
>
```

FORM Defining the output format

With the FORM command you can determine the output form of commands R and SEND. The following output fields can be defined after the command FORM.

FORM [amount of decimals] [water content quantity] [+-] [u][status][other quantities] [u][date][time]

The fields can be given in any order, except the unit field U, that can be given only after a quantity or +-. You can give only one field or several fields and write the field descriptions either in capital or small letters. Leave a space between the fields.

BASIC FIELDS

[amount of decimals]: Type number of digits before and after the decimal point. As an example: giving **2.1** before the RH quantity outputs a reading with two digits before the point and one after the point, as follows: 80.1. You can define different amount of decimals before every quantity, if needed.

[water content quantity]: Type one or several of the following quantities: **TD/ TDF/ H2O/ RH/ PW** to select the water content quantity.

TD= dewpoint temperature
TDF= dewpoint/frostpoint temperature
H2O= humid air volume/dry air volume
RH=relative humidity
PW= partial water vapour pressure

[+-] Type **+-** to have an error limit value after a quantity.

[u] Type **U** to show a unit label after a quantity**.** By typing **UU** results two letters label, **UUU** three letters etc. If needed, change the unit by using the separate command **UNIT** (or by using the display menu**)**. This field shall be defined only after quantity field.

[status] Type **STATUS** to show a state of a measurement system.
The state can be one of the following: STOP (water content measurement not operating, OK (normal operation), WAIT , ERR (error in measurement).

[other quantities] Type one or several of the following quantities: **T, P, FLOW**

T=temperature
P=pressure
FLOW=air flow rate

[date] Type **DATE** to have a date. The date is shown in form of: yyyy-mm-dd.

[time] Type **TIME** to have a time shown. The time is shown in form of: hh:mm:ss.

OUTPUT MODIFICATION FIELDS

[text field] Type the text you want inside the quotation marks **"text".**

[ASCII character] Type **\xxx** where xxx is a three digit decimal number of the character, for example \035 outputs the # character.

[line feed] Type **\ n**

[carriage return] Type **\ r**

[space] Type **" "** (Note! Leave a space in between the quotation marks)

[horizontal tabulation] Type **\ t**

If you have problems in typing \ (backslash) character, you can use # instead of it.

Examples

1.Output needed: Dewpoint/Frostpoint temperature with a unit label by using three digits before and after the point. The error value shown after the reading (with two decimals). Carriage return and line feed in the end.

```
>form "Tdf=" 3.3 Tdf "+-" 1.2 +- uu \r\n
"Tdf=" 3.3 Tdf "+-" 1.2 +- UU \r \n
>
>send
Tdf=-80.213+-0.00'C
>
```

2.Output needed (factory default): Dewpoint/Frostpoint temperature and the error with a unit label. Process temperature, pressure, flow and status to be shown. The fields are separated with horizontal tabulation. Carriage return and line feed in the end.

```
>form
"Tdf=" 3.3 Tdf "+-" 1.2 +- UU \r \n
? 3.3Tdf\t 1.2+-\t UU\t 3.2T\t UU\t 2.4P\t UUU\t 1.2flow\t
UUUU\t STATUS\r\n
>
>send
-80.197 0.00    'C       -1.00  'C       3.0411 bar     5.00
slpm    STOP
>
```

3.Output needed: Relative humidity and pressure to be shown with a unit. The fields are separated with " " marks. Carriage return and line feed in the end.

```
>form 2.1 rh " " u " " 2.4 p " " uuuu\r\n
2.1 RH " " U " " 2.4 P " " UUUU \r \n
>send
103.8 %  1.0135 bar
```

Operational commands

START Starting the measurement

START ↵

Starts the dewpoint measurement and activates the cooling system.

STOP Stopping the measurement

STOP ↵

Stops the dewpoint measurement and disables the cooling system.

PUMP Starting/Stopping the optional sample gas pump

PUMP ON/OFF ↵

Example:

```
>PUMP <CR>
Suck              : OFF<CR><LF>
>
>PUMP ON <CR>
Suck              : ON <CR><LF>
>
>PUMP OFF <CR>
Suck              : OFF<CR><LF>
>
```

HEAT Starting/Stopping the optional heater

HEAT ON/OFF ↵

Example:

```
>HEAT
Heat              :               OFF
>
>HEAT ON
Heat              :                ON
>
>HEAT OFF
Heat              :               OFF
>
```

SALT Enables/disables the salt contamination detection

SALT ON/OFF [interval]↵

Default **SALT ON.**

```
>SALT <CR>
Salt sensing   :      OFF      24 <CR><LF>
>
```

Salt sensing is off.

```
>SALT ON <CR>
Salt sensing   :       ON      24 <CR><LF>
>
```

Salt sensing is on and detection interval is 24 h.

```
>SALT 30 <CR>
Salt sensing   :       ON      30 <CR><LF>
>
```

Salt sensing is on and detection interval is 30 h.

```
>SALT ON 24 <CR>
Salt sensing   :       ON      24 <CR><LF>
>
```

Salt sensing is on and detection interval is 24 h.

SCAL Starts the salt detection limit determination cycle

SCAL ↵

The determination of the salt detection limit can take several minutes. Please see also page 40 for more information about salt detecting.

```
>scal
Salt limit     :  0.36280
>
```

Setting commands

SERI Setting the serial communication parameters

SERI [baud] [parity] [bits] [stops] [duplex]↵

where
[baud]=300/600/1200/2400/4800/9600/19200/38400/57600/115200
[parity]=N (none)/ E (even)/O (odd)
[bits]=7 (7 bits)/ 8 (8 bits)
[stops]=1 (1 stop bit)/2 (2 stop bits)
[duplex]= H(half-duplex)/ F (full-duplex)

The current settings are output if you give the command without the parameter fields.

Factory default: 9600/8/none/1.

The fields can be given in any order. The new settings are valid immediately after the change. If you choose a half-duplex mode, the echo turns automatically into OFF-position.

```
>seri 19200 n 8 1 f
19200 N 8 1 FDX
```

UNIT Setting the units

UNIT [x]↵

where x= unit = **C** (dewpoint, temperature), **F** (dewpoint, temperature), **hPa** (pressure)**, torr** (pressure), **psi** pressure)**, bar (**pressure)**, slpm** (sample flow)**, scfh** (sample flow).

The unit is set by typing the desired unit(s) after the command UNIT.

NOTE When using the UNIT command, the unit of ambient temperature measurement changes to be the same as the unit of dewpoint/frostpoint temperature. The display units change simultaneously.

Examples:

```
>unit
Active units:   'C      hPa     slpm
```

The unit is changed to Fahrenheit degrees:

```
>unit f
Active units:   'F      hPa     slpm
```

The pressure unit is changed to bar-unit:

```
>unit bar
Active units:   'F      bar     slpm
```

The flow unit is changed to scfh-unit:

```
>unit scfh
Active units:   'F      bar     scfh
>
```

TIME Setting the date and time

TIME [date time] ↵

where date= yyyy-mm-dd (24 hour clock)
time=hh:mm:ss

Example:

```
>time
Current time:   2000-01-01 02:55:17
Enter new date (yyyy-mm-dd):    2001-10-05
Enter new time (hh:mm:ss):      12:07:00
```

ALARM Setting the relays

The optional relays turn ON/OFF when the measured value reaches the predefined set point.

ALARM [n q dir work release] ↵

where

n =	**1** or **2** (number of the relay)
q =	**TDF/TD/H2O/RH/PW/T/P/FLOW** (quantity)
dir =	**HI** or **LO** (HI: the relay is active above the set point, LO: the relay is active below the setpoint)
work =	the setpoint above/below which you want the relay to be activated.
release =	the setpoint below/above which you want the relay to be activated.

All the fields must be defined. When the HI is selected, 'work' setpoint has to be greater than 'release' set point. If LO is selected, 'work' setpoint has to be lower than 'release' setpoint.

Example:

```
>alarm 1 rh hi 20 18
Ch1:    RH      HI          20      18 %
Ch2:    Tdf     HI          20      15 'C
```

ASEL Setting the analog outputs

Set the optional analog outputs with this command.

ASEL [x y z]↵

where: x = channel 1 quantity **(TDF/TD/H2O/RH/PW/T/P/FLOW)**
y = channel 2 quantity **(TDF/TD/H2O/RH/PW/T/P/FLOW)**
z = channel 3 quantity **(TDF/TD/H2O/RH/PW/T/P/FLOW)**

Example:

```
>asel
Ch1:    Tdf
```

```
Ch2:    P
Ch3:    flow

>asel rh p t
Ch1:    RH
Ch2:    P
Ch3:    T
>
```

ASCL Scaling the analog outputs

Scale the optional analog outputs with the command.

ASCL↵

Give the values at 4 mA (LO) and 20 mA (HI) and press ENTER.

```
>ascl
Ch1 (Tdf) LO:       -80 'C      ? -70
Ch1 (Tdf) HI:        60 'C      ? 60
Ch2 (T) LO:         0.5 'C      ? -80
Ch2 (T) HI:         100 'C      ? 80
Ch3 (P) LO:           0 bar     ? 0
Ch3 (P) HI:          20 bar     ? 2
>
```

COOLER Setting the cooling method status

COOLER [WATER/AIR] ↵

```
>COOLER <CR>
Cooler          : AIR <CR><LF>
>
>COOLER  WATER <CR>
Cooler          : WATER <CR><LF>
>
>COOLER  AIR <CR>
Cooler       : AIR      <CR><LF>
```

FLOW Setting the flow value

FLOW x.xx↵

where x.xx= sample air flow value

Sets the flow value in current unit selected with UNIT command. This command is used only when there is no flow sensor in the system. Flow value is needed for the dewpoint calculation algorithm, especially when the dew/frostpoint is changing.

```
>flow
Flow:                  1 slpm    ? 1.2
>
```

NOTE	If the flow setting is frequently adjusted, e.g. by using an external flow meter as a flow input source, the command XFLOW is recommended.

XFLOW Setting the flow value temporarily

XFLOW x.xxx↵

where x.xxx= sample air flow value

The function of XFLOW is the same as with FLOW command except that with XFLOW command the setting is valid only until power is turned off or command XFLOW is given without parameters. After this the flow rate stored with command FLOW is valid again.

PRES Setting the pressure

PRES xx.xx↵

where xx.xx = sample air pressure value .

Sets the pressure if there is no pressure transducer in the system. The pressure value is needed in volume flow rate calculations in the Td measuring algorithm as well as in Td -> ppm unit conversion.

Example:

```
>pres
Pressure:        1.0132 bar     ? 1.00
>pres
Pressure:              1 bar     ?
```

NOTE

If the pressure setting is frequently adjusted, e.g. by using an external barometer as a pressure input source, the command XPRES is recommended.

XPRES Setting the pressure temporarily

XPRES xx.xx↵

where xx.xx = sample air pressure value

The function XPRES is the same as with PRES command except that with XPRES command the setting is valid only until power is turned off or XPRES command is given without a pressure value. After this the pressure stored with command PRES is valid again.

```
>pres 1.0231
Pressure:        1.0231 bar
>xpres 5.5
Pressure:           5.5 bar
>xpres
Pressure:        1.0231 bar
>
```

TP Setting the temperature

Sets the temperature if there is no temperature sensor in the system.

TP xx.xx↵

where xx.xx= temperature

Example:

```
>tp
Temperature:         20 'C      ? 22
>tp
Temperature:         22 'C      ?
```

NOTE

If the temperature setting is frequently adjusted, e.g. by using an external thermometer as a temperature input source, the command XTP is recommended.

XTP Setting the temperature temporarily

XTP xx.xx↵

where xx.xx= temperature

The function XTP is the same as with TP command except that with XTP command the setting is valid only until power is turned off or XTP command is given without parameters. After this the pressure stored with command TP is valid again.

Adjustments

CDP Adjusting the dewpoint temperature (in 4...10 points)

1. Turn the switch 4 (page 10, service switches) to ON-position to enable the adjustment. After adjustment return the switch 4 to OFF-position.

2. Firstly, type **CPDZERO** to clear the calibration coefficients.

CDPZERO ↵

3. Type CPD, then give data pairs consisting of reference value and measured value for a maximum of 10 calibration points. Input can be terminated by pressing ENTER. After data has been input, a confirmation is requested before previous calibration coefficients will be overwritten.

↵ CDP ↵

After data has been input and confirmed, the calibration algorithm calculates the 3rd degree polynome to describe the measured deviation as a function of the measured dew/frostpoint. The polynome is calculated from the reference value by performing a least squares fit utilizing matrix inversion. This 3rd degree deviation model is then used for correcting the dew/frostpoint display.

The **CDP*** command displays also the coefficients of the correction polynome, as well as the reference value and residual error for each calibration data point.

CDP <CR>
or
CDP * <CR>

```
>CDP <CR>
  1. reference   : -39.99 <CR>
  1. measurement : -40.009 <CR>
  2. reference   : -30.01 <CR>
  2. measurement : -30.030 <CR>
  3. reference   : -20.01 <CR>
  3. measurement : -20.026 <CR>
  4. reference   : -9.98 <CR>
  4. measurement : -9.977 <CR>
  5. reference   : 0 <CR>
  5. measurement : -0.006 <CR>
  6. reference   : 10 <CR>
                         6. measurement : 10.002 <CR>
```

```
  7. reference   : 19.99 <CR>
  7. measurement : 19.982 <CR>
  8. reference   : 29.98 <CR>
  8. measurement : 29.989 <CR>
  9. reference   : 39.98 <CR>
  9. measurement : 39.989 <CR>
 10. reference   : <CR>
<CR><LF>
Reference   Measurement<CR><LF>
    -39.990     -40.009<CR><LF>
    -30.010     -30.030<CR><LF>
    -20.010     -20.026<CR><LF>
     -9.980      -9.977<CR><LF>
      0.000      -0.006<CR><LF>
     10.000      10.002<CR><LF>
     19.990      19.982<CR><LF>
     29.980      29.989<CR><LF>
     39.980      39.989<CR><LF>
 Overwrite previous calibration ?
Y/N<CR><LF>
OK<CR><LF>
>

>CDP * <CR>
  1. reference   : -39.99 <CR>
  1. measurement : -40.009 <CR>
  2. reference   : -30.01 <CR>
  2. measurement : -30.030 <CR>
  3. reference   : -20.01 <CR>
  3. measurement : -20.026 <CR>
  4. reference   : -9.98 <CR>
  4. measurement : -9.977 <CR>
  5. reference   : 0 <CR>
  5. measurement : -0.006 <CR>
  6. reference   : 10 <CR>
  6. measurement : 10.002 <CR>
  7. reference   : 19.99 <CR>
  7. measurement : 19.982 <CR>
  8. reference   : 29.98 <CR>
  8. measurement : 29.989 <CR>
  9. reference   : 39.98 <CR>
  9. measurement : 39.989 <CR>
 10. reference   : <CR>
<CR><LF>
Reference   Measurement<CR><LF>
    -39.990     -40.009<CR><LF>
    -30.010     -30.030<CR><LF>
    -20.010     -20.026<CR><LF>
     -9.980      -9.977<CR><LF>
      0.000      -0.006<CR><LF>
     10.000      10.002<CR><LF>
     19.990      19.982<CR><LF>
     29.980      29.989<CR><LF>
     39.980      39.989<CR><LF>
 Overwrite previous calibration ?
Y/N<CR><LF>
```

```
   2.40135193E-01<CR><LF>
  -2.59960938E+00<CR><LF>
   9.08935547E+00<CR><LF>
  -1.30498052E+01<CR><LF>
-4.00089979E+01  -1.94864569E-02<CR><LF>
  -3.00300002E+01  -1.91654568E-02<CR><LF>
  -2.00259995E+01  -1.26176178E-02<CR><LF>
  -9.97700024E+00  -5.47681761E-03<CR><LF>
  -6.00000000E-03  -1.04680657E-03<CR><LF>
   1.00020003E+01  -2.92509794E-05<CR><LF>
   1.99820004E+01  -7.64131546E-04<CR><LF>
   2.99889994E+01   8.67143250E-04<CR><LF>
   3.99889994E+01   1.14340186E-02<CR><LF>
OK<CR><LF>
>
```

CTP Adjusting the temperature (in 2 points)

1. Turn the switch 4 (see page 10, service switches) to ON-position to enable the adjustment. After adjustment return the switch 4 to OFF-position.

2. Set the temperature sensor to the reference conditions. Wait until the reading is stabilized.

3. Type the command CTP and give the value of the first reference, press ENTER.

CTP ↵

```
>ctp
Tp :  20.0000  1. ref ? 21
Press any key when ready ...
```

4. Set the temperature sensor to the second reference conditions. Wait until the reading is stabilized.

5. Press any key and give the value of the second reference, press ENTER.

```
Tp :  20.0000  2. ref ? 80
OK
>
```

FCAL Adjusting the flow meter (in 1 point)

FCAL ↵

1. Turn the switch 4 (see page 10, service switches) to ON-position to enable the adjustment. After adjustment return the switch 4 to OFF-position.

2. Set the flow meter to the reference conditions. Wait until the reading is stabilized.

3. Type the command FCAL and give the reference.

PCAL Adjusting the pressure sensor (in 2 points)

1. Turn the switch 4 (see page 10 , service switches) to ON-position to enable the adjustment. After adjustment return the switch 4 to OFF-position.

2. Set the pressure sensor to the reference conditions. Wait until the reading is stabilized.

3. Type the command PCAL and give the value of the first reference, press ENTER.

PCAL ↵

```
pcal
 P1 ( bar )  ? 1
 Press any key when ready ...
```

4. Set the pressure sensor to the second reference conditions. Wait until the reading is stabilized.

5. Press any key and give the value of the second reference, press ENTER.

```
P2 ( bar )  ? 3
>
```

Others

? Outputting the device settings

? ↵

?? Outputting the device settings in POLL-state

?? ↵

DEL Deleting the datafiles

DEL [file]↵

where file= **1...**(number of the file to be deleted, file numbers are seen with the command DIR)

NOTE	Command DEL without the file number erases all datafiles !

DIR Outputting list of the datafiles

DIR ↵

ECHO Setting the echo ON/OFF

ECHO [ON/OFF]↵

ERRS Outputting the error messages

ERRS↵

Outputs the error history of the device in compact format. By typing ERRS RESET you can empty the memory.

HELP Outputting the commands

HELP ↵

```
>help
Available commands:
ADDR    CLOSE   COOLER  FLOW    ICE     INIE    INTV    OPEN
PRES    PUMP    R       SALT    SEND    SMODE   SNUM    START
STOP    TIME    TP      UNIT    VERS    ECHO    ALARM   ASEL
SERI    FORM    ERRS    ?       DIR     DEL     PLAY    HELP
```

INIE Reverting the factory settings

INIE ↵

```
>inie
OK
>
```

Does not affect calibration.

SMODE Selecting the operation mode

SMODE x↵

where x = STOP, RUN or POLL.

The SMODE command is used to set or inspect the default operation mode of the EIA-232 (and optional RS485) interfaces.

STOP mode: After power-up the transmitter outputs its type and software version and then waits for further commands.

RUN mode: Continuous output starts automatically from power-up. Output can be defined with the command FORM. Only command S can be used.

POLL mode: Allows the communication with multiple transmitters or other digital instruments connected to one serial bus. Only the commands OPEN addr and SEND addr can be used. The transmitter does not echo in POLL mode.

OPEN & CLOSE Opening and closing the lines

OPEN x↵

x = **0...99** (address of the device)

CLOSE ↵

In STOP-mode: command OPEN has no effect, CLOSE sets the transmitter in POLL-mode.

In POLL-mode: command OPEN sets the transmitter temporarily in STOP-mode, command CLOSE returns the device to POLL-mode.

PLAY Outputting the datafile or history memory

PLAY [file]↵

where file = **1....** (number of the file to be resulted)

Example:

```
>play 9
File 9: 2001-10-18 15:38:56     (11)
Date       Time         RH      T       P       flow
yyyy-mm-dd hh:mm:ss     %       'C      bar     slpm
2001-10-18 15:38:56      45.876  +20.00  1.0132  1.00   OK
2001-10-18 15:39:01      45.876  +20.00  1.0132  1.00   OK
2001-10-18 15:39:06      45.742  +20.00  1.0132  1.00   OK
2001-10-18 15:39:11      45.742  +20.00  1.0132  1.00   OK
2001-10-18 15:39:16      45.666  +20.00  1.0132  1.00   OK
2001-10-18 15:39:21      45.666  +20.00  1.0132  1.00   OK
```

Use PLAY without the file number to output the contents of the history memory (i.e. contents of the graphical trend).

SCC Sensor circuit check

↵ SCC ON/OFF xx↵

where xx = checking interval (h)

```
>scc
Sensor check   :       ON       6
>scc on 8
Sensor check   :       ON       8
```

SSC Sensor status check

↵ SSC ON/OFF xx↵

where xx = checking interval (s)

Sets the transient recovery time (or disables transient recovery).
Turns the transient recovery ON/OFF.

```
>SSC <CR>
Status check   :      OFF      24<CR><LF>
>

>SSC ON <CR>
Status check   :      ON       24<CR><LF>
>

>SSC ON 15<CR>
Status check   :      ON       15<CR><LF>
>
```

SNUM Outputting the serial numbers of DM500 and DMP501

↵ SNUM↵

VERS Outputting the program name and version

↵ VERS↵

```
>vers
DMI500 / 1.00
DMPS500 / 0.60
>
```

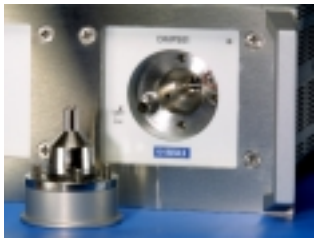
CHAPTER 16

MAINTENANCE

Cleaning of the sensor

Clean the sensor whenever the system gives a warning of contamination on the sensor. Cleaning is also strongly recommended before calibration and adjustment or when there is a reason to believe that the measurement is instable or the offset is increased. Contamination typically causes a positive offset to the measured dewpoint when there is a liquid phase on the sensor. When measuring frostpoints, the instability of the measured value increases if the sensor is dirty, but usually there is no offset.

The sensor is robust and constructed of hard materials. Thus even frequent periodic cleaning of the sensor can be done without any concern of sensor weardown.



1.Remove the sensor cap.

2.Clean the sensor surface.

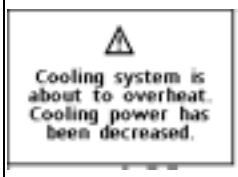
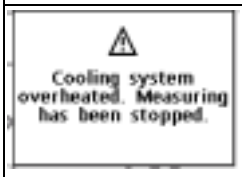
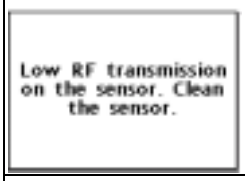
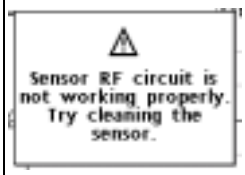
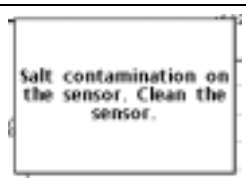
1. Turn off the measuring mode; the sensor shall not be cooled.
2. Loosen with an Allen key the three Allen screws of the sensor cap. (Note that the screws have retainers, they do not come off completely).
3. Remove the sensor cap.
4. Take a rectangular piece of soft, clean paper tissue (optical or clean room grade tissue). Fold it twice to obtain a fourfold tissue and roll it diagonally into a tight roll. Wet one end of the roll with pure ethanol or isopropyl alcohol, firmly press the end of the paper roll against the vertical sensor surface (in the bottom of the hole) and clean the sensor with rotating movements. Make another paper roll and dry the sensor.

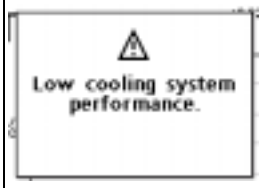
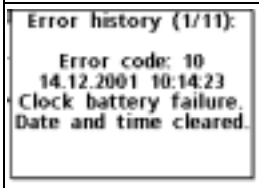
   If using a cotton-wool stick, press the end of the stick against a clean surface to have a flat tip for cleaning.
5. After cleaning, the sensor surface should look like a clean mirror surface. There should not be any oily stains, spots or dust.

6. If the system has warned of hygroscopic contamination on the sensor, it is recommended to clean the sensor 2-4 times with distilled water before the final alcohol cleaning. The cleaning procedure with distilled water is the same as that with ethanol.
7. Replace the sensor cap and fasten the three allen screws. See that the small o-ring at 2 o'clock is in place before replacing the cap.

If the sensor is very dirty, the probe can be placed to upright position, and a small amount of cleaning liquid can be poured directly on the sensor element instead of wetting the tissue. Otherwise the cleaning is performed as described above, but the larger amount of water or solvent helps remove dirt without leaving residue. Be careful not to pour liquid into gas channel openings at 2 and 8 o'clock.

Error messages

Error Message	Interpretation and action
	Please check that the cooling air/water temperatures and flows are correct, see chapter *Setting up for operation*, page 19. In case of constant error, please contact Vaisala, see page 11.
	Please check that the cooling air/water temperatures and flows are correct , see , see chapter *Setting up for operation*, page 19 . In case of constant error, please contact Vaisala, see page 11.
	Clean the sensor, see page 77. In case of constant error, please contact Vaisala, see page 11.
	Clean the sensor, see page 77. In case of constant error, please contact Vaisala, see page 11.
	Clean the sensor throughly using distilled water, see page 77. In case of constant error, please contact Vaisala, see page 11.

	Check that the flow rate and temperature of the cooling system as well as the sample gas flow is adequate, see chapter *Setting up for operation*, page 19 . In case of constant error, please contact Vaisala, see page 11.
	DMI500 restarted due to an internal failure * Please contact Vaisala, send the device for repair, page 11.
	User settings damaged. Factory settings reverted*. In case of constant error, please contact Vaisala, see page 11.
	Please contact Vaisala, send the device for repair, page 11.
	Clock battery failure. Please contact Vaisala, send the device for repair, page 11.
DMI500 selftest "C/D/F/L" failed. Let the service check the device.	Please contact Vaisala, send the device for repair, page 11.

Errors marked with are shown only in the error history log.

Vaisala SSD Service Centres

Vaisala SSD Service, Vanha Nurmijärventie 21 FIN-01670 Vantaa, FINLAND.
Phone: +358 9 8949 2758, Fax +358 9 8949 2295, ssdservice@vaisala.com

Vaisala KK, 42 Kagurazaka 6-Chome, Shinjuku-Ku, Tokyo 162-0825, JAPAN.
Phone: +81 3 3266 9611, Fax +81 3 3266 9610, aftersales.asia@vaisala.com

Vaisala Inc., 100 Commerce Way, Woburn, MA 01801-1068, USA.
Phone: +1 781 933 4500, Fax +1 781 933 8029, us-customersupport@vaisala.com

Internet: http://www.vaisala.com
Technical support: helpdesk@vaisala.com

CHAPTER 17
SPECIFICATIONS

Measured variables

Dewpoint temperature

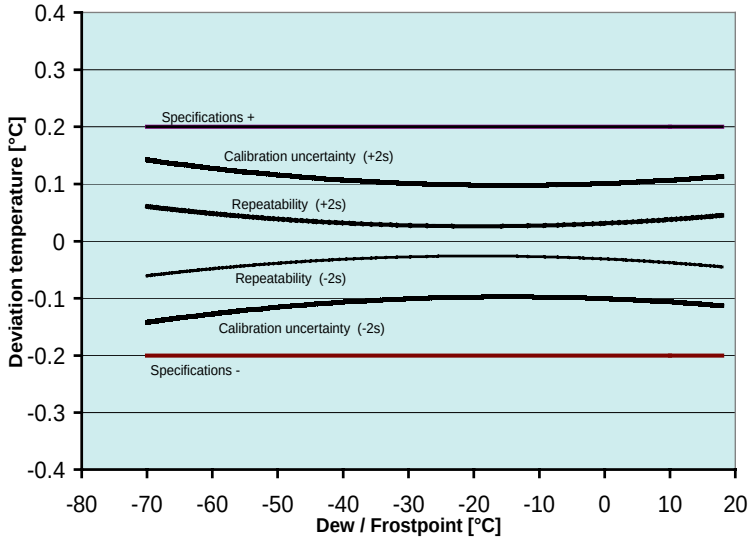
DM500S	(standard)	-40...+60 ºC T_d
DM500H	(high)	-60...+60 ºC T_d
DM500X	(extended)	-75...+60 ºC T_d

The upper limit value is with heating option only. Without a heating option, limited to ambient temperature. Standard calibration up to + 18 ºC $T_{d.}$

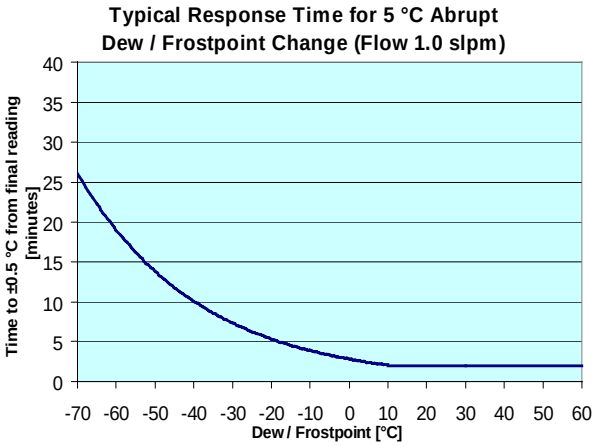
Accuracy

standard (traceable to international standards)	±0.2 ºC Td
optional (traceable to national primary standard)	±0.1 ºC Td

Repeatability (see graph below) <±0.05 ºC Td (2Σ)



Response time (see the graph below)



External temperature (optional)

Sensor	Pt100RTD DIN IEC 751 class 1/4B
Measurement range	-40...+80 °C
Typical accuracy at +20 °C	± 0.1 °C
Typical temperature dependance of electronics	0.001 °C
Cable length	2 meters

Integrated pressure (optional)

for ppm_v calculations	
Measurement range	0...2 bar or 0... 20 bar
Accuracy	± 1.0 % of full scale

Integrated flow (optional)

Measurement range	0...2 l/min
Accuracy	± 10 % of reading
Integrated flow adjustment	

General

DMP501 Dewpoint Sensing Unit

Operating voltage (when used stand alone)	12 VDC

Operating temperature	-10...+60 ºC
Pressure of sample gas	0...20 bar
Sample gas flow rate	1.0 slpm
Cooling water temperature	0...15 ºC
Operating gases	Air, N_2, Ar, SF6; nontoxic, noncorrosive, nonflammable gases only.
Options may have extra restrictions.	
Electronics housing material	aluminium, stainless steel
Wetted parts' materials	Stainless steel (AISI 316L), silicone elastomer, Vectra LCP, tantalum, quartz
Housing classification	IP31 (NEMA 2)
Mechanical piping connections	Swagelok 6 mm/ /1/4"
Storage temperature range	-40...+70 ºC
Weight	7 kg
Minimum heat removal capacity of the cooling water system	250 W@5ºC

Options for DMP501

Pump	0...1 l/min, 0... 200 mbar differential pressure
Heated internal gas sampling	
Connection cable to DMI500	2.5 or 10 meters

General

DMI500 User Interface Unit

Operating voltage	100...230 VAC
Operating power	max 460 W
Display	B/W LCD with backlight
Menu languages	English, German, French, Finnish and Spanish
Operating temperature	0...+40 ºC
Storage temperature range	-40...+70 ºC
Electronics housing material	PPE+PS plastic, aluminium, stainless steel
Housing classification	IP31 (NEMA 2)
Weight	7.5 kg

Options for DMI500

Configurable alarm relays	42 VDC (60 V Peak)/0.75 A
Handle for portable model	
Front panel for rack installations	

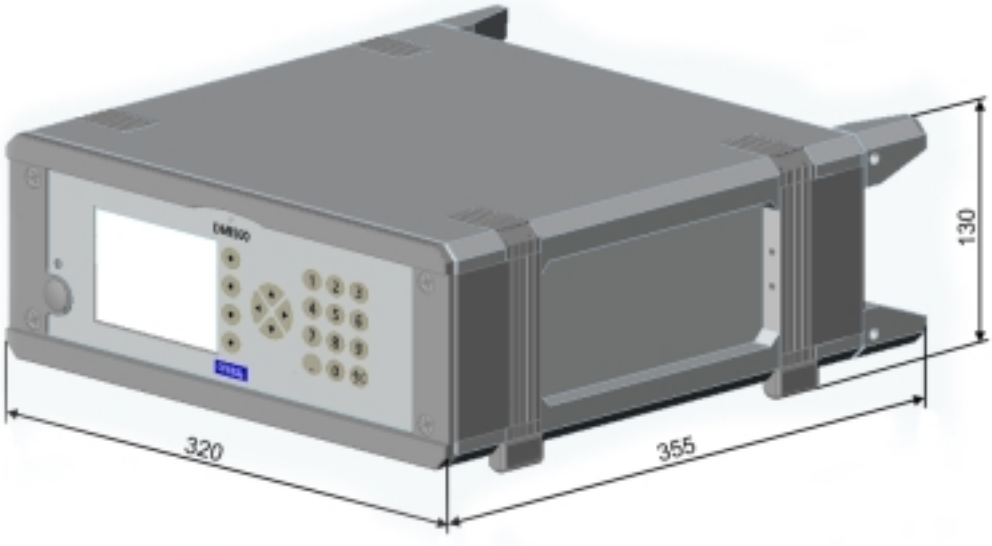
Outputs

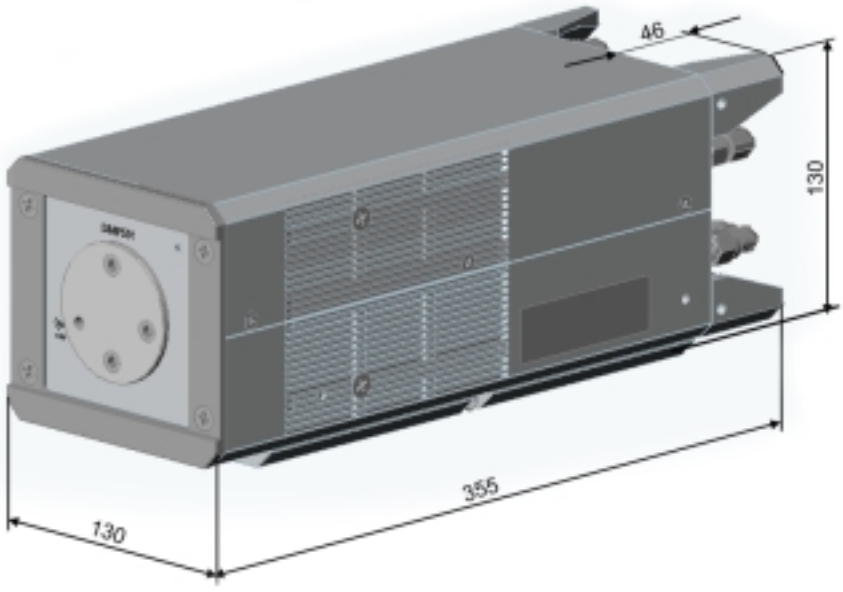
Digital	
EIA-232 (RS232) serial output	
RS485 serial output	
Analog outputs (optional, three channels)	4...20 mA (galvanic isolation)
Optional LonWorks® interface	TP/FT-10

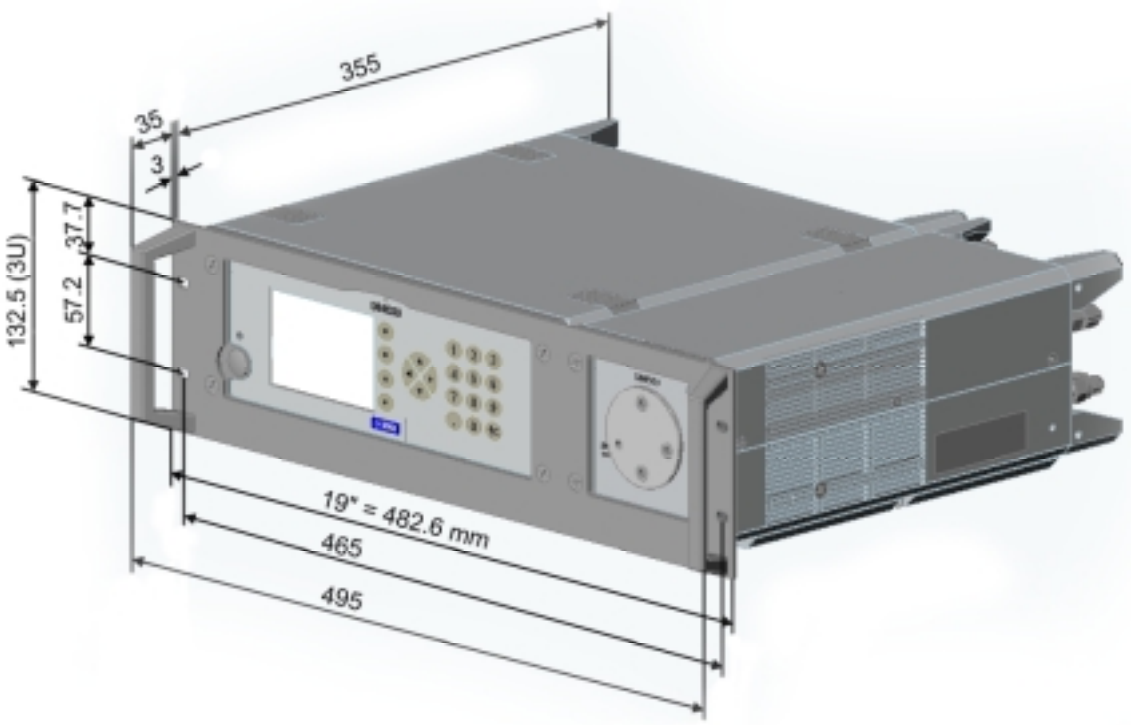
Electromagnetic compatibility

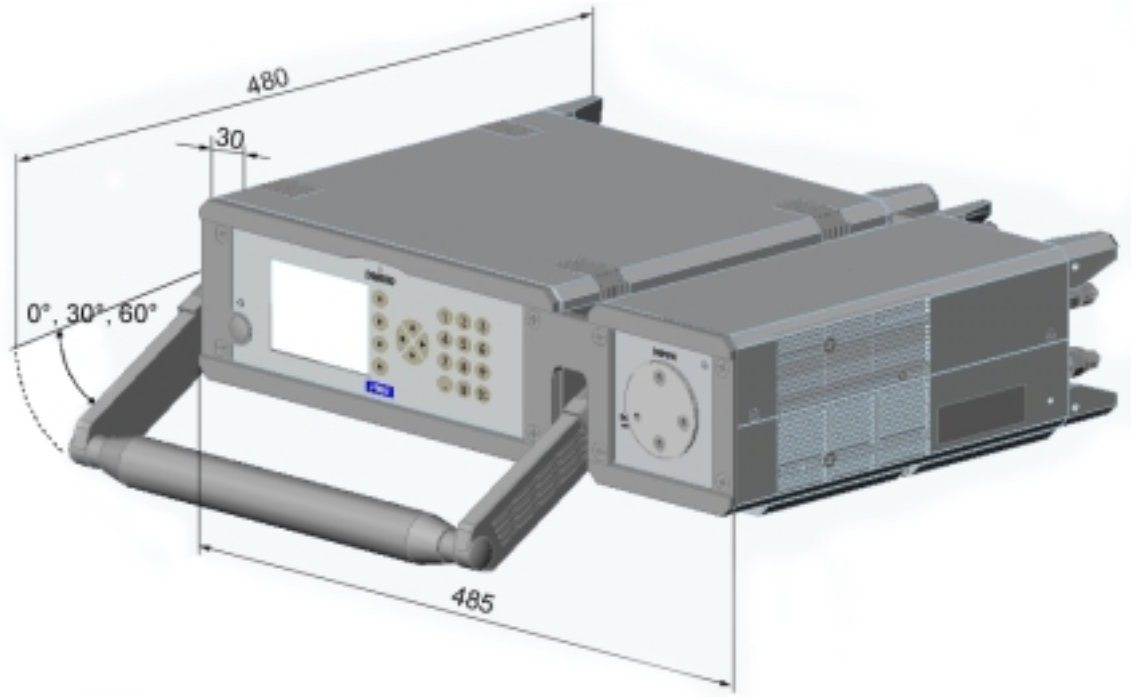
Complies with EMC standard EN 61326-1:1997 + AM1:1998; Laboratory Environment

Dimensions (in mm)






355
35
3
37.7
57.2
132.5 (3U)
19" = 482.6 mm
465
495


480
30
0°, 30°, 60°
485

APPENDIX 1

HUMIDITY THEORY

Measured and calculated results of DM500

DM500 measures the dewpoint temperature of a gas by condensing water on a surface and using SAW technology to detect this condensation. The temperature at which condensation occurs is accurately measured by a four wire platinum resistance temperature sensor and is reported as dewpoint/frostpoint temperature. Other humidity parameters are calculated by using the measured dewpoint/frostpoint temperature data and either measured or set values for pressure and temperature.

Water vapor in air

Water vapor is water in the gaseous phase. It is an abundant component of the earth's atmosphere, and it is also common in many industrial processes. At atmospheric pressure, water behaves like an ideal gas.

Dalton's law states that in a gas mixture, such as air, the total pressure of the gas is the sum of the partial pressures of each of the component gases

$P_{total} = P_{nitrogen} + P_{oxygen} + P_{water} + P_{others}$

Thus, atmospheric pressure is actually the sum of the partial pressures of nitrogen, oxygen, water vapor, carbon dioxide, and small amounts of other gases.

There are many ways of expressing the water vapor content of a gas. Some water vapor quantities, such as dewpoint temperature, can be measured directly and fundamentally. Other parameters, such as relative humidity, require knowledge of additional information, such as the temperature of the gas.

Saturation vapor pressure

Saturation vapor pressure is the maximum pressure of water vapor that can exist at a given temperature. This quantity is expressed in pressure units such as Pascals or millibars, and is often represented by the symbol "*e*." There is a unique saturation vapor pressure for any temperature. Thus, if a gas is cooled until condensation forms (the dewpoint temperature), it is possible to determine the saturation vapor by measuring the temperature at which condensation forms or remains in equilibrium.

Dewpoint temperature (T_d)

Dewpoint is the temperature at which condensation begins to form when a gas is cooled. An object or surface is said to be at the dewpoint temperature when condensation is maintained in an equilibrium condition (amount of condensation is neither shrinking nor growing). Dewpoint has a unique correlation to the saturation vapor pressure of water. Accurate determination of dewpoint establishes knowledge of the partial pressure of water vapor in a gas. Knowledge of additional gas parameters, such as temperature and pressure, enable calculation of commonly used humidity parameters (percent relative humidity, parts per million by volume, mixing ratio, etc.).

Frost point temperature (T_f)

Dewpoints below 0°C are often referred to as frost points, although the term "dewpoint" is often used interchangeably. Frost point is the temperature at which a gas is saturated with respect to a plane surface of ice. Saturation vapor pressure over ice is slightly lower than over water. This difference can be important in the temperature ranges below zero (0 °C) where it is possible to have condensation either in the solid phase (frost) or in the liquid state (dew, supercooled water).

Partial pressure of water vapor (P_w)

Partial pressure of water vapor refers to the part of the overall pressure exerted by the water vapor component of a gas. Note that the partial pressure of water vapor can be calculated when the dewpoint temperature of a gas is known.

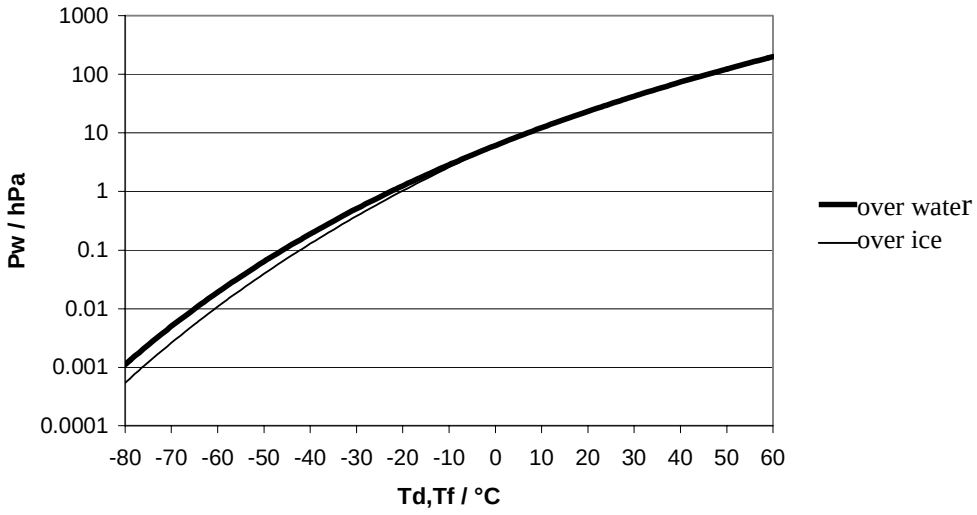
$$P_w = A * 10^{(m*Td/(Td+T_n))}$$

Likewise, dewpoint temperature can be calculated for a given partial pressure of water vapor.

$$T_d = T_n / (m/\log_{10}(P_w/A)-1)$$

where T_d is a dewpoint temperature T_n, m and A are constants and their value depend on the temperature range as follows:

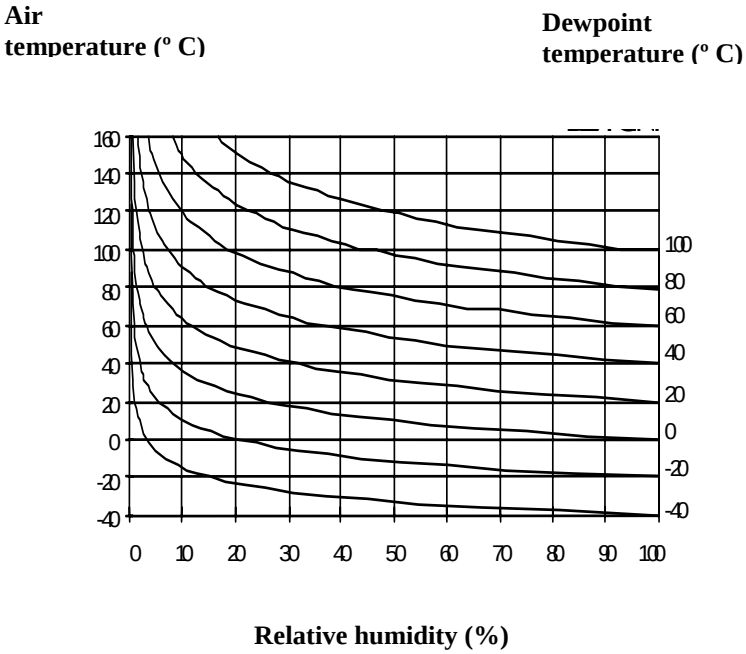
over water	**A**	**m**	**T_n**
0...60 ºC	6.1078	7.5	237.3
-20...50 ºC	6.1162	7.5892	240.71
-70...0 (over ice)	6.1134	9.7911	273.47



Relative humidity

Relative humidity (RH) is the ratio of the amount of water vapor actually in the air compared to the maximum amount the can be mixed in air at that particular temperature. It is defined below as the ratio of the water vapor pressure P_w to the saturation water vapor pressure P_{ws}.

$$RH = P_w / P_{ws} * 100\ \%$$



Humid air volume/ dry air volume PPM_v

Parts per million (PPM) by volume is the ratio of the partial pressure of the water vapor to the partial pressure of dry gas. This can be calculated with a reasonable accuracy with following formula

$$\mathbf{PPM_v = (P_w/(P_{tot}-P_w)) * 10^6}$$

where P_w= water vapor pressure
P_{tot}=total pressure

Effect of pressure on dewpoint

Changing the total pressure of a gas changes the partial pressures of the component gases according to Dalton's law, and therefore changes the dewpoint/frostpoint temperature of the gas. This can be represented as follows:

$$\mathbf{Pt_1/Pw_1 = Pt_2/Pw_2}$$

Where Pt is the total pressure of the gas and Pw is the partial pressure of water vapor.

Using a condensation hygrometer

It is useful to consider the behavior of water vapor when working with any condensation hygrometer. Keep the following in mind when making measurements:

Contamination – Water soluble contaminants, such as salt, can have a significant effect on saturation vapor pressure. Some gases will also go into solution with water. Water soluble contaminants cause a lowering of vapor pressure known as Raoult Effect, and a corresponding measurement error.

Response Time – The response time of a hygrometer is proportional to the amount of water vapor in the gas being measured. Thus, at dewpoint temperatures of –60°C, things take ten times longer than at –40° because there is ten times less water vapor.

Condensation - It is important to remember that condensation will form on any surface if the temperature of that surface is at or below the dewpoint temperature of gas that is in contact with the surface. In practice, condensation may form in sample lines or on interior or exterior parts of the hygrometer. Condensation inside the sample line will cause a measurement error.