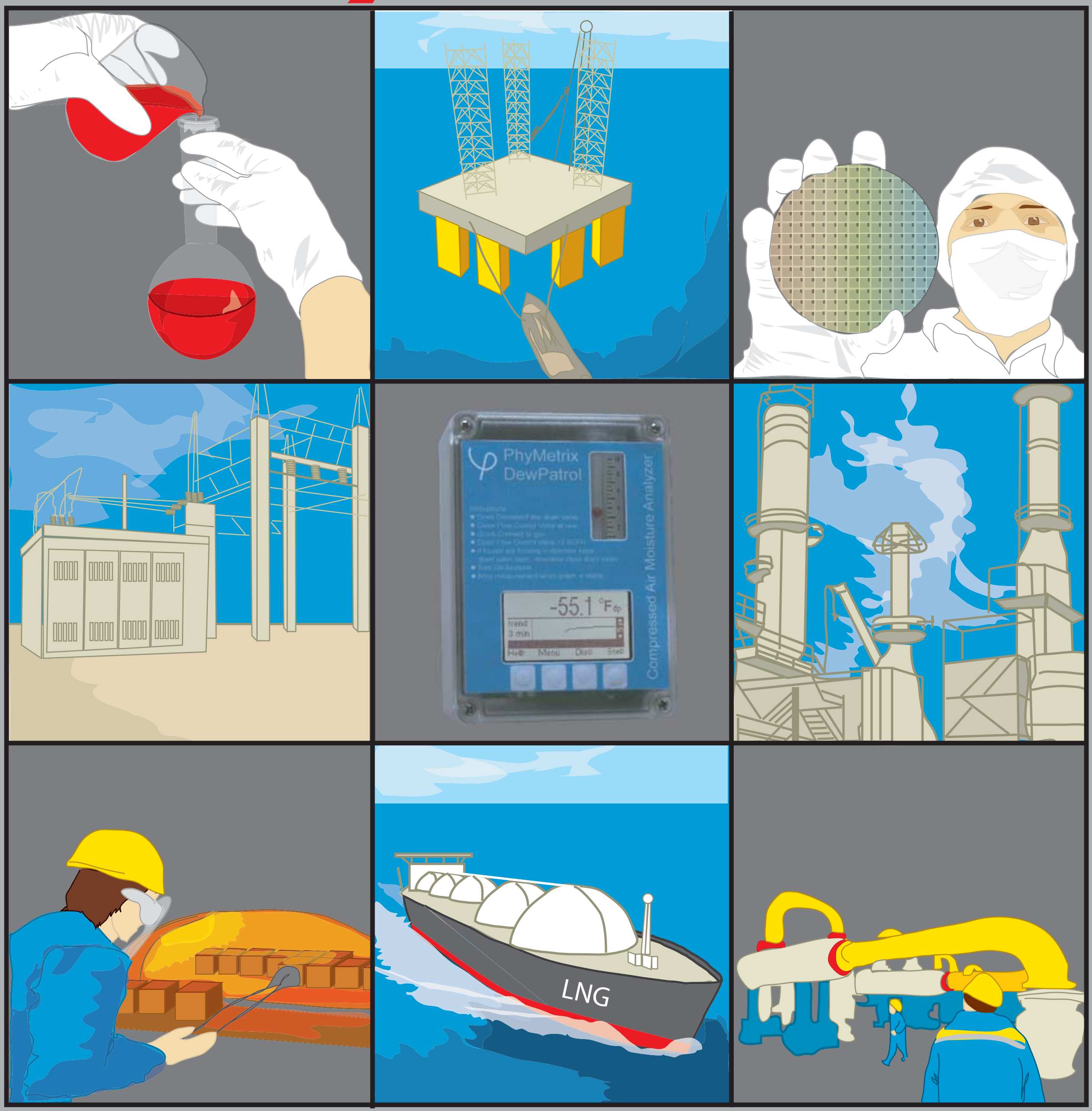
PhyMetrix®



PhyMetrix dewPatrol Moisture Analyzer User's Manual

www.Phymetrix.com

Read this manual before using the analyzer. For personal and system safety, and for optimum product performance, make sure you thoroughly understand the contents before installing, using, or maintaining this analyzer.

Please visit our website at www.phymetrix.com for other products that may be applicable to your needs.

Every effort has been made to ensure accuracy in the contents of this manual. Should there be any doubts to the accuracy of the content please contact the manufacturer.
The contents of this manual are subject to change without notice.

Warranty

This instrument is warranted, to the original end-user purchaser, against defects in materials and workmanship. Liability under this warranty is limited to restoring the instrument to normal operation or replacing the analyzer, at the sole discretion of the manufacturer. Batteries are specifically excluded from any liability. This warranty is effective from the date of delivery to the original purchaser. If Phymetrix determines that the equipment was defective, the warranty period is:

- one year from delivery for electronic or mechanical failures
- one year from delivery for sensor shelf life

If Phymetrix determines that the equipment was damaged by misuse, improper installation, the use of unauthorized replacement parts, or operating conditions outside the guidelines specified, the repairs are not covered under this warranty.

Normal wear and tear, parts damaged by abuse, misuse, negligence or accidents are specifically excluded from the warranty.

Purchaser acknowledges that in accepting and using this analyzer, notwithstanding any contrary term or provision in the purchaser's purchase order or otherwise, the only warranty extended by Phymetrix is the express warranty contained herein. Purchaser further acknowledges that there are no other warranties expressed or implied, including without limitation, the warranty of merchantability or fitness for a particular purpose; that there are no warranties which extend beyond the description of the face hereof; that no oral warranties, representations, or guarantees of any kind have been made by Phymetrix, its distributors or the agents of either of them, that in any way alter the terms of this warranty; that Phymetrix and its distributors shall in no event be liable for any consequential or incidental damages, including but not limited to injury to the person or property of the purchaser or others, and from other losses or expenses incurred by the purchaser arising from the use, operation, storage or maintenance of the product covered by the warranty; that Phymetrix's liability under this warranty is restricted to repair or replacement of defective parts at Phymetrix sole option; and that Phymetrix neither assumes nor authorizes any other person to assume for it any other warranty. The warranty shall be void if serial numbers affixed to the products are removed, obliterated or defaced.

Return Policy / Procedures

If equipment malfunction is suspected or it is determined that the analyzer needs recalibration, please contact Phymetrix.
Communicate the instrument model number, serial number, application including dewpoint range being measured, and the details of the problem.
If the analyzer needs factory service you will be issued a RMA and shipping instructions.

The factory will diagnose the equipment and upon determining the problem will notify you whether the terms of the warranty cover the required repair. If the costs are not covered you will need to approve the estimated cost in order to proceed with the repair.

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1 Introduction

Thank you for purchasing the state-of-the-art Phymetrix DewPatrol Moisture Analyzer, it is a weatherproof handheld analyzer which includes a built-in liquid separator, metering valve and flow meter. This User's Manual describes the functions of this analyzer as well as its operating methods and handling precautions. There are also some sections that review general knowledge and concepts of water vapor science. Read this manual thoroughly before using the analyzer. Check our website "www.phymetrix.com/" for latest versions of documentation regarding this analyzer.

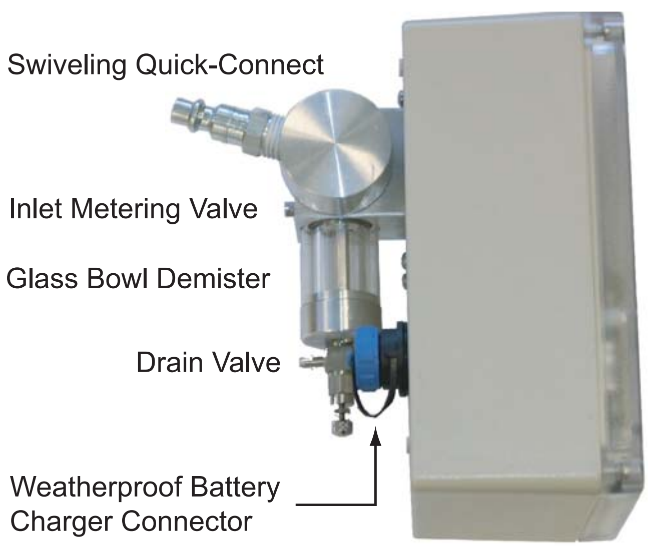
<u>Conventions used in this manual:</u>

- When using the word "*system*" in this manual we are referring to the user's system in which the moisture content is being measured. This could be a simple configuration of a pressurized gas bottle with a pressure regulator, or a complex system of dryers, filters, regulators, long tubing, valves etc.
- When referring to text that is displayed on the analyzer screen, it is presented in this manual using a font that makes it **`stand out`**.

The analyzer part number is displayed upon power-up and in the *About* screen, the dash numbers following the main part number signify options as follows:
-P for internal pressure sensor, **-A** for analog output 4/20mA, **R-** for alarm relay or AV alarm

Check to see that your analyzer has arrived intact with all accessories. The international plug kit is supplied only when shipped outside the USA. The rechargeable batteries are factory installed, and are not user serviceable.

DewPatrol Side View



Model: PDPa

Save the packing materials until you have verified that there is no concealed damage, it may also be useful for future transportation.

2 Important Principles of Operation

2.1 Sensor Operating Principle

The nanopore sensor utilized in this analyzer measures the amount of water vapor molecules that have entered its pores. This amount is directly proportional to the partial water vapor pressure in the gas surrounding the sensor, and the partial water vapor pressure is dependent on the water vapor content of the gas and the total pressure of the gas. Thus to compute the water vapor content of the gas under measurement the analyzer has to "know" the total pressure of the gas. If the analyzer was purchased with the pressure sensor option then the total pressure is measured and utilized by the analyzer, if there is no built-in pressure sensor then the user should enter the total pressure into the analyzer, this can be easily done by entering atmospheric pressure (the analyzer default setting) and measuring at atmospheric pressure by allowing the outlet (exhaust) port to vent without restrictions.

2.2 Sampling Mechanism Operating Principle

The analyzer is equipped with a built-in sampling system which has the required tight seals to measure low moisture. The connection to the air system is simple, using existing quick connect, allowing installation directly on the compressed air pipe or hose. The swiveling inlet port adjusts for comfortable viewing under all installation conditions. Alternatively dewPatrol can be permanently installed using its 1/4"NPT inlet port. DewPatrol includes integral sampling system consisting of inlet flow control valve, flow meter, particulate filter, coalescing filter (glass 360° view) demister with drain valve, and a convenient swiveling quick connect inlet port.

3 ⚠ Precautions ⚠

- Observe the appropriate electrical safety codes and regulations. Consult with National Electrical Code, and/or other nationally or locally recognized procedures relevant to your location.
- When measuring flammable, explosive or toxic gasses; vent the sample outlet to a safe and appropriate location.
- When measuring high pressure samples (do not exceed 150 psia or optional 500 psia); be sure that the system is depressurized before connecting or disconnecting the sample tubing.
- Corrosives such as Ammonia, HCl and Chlorine should be avoided; H_2S and SO_2 can be present if the moisture content is below 10 PPMv.
- Avoid extreme temperatures, pressures and mechanical vibration, refer to specifications.
- Do not disassemble the analyzer.
- Do not use with contaminants and liquids, refer to section 5.2 for sample conditioning.
- The handheld analyzer is weatherproof and can be left in the rain, however the inlet and outlet ports must be protected from ingress. Do not leave the analyzer exposed to rain or other contamination sources while the inlet or outlet ports are unprotected. When performing a measurement at atmospheric pressure, the outlet port is sufficiently protected from rain if there is at least 1 LPM (2 SCFH) of flow. Be sure to have the USB connector protective cap secured in order to meet the weatherproof specifications.

4 Moisture System Considerations

This section is offered as background information. There are several considerations in keeping your system at a stable and pure moisture level, free of contamination from ambient air moisture:

- The integrity of the materials isolating the pure gas from the external air, including leaks from poorly secured fittings.
- The backflow of moisture through the exhaust outlet, the exhausts of both the analyzer and the user system under measurement should be considered.
- The effects of temperature on the equilibrium of moisture and the surrounding materials, often observed as diurnal cycles in the measurement.

4.1 Integrity of the Materials of the User's System

Before considering the materials of a system where a specified dewpoint level must be maintained, one should review two concepts.

- Compared to the structure of solids the water molecule is much smaller. This is true compared to even the crystalline structure of metals but especially important in the polymer structure of plastics.
- Water vapor pressure in gasses obeys Dalton's law of partial pressures, which states that the overall pressure of a gas is the sum of its constituent gases. And each gas seeks to equilibrate its pressure across gradients of only its own gas pressure.

Let's consider air in a pipe at a total pressure of 100 psia, which has been dried down to -40°C dewpoint. The partial water vapor pressure in the pipe is 0.13mB. If the ambient temperature is 22°C with relative humidity of 30%, then the partial water vapor pressure in the surrounding atmosphere is 7.9mB or approximately 60 times greater than the partial water vapor pressure in the pipe. Thus even though the total pressure in the pipe is much greater that the pressure outside, the reverse is true for the water vapor pressure, and as we discussed earlier the water vapor seeks to equilibrate its pressure thus it "wants" to flow from the outside to the inside and will do so through the cracks in the joints (such as poorly tightened fittings, or NPT threads even if they are properly taped), as well as through the walls of pipes tubes and other vessels. The integrity of the system is extremely important in maintaining a stable low dewpoint; for dewpoints below -60°C always use stainless steel or PTFE (Teflon), while for higher dewpoints you can use copper or galvanized steel; but never use rubber, Tygon, Nylon or other plastic or tubing. Pressure regulators often use rubber diaphragms, check and if necessary replace with a stainless steel diaphragm regulator. Filter bowls should be stainless steel or glass, plastic bowls should be avoided. If a flow meter is placed at the inlet of the analyzer it should have a glass tube and be rated for the expected pressure levels, however in general it is best to place flow meters at the analyzer exhaust.

Another material consideration relates to materials sealed in the system such as paper filters; these may not contribute to leaks but will greatly slow down the measurement because they will adsorb and desorb water molecules as the system dewpoint is changing.

4.2 Moisture Backflow Along the Walls of the Exhaust Tubing

The linear velocity of gas flowing in a tube is close to zero immediately along the wall of the tube. This coupled with the previously discussed "need" for the moisture to flow from the higher water vapor pressure to the lower one, allows for water molecules to flow against the flow through the exhaust outlet into the sampling chamber of the analyzer. The fact that water molecules are highly polar further enhances their ability to migrate against the gas flow at the sampling chamber outlet. To prevent this backflow of moisture from influencing the measurement, a minimum flow of 2 SCFH (1 SLPM) should be maintained; higher flows will produce faster equilibrium time and thus are desirable for quick measuring.

4.3 Temperature Dependant Equilibrium

The effect of ambient temperature on the gas partial water vapor pressure of a system can change the moisture content of the gas. This is not the temperature sensitivity of the measuring analyzer, rather the actual change of partial water vapor pressure in the user's system due to increase in ambient temperature and thus the increase of energy of the water molecules on and in the walls of the system (tubing, vessels etc…). A typical example would be the observation of a daily cycling of the measurement in a system with tubing or other components exposed to direct sunlight. During the day as the sun transfers energy into the system, the dewpoint will appear to increase, while at night the dewpoint will appear to decrease. There may be other reasons for this daily dewpoint cycling such as the effect of sun/temperature on the efficiency of gas dryers etc. It is possible to minimize this effect using sun shields and tubing insulators. Alternatively one may study the response of the particular system to ambient temperature, by logging data over several days during different seasons, and compensating the measurements for this effect. The temperature effect will vary greatly depending on the size and materials of the system, for example stainless steel walls will have a much smaller effect than brass or copper walls.

5 Sampling Techniques

The amount of moisture measured will be influenced by the system moisture content as well as leaks in the system and transient effects of adsorption / desorption from materials in the system (as described in the previous section).

5.1 Choosing a Measurement Site

Portable analyzers because of the nature of the situation (spot checking) perform extractive measurements. It is important to choose an appropriate sampling location that is representative of the moisture content of the system of interest.

5.2 Sample Conditioning

Particulate and liquid contaminants can affect the measurement, especially the response time. Sample conditioning may be necessary to remove contaminants and improve the measurement and the longevity of the sensor. Make sure that sample conditioning components are made of suitable materials. Avoid paper or other fiber filter elements, use stainless steel instead. For expected dewpoints below -50°Cdp (39 PPMv), avoid plastic filter bowls, use stainless steel or glass instead. Make sure that highly hygroscopic contaminants (e.g. Triethylene Glycol used in drying Natural Gas) do not reach and coat the sensor as they will disturb the sensor to system equilibrium and can greatly affect the measurement and response time when the analyzer is used at other locations. Drain trapped liquids from filter bowls.

If the application is suspect of possible presence of liquids for example:

• Compressed air with possible oil and/or water,
• Gas Insulated Switchgear or Transformer, SF_6 or N_2 blanket with suspected oil carryover,
• Natural Gas with possible Triethylene Glycol carryover,

The built-in Gas-Liquid separator *Mini-Demister* provides a visible area of liquid separation and a metering valve for draining the accumulated liquid. Refer to *Appendix A* for details on the use of the Mini-Demister.

5.3 Tubing and Fittings

Make sure all tubing is constructed of materials suitable for low dewpoint measurement, i.e. stainless steel or Teflon, do not use rubber or plastic tubing (refer to section 4.1 for more details). If using quick disconnect on inlet, be aware that some female disconnects do not seal as tightly as others.
Check for leaks after connecting.
Flow meters can be a source of moisture ingress especially if they have a plastic flow tube; ensure flow meters are connected at the analyzer exhaust, not at inlet. However the metering valve should be at the inlet in order to maintain constant atmospheric pressure in the sampling chamber.

5.4 Sample Pressure

Pressure variations will affect the measurement. Higher pressure is more likely to produce condensation and thus erroneous readings or even damage the sensor. If the sample pressure needs to be reduced use a suitable pressure dropping device such as a stainless steel needle valve or pressure regulator with a stainless steel diaphragm or a flow control orifice. Make sure Joule-Thomson effects do not cool the gas below hydrocarbon and water dewpoints.

5.5 Measuring Gasses at Pressures above 50 psia

When sampling gases from sources above 50 psia the user needs to exercise some caution.

The inlet metering valve eliminates the need for any pressure regulators while maintaining sufficient but not excessive flows throughout the pressure rating of the analyzer.

Measuring with the DewPatrol, Near Atmospheric Pressure

It is recommended for most applications to perform the measurement at near atmospheric pressure. Adjusting the inlet metering valve and allowing the outlet to be unrestricted (other than the provided orifice), assures that the analyzer has sufficient but not excessive flow and the pressure inside the sampling chamber is near atmospheric. This approach guarantees safe conditions and eliminates the need for the optional pressure sensor. If there is no pressure sensor the analyzer can be set with atmospheric pressure 14.7psia for the "`Mea. at`" setting of the pressure correction (refer to section 7.5).

Measuring with the DewPatrol, at Pressure of Sample

If it is desired to perform the measurement at the same pressure as the sample, up to the rating of the analyzer (300 psia standard), the analyzer must be ordered with an internal orifice in its exhaust path, then fully open the inlet valve thus pressurizing the sample chamber and letting the built-in orifice provide flow control.

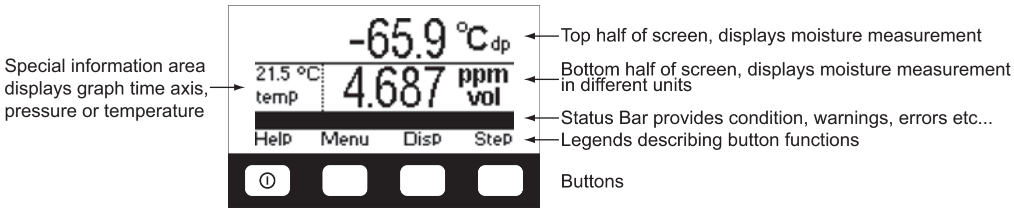
In this mode of use, to perform accurate measurements, you must know the pressure and enter it into the analyzer, or order the optional built-in pressure sensor which will perform the measurement and correction automatically.

The dewPatrol can be ordered with a built-in orifice in its exhaust. This orifice can be used to regulate the flow from various pressures. The 0.016" dia. orifice, has flows described in the following table.

source pressure psia - (Bar)	flow SLPM (0.016" orifice)
15 - (1.03)	0.7
25 - (1.72)	2
35 - (2.4)	3
55 - (3.8)	4.8
75 - (5.2)	6.6
100 - (6.9)	8.5
150 - (10.3)	13.4

6 User Interface Overview

The analyzer user interface consists of a backlit graphic LCD display, an audio sounder, four metal dome tactile buttons, an inlet metering valve and a demister drain valve. The button functions are dependent on the required selection choices thus appropriate legends appear on the display immediately above the buttons.



Note: A personal computer Virtual Analyzer program is available on our website (phymetrix.com) allowing the user to familiarize themselves with the user interface and train on its operation.

The ⏻ icon is printed on the left most button, to indicate that it is used to turn ON/OFF the analyzer. Momentarily pressing this button will turn ON the analyzer; to turn OFF the analyzer the left most button must be held pressed for at least 3 seconds – then a message will appear on the screen to indicate that the analyzer is shutting OFF. In normal operation momentary presses of this button will cause the analyzer to display a context sensitive help screen, as indicated by the **Help** legend above it.

Note that the analyzer distinguishes between long and short presses of the buttons. Normally to operate the analyzer one must perform short presses (less than 1 second), the button must be released after the beep.

7 Operating the Analyzer

Performing measurements with the analyzer is a simple process:

- Connect the sample gas to the analyzer (refer to section 5)
- Adjust the flow of the gas to be greater than 1 LPM (2 SCFH)
- Turn ON the analyzer

Instructions:

- Open Demister/Filter drain Valve.
- Close Flow Control Valve at rear.
- Quick-Connect to gas.
- Open Flow Control Valve > 2 SCFH (1 LPM).
- If liquids are forming in demister keep drain valve open, otherwise valve can be closed.
- Turn On Analyzer.
- Select the graphing display mode
- Observe the graph and take readings when it is stable (flattened)
- When finished turn OFF the analyzer, the analyzer has an auto turnoff feature thus if left on it will turn off by default in 5 minutes if no buttons are pressed.

7.1 Mechanical Connections

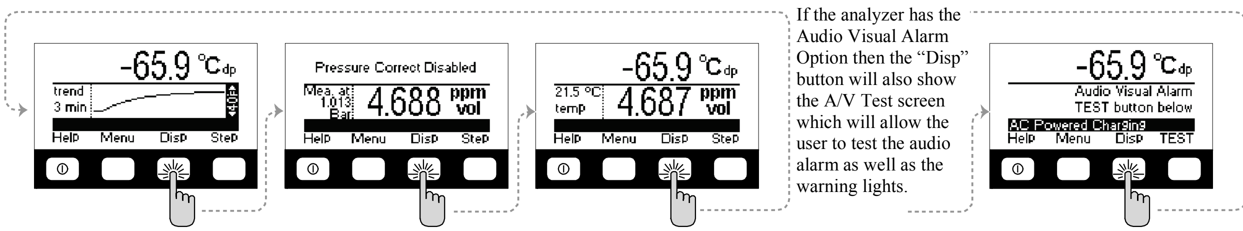
Connections for inlet and outlet of the gas being measured are made through ¼" NPT female adjustable swivel. The dewPatrol inlet is supplied, as factory default, with a 40 micron Particulate Filter and a Male Industrial 1/4 Quick-Disconnect Hose Coupling.
The inlet quick-disconnect and/or filter can be changed for the user's particular needs.
Make sure that the analyzer case/enclosure is not stressed while loosening or tightening the fittings, always use two wrenches. refer to Appendix B.
Note that the inlet particulate filter will cause a slowdown in the measurement as the element will adsorb/desorb moisture.

7.2 Powering the Analyzer ON or OFF

To turn ON the analyzer, press the left button (marked with the ⏻ icon) and hold for approximately one second until the display comes on.
To turn OFF the analyzer, press the ⏻ button and hold it for 3 seconds or more, when the shutdown screen appears release it.
To conserve battery power, the analyzer will auto-shutoff if the user buttons are not pressed for 5 minutes.
The auto-shutoff is preceded by warning the user for 10 seconds, providing the ability to cancel the shutoff. The 5 minute auto-shutoff is a factory default that may be disabled or modified by the user through the **`Autoshutoff`** option available in **`MENU-3`**.
When operating from an external power source (USB connection to PC or wall transformer), the analyzer will not shutoff.

7.3 The Display Mode

Once powered, the analyzer will enter one of three display modes (whichever was last used) that show the measurements performed by the analyzer. Pressing the `Disp` button will change the display mode. Use the mode best suited for your application, in most cases when making *Spot* measurements the *Graph Mode* is best for determining when the measurement can be taken.



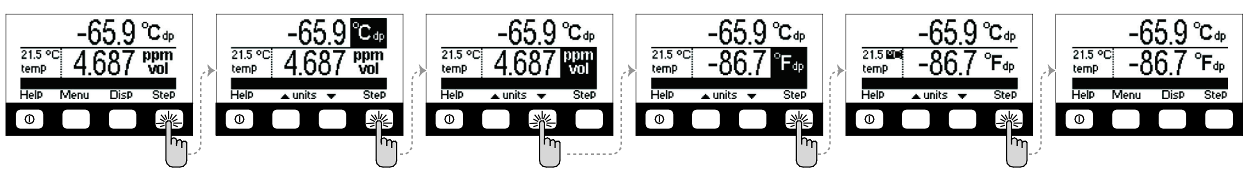
- <u>Dewpoint Units and Graph</u> of the measured dewpoint in the last 3 or 90 minutes is displayed. The graph span (Y-axis above shown 40°Fdp) will automatically resize to accommodate the minimum and maximum measurements in the last 90 or 3 minutes. Select the 90 or 3 minute time axis by choosing *Continuous* or *Spot* measurement modes in the `ModeOfUse` option available in `MENU-2`.
- <u>Pressure corrected and at pressure measurements</u>, as well as the gas pressure in the sampling chamber is displayed. The pressure correction selection in this display mode will be also utilized in the other two display modes. If pressure correction is enabled, then the status bar will provide an indication in all three display modes, so that the user is made aware that the displayed measurement is pressure corrected. In the example shown above, the pressure correction is disabled.
- <u>Dual Dewpoint Units and Temperature</u> of gas under measurement is displayed. Allows the user to view the measurement in two different units as well as the temperature in the sampling chamber. In the right most screen in the example above the moisture content is being viewed in °C and in ppm by volume, while the temperature is displayed to be 21.5°C.

7.4 Units to Display the Measurement

Measuring water vapor content in gasses presents many challenges not the least of which is understanding the units of measuring. Different industries require different units of measure for various reasons some technical some historical. The units typically used are in several categories:
a) The <u>ratio of the volume</u> occupied by the water vapor to the volume occupied by the other gasses in the mixture. These measurements are expressed in Parts Per Million by volume **PPMv**, or Parts Per Billion by volume **PPBv**, or Volume Concentration %.
b) The <u>ratio of the weight</u> of the water vapor to the weight of the other gasses in the mixture. These measurements are usually expressed in Parts Per Million by weight **PPMw**.
c) The <u>density of water vapor</u> in the mixture of gasses, is the ratio of the weight of the water vapor to the volume occupied (at atmospheric pressure) by the total mixture of gasses. These measurements are expressed in grams per cubic meter (**g/m^3**), or pounds of water per million standard cubic feet (**$LbsH_2O/MMSCF$**) the analyzer displays these units as $\frac{Lb\ H_2O}{10^6\ SCF}$

d) The partial vapor pressure of water vapor – the pressure exerted by the water vapor only, without considering the other gasses in the mixture. These measurements are expressed in units of pressure such a **microBar**, mmHg, or any other pressure units that may be convenient.
e) The dewpoint of the gas mixture - the temperature at which the water vapor in the gas is saturated. This means that if the gas temperature was above the dewpoint temperature and contained water only in vapor form, then if the gas is cooled, when it reaches the dewpoint temperature the water vapor will just start to form condensation. Dewpoint measurements are expressed in units of temperature such as **°C** or **°F**.
There are other measurement categories for expressing water vapor content in gasses however they are not central in the context of this analyzer, and are listed for completeness: Relative Humidity, Mixing Ratio, Absolute Humidity, Humid Volume of Air, Weight concentration %, Delta Dewpoint. A freeware program compatible with Microsoft® Windows, as well as Apple and Android smart phones, is available for downloading at phymetrix.com/software/ facilitating easy conversions between the above categories of units of measure.
In this analyzer, moisture content of the gas being measured can be displayed in a variety of units: °C & °F dewpoint, ppmV, ppmW, µB H_2O vapor pressure, grams of H_2O / m^3, and Lbs H_2O /10^6 standard cubic feet in Natural Gas. Use the `Step` button (right most) to highlight the units of the measurement and use the ▲ and ▼ buttons to change the units to the desired values. If the instrument is unlocked then the unit changes will be permanent even after the analyzer is powered OFF.

The following diagram depicts the button presses required to change the units in which the measurement is displayed on the bottom half of the screen from ppmV to °F.



Similarly the units for the top half of the screen or the temperature can be changed.
If the instrument is locked then the change will last for 5 seconds so the newly selected units can be viewed, then the selection will revert to the original units. The status bar will indicate `Locked-change is temporary` and will produce beeping sounds.

7.5 Pressure Correction

In the previous section the summary of the units of measure for water vapor content reveals that the units can be organized in three groups:

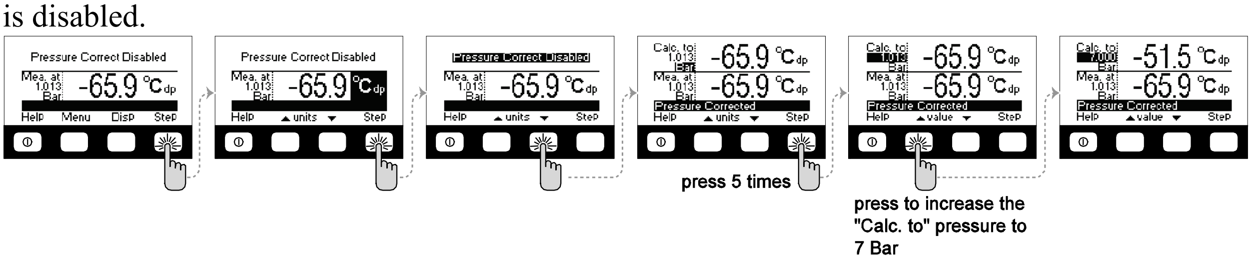
1) Proportion of water vapor in the gas is measured in several different categories such as PPMv, PPMw, or LbsH_2O/MMSCF.
2) Pressure exerted by the water vapor.
3) Temperature at which the water vapor is saturated in the gas.

The measurements of group 1 are most intuitive as they can be visualized as a proportion of water in a gas mixture. These units are independent of the pressure of the gas that is being described. For example if we say that the gas has seven pounds of water per million standard cubic feet, we are describing the water content irrelevant of the pressure at which the gas may be.

The measurements in group 2 are in units of pressure and may at first seem an unusual way of measuring content but if we recall Dalton's Law of gases it becomes evident of the usefulness of this means of expressing water vapor content in gasses. Note however that if the total gas pressure is increased the partial water vapor pressure will also increase, thus the content of water vapor in a gas is not fully described by the partial water vapor pressure – we would also need to specify the total pressure of the gas mixture.
The measurements in group 3 are units of temperature, describing the water vapor saturation temperature in the gas mixture. This method of expressing water vapor content is also affected by the total pressure; if the total pressure is increased the gas will become saturated at a higher temperature. Thus we would also need to know the total pressure of the gas mixture in order to describe its water vapor content with dewpoint units.

As we discussed earlier this analyzer measures the partial water vapor pressure in the gas and computes the water vapor content in the chosen measurement units to display on its screen. To make this computation the analyzer software needs to "know" the total gas pressure. This pressure can be automatically measured by the optional internal pressure sensor, or if the analyzer was not purchased with that option then the pressure can be entered by the user. To simplify operation the user can enter atmospheric pressure and measure at atmospheric pressure by allowing the exhaust of the analyzer to be unobstructed.

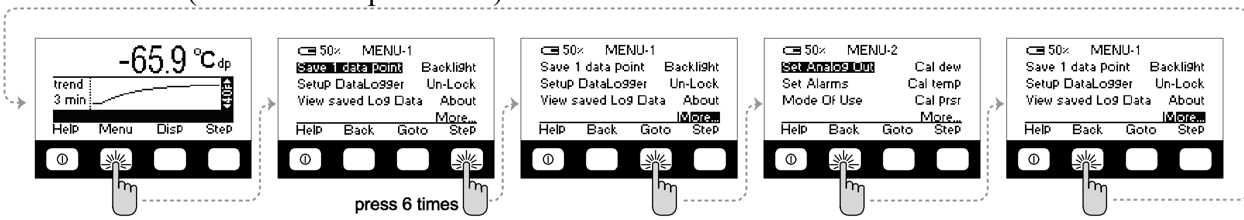
Let's consider an example where the gas under test is measured at atmospheric pressure, however the gas is in a pipeline at much higher pressure, and the user wants to know if there could be water condensation in the pipe. Reading the dewpoint at atmospheric pressure does not allow us to compare it to the expected low ambient temperature in order to determine if condensation will occur; we would need to know the dewpoint at the same pressure as is present in the pipeline. The analyzer can compute this dewpoint by having its Pressure Correction feature enabled, and having the user enter the pressure in the pipeline. This can be done by pressing the `Disp` button until the analyzer displays the Pressure correct mode. By factory default the pressure correction is disabled.



The above diagram depicts the steps required to enable the pressure correction and set up the "Calculated to" pressure to 7 Bar (about 100 psia). This example shows the analyzer measuring the gas at atmospheric pressure (1.013 Bar) to have a dewpoint of -69.5°C, and calculating that the same gas when at 7 Bar will have a dewpoint of -51.5°C.
If the user switches to the Graphing or Dual Units display mode, the displayed measurements will be -51.5°C; there will be a reminder that the computation is being performed with the status bar message `Pressure Corrected`.
To disable the pressure correction computation; while in the Pressure Correct display mode, press the `Step` button until the `Calc.to` pressure *units* are highlighted, and then press the ▲ or ▼ button until the `Pressure Correct Disabled` message appears on the top half of the screen.

7.6 Navigating Through the Menus

While in any of the three display mode screens, press the **`Menu`** button to go to the **`MENU-1`** screen. This screen contains seven options; the last one is labeled **`More`**➞ press the **`Step`** button six times until the **`More`**➞ option is highlighted, then press the **`Goto`** button to go to the **`MENU-2`** screen (refer to example below).



Similarly by accessing the **`More`**➞ option of **`MENU-2`** will navigate to **`MENU-3`**.
While in **`MENU-3`** to go back to **`MENU-2`** press the **`Back`** button. Similarly navigate back to the **`MENU-1`** screen and back to the display screen.
If the analyzer is left in any of the MENU modes and the buttons are not pressed for 3 minutes then it will revert back to the display screen.
While in any of the MENU screens press the **`Step`** button until the desired option is highlighted, then press the **`Goto`** button to enter the edit / view mode for that option.

7.7 The Functions Available in the Menus

MENU-1

Save 1 Data Point or **Start-Stop Log**

If Data Logging is setup for *Single Point* logging then this menu choice allows the user to save a single point in the log. If the setup is for *Continuous* logging then this menu choice allows the user to start or stop the logging. In both cases the user can choose the location tag associated with the measurement. *Refer to Data Logging section for more details.*

Setup DataLogger

This menu choice allows the user to select the logging mode to be either *Single Point* or *Continuous*, in addition in the continuous mode it allows selecting the sampling period and the total number of samples to be saved.

View saved Log Data

This menu choice allows viewing the logged data on the analyzer.

Backlight

This menu choice allows selecting the intensity of the backlight. Keep in mind that the lower the intensity the longer will the analyzer operate on a single charge. If the backlight is turned off it will light at a 20% intensity for 10 seconds after a button is pressed.

Un-Lock

This menu choice allows the user to lock or unlock the analyzer. The user can setup the analyzer, using the PhyAI.exe program, to require a password in order to unlock it or can allow unlocking without a password. A locked analyzer will prevent the operator from making permanent changes.

About

This menu choice provides information regarding the software version and copyright, as well as the analyzer and sensor serial numbers. In addition the date when the analyzer was last calibrated is displayed.

MENU-2

Set Analog Out

For analyzers equipped with the analog 4/20mA output option this menu choice allows setting the measured dewpoint that will correspond to the 4mA and the 20mA values, as well as testing the analog output interface.

Set Alarms

For analyzers equipped with Audio-Visual Alarm or Relays this menu choice allows modifying the alarm set points.

Mode Of Use

This menu choice allows selecting either *SpotCheck* or *Continuous* modes of operation. Use the **Sel** button to switch between modes of operation. In the *SpotCheck* mode it is assumed that the sensor is normally kept in desiccant. Occasionally it is connected to the gas to be measured and a single quick spot measurement is made. In this mode the measurement graph spans 3 minutes to indicate if the reading is stable. When the line seems flattened the reading can be taken. In the *Continuous* mode it is assumed that the analyzer is normally kept attached to the gas to be measured. In this mode the measurement graph spans 90 minutes to indicate the recent history of the measurement.

Cal dew

This menu choice allows the user to enter a single calibration point, by exposing the analyzer to a gas with a known dewpoint and enter that dewpoint value to create a single point calibration.

Cal temp

This menu choice allows setting the slope and offset for calibrating the two temperature sensors in the analyzer. 'Td' is the temperature sensor located at the dewpoint sampling chamber and measures the temperature of the gas being sampled. 'Tb' is the temperature sensor located on the circuit board.

Cal prsr

This menu choice allows setting the slope and offset for calibrating the pressure sensor which measures the pressure of the gas in the sampling chamber.

MENU-3

Lockable Items

This menu choice allows selecting which items can be locked.

Status Bar

This menu choice allows selecting the items that will be displayed on the status bar.

Time-Date

This menu option allows setting the battery-backed clock calendar.

Autoshutoff

This menu choice allows selecting the auto shutoff times of the battery saver. The automatic shutoff is meant as a battery saver, thus when it is disabled it becomes the user's responsibility to shut off the analyzer when the measurements are complete.

PPMw factors

This menu choice allows the user to select the method of PPMw computations. The user can select measurement in gas and the molecular weight of the gas, or measurement in liquid and Henry's constant associated with the liquid.

Language de fr es

This menu choice allows the user the select the language in which the analyzer menus appear. Available languages are English, German, French and Spanish.

MENU-4

COMs

This menu choice is provided for commonality with other analyzers

Dig. Out PWM

This menu choice is provided for controlling the pulse width modulation of digital outputs such as relays or solenoids in order to facilitate power savings.

Set Thermostat

This menu choice is provided for commonality with on-line analyzers.

HART

This menu choice allows selecting the HART polling address.

Modbus

This menu choice allows setting the communications port for analyzers that have serial communications RS-485/422 output options, also provides selections for Modbus operating modes RTU/ASCII as well as the Modbus address.

7.8 External Connections

7.8.1 USB - Battery Use & Charging

The first time a PC is connected to this analyzer, it may need to initialize its USB drivers, which are available as a standard in all MS-Windows® XP and up operating systems. Please wait for this initialization to complete before using the interface. After this initialization, some PC's may require that their USB devices be unplugged and plugged back in, to properly enumerate the devices.

This driver initialization is required in order for the Analyzer to be able to properly charge from the PC's USB port.

If your PC does not have the driver and prompts you for a driver install, download the PhyAI.zip file from phymetrix.com/software/ select "Analyzer Interface", and follow the instructions in the "Driver READ ME.txt" file. The PhyAI.exe program is also contained in this zip file.

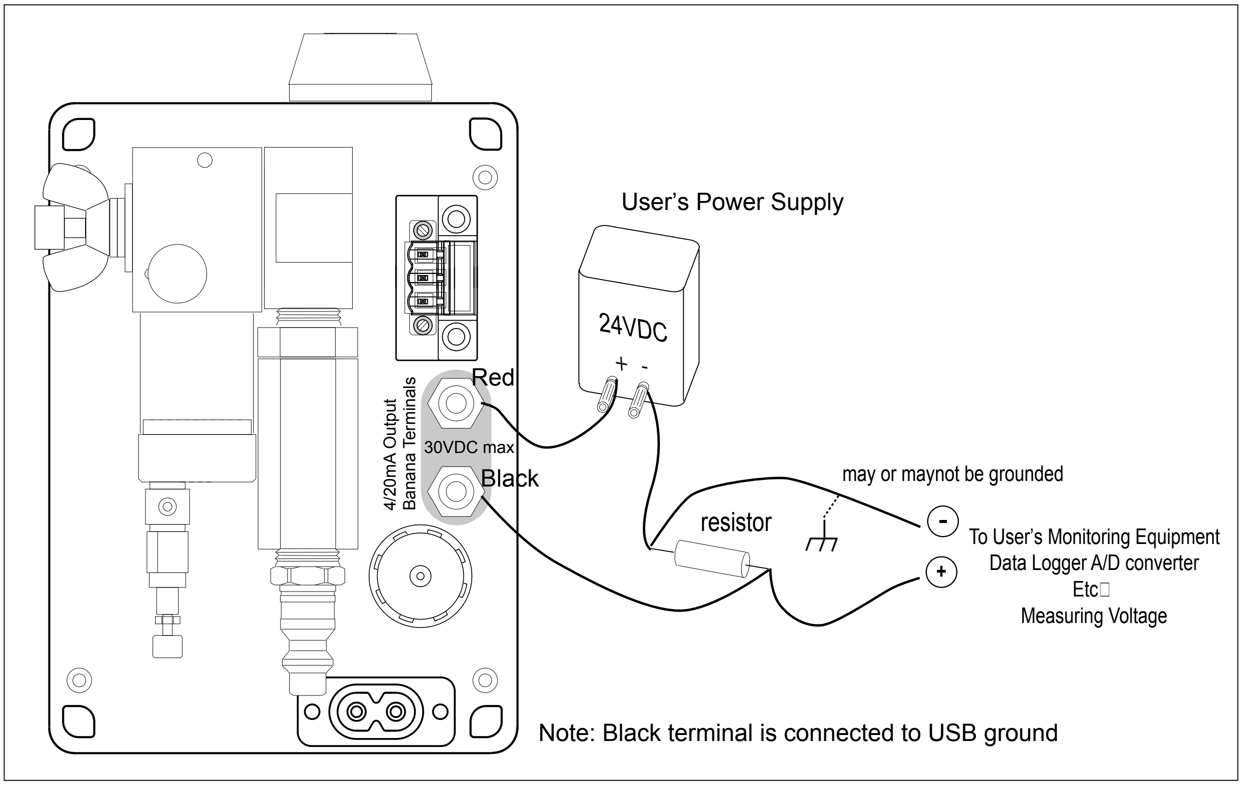
Digital Data - The analyzer can be connected to a personal computer and to the PhyAI.exe program through the USB connector, using the provided USB cable. The USB connector has a weatherproof cap which has to be unscrewed to gain access to the mini-B connector. The cap has a captive strap so that the cap is not lost. Please screw the cap back on to the connector when not in use in order to retain the weatherproof integrity of the analyzer.

External Power & Battery Recharging - The analyzer uses a rechargeable Li-Ion battery. A fully charged battery will power the analyzer continuously for 35 hours without the backlight or 12 hours with backlight at 100%; thus a single charge can provide many months of operational use. The amount of remaining charge appears on the upper-left of the MENU display screens, it is shown with a graphic 10 step bar in a battery icon and as a percentage. In addition as necessary the status bar displays a Low Battery message, indicating that the battery should be recharged, which can be done by plugging the analyzer into any PC's USB port (driver must be installed, see above) or by using the provided wall transformer. Do not exceed 5.5VDC on USB connector. The status bar indicates the states of the USB connection and battery charging. Normally USB ports provide 0.5A at 5VDC, but some USB hubs provide only 0.1A thus charging the battery at a slower rate. When connected to a 0.5A source a discharged battery will fully charge in 3.5 hours, when connected to a 0.1A source it will charge in 15 hours.

7.8.2 4/20mA Loop

Analyzers equipped with Analog I/O 4/20 mA output option, provide this output on the USB connector as well as **on two banana jacks in the back of the analyzer**.

The 4/20 mA loop is configured as a sink. It does not provide current; it sinks current from the user provided power supply. Do not exceed 30VDC on this connection.



7.8.3 Alarm Relay

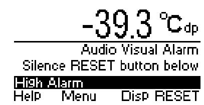
Analyzers equipped with the optional Alarm Relay have a pluggable screw terminal connector in the rear (refer to Appendix B) providing wiring positions for the Common, Normally Closed and Normally Open 3A-250VAC/30VDC contacts of the Relay.
The **`Set Alarms`** of the **`MENU-2`** screen provides the necessary dialog to set the various parameters of the Alarm performance.

Designs with circuitry activated by relay contacts should consider noise from contact bounce, an option for debouncing is placing an appropriately rated capacitor across the relay contacts.

7.9 AudioVisual Alarm (NFPA compliant)

Analyzers equipped with the optional audiovisual alarm have a loud (>80dB @ 3 feet) sounder and bright red visual alarm. The alarm trigger point can be programmed from the `Set Alarms` of the `MENU-2` screen under alarm2. As a default the trigger point is set to -40°Cdp with +/-0.5°Cdp hysteresis, it can be set by the user to any desired value. The AV-alarm operates as follows:

- suppose that the gas being measured is dry, let say -60°Cdp
- further suppose some disturbance causes the gas to get wetter
- when the measurement increases to or above -39.5°Cdp, the alarm activates
- the alarm activation causes:
    - the red lights to turn ON
    - the sounder to activate
    - the display screen changes to the Alarm Mode showing a RESET button



- the user can press the RESET button to silence the sounder but the red lights remain lit as long as the alarm is active
- when the measured value drops below -40.5°Cdp, the alarm deactivates
- when deactivated the red lights turn off, if sounder was on it also turns off

The process repeats if conditions repeat. At any time the user may navigate to the Alarm Mode Display and press the TEST button to verify that the lights and sounder are operating properly. This AV-alarm complies with the recommendations of NFPA 99, 1996 edition.

8 Data Logging

The analyzer has a built-in memory capable of storing data. The data can be stored in one of two modes, *Single Point* or *Continuous*.

Single Point data can be viewed on the analyzer screen. A personal computer Microsoft Windows® compatible program PhyAI.exe is available, which allows the user to view and/or erase the *Single Point* or *Continuous* data in the analyzer's memory.

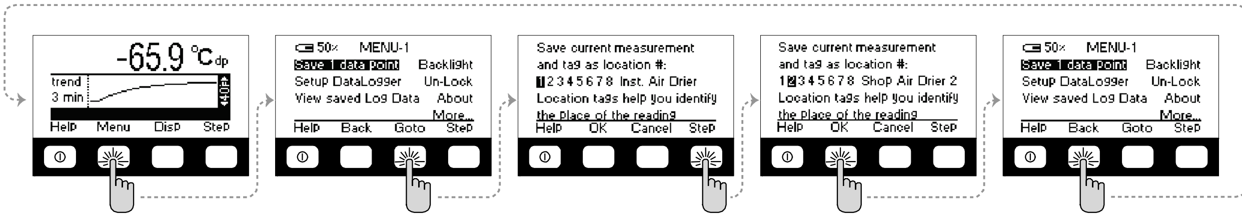
The user can choose the mode (*Single Point* or *Continuous*) of how data should be logged from the `Setup DataLogger` option available on `MENU-1`.

In addition the analyzer can be connected via its USB port to a personal computer. By using the PhyAI.exe program, the analyzer can continuously transmit its real-time measurements to an MS Excel® spreadsheet to log the data directly to the PC disk drive as well as plot it in real time. This method of data logging may be useful in stationary measurement installations, or portable uses (with a laptop computer) requiring very large amounts of data logging.

8.1 Single Data Point Log

Single Point data logging is intended to be utilized as a "note pad". If the user needs to perform single point samples at one or more locations, instead of writing down the measurement on a note pad, the user can with a few button presses save the measurement (dew, temperature and pressure) information with current date/time as well as a tag identifying the location. At a later time the user can view the saved data on the analyzer screen or on a personal computer. The location tags can be up to 16 characters long and can be customized by the user (using the PhyAI.exe program) to describe their particular locations and/or employee identification.

The `SetupDataLogger` option available on `MENU-1` allows the user to choose the Log type to be *Single Point*. Once the analyzer is setup for *Single Point* data logging, the current measurement can be saved in the data log memory with the following key press sequence:



The above depicted sequence consists of 5 key presses to log the measurement and tag it as location #2 labeled "Shop Air Drier 2". A maximum of 10 key presses may be required depending on the desired location tag. If location tags are not utilized then it will always consist of 4 key presses and will be logged as location #1. This is clearly easier than writing down the measurement, as well less likely to make a mistake, or forgetting to write down the time, temperature, pressure or location. The analyzer has blank (empty) location tags when shipped from the factory. They can be modified using the PhyAI.exe program to have any textual message up to 16 characters long.

8.2 Continuous Data Logging

Continuous data logging is useful in studying the moisture content, temperature and pressure of the gas being measured over a long period of time. The analyzer can store over 4000 points of data, at a user selectable period (5 seconds to 1275 seconds), thus data can be gathered with very fine resolution or with coarser resolution that can record data for approximately 2 months. The total number of points to be logged can be limited to be less that the total free memory as to conserve it for other use. When deciding on the choice of sampling period and total number of data points to capture; consider the response time of the system in which the moisture content is being measured as well as what is the desired total time for which data has to be logged.

The `SetupDataLogger` option available on `MENU-1` allows the user to choose the Log type to be *Continuous* and then to choose the period (in 5 second increments up to 1275 seconds). As the period is modified the analyzer will compute and display the total free records in the memory and the amount of time that the data can be logged for using the currently selected period. The user can also set a limit for the total number of points to be logged depending on the requirements of the application.

Once the analyzer is setup for *Continuous* data logging, the logging can be started from the `Start-Stop Log` option available on `MENU-1`. While *Continuous* data logging is running there will be an indication on the status bar "Logging Data".

The analyzer is capable to turn itself OFF between samples and when it is required to automatically turn itself ON to log a sample. A built-in algorithm decides on the parameters of this sleep – wakeup cycling, thus maximizing the battery longevity and performing long term (up to 2 months) measurements with a single battery charge. To operate in this mode make sure that the "Auto-shutoff" is enabled, then start the continuous log and leave the analyzer ON, if the algorithm determines that in this setup turning OFF will save battery power the analyzer will automatically turn OFF and then it will automatically turn ON.

If the user attempts to manually turn OFF the analyzer while the *Continuous* data logging is running, a query screen asks if the logging should be stopped and analyzer turned OFF or if the logging should continue when the analyzer is turned back ON.

8.3 Retrieving the Data / Clearing the Memory

To retrieve the data from the analyzer memory, it is required to install the PhyAI.exe program on a Microsoft Windows® compatible personal computer with a USB port. Single point data log can be viewed on the analyzer screen from the `View saved Log Data` option available on the `MENU-1`.

8.4 Logging Data Directly into a Personal Computer

The PhyAI.exe program allows the user to log data in real time directly into Excel 2003 via the OLE interface and plot the data in an excel graph. Excel 2007 will also perform data logging however when prompted from the PhyAI program to automatically plot dual axis graphs it will plot only single axis graphs, all other functions will operate properly, dual axis graphs can be plotted manually.

9 Single Point Calibration

If necessary to adjust the measurement without having to send the analyzer for recalibration, the user can expose the analyzer to a gas with a known moisture content. The known value can be entered into the program and the analyzer can be set to adjust the measured value such that the reported value is equal to the known moisture content of the gas. Once the single Point Calibration is performed, this adjustment will be applied as a constant offset on the full range of the measurement as long as the Single Point Calibration is enabled; the user can at any time disable or enable this calibration point or perform a new single point calibration (changes can be made only when unlocked.) In order to alert the user that the measured value is being adjusted, the status bar will provide an indication when the Single Point Calibration is being applied. When the single Point Calibration is disabled the analyzer will compute the measurements per original factory settings.

Caution! Before a calibration is performed the user should be absolutely certain of the moisture content of the gas that the analyzer is being exposed to. It is also very important that the analyzer is allowed sufficient time to equilibrate with the gas of known moisture content, which can be determined by observing a flat graph line in the continuous mode of measurement. Any inlet filter, such as the one supplied with the dewPatrol, may cause a delay in response time, thus it may be useful to remove the filter while performing a calibration.

Single Point Calibration is accomplished by exposing the analyzer to a gas with a known moisture level. The gas can be any clean inert gas such as Air or N2 or Ar etc, or can be the gas that is being measured verified by another recently NIST traceable calibrated portable analyzer. If a certified bottle of gas is used, it is preferred that the moisture level is close to the expected moisture level that the user normally measures but it does not have to be. Usually bottles of gas can be purchased with known moisture levels from 1 ppm to 500 ppm. Be careful to differentiate known exact moisture level of the bottle of gas vs. a bottle of gas with a guaranteed maximum moisture level which is normally how gas is sold. Thus a bottle of bone-dry Nitrogen guaranteed to have less than 1 ppm of moisture may actually have 0.5 ppm of moisture and therefore cannot be used for calibration. One has to purchase calibration gas with an exact known moisture level. The calibration gas bottle will be at some high pressure thus a pressure regulator is required. One must be careful to assure that the pressure regulator has a stainless steel diaphragm so that moisture from the atmosphere does not ingress into the calibration gas stream. Many pressure regulators can have a stainless steel body but a rubber diaphragm, and rubber is “transparent” to water vapor molecules. The pressure regulator and high pressure connections to the bottle must be sufficiently purged from ambient moisture by opening and closing the gas bottle valve about 4 to 5 times and allowing gas to vent in between. The gas being supplied to the analyzer should be just above atmospheric pressure, so there is at least one or two liters per minute flow through the analyzer. Once the analyzer is exposed to the calibration gas and measures a stable value, or if a portable reference analyzer is used and the reading has stabilized; the known moisture amount can be entered into the PPMa analyzer and a single point calibration can be performed. Refer to *Appendix C Manual Calibration Procedure*, for step by step instructions.

Factory calibration is performed at a calibration laboratory such as we have at our facility. In this case the analyzer is exposed to many different (usually 10) moisture levels that are verified by a NIST traceable standard (e.g. chilled mirror) and the analyzer is corrected at each of these points.

10 Troubleshooting and Maintenance

This analyzer is designed to be maintenance and trouble free. However should problems occur due to process conditions or other factors, use this chapter for troubleshooting purposes. If the encountered circumstances are not discussed in this manual please contact Phymetrix. Spare parts may be ordered through Phymetrix.

10.1 Cleaning

The analyzer enclosure may be cleaned using a moist cloth.
The miniDemister glass bowl may be removed and cleaned with alcohol.
The sensor is not user serviceable and should not be cleaned by the user. If it is contaminated please acquire an RMA and send the analyzer for repair.

10.2 Recharging the Battery

The amount of remaining charge in the battery appears on the upper-left of the MENU display screens, it is shown with a graphic 10 step bar in a battery icon and as a percentage. If needed the status bar will display a `Low Battery` message, indicating that the battery should be recharged. Recharging can be performed by plugging the analyzer into any PC’s USB port (the USB driver must be installed refer to section 7.9) or by using the provided wall transformer (refer to section 7.8). Do not exceed 5.5VDC on USB connector. The status bar indicates the states of the USB connection and battery charging. Normally USB ports provide 0.5A at 5VDC (status bar will indicate `USB Charging High Current`), but some USB hubs provide only 0.1A (status bar will indicate `USB Charging Low Current`), thus charging the battery at a slower rate. When connected to a 0.5A source a discharged battery will fully charge in 3.5 hours, when connected to a 0.1A source it will charge in 15 hours.

10.3 Self Diagnostics

The analyzer constantly performs self diagnostics to determine if all parts are operating properly. The results of the diagnostics are displayed on the status bar.

Table 1 Status Bar Messages

Status bar Message	Meaning
`Pressure Corrected`	The analyzer is computing the moisture measurement using pressure correction
`AO frozen`	The Analog output (4/20mA) is being kept frozen (unchanging) by some part of the program.
`Single Point Cal Enabled`	Single point calibrations are being performed. Can be disabled from the Cal dew function in MENU-2
`Logging Data`	The continuous data logging is enabled and running.
`USB Charging High Current`	The USB port is connected to a PC with 0.5A source and the battery is being charged.
`USB Charging Low Current`	The USB port is connected to a PC with 0.1A source and the battery is being charged.
`USB Connected Battery Full`	The USB port is connected to a PC, but the battery does not need charging
`AC Powered Battery Full`	The USB port is connected to a wall transformer, but the battery does not need charging
`AC Powered Charging`	The USB port is connected to a wall transformer and the battery is being charged.
`Calibration Past Due`	The analyzer compared the date since the last calibration to the date in the battery backed clock/calendar and computed that the time exceeded the settings of the number of months between recalibrations.
`Max Pressure Exceeded`	The pressure sensor inside the sampling chamber is measuring more than rated pressure of the pressure sensor.
`Temperature Sensor Error`	One or both of the temperature sensors are not operating properly, cable unplugged etc.
`Pressure Sensor Error`	The pressure sensor is not operating properly, cable unplugged etc.
`Analog Output Loop Open`	The analog output is not connected to a proper source.
`Battery Low`	The battery needs to be recharged.
`Temp Range Exceeded`	The temperature exceeds +70°C
`Sensor Range Exceeded`	The moisture sensor measurement exceeds the preprogrammed parameters.
`Sensor Msr Err=x`	The moisture sensor measuring circuit has detected an error.

10.4 Suspected Erroneous Measurements

Some of the most common suspected erroneous conditions are listed in the following table included are common reasons and suggested remedies.

If the measurement is suspected to be erroneous, before calling for support, it may be helpful to have the following information:

- Type of gas being measured.
- Expected dewpoint.
- Nominal pressure (consider back pressure).
- Nominal temperature.
- Nominal flow rate though the analyzer.
- Flow diagram or description of system, showing items and their materials of construction. Include materials of filter elements, regulator diaphragms, and valve seats.
- Possible contaminants (particulates, liquids, oil, glycol, cleaning solutions, etc.).
- Are the pipes and analyzer purged before measuring? How long? Flow rate? With the same gas that will be measured?
- Are the pipe/tubing connections/fittings leak tested?
- If using quick disconnect on inlet, be aware that some female disconnects do not seal as tightly as others.
- If other equipment was used to verify the dewpoint, what is the equipment (include model number)? What is its specified measuring range? When was it last calibrated/certified?
- If using bottled gas for reference: Manufacturer? Content and accuracy markings? What is the pressure in the bottle at time of comparison? What is the ambient temperature where the bottle is stored? What are the materials of construction of the pressure regulator, especially the diaphragm?

Table 2 Guide to Troubleshooting Measurements

Problem or Unexpected Observation Behavior	Likely Source of Problem	Analysis	Remedy
Measurement is **dryer** than is expected.	Equilibrium	Before concluding that there is an incorrect measurement, make sure that the system is at equilibrium.	Use the graph display and wait for equilibrium.
	Sampling point	Consider if the sampling point could be dryer than the rest of the system.	If necessary find a more appropriate sample point
	Damage Corrosion, abrasion	Contaminants can damage the sensor.	Refer to sections: **Error! Reference source not found.** Precautions and 5.2 Sample conditioning.
	Needs recalibration	Depending on the application recalibration may be yearly or in 5 years.	Consult with factory.
Measurement is **wetter** than is expected.	Equilibrium	Before concluding that there is an incorrect measurement, make sure that the system is at equilibrium.	Use the graph display and wait for equilibrium.
	Sampling point	Consider if the sampling point could be wetter than the rest of the system.	If necessary find a more appropriate sample point
	Condensation	Refer to the "Measurement is **not changing**" observation below	
	Damage Corrosion, abrasion	Contaminants can damage the sensor.	Refer to sections: **Error! Reference source not found.** Precautions and 5.2 Sample conditioning.
	Incompatible materials in system with low dewpoint.	Refer to section 4.1 Integrity of the materials of the system.	Replace inappropriate materials.
	Leaks	Check for leaks around all interconnections.	Tighten fittings. Repair the leaks.
	Needs recalibration	Depending on the application recalibration may be yearly or in 5 years.	Consult with factory.
Measurement is changing **slower** than expected.	Equilibrium	The rate at which the system will reach equilibrium depends on the system particulars, such at ambient temperature, internal pressure, flow rates, system materials of construction, surface area of system internals.	Previous experience may be indicative of the system response time. It is common for systems to take hours to equilibrate.
	Sampling point	Is the sampling point in the direct flow of the system gas, or is it at a dead end of the distribution system?	Sample in the direct flow.
	Contamination	Are there hygroscopic contaminants?	Clean the sensor and install filters.
	Out-gassing	Are there materials in the system that could be out-gassing?	Replace the hygroscopic materials.
	Leaks	Check for leaks around all interconnections.	Tighten fittings. Repair the leaks.
	Large diameter sampling tubing	Larger diameter tubing have larger surfaces.	Use smallest practical tubing diameter, 1/8" recommended
	Low flow rate	Response time is normally greatly influenced by flow rate, but if the measurement value is influenced by flow rate there may be a leak.	Flow rate should be greater than 1 LPM.
Measurement is **not changing**, always shows a dewpoint close to ambient temperature.	Condensation	Condensation may have occurred from a slug of water or from previous conditions where the gas dewpoint was greater than the ambient temperature. Condensation typically accumulates in filter bowls or other low points in the system. Then evaporates and produces a high dewpoint.	Drain the condensate and allow the system to dry down.
Measurement has a **daily cycle**	Thermally induced water vapor pressure change.	Refer to section 4.3 Temperature dependant equilibrium	

11 Specifications

Temperature Range	Enclosure: -40°C to +60°C Electronics: -40°C to +85°C LCD operating: -20°C to +70°C storage: -30°C to +80°C Moisture Sensor: -20°C to +60°C Pressure Sensor: -20°C to +85°C
Moisture Sensor	Range -110°C to +20°C Accuracy: ±2°C temperature corrected Repeatability: 0.8°C Response time: 95% of step change in 3 min. Sample flow: >1 LPM
Temperature Sensors	-40°C to +70°C ±2°C
Pressure Sensor	2 to 300 PSIA ±1%, 316L stainless steel wetted parts (the pressure sensor is OPTIONAL)
Ergonomics	Easy to carry or use on desktop, lightweight 2 Lbs Easy to read graphic LCD display with user controlled backlight brightness (LCD is readable without the backlight) Snap dome tactile membrane switches with dynamically assigned legends Audible feedback upon button press as well as for warnings and alarms Auto scaling graph / histogram on moisture measurement display for stability verification Easy to use with verbose built-in context sensitive Help screens Battery Saver, with user selectable Auto-power-down times, can also be disabled Built-in optional pressure measurement and pressure corrected moisture readings, simultaneously displayed with the uncorrected reading for greater ease of understanding Verbose Status bar with indications, warnings and audible errors User selectable locking with or without a password. Built-in battery backed clock calendar
Electrical	External AC Universal Power adapter (100-240VAC 50-60Hz) with USB connector Rechargeable Li-Ion battery, recharges through the USB connector from the PC or from the supplied universal power adapter Sampling system and sensor are isolated from electrical interface and supply grounds, if equipped with AC power option then sampling system is internally grounded to electrical interface to prevent interference noise. Measurement resolution of moisture sensor: 1pF resulting in less than 0.01°C External power and I/O: USB mini B female connector - IP67 / IP68 with Sealing Cap Alarm Relay Option - 3A, 250VAC/30VDC contacts, rear panel pluggable screw terminal connector with normally open and normally closed contacts. Audio Visual Alarm Option: weatherproof sounder >80db @ 3feet, red alarm lights consist of 3 jumbo LED's 5100 mcd. each. complies with the recommendations of NFPA 99, 1996 edition
Mechanical	1/4" NPT Female Swivel inlet, allowing connection with standard quick connect Aluminum and Viton wetted parts, small surface area sampling chamber for fast response time. Enclosure ABS (UL94-HB), with EDPM gasket to meet IP65, NEMA-4X Dimensions- H: 5.71" (145mm) W: 4.13" (105mm) D: 2.56" (65mm) Weight Total: 2 Lbs (~1 Kg) Pressure: Inlet 300 psi (20 bar), Exhaust Outlet 50 psi (3.4 bar) DO NOT BLOCK Sample Gas Inlet: Male Industrial 1/4 Quick-Disconnect Hose Coupling Sample Gas Inlet: 40 micron Particulate Filter
Miscellaneous Features	NIST traceable calibrations Built-in metering valve and flow meter, no need for external pressure regulator in most applications. Built-in demister for liquid knock-out, to separate liquid vapor mixtures such that they do not compromise sensitive analyzer components Units of measure: °C & °F dewpoint, ppmV, ppmW, μB H_2O vapor pressure, grams of H_2O / m^3 and Lbs H_2O /10^6 standard cubic feet in Natural Gas. Digital & Analog I/O Data logging – single point, multipoint, time stamping etc… Virtual Analyzer PC software for training, allows the user to experience the exact interface on their own PC with voice help explanations

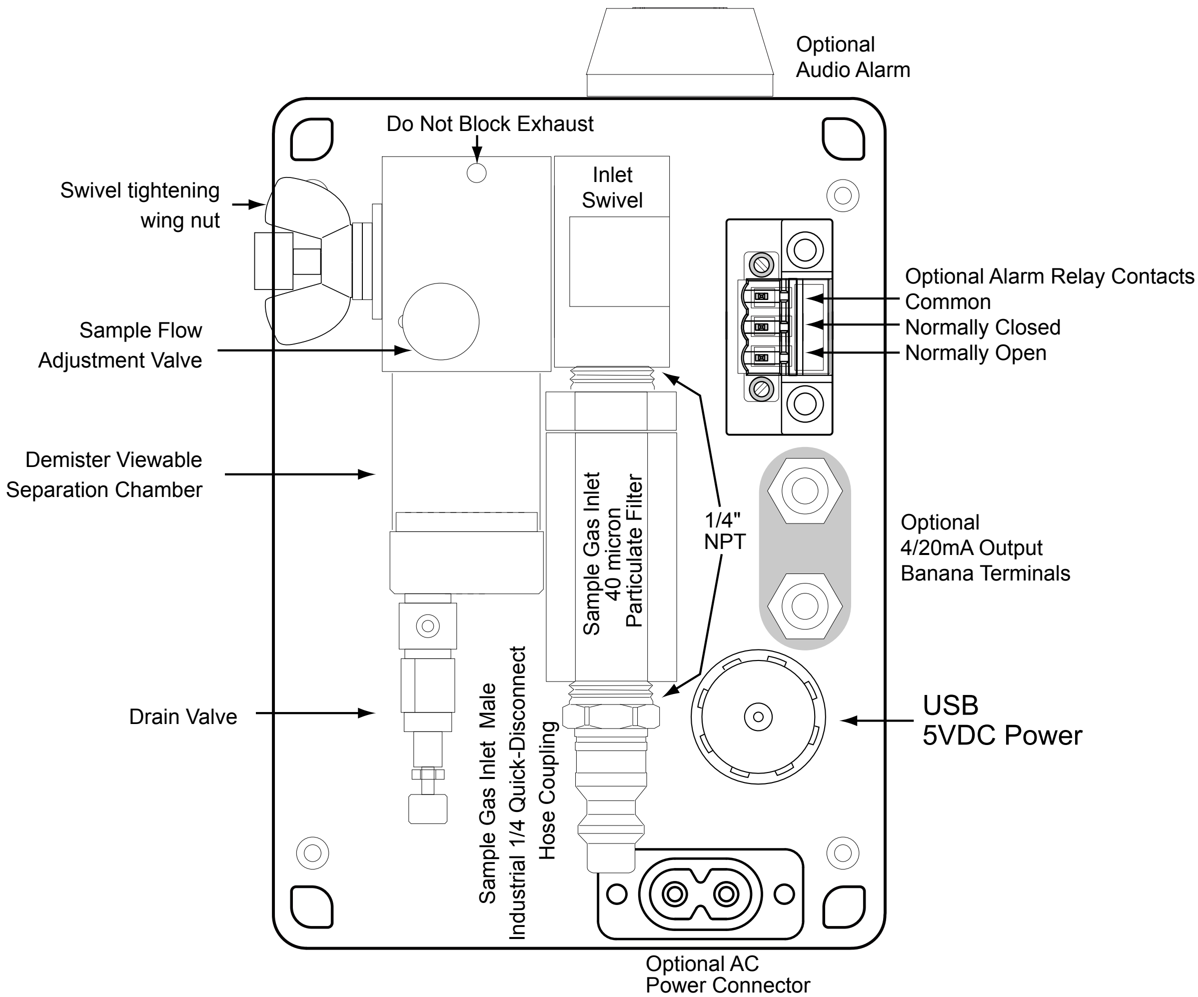
Appendix A Mini-Demister

The Phymetrix Mini-Demister is specifically designed to separate liquid vapor mixtures in order to prevent compromising sensitive analyzer components from air compressor oil carryover and/or water condensate in compressed air lines. In addition it is very effective for blanket gas oil carryover separation or Natural Gas Triethylene Glycol carryover. Conveniently fits at the rear of the dewPatrol hand-held moisture analyzer. Enhances analyzer integrity, speed of response and accuracy.

Operates by allowing liquids to settle to the bottom of the separator under force of gravity, where they are drained out through a metering valve. The sample travels through the container tube at a low velocity; thus minimizing the entrainment of any liquid droplets in the gas as it exits near the top of the separator and flows down into the analyzer. The glass container tube affords the operator a 360° view of the accumulated liquid. Adjusting the drain metering valve optimizes the liquid removal with minimum waste of sample gas.

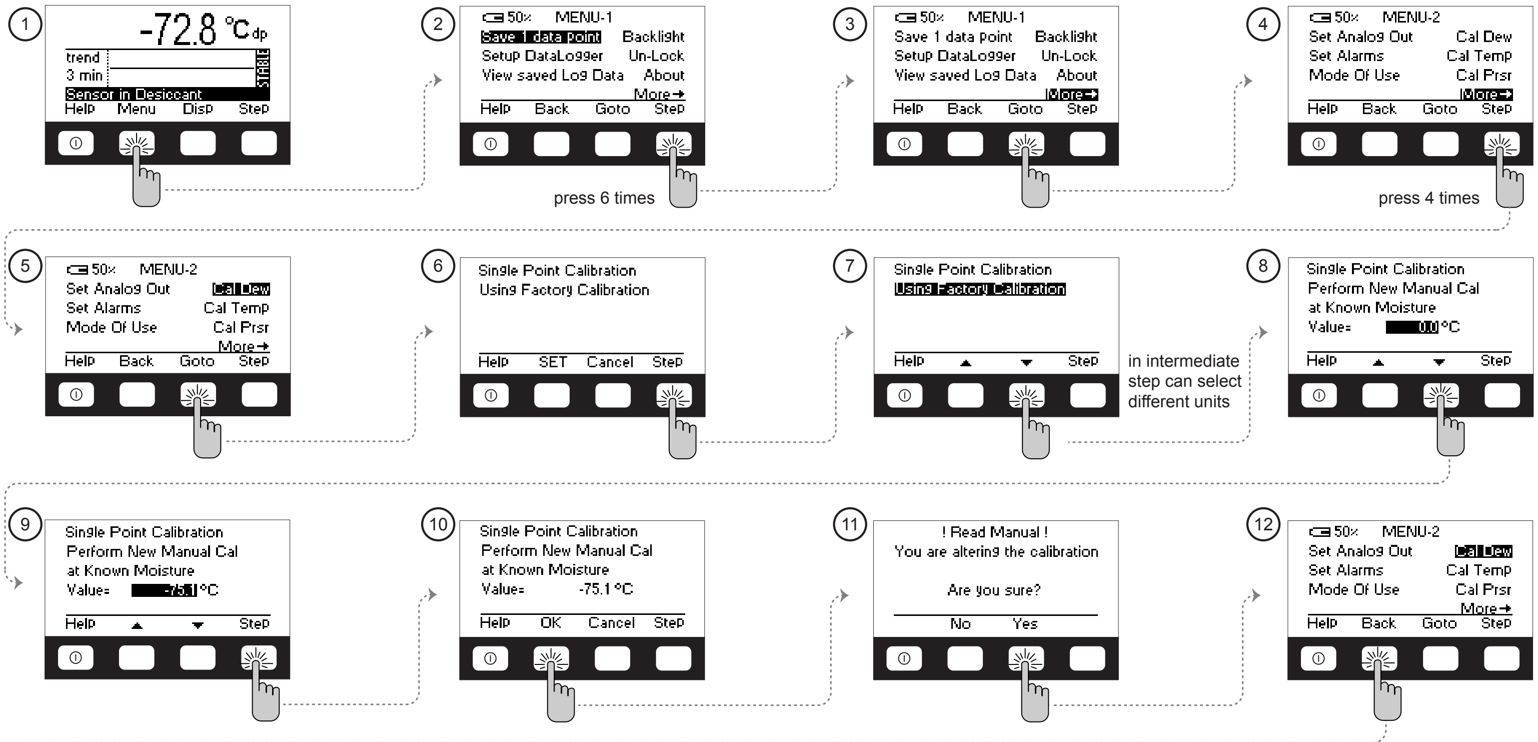
On the separator bottom the rotatable drain valve and port can be positioned as needed.
The Mini-Demister is easy to disassemble and clean if needed. The glass tube is rated for 425 psi and has an outer impact resistant protective clear plastic shield that prevents nicks and scratches in the field.
Superior to coalescing filters because the liquid is visible, drains out in a controlled fashion and does not accumulate in absorbent materials to outgas when the analyzer is used in other measurements. There are no hygroscopic materials employed.

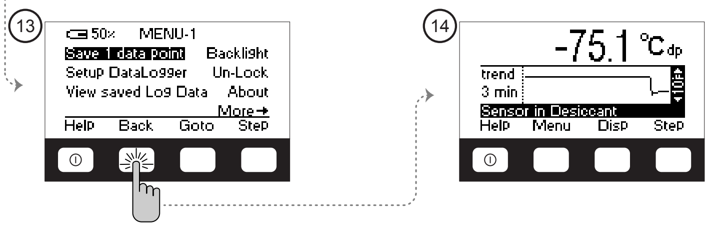
Appendix B DewPatrol Rear View

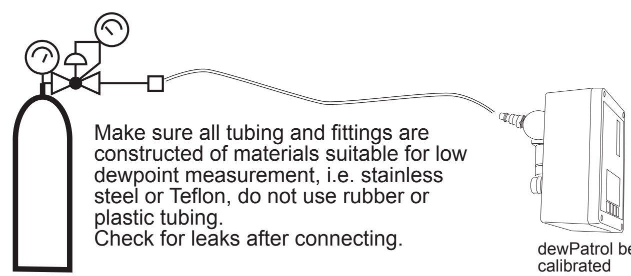


Manual Calibration Procedure

Step-by-step example of performing a single point calibration on a Phymetrix Analyzer







Make sure all tubing and fittings are constructed of materials suitable for low dewpoint measurement, i.e. stainless steel or Teflon, do not use rubber or plastic tubing.
Check for leaks after connecting.

Nitrogen with NIST Certified Moisture Content

dewPatrol being calibrated

In this example it is assumed that the calibration bottle is labeled to contain 2.3 ppmv of water, which computes to a dewpoint of -75.1°C at atmospheric pressure.

In the first picture (top left) #1 the analyzer has stabilized on -72.8°C which does not match the known value of the calibration gas. The known value of -75.1°C is entered in steps 8&9 by using the up and down arrows. In the last picture #14 the analyzer is reading the corrected value.

Appendix D Analyzer Calibration Log

Analyzer Serial Number: _____________
Sensor Serial Number: _____________

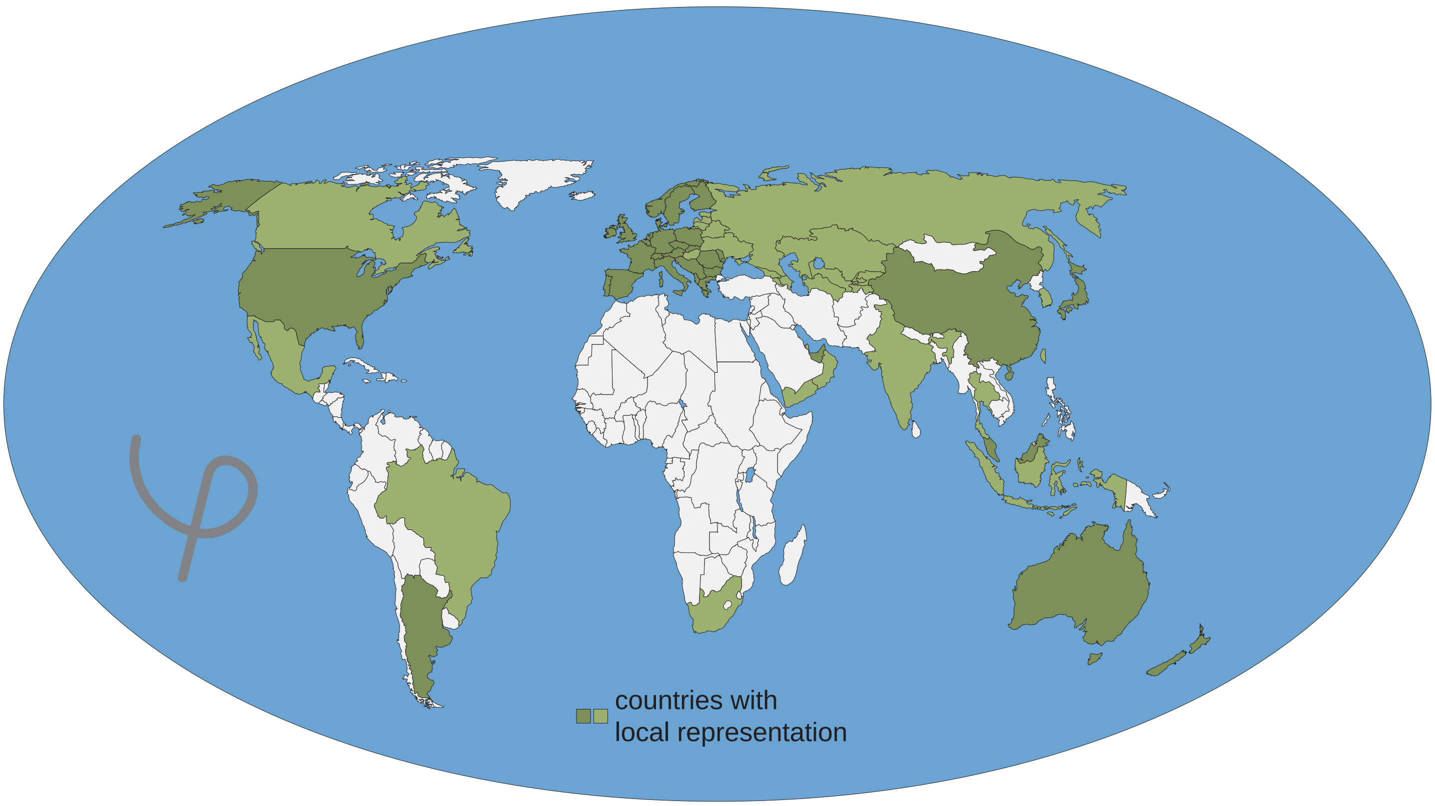
Date	Performed by	Comments

Notes:

Moisture Measurement Innovation at Work

Integrating nanotechnology into moisture measurement

PhyMetrix®



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