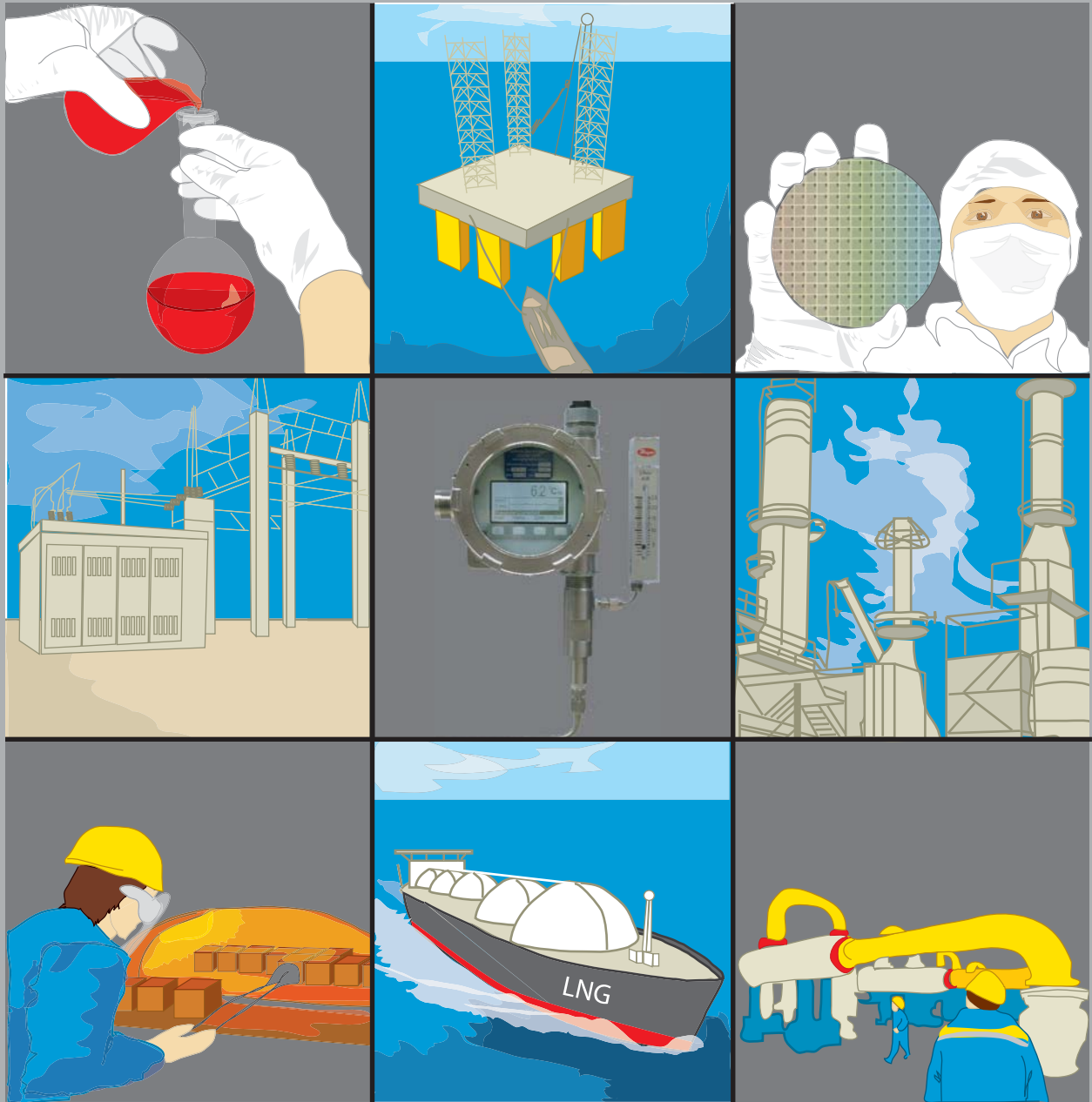


# $\Phi$ PhyMetrix®



## PhyMetrix Explosion proof Moisture analyzer Model ExMa User's Manual



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](http://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.

The instructions, procedures, drawings, specifications and concepts contained in this manual are the property of Phymetrix Inc., and shall not be used as the basis for the manufacture or sale of apparatus or services, or reproduced or copied or transmitted in any form or by any means without written permission.

## 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 Explosion proof Moisture Analyzer model *ExMa*. This User's Manual describes the functions of this analyzer as well as the 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. There is a Quick Setup Manual describing the main functions and basic procedures for performing measuring operations. Check our website "www.phymetrix.com" for latest versions of documentation regarding these analyzers.

After reading this manual, keep it easily accessible for future reference. It may come in handy when there are some challenging measurements to be performed.

## Conventions used in this manual:

- 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:

**-I** for Explosion Proof certification, **-P** for internal pressure sensor,  
**-A** for analog output 4/20mA, **-R** for Alarm Relays.

Check to see that your analyzer has arrived intact with all accessories that were ordered.



Model: ExMa shown with *optional* filter pressure regulator and exhaust flow meter

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 dependant 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 content; it consists of a stainless steel 100 micron filter and a flow control orifice, which may be placed at either the inlet(factory default) or outlet of the sampling cell or removed. The gas under measurement is exposed only to the stainless steel walls of the sampling system.

## 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 5000 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<sub>2</sub>S and SO<sub>2</sub> 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.
- Avoid exposing the sensor to ambient air as it may slowdown your next measurement.
- The ExMa is weatherproof as long as the cover is tightly closed, and the conduit ports are appropriately sealed.
- 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.

## 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 back diffusion 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  $-40^{\circ}\text{C}$  dewpoint. The partial water vapor pressure in the pipe is 0.13mB. If the ambient temperature is  $22^{\circ}\text{C}$  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 than 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  $-60^{\circ}\text{C}$  always use stainless steel or PTFE, while for higher dewpoints you can use copper or galvanized steel; but never use rubber, Tygon, Nylon or other plastic 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 Back Diffusion (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 total 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, the analyzer should have at least 12" in length of 1/8" dia. stainless steel tubing at its exhaust port, and 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. A small pigtail (coiled 1/8" dia. ss. tubing 12" long) can be connected to the exhaust port of the analyzer. The short tube with attached flow meter also provides protection from back diffusion of moisture.

### 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 sections).

### 5.1 Choosing a Measurement Site

The ExMa has been designed to 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 effect 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  $-50^{\circ}\text{Cdp}$  (39 PPMv), avoid plastic filter bowls, use stainless steel or glass instead. 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,  $\text{SF}_6$  or  $\text{N}_2$  blanket with suspected oil carryover,
- Natural Gas with possible Triethylene Glycol carryover,

Consult with Phymetrix for specialized sampling systems.

## 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). 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 metering valves should be at the inlet in order to maintain constant atmospheric pressure in the sampling chamber.

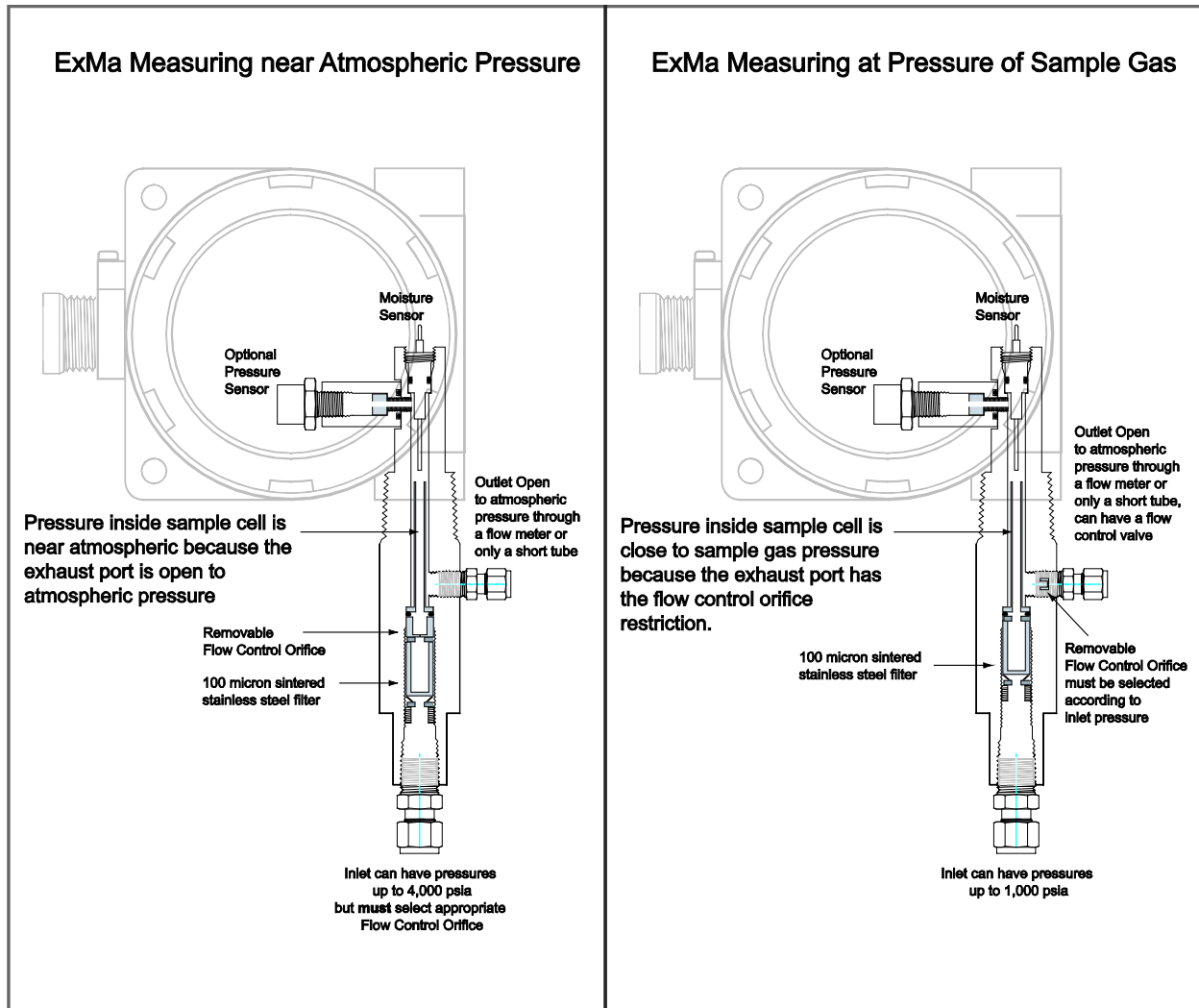
## 5.4 Sample Pressure

Pressure variations will effect 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 Pressure Considerations

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

The model **ExMa** has a built-in orifice. This orifice can be used to regulate the flow from various pressures.



- The sample cell has a built-in filter and flow control orifice at the inlet.
- On Request the orifice can be moved to the outlet to perform measurements at pressure.

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

For example 0.004” to 0.016” dia. orifices, produces flows described in the following table.

source pressure psia - (Bar)	flow SLPM 0.016” orifice	flow SLPM 0.012” orifice)	flow SLPM 0.008” orifice	flow SLPM 0.006” orifice	flow SLPM 0.004” orifice
15 - (1.03)	0.7	0.4	0.17	0.08	0.04
25 - (1.72)	2	1.3	0.6	0.3	0.1
35 - (2.4)	3	1.9	0.8	0.5	0.2
55 - (3.8)	4.8	3.0	1.4	0.7	0.3
75 - (5.2)	6.6	4.1	1.9	1.0	0.4
100 - (6.9)	8.9	5.5	2.6	1.4	0.6
150 - (10.3)	13.4	8.3	3.8	2.1	0.9
200 - (13.8)	17.9	11.0	5.1	2.7	1.1
300 - (20.7)	26.8	16.6	7.7	4.1	1.7
400 - (27.6)	35.7	22.1	10.3	5.5	2.3
500 - (34.5)	44.7	27.6	12.8	6.9	2.9
600 - (41.4)	53.6	33.1	15.4	8.2	3.4
700 - (48.3)	62.5	38.7	18.0	9.6	4.0
800 - (55.1)	71.5	44.2	20.5	11.0	4.6
900 - (62)	80.4	49.7	23.1	12.4	5.1
1000 - (68.9)	89.3	55.2	25.7	13.7	5.7
1500 - (103.4)	134.0	82.8	38.5	20.6	8.6
2000 - (137.9)	178.7	110.5	51.3	27.5	11.4

The grayed boxes are preferred operating points. Other orifices can be provided to accommodate different pressures and flows. Consult PhyMetrix support for its proper sizing.

### Measuring with the ExMa, Near Atmospheric Pressure

It is recommended for most applications to perform the measurement at near atmospheric pressure. Placing the flow control orifice at the inlet and allowing the outlet to be unrestricted (other than the exhaust pigtail and flow meter), 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 8.3), the orifice and unrestricted outlet will guarantee repeatable conditions for all pressures within the rating of the orifice.

### Measuring with the ExMa, 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 (5000 psia standard), then place the orifice at the outlet.

The analyzer is now setup with the orifice at the outlet, thus the measuring chamber will be pressurized to the same pressure as your sample. 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.

## 6 Installation

### 6.1 Mechanical Installation

The ExMa can be mounted directly on the pipe or can be mounted on a panel surface and connected with tubing. Refer to Appendix A ExMa Installation Drawing.

Connections for inlet and outlet of the gas being measured are made through a variety of available options e.g. 1/8" or 1/4" Swagelok® tubing compression fittings.

Refer to Mechanical Installation Drawing Appendix A.

### 6.2 Electrical Connections: Power, 4/20mA Analog Output, Serial I/O

#### 6.2.1 Powering the ExMa

The ExMa has two (2) standard modes of being powered.

- 1) **AC powered** from 90-260 VAC 47-440 Hz
- 2) **DC powered** from a 12 – 24 VDC 10VA power supply

Optionally the ExMa can be ordered to also operate in **4/20mA Loop Powered** mode.

Refer to the **ExMa Electrical Connection** diagram in Appendix B for the various power modes and the specific wiring for each mode.

#### 6.2.2 Analog Output 4/20mA

The ExMa has an isolated 4/20mA output, which may be connected as a sink in configurations where the power is provided externally, or if the ExMa is actively powered (modes 1&2) the 4/20mA can be configured to source the current.

Refer to the **ExMa Electrical Connection** diagram in Appendix B for the 4/20mA configurations and specific wiring for each.

The ExMa status bar will have an **Analog Output Loop Open** message if the 4/20mA output is not connected. The user menus allow the user to force the 4/20mA output to known values for purposes of testing and calibrating the 4/20mA interface, refer to section 8.5.

#### 6.2.3 ExMa HART interface

The ExMa is equipped with a HART interface which overlays digital signals on the 4-20mA loop current. Thus the ExMa can be used in any 4-20mA loop and can simultaneously communicate digitally on the same two wires.

The ExMa responds to all of the HART Universal (Common Practice) Commands as well as some important setup and configuration commands.

When wiring the ExMa for use with HART make sure that there is sufficient resistance between the power supply and the ExMa 4/20 interface. Usually there is a 250 Ohm resistor used for sensing the current this is adequate to provide the proper impedance isolation for HART modems to operate properly.



*HART Commands Implemented in the ExMa*

HART Command		Description	
#	Name		
0	Read Unique Identifier	Read Device identification such as address, manufacturer, revision level etc.	
1	Read Primary Variable	Read the measurement of the Primary Variable (P.V.)	
2	Read Current and % of range	Read the current that is produced by the Primary Variable and the percent of range it represents. These depend on the command #51 measurement assigned to the P.V., the value of that measurement and the assignments of command #35.	
3	Read Dynamic Variables and P.V. current	Read the measurements of up to 4 measurement variables as assigned by command # 51.	
6	Write Polling Address	Assign a polling address to a device. An address (1-15) puts the device in fixed 4mA mode for multidrop connectivity. Address 0 puts the device in 4/20mA mode.	
11	Read Unique Identifier Associated with Tag	Find device that has the desired textual Tag assigned by command # 18.	
12	Read Message	Read information written by command # 17.	
13	Read Tag, Descriptor and Date	Read information written by command # 18.	
14	Read P.V. Sensor Information	Information on primary sensor Serial Number, range etc.	
15	Read P.V. Output Setup	Analog output range, alarms etc.	
16	Read Final Assembly Number	Read number written by command # 19.	
17	Write Message	For use by owner/operator to identify the device and its use.	
18	Write Tag, Descriptor and Date	For use by owner/operator to identify the device and its use. Can search for the Tag, with command # 11, on multidrop connections.	
19	Write Final Assembly Number	For use by owner/operator to identify the device and its use.	
35	Write Primary Variable Range Values	Setup the measurement units and values that correspond to 4mA and 20mA output of the loop.	
40	Analog Out Fixed	Forces the Analog Output DAC to a specified value.	
44	Write Primary Variable Units	Select the units of measure for the Primary Variable.	
45	Trim DAC Zero	Trims the DAC Zero by difference of Cmnd. #40 and observed value.	
46	Trim DAC Gain	Trims the DAC Gain by ratio of Cmnd. #40 and observed value.	
50	Read Dynamic Variable Assignments	Read the assignments of command # 51.	Measurement Variables and [available units]: 00 – Moisture Measurement °C & °F dewpoint, ppmV, mB H <sub>2</sub> O vapor pressure, grams of H <sub>2</sub> O / m <sup>3</sup> and Lbs H <sub>2</sub> O / 10 <sup>6</sup> standard cubic feet in Natural Gas 01 – Temperature of Gas [ °C, °F ] 02 – Temperature of Board [ °C, °F ] 03 – Pressure [ psi, bar, mbar, kg/sqcm, pascal ... ] 08 – Loop Voltage [ mV ] 09 – Status Bits
51	Write Dynamic Variable Assignments	Assign Measurement Variables to each of the four primary variables reported by the analyzer by command # 3.	
53	Write Transmitter Variable Units	Select Units of measure for each of the Variables.	
108	Write Burst Command Number	Select command number to burst.	
109	Burst Mode Control	Enable/Disable burst (continuous) transmissions.	

*A free of charge program may be downloaded from our website [www.phymetrix.com](http://www.phymetrix.com) that allows communicating with the ExMa HART interface.*

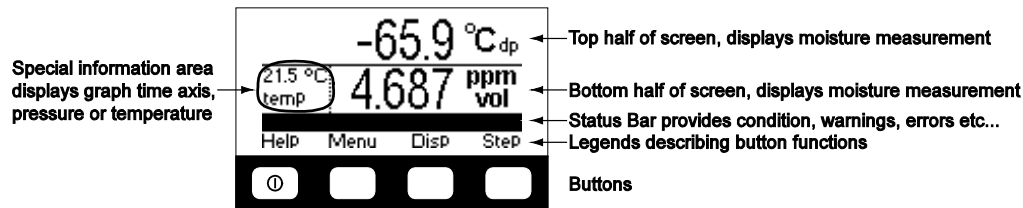
The ExMa HART interface Address is the Instrument Serial Number which can be seen in the About menu. The ExMa can be set up to operate in HART polling mode by selecting a polling address 1-15 in the **HART** user interface menu, in this mode multiple (up to 15) ExMa's or other HART devices can communicate on the same loop but each device consumes only 4mA.

#### 6.2.4 Serial I/O RS485/RS-422

The ExMa can optionally provide a RS-485/422 interface in power modes 1 and 2. Refer to the ExMa Electrical Connection diagram in Appendix B for connections. The default communication port settings are 19200, E, 7, 2; however they can be modified in the **COMs** user interface menu.

## 7 User Interface Overview

The analyzer user interface consists of a backlit graphic LCD display, an audio sounder and four touch areas on the glass cover of the explosion proof enclosure. These touch areas provide the button functions which are dependant on the required selection choices, thus appropriate legends appear on the display immediately above the touch areas. For ease of discussion we will refer to these touch areas as “buttons” in the rest of the user’s manual. To “press” a button, the user must touch the appropriate *metal colored oval area* on the glass with a finger. It may be necessary to press the finger firmly on the glass to get a wide contact area. When a button is activated a small light will be illuminated immediately above the touch area.



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

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

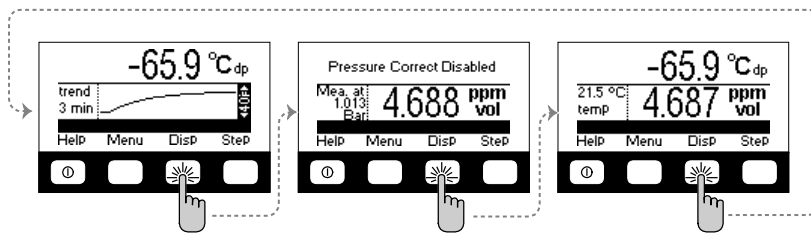
## 8 Operating the Analyzer

Performing measurements with the analyzer is a simple process:

- Connect the sample gas to the analyzer (refer to section 5.2 and section 6.1)
- Connect Power and Signals to the analyzer (refer to section 6.2)
- If possible adjust the flow of the gas to be greater than 1 LPM (2 SCFH)
- Select the graphing display mode
- Observe the reading once the graph is stable
- Change the display mode if desired

### 8.1 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.



- Dewpoint Units and Graph of the measured dewpoint in the last 90 minutes is displayed. The graph span (Y-axis above shown  $40\text{ }^{\circ}\text{Fdp}$ ) will automatically resize to accommodate the minimum and maximum measurements in the last 90 minutes. Select between 90 or 3 minute time axis by choosing *Continuous* or *Spot* measurement modes in the **Mode Of Use** option available in **MENU-2**.
- Pressure corrected and at pressure measurements, 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.
- Dual Dewpoint Units and Temperature 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  $^{\circ}\text{C}$  and in ppm by volume, while the temperature is displayed to be  $21.5\text{ }^{\circ}\text{C}$ .

### 8.2 Units to Display the Measurement

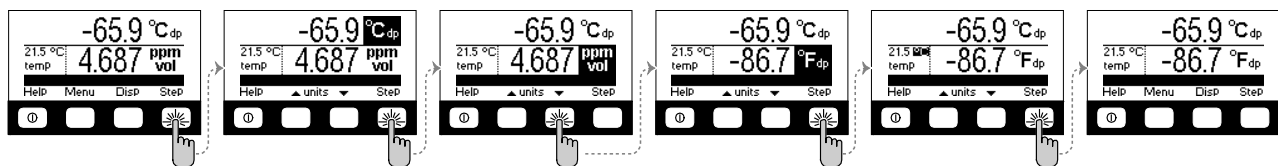
Measuring water vapor content in gasses presents many challenges not the least of which is understanding the units of measuring. Different industries require different units of measure for various reasons some technical some historical. The units typically used are in several categories:

- a) The ratio of the volume 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 ratio of the weight 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 density of water vapor 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 ( $\text{g/m}^3$ ), or pounds of water per million standard cubic feet (**LbsH<sub>2</sub>O/MMSCF**).
- 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. Freeware programs compatible with Microsoft® Windows, as well as with Apple and Android smart-phones, are available for downloading at [www.phymetrix.com](http://www.phymetrix.com) 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,  $\mu\text{B H}_2\text{O}$  vapor pressure, grams of  $\text{H}_2\text{O} / \text{m}^3$ , and Lbs  $\text{H}_2\text{O} / 10^6$  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.

### 8.3 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:

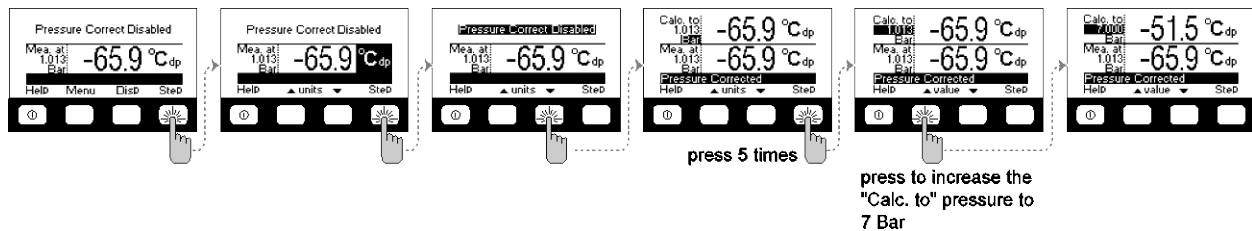
- 1) Proportion of water vapor in the gas is measured in several different categories such as PPMv, PPMw, or LbsH<sub>2</sub>O/MMSCF.
- 2) Pressure exerted by the water vapor.
- 3) Temperature at which the water vapor is saturated in the gas.

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.

Lets 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

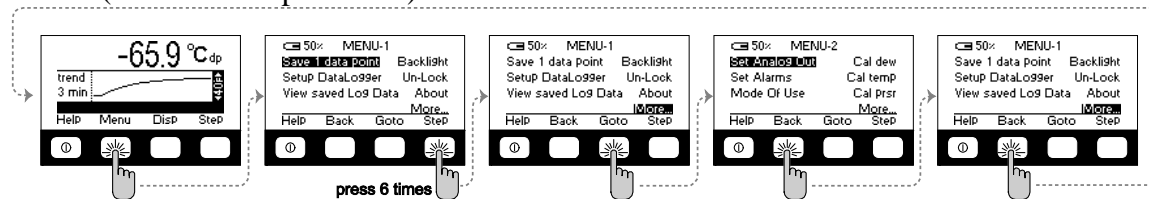
the gas at atmospheric pressure (1.013 Bar) to have a dewpoint of  $-69.5^{\circ}\text{C}$ , and calculating that the same gas when at 7 Bar will have a dewpoint of  $-51.5^{\circ}\text{C}$ .

If the user switches to the Graphing or Dual Units display mode, the displayed measurements will be  $-51.5^{\circ}\text{C}$ ; 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.

## 8.4 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.

## 8.5 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 id 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 is provided for commonality with portable analyzers that have the ability of selecting the intensity of the backlight, it serves no purpose in the on-line analyzer.

### **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 Alarm Relays this menu choice allows setting the alarm relays.

### **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 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 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. For Analyzers equipped with a Self Calibrating Solenoid Valve, this menu choice allows the user to setup the self calibrating schedule.

### **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 optional 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 is provided for commonality with portable analyzers that have battery saver shutoff.

### **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 to select the language in which the analyzer menus appear. Available languages are English, German, French and Spanish.

## **MENU-4**

### **COMs**

This menu choice allows setting the communications port for analyzers that have serial communications RS-485/422 output options.

### **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 on-line analyzers equipped with sample heating for controlling the temperature of an enclosure.

### **HART**

This menu choice allows selecting the HART polling address.

## **9 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 serial port or HART interface 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.

*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 than 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 **Setup DataLogger** 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”.

## 9.1 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 serial port. Single point data log can be viewed on the analyzer screen from the **View saved Log Data** option available on the **MENU-1**.

## 9.2 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.

## 10 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.*

## 11 Using the ExMa for temperature control

When the ExMa is installed in an enclosure (for example in a sample system) it can be equipped such that it can control an enclosure heater and or cooler. These functions are controlled through the **Set Thermostat** menu choice in **MENU-4**.

If either a cooler or heater or both are installed, the appropriate fields in this menu will allow the user to select the temperature for each item and hysteresis for cooler, as well as which temperature sensor to use for controlling the temperature (sample gas or circuit board).

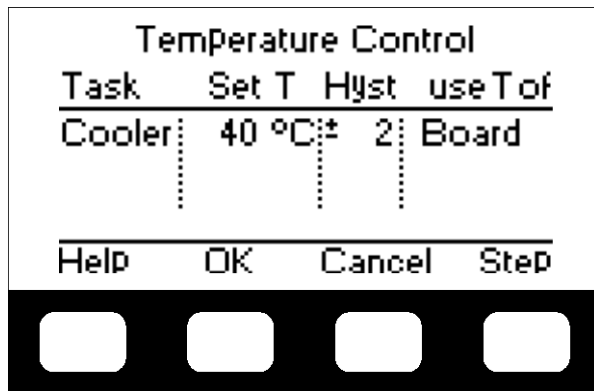
The cooler is controlled as a thermostat, while the Heater control is PID.

This menu has up to two rows of data, one for cooler and one for heater, if installed.

For each there are four columns of parameters that may be modified. The *temperature*, the *units* of the temperature, *hysteresis* (for cooler only) and which *temperature sensor* to use.

For example if in the Cooler row the selections are **40 °C +/-2 Board**, this means that when the board temperature sensor exceeds 42°C the cooler solenoid will be energized, and when the board temperature is below 38°C the cooler solenoid will be de-energized.

Use the **Step** key to move the highlight over the parameter that needs to be changed, and then use **▲** or **▼** to change the parameter. To finish, press the **Step** key until there are no highlights. Press the **OK** key so that the analyzer saves the selection or press the **Cancel** key if you are not sure about the selections and would like to leave the menu without making any changes.



## 12 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.

### 12.1 Cleaning

The analyzer enclosure may be cleaned using a moist cloth.

The flow control orifice of the ExMa can be removed and cleaned with solvents.

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.

### 12.2 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
<b>Pressure Corrected</b>	The analyzer is computing the moisture measurement using pressure correction
<b>AO frozen</b>	The Analog output (4/20mA) is being kept frozen (unchanging) by some part of the program.
<b>Single Point Cal Enabled</b>	Single point calibrations are being performed. Can be disabled from the Cal dew function in MENU-2
<b>Logging Data</b>	The continuous data logging is enabled and running.
<b>Calibration Past Due</b>	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.
<b>Max Pressure Exceeded</b>	The pressure sensor inside the sampling chamber is measuring more than rated pressure of the pressure sensor.
<b>Temperature Sensor Error</b>	One or both of the temperature sensors are not operating properly, cable unplugged etc.
<b>Pressure Sensor Error</b>	The pressure sensor is not operating properly, cable unplugged etc.
<b>Analog Output Loop Open</b>	The analog output is not connected to a proper source.
<b>Battery Low</b>	The battery needs to be recharged.
<b>Temp Range Exceeded</b>	The temperature exceeds +70°C
<b>Sensor Range Exceeded</b>	The moisture sensor measurement exceeds the preprogrammed parameters.
<b>Sensor Msr Err=x</b>	The moisture sensor measuring circuit has detected an error.

### 12.3 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 through 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?
- 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?

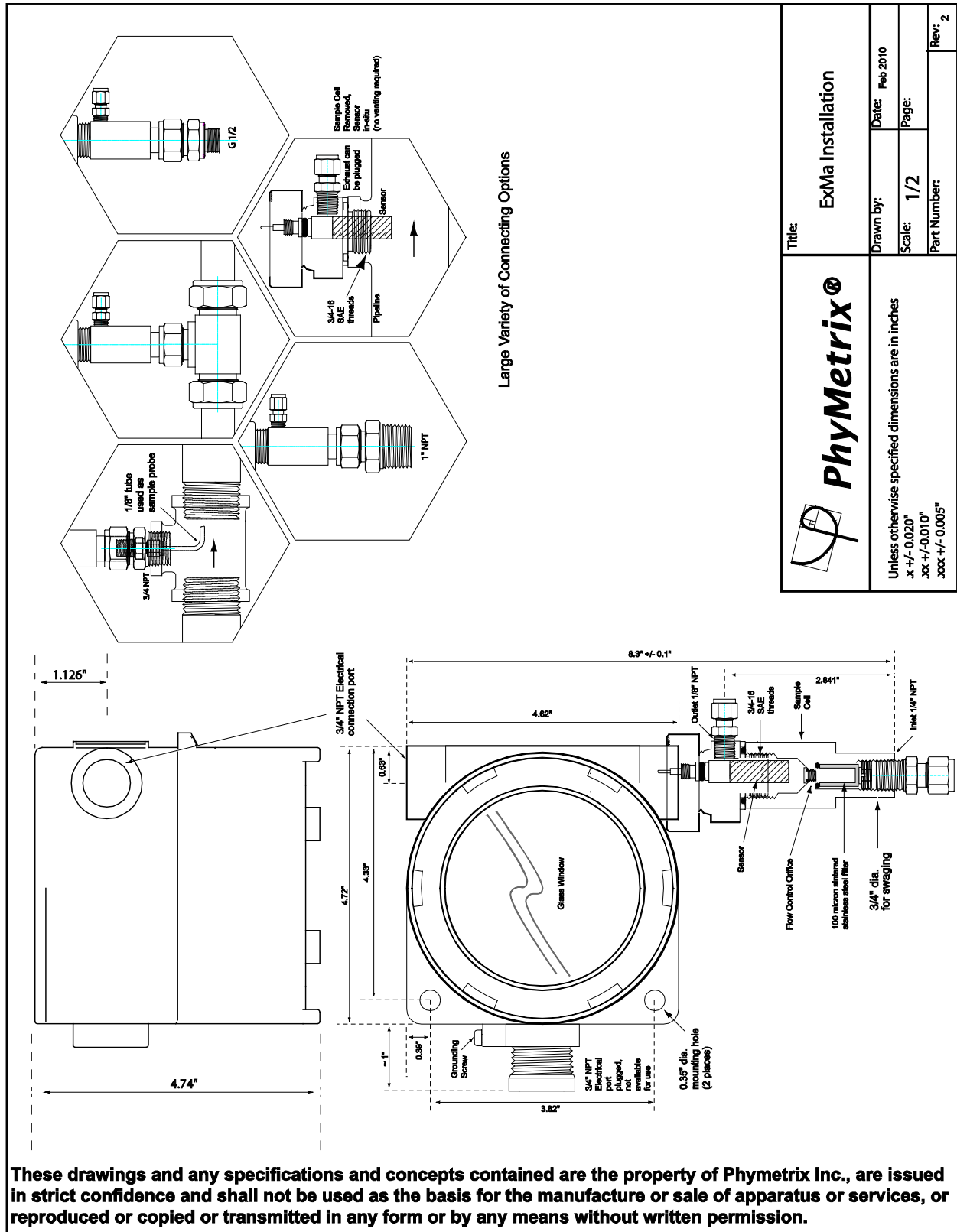
**Table 2 Guide to Troubleshooting Measurements**

<b>Problem or Unexpected Observation Behavior</b>	<b>Likely Source of Problem</b>	<b>Analysis</b>	<b>Remedy</b>
Measurement is <b>drier</b> 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 drier 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: 3 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 <b>wetter</b> 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 <b>not changing</b> ” observation below	
	Damage Corrosion, abrasion	Contaminants can damage the sensor.	Refer to sections: 3 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.
Measurement is changing <b>slower</b> than expected.	Needs recalibration	Depending on the application recalibration may be yearly or in 5 years.	Consult with factory.
	Equilibrium	The rate at which the system will reach equilibrium depends on the system particulars, such as 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
Measurement is <b>not changing</b> , always shows a dewpoint close to ambient temperature.	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.
	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 <b>daily cycle</b>	Thermally induced water vapor pressure change.	Refer to section 4.3 Temperature dependant equilibrium	

### 13 Specifications for Model ExMa

Temperature Range	ExMa Analyzer: -20°C to +60°C Electronics: -40°C to +85°C Moisture Sensor: -20°C to +60°C Pressure Sensor: -20°C to +85°C LCD operating: -20°C to +70°C      storage: -30°C to +80°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 1000 PSIA ±1%, 316L stainless steel wetted parts (higher pressures can be ordered)
Electrical	3 automatic detection - self configuring power modes: 1) 90-260VAC 47-440Hz or 2) 12-24VDC 10VA or 3) 4/20mA Loop Powered Power modes 1 or 2 have the following optional I/O: a) RS-422/485 isolated b) 4/20mA sink or source; isolated; with HART® c) 3 Alarm Relays - 3A, 250VAC / 30VDC contacts
Mechanical	3/4" OD tube and 1/4" NPTF Inlet, 1/8" NPTF Outlet All 316 Stainless Steel wetted parts, small surface area stainless steel sampling chamber for fast response time. Enclosure Aluminum or optional 316 Stainless Steel, Glass lens, IP66 & IP68 FM/CSA Explosion Proof Certified Class I, Div I, Groups B, C And D Class II, III, Div 1, Groups E, F And G ATEX Explosion Proof Certified ATEX 2 GD, Exd I & IIC; IECEx, Exd I & IIC Dimensions SS enclosure- L: 8.7" (221mm) W: 5.8" (147mm) H: 4.8" (122mm) Weight Total: 8.4 Lbs (3.8 Kg) Pressure: 5000 PSIA (345 Bar) Flow Control Orifice can be placed at Inlet(default) or Outlet; Built in serviceable/cleanable 100 micron Filter
Miscellaneous Features	Through the glass user interface buttons, allow operation while enclosure is closed NIST traceable calibrations Units of measure: °C & °F dewpoint, ppmV, ppmW, µB H <sub>2</sub> O vapor pressure, grams of H <sub>2</sub> O / m <sup>3</sup> and Lbs H <sub>2</sub> O / 10 <sup>6</sup> standard cubic feet in Natural Gas Virtual Analyzer PC software for training and evaluation, allows the user to experience the exact interface on their own PC with voice explanations

# Appendix A ExMa Installation Drawing

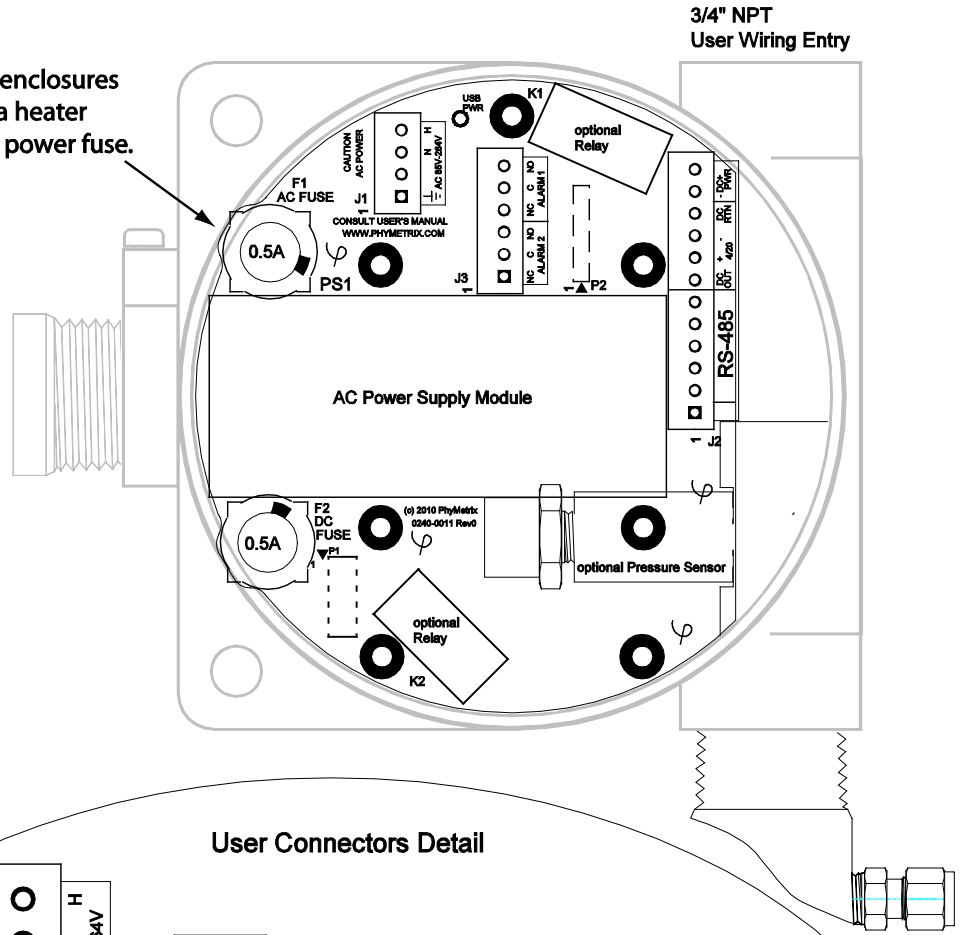


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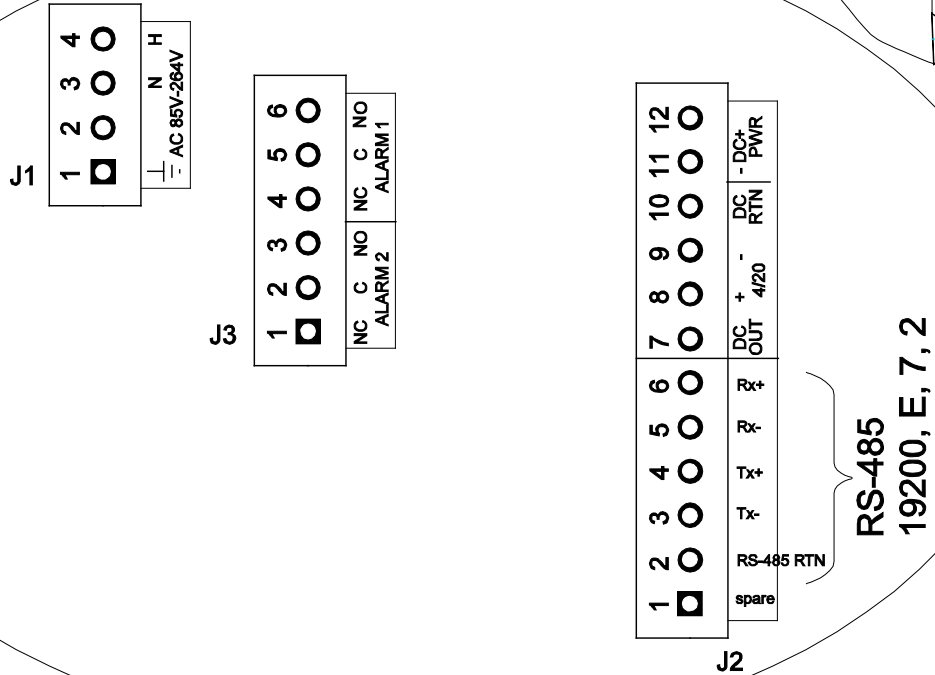


# Appendix B ExMa Electrical Connections

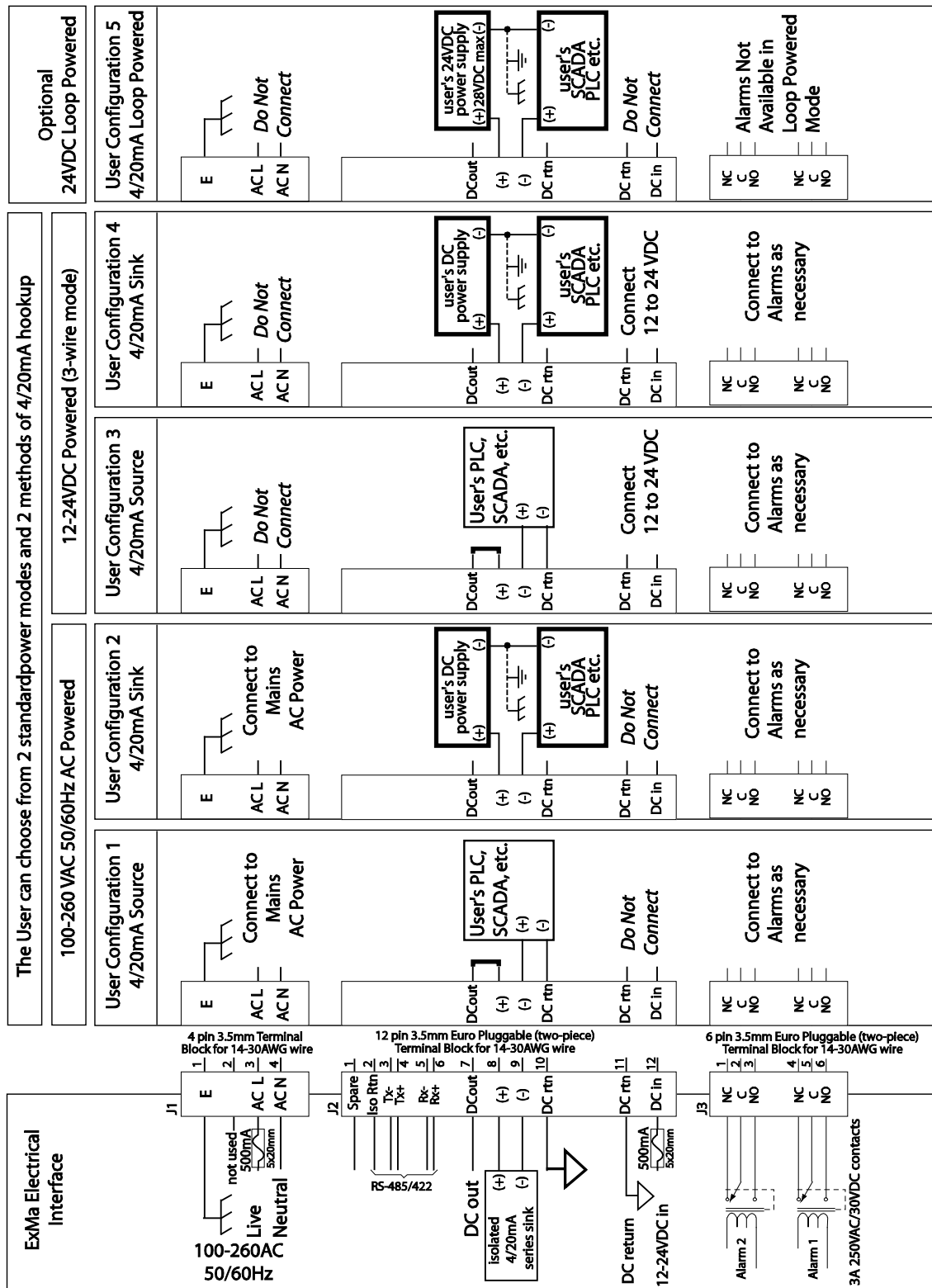
Sample system enclosures equipped with a heater require a 3A AC power fuse.



## User Connectors Detail

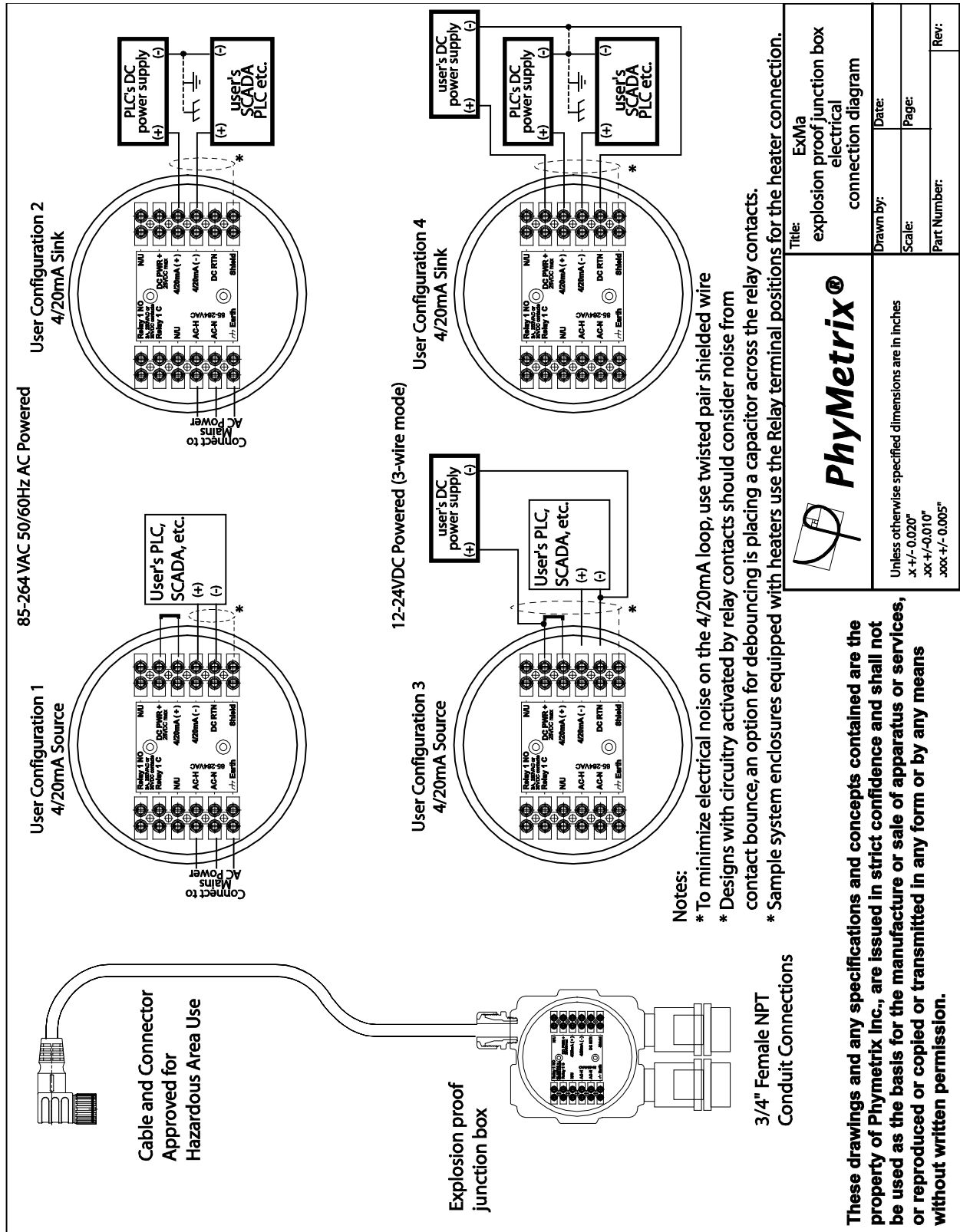


# Appendix B ExMa Electrical Connections



# Appendix B

# ExMa Electrical Connections



## **Appendix C Notes on ExMa use in low power applications e.g. solar power**

For all power consumption calculations it is assumed that the ExMa will be powered by 12VDC, unless otherwise noted.

Power connections:

+12VDC to J2 pin 12

RETURN (Gnd) (-) to J2 pin 11

### Analyzer Power Consumption

The ExMa (with the display backlight OFF) will draw about 13 mA from 12VDC power.

The display backlight will draw an additional 2.5 mA at 100% and proportionally lower on the other settings, which can be user selected. The backlight can be turned OFF, but each time the user presses a button on the screen the backlight will turn on to a low setting (~ 0.5 mA) for a few seconds.

### Analog Output Power Consumption

The Analog output will use 4 to 20 mA depending on the measurement. It is also possible to order the ExMa with voltage output 1-5V, which will further reduce current consumption by avoiding the 4-20 mA.

### Relay Power Consumption

It is better not to have Alarm Relays for solar Powered Application, but if they are needed, in order to conserve current there is a pulse width modulator for the Alarm Relay drive. The Relays will each draw about 37 mA at 100% PWM, and proportionally less e.g. at 55% about 21 mA. The Relay PWM percentage can be user selected. (go to MENU-4)

Be sure to configure the relay polarities in such a way that power consumption is minimized. For example if only one Relay will be used then configure the other to a very high dewpoint and select the polarity such that the relay is not energized. For the Relay that is used select the polarity such that current draw is minimized, but also consider that having the Relay energized while conditions are "GOOD" provides a fail safe operation in that if the analyzer loses power the relay will signal an alarm condition.

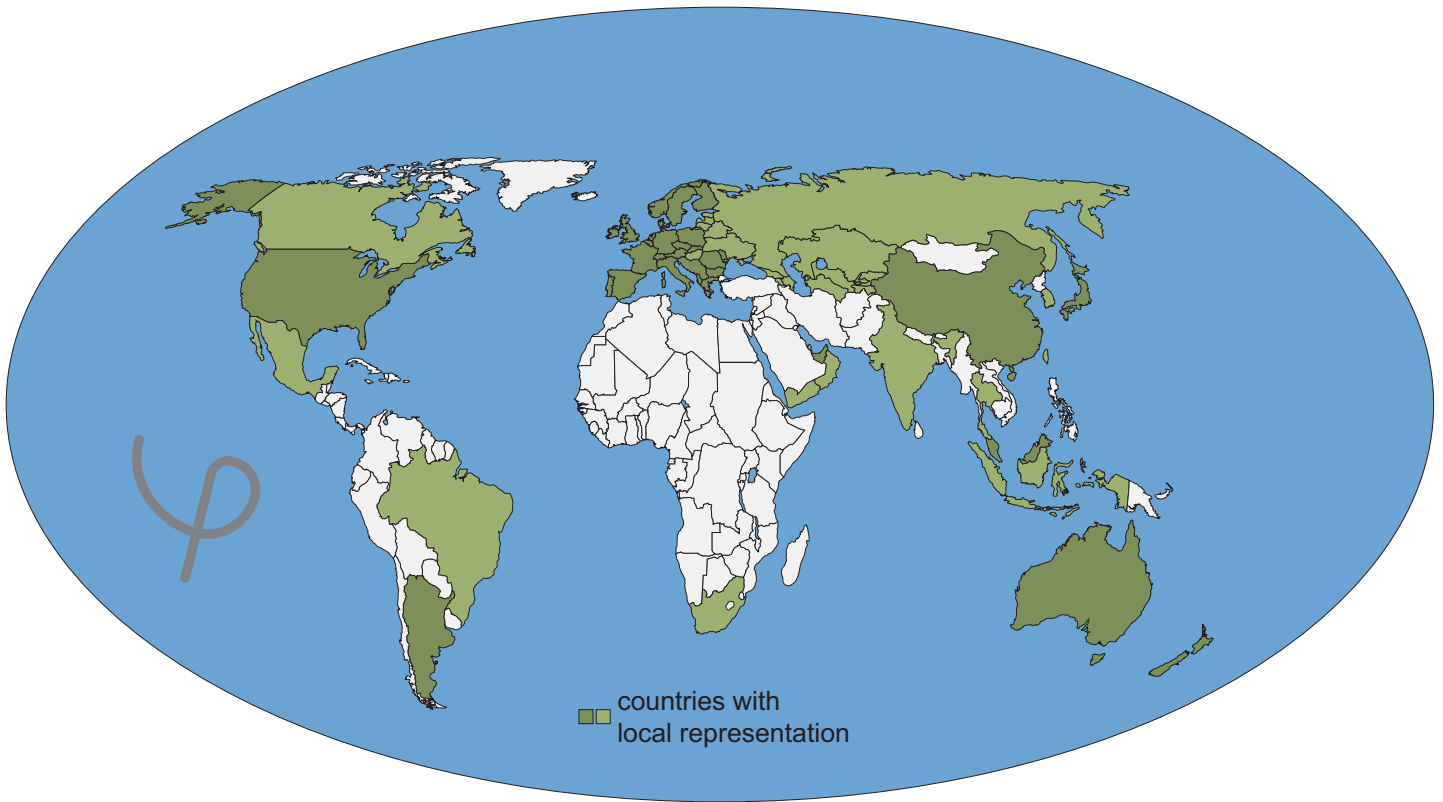
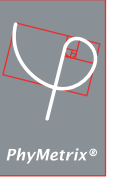






# Moisture Measurement Innovation at Work

Integrating nanotechnology into moisture measurement



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