Vaporstat™ Model 9002

Infrared Absolute Humidity Sensor
Measures Dewpoint or Absolute Humidity / Mixing Ratio

Operating/Installation Manual

Applications

The Vaporstat™ is the first of a new generation of low-cost, commercially available humidity sensing devices that directly measure dew point or absolute humidity. Dew point and absolute humidity measurements directly correspond to the absolute amount of water vapor in the air, and are not temperature-dependent like relative humidity. The Vaporstat™ has measurement characteristics similar to chilled mirror hygrometers, but at a fraction of the cost and with considerably less adjustment and maintenance.

The Vaporstat™ can be used in any application where it is necessary to monitor or control moisture levels in outdoor or indoor ambient conditions, particularly where temperatures may vary within a space or in the air delivered to a space.

Recommended Uses Include:

- Desiccant system control (space and process) for manufacturing and retail applications
- Humidification/dehumidification control in a variety of applications
- Economizer/mixed-air control on air handlers and rooftop A/C units
- Monitoring and control to avoid mold and mildew conditions

Key Features

- Directly measures dew point or absolute humidity
- Measurement provided in °F dew point
- Telaire's patented Absorption Infrared™ technology provides high accuracy in a compact and low cost package
- Gold-plated optical sensing element increases sensor life and durability
- Easily calibrated in field using dry nitrogen gas or a reference sensor
- Dual simultaneous analog outputs: 0-10 volts and 4-20 milliamperes
- Relay (normally open or closed) with adjustable set point and hysteresis (dead band)
- On-board altitude correction (set via keypad)
- Conformal-coated electronics to insure durability in harsh climates
- Tamper resistant cover protects keypad and allows for visible or hidden display
- Utilizes Telaire's standard accessory enclosures for duct mounting or outside mounting

Low Cost Infrared Humidity Measurement

Infrared hygrometers have traditionally been used in high-end scientific and meteorological applications for accurate measurements of absolute humidity. Telaire has applied its low-cost infrared gas-sensing platform to measure water vapor, making Vaporstat™ the first direct measuring water vapor sensor available as a commercial instrument for HVAC and industrial applications.

Traditional measurement of humidity uses technology that relies on some physical or chemical interaction with the water being measured. RH sensors that use capacitive or polymer sensors depend on water in the air being absorbed into a thin film material, which changes its' resistance depending on the water content. Changing concentrations of water vapor can cause changes in the sensor over time that may affect accuracy and cause drift. Also, when exposed to levels near saturation (95-100% RH), they can become inaccurate and be rendered non-functional. Other contaminants in the air may also have unwanted effects on sensor stability, accuracy or useful life.

Infrared-based water vapor measurement is "non-interactive" in nature. Infrared measurement does not depend on physical or chemical interaction with the sensor element. Telaire's Vaporstat™ sensor works on the principle that water vapor absorbs infrared light at a specific wavelength. The Vaporstat™ simply pulses infrared light through a sample of air and measures the amount of that light being absorbed by water molecules. The infrared detector undergoes no physical or chemical interaction, and because the sensor is slightly heated by the infrared source, it can measure concentrations at saturation levels.

1. Introduction

The Vaporstat™ represents the first infrared-based hygrometer for measurement applications in the range of 0 to 80 °F dew point. The sensor package is designed for wall mounting. Telaire also makes standard enclosures that allow the Vaporstat™ to be mounted in a variety of applications including aspirated sampling of in-duct concentrations, outside air measurement and measurement in wet environments.

This manual covers installation, wiring and adjustment of the sensor and provides conversion information to translate the dew point measurement of the sensor to other measurements of humidity, including grains/lb and relative humidity.

2. Specifications

Measurement Method
Non-Dispersive Infrared (NDIR), Dual-Channel, Non-Interactive, Non-Saturating

Sensor Output Units
°F dew point

Measurement Range
0°F to 80°F dew point (-18°C to 27°C dew point)

Typical Dew Point Accuracy @ 77°F (25°C), 26°F to 80°F DP Range (-3 to 27°C DP)
(As measured against a factory certified reference):
±3.6°F (2°C) dew point

Altitude Correction
User adjustable in 500 ft. increments using keypad

Operating Temperature Range
Room & Duct
32°F to 120°F (0°C to 49°C), 1508 enclosure required for duct mounting

Outdoor
-20°F to 120°F (-29°C to 49°C), when installed in 1551 enclosure

Storage Temperature:
14°F to 170°F, (-10°C to 77°C)

Input Power:
18 – 30 VAC, 50/60Hz (half wave rectified)
18 – 42 VDC
1.75 VA average, 2.75 VA peak

Analog Outputs (available simultaneously):
0-10 V DC (100 Ohm output impedance)
4 – 20 mA (RL_{max} – 500 Ohms)

Relay Output:
- Normally open and normally closed (SPDT)
- Gold Bifurcated, 2A max @ 24 V

On Board Keypad Adjustments:
- Select °F dew point output and display
- Measurement range
- Analog output range
- Zero concentration calibration (using nitrogen gas)
- Calibration to ambient air
- Relay set point
- Relay hysteresis (dead band)

Limited Warranty:
18 months (see warranty card for details)

Sensor Rated Life:
15 years

Installation:
- Wall
- Duct with aspiration box (model 1508)
- Outside air with enclosure (model 1551)

Accessories
2076 Calibration Kit

Field Calibration

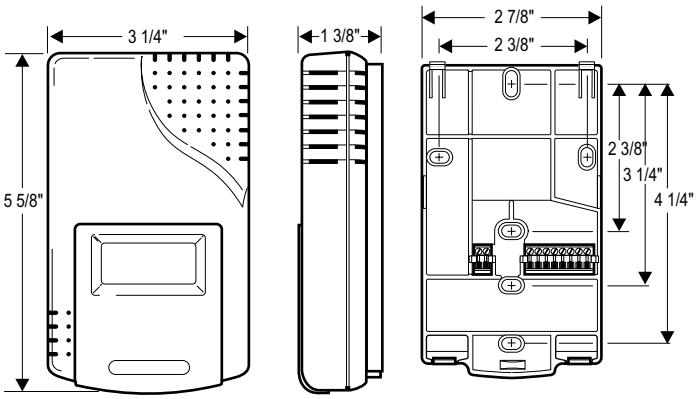
The Vaporstat™ features a dual-beam optical assembly that utilizes a neutral reference measurement to adjust for minute changes that may occur in the optics. Although this feature will minimize sensor drift, field calibration at sensor installation and subsequent periodic calibration is still recommended to maintain optimum accuracy.

Each sensor has an individually developed curve, based on a certified chilled mirror hygrometer, with over 8 calibration points. This individualized curve is stored in the sensor's permanent memory and is valid for the life of the sensor. Using a reference device to field calibrate the sensor at a known concentration re-establishes its original calibration accuracy. Reference devices include:

· A calibrated, reference dew point sensor

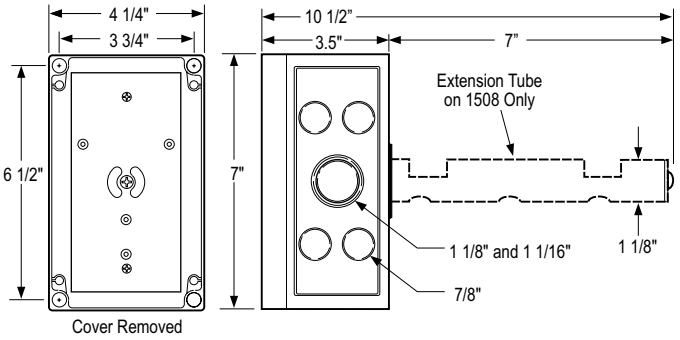
· Dry nitrogen gas, flowed through the sensor (Telaire Calibration Kit 2076)

3. Dimensional Drawings



Comes with separate mounting bracket. Middle view shown with bracket installed.

Accessory Enclosures



1505, 1508 and 1551 Enclosures. Enclosure housing is the same size for all 1500's with the exception of the 1508 which includes extension tube (as shown in illustration). The 1551 enclosure will allow the sensor to operate in low temperature environments to -20°F (-29°C)

4. Installing The Sensor

Basic Installation of the Mounting Plate & Sensor

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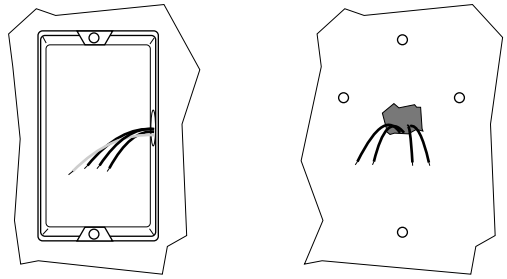

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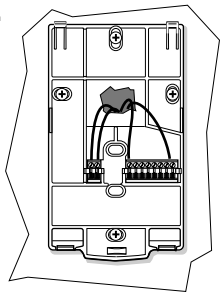

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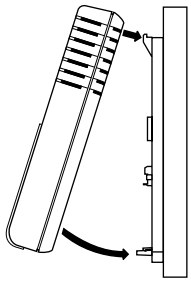

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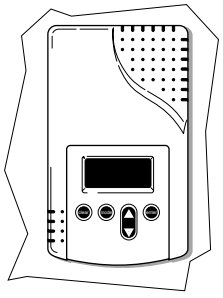

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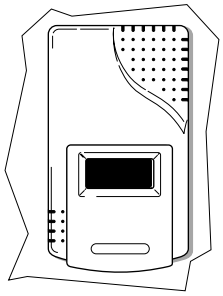
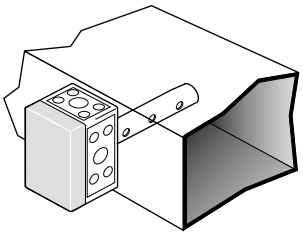


1. Prepare for installation by using the mounting holes configured for US or European junction boxes.
2. Use the mounting plate as a template to mark mounting holes.
3. Secure the Mounting Plate to the wall or junction box and make necessary wire connections.
4. Mount the Controller on the base by aligning the top clips and then securing to the bottom clips. A “snap” sound will indicate that the sensor is secure. The sensor will now have power. A 2 minute warm-up will take place. After 2 minutes, the sensor will stabilize and display the “**Normal Mode**” (current water vapor concentration).
5. Using the procedure noted in Section 7 adjust the sensor to provide the proper elevation correction for your location.
6. Finish installation by sliding the cover over the menu keys and secure with the supplied screw.

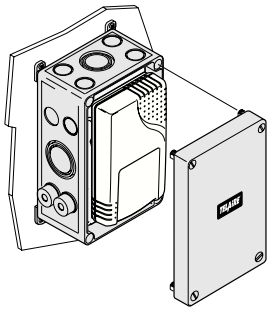
5. Accessory Enclosures

Model 1508 Duct Mount Enclosure (Aspiration Box)



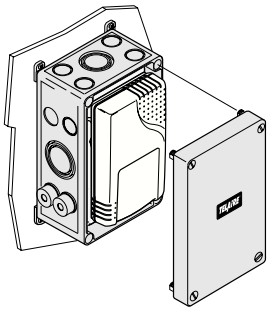
The Vaporstat™ can be installed inside a model 1508 Duct Mount Enclosure to measure water vapor in the ductwork. The enclosure is mounted outside the ductwork for ease of maintenance and operation. Refer to the model 1508 Duct Mount Enclosure installation instructions for complete details.

Model 1551 Outside Air Measurement Enclosure



The model 1551 Outside Air Measurement Enclosure allows the measurement of outside water vapor concentrations. This NEMA-3R weatherproof enclosure has two functions for a ventilation system: to control the system by directly comparing the outside and indoor water vapor levels; an internal temperature controller allows the sensor to make accurate outdoor measurements over an extended temperature range. Refer to the model 1551 Outside Air Measurement Enclosure installation instructions for complete details.

Model 1505 Harsh Environment Enclosure

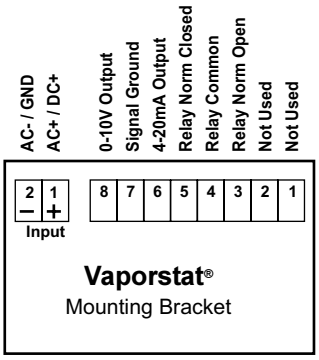


The Model 1505 Harsh Environment Enclosure allows you to measure water vapor in extreme environments where the sensor might be subjected to condensation or water spray such as those found in greenhouses or breweries. The 1505 is NEMA-3R rated like the 1551, but it does not have the internal heat stabilizers. Refer to the Model 1505 Harsh Environment Enclosure installation instructions for complete details.

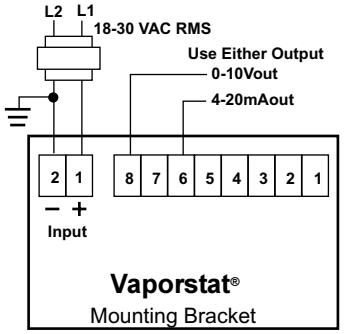
6. Typical Wiring Diagrams

The Vaporstat™ cannot be wired in a 2-wire configuration where the power supply also carries the current output of the sensor. Only the 3- and 4-wire configurations pictured above are possible.

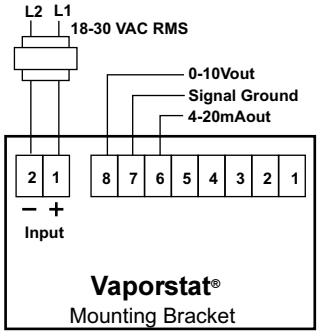
Pin Designations for the Mounting Bracket



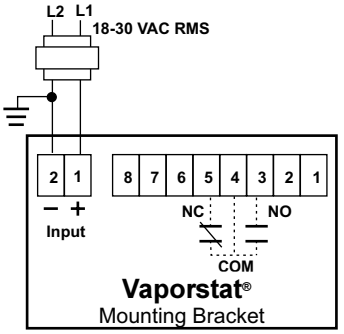
AC Power 3-Wire System



Isolated AC Power 4-Wire System



Using the Relay Contacts



7. Vaporstat™ Operating Modes & Adjustments

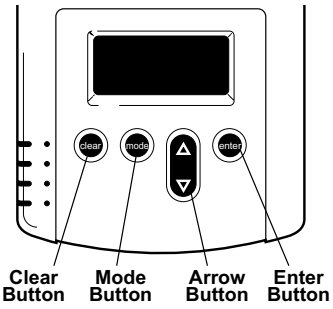
7.1 Operating Modes

The Vaporstat™ has three operating modes:

Measurement Mode: The sensor operates in the measurement mode.

Adjustment Mode: Allows for adjustment of sensor operational characteristics including altitude correction, configuration of display/output, adjust measurement range, adjust analog output signal range, adjust relay set point and dead band.

Calibration Mode: This mode can be used to calibrate the sensor in the field.



7.2 Keypad Buttons

Clear: Exit Adjustment or Calibration **mode** and return to measurement mode.

Mode: When in the Adjustment Mode, the **mode** button will advance the Vaporstat™ to the next variable that can be adjusted.

Arrows: Allows user to increase or decrease values or choose between selected variables in the sensor.

Enter: When an adjustment is made to the sensor, pressing the **enter** button will program the new setting or selection into the sensor.

Clear + Mode (3 sec): Enter Adjustment Mode

Clear + Enter (3 sec): Enter Calibration Mode

7.3 Adjusting the Sensor Using the Onboard Keypad

The sensor is shipped with the factory settings detailed below. These default settings can be adjusted using the keypad and procedures outlined in this section. When in Adjustment Mode, the selection of various adjustment parameters appears sequentially in the order detailed below. Pressing **clear** at any time will exit the Adjustment Mode.

Note: If an adjustment is made to any of the sensor parameters it will be retained by the Vaporstat™ even when the sensor is powered off. Adjustments to the output of the sensor will only apply to the unit of measure selected for the display mode. The non-selected display mode will continue to operate at its' factory setting. For example, if the output range of the dew point measurement is adjusted, the grains/lb settings will not be affected and remain at the initial factory settings.

Factory Settings

Default Measurement Unit	Dew Point	
Selected Measurement Unit	Dew Point	Grains/lb
Display	°F Dew Point	Grains/lb
Measurement Range	0-80°F Dew Point	0-140 Grains/lb
Analog Output	0-10V and 4-20 mA	0-10V and 4-20 mA
Relay Set Point	55°F Dew Point	65 Grains/lb
Relay Hysteresis (Dead Band)	2°F Dew Point	5 Grains/lb
Altitude	N/A	Sea Level (0 feet)

7.3.1 Adjustment Required For Installation

Select Display Units (°F dew point or grains/lb): Factory set for dew point. The units selected for display on the LCD will also correspond to the units used for the analog output and relay setting of the Vaporstat™

Set Elevation: Since the density of air and gases are affected by altitude, a correction must be made to the reading in grains/lb units, depending on the altitude. A local weather office can provide you with your area's average elevation (elevations for most major cities are also available at www.telaire.com. Use the navigation menu to go to Support > IAQ >Altitude Reference Chart. The sensor is factory set for sea level operation.

Calibration: It is also recommended that the user perform a single point zero or ambient calibration of the sensor to ensure maximum accuracy at start-up, for details please refer to Section 8, Calibration.

To Place In Adjustment Mode

1. Hold the **clear + mode** buttons for 5 seconds
2. Each adjustment mode will appear sequentially on the display. Pressing **mode** or **enter** will move to the next adjustment value. As described below, the sequence that adjustment values will appear in is as follows: Altitude, Display Units, Analog Output, and Relay.

To Adjust Altitude

1. Use the **arrow button** to adjust altitude up or down in 500-foot increments
2. When altitude is set press **enter** to store the correction in the sensor
3. Press **mode** to move to water vapor display or **clear** to exit Adjustment Mode

To Select Display/Output Units between Dew Point (DEW PT) or Grains/lb (Grains)

1. Press **mode** button to leave or skip the elevation selection
2. Use **arrows** to select **GRAINS** or **DEW PT**
3. Press **enter** to confirm selection
4. Press **mode** to move to SETTINGS or **clear** to exit Adjustment Mode

See section 8 for instructions on Calibration.

7.3.2 Output Adjustments

It is only necessary to make the adjustments described in this section if you would like to adjust the measurement range of the sensor, and/or the analog output range or adjust relay settings. If you do not wish to make these adjustments press **clear** after your have selected the display/output units.

To Adjust Output Ranges

1. Use the steps described in 7.3.1 to cycle through the startup adjustments on the sensor until you see the display SETTINGS.
2. Press the **mode** button to begin to adjust settings.

Adjust Measurement Value for Lower Output Limit (doesn't affect display)

1. The display will indicate **GRN FROM** or **DP FROM**
2. Use the **arrow** button to adjust the sensor output value you want to correspond to the low limit used for the analog output.
3. Press **enter** to confirm selection, an arrow should flash on the lower display (not necessary if no adjustment is made).
4. Press **mode** to move to the next selection

Adjust Measurement Value for Upper Output Limit (doesn't affect display)

1. The display will indicate **GRN TO** or **DP TO**
2. Use the **arrow** button to adjust the sensor output value you want to correspond to the upper limit used for the analog output (note it is possible to adjust the output to consider concentrations up to 300 grains or a 100°F dew point)
3. Press **enter** to confirm selection (not necessary if no adjustment is made).
4. Press **mode** to move to the next selection

Analog Output: The analog output of the sensor will correspond to the units selected for the LCD display. The sensor is factory set to provide linear 0-10 volt and 4-20ma outputs over the full measurement scale of the sensor. If necessary, the analog output range and the measurement range can be user-adjusted to meet any unique requirements as described below (e.g. a data logger, which may only accept a 0-5 volt input).

Select Analog Output Scaling Units

1. The top line of the display will read **OUTPUT:**
2. Use the **arrow** button to select if you want to scale the measurement range to **V** or **mA**. (Note: The scaling adjustment you select will be applied to both the voltage and mA output. For example, if you program a 0-5 volt output for a 0 to 80 F measurement range, the mA output will be 4-12mA for a 0 to 80 F measurement range.)
3. Once you have selected the preferred value for scaling (**V** or **mA**) press **mode**

Select Lower Limit For Analog Output

1. The top line of the display will read **V FROM** (or **mA FROM**)
2. Use the **arrow** button to select the lower analog output value you wish to use to correspond to the low limit measurement value set in Step 2 above
3. Press **enter** to confirm selection (not necessary if no adjustment is made)
4. Press **mode** to move to the next selection

Select Upper Limit For Analog Output

1. The top line of the display will read **V TO** (or **mA TO**)
2. Use the **arrow** button to select the upper analog output value you wish to use to correspond to the low limit measurement value set in Step 3 above
3. Press **enter** to confirm selection (not necessary if no adjustment is made)
4. Press **mode** to move to the next selection

Relay Set Point & Hysteresis: The normally open/closed relay contacts can be set to a specific set point and hysteresis (dead band). The set point is the point at which the relay is energized as concentrations rise. Hysteresis is the difference at which the relay de-energizes when concentrations drop below the set point. The sensor relay is factory-set to energize at 55°F dew point (65 grains/lb). The hysteresis is factory-set at 2°F dew point (5 grains/lb).

To Adjust Relay Activation Levels

1. The top line of the display will read **RELAY ON**
2. Use **arrows** to select relay on value desired (set point)
3. Press **enter** to confirm selection
4. Press **mode** button to go to the next selection
5. The top line of the display will read **HYSTER**
6. Use **arrows** to select relay hysteresis value desired (dead band)
7. Press **enter** to confirm selection
8. Press **mode** button to exit adjustment mode

8. Calibration

8.1 Overview

Periodic calibration of the Vaporstat™ is recommended to maintain optimum accuracy throughout the life of the sensor. Sensor calibration can be verified or reestablished at any time by using a reference device. Appropriate reference devices include a recently calibrated hand-held dew point sensor, or flowing a zero calibration gas through the sensor. Calibration using this technique will reestablish the sensor to its' original factory calibration curve.. Telaire offers the model 2076 calibration kit, which provides a zero calibration gas, certified to have less than 0.1 grains/lb of water vapor content, and is ideal for this purpose.

Infrared sensors are unique in that sensor drift occurs at the zero point of the sensor calibration and not the span concentration; therefore span calibration of the sensor is not required.

Please refer to the model 2076 calibration kit manual for additional information.

8.2 Calibration Description

The sensor provides two choices for calibration. Each method adjusts the zero setting of the sensor. Only one of these methods should be used for a calibration.

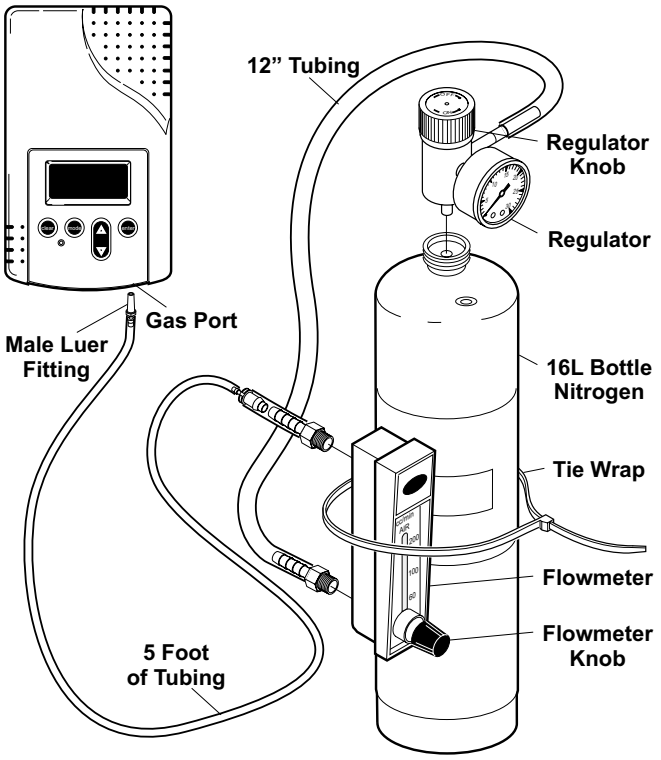
Single Point Calibration: This calibration mode allows the user to calibrate the sensor in ambient air to a known concentration as measured by a recently calibrated reference device (e.g. a hand held sensor which displays dew point or grains). This type of calibration will ensure that the greatest sensor accuracy is provided at or near this concentration used for calibration. This type of calibration is particularly recommended if high accuracy of the sensor is required over a narrow range of operation (e.g. clean rooms). To perform this calibration you must feel confident that the reference device you are using has been recently and properly calibrated. The calibration kit is not necessary to perform a Single Point Calibration.

Zero Point Calibration : This calibration mode allows the user to calibrate the sensor to a verified zero concentration of water vapor.

8.3 Calibration Procedure

Determine which calibration procedure you will use to calibrate the sensor - Single Point or Zero Point calibration. For best results, the sensor should be allowed to warm-up for at least ten minutes prior to calibration.

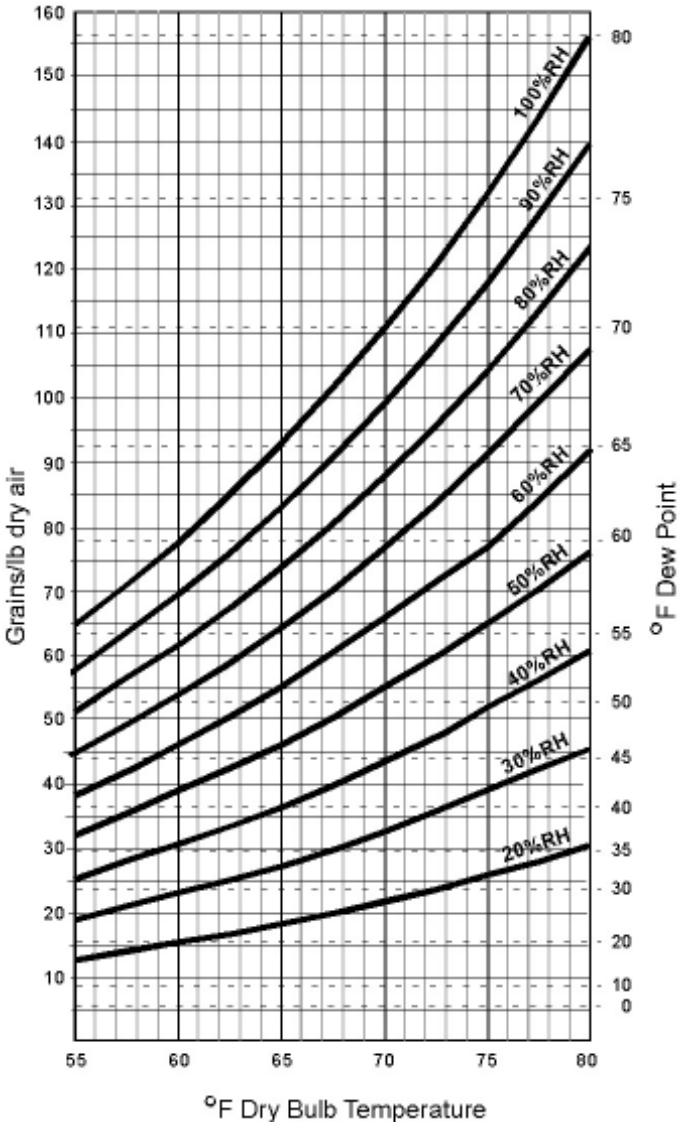
8.3.1 Single Point Calibration the reference measurement device should be warmed up and in normal measurement/ operating mode. The Vaporstat™ should be in an environment where concentrations will remain very stable for a minimum of 10 minutes during calibration. Avoid breathing in the direction of the sensor. Exhaled air contains high levels of moisture and could disrupt the calibration process.



1. Press and hold the **clear + enter** buttons on the Vaporstat™ for 5 seconds. The word **CAL** will appear in the top line of the LCD Display.
2. Use the arrow buttons to change the display to read **SINGLE**. When **SINGLE** is displayed, a water vapor value will display in the lower screen.
3. Use the arrow button to adjust the sensor to reflect the concentration displayed on your reference device.
4. Press the **enter** button to calibrate the sensor to the value selected on the display based on ambient air conditions. Once the **enter** button is pressed the calibration process will take approximately 8 minutes, during which time the green LED below the display will flash. Once calibration is complete the sensor will revert to its normal display mode.

8.3.2 Zero Point Calibration all tubing should be connected between the gas bottle and the sensor inlet flow port. Gas should be flowing to the sensor at a rate of 80-100 cc/minute for a minimum of 5 minutes prior to initiating calibration.

1. Attach the short hose to the bottom port on the flow meter.
2. Attach the long hose to the top port on the flow meter.
3. To insure the meter is kept in the vertical position, secure the flow meter to the side of gas bottle using the supplied tie wrap
4. Remove the protective cap from the nitrogen bottle and attach the gas regulator
5. Attach the open end of the bottom hose (located on the flow meter) to the gas regulator. Slide the hose far enough on the gas port to ensure a secure, airtight connection
6. Insert the male Luer fitting (located on the longer hose) into the calibration port, located on the bottom of the Vaporstat™.
7. Verify all the components are installed correctly and initiate the calibration process by turning the knob on the regulator. Turn the knob until the indicator reaches 7 PSI
8. Turn the flow meter knob until the floater reaches 80-100 cc/min
9. Allow the gas to flow for at least 5 minutes before proceeding
10. Press and hold the **clear + enter** buttons on the keypad for 5 seconds. The word **CAL** will appear in the top line of the LCD Display
11. Use the arrow buttons to toggle to the **ZERO** calibration mode
12. When **ZERO** is displayed, press the **enter** button to initiate the calibration process
13. Once the **enter** button is pressed the calibration process will take approximately 8 minutes, during which time the green LED below the display will flash repeatedly. Once calibration is complete the sensor will revert to its normal display mode.
14. Once the display has returned to normal, turn the gas off and disconnect the tubing connection to complete the process



9.0 Conversion Factors

9.1 Dew Point & Relative Humidity (RH)

While the measure of relative humidity is highly dependent on the temperature of air, the measurement of dew point is not. We can use dew point to predict what the relative humidity of air will be at a particular temperature. For a designer or controls contractor this means that dew point can be used to predict and control water concentrations in air to ensure a target relative humidity is not exceeded for a design indoor temperature condition. The chart (on right) can be used to establish dew point set points for various common target relative humidity levels over a range of typical conditioned space temperatures.

10. Troubleshooting

Symptom

·LCD Display is blank after the 2-minute warm-up period.

Remedy

·Remove the sensor from the wiring plate and check the voltage on pins 1 and 2 of the 2-pin terminal block. The voltage should be: 18-30 VAC RMS or 18-42 VDC.

·Ensure that the sensor pins that connect to the 2-pin terminal block are not broken, bent, or damaged.

·If the LCD display is still blank after replacing the sensor on the mounting plate, call Telaire or your distributor/dealer for a return authorization number.

Symptom

·Green light is not illuminated after the two-minute warm-up period.

Remedy

·Remove the sensor from the wiring plate and check the voltage on pins 1 and 2 of the 2-pin terminal block. The voltage should be: 18-30 VAC RMS or 18-42 VDC.

·Ensure that the two pins on the sensor that connect to the 2-pin terminal block are not broken, bent, or damaged.

·If the green light is still not illuminated after replacing the sensor on the mounting plate, try verifying the sensor operation using the Vaporview™ software or checking the output signal on the building automation system.

·If there is not an output signal, call Telaire or your distributor/dealer for a return authorization number.

Symptom

·Suspect the sensor is out of calibration.

Remedy

· Perform a zero calibration on the sensor using the procedure described in step 8.

Symptom

·Relay does not actuate at the proper set point.

Remedy

·Using the LCD menu, verify that the relay set point is correct.

·If the relay does not actuate at the proper set point, call Telaire or your distributor/dealer for a return authorization number.

This product is covered by one or more of the following patents:

5,650,624
5,721,430
5,444,249
5,747,808
5,834,777
5,163,332
5,340,986
5,502,308
6,344,798
6,023,069
5,370,114
5,601,079
5,691,704
5,767,776
5,966,077
6,107,925
5,798,700
5,945,924
5,592,147
6,255,653
6,250,133
6,285,290

Warranty

Telaire seeks to present reliable information concerning the composition, properties and use of its products, however; (1) All advice concerning selection and use of any product is provided at no charge and with no warranty. (2) No warranty is made hereby. Products described herein are warranted to conform to Telaire specifications only at the time of sale. All sales are subject to Telaire standard terms and conditions, which are reproduced on the reverse side of each invoice. All warranties of merchantability and fitness of purpose are disclaimed and remedy for any breach of warranty is limited to replacement of the defective product. (3) Telaire assumes no responsibility for any patent liability arising from the use of any product in a process, manner or formula not designed by Telaire.

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