VP-4

Vapor Pressure, Temperature, Barometric Pressure & Relative Humidity Sensor

Operator's Manual

Decagon Devices, Inc.

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1 Introduction

1.1 Customer Support

If you ever need assistance with your VP-4, or if you just have questions or feedback, there are several ways to contact us. Customer service representatives are available to speak with you Monday through Friday, between 7am and 5pm Pacific time.

Note: If you purchased your VP-4 through a distributor, please contact them for assistance.

Email:
support@decagon.com or **sales@decagon.com**

Phone:
509-332-5600

Fax:
509-332-5158

If contacting us by email or fax, please include as part of your message your instrument serial number, your name, address, phone, fax number, and a description of your problem or question.

Please read these instructions before operating your sensor to ensure that it performs to its full potential.

1.2 Warranty

The sensor has a 30-day satisfaction guarantee and a one-year warranty on parts and labor. Your warranty automatically validates upon receipt of the instrument.

10 Declaration of Conformity

Application of Council Directive:	2004/108/EC and 2011/65/EU
Standards to which conformity is declared:	EN 61326-1:2013 and EN 50581:2012
Manufacturer's Name:	Decagon Devices, Inc. 2365 NE Hopkins Ct. Pullman, WA 99163 USA
Type of Equipment:	Temperature, Humidity, Pressure Sensor
Model Number:	VP-4
Year of First Manufacture:	2015

This is to certify that the VP-4 manufactured by Decagon Devices, Inc., a corporation based in Pullman, Washington, USA meets or exceeds the standards for CE compliance as per the Council Directives noted above. All instruments are built at the factory at Decagon and pertinent testing documentation is freely available for verification.

9 References

Buck, A.L.. (1981). New equations for computing vapor pressure and enhancement factor. *Journal of Applied Meteorology*, 20, 1527-1532.

Goff, J.A. and S. Gratch. (1946). Low-pressure properties of water from $-160°$ to 212 °F. *Transactions of the American society of heating and ventilating engineers*, 51, 125-164.

Murray, F.W.. (1967). On the computation of saturation vapor pressure. *Journal of Applied Meteorology*, 6, 203-204.

WMO. (2008). Guide to meteorological instruments and methods of observation. *World Meteorological Organization*, 7, 8, Geneva, Switzerland.

1.3 Seller's Liability

Seller warrants new equipment of its own manufacture against defective workmanship and materials for a period of one year from the date of receipt of equipment.

Note: We do not consider the results of ordinary wear and tear, neglect, misuse, accident as defects.

The Seller's liability for defective parts shall in no event exceed the furnishing of replacement parts "freight on board" the factory where originally manufactured. Material and equipment covered hereby which is not manufactured by Seller shall be covered only by the warranty of its manufacturer. Seller shall not be liable to Buyer for loss, damage or injuries to persons (including death), or to property or things of whatsoever kind (including, but not without limitation, loss of anticipated profits), occasioned by or arising out of the installation, operation, use, misuse, nonuse, repair, or replacement of said material and equipment, or out of the use of any method or process for which the same may be employed. The use of this equipment constitutes Buyer's acceptance of the terms set forth in this warranty. There are no understandings, representations, or warranties of any kind, express, implied, statutory or otherwise (including, but without limitation, the implied warranties of merchantability and fitness for a particular purpose), not expressly set forth herein.

2 About VP-4

The VP-4 measures air temperature, relative humidity (RH), vapor pressure, and barometric pressure. A microprocessor within the VP-4 calculates vapor pressure from the RH and temperature measurements. The VP-4 uses a sensor chip to measure both air temperature and RH and a secondary chip to measure barometric pressure. Each VP-4 has calibrations coefficients stored on board. The calibration coefficients are applied before data are output. Air temperature, relative humidity, vapor pressure, and barometric pressure are output from the sensor using an RS232 (TTL) string and the common SDI-12 communication protocol.

The VP-4 sensor is packaged in a rugged Delrin housing with the sensor electronics potted in marine grade polyurethane encapsulant. The RH/T sensor chip is protected by a hydrophobic porous Teflon filter that is water and dust proof, but has an extremely high vapor conductance allowing fast sensor equilibration with the surrounding atmosphere. An additional stainless steel screen protects the Teflon filter and RH/T sensor from impact and abrasion. The rugged design allows the VP-4 to withstand long term exposure to hostile conditions, making it ideal for a wide range of applications including standard meteorological monitoring, evapotranspiration measurement, greenhouse monitoring and control, concrete moisture monitoring, and building humidity monitoring for mold prevention and remediation.

2.1 Specifications

Relative Humidity

Range: 0 to 100% RH

Resolution: 0.1% RH

Accuracy: Sensor measurement accuracy is variable across a range of RH. Refer to the chart in Figure 1 to determine the accuracy specification for the VP-4 sensor:

8 Troubleshooting

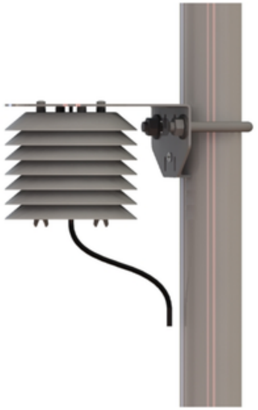
If you encounter problems with the VP-4 sensor, they most likely manifest themselves in the form of no reading from communication problems, catastrophic sensor failure, or highly inaccurate measurements due to sensor poisoning by volatile chemicals. Before contacting Decagon about the sensor, do the following:

Data Logger

1. Check to make sure the connections to the data logger are both correct and secure.
2. Ensure that your data logger batteries are not dead or weakened.
3. Check the configuration of your data logger in ECH2O Utility or ECH2O DataTrac to make sure you have selected VP-4.

Sensors

1. Check sensor cables for nicks or cuts that could cause a malfunction.
2. Check your screen and filter to make sure that they are not contaminated or blocked. Airflow must not be restricted through the filter.
3. In the case of inaccurate readings, consider evaluating sensor accuracy and/or reconditioning the sensor as described in the RH Sensor section.



Note: Be sure to fasten the sensor cord to your mounting post to help support the weight of the cable in order to prevent it from being pulled out.

Equilibration Time (τ, 63%): <40 s (response time in 1 m/s air stream)

Hysteresis: <1% RH typical

Long term Drift: <0.5% RH/year typical

Humidity Accuracy [%RH]

Humidity [%RH]	0°C	10°C	20°C	30°C	40°C	50°C	60°C	70°C	80°C
100%	±5%	±5%	±5%	±5%	±5%	±5%	±5%	±6%	±10%
95%	±5%	±5%	±4%	±4%	±4%	±4%	±4%	±5%	±8%
90%	±5%	±4%	±2%	±2%	±3%	±3%	±4%	±5%	±8%
85%	±5%	±4%	±2%	±2%	±3%	±3%	±4%	±5%	±8%
80%	±4%	±4%	±2%	±2%	±3%	±3%	±3%	±4%	±6%
75%	±4%	±4%	±2%	±2%	±3%	±3%	±3%	±4%	±6%
70%	±4%	±4%	±2%	±2%	±3%	±3%	±3%	±4%	±6%
65%	±4%	±4%	±2%	±2%	±3%	±3%	±3%	±4%	±6%
60%	±4%	±3%	±2%	±2%	±2%	±2%	±2%	±3%	±5%
55%	±4%	±2%	±2%	±2%	±2%	±2%	±2%	±3%	±5%
50%	±4%	±2%	±2%	±2%	±2%	±2%	±2%	±3%	±5%
45%	±4%	±2%	±2%	±2%	±2%	±2%	±2%	±3%	±4%
40%	±4%	±2%	±2%	±2%	±2%	±2%	±2%	±3%	±4%
35%	±4%	±3%	±2%	±2%	±2%	±2%	±2%	±3%	±4%
30%	±4%	±3%	±2%	±2%	±2%	±2%	±2%	±3%	±4%
25%	±4%	±3%	±2%	±2%	±2%	±2%	±2%	±3%	±4%
20%	±4%	±4%	±2%	±2%	±3%	±3%	±3%	±3%	±4%
15%	±5%	±4%	±2%	±2%	±3%	±3%	±4%	±4%	±5%
10%	±8%	±5%	±3%	±3%	±4%	±4%	±4%	±5%	±8%
5%	±8%	±8%	±5%	±5%	±5%	±5%	±5%	±6%	±10%
0%	±12%	±12%	±5%	±5%	±6%	±6%	±6%	±10%	±12%

Temperature [°C]

Figure 1: Humidity Accuracy Chart

Temperature

Range: −40 °C to 80 °C

Resolution: 0.1 °C

Accuracy: Sensor measurement accuracy is variable across a range of temperatures. Refer to the chart in Figure 2 to determine the accuracy specification for the VP-4 sensor:

Equilibration Time (τ, 63%): < 400 s (response time in 1 m/s air stream)

Long term drift: < 0.04 °C/year typical

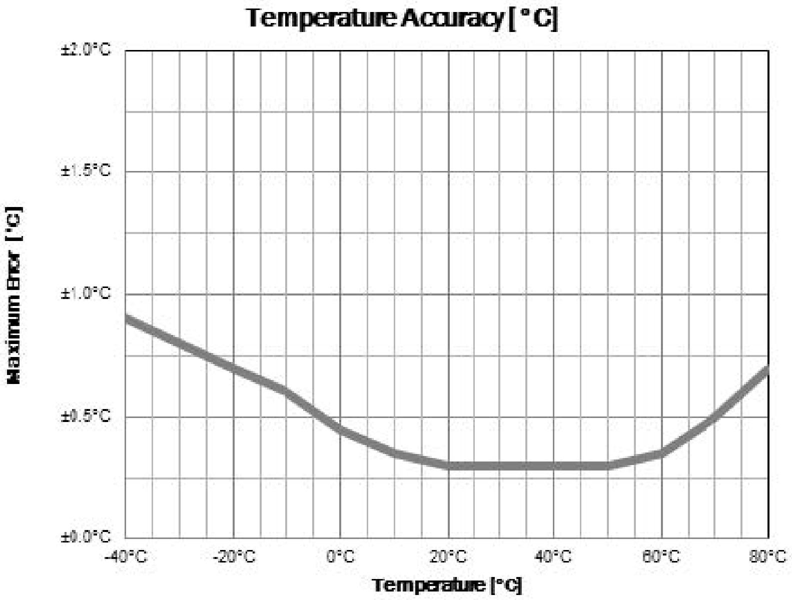


Figure 2: Temperature Accuracy Chart

Vapor Pressure

Range: 0 to 47 kPa

Resolution: 0.001 kPa

Accuracy: Sensor measurement accuracy is variable across a range of temperatures and RH. Refer to the chart below to determine the accuracy specification for the VP-4 sensor:

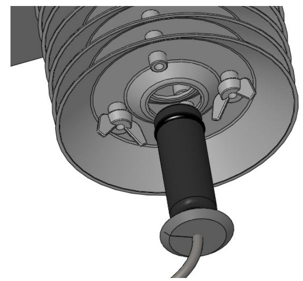
7 Installation

Installation in a Radiation Shield

Relative humidity is measured at the temperature of the humidity sensor. For this to be an accurate representation of the atmospheric humidity, it is critical that the humidity sensor be at air temperature. For most outdoor and greenhouse measurement scenarios, house the VP-4 in a radiation shield with adequate air flow to allow the sensor to come into equilibrium with air temperature. In general, temperature and humidity measurements become more accurate as wind speed increases. A radiation shield is not critical for non-greenhouse, indoor monitoring applications where radiation loading is small.

Decagons radiation shield comes with a mounting bracket and seven discs that prevent direct sunlight from coming into coming contact with the sensor. This isolation from solar radiation prevents false readings of elevated temperatures, allowing for accurate measurement of ambient air temperature. To install the sensor in the radiation shield follow the directions 1 through 4.

1. Gently pry the white cap from the bottom center hole of the radiation shield.
2. Slide the white cap onto the cable of the sensor.
3. Insert the sensor into the bottom of the shield and snap the cap back into place.



4. The unit can then be mounted on the desired surface for your study.

Direct SDI-12 communication is supported in the Terminal Emulator mode under the “Tools” menu on the Connect screen. Detailed information on setting the address using CSI data loggers can be found on our website at http://www.decagon.com/support/downloads.

Power

The VP-4 is an extremely low power sensor. When continuously powered, but not making a measurement or communicating, it uses 30μA. When using the sensor as part of an SDI-12 bus, it is recommended that the sensors be excited continuously to avoid issues with initial sensor startup interfering with the SDI-12 communications.

Reading

When reading the VP-4 in SDI-12 mode, the first number output by the sensor is vapor pressure in kPa, the second number is temperature in Celsius, the third number is relative humidity in a unitless ratio from 0 to 1 (0 to 100%), and the fourth number is barometric pressure in kPa.

Vapor Pressure Accuracy [kPa]

Humidity [%RH] \ Temperature [°C]	0°C	10°C	20°C	30°C	40°C	50°C	60°C	70°C	80°C
100%	± 0.05	± 0.09	± 0.16	± 0.29	± 0.49	± 0.81	± 1.30	± 2.62	± 6.32
95%	± 0.05	± 0.09	± 0.14	± 0.24	± 0.41	± 0.68	± 1.08	± 2.26	± 5.27
90%	± 0.05	± 0.07	± 0.09	± 0.15	± 0.33	± 0.54	± 1.06	± 2.23	± 5.20
85%	± 0.05	± 0.07	± 0.08	± 0.15	± 0.33	± 0.53	± 1.05	± 2.19	± 5.13
80%	± 0.04	± 0.07	± 0.08	± 0.15	± 0.32	± 0.53	± 0.83	± 1.84	± 4.07
75%	± 0.04	± 0.07	± 0.08	± 0.14	± 0.31	± 0.52	± 0.82	± 1.80	± 4.00
70%	± 0.04	± 0.07	± 0.08	± 0.14	± 0.31	± 0.51	± 0.81	± 1.77	± 3.93
65%	± 0.04	± 0.07	± 0.08	± 0.13	± 0.30	± 0.50	± 0.79	± 1.73	± 3.86
60%	± 0.04	± 0.05	± 0.07	± 0.13	± 0.22	± 0.36	± 0.57	± 1.38	± 3.30
55%	± 0.04	± 0.04	± 0.07	± 0.13	± 0.22	± 0.35	± 0.56	± 1.34	± 3.23
50%	± 0.03	± 0.04	± 0.07	± 0.12	± 0.21	± 0.34	± 0.55	± 1.31	± 3.16
45%	± 0.03	± 0.04	± 0.07	± 0.12	± 0.20	± 0.33	± 0.53	± 1.27	± 2.60
40%	± 0.03	± 0.03	± 0.07	± 0.12	± 0.20	± 0.33	± 0.52	± 1.24	± 2.53
35%	± 0.03	± 0.05	± 0.06	± 0.11	± 0.19	± 0.32	± 0.50	± 1.20	± 2.46
30%	± 0.03	± 0.05	± 0.06	± 0.11	± 0.19	± 0.31	± 0.49	± 1.17	± 2.39
25%	± 0.03	± 0.04	± 0.06	± 0.10	± 0.18	± 0.30	± 0.48	± 1.14	± 2.32
20%	± 0.03	± 0.06	± 0.06	± 0.10	± 0.25	± 0.41	± 0.67	± 1.10	± 2.25
15%	± 0.03	± 0.05	± 0.05	± 0.10	± 0.24	± 0.40	± 0.85	± 1.39	± 2.67
10%	± 0.05	± 0.07	± 0.08	± 0.14	± 0.31	± 0.52	± 0.84	± 1.67	± 4.08
5%	± 0.05	± 0.10	± 0.12	± 0.22	± 0.38	± 0.64	± 1.03	± 1.96	± 5.00
0%	± 0.08	± 0.15	± 0.12	± 0.22	± 0.45	± 0.75	± 1.22	± 3.21	± 5.92

Figure 3: Vapor Pressure Accuracy

Barometric Pressure

Range: 49 to 109 kPa

Resolution: 0.01 kPa

Accuracy: 0.4 kPa

General

Dimensions: 1.96 cm (dia) x 5.4 cm (h)

Power requirements: 3.6 to 15 VDC, 0.03 mA quiescent, 4 mA during 300 ms measurement

Response (Measurement) Time: 300 ms

Output: Decagon Digital or SDI-12

Operating Temperature: −40 to 80 °C

Connector types: 3.5 mm (stereo) plug or stripped & tinned lead wires (Pigtail)

Cable Length: 5 m standard; custom cable length available upon request

Data Logger Compatibility (not exclusive):
Decagon: Em50, Em50R, Em50G (Firmware 2.19+)
Campbell Scientific: Any logger with serial I/O (CR10X, CR850, 1000, 3000, etc.)

Handheld Reader Compatibility: ProCheck (rev 1.57+)

Software Compatibility
ECH2O Utility (rev 1.74+)
DataTrac (rev 3.11+)

Table 2: SDI-12 Commands

Send Identification	aI!	a13DECAGON VP-4 385<CR><LF>
Change Address	aAb!	b<CR><LF>(b is new address)
Address Query	?!	a<CR><LF>
Start Measurement	aM!	a0013<CR><LF>
Send Data	aD0!	a+1.170 + 21.5 + 0.457 +92.25<CR><LF>(4 values)

SDI-12 Sensor Bus

Up to 62 sensors can be connected to the same 12 V supply and communication port on a data logger. This simplifies wiring because no multiplexer is necessary. However, one sensor problem can bring down the entire array (through a short circuit or incorrect address settings). If you use an SDI-12 sensor bus we recommend that you make an independent junction box with wire harnesses where all sensor wires attach to lugs so sensors can be disconnected individually if a problem arises. A single three-wire cable can be run from the junction box to the data logger.

SDI-12 Address

The SDI-12 protocol requires that all sensors have a unique address. VP-4 sensors come from the factory with an SDI-12 address of 0. To add more than one SDI-12 sensor to a system, the sensor address must be changed. Address options include 0...9, A...Z, a...z. The best and easiest way to change an address is to use Decagon's ProCheck (if the option is not available on your ProCheck, please upgrade to the latest version of firmware). SDI-12 addressing can be accessed in the CONFIG menu by selecting SDI-12 Address. Addresses may then be changed by simply pressing the up or down arrows until you see the desired address and pushing Enter.

The SDI-12 communication protocol is supported by Campbell Scientific data loggers like the CR10X, CR200, CR1000, CR3000, etc.

6 Communication

The Decagon VP-4 sensor can communicate using two different methods, Decagon serial string or SDI-12 communication protocol. In this chapter we briefly discuss the specifics of each of these communication methods. Please visit www.decagon.com/support/literature for the complete Integrator's Guide, which gives more detailed explanations and instructions.

6.1 Digital Communication for Data Logger

SDI-12 Communication

The communications between the VP-4 and the Decagon logger is automatic and only requires you to select the correct sensor configuration for the sensor port. When a Decagon logger applies excitation voltage, the VP-4 sensor makes a measurement. Within about 550 ms of excitation three measurement values transmit to the data logger as a serial stream of ASCII characters complete with checksum and sensor identification. Please see the VP-4 Integrators Guide.docx document available from www.decagon.com/support/literature for more information on this communication protocol.

SDI-12 Commands

Table 2 provides SDI-12 commands that the VP-4 sensor responds to. The sensor address is shown as a. If a ? is substituted for a all addresses respond.

3 Theory

Relative Humidity

The VP-4 utilizes a capacitance type RH sensor to measure the relative humidity of the surrounding air. Relative humidity is measured at the same location as the temperature sensor. For this to be an accurate representation of the atmospheric humidity, it is critical that the humidity sensor be at air temperature. For most measurement scenarios, the VP-4 should be housed in a radiation shield with adequate air flow to allow the sensor to come into equilibrium with air temperature. This is not as critical for non-greenhouse, indoor monitoring applications where radiation loading is small.

The VP-4 sensor provides a RH measurement that is referenced to saturation vapor pressure over liquid water, even at temperatures below freezing where ice is likely to be present instead of super cooled water. Although this is the standard way to define RH (WMO, 2008), it has the disadvantage of providing incorrect RH values below freezing when referenced to ice. The figure below shows the maximum RH the VP-4 measures at saturation, 100% RH and with temperatures below zero. RH values below saturation can be corrected using the correction shown in the figure for a given temperature.

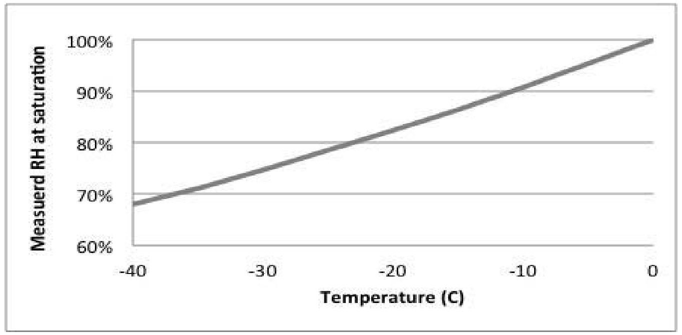


Figure 4: RH Value Corrections

Temperature

The VP-4 has a band gap temperature sensor integrated into the sensor electronics. The temperature sensor is located with the RH sensor and accurately measures the sensor temperature. Sensor temperature should remain close to air temperature if you adequately shield and aspirate the VP-4 radiation shield.

Vapor Pressure

Vapor pressure is calculated from the primary measurements of sensor RH and sensor temperature. The saturation vapor pressure (e_s) is calculated from the sensor temperature using the Magnus-Tetens equation for calculating saturation vapor pressure over liquid water formulated by Murray (1967)

$$e_s = a exp\left(\frac{bT}{T + c}\right) \tag{1}$$

with coefficients described by Buck (1981): $a = 0.611$ kPa, $b = 17.502$, $c = 240.97\ °C$, and T is temperature in $°C$. Vapor pressure is simply the product of saturation vapor pressure and RH, with RH expressed as a unitless ratio ranging from 0 to 1.

$$Vapor\ Pressure = e_s \times RH \tag{2}$$

Unlike relative humidity, vapor pressure does not depend on temperature, and is relatively conservative over small spatial scales. This means that the vapor pressure of the atmosphere near the VP-4 is the same as the vapor pressure at the VP-4 sensor, even if the VP-4 is not at the same temperature as the atmosphere. Additionally, it is the vapor pressure of the atmosphere (not RH) that controls the rate of vapor phase water transport (e.g. evaporation, transpiration, and distribution of water vapor). As discussed above, RH measurements below a temperature of 0 °C introduce errors introduced due to the use of liquid water as the reference. However, because the Buck (1981) formulation for liquid water is used to calculate vapor pressure over the full temperature range, VP-4 vapor pressure output values are correct over the full temperature range.

digital input, the bare ground wire to ground as illustrated below.

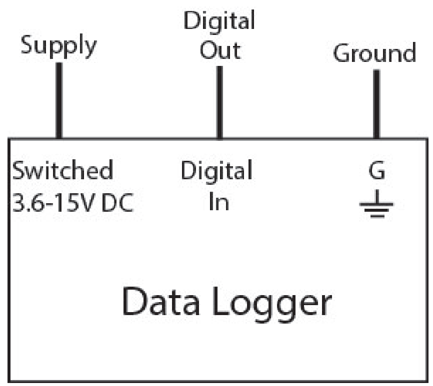


Figure 7: Wiring Diagram

Note: The acceptable range of excitation voltages is from 3.6 to 15 VDC. If you wish to read the VP-4 with the Campbell Scientific Data Loggers, you must power the sensors off a 12 V or switched 12 V port.

If your VP-4 has a standard 3.5 mm plug, and if you wish to connect it to a non-Decagon data logger, you have two options. First, you can clip off the plug on the sensor cable, strip and tin the wires, and wire it directly into the data logger. This has the advantage of creating a direct connection with no chance of the sensor becoming unplugged; however, it then cannot be easily used in the future with a Decagon readout unit or data logger. The other option is to obtain an adapter cable from Decagon. The 3-wire sensor adapter cable has a connector for the sensor jack on one end, and three wires on the other end for connection to a data logger (this type of wire is often referred to as a "pigtail adapter"). Both the stripped and tinned adapter cable wires have the same termination as seen above; the white wire is excitation, red is output, and the bare wire is ground.

val. Logger configuration may be done using either ECH2O Utility or DataTrac 3 (see respective manuals). Please check your software version to ensure it supports the VP-4. To update your software to the latest version, please visit Decagons free software download site: www.decagon.com/support/downloads. The following firmware and software support the VP-4 sensor:

Em50, Em50R, Em50G Firmware version 2.19 or greater
ProCheck Firmware version 1.57 or greater
ECH2O Utility 1.74 or greater
DataTrac 3.11 or greater

To download data from the logger to your computer, you need to use the ECH2O Utility, DataTrac 3 or a terminal program on your computer.

5.2 Connecting to a Non-Decagon Logger

The VP-4 sensor may be purchased for use with non-Decagon data loggers. These sensors typically come configured with stripped and tinned (pigtail) lead wires for use with screw terminals. Refer to your distinct logger manual for details on wiring. Our Integrator's Guide gives detailed instructions on connecting the VP-4 sensor to non-Decagon loggers. Please visit www.decagon.com/support/literature to reference the complete Integrator's Guide.

5.3 Pigtail End Wiring

Figure 6: Pigtail Wiring

Connect the wires to the data logger as shown, with the supply wire (white) connected to the excitation, the digital out wire (red) to a

4 RH Sensor

RH Sensor Stability

Each VP-4 sensor is verified as accurate before leaving our facility. However, all capacitance RH sensors drift over long periods of exposure to environmental conditions. The VP-4 RH sensor typically drifts less than 0.5% RH per year. We recommend that VP-4 sensors be calibrated every one to two years under normal use conditions to ensure best possible accuracy. To have your VP-4 fully calibrated or calibrate contact support@decagon.com and ask about our calibration service. See Section 4.1 for more information about calibration.

The polymer RH sensing element in the VP-4 can also be "poisoned" by exposure to volatile organic compounds, solvents, and other chemicals. The effects of exposure to these chemicals can range from subtle loss of accuracy to catastrophic failure. If you suspect that your VP-4 has suffered chemical exposure or notice questionable RH measurements, you can check the sensor accuracy using known RH conditions.

A convenient method for generating known RH conditions is through the use of salt solutions. For an initial check, we recommend preparing a saturated NaCl solution, which has an equilibrium RH of 0.75 (75%). To prepare the salt solution, start with lab grade NaCl and mix in enough water that there is a thin layer of liquid water present over a thick slurry of NaCl crystals. The VP-4 sensor can either be sealed into a chamber or bell jar with the salt solution or the opening of the VP-4 can be sealed into a small chamber that contains the salt solution. Whatever method is used, it is critical that the VP-4 sensor be at the same temperature as the salt solution or large errors in the measured RH occur.

Salt solutions prepared at a wide range of RH are available from Decagon (see chart below). It is possible to prepare your own solutions using the mixing ratios shown below, but great care and precision are required to obtain accurate results. It is especially important that the salt used be pure and dry. Decagon salt solutions are specified accurate to within ±0.3% RH. As mentioned above, it is critical that the VP-4 sensor be at the same temperature as the salt solution or large errors in the measured RH occur.

Table 1: Salt Solutions

Equilibrium RH % Saturation	Salt	**Molality (m)** (mol salt/kg water)
25%	LiCl	13.41 m
50%	LiCl	8.57 m
76%	NaCl	6.00 m
92%	NaCl	2.33 m

4.1 RH Sensor Conditioning

If a VP-4 sensor has been exposed to solvents or other chemicals, the following conditioning procedure may bring the sensor back to the original calibration state. First, bake the sensor in dry heat at 100 to 105 °C for 10 hours. Then re-hydrate the sensors at 20 to 30 °C under ~75% RH for 12 hours. A 75% RH environment can be conveniently established by sealing the sensor in a headspace over saturated NaCl prepared as described above.

RH Sensor Calibration

Decagon offers a service to calibrate VP-4 sensors (contact Decagon Support at support@decagon.com for more information). Prior to shipping the RH sensors are verified over salt solutions at 25%, 50%, and 76% RH, to ensure that they are properly functioning.

We recommend that VP-4 sensors be re-calibrated every one to two years under normal use conditions to ensure best possible accuracy. For safety-critical or especially high accuracy applications, more frequent calibration is recommended. Additionally, if sensors have been poisoned by chemical exposure and conditioning fails to restore accurate measurements, the sensors should be sent back to Decagon for evaluation and possible calibration.

5 Connecting Sensors

We designed the VP-4 sensor to work most efficiently with Decagon Em50, Em50R, and Em50G data loggers, or the ProCheck handheld reader. The standard sensor with 3.5 mm stereo connector quickly connects to and is easily configured with a Decagon data logger or ProCheck.

The VP-4 sensor incorporates several features that also make it an excellent sensor for use with third party loggers. The sensor may be purchased with stripped and tinned wires (pigtail) for terminal connections. Visit our website at www.decagon.com/support/literature to get extensive directions on how to integrate the VP-4 sensor into third party loggers.

The VP-4 sensor comes standard with a five meter cable. Sensors may be purchased with custom cable lengths for an additional fee (on a per-meter fee basis). Decagon has tested its digital sensor successfully up to 1,000 meters (3,200 ft). This option eliminates the need for splicing the cable (a possible failure point).

5.1 Connecting to an Em50 Series Logger

We designed the VP-4 to work seamlessly with the Em50 series data loggers. Simply plug the 3.5 mm "stereo plug" connector into one of the five sensor ports on your Em50 series data logger.

Figure 5: 3.5 mm Stereo Plug Wiring

Once the VP-4 has been connected to your Em50 series data logger, configure the logger port for the VP-4 and set the measurement inter-