



Installation & Maintenance Instructions

XPDM User Manual



When calling for technical support.....

..... please have your serial numbers ready.

The Sensor and Instrument Serial Numbers are on the rear of the instrument, also see section 5.2.4.

Sensor Serial No.: _____

Instrument Serial No.: _____

Your Representative is:
COSA INSTRUMENT CORPORATION
55 Oak Street, Norwood, NJ 07648
Tel.: (201) 767-6600 - Fax.: (201) 767-6804

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Check the Internet for updates; The latest revision of this manual is available in Adobe Acrobat format at: <http://www.xentaur.com>

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1. Introduction

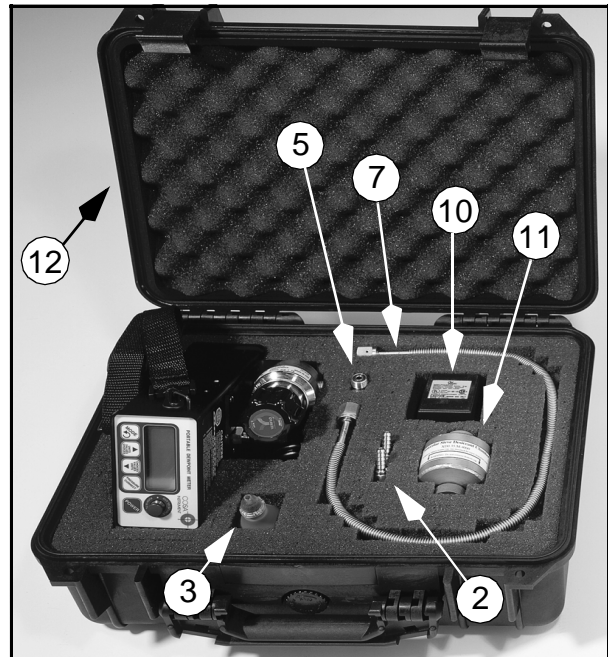
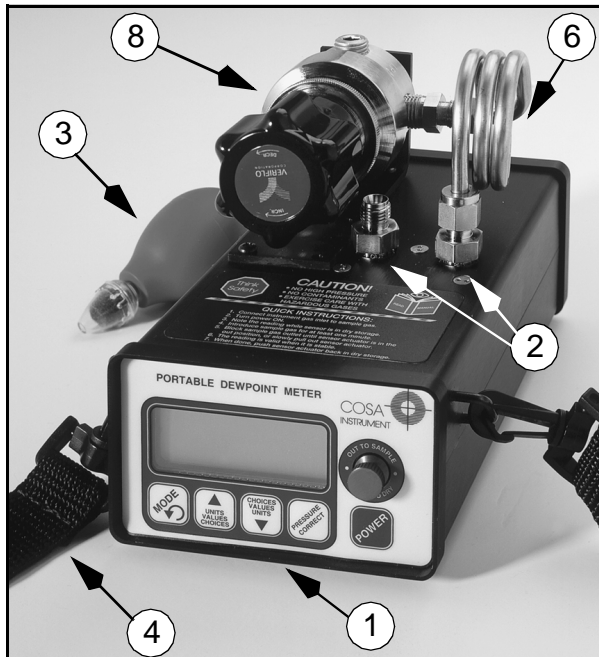
The XPDM is a portable, hand-held, microprocessor controlled, battery operated dew-point meter with built in dry-storage for the sensor. The instrument is ideally suited for all applications, where quick and precise measurements are required.

Standard Equipment:

1. XPDM Portable Instrument with sensor, desiccant cartridge and lithium battery.
2. 2VCO® to Swagelok® fittings and 2 Swagelok® to barbed hose fittings.
3. Calibration bulb.
4. Shoulder strap.

Optional Equipment:

5. VCO® to VCO® Fittings.
6. Pig tail.
7. Flexible stainless steel hose.
8. Pressure regulator, all stainless steel, (preset at 1.5 atm) with mounting bracket.
9. Coalescing filter, all stainless steel with mounting bracket.(not shown)
10. Wall transformer (with factory installed I/O option).
11. Replacement desiccant cartridge.
12. Padded transport case.

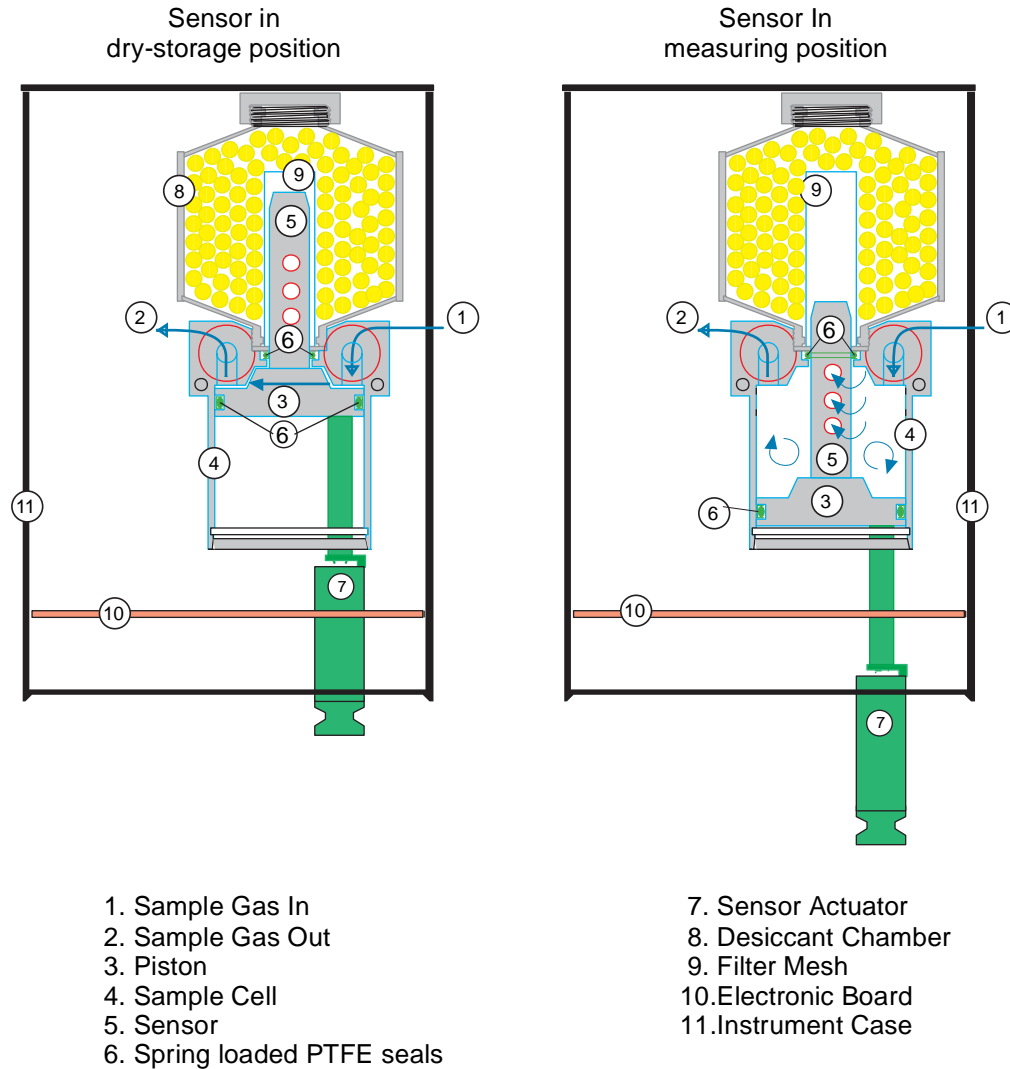


2. Precautions

- Warranty limitation: The XPDM's sample cell/piston assembly should not be disassembled except by factory trained personnel. The warranty is voided, if the sample cell piston assembly is disassembled by the customer.
- Avoid contaminated sample streams: The XPDM has been designed to allow for fast and precise measurements of dewpoints as low as -100 °C. Therefore, all surfaces in contact with the sample stream are made from electropolished stainless steel. This minimizes the time for the instrument to reach equilibrium with the sample stream, thus speeding up the measurement. The introduction of corrosive gases or gases contaminated with oils, solvents etc. may damage or coat the electropolished surfaces and slow down the measurement. Surfaces contaminated with oils etc. can be cleaned by factory trained personnel (please contact your sales representative). Surfaces damaged by corrosive gases are damaged permanently, causing longer response times. Gases containing chlorine, ammonia, HCl or SO₂ may also cause damage to the sensor. SO₂ can be monitored when the moisture content is low.
- Avoid liquid water: Avoid the introduction of liquid water into the sample cell, as this may damage the sensor. Do not breathe directly into the instruments sample ports, as condensation may form which could damage the sensor element. If liquid water can not be avoided, order the XTR-65W sensor which is water proof, but has a limited range, and a slower dry down response.
- Avoid high pressure: The XPDM has been designed for operation at pressures slightly above atmospheric, however each sample cell, sensor, piston, dry-storage assembly has been tested for pressures up to 120 PSI. Do not introduce sample streams, which could cause pressure rises above 100 PSI. Make your measurements at atmospheric pressures, and use the pressure calculation feature to calculate dewpoints at higher pressures. Ask your representative for a regulator installation kit.
- Exercise Caution with Hazardous Gases: Please use appropriate precautions if the sample you are about to measure is hazardous. Place the unit in a safe area, if it is to be used with hazardous gases. Please be aware that the possibility of a small leak always exists. Such a leak will not influence the accuracy of the measurement, but may represent a risk if the sample gas is of hazardous nature.
- Avoid Extreme temperatures: Do not install the unit near heat sources such as radiators or air ducts. The instruments' operating temperature range is -10°C to 50°C.
- Avoid Mechanical Vibration: Do not install the unit in places subject to extreme mechanical vibration or shock. Use resilient mounting, if shock and vibration are not avoidable. Call your representative if in doubt.
- Avoid long exposures of sensor element to room air: For reasons explained later in this manual (section 7), do not expose the sensor to room air for longer than necessary (1 - 2 Minutes). The sensor is exposed to room air, when the sensor actuator is in the out position and no sample line is connected, or the sample gas is shut off. It is best to push the sensor back into dry-storage, after a measurement is completed and whenever the instrument is not in use.
- Do not force the Actuator: Remove any port obstructions (such as shipping caps) before operating the Actuator.

3. Principle of Operation

Dewpoint sensors, like all hygroscopic materials, adsorb much faster than they desorb. Therefore, an accurate measurement will be obtained much faster, if at the beginning of the measurement, the sensor is at a dewpoint drier than the gas to be measured. The XPDM design allows the sensor to be moved directly between dry-storage and the sample cell, without any exposure to ambient air.



The drawing on the left shows the XPDM with the sensor in dry-storage position. The sensor is enclosed in a gas-tight container and surrounded by desiccant. The sample gas passes through the sample chamber and prepares the environment for measurement. Blocking of the outlet port will pressurize the sample chamber and move the piston into the position shown on the right. The sensor is now exposed to the sample gas without ever having been exposed to ambient air. After the measurement is taken, pushing in the sensor actuator will return the sensor into dry-storage, where it will dry down and ready itself for another fast measurement.

A note about dry-storage

The dry-storage consist of a stainless steel container filled with desiccant. The electropolished stainless steel sensor guard slides between the dry-storage and the sample cell through a spring energized PTFE seal, assuring maximum possible gas tightness and minimum gas transport between the two chambers when the sensor is moved. When in dry-storage, the sensor guard is separated from the desiccant by a stainless steel wire mesh with a thickness of 127 μ (0.005") and a mesh size of 100 μ . This keeps the distance between the sensor and the desiccant to a minimum, which is critical for fast and low dry-downs, while protecting the sensor from contamination with desiccant particles.

The factory supplied desiccant provides dry-storage dewpoints as low as -80°C when fresh. When the sensor is pushed into dry-storage it will take some time to dry down completely and reach equilibrium with the dewpoint in the dry-storage. The dry-down time to equilibrium depends on how wet the sensor was before it was returned to dry-storage, and in case that it was completely wet, how long it had remained in wet condition.

To take full advantage of the dry-storage, make sure, that the dry-storage dewpoint is below the expected dewpoint of the sample gas by periodically checking the indicated dewpoint after the sensor has remained in dry-storage for an extended period of time, for example over night. Replace the desiccant cartridge, if the dry-storage dewpoint is much higher than -80°C and above your expected sample dewpoints.

4. Operating the XPDM

4.1. Sample Hook-up

4.1.1. Fittings

The XPDM can be hooked up to the sample gas using a variety of fittings, depending on the application. The instruments' sample ports are 1/4" VCO® female, to assure proper seals for even the lowest dewpoint measurements.

Depending on the application and needs, we recommend the use of one of the following methods of attachment:

- VCO® → VCO®: This method is ideal for all applications, including the use of flexible stainless steel hoses, available optionally.
- VCO® → Swagelok®: This method is suitable for all applications where rigid pipe connections are acceptable.
- VCO® → Swagelok® → Barbed Hose Fitting: This method is acceptable for dewpoints above -65°C and should in all cases be used only with PTFE tubing.

4.1.2 Recommended Pipes

Stainless steel pipes should be used exclusively, for dewpoints below -65°C. Your representative has a flexible stainless steel hose available. The length of the sample line to the instrument should be kept as short as possible, to assure fast equilibrium. We recommend the attachment of at least 12" long stainless steel pipe at the outlet port to avoid back flow of ambient air when sampling at low flow rates, ask your representative for the optional pigtail.

PTFE tubes are perfectly acceptable, and offer advantages due to their flexibility, for dewpoints above -65°C. However, PTFE tubes should be kept as short as possible.

Under no circumstances use rubber or plastic tubes, which are both, hygroscopic and permeable. No valid measurements can be expected when such materials are used.

4.1.3. Sample conditioning

- Pre-filters: Do not use any pre-filters for oil, particles or liquid water when measuring dewpoints below -65°C. Pre-filters store and release water vapor, and slow down and distort the measurement at low dewpoints.
- Pressure regulators: Do not use a pressure regulator containing any materials other than stainless steel, for dewpoints below -65°C. To ensure the use of the right product, use regulators provided by your sales representative.

4.2. Measuring

- Turn the unit on by pushing the Power button.
- Select the desired engineering units, using the up or down buttons.
- Take note of the indicated dewpoint while the sensor is still in dry-storage.
- Introduce the sample gas into the unit while the output port is unobstructed. Wait one minute, for every 20°C below 0°C of expected dewpoint, to allow the interconnecting hose or tube as well as the sample chamber to adapt to the sample dewpoint (eg. if expecting -60°C, wait for 3 minutes).
- Block the outlet port. The small pressure build-up in the sample chamber should be sufficient to push out the piston and move the sensor into the sample chamber. If not

sufficient, assist by gently pulling on the sensor actuator located on the front of the instrument, while still blocking the sample outlet port.

- Observe the change in dewpoint indication. The reading will be stable within about 3 minutes, if the dewpoint is increasing. A longer stabilization period will be required, if the dewpoint is decreasing. Make sure the reading has completely stabilized before taking the final reading. After the reading is taken, push the sensor actuator back into the dry-down position.

Note that when the instrument is being operated on a battery it will shut off automatically if no buttons are pressed for: 6 minutes when sensor is in the sample chamber (the out position), or 3 minutes when sensor is in the desiccant.

The unit does not have to be “on” while waiting for purging or stabilization.

5.0 The User Interface

The user interface consists of a custom LCD display, an audio indicator, 5 push buttons and a sensor actuator.

5.1 Display Conventions

- To display letters with the 7 segment numeric display, the following pseudo-alpha- numerics are used:

Numbers:

0	1	2	3	4	5	6	7	8	9
0	1	2	3	4	5	6	7	8	9

Letters:

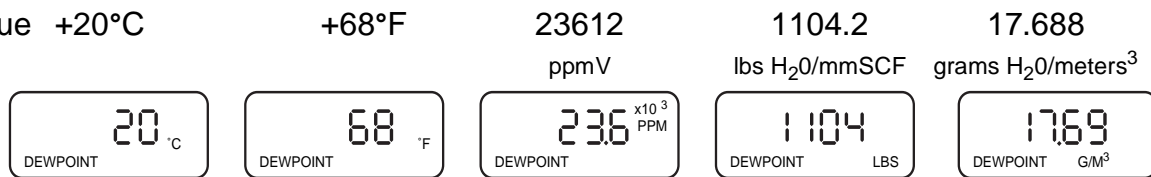
A	B	C	D	E	F	G	H	I	J	L	N	O	P	Q	R	S	T	U	X	Y	Z
A	b	c	d	E	F	G	H	I	J	L	n	o	P	q	r	S	t	U	x	Y	Z

Symbols:

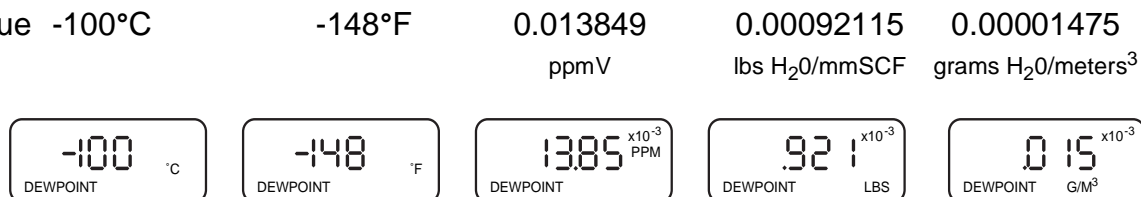
?	-	.
?	-	.

- The instrument will indicate whether a particular mode lets you change a parameter by showing the word "SET" in the upper left corner of the display. Be careful not to change any parameter inadvertently.
- °C°F appear simultaneously, to indicate the sensors' attenuation in decibels.
- Values higher than ± 1999 and lower than ± 0.01 are displayed in powers of $10^{\pm 3}$. Either a " 10^3 " or " 10^{-3} " will appear above and to the right of the displayed value, if this is required, and the value will be rounded off to $3\frac{1}{2}$ digits. Examples follow:

actual
value



actual
value



5.2 Operating State

Refer to Appendix A for a flow diagram of the operating state. The XPDM is powered ON by pressing the 'Power' button until a beep is heard; to activate the backlight, continue to depress the 'Power' button until the backlight turns on. Keep in mind that with the backlight on the unit consumes about 5 times more power.

Upon power up the unit performs certain initialization tests (see section 9), and enters the 'Operating State', in the Viewing Dewpoint mode. Depressing the 'Mode' button will change modes in the following order: Viewing Dewpoint → Viewing Sensor Temperature → Start Autocal → Viewing Serial Number → (back to) Viewing Dewpoint. The unit will return to Viewing Dewpoint mode if no buttons are pressed for 30 seconds, unless it is performing Autocal.

5.2.1 Viewing Dewpoint Mode

In this mode the user can view the dewpoint, signified by the presence of the 'DEW-POINT' legend on the lower left of the display. The available engineering units in which to view the moisture content are °C, °F, PPM, LBS and G/M³; the up and down buttons scroll back and forth through these units in respective order. The °C and °F are dewpoint readings. The ppm is parts per million by volume computed at the sensor pressure (more about pressure later). The Lbs and G/M³ are pounds of water per million standard cubic feet and grams of water per standard cubic meters, both in Natural Gas, they are computed according to data derived by IGT Research Bulletin 8, taking into account sensor pressure.

A short press of the 'pressure correct' button toggles the unit in and out of pressure correct mode. When there is no pressure correction applied the PSI legend does not appear. The PSI legend flashes at the bottom of the display, when there is pressure correction in the computation of the displayed values.

Pressure correction is used in the context that the values displayed signify the moisture content at some pressure (we refer to this as the 'Gas Pressure') different than the pressure at the sensor. Note that PPM, LBS and G/M³ readings are by definition unaffected by pressure correction because only the pressure at the sensor affects their value. While °C and °F are affected by pressure correction by reporting what the dewpoint would be at the Gas Pressure when the dewpoint is what is measured at the pressure at the sensor. However, this also implies that whether pressure correction is applied or not the PPM, LBS and G/M³ readings are affected by the setting of the sensor pressure.

Sensor pressure is used in the context that this is the pressure inside the sampling chamber when performing the measurement.

Gas pressure is used in the context that this is the pressure to be used in computing what the dewpoint would be at a pressure different than the one in the sampling chamber.

A long press of the Pressure Correct button, while in the pressure correct mode (flashing PSI legend), changes the unit to the View/Set Sensor Pressure sub-state. The display has the 'SET' and 'PSI' legends on and alternately shows \overline{SEN} and the currently set value for the sensor pressure. The up and down buttons allow the user to modify the sensor pressure, while a short press of the pressure correct button toggles the Sensor Pressure setting between whatever value is on the display and 14.7 psi ---- this is a quick way to go

back to atmospheric settings. A long press of the pressure correct button changes the unit back to the Viewing Dewpoint Mode. Pressing the 'Mode' button changes the unit to the View/Set Gas Pressure sub-state. The display has the 'SET' and 'PSI' legends on and alternately shows $\overline{\text{PS}}$ and the currently set value for the gas pressure. The up, down and pressure correct buttons operate in the same manner as in the Sensor Pressure sub-state. Pressing the 'Mode' button changes the unit back to View/Set Sensor Pressure sub-state, and so forth.

Note: The units leave the factory in the lock mode and must be unlocked before this procedure can take place (see section 5.3 #7 to unlock).

The factory default settings are: 14.7psi for both sensor and gas pressure and pressure correction disabled.

When Pressure correction is disabled all dewpoints are computed by assuming that both Sensor and Gas Pressures are 14.7psi.

5.2.2 Viewing Temperature at the Sensor

In this mode the user can view the temperature at the sensor inside the sampling chamber, signified by the flashing 'TEMP' legend on the lower left of the display. The available units in which to view the temperature are °C and °F. The up and down buttons switch back and forth between these units.

Pressing the 'Mode' button changes to the Start Autocal Mode.

5.2.3 Start Autocal Mode

In this mode the user is prompted to confirm that Autocal should be initiated. This mode can be skipped by pressing the 'Mode' button to go to the View Serial Number Mode or by cancelling with the down or pressure correct buttons which displays the word $\overline{\text{RN}}$ for 1/2 second and goes back to the Viewing Dewpoint Mode.

Autocal can be initiated by pressing the 'up' button. The unit will check if the sensor is in the sampling chamber, if not it will prompt the user to pull the sensor out of the desiccant by beeping and displaying alternately $\overline{\text{PUL}}$ and $\overline{\text{PUL}}$. Pull the sensor actuator out, when this message appears.

Since Autocal is a irreversible recalibration of the instrument there is one more beeping and visual prompting with alternating $\overline{\text{RF}}$ and $\overline{\text{RC}}$. The down and pressure correct buttons allow cancelling the Autocal, while the up button confirms it. The unit starts taking measurements for 1 minute while displaying alternately flashing $\overline{\text{RC}}$. During this time the user should occasionally pump saturated air using the calibration bulb into the sample chamber (see Autocal Instructions). An alternating $\overline{\text{SEN}}$ and $\overline{\text{LO}}$, after one minute, accompanied by a beeping, indicates the sensor has a reading too low to be from a saturated sensor. This error will cause Autocal to be cancelled. However, if the sensor reading is within range of a saturated sensor, a new calibration is calculated (some numbers flash on the display), $\overline{\text{END}}$ is displayed for 1 second, and the new calibration values are saved in EEPROM.

5.2.4 Viewing Serial Number Mode

In this mode the user can view the serial number of the sensor. The display shows the serial number by alternately displaying $\overline{\text{SN}}$ and the number. If the number is larger than

6. Options

The instrument can be optionally equipped with an output/power supply board, to allow for the following capabilities:

1. RS-232C.
2. Current Loop output (4-20mA or 0-24mA).
3. Operation from an external power supply e.g. a wall transformer.

6.1 RS-232C

The RS-232C output is provided on a 9 pin sub "D" female connector, located at the rear of the instrument. The configuration is 9600 baud, Even Parity, 7 Bits, 1 Stop. The interface is isolated from the sensor and case (however as a safety precaution there is a 1MΩ shunt to prevent electrostatic buildup and discharge), it is configured as a modem, thus it can be directly plugged into a PC. To also use the current loop output, a special cable is needed since the connector is shared, see the pin out table below.

In order to receive the dewpoint in the currently selected engineering units, the host computer must query the XPDM with:

?^{c_R}

The XPDM will respond with the dewpoint, followed by characters indicating the currently selected engineering units, followed by carriage return e.g.:

-79.1degC^{c_R}

or

-110.4degF^{c_R}

or

0.0339LbsH2O/mmscf^{c_R}

or

0.625ppmV^{c_R}

or

0.00544g/m3^{c_R}

If an error condition exists the XPDM will respond to the question mark with a phrase describing the error:

SensOpen^{c_R} or **SensSaturated^{c_R}** or **SensShorted^{c_R}**

NOTE: Characters marked in bold are indications of sent or received strings.

9 pin "D" female connector pin assignments

pin	Signal	pin	Signal
1	Current Loop out	6	strapped to 4
2	Tx	7	looped from pin 8 through RS-232 level driver
3	Rx	8	looped to pin 7 through RS-232 level receiver.
4	strapped to 6	9	current loop select:Open=0-24mA,Grounded=4-20mA
5	Gnd-RS232 & Current Loop		

If the current loop is not being used, it is safe to connect the DB9 connector directly to a PC; pins 1&9 will not be damaged or cause damage.

The RS-232 levels are generated by the instrument only when an RS-232 level is detected at the DB9 input. Therefore, when operating from a battery to conserve its power, disconnect the RS-232 cable unless necessary for the operation.

6.2 Current Loop Output

The current loop signal is provided on the 9 pin sub 'D' female connector located at the rear of the instrument. The current loop output functions only when the instrument is operated from an external power supply. Pin 1 is the positive current loop output while pin 5 is the ground.

This output is isolated from the sensor and case, however as a safety precaution, there is a 1M Ω shunt to prevent electrostatic buildup and discharge.

Note that this connector is shared with the RS-232C interface, see section 6.1 for full pin assignments. Pin 9 controls the range of the current loop, when grounded the output is 4-20mA, when left open the output is 0-24mA. The current loop is capable of driving loads from 0 Ω to 500 Ω . The output is linearly proportional to the selected engineering units. The output may be scaled such that it spans only a portion of the full range of the sensor, this feature may be useful in cases where a higher resolution output is required over a narrow dewpoint range, or vice versa. To verify or change the current loop scaling follow the instructions in the set-up mode section 5.3.

The current output is computed by the microprocessor as follows:

If pin 9 is grounded for a 4-20mA range:

$$O = \frac{(R - L)}{(H - L)} \times 16 + 4$$

Where:

O =output current in mA.

R = value of Reading shown on display in selected engineering units.

L = value of Low Limit of Output Scaling converted to selected engineering units.

H = value of High Limit of Output Scaling converted to selected engineering units.

See section 5.3 to select values for L & H. Their factory defaults are the upper and lower range of the sensor i.e. for XTR-100 $L = -100^{\circ}\text{C}$ and $H = +20^{\circ}\text{C}$. The values for L & H are set up always in $^{\circ}\text{C}$, however the microprocessor converts them to the currently selected units. Note that because R, L and H are all in the same engineering units the output current is proportional to the selected engineering units. The current is linearly proportional to dewpoint, if the selected units are $^{\circ}\text{C}$ or $^{\circ}\text{F}$, however if the selected units are Lbs, ppm or G/M^3 then the current is approximately logarithmically proportional to dewpoint see Appendix C.

After hooking up the current loop output, it can be forced to its low, mid and high points by following the instructions in section 5.3. This procedure may be helpful in testing the connection and setting-up the termination equipment.

6.3 Operating from an external Power Supply

The external power connector is a 2mm power jack located on the rear of the unit. This input can accept either AC or DC power and is thus polarity independent.

The unit requires 13VDC to 25VDC, when operating from external DC power.

The unit requires 12VACrms to 25VACrms, when operating from external AC power.

In either case the unit can draw up to 50mA when the backlight is on and supplying current loop output. The power input is protected with a 250mA fuse.

The power input is isolated from the sensor and case, however as a safety precaution, there is a 1M Ω shunt to prevent electrostatic buildup and discharge.

7. Automatic Calibration

The instrument is calibrated at the factory with the shipped sensor, and does not need to be re-calibrated prior to use. *Do not re-calibrate the unit unless you suspect a problem.*

The XPDM instrument takes advantage of the pre-designed saturation point of Xentaur HTF™ sensors. Because Xentaur HTF™ sensors saturate at a factory designed dew-point above +20°C, they can be calibrated by simply exposing them to a micro-climate with any dewpoint above +20°C and adjusting the calibration equation.

Remember that the micro-climate does not have to be accurate, it just has to be higher than the pre-designed saturation level.

The automatic calibration procedure is as follows:

1. Make sure that the ambient temperature where you are performing the autocal is above +20°C. Check the temperature of the unit using its built in temperature indication.
2. Remove the adapter from the bulb (hand pump).
3. Moisten the sponge with 1 or 2 drops of water and replace the adapter back on the mouth of the bulb.
4. Turn instrument on. Refer to section 5.2.
5. Press the Mode key twice. The display will indicate \overline{CAL} .
6. Press the Up key, to confirm you want to perform a calibration.
7. Pull sensor actuator to measurement position, and pump into one of the input ports.
8. Push Up key to initiate the calibration procedure.
9. Keep pumping intermittently to assure wet micro climate in sample cell, while the display is flashing $\overline{CAL}/\underline{CAL}$.
10. After one minute, the instrument displays calibration numbers to be stored in the instruments memory, displays \overline{END} , and thereafter goes back into measuring mode. The instrument is now calibrated.
11. Push in the sensor actuator.

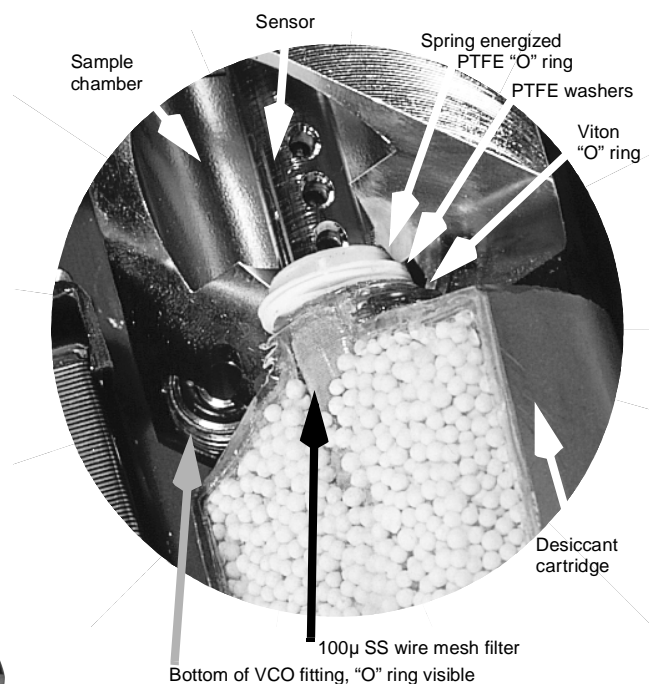
Instrument calibration is recommended in 12 month intervals, the XTR65 sensor should be recalibrated after prolonged exposure to liquid water. Make sure the sensor has been sufficiently dried down and, simply follow steps 1 - 11 of the above procedure.

It is recommended to keep the sensor exposure to room air as short as possible to avoid super saturation of the sensor. While super saturation is not damaging to the sensor, it will prolong the initial dry-down time after it is exposed to a dry environment. Therefore, move the sensor out of the dry-storage only after you are ready to proceed with the calibration procedure and push the sensor in dry-storage immediately after the calibration procedure is completed. Under certain conditions, an over (super) saturated sensor may need to be completely dried out before either auto calibration or manual calibration is performed. Symptoms of these conditions are a sensor that will not go through the automatic calibration function to the \overline{END} display, or a sensor that will not dry down after calibration. To dry, install sensor in either a known dry gas stream i.e. instrument quality air or dry nitrogen, or push the sensor back into the dry-storage. After a minimum dry out period of 24 hours, proceed with the calibration procedure.

8. Changing desiccant cartridge and/or battery.

















In order to change desiccant cartridge and/or battery, remove the two thumb screws on the rear cover. These screws are approximately seven inches long and after they are loose must be pulled out. If the instrument has a filter bracket installed the screws holding the bracket to the bottom cover must also be removed. Then the bottom cover may be removed.


- The battery may be replaced with another 9V battery (we recommend lithium) by simply pulling it out of its holder.
- The desiccant cartridge may be replaced by unscrewing it and pulling it out. The sensor must be in the sample chamber, this position is reached by pulling out the sensor actuator. The replacement cartridge is in a sealed tin container. Open the container and remove the replacement desiccant cartridge. Remove the GREEN cap, **DO NOT** open the RED cap as the desiccant will spill out. Screw in the replacement desiccant cartridge making sure that the same seals are in place as when you removed the old cartridge, such as the PTFE washer and Viton 'O' ring. Tighten the desiccant cartridge securely into place. Move the sensor actuator back and forth to make sure that the sensor moves in and out of the desiccant smoothly.



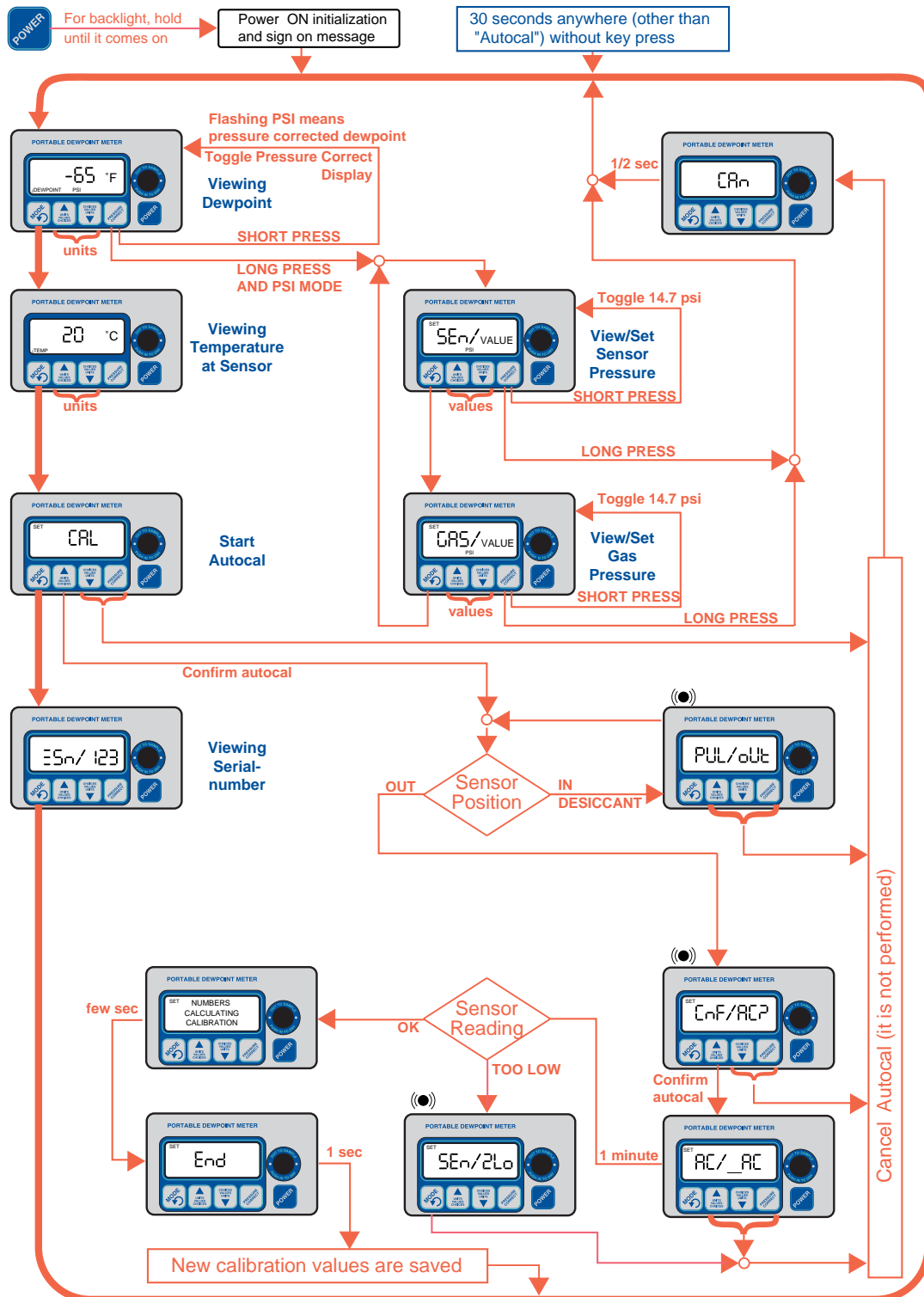
Bottom view of XPDM with cover open. The sample chamber and desiccant cartridge are shown cut open to facilitate an understanding of the mechanism and how it is assembled.

9. Special messages, warnings and error indications

DISPLAY	EXPLANATION	REQUIRED ACTION
LO Err 	PROM check sum failed.	cycle power / replace battery, if problem persists, return to your representative for service.
HI Err 	RAM write/read test failed.	
% Err 	Unidentified power-up failure.	
C.S.F/ Err/Rd 	EEPROM C heck S um F ailed.	
Err/rEF 	A/D converter failure.	replace battery.
Lo/bAt 	Low battery voltage.	
LO rNG/ TEMP 	Instrument low temperature range has been exceeded.	make sure that the unit is at a temperature of -10°C to +50°C.
HI rNG/ TEMP 	Instrument high temperature range has been exceeded.	
oPn/ SAt/ SHr/ ...	Sensor circuit is open .	check sensor. wetup sensor to see if it will react dry down the sensor. check sensor. select sensor and autocal.
	Sensor is saturated .	
	Sensor circuit is shorted .	
	Trying to calculate dewpoint for undefined sensor.	
dry	Viewing dewpoint while sensor is in desiccant dry - storage.	a reminder that the dewpoint in the desiccant is being measured.
db 	Trying to calibrate an undefined sensor.	see autocal instructions.
PUL/oUt 	Prompting to pull out the sensor from desiccant to perform autocal.	
SEn/2Lo 	S ensor reading is ' too low ' to be from a saturated sensor, for autocal.	
Err/EEP 	EEPROM write cycle not completed.	if this persists, return for service.
LoC 	Attempting to modify a locked unit.	unlock unit, see set-up mode.
In-/oUt 	Sensor is neither in nor out of desiccant.	pull out or push in the sensor actuator
ΞEn 	Turn on message, Xentaur (Greek Ξ=Χ)	
bYE 	Turn off message, good- bye .	

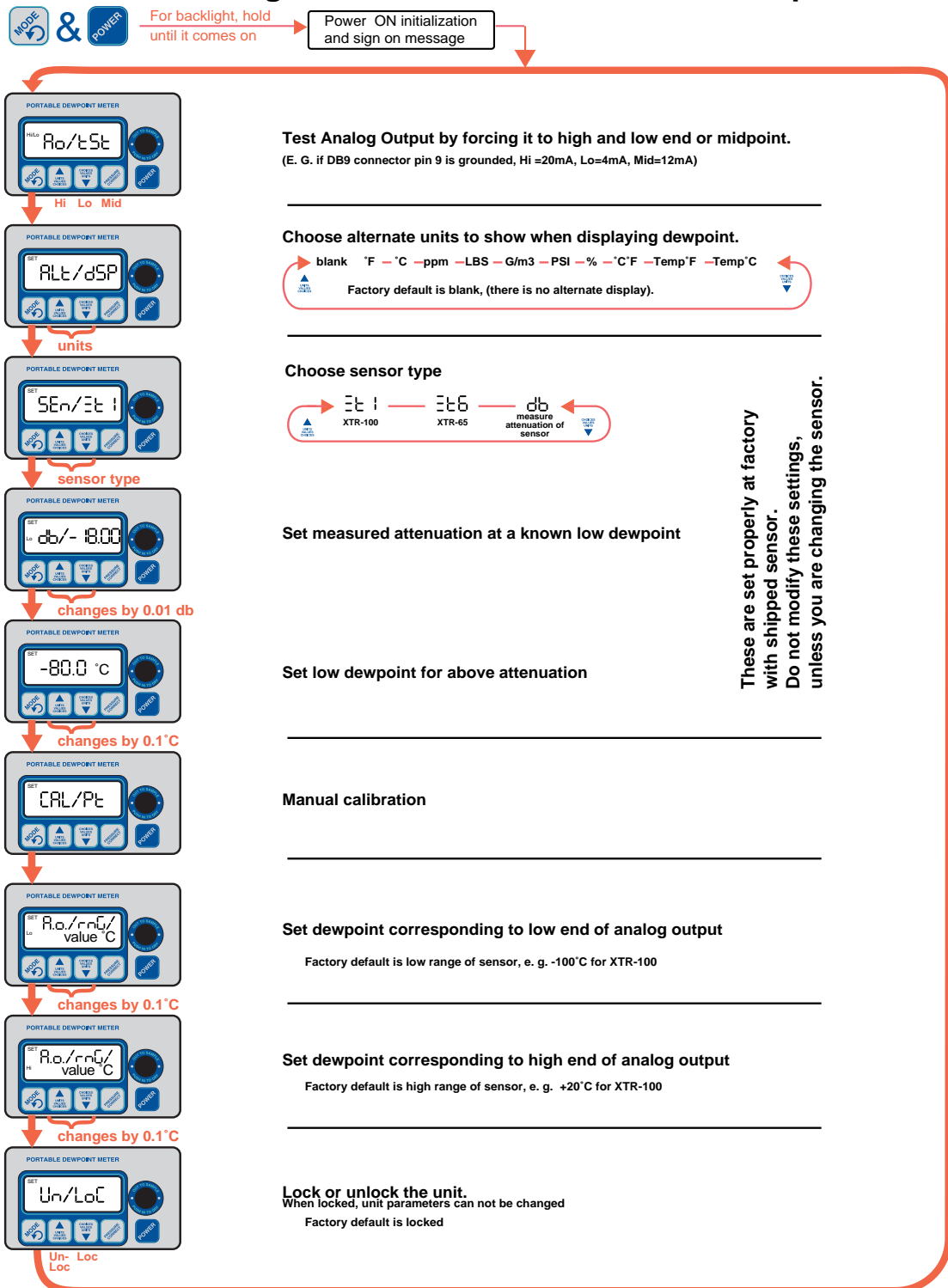
Legend:  denotes a beeping accompaniment to the message.
/ denotes alternately flashing messages.

Appendix A: Flow diagram of User Interface in the Operating State



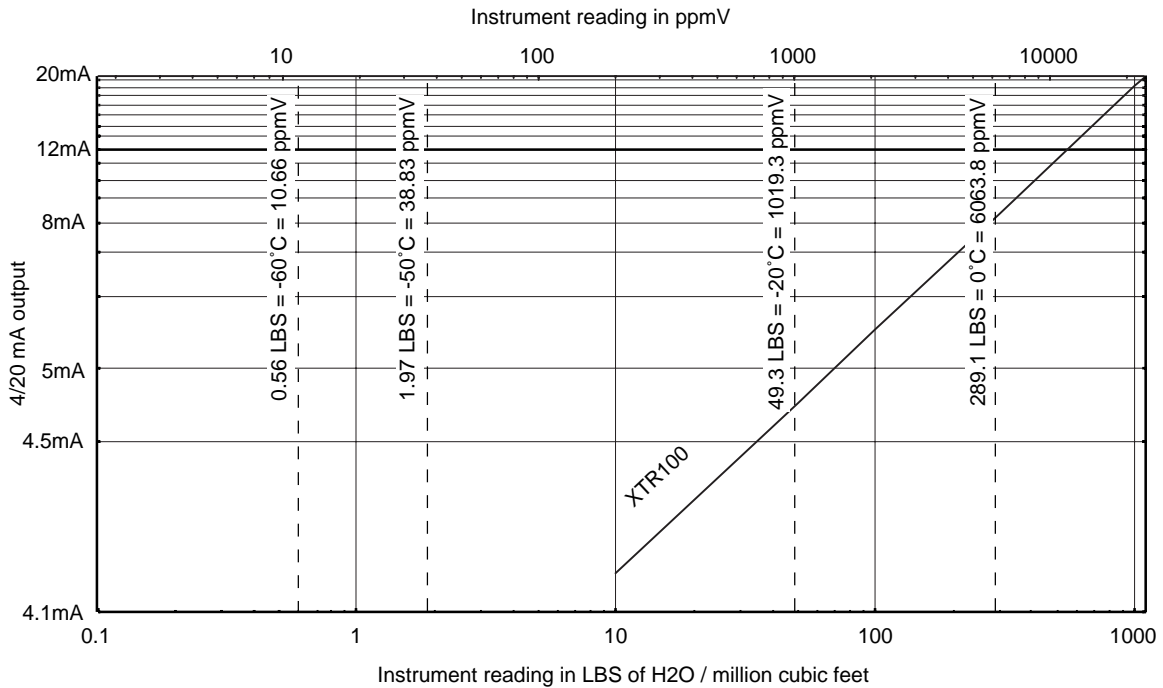
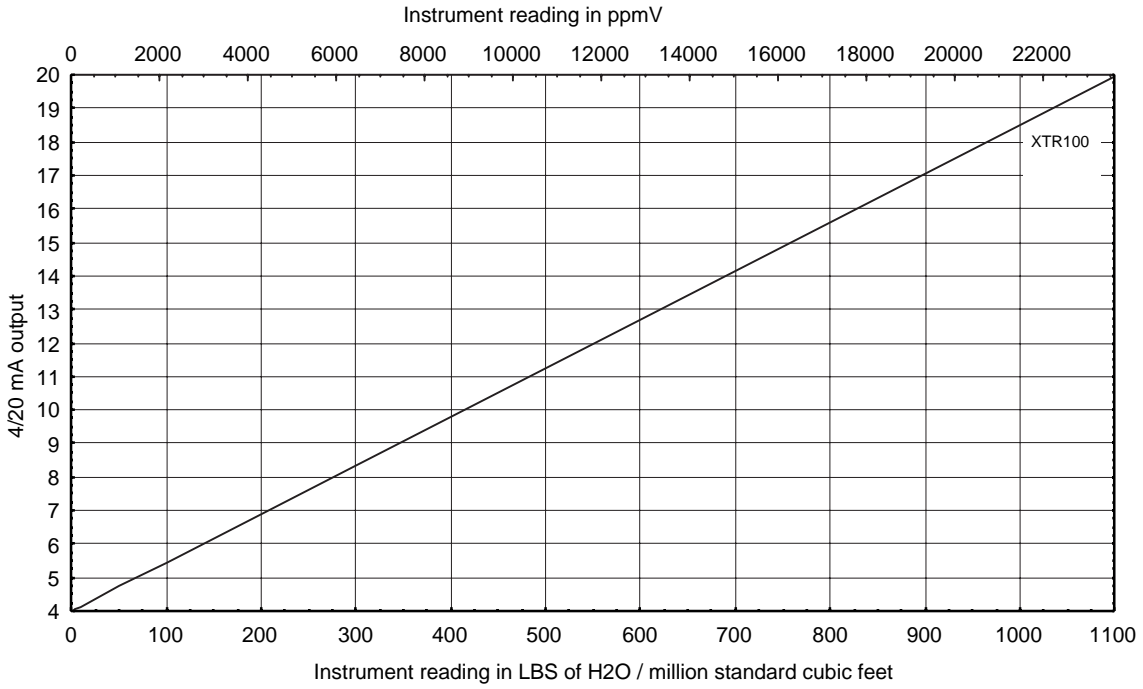
Legend: / separates alternatively displayed messages
 (●) denotes beeping
 Buttons without designator or arrow leading out, perform no function

Appendix B: Flow Diagram of User Interface in the Set-Up State

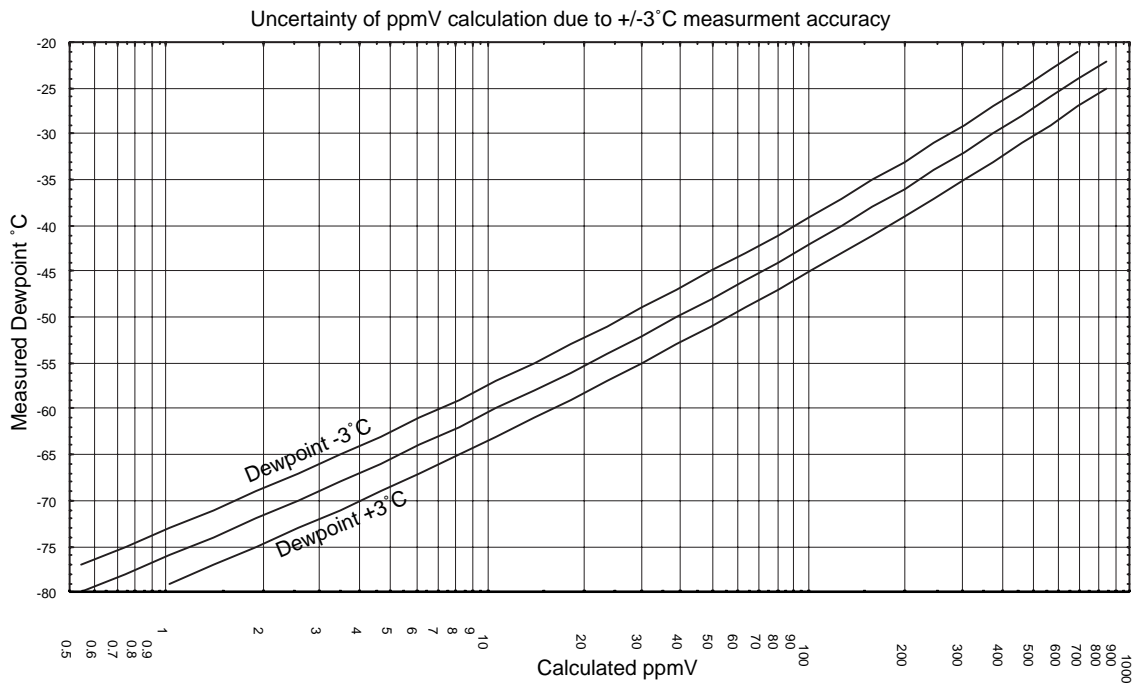
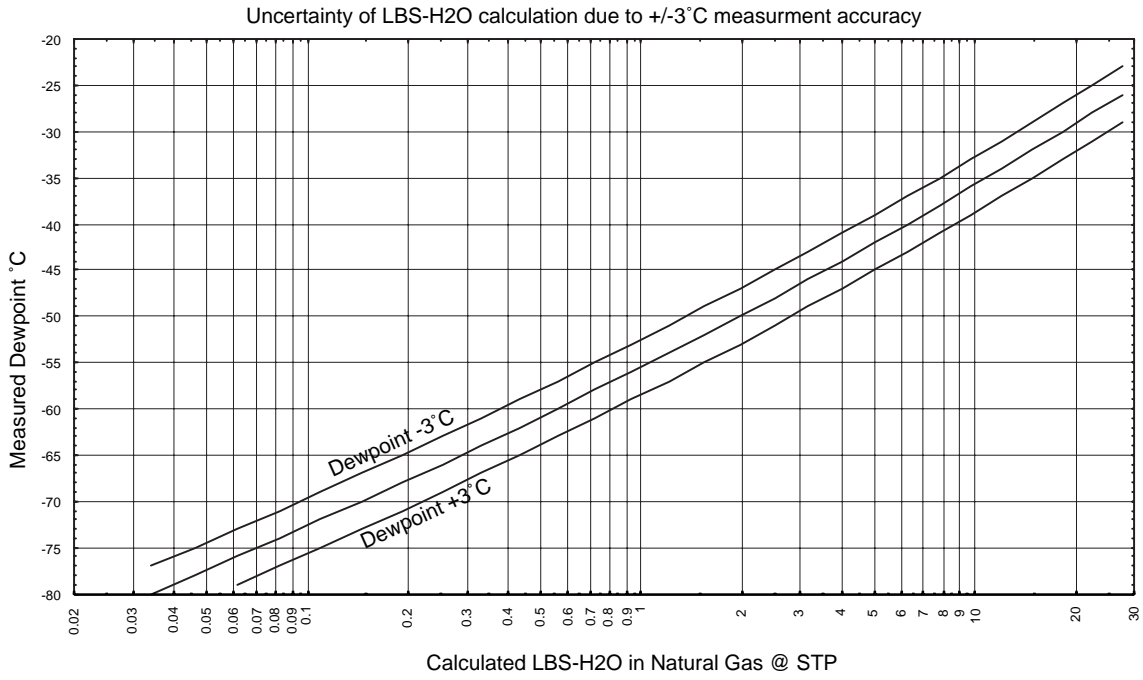


Legend: / separates alternatively displayed messages
 Buttons without designator or arrow leading out, perform no function

Appendix C: Relationship of Instrument Reading and 4-20mA output when lbs of H₂O/million standard cft or ppmv engineering units are selected.



Appendix D: Uncertainty in LBS and PPMV calculations



Appendix E: Battery Life

